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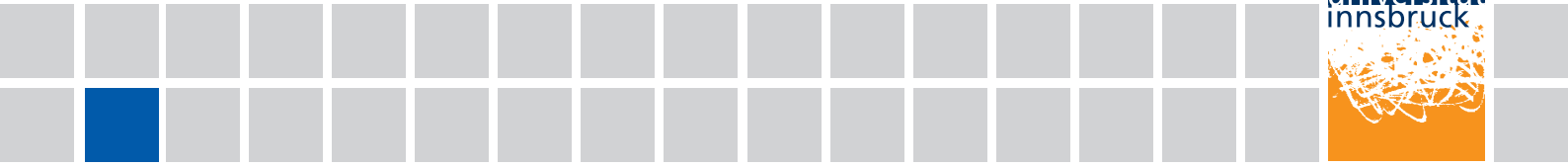


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PAN GEO
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Hugo Ortner

This book contains the abstracts of the GeoTIROL 2016 meeting. The abstracts are sorted from A to Z according to the authors names. In the abstracts sections title, authors, organizations, the presenting authors e-mail, keywords, the abstract, the session and the type of presentation are given. The star indicates the presenting author in the list of contributions and the abstracts.

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DIFFICULTIES IN USING THE DISTINCT ELEMENT METHOD (3DEC) FOR ANALYZING WEDGE- FAILURES

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Wedge stability analysis, Distinct element method, Numerical analysis

The current study investigates the stability of a jointed rock slope where wedge failure can be observed in big scale. Stability analysis is performed numerically and analytically.

Numerical analyses are conducted using three dimensional discrete element code (3DEC) and results are represented in terms of factor of safety (FOS) using shear strength reduction technique. Rock slope is modeled separately with deformable and rigid blocks and each model is analyzed considering the joint sets with different orientation and spacing. It is revealed that the built-in command of 3DEC, solve fos, should be used with caution when a huge wedge is analyzed using deformable blocks.

Analytical stability calculations are done based on the solution represented by Wyllie & Mah. It is discussed that when a huge jointed rock slope is investigated analytically how the results are changing considering different joint systems and it is also illustrated that how the most critical cases can be determined.

It is demonstrated that with numerical calculations different joint models can be assigned to the joint sets but on the other hand the results may be change drastically. As a result, it is important to select the suitable joint model that is in good agreement with the observations. It is illustrated that when the same wedge geometry is analyzed numerically and analytically, the same results is obtained if the coulomb slip model (no residual values) is used, otherwise the results compared to the analytical solution can be differ significantly. The difference between the results is more clear when the water content of the joint system also is taken into account. Finally, it is indicated that on the contrary to analytical methods, numerical methods are using deformable joints and are able to model influence of the joints stiffness which results a small rotation movements during the failure process.

THE KINK IN THE PERIADRIATIC FAULT SYSTEM SW OF THE TAUERN WINDOW

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Periadriatic Lineament, Meran-Mauls-Basement, Fartleis fault, Meran-Mauls fault, Pustertal-Gailtal fault

In the area of Sterzing (South Tyrol) the Periadriatic fault system (PFS) shows a distinctive kink changing its orientation and kinematics from a Top-to-SE thrust in the western area (Meran-Mauls fault, MMF) to an approximately W-E striking dextral strike-slip fault (Pustertal-Gailtal fault, PGF) east of the valley. For the present study the eastern End of the MMF was mapped out in order to better understand the evolution of the kink. The results are presented in form of maps and cross sections.

The Austroalpine basement in the hanging wall of the Meran-Mauls fault is represented by the Meran-Mauls-Basement (MMB) showing nearly no Alpine metamorphic overprint and belonging to the Drauzug-Gurktal Nappe system according to Schmid et al. (2004). The subdivision of the MMB in three (Pomella et al. 2012) or four units (Bargossi et al., 2010) is still under discussion; this study follows the three-units hypothesis. The uppermost St. Leonhard unit overthrusts the Hirzer unit with its (para)autochthonous Mesozoic cover (Pens unit according to Bargossi et al. 2010) and the Schenna unit. The latter represents the tectonically lowest part of the MMB and is present only further to the south near Meran. Along the Meran-Mauls fault a thin sliver of Paleogene intrusive rocks belonging to the so called "Tonalitic Lamellae" is cropping out. The Permian Brixen-Granodiorite in the foot wall of the Periadriatic Lineament represents the Southalpine basement and shows no metamorphic overprint.

Structural features observed in the study area are dominated by the dynamics of the Southalpine-Indenter. The dominant foliations as well as the major faults are dipping towards NW-NNW. The dip angle of the foliation varies between 30° and 50°, close to the MMF also 60°-70° are common. Two different sets of stretching lineations can be observed especially close to the MMF: an older approximately horizontal one and a younger dip-slip lineation. Close to the kink area the MMF is offset by minor ~N-S oriented faults.

MULTIDISCIPLINARY APPROACH TO EVALUATE CONNECTION BETWEEN PERMAFROST DEGRADATION AND DEEP SEATED GRAVITATIONAL SLIDE DEFORMATION ACTIVITY: A CASE STUDY FROM SCHNALSTAL, SOUTH TYROLEAN ALPS, ITALY

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integrated monitoring, permafrost, DSGSD, Rock Glacier, Geomorphological Survey

During the 20th century, Alpine permafrost has warmed by about 0.6°C due the global warming (Harris and Haeberli, 2003; Harris et al., 2003). Moreover, its degradation is playing an increasing influence in determining slope instabilities in high mountain areas (Smith, 1988; Zimmermann and Haeberli, 1989; Barsch, 1993; Rebetz et al., 1997), representing a major issue for landscape management (Agrawala, 2007; Lopez-Moreno et al., 2008). In this context, the Italy-Swiss “SloMove” Interreg Project promoted an experimental composite monitoring in the Italian Alps. This monitoring aimed to reconstruct the geomorphological processes, their state of activity and the role of permafrost in landslide activity. In this study, a multidisciplinary approach that integrates field survey, GPS measurements, time series analysis of PSInSAR data and GIS techniques has been adopted.

The investigated area extends just north of the touristic site of Maso Corto/Kurzras, (South Tyrol, Italy) and is located within the Oetztal-Stubai Crystalline Complex (OSCC).

Data elaborations show that an area of 2km² is affected by a Deep Seated Gravitational Slide (DSGSD) that involves the OSCC rocks throughout most part of the slope. Movement is east-southeastward and extremely slow but not laterally homogenous so that we identified zones with different activity rate: full activity, exhaustion phase and incipient phase. Rock glaciers in the study area do not appear to be linked to the DSGSD and can be considered as active with very low activity rate.

Main conclusions of this work are:

- Reconstruction of the DSGSD main predisposing factors.
- Reconstruction of the DSGSD activity rate and of the role of permafrost in its evolution.
- Reconstruction of the state of permafrost in the study area on the base of rock glaciers activity rate.
- Reconstruction of the correlation among the occurrence of rock glaciers, blocky slope deposits and DSGSD.

We consider that this method can be used to reconstruct the local permafrost conditions and to support the risk zonation in populated sites, in other mountain areas.

EINSATZ VON CLUSTERINGALGORITHMEN ZUR INTERPRETATION VON 3D SEISMISCHEN DATEN

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3D Seismik, Clustering, Seismische Attribute, Seismische Fazies, Geobody

Es gibt viele unterschiedliche Werkzeuge um 3D seismische Daten zu interpretieren. Die konventionelle Variante ist die manuelle Interpretation von seismischen Daten. Dies wird anhand von Horizonten und Störungen in Inline und Crossline Richtungen bzw. mit Unterstützung von seismischen Attributen in Z – Ebenen bzw. Horizontebenen durchgeführt. Eine alternative Variante wird in dieser Arbeit betrachtet. Basierend auf Erfahrungen in der Geophysik und von anderen Naturwissenschaften, wie Medizin bzw. Fernerkundung, werden Clustering Algorithmen untersucht, die die Möglichkeit bieten, gesamte seismische Fazies zu extrahieren. Für diese Extraktion werden unterschiedliche seismische Attribute benötigt, die eine Unterscheidung der einzelnen seismischen Fazies ermöglicht. Des Weiteren müssen Algorithmen eingesetzt werden die diese Fazies segmentieren. Welche Arten von Clustering Algorithmen einsetzbar sind, bzw. welche Vorteile und Nachteile damit verbunden sind, wird betrachtet.

GEOCHEMICAL CONSTRAINTS ON THE GIANT BIF-HOSTED HEMATITE SYSTEM IN THE HAMERSLEY PROVINCE, WESTERN AUSTRALIA

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high-grade iron ore, Paleoproterozoic Lake Superior BIF, mineral chemistry, Pb isotopes

Banded iron formations (BIF) host the most important iron resources at the global scale, both in terms of iron grade and tonnage. The ever-increasing amount of research data on BIF mainly focusses on the rocks' potentials as proxies for the interplay of hydrothermal, bacterial, and even glacial processes in the changing marine environments through (early) earth's history. However, post-sedimentary processes will modify the initially ~20-35% Fe-containing BIF to an economically sought-after high-grade (58-68% Fe) ore. The Hamersley Province in Western Australia hosts about one quarter of the global iron ore reserves and is therefore the most important high-grade iron ore province in the world, predominantly feeding the hungry steel markets of eastern Asia. The integration of new mineralogical, geochemical, stable and radiogenic isotopic, and geochronological data from high-grade hematite-goethite deposits and regional basement rocks in the Hamersley Province provides a new perspective to the genesis of a world-class BIF-hosted iron ore system. The prevailing supergene-metamorphic model for microplaty hematite ore is, with this new data, not an adequate explanation anymore for the formation of ore bodies. In contrary, with the new findings, it may be possible to unify the present and somewhat inconsistent set of hypogene-hydrothermal models to one model, which involves regionally active, polyphase ore formation under temporally significant involvement of either the Archean mafic basement, or carbonate-bearing rocks in the stratigraphic footwall.

IN-SITU MINOR AND TRACE ELEMENTS IN SULPHIDES OF THE ÖTZTAL-STUBAI UNITS: FIRST RESULTS FROM MXRF AND EPMA

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Germanium, Gallium, Indium, high-tech metals, alpine copper-lead-zink ore

Here we present first results of a regional survey study that focusses on the distribution of minor and trace metal in Cu-Zn-Pb ores of the metamorphic Ötztal-Stubai units. The sample set derives from various ore deposits and occurrences in the Austrian part of this tectonostratigraphic super-unit and the parageneses of the ores have been described earlier (Vavtar, 1998, Die Erzanreicherungen im Nordtiroler Stubai-, Ötztal-und Silvrettakristallin, Arch. f. Lagerst.forsch. Geol. B.-A., 9, pp. 103-153). The study is part of a large-scale survey initiated and financed by the Ministerium für Wissenschaft, Forschung und Wirtschaft and carried out by Montanuniversity Leoben, University Innsbruck and Geologische Bundesanstalt. The aim of the survey is to evaluate the economic potentials and the fundamental enrichment processes of High-Tech metals, such as Gallium, Germanium, Indium, in Austrian sulphide ore. In the reconnaissance study presented here, we employ element mapping and spot analyses by means of micro X-Ray fluorescence (μ XRF) and electron microprobe analyzing (EMPA). The combined approach allows us to investigate the ore mineral parageneses in whole samples and at the microscale, and also the quantification of elements down to ~50-100ppm.

DIE MONOTIS-DACTYLIOCERAS-BANK IN DER POSIDONIENSCHIEFER-FORMATION (TOARCIIUM, SÜDDEUTSCHLAND): KONDENSATIONSHORIZONT, TEMPESTIT ODER TSUNAMI-ABLAGERUNG?

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Unterer Jura, Schill, Beulenrippeln, Tempestit, Tsunami

Die Monotis-Dactylioceras-Bank ist eine auffällige Schillkalkbank, welche im späten 18. Jahrhundert in Bayern als Marmor genutzt wurde. Die Bank zeichnet sich durch linke Klappen der Muschel *Meleagrinea substriata* (von Münster) und lokale Anreicherungen des Ammoniten *Dactylioceras athleticum* (Simpson) aus, und wurde bisher als Produkt einer Regression oder eines Sturmereignisses betrachtet. In der Tat erscheinen drei verschiedene Interpretationen der Schalenanreicherung möglich: (i) Kondensationshorizont, (ii) Sturmablagerung oder (iii) Tsunami-Abtragung. Neue Beobachtungen, insbesondere von Beulenrippeln und Solmarken, weisen auf eine ereignisartige Entstehung der Bank hin. Während die meisten Beobachtungen mit einer Bildung durch ein Sturmereignis in Einklang stehen, deutet das einmalige Auftreten innerhalb des 4.4 Millionen Jahre langen Toarciums und die inverse Gradierung der Schalen auf eine mögliche Entstehung infolge eines Tsunamis hin. Die letztere Hypothese wird gestützt durch zeitgleiche Seismite im Gebiet der westlichen Tethys und Mikrit-Auspressungen in Schichten unterhalb der Monotis-Dactylioceras-Bank, welche eine Erdbeben-induzierte Sediment-Verflüssigung widerspiegeln könnten.

CONODONT BIOSTATIGRAPHY OF FAMENNIAN-TOURNAISIAN BOUNDARY DEPOSITS FROM EASTERN TAURIDES, TURKEY

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Taurides, conodonts, Famennian-Tournaisian boundary

The conodont fauna from the Devonian/Carboniferous Naltaş section in Eastern Taurides (Turkey) embracing mainly limestones, shales and siltstones have been studied mainly for biostratigraphic purposes. The section starts at the base with bioturbated limestones alternating with shales and is followed upwards by platy limestones, and continues with the alternations of bioturbated and platy limestones. Towards the upper part of the succession the alternations of limestone, shales and siltstones reappear again and the top of the section is capped by quartz arenitic sandstone. Several beds within the studied section in the Taurides are barren of conodonts, whereas others contain not very abundant, but all significant taxa. The upper Famennian of the succession is characterized by the presence of *Siphonodella praesulcata*, *Bispathodus aculeatus aculeatus*, *Bispathodus spinulicostatus*, *Bispathodus stabilis*, *Branmehla inornata*, *Polygnathodus inornatus*, *Polygnathus communis communis*, *Pseudopolygnathus primus*. Furthermore, the Lower Carboniferous, Tournaisian, is represented by the first appearance of *Siphonodella sulcata* and accompanying occurrences of *Polygnathus communis communis*, *Polygnathodus inornatus*, *Polygnathodus longiposticus*, *Pseudopolygnathodus primus* and *Siphonodella praesulcata*. Based on these conodont assemblages, the D/C boundary has been delineated by the first occurrence of *Siphonodella sulcata*, conventionally an index taxon for the basal part of the Tournaisian.

ORBITALLY PACED PHOSPHOGENESIS IN MEDITERRANEAN SHALLOW MARINE CARBONATES DURING THE MIDDLE MIOCENE MONTEREY EVENT

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Monterey event; natural gamma radiation; phosphogenesis; orbital forcing; rare earth elements

During the Oligo-Miocene major phases of phosphogenesis occurred in the Earth's oceans. Particularly in the Mediterranean region phosphate-rich sediments are well-known during this time. However, most phosphate-rich beds represent condensed or allochthonous hemipelagic deposits, formed by a complex interplay of physical and chemical enrichment processes. These underlying processes limit the application of these records for the study of a possible Milankovitch-scale climate control on Miocene phosphogenesis. In this regard the middle Miocene "Monterey event" is of particular interest, as it represents a documented phase of phosphogenesis coupled with a prominent carbon isotope excursion containing nine orbitally paced carbon isotope maxima (CM-events).

The Oligo-Miocene shallow marine Decontra section located on the Maiella Platform (central Apennines, Italy), is a widely continuous carbonate succession in a mostly outer to middle neritic setting. Of particular interest are the well-winnowed grain- to packstones of the middle Miocene Bryozoan Limestone, where occurrences of authigenic phosphate grains coincide with the Monterey event. These conditions allow to resolve the influence of orbital forcing on phosphogenesis, within a bio-, chemo- and cyclostratigraphically constrained stratigraphic model.

LA-ICP-MS analyses indicate a significant enrichment of Uranium in the studied authigenic phosphate grains compared to the surrounding carbonate sediment. The use of rare earth element proxies proved a valuable tool for the characterization of the studied phosphates in terms of their formation conditions and depositional history, indicating their predominantly authigenic origin. Coupled with the absence of any other major gamma-ray sources within the sediment this allowed the use of natural gamma radiation (GR) as a proxy for autochthonous phosphate content within the section.

Time series analysis of high-resolution GR data indicates a strong influence of the 405-kyr long-eccentricity cycle on natural gamma radiation in the Bryozoan Limestone. Our results thus link maxima in the GR record and phosphate content to orbitally paced increases in the burial of organic carbon during the CM-events of the "Monterey event". Thus, phosphogenesis during the middle Miocene in the Mediterranean was controlled by the 405-kyr-eccentricity and its influence on large-scale paleoproductivity patterns in the Mediterranean.

MULTIKOMPONENTENSYSYSTEM EINER ALPINEN KARSTQUELLE AM BEISPIEL DER SCHWARZEN TORREN, BLUNTAUTAL

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Karst, Grundwasser, Monitoring, Haselgebirge, Störung

Das Hagengebirge im Bundesland Salzburg ist als typisches Karstplateau ausgeprägt, eingebettet in den Salzburger und Berchtesgadener Kalkalpen. Es wird durch zwei wesentliche Scharen von Störungen durchzogen: Ein Nordost-Südwest streichendes System, dessen bedeutendster Vertreter als „Torschartenstörung“ bekannt ist, und einem orthogonal dazu stehenden NW-SE-streichenden Störungssystem. Am Nordrand des Gebirges prägt die +/- WSW-ENE verlaufende Torrener Joch Störungszone Landschaft und Hydrogeologie.

Das prinzipielle hydrogeologische Setting ist aus Färbeversuchen der 70er und 80er Jahre des letzten Jahrhunderts bekannt. Demgemäß erfolgt der Großteil des unterirdischen Abflusses gegen Nord in Richtung der zahlreichen Karstquellen des Bluntautales; die östlich der Torschartenstörung versickernden Wässer entwässern direkt in das tief eingeschnittene Salzachtal am Ostrand des Gebirges. Entlang der Torschartenstörung selbst dringen Wässer in größere Tiefen, werden durch Kontakt mit Haselgebirge mineralisiert und treten im südlichen Salzburger Becken als Quelle an der Oberfläche und direkt unterirdisch in den Porenaquifer aus.

Verschiedene hydrogeologische Dauermessprogramme zeigen, dass sich die Situation als deutlich komplexer darstellt als bisher angenommen. Für die wichtigste Quelle, die Schwarzen Torren, muss ein Multikomponentensystem aus mindestens vier unterschiedlichen Hauptzubringern angenommen werden. Die nur periodisch aktiven Weißen Torren stellen zweifellos einen Überlauf des Systems dar, unterscheiden sich aber in den Eigenschaften des Wassers von den Schwarzen Torren. In letzter Konsequenz hängt die Torrener Bärenhöhle direkt mit dem System zusammen. Von etwa 300 m vermuteten Wasserspiegelschwankungen konnten in dieser Höhle 230 m messtechnisch nachgewiesen und bestätigt werden. Die ebenfalls an einer SW-NE-streichenden Störung angelegte Höhle zeichnet sich durch eine vom Wasserstand abhängige Umkehr der Abflussrichtung und einen komplexen Zusammenhang mit dem Quellsystem der Weißen Torren aus. Praktisch alle Quellgruppen an der Nordflanke des Hagengebirges sind an SW-NE-streichende Störungen gebunden. Im Porenaquifer des Bluntautals kommt zu Trockenzeiten die Torren komplett zur Versickerung. Die wichtigste Sickerstelle befindet sich in Verlängerung einer SW-NE-streichenden Störung. Die Quellgruppe der Schwarzen Torren zeigt in Trockenzeiten (Abfluss ~ 100 l/s) elektrische Leitfähigkeiten von etwa 160 $\mu\text{S}/\text{cm}$. Bei Hochwasser (Abfluss $\gg 1 \text{ m}^3/\text{s}$) liegt die Leitfähigkeit bei 150 bis 190 $\mu\text{S}/\text{cm}$. Bei Mittelwasser (Abfluss $< 1 \text{ m}^3/\text{s}$) kann die Leitfähigkeit auf bis zu 1.200 $\mu\text{S}/\text{cm}$ steigen. Die Mineralisierung ist augenscheinlich auf alpines Haselgebirge (NaCl und CaSO_4) zurückzuführen.

RADIOLARIAN, BELEMNITES, RYNHONELLITES AND APTYCHI FROM THE CZAJAKOWA RADIOLARITE FORMATION IN THE STRATOTYPE SECTION, PIENINY KLIPPEN BELT, POLAND

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Radiolarians, Belemnites, Rynhonellites, Aptychi

This research focuses on biostratigraphy of the Czajakowa Radiolarite Formation (CRF) in its stratotype section located in the Polish part of the Pieniny Klippen Belt (PKB). The section comprises CRF deposits of the Niedzica succession located at the Czajakowa Skała Klippe situated in the Homole Gorge (Małe Pieniny Ridge). CRF consists of three members (Mb) as: the Kamionka Radiolarite Mb including stratigraphically lower package of red radiolarite; the Podmajerz Radiolarite Mb including green radiolarites and the Buwałd Radiolarite Mb including upper package of red radiolarite (Birkenmajer, 1977).

The fossils have been collected and analysed in 25 samples taken along the whole section outcropped. All members of CRF contain radiolarians as a main fossils. The identified radiolarian assemblage consist of 37 well preserved taxa. Cephalopod remnants as aptychi (Ammonoidea), belemnites and rynchonellites (Nautiloidea) are very rare. All remnants of cephalopods are present in three samples located in the Podmajerz Radiolarite Mb. The material studied is of varying quality, usually incomplete or fragmentary, probably as a result of diagenesis and strong tectonic distribution of the host rocks. Rostra of belemnites belong to species as *Hibolites jumaranis*, *Hibolites longiscissus*, *Hibolites budhaichus*. The studied aptychi are thick-shelled and represent adult stage. The *Lamellaptychus* and *Laevaptychus* have been recognized.

The age of the whole sequence has been stated based on radiolarians as early Oxfordian through early Kimmeridgian. Singular occurrences of aptychi (Ammonoidea) and belemnites indicated that green radiolarite of the Podmajerz radiolarite Member represent lower and middle Oxfordian.

Acknowledgements

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References

Birkenmajer, K. (1977). Jurassic and Cretaceous stratigraphic unit of the Pieniny Klippen Belt, Carpathians, Poland. *Studia Geologica Polonica*, 45, 1–178.

KINEMATIC EVOLUTION OF THE VELEBIT MOUNTAINS – A CASE STUDY FROM THE CROATIAN SEGMENT OF THE DINARIDES FOLD-AND-THRUST BELT VALIDATED BY KINEMATIC FORWARD MODELS

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Dinarides, Fold-and-Thrust Belt, Kinematic Modelling

The circum-Mediterranean orogens record a long-lasting history of convergence between the European and the African plates. The Adriatic microplate played a key role in the formation of the fold-and-thrust belt of the Dinarides. This NW-SE-trending mountain belt resulted from the collision between the Adriatic and European plates in the Late Cretaceous and the subsequent post-collisional deformation. The amount of convergence between Adria and Europe is a matter of debate. To resolve this, we intend balancing and restoring several geological cross-sections across the northern external Dinarides.

In the external Dinarides of Croatia, the Velebit Mountains, located at the Adriatic coast, form the most prominent topographic elevation reaching c. 1700 m. This range forms a large-scale anticline. However, in detail neither the underlying structures nor the kinematic evolution of this mountain range are properly understood. The Velebit Mountains consist mainly of early Paleogene to Mesozoic carbonate platform rocks, which are overlain by a most likely syn-deformational carbonate breccia of (disputed) Eocene to early Oligocene age. The oldest units exposed are Permian clastic rocks in the center of the Velebit Mountains, which are fault-bounded against younger carbonate platform deposits to the east. In earlier cross-sections, this fault was interpreted as a large-scale NE dipping normal fault with a vertical offset of 4 km. However, this fault, and with it the earlier cross-section, is problematic to restore.

In order to find the geologically most viable kinematic evolution model, different forward- and backward-models of 2D-cross-sections along-strike of the external Dinarides were generated. The lack of available underground data in the study area subjects our models to some ambiguity. Despite this, two different deformation scenarios can explain the observed structures in the Velebit. In the first set of models, a polyphase evolution of the Velebit was assumed, involving either 1a) extension post-dating contraction or 1b) extension pre-dating contraction. In a second model, a single-phase contractional deformation scenario, involving 2a) angular shearing leading to progressive backlimb-backthrust-rotation or 2b) a single large-scale forelimb backthrust, was assumed. Preliminary results show that the single-phase (backthrust) scenario fits better the regional perspective due to the absence of other major extensional structures.

SPELEOLOGICAL EVIDENCES OF CURRENT TECTONIC ACTIVITY ALONG MAJOR FAULT SYSTEMS OF THE EASTERN ALPS

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Eastern Alps, active tectonics, fault, seismicity

Caves in the Eastern Alps were investigated for evidences of active tectonics related to the Salzach-Ennstal-Mariazell-Puchberg (SEMP), Mur-Mürz, Periadriatic, Lavanttal, and Vienna Basin Transform faults within the framework of the "Speleotect" project of the Austrian Science Fund (FWF P25884-N29). A branch of the sinistral SEMP cut through the Hirschgruben cave on Mt. Hochschwab and caused sheared stalagmites, striated and faulted flowstone with an offset of at least 20 cm between 118 ka (end of the Last Interglacial) and 9 ka BP (early Holocene). Similarly, preliminary dating of a normal fault in nearby Speikboden Cave indicates an activity between 364 and 51 ka BP. Another cave in that area, Potential Shaft also revealed an E-W (SEMP sub-parallel) active oblique reverse fault with an offset of about 1.3 cm, but the radiometric dating was not successful yet as the flowstone was too old or contained too much detritus. At the eastern termination of the SEMP fault in Emmerberg Cave near the Vienna Basin, a parallel sinistral fault with 4 cm of offset showed an activity between 77.2 and 136.2 ka BP. So far the most spectacular examples of faulted cave galleries and deformed flowstone were found in Wartburg Cave (a part of the Obir Caves) located few kilometers north of the Periadriatic Fault within a broader zone of transpression. Deformed flowstones along a NNE-SSW striking fault with a documented left-lateral 38 cm offset showed an activity between 7 and 45 ka BP.

Seven automated 3D crack-gauges TM71 were installed at active faults in six karst caves throughout the Eastern Alps. Several micro-displacement events have been registered; these events sometimes revealed the same mechanisms as the geologically documented kinematics of the particular active faults, but in some cases performed completely opposite kinematics. Compared to regional seismic activity (data provided by ZAMG), these events occurred in seismically rather quiet days, however, usually about 1 – 10 days prior to local earthquakes of different magnitudes (varying between ML 0.1 and 3.3). These events could probably be related to regional elastic strain accumulation, relaxation and further gravitational mass movements at some sites.

SILURIAN ANOXIC EVENTS AT THE CELLON SECTION (AUSTRIA) THROUGH AN ICHNOFABRIC EYE

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ichnology, ichnofabric, anoxic events, Lau event, Chondrites

The Ordovician and Silurian periods are characterized by major biotic and geochemical events, among which large carbon isotope excursions associated with mass extinctions and anoxia. The Cellon section (Austria) is an ideal case study to understand the dynamics of these events. In fact, it represents not only a reference section for the Silurian of the world, but also it provides an almost continuous sedimentary record ranging from the Upper Ordovician to the Lower Devonian.

The goal of this study is to understand the relationship between the mentioned biotic and geochemical events and organism-substrate interactions. To this aim, the ichnofabric approach – considering the aspects of sediment texture imparted by biogenic activity – is applied to the Cellon Section. Results show three oxygen-related ichnofabrics:

The *Thalassinoides* ichnofabric is characterized by intense bioturbation (bioturbation index 5-6) and the dominant presence of *Thalassinoides* burrows. Because of the high bioturbation index, this ichnofabric is interpreted to reflect oxygenated condition of bottom waters.

The Chondrites ichnofabric is characterized by low bioturbation (BI 0-1) and the monoichnospecific presence of Chondrites. Because of the chemosymbiotic, sulphide-mining strategy of the Chondrites producers, this ichnofabric is interpreted to represent dysoxic conditions.

The unbioturbated ichnofabric is characterized by laminated, unbioturbated (BI 0) fabrics. The absence of benthic activity suggest widespread anoxic conditions.

Data interpretation suggest that the onset of anoxic events are characterized by a relatively abrupt transition from sediment-feeding strategies (*Thalassinoides* ichnofabric) to chemosymbiotic ones (Chondrites).

ASSESSING FRICTION COEFFICIENTS IN FORESTS FOR ROCKFALL PROPAGATION MODELLING

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Rockfall, GIS-based modelling, friction, forest parameters

Within the frame of the project "Indicative Natural Hazard Maps in the Province of Styria" a GIS-based approach has been analysed aiming at the identification of areas which are potentially endangered by rockfall, considering the protective effect of forest. The study area is the Province of Styria, located in the southeastern part of Austria and covering approx. 16.400 km².

Potential source areas are identified using a slope angle threshold derived from ALS data. The mean block masses of each geotechnical unit, representing the most probable event, were classified according to field observations, resulting in three representative volume classes.

The run-out distances and propagation velocities are calculated on the basis of energy conservation of a mass that is considered to move over a slope surface as defined by Scheidegger (1975). In this approach, a friction coefficient is responsible for energy loss. For each cell in the falltrack, the velocity of the falling rock is calculated. The method is implemented as a random walk in conjunction with a Monte Carlo approach (Wichmann 2006).

Forest cover characteristics were taken into account for the estimation of the friction coefficient. This step was based on a detailed characterisation of forest parameters on basis of ALS and satellite data. An automatic segmentation to forestal units was performed resulting in a GIS database with a total of 6.9 million polygons. The following forest parameters were selected: (a) treetop number per unit area, (b) crown coverage, (c) height of upper layer and (d) vertical forest structure.

Friction coefficients were adjusted by calibrating modelled propagation areas with GPS measurements of rock fall boulders. This was done in an iterative process for each volume class in several representative test sites. Due to the fact that small rocks retard more easily than bigger rocks, for each volume class different friction coefficients were defined. These have been assigned to each of the forestal unit polygons. The model calibration procedure and model results are presented in the current contribution.

CALCAREOUS PLANKTON FLUXES IN THE UPWELLING AREA OFF NW-AFRICA – DYNAMICS AND TRENDS DEPICTED FROM SEDIMENT TRAPS OF THE PAST 20 YEARS

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Calcareous plankton fluxes were determined from four time intervals (1989/90, 1998/99, 2002/03, and 2008/09) of mooring site CB off Cape Blanc (21°15'N 20°45'W). We tried to analyze only flux records, which were not influenced by any major climatic oscillation such as NAO, ENSO, or AMO. The mooring site is located within the filamentous mixing area of one of the prominent Eastern Boundary Upwelling Systems (EBUS). Due to a low supply of dissolved silicate from subsurface waters, the surface ocean is characterized by predominantly carbonate secreting primary producers, such as coccolithophores, planktic foraminifers, and pteropods. The sediment trap time series data collected at 3600 m water depth were used to reveal seasonal and inter-annual changes in species fluxes and assemblage composition, but also long-term trends in carbonate fluxes.

The comparison of the four selected time intervals revealed variable flux patterns, which reflect the prevailing hydrographic conditions of this dynamic offshore upwelling region. Seasonal variations in species fluxes and/or assemblage compositions occurred in all the calcareous groups, whereas inter-annual fluctuations were less obvious: all groups showed a surprisingly constant flux pattern, with only little variations. Flux of coccoliths was generally highest during winter/spring and in early fall. Highest fluxes of planktic foraminifers were observed during summer (species preferring cooler water conditions) and winter (warm water species). Pteropods' flux shows the most constant pattern over the years with distinct maxima in late summer. No long-term trend of any carbonate producer was observed. The organism fluxes as well as the general composition of the assemblages have not changed and the calculated carbonate fluxes of the major plankton groups - even aragonitic pteropods were observed in rather constant numbers - give no evidence of an increasing influence of ocean acidification or any ecosystem change.

ABRASIVITY OF SOIL AND ROCK AND ITS EFFECT ON SPECIAL GEOTECHNICAL WORKS

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Engineering Geology, Abrasivity, Special Geotechnical Works, Drilling Performance, Wear and Tear

The first step of the execution of bored piles, diaphragm or cut-off walls is always the excavation process which may be associated with drilling, grabbing or cutting abrasive soil or rock. To allow serious project tendering, not only ground conditions like grain size distribution and packing density of granular soil, or like strength and fracturing of rock must be given. In addition, the abrasivity of the material must be known, especially if the drilling or cutting resistance leads to slow excavation rates. This is due to the interaction between wear & tear, and performance. Higher abrasivity will not only cause higher wear and tear but also will result in extra-ordinary slower excavation rates due to less effective tools. However, with a bad performance, the effective wear & tear might be much worse than one would expect from only a slightly higher abrasivity of the drilled soil. Larger grains will contribute to higher wear and tear as well as more angular or even crushed material. The influences are well known in general and can be taken into account for comparative analyses of production performance and associated wear & tear. BAUER Spezialtiefbau uses a prediction tool which reflects the mayor ground conditions, including the abrasivity, determined by either LCPC, Cerchar or equivalent quartz content, then ranked into BAUER w&t classes, and calibrated by considering the real productuion process in order to relate the changes in soil or rock paramters on the net productivity only. The final result from the prognosis, to assist the tender engineer, includes the subsequent gross productivity and allover wear & tear. Case studies will be presented and discussed in the context of the new ATV DIN "General technical specifications in construction contracts" where the abrasivity is re-introduced as one of the compulsory geotechnical parameters to be given for planning of drilling works (ATV DIN 18301).

NEW SCIENCE IN THE INTERNATIONAL OCEAN DISCOVERY PROGRAM (IODP): PERSPECTIVES, AND ACHIEVEMENTS TO DATE

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Ocean Drilling, IODP, Science Plan, ECORD, Review

The year 2013 has seen the launch of the present ten-year phase of ocean exploration by scientific drilling through the IODP. Unlike earlier programs, the degree of integration in science operations is lower, with three independently financed platform providers, one of them being the ECORD (European Consortium for Ocean Research Drilling) with its MSP (Mission-Specific Platform) operations. ECORD currently has sixteen European contributing member countries plus Canada and Israel.

The strong link within IODP is rooted exclusively in the science laid down in a ten-year plan (2013-2023), to implement a unique proposal-driven program centered around four big topics. These are: (1) Climate and Ocean, (2) Earth in Motion, (3) Earth Connections and (4) the Deep Biosphere. While the first two reflect evolutions of long-standing research efforts to understand surface and deep processes in the Earth System from an oceanic perspective, Topics 3 and 4 are at least partly explorative efforts to chart and overcome present frontiers of knowledge in Solid Earth Science.

In the period 2013 to 2016 IODP expeditions or series of expeditions have concentrated on the Pacific and Indian Oceans, to better understand climate history, especially monsoon evolution, and subduction processes that pose major geological hazards by earthquakes and associated tsunamis. Recent ECORD-led MSP expeditions focused on alteration processes and their bio- and geochemical signatures and budgets in the oceanic crust (Exp. 357, Atlantis Massif, Atlantic Ocean), and the dynamics of large asteroid impact cratering (Exp. 364, Chicxulub Impact Crater, offshore Mexico), a rare geological super-hazard.

This contribution explains the IODP program itself and reviews recent research highlights and scientific advances. It discusses the European role as an operator in environments where conventional drillships cannot work efficiently. An outlook will be given regarding the activities towards the third decade of our century.

PALEOGENE AND NEOGENE KINEMATICS OF THE ALPINE-CARPATHIAN FOLD-THRUST BELT AT THE ALPINE-CARPATHIAN TRANSITION

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Alps, Carpathians, Paleogene, Neogene, kinematics

In our study we analyze the kinematics of a ~300 km long segment of the Alpine-Carpathian orogen using novel outcrop data and regional seismic profiles from the West Carpathians to unravel the kinematics and timing of Eocene to Late Miocene deformation of the fold-thrust belt. Comparison with data from the Eastern Alps and the Vienna Basin lead to an updated tectonic model for the Paleogene and Neogene of the Alpine-Carpathian transition, which includes the following three stages:

(1) Eocene to Early Oligocene NNW-directed foreland-propagating thrusting. Thrusts are directed perpendicular to the strike of the European foreland in Outer West Carpathians (OWC) and sub-parallel to the thrusts observed in the Eastern Alps west of the Vienna Basin. (2) Continued Late Oligocene to Early Miocene NNW-directed foreland-propagating thrusting simultaneous with sinistral strike-slip reactivation of former nappe boundaries in the hinterland of the active thrusts. This deformation corresponds to the early stage of eastward lateral extrusion of the Eastern Alps. The ENE-striking sinistral faults in the OWC are kinematical equivalents of the SEMP fault system in the Eastern Alps, which was active at the same time. The latest stage of thrusting is characterized by SSE-directed out-of-sequence thrusts in the hinterland of the OWC and the reactivation of Variscan basement thrusts in the European foreland as SSE-directed backthrusts.

(3) Formation of (N)NE-striking sinistral strike-slip faults which are kinematically linked to NE-directed out-of-sequence thrusts post-dating NNW-directed thrusting. The sinistral faults formed coeval with the opening of the Vienna pull-apart basin in the Middle to Late Miocene stage of lateral extrusion.

Unlike proposed in previous studies the West Carpathians do not appear to be affected by Oligocene to Early Miocene crustal-scale wrenching in the Pieniny Klippen Belt. Our data show that the deformation of the Klippen Belt is fully in line with the Eocene to Late Miocene tectonic evolution reconstructed for the OWC.

STRUCTURAL GEOLOGY AND TOPOGRAPHIC MAPPING OF KELANTAN RIVER BASIN USING PALSAR-2 REMOTE SENSING DATA FOR HIGH RISK AREA DELINEATION

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ALOS-2; PALSAR-2; Geological origin hazards; Tropical environments; Peninsular Malaysia

Identification of high potential risk and susceptible zones for natural hazards of geological origin is one of the most important applications of advanced remote sensing technology in tropical environments. Yearly, several landslides occur during heavy monsoon rainfall in Kelantan river basin, Peninsular Malaysia, which are obviously connected to geological structures and topographical features of the region. In this study, the recently launched Phased Array type L-band Synthetic Aperture Radar-2 (PALSAR-2) onboard the Advanced Land Observing Satellite-2 (ALOS-2), remote sensing data were used to map geologic structural and topographical features in the Kelantan river basin for identification of high potential risk and susceptible zones for landslides and flooding areas. A ScanSAR and two fine mode dual polarization level 3.1 images cover Kelantan state were processed for comprehensive analysis of major geological structures and detailed characterizations of lineaments, drainage patterns and lithology at both regional and district scales. Red-Green-Blue (RGB) colour-composite was applied to different polarization channels of PALSAR-2 data to extract variety of geological information. Directional convolution filters were applied to the data for identifying linear features in particular directions and edge enhancement in the spatial domain. The analysis of the data indicate that many of flooded areas were associated with high potential risk zones for hydro-geological hazards such as wetlands, urban areas, floodplain scroll, meander bend, dendritic and sub-dendritic drainage patterns, which are located in flat topography regions. Numerous landslide points were located in rectangular drainage system that associated with topographic slope of metamorphic and quaternary rock units. Geo-hazard mitigation programmes could be conducted in the landslide recurrence regions and flooded areas for reducing natural catastrophes leading to loss of financial investments and death in the Kelantan river basin.

EU-PROJECT “CHEAP-GSHPs”– REDUCED INSTALLATION COSTS FOR GEOTHERMAL HEATING BY USING NEW DEVELOPED HEAT BASKETS AND DRILLING TECHNIQUES

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new heat baskets, cost reduction, improved drilling technique

Nowadays the energy price fluctuations and the economic crisis are jeopardizing the development and diffusion of renewable technologies and sources. With the aim of both reduce the overall costs of shallow geothermal systems and improve their installation safety, an European project has took place recently, under the Horizon 2020 EU Framework Programme for Research and Innovation. The acronym of this project is Cheap-GSHPs, meaning "cheap and efficient application of reliable ground source heat exchangers and pumps"; the CHEAP-GSHPs project involves 17 partners among 9 European countries such Belgium, France, Germany, Greece, Ireland, Italy, Romania, Spain, Switzerland. In order to achieve the planned targets, an holistic approach is adopted, where all involved elements that take part of shallow geothermal activities are here integrated.

In order to reduce the drilling specific costs of geothermal installations two major developments should be generated within this project. On one hand the geometry of a state-of-the-art, heat basket type ground source heat exchanger (GSHE) is modified drastically to receive a better performance of the geothermal installation. On the other hand an innovative drilling technique, called "easy drill" is developed further in order to drill larger borehole diameter which are finally combined with the new heat basket type GSHE. This combination of GSHE and drilling technique is tested technically and economically on the drilling site. The aim of these research activities is the cost reduction of geothermal installations with the main focus on the drilling cost reduction.

THE ULTRAMAFIC BODY OF NAUDERS – PART OF THE DEEPER MANTLE OF THE TASNA OCEAN-CONTINENT-TRANSITION

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Ocean-continent transition, Iherzolite, Engadine Window, geochemistry, petrology

Ultramafic complexes of Mesozoic within the Penninic Windows of the Eastern Alps mostly are related to ophiolitic fragments representing former oceanic crust. All of these mantle fragments are highly serpentinized and show in the Eastern Alps harzburgitic composition. Only few exceptions are composed of rather undepleted Iherzolitic rocks. (e.g. in the zone of Matrei south of the Tauern window and in the north in the Lower Austroalpine Reckner complex). Another Iherzolite complex occurs SW Nauders and is located between greenschists and sediments to the north, both related to the North Penninic zone of Pfunds, and continental rocks of the Middle Penninic Tasna nappe to the south, indicating a Middle Penninic position as is demonstrated by geological mapping (BERTLE, 2004). Locally, small gabbroic intrusions and synfoliation pyroxenitic layers and more rarely with preserved volcanic texture are connected to the Iherzolites. The coarse-grained Iherzolite of Nauders carries a well-preserved primary assemblage of olivine ($Fo_{0.90}$), clinopyroxene ($X_{Mg} = 0.90$ to 0.91 , with up to 2 wt% Na_2O and 6–7 wt% Al_2O_3), orthopyroxene ($En_{0.89-0.90}$, with 0.4–0.6 wt% CaO and 4–5 wt% Al_2O_3) and a green spinel (with a $Cr\# = 0.065$ and a $X_{Mg} = 0.796$). This assemblage is partly replaced by pure diopside (rimming clinopyroxene), minor amphibole (Na- and Ti-rich pargasite), serpentine and carbonate as well as brown spinel. Chondrite-normalized REE patterns of the ultramafic rock of Nauders are rather flat with slightly depleted LREE (MELCHER et al., 2002), similar to other Iherzolitic samples of the Mesozoic units. Small gabbroic bodies and rare cross-cutting basaltic dikes are associated with the ultramafic rocks. Based on their less mobile trace element (HFSE) geochemistry, they more likely represent within-plate magmas than typical mid-ocean ridge basalts. Based on the differences in preservation and geological setting, and in the geochemical composition of associated mafic rocks the ultramafic complex of Nauders might better correspond to tectonic setting such as, e.g. the Valmalenco complex (MÜNTENER et al., 2000, MANATSCHAL et al., 2006), which is currently interpreted as a fragment of a pre-oceanic subcontinental mantle of the Briançonnais microplate, emplaced and denuded during late Jurassic to early Cretaceous time (BERTLE, 2004).

RECONSTRUCTION OF DUST INPUT INTO THE EASTERN MEDITERRANEAN SEA USING END MEMBER MODELLING

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end member modelling, Eastern Mediterranean Sea, Saharan dust, African Humid Periods

The Eastern Mediterranean Sea (EMS) is a key area for understanding the climate dynamics of the late Quaternary. It is influenced by sedimentological signals from Northern Africa as well as from the European borderlands and can therefore provide information about the climate dynamics in these regions. This study reconstructs the dust input from the Sahara into the EMS and contributes to the ongoing debate on the dynamics of the African Humid Periods (AHPs) that are coupled with the formation of organic-rich sediment layers (sapropels).

We present a high-resolution dataset (0.5 cm spacing) of sediment core GeoTü SL71, recovered SW of Crete, spanning the last 180 ka. We analysed the clay mineral composition using XRD and the grain size distribution of the silt fraction using a laser particle analyser. Main and trace elements were detected by XRF scanning. The different datasets were fed into an endmember modelling program. In each dataset a Saharan dust endmember (SDEM) could be identified.

The SDEM in the clay mineral data is characterized by a high amount of kaolinite and palygorskite. It shows a strong decrease of the loading at the beginning and an abrupt and drastic increase at the end of the AHPs. Afterwards it gradually decreases to a base level.

The SDEM in the XRF data is characterized by high concentrations of Si, K, Ti, and Zr, shows an abrupt decrease at the beginning and an abrupt increase back to the previous level at the end of the AHPs. Unlike the clay mineral SDEM, it shows relatively constant loadings between the AHPs. The SDEM in the silt grain size data is bimodal with modes of 16 μm and 40 μm . It shows a decrease in the loading at the beginning of the AHPs and an abrupt rise to a higher level after their termination. The loading shows higher fluctuation than the XRF and clay mineral SDEM.

The temporal patterns of all three SDEMs display a reduction of Saharan dust input to the EMS during the AHPs. End member modelling proved to be a valuable tool for identifying source-related signals combining different sedimentological and geochemical datasets.

STRUCTURE OF THE UPPER MANTLE BENEATH THE ALPS AND APENNINES AS SEEN BY RECEIVER FUNCTIONS

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Alps, Apennines, Upper Mantle, Deformation, Anisotropy

The boundary between the African and Eurasian plates in the Mediterranean area consists of a broad zone of deformation, due to the convergence between the two plates. Since late Cretaceous the Adriatic microplate, acting as a promontory of Africa, has deeply indented Europe, resulting in the Alpine orogeny. Within the convergence of the large (Europe and Africa) plates, the Adriatic microplate moves independently, and rotates counterclockwise with respect to stable Europe, controlling the strain pattern along its boundaries. The Apennines nucleated along the retro-belt of the Alps, moving southward, where oceanic or thinned continental lithosphere was present.

The Alps show a double-vergent growth, with the involvement of large volumes of basement and the exhumation of metamorphic rocks belonging to the European, oceanic and African realms. The Apennines describe an arc from northwestern Italy, down throughout the Italian peninsula, continuing to the southwest into Sicily and merging into the Maghrebides of northwestern Africa. Alps and Apennines developed along opposite subductions, in an area characterized by strong variability of tectonic signatures.

In order to shed light on these complex tectonic structures, we aim unraveling both the isotropic and anisotropic properties of the Alpine and Apennines mantle; teleseismic observations recorded at permanent and temporary seismic stations have been employed to produce images of the lithospheric discontinuities with tens of kilometers lateral resolution. We illustrate the feasibility of the lithosphere-asthenosphere boundary detection on a regional scale through P- and S-receiver functions, and detect the occurrence of deeper seismic discontinuities due both to positive and negative seismic velocity jumps.

AUF DEM WEG ZUR „GLEICHEN SPRACHE“ IM QUARTÄR UND BEI MASSENBEWEGUNGEN.

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Quartär, Massenbewegungen, Standards

Die „gleiche Sprache“ im Sinne von gleich verstandenen und ebenso verwendeten Begriffen ist in den Geowissenschaften von essenzieller Bedeutung für die Erhebung, Auswertung und Darstellung von Geodaten. Die Geologische Bundesanstalt (GBA), als zentrale Einrichtung für Wissensmanagement in den Geowissenschaften in Österreich, sieht sich daher verpflichtet, die dafür benötigten Standards zu definieren. Aufbauend auf der Generallegende für die pleistozänen und holozänen Sedimente des Periglazialraumes (Krenmayr et al. 2012) und auf die bisher in den GBA-Karten verwendeten Begriffe wurde eine Nomenklatur für Einheiten und Ablagerungsformen des Quartärs inklusive Massenbewegungen entwickelt. Diese werden in kartierbare Sedimentkörper (lithogenetische Einheiten) und oberflächliche Reliefformen (geomorphologische Einheiten) unter grundsätzlicher Berücksichtigung der etablierten prozessorientierten Klassifikation eingeteilt. Die Begriffe sind entsprechend thematisch-prozessorientiert zusammengefasst und folgen einer einfachen hierarchischen Ordnung. Durch die Hierarchisierung können die Begriffe in Aufnahmemaßstäben (1:10.000) bis hin zu Darstellungsmaßstäben (1:25.000, 1:50.000, 1:200.000) sowie auch in der Punktdatenaufnahme verwendet werden. Derzeit wird dieser neue Standard aktiv in der geologischen Landesaufnahme und bei der Finalisierung von neuen Kartenblättern (1:25.000 und 1:50.000) verwendet und seine Anwendbarkeit in der Praxis evaluiert. An der Fertigstellung der Begriffsdefinitionen inkl. Literaturzitate und der Übernahme beziehungsweise dem Abgleich der Begriffe mit dem GBA-Thesaurus wird gearbeitet. Bei der Präsentation auf der GeoTirol 2016 geben wir einen Überblick über den aktuellen Stand und diskutieren die zugrundeliegenden Konzepte für die Einteilung der quartären Ablagerungen, der geomorphologischen Einheiten und der Massenbewegungen.

Literatur:

Krenmayr, H.; Coric, S.; Gebhardt, H.; Iglseder, C.; Linner, M.; Mandl, G.; Reitner, J.; Rockenschaub, M.; Roetzel, R. & Rupp, C. (2012): Generallegende der pleistozänen bis holozänen Sedimente und Verwitterungsprodukte des Periglazialraumes auf den geologischen Spezialkarten (1:50.000, 1:25.000) der Geologischen Bundesanstalt - In: Jahrbuch der Geologischen Bundesanstalt 152. 57-66, Wien.

IDENTIFICATION OF FACTORS CONTROLLING GROUNDWATER LEVELS IN A CHANGING ENVIRONMENT

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Groundwater drought, drought indices, climate change, stream-aquifer interaction

Climate change is expected to alter the hydrological cycle and thus the amount and timing of groundwater recharge, storage, and discharge. In particular, the interannual variability of the climate in Europe is expected to increase, suggesting more frequent and severe extreme events such as droughts and floods. To identify and analyse the occurrence of extreme events in precipitation the Standard Precipitation Index SPI (McKee et al., 1993) has been used for more than 20 years. Only recently a corresponding Standardized Groundwater level Index SGI (Bloomfield and Marchant, 2013) has been proposed for identifying groundwater drought, but the relationship between SPI and SGI is not well understood yet and appears to be site specific. This work aims to identify factors controlling SGI values in different types of alluvial aquifers using the example of the Mur valley (Austria). As river stage fluctuations potentially exert influence on groundwater levels in nearby wells, standardized river stages are considered in addition to SPI and SGI. Within a narrow part of the valley, most SGI values indeed are found to be highly correlated with river stages, whereas the correlation of SGI with SPI is weak. Yet, groundwater levels within an inneralpine basin that are little correlated with river stages still show similar or only slightly higher correlation with SPI. In contrast, SGI is highly correlated with SPI within the foreland basin. In addition to these spatial differences within the valley, remarkable temporal changes are found at each of the sites. It appears that changes in the system within the last decade tend to favour higher correlations of SGI with SPI than those found for previous decades. Hence, the correlation of SGI and SPI appears to depend on both the hydrogeological setting and on changing environmental conditions.

References

- Bloomfield, J. P., Marchant, B. P. (2013): Analysis of groundwater drought building on the standardised precipitation index approach. *Hydrol. Earth Syst. Sci.*, 17, 4769-4787.
- McKee, T.B., Doesken, N.J., Kleist, J., (1993): The Relationship of Drought Frequency and Duration to Time Scales. *Proceedings of the 8th Conference on Applied Climatology*, Boston, USA, American Meteorological Society Boston MA, 179–184.

A COUPLED MODELING APPROACH TO ASSESS THE SURFACE WATER - GROUND WATER INTERACTIONS FOR THE MIDDLE ELBE ON REGIONAL SCALE

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Elbe, surface water-ground water interactions, coupled modeling, MODFLOW, SOBEK

The region of the Middle Elbe is located in Saxony-Anhalt, Germany, and represents a formerly glaciated landscape. Glacial landscapes are typically heterogeneous in terms of sediment composition and their lateral distribution. These heterogeneities cause strong variations in the ground water flow patterns and may affect the interactions between the surface water and the ground water on local scale.

The Elbe river is one of the most important waterways in Germany. To sustainably use the Elbe river, it is indispensable to gain a profound understanding of the flow processes and to assess the relations between the river and its environment.

In our study, we investigated the exchange processes between the Elbe river and the underlying aquifer on a regional scale. Therefore, the river reach between Wittenberg and Aken and its floodplain served as our study area. We developed a coupled surface water and ground water modeling approach using the model codes of MODFLOW and SOBEK based on data provided by the BfG.

Our results demonstrate that it is possible to assess numerically the exchange processes between the Elbe river and the coupled ground water system. Though the local geological heterogeneities are expected to affect the ground water flow patterns, the regional-scale modeling approach reproduces the exchange processes between the Elbe river and the ground water system reasonably well.

The results show that the ground water dynamics near the Elbe river are strongly coupled to the river discharge whereas the ground water dynamics in the floodplain are mostly decoupled from the river hydraulics. Our results further indicate that river leakage controls the ground water recharge in the riparian area of the Elbe river.

Our modeling approach represents a convenient option for decision-making purposes, such as the planning of water management systems or the assessment of transport processes, and may provide boundary conditions for models on smaller scale or transport models. In addition, the modeling approach constitutes a powerful tool which can also be used to investigate flow dynamics in other model areas with reduced data availability.

GROWTH DYNAMICS OF GEOTHERMAL CARBONATE SCALINGS: FORENSIC STUDIES BASED ON HIGH-RESOLUTION MINERALOGICAL & GEOCHEMICAL ANALYSES

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geothermal scaling, carbonate precipitates, thermal waters, Pannonian Basin, environmental archive

Mineral precipitates (scaling) arising from thermal waters are widespread due to high dissolved solid and gas contents at elevated temperature and pressure in deep aquifers. Reduction of inner diameters or complete clogging of wells, downhole pumps, transport pipes and heat exchangers by carbonate, sulfate or silica minerals constitutes a major problem in geothermal heat- and electric power production. A detailed understanding of the spatiotemporally variable scaling progress depending on natural (hydrochemistry) and man-made (production-specific) environmental conditions is attempted.

Carbonate scalings were recovered from geothermal facilities distributed over the Pannonian Basin. Samples of up to 10 cm thickness in pipes represent mineral precipitation from weeks up to 45 years and were formed from waters of different aquifer and depth conditions, i.e. fluid-temperature, flow rate, operating pressure and hydrochemistry. These scalings constitute an environmental archive of solid-fluid interaction captured in their chemical composition and variable petrography. Using state-of-the-art analytical techniques including micromill-sampling for stable carbon and oxygen isotopes, laser-ablation ICP-MS and electron microprobe analysis for minor/trace elemental compositions, microscopic methods (SEM) and hydrogeochemical modelling combined with installation-specific data we evaluate favorable vs. retarding scaling growth conditions.

Our results support a major role of distinct nucleation and crystal growth mechanisms, i.e. wall crystallization (on different materials) vs. particulate nucleation (in suspension) and agglomeration determining scaling consistency, porosity and progress. The occurrence of local steel corrosion can further enhance scaling formation. C and O isotopic compositions of thermal waters and associated carbonates sampled at different sites indicate near-equilibrium precipitation of the geothermal scalings. In this regard a 7.5 cm thick (deposited 1967-2012) scaling from a pipe leaving a thermal water storage tank towards Széchenyi Spa (Budapest) was analyzed at high resolution. Applying the oxygen isotope thermometer reveals an increase in water-temperature from ca. 65 °C to the currently measured 73 °C in the upper portion (recent past) of the scaling further supported by increased aragonite contents disseminated within calcite in this section. The potential of carbonate scalings for fundamental geochemical method improvement, i.e. the evaluation and calibration of established and novel (clumped) isotope geothermometers using scalings of well characterized precipitation conditions will be addressed.

ARAGONITE-CALCITE VEIN MINERALIZATIONS FROM THE „ERZBERG“ IRON-ORE MINE: RADIOMETRIC DATING, HYDROGEOCHEMICAL & NEOTECTONIC CONSTRAINTS

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vein carbonate, U-Th dating, neotectonics, water-rock interaction, Erzberg

The Erzberg is the world's largest siderite deposit and one of Austria's most prominent geological sites due to its historic and economic value. Within ore-bearing Devonian carbonates aragonite-calcite precipitates occur in vertical fractures that are referred to as "erzbergite" in museums and mineral collections.

In order to better understand the formation conditions of these mineral precipitates we collected samples in-situ, i. e. from veins currently accessible and being cm to dm in horizontal and tenths of meters in vertical extension. Several fractures also contain fragments of coarse siderite/ankerite host-rock components embedded in a fine-grained matrix partially cemented by secondary carbonate. Microstructural inspection shows that these fragments are of cataclastic origin. In addition, slickenside striations are present at most sample sites and indicate sinistral strike-slip along the near vertical faults – today entirely filled (healed) with aragonite/calcite. ^{238}U - ^{234}U - ^{230}Th dating using multi-collector ICP-MS allowed to constrain inception and ending of carbonate precipitation. All samples dated so far ($n=20$) are from the Late Pleistocene and most are younger than the last glacial maximum. A 10 cm thick laminated aragonite-calcite sequence recovered in-situ revealed an age of 14.7 ± 0.3 kyr BP near its base (approx. initial precipitation on one fault plane) and 13.1 ± 0.2 kyr near top (end of growth at second wall). Another 4 cm thick erzbergite sample composed of solely aragonite filling a tenths of meters extending fault yielded 10.4 ± 0.2 kyr (base) and 1.03 ± 0.04 kyr (top). A 25 cm sample from our university collections covers 14.2 ± 0.2 to 5.0 ± 0.2 kyr. In essence, the precipitates support geologically young and relatively short time intervals of fracture infilling and we consider it unlikely that the voids themselves are much older, i.e. open for hundred-thousands or even millions of years and being filled with carbonate instantaneously.

Regarding the particular erzbergite formation conditions carbonate $\delta^{13}\text{C}$ values, clumped isotopes, frequent iron-oxyhydroxide inclusions and elevated sulfate concentrations measured in modern local waters support cool meteoric waters in connection with sulfide oxidation and sulfuric acid evolution as an efficient mechanism of host-rock dissolution, mobilization and often rapid vein mineralization. Fresh reaction surfaces in fractures resulting from (seismo)tectonic activity would enhance such fluid-rock interaction.

LARGE-SCALE SEISMIC ANISOTROPY UNDER THE ALPS

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Seismology, Tectonics, Deformation, Orogeny, Extrusion

Preferred alignment in upper mantle structure develops in response to past and present-day tectonic deformation. Such an alignment causes directionally-dependent differences in seismic wave velocities, which we call "seismic anisotropy". The effect of anisotropy due to upper mantle fabrics can be easily seen in seismological observations. This is of particular interest, since it is the main tool for constraining in-situ deformation within the deeper Earth.

We have evaluated upper mantle anisotropy beneath the Alps by analyzing the splitting of shear-wave phases (i.p. SKS). Using data collected at permanent broadband stations, we have measured fast polarization azimuths and delay times all along the Alps, and we observe a clear trend, with fast orientations more or less aligned with the strike of the mountain chain.

While the western and central Alps are apparently associated with a relatively simple one-layer anisotropic structure, this is not the case for the easternmost Alps, where the data require the presence of two anisotropic layers. We discuss what this might mean, in light of existing tomographic models of the upper mantle under the Alps.

We will further discuss the major assumptions in the study of seismic anisotropy, and why particular care needs to be taken, if seismic anisotropy is to be interpreted correctly. Among others, this concerns the still-existing ambiguity between plate-motion-induced flow and "coherent fossil deformation", the Vinnik-Silver debate. This debate has divided the international seismic anisotropy community for the last 25 years, and we have only very recently understood that seismic body-wave data actually allow resolving this issue. We will discuss this and some other open questions - and what we might be able to say about the Alps, using the data from the AlpArray that are currently collected.

KONZEPTIONELLES HYDROGEOLOGISCHES MODELL REZENTER MASSENBEWEGUNGEN AM BEISPIEL DER EMBACHER PLAIKE UND HOCHEBENE, SALZBURG, ÖSTERREICH.

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Hydrogeologie, Massenbewegung, quartäre Ablagerung, Embacher Plaike, konzeptionelles hydrogeologisches

Die Embacher Plaike ist eine aktive Massenbewegung, die von der Embacher Hochebene bis hinunter zur Salzach reicht. Die davon ausgehenden Gefahren sind durch das Rückschreiten der Abrisskante in Richtung der Ortschaft Embach, sowie durch die mögliche Aufstauung der Salzach gegeben. Bewegungen in der Plaike werden durch Wasser induziert. Eine wesentliche Grundlage für Gegenmaßnahmen und die Stabilisierung der Embacher Plaike ist das Verständnis der hydrogeologischen Gegebenheiten in der Plaike und der darüber liegenden Hochebene rund um Embach.

Geologisch gesehen liegt das Untersuchungsgebiet in der Grauwackenzone, die in diesem Bereich aus verschiedenen Phylliten und metamorphen Vulkaniten aufgebaut ist, die mittelsteil nach NE einfallen. Im Hangenden des Grundgebirges findet man quartäre, fluviatile, leicht schräggeschichtete Schotter und Sande, die großteils zu Konglomerat verkittet sind und eine Mächtigkeit von bis zu 40m aufweisen. Lokal werden die Konglomerate von Deltaschottern überlagert, regional haben sich über diesen Seetone abgelagert. Darüber findet man 10-40m mächtige Moränenablagerungen. Das Untersuchungsgebiet befindet sich im Nahbereich der Salzach-Ennstal-Mariazell-Puchberg-Störung. Die Tauernnordrandstörung, welche das Tauernfenster und die Grauwackenzone trennt, verläuft südlich der Embacher Plaike auf der Embacher Hochebene.

Im Zuge einer hydrogeologischen Kartierung der Embacher Plaike sowie des orographischen Einzugsgebietes des Salater- und Kirchbaches als Hauptentwässerung der Embacher Hochebene, wurden Quellwässer mit elektrischen Leitfähigkeitswerten zwischen 178 und 1230 $\mu\text{S}/\text{cm}$ erhoben. Hydrochemische Untersuchungen zeigen, dass die elektrische Leitfähigkeit im Wesentlichen von räumlich stark variierenden Sulfatgehalten gesteuert wird. Sehr niedrige $\delta^{34}\text{S}$ -Werte in den höher mineralisierten Wässern deuten auf die Lösung von primären Sulfiden hin, deren Herkunft derzeit noch nicht geklärt ist. Abflussmessprofile entlang des Kirchbaches zeigen ein effluentes Fließverhalten. Zusätzlich ergab ein Markierungsversuch im November 2015 keinen Nachweis einer hydraulischen Verbindung zwischen Salater- und Kirchbach zur Embacher Plaike. Untermuert wird dies durch eine Wasserbilanz für das Einzugsgebiet der Embacher Plaike, die zeigt, dass der Abfluss in der Plaike für das Einzugsgebiet ausreicht und kein zusätzlicher Wasserzufluss erforderlich ist. Zusammenfassend ergibt sich aus den Ergebnissen dieser Untersuchungen, dass die Embacher Plaike im Wesentlichen nicht oder nur in einem sehr geringen, untergeordneten Ausmaß mit dem hydrogeologischen System der Embacher Hochebene (Salater- und Kirchbach) hydraulisch verbunden ist. Dies lässt auf ein eigenes abgegrenztes hydrogeologisches System für die Plaike schließen.

MIDDLE TRIASSIC PALAEOTECTONIC AND FACIAL LINKS BETWEEN BUDVA ZONE (MONTENEGRO) AND SOUTHERN ALPS.

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Dinariden, Budva Zone, Anisian Palaeotectonics, Montenegro

The Budva Zone, presently interpreted as part of the External Dinarides s. l., is a very complex pile of thin-skinned thrust units and olistoliths which is tectonically underlain by the Dalmatian-Ionian Zone and overlain by the High Karst Zone (for a comprehensive overview see Cvetkovic et al., 2016). The underlying and overlying zones are composed in general of Mesozoic shallow water carbonate platforms, whereas the Budva Zone is characterized by Triassic and Jurassic hemipelagic and pelagic limestones, radiolarites and olistolithes.

A controversial topic is the interpretation of the "Anisian Flysch" (Tudjemili Fm) which is underlain (and overlain?) by thick successions of conglomerates (Crnica Fm.) of terrigenous facies. The conglomerates are composed of well-rounded pebbles up to dm in diameter in channel fillings. They unconformably cover an erosional surface (usually overprinted by tectonic movements) along which some 100 m of Permian, Lower Triassic (Werfen-like facies) and Lower Anisian greyish and reddish (Steinalm limestone equivalent) strata have been removed and resedimentated. Few clasts of fine grained quartz conglomerates (?Upper Carboniferous) have also been found. The required tectonic elevations for subaerial erosion have been interpreted by Milovanovic, 1954 as a result of Anisian orogenic tectonics ("Montenegrinische Phase") with coeval flysch sedimentation. But the "Anisian Flysch" (Tudjemili Fm) is composed of a succession of silty marls with intercalated graded calcarenites, calcareous sandstones and siltstones with diverse fauna of brachiopods, crinoids and ammonoids, as such no real flysch. In the Sutorman section it contains slide blocks of reefal limestones with calcareous sponges, Tubiphytes and microbial crusts and large olistoliths of Steinalm Lmst. They may result from scarps along normal faults at the margin of the basin.

In general we observe in the Budva Anisian very similar facies developments to the Southern Alps where Richthofen Conglomerate (Peres Fm) and basinal Prags/Braies Group along tilted blocks with footwall uplift confirm Middle Anisian normal faulting in an extensional tectonic regime. We therefore reject the concept of a "Montenegrinian phase" and conclude that the Budva Zone and the Eastern Southern Alps were located in a similar palaeotectonic position on the passive continental margin of Adria facing Neotethys/Palaeotethys.

MICROSTRUCTURAL OBSERVATIONS ON HYDROTHERMAL VEINS OF SITE U1414, IODP EXPEDITION 344 (CRISP 2)

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hydrothermal veins, microstructures, paleostress, subduction zone, Cocos Plate

The erosive margin offshore Osa Peninsula (Costa Rica) is characterized by the subducting aseismic Cocos Ridge, which has lifted the seismogenic zone in the reach of scientific drilling. To understand the processes occurring in the Cocos Plate in the vicinity to the Middle America Trench, we investigated microstructures in hydrothermal veins, transecting the lithified sediments and the igneous basement at IODP Site U1414. Calcite twins and subgrains are intracrystalline deformation mechanisms and emerge in these hydrothermal calcite veins, especially within the lithified sediments. Calcite twin lamellae occur between 2 and 120 μm width. The most abundant twin type, after the classification of Burkhard (1993,) is type II. Type II twins show a significant thickness, straight twin boundaries and are indicative for temperatures between 150 to 300°C. Differential stress varies between 3.13 to 177.69 MPa, with a mean value of 73.10 MPa, calculation after Rowe and Rutter (1990). Further investigations were made by cathodoluminescence (CL) and electron backscattered diffraction (EBSD). These differential stresses exceed the lithostatic pressures within hole U1414A by a factor of 10 and are therefore assumed to be related to tectonic stresses related to plate convergence. The observed microstructures indicate a beginning deformation, mainly in the upper lithified sediments, and are assumed to be related to the bending of the incoming plate.

References:

- Burkhard, M., 1993. Calcite twins, their geometry, appearance and significance as stress-strain markers and indicators of tectonic regime: a review. *Journal of Structural Geology* 15, 351-368.
- Rowe, K.J., Rutter, E.H., 1990. Paleostress estimation using calcite twinning: experimental calibration and application to nature. *Journal of Structural Geology* 12, 1-17.

UNRAVELING THE THERMAL EVOLUTION OF SITE U1414 BY STABLE ISOTOPE AND FLUID INCLUSION ANALYSES, IODP EXPEDITION 344

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fluid inclusions, stable isotopes, hydrothermal veins, Cocos Plate

IODP Expedition 344 is the second expedition of the Costa Rica Seismogenesis Project (Program A), which was designed to reveal processes that effect nucleation and seismic rupture of large earthquakes at erosional subduction zones. Site 344-U1414, located 1 km seaward of the deformation front offshore Costa Rica, serves to evaluate fluid/rock interaction and geochemical processes linked with the tectonic evolution of the incoming Cocos Plate from the Early Miocene up to recent times. Combined microthermometric analyses of fluid inclusions and stable isotope analyses of hydrothermal veins within lithified sediments and the igneous basement (Cocos Ridge basalt), was used to reveal the thermal history of Site 344-U1414. Veins within the basalt show polyminerally filling of clay minerals, calcite, aragonite and quartz. Whereby veins in the sedimentary rocks are monomineralic filled by calcite and subordinately by quartz. Both contain different types of fluid inclusions with high and low entrapment temperatures and low saline fluids. Blocky veins with embedded wall rock fragments, appear in the sediments and in the basalt, indicate hydraulic fracturing. As well as, the occurrence of decrepitated fluid inclusions, formed by increased internal overpressure, related to isobaric heating. Elongated fluid inclusion planes, arc-like fluid inclusions and low homogenization temperatures indicate subsequent isobaric cooling. The carbon isotopic composition of calcite and aragonite veins obtains a variation from -3.0 to -0.4‰. The $\delta^{18}\text{O}$ values can be differentiated in two groups, depending on the formation temperature, with values from -13.6 to -9.3‰ and -10.8 to -4.7‰, respectively. The stable isotopic content and the results of fluid inclusion analyses indicate that the source of fluids is a mixture of mobilized pore water and invaded seawater that communicated with high temperature fluids. We propose that lithification of the sediments was accompanied with a first stage of vein development in the Middle Miocene and was a result of the Galapagos hotspot activity. Heat advection led to subsequent vein modification related to isobaric heating. The latest mineralization occurred during crustal cooling up to recent times.

HYDROGEOLOGISCHE ASPEKTE BEIM BAU DES BRENNER BASISTUNNELS

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Tunnel, Hydrogeologie, Festgesteine, Wasserzutritte

Seit August 2007 wird am 55km langen Brenner Basistunnels als 3 röhriige Eisenbahnverbindung zwischen Innsbruck in Österreich und Franzensfeste in Italien gebaut. Bis dato wurden ca. 42 Tunnelkilometer sowohl in konventioneller Bauweise als auch maschinell vorgetrieben. Es wird einleitend auf den Stand der Arbeiten als auch auf die wesentlichen, künftigen Meilensteine des Projektes aus geologischer Sicht eingegangen.

Aus hydrogeologischer Sicht liegt der Basistunnel großteils in magmatischen und metamorphen Festgesteinen. Nur ein kurzer Abschnitt unmittelbar nördlich des Südportals muss im wasserführenden Lockergestein aufgefahen werden. Auf Erfahrungen beim Vortrieb der Erkundungsstollen in den Festgesteinen wird aus hydrogeologischer Sicht eingegangen.

Diesbezüglich sind die Absenkungen der Formationswasserdrucke in den Schiefer-dominierten Festgesteinen, welche durch quartäre Lockergesteinsaquifere mit wasserwirtschaftlicher Bedeutung überlagert werden, von Interesse. Spröd reagierende Gesteine wie Granite und Marmore zeigen hingegen eine Wasserführung mit baurelevanter Bedeutung auch in großen Tiefen. Auf Erfahrungen auch aus der Baureifmachung dieser Abschnitte wird eingegangen.

SHALLOW P-WAVE AND S-WAVE SEISMIC IMAGING OF OVERDEEPEMED ALPINE STRUCTURES

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reflection seismics, shear waves, multi-component techniques, seismic facies, ICDP proposal DOVE

The sedimentary infill of overdeepened valleys and basins is objective for a DFG-funded project (grants KR2073/3-1, GA749/5-1), preparatory to the ICDP proposal DOVE (Drilling Overdeepened Alpine Valleys). Imaging their sediment succession enables us to interpret structures and deposits of different facies environments, which yield to information about, e.g., glacial cycles, geohazards, and groundwater resources. Here, we examine the benefit of combined application of shallow P-wave reflection seismics together with S-wave and multicomponent reflection seismic techniques at two study areas.

The Tannwald Basin, located about 50 km north of Lake Constance at the terminal moraine of the last glacial maximum, represents an overdeepened branch basin of the Rhine glacier in the alpine foreland. Here, we accomplished three reflection seismic campaigns with five high-resolution P-wave profiles, two SH-wave profiles, and one profile using multi-component technique (3-C receivers, SV- and SH-wave sources). In addition, several cross-lines were registered to study 3-D effects and to evaluate a 3-D approach for multi-component reflection seismics.

By P-wave reflection seismics, we reveal the Molasse base of the Tannwald Basin in depth between 80 and 240 m, verified by a nearby research borehole from the 1990s. The sedimentary infill is locally glacio-tectonically disturbed and delineate spatially-spread reflection pattern of different seismic facies, which we interpret as lacustrine, glacial-fluvial, and deltaic sediments. However, SH-waves show only parts of the bedrock reflections and the P-wave reflection inventory, but some SH-wave reflections of the Quaternary deposits can be correlated with P-wave reflections. Possible reasons for different performance of P- and SH-waves may be the response to different elastic parameters, damping, or scattering, which results in a lower maximum penetration depth of SH-waves.

The Lienz Basin constitute an inner alpine basin at the junction of four glaciers in the Pleistocene with a speculated depth of 500 m. In August/September 2016, we will accomplish two seismic reflection campaigns comprising high-resolution P-wave, SH-wave, and multi-component measurements. An open question is if we can distinguish between sediments of different glaciations and can characterize different facies in the Lienz Basin as well.

POST-HIRNANTIAN (LATEST ORDOVICIAN-EARLY SILURIAN) ENVIRONMENTS IN ETHIOPIA: FIRST EVIDENCE FROM SEDIMENTOLOGY AND PALYNOLOGY

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Post-Hirnantian, cryptospores, post-glacial, environments, Ethiopia

First clear data of land-living plants in form of cryptospores in Gondwanan sediments dates well back into the Middle Ordovician. However, the earliest macroplant remains do not appear before the Mid Silurian. In the time between, plant evolution on terrestrial environments in Gondwana was severely hampered by the Hirnantian glaciation event. The nature of the plants remains mysterious. How did they survive the glaciation and how did they recolonise once glaciated areas? First answers to these questions are expected from fine-grained early post-glacial continental or marginal marine sediments because of their promising potential for macroflora preservation. However, such deposits are rare in Gondwana with the fossil record highly biased towards marine sediments.

Recently discovered outcrops of cryptospore-bearing post-glacial Early Palaeozoic fine grained siliciclastics in northern Ethiopia represent such promising terrestrial or very marginal marine deposits. They contain cryptospores that form the first body fossil proof of Early Palaeozoic sediments in NE Africa. Together with co-occurring sporangia remains they have the potential to shed light on the early post-Hirnantian plant colonisation of terrestrial ecosystems in Gondwana.

The fine-grained sediments overlay glaciogenic sediments. They fill a relic glacial topography, either representing underfilled glacial troughs or sub-glacial channels. Missing bioturbation and the abundance of pyrite and siderite indicate a generally low-oxygen depositional environment. Truncation of the succession by cross-bedded sandstones that contain marine trace fossils document a post-glacial transgression coming from south of the Palaeotethys which flooded far interior regions of Gondwana.

In studied levels of the sections, the palynomorph assemblage is dominated by the land-derived cryptospores and algae of possibly freshwater origin. Typical open marine elements such as acritarchs and scolecodonts are extremely rare, chitinozoans are missing so far. Microscopically pyritized objects of unknown affinity but of probably primary organic origin likely reflect metabolic products during very early mineralization processes in anaerobic habitats or at oxic-anoxic interfaces. The very well-preserved cryptospore assemblages enables the dating of postglacial sedimentary sequences in northern Ethiopia to the late Ordovician/early Silurian for the first time. The detailed sampling in two continuous surface sections allows insights into the evolution of terrestrial plants in environments developing after the retreat of the glaciers.

LONG-TERM MONITORING OF DISPLACEMENTS BY DIGITAL IMAGE ANALYSIS

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Monitoring, Displacements, Digital Image Analysis, Remote Sensing

Performing long-term displacement measurements of structures in remote areas like high rock buttes in alpine regions is often very difficult, as the direct installation of measurement devices and a continuous reading is not possible or too expensive due to low accessibility. In most cases, tape extensometers or distance measurement instruments have to be installed directly on the moving rock part and a continuous reading is necessary, unless an electronic device records the measurements. The analysis of digital images to calculate the relative position of reference targets, as a form of remote sensing, seems to be an adequate alternative.

This paper investigates the applicability of digital image analysis to perform long-term monitoring programmes with digital cameras. Therefore, the movement of a mobile reference target in relation to a stationary target will be detected on digital images and back-calculated. The system will be tested in the field under simple conditions to detect the limitations of and requirements on the system as well as the accuracy and the influencing factors, like the atmosphere or a dynamic camera position. Afterwards, the method shall be applied on an actual example of a potentially instable rock tower close to Nötsch (Carinthia) to detect displacements along the shear bands and the total movement of the whole rock tower. Advantage of this technique would be the one-time installation of the reference targets in accessible areas and the constant reading of the displacements by remote sensing.

HEDLEYITE FROM ALBANIAN OPHIOLITIC COMPLEX

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gold tellurobismutite IAT SSZ ophiolite albania

Albanides, geological structure of Albania's territory, represent a segment between Dinarides-Hellenides arc. The most important geological feature is the ophiolitic formation as part of Mesozoic Tethian ophiolitic realm.

Albanian ophiolitic formation covering about 4300 km², is divided in two belts, western and eastern ones. The last one is distinguished by high depleted mantle hartzburgitic-type and TiO₂-poor lavas with a range of TiO₂ down to 0.3%, having boninitic affinities. The important and various mineralization -types are related to different parts of ophiolitic pile such as chromitite, PGM, disseminated Ni-sulfur PGE-bearing, vein Cu-quartz-type, massive and stockwork Cu and polymetallic mineralization of volcano-sedimentary origin.

The particular, very rare mineral, hedleyite, Bi₇Te₃, of Helshan, Albania, belongs to hydrothermal Cu-Co-Au-mineralization type. This tellurobismutite mineral is a special variety that contains high amount of Au, 6.49% which represents a very rare variety, goldhedleyite.a

The mineralization hedleyite-bearing have vein shape of ore body situated in contact between gabbro-ultramafic rocks. In this area occur volcanic basaltic rocks, plagiogranites and intense sheeted dyke complex. The mineral association is composed chiefly by chalcopyrite and pyrrhotite as well as little amount of cobaltite and native gold. The aggregate grains of cobaltite hosted in chalcopyrite ground mass, are intersected by the chalcopyrite veins. The composition of this cobaltite is particularly contains high in amounts of Ni, 9.2% that is nickelcobaltite variety.

The hedleyite as common lens-like inclusion with nickeline, occurs within host cobaltite crystals. The formula of hedleyite (deposit of Helshani, Albania) by electronic microprobe analyses as follows:

(Bi_{5.82} Au_{0.58} Co_{0.42} Ni_{0.19} Fe_{0.02} Sb_{0.03})_{7.06} (Te_{2.81} S_{0.13}).

The formation of this goldbismuthotellurid mineral in association with nickelcobaltite is conditioned by hydrothermal activity related to fluid circulation in crust mantle contact. It is suggested that these fluids are derived from plagiogranite intrusion and sheeted dyke complex. The hydrothermal fluids are enriched with Ni extracted from ultramafic wallrocks.

SIEGENITE FROM ALBANIAN OPHIOLITIC COMPLEX

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Ni, Cu linnaite ophiolite MORB Albania

The geological structure of Albania belongs to the Alpine-Mediterranean folded belt. Its particular feature is the Jurassic ophiolitic formation which covered a large surface, about 4300km². This formation is divided in two belts, eastern of IAT-type and western of MORB-one. The last belt is composed by mantle lherzolite-hartzburgite type and plagioclase-rich basal cumulates contains 0.3-3.8% Al₂O₃ and by TiO₂-rich lavas (1.5-2% TiO₂). These features indicate that western ophiolitic belt was originated from a magmatic source that was less depleted, 5-10%.

Some mineralization -types are related to different parts of ophiolitic section such as chromitite of Al-rich type, Fe-Ti and vein Cu-sulfide ones. The siegenite-bearing hydrothermal Cu-sulfide mineralization is situated in an area composed by gabbro, troctolite and lherzolite rocks. The lens-like ore body related to contact between these rocks is composed by chlorites, chalcopyrite and pyrrhotite whereas the other minerals as siegenite, magnetite and sphalerite are scarce. The aggregate grains of siegenite are situated in host ground mass of chalcopyrite. A thin network veinlets of magnetite fills the cleavage planes of chalcopyrite and some skeleton grains of sphalerite occur in last ground mass.

The siegenite of Kabashi, Albania deposit is distinguished by high contents of Ni and less of Co in comparison with the one of Siegen, Germany. This feature is as result of enrichment of Ni by hydrothermal fluids, extracted from Ni-rich ultramafic rocks. The formula of this siegenite by electronic microprobe analyses as follows:

(Fe_{0.61} Cu_{0.26} Ni_{0.09})_{1.00} (Ni_{1.13} Co_{0.87})_{2.00} S_{4.00}

MÖGLICHKEITEN UND GRENZEN GIS-GESTÜTZTER AUTOMATISCHER ABLEITUNG VON DOLINEN AUS LIDAR-GENERIERTEN DIGITALEN GELÄNDEMODELLEN – ERFAHRUNGEN AUS DER PRAXIS

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Dolinen, Digitales Geländemodell, LiDAR, Modellierung, Georisiken

Heute ermöglichen LiDAR-Messungen das Erstellen von hochaufgelösten Digitalen Geländemodellen (DGM) in Zentimetergenauigkeit. Die Anwendungsmöglichkeiten sind vielfältig und erlauben eine zeitsparende, detaillierte Analyse sehr großer Gebiete. Darunter fällt auch die flächenhafte Erfassung von Dolinen. Als Georisiko in der Bevölkerung oft wenig beachtet, rücken diese in der Planung zunehmend in den Fokus. Mittels der integrierten Funktionen und Tools von ArcGIS (Version 10.3.1) wurde untersucht inwiefern die Erfassung von Dolinen über die Ableitung von abflusslosen Senken und gleichzeitiger Minimierung von Fehltreffern aus einem DGM möglich ist. Als Entwicklungs- und Testgebiet für das Modell zur Ableitung von Dolinen wurde ein ca. 65 km² großer Ausschnitt des Paintener Forsts im Landkreis Kelheim in Bayern herangezogen. Dieser wurde bereits für das Projekt „Gefahrenhinweiskarte Jura“ des Bayerischen Landesamts für Umwelt bearbeitet, weshalb ein flächenhafter Datensatz für Geogefahren vorliegt. Die Erfassung und Digitalisierung von Dolinen geschieht bisher händisch, auf Grundlage eines aus dem DGM berechneten Schattenmodells und verschiedener Kartenwerke. Das neu entwickelte Modell soll hierfür zukünftig als bestmögliche Unterstützung dienen. Von den 2976 durch das Modell abgeleiteten Senken entsprachen 2100 (70,5%) den händisch erfassten Dolinen. Die restlichen 876 Senken (29,5%) waren Fehltreffer. Es zeigte sich, dass eine vollständig automatische Ableitung ohne Interpretation und manuelle Korrektur aktuell nicht möglich sein wird. Problematisch sind insbesondere anthropogene Strukturen wie Schürfe, Steinbrüche, Bombentrichter u.a., die ebenfalls abflusslose Senken darstellen können und zu Fehltreffern führen. Des Weiteren muss das DGM entsprechend vorbereitet (geglättet) werden, um weitere Fehlerquellen aufgrund von Artefakten (z.B. unruhige Morphologie mit falschen Senken unter dichtem Baumbestand) oder zu präziser Darstellung (z.B. Ackerfurchen als Senke) möglichst zu vermeiden. Trotzdem bietet das entwickelte Modell eine Erleichterung der visuellen Interpretation und liefert darüber hinaus noch automatisierte Angaben über die Geometrie (Länge, Breite, Tiefe) sowie die Abgrenzung als Polygon und den tiefsten Punkt pro Senke/Doline. Zudem ist es nicht regional beschränkt und kann grundsätzlich in verschiedenen Landschaftstypen eingesetzt werden. Zukünftige Entwicklungen werden sich vor allem auf die Eliminierung von Fehltreffern konzentrieren.

DIE STRATIGRAPHIE UND PALÄOÖKOLOGIE DER LEITHAKALKE IM SÜDLICHEN WIENER BECKEN AUS DER BOHRUNG BRUCKNEUDORF EKB02

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Leithakalke, Wiener Becken, Nannofossilien, Foraminiferen

In der Ortsgemeinde Bruckneudorf im Burgenland wurde zur Erschließung eines neuen Brunnens eine 40m tiefe Erkundungsbohrung am Nordrand des Leithagebirges abgeteuft. Das Leithagebirge erstreckt sich als 35 km langer und bis zu 7 km breiter Höhenzug, der das Wiener Becken von der Ungarischen Tiefebene trennt. Die Störungsgeometrie innerhalb des Beckens und die rhombische Form sind deutliche Belege für die Entstehung als pull-apart Becken, die im Karpatium eingesetzt hat. Während des Mittleren Miozäns (Langhium) verkörpert das Leithagebirge eine isolierte Karbonatplattform, die durch eine Vielzahl verschiedener Faziestypen aus Korallen, Mollusken und Echinodermaten gekennzeichnet ist.

Die 40m tiefe Erkundungsbohrung zeichnet sich in den hangenden 8m durch rötlichbraune bis graue sandige und kiesige Sedimente aus. Die wenigen, aber gut erhaltenen Faunenelemente mit *Ammonia parkinsonia* (d'Orbigny), *Ammonia tepida* (Cushman), *Porosononion granosum* (d'Orbigny) und *Porosononion martkobi* (Bogdanowicz) sprechen für Sarmat. Kalkige Nannoplanktonvergesellschaftungen besteht überwiegend aus umgelagerten mitteleozänen (*Reticulofenestra hillae*, *R. umbilicus*, *Discoaster baraberdensis* etc.) und selten aus miozänen Elementen (*Umbilicosphaera jafari*). Die wenigen sarmatischen Arten deuten auf flachmarine, möglicherweise hyposaline Bedingungen hin.

Die dunkelgrauen Tonmergel (8m – 13m) enthalten *Orbulina suturalis* (Brönnimann) und *Praeorbulina circularis* (Blow), was der höheren Lagenidenzone entspricht. Die Gattung *Amphistegina* ist relativ gut vertreten. Die diverse benthonische Foraminiferenfauna deutet auf einen (tiefneritischen bis) seicht bathyalen Lebensraum hin. Das Fehlen von *Sphenolithus heteromorphus* sowie reiche Nannoflora mit *Calcidiscus premacintyreii*, *Reticulofenestra pseudoumbilicus* >7µm etc. weist auf die Nannoplankton Zone NN6 hin.

Von 13m bis 40,4m wurden mergelige, an Corallinaceen und Amphisteginen reiche, Leithakalke durchteuft. Das gemeinsame Auftreten von *Amphistegina mammilla* (Fichtel & Moll) und *Bolivina fastigia* (Cushman) deuten auf die Lagenidenzone. Wichtige Faunenelemente wie *Elphidium fichtelianum* (d'Orbigny), *Elphidium granulatum* (Costa), *Lobatula lobatula* (Walker & Jacob) weisen auf inneres bis flaches mittleres Neritikum hin. Die Proben aus den Leithakalken enthalten *Sphenolithus heteromorphus* und können somit in NN5 eingestuft werden.

EGERIAN CALCAREOUS NANNOFOSSILS AND FORAMINIFERS (PALEOECOLOGY AND BIOSTRATIGRAPHY) FROM THE NORTH ALPINE FORELAND BASIN OF UPPER AUSTRIA

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Alpine Foreland Basin, Egerian, paleoecology, biostratigraphy

To obtain a more accurate definition of the **Eferding Formation**, foraminiferal faunas and calcareous nannofossils of the outcrops Unterrudling and Polsenz were studied in detail. The Unterrudling Eferding Formation is developed on top of the shallow marine Linz-Melk Formation, Polsenz represents a younger part of the Eferding Formation. Moderately to bad preserved planktonic foraminifers from both sections (*Globigerina wagneri*, *Globorotaloides suteri*, *Globoturbotalita ouachitaensis*, *Beella rohiensis*; *Globigerinoides primordius*) are characteristic for the lower Egerian. Calcareous nannoplankton assemblages allow an attribution in uppermost NP25. Benthic foraminiferal faunas from Unterrudling suggest a deepening from a deeper neritic depositional environment in the lower part of the section to a bathyal one in the uppermost part. Calcareous nannoplankton indicate a stable marine environment, probably established by an unhampered communication with the open Paratethys Sea. The slightly younger Polsenz section was again deposited in a deeper neritic environment, characterized by unfavourable habitat conditions like stagnant bottom waters and repeated oxygen crisis recorded by poor and extremely low diverse benthic foraminiferal faunas. with occasionally high numbers of arenaceous foraminifera.

Lower Miocene sediments of core UE50 drilled in the surroundings of Linz/Ebelsberg were quantitatively examined to define the stratigraphical position of the **Ebelsberg Formation** and to investigate paleo-conditions during the lowermost Miocene in the North Alpine Foreland Basin. Stratigraphical analysis of the foraminiferal faunas represented by common *Gaudryinopsis austriacus*, *Amphicoryna danuviensis*, *Tenuitella minutissima* and *Tenuitellinata pseudoedita* gives an age of Upper Egerian (lower Aquitanian), which can be restricted to NN1 by means of calcareous nannofossils. Paleoeological analyses point out a deep neritic to bathyal marine realm with cold deep water and cool surface water with increasing eutrophication as a result of upwelling and short-time fresh-water influx. High organic production in the water column resulted in ongoing accumulation of organic material on the sea floor, which finally led to oxygen deficiency and to a drastic change in benthic foraminiferal faunas in the uppermost part of the core.

THE JEGŁOWA METACONGLOMERATE (“DATTELQUARZIT”, SW POLAND): A SOURCE OF CONFLICTING MICROSTRUCTURAL INTERPRETATIONS SINCE THE ADVENT OF MODERN FABRIC ANALYSIS BY BRUNO SANDER

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microstructure, Dattelquartzite, SPO, LPO, strain

The Jegłowa metaconglomerate is part of a quartz-rich presumably Devonian metasedimentary unit, which crops out near Jegłowa (Strzelin Massif), 40 km south of Wrocław in Poland. The rocks in that area, which have been already studied by Goethe (1823), record a strong L-fabric and have experienced an upper greenschist to amphibolite facies metamorphism followed by a hydrothermal low-grade metamorphic overprint. The quartz metaconglomerate layers are composed of aligned up to several cm long prolate pebbles (geometric means: $X/Y=2.6$, $Y/Z=1.4$), which show a resemblance to dates (therefore the German name “Dattelquarzit”). The pebbles are composed of polycrystalline quartz of 1.5 mm in diameter on average, whereas the matrix consists of densely packed smaller pebbles with a smaller grain size.

The “Dattelquarzit” has been initially interpreted as concretions (Rose, 1867) but later re-interpreted as tectonically deformed conglomerates (e.g. Schuhmacher, 1878). Influenced by the seminal work of Bruno Sander (Sander, 1930), Drescher (1932) investigated the “Dattelquarzit” with detailed studies of the quartz texture in the pebbles and the matrix. Based on the observation that the pebbles record various maxima oblique to the long axes of the pebbles but the finer-grained matrix revealed a girdle distribution, Drescher concluded that the pebbles are recrystallized lenses separated by a network of anastomosing shear zones (i.e. the matrix). This interpretation was criticized by Scheumann (1932, 1936) who emphasized the occurrence of polymict pebbles and favored the interpretation of a meta-conglomerate.

Although we have no doubts that the “Dattelquartzite” is a metaconglomerate, our microstructural investigations highlight a complex heterogeneous deformation history comprising inherited textures overprinted by various deformation mechanisms, which partitioned between the pebbles and the matrix and localizing within diffuse shear zones within the rocks.

Goethe, J. W. v., 1823. 7. Bull. d. naturw. Sekt. Schles. Ges., 11.
 Rose, G., 1867. Hg. v. Justus Roth, Berlin.
 Schuhmacher, E., 1878. Z. d. deutsch. Geol. Ges., 30, 427.
 Sander B. 1930. Verlag J. Springer, Wien.
 Drescher, F.K., 1932. Z. f. Kristall., Min. und Petrogr., 42, 217-263.
 Scheumann, K.H., 1932. Z. f. Kristall., Min. u. Petrogr. 42, 264-284.
 Scheumann, K.H., 1936. Z. f. Kristall., Min. u. Petrogr. 42, 325-372.

A MIDDLE TRIASSIC CRINOID FAUNA FROM SUTORMAN, BUDVA ZONE (SOUTHERN MONTENEGRO)

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Crinoids, Middle Triassic, Budva Zone

In the Anisian Tudjemili Formation of Sutorman, in southern Montenegro a rich crinoid fauna has been discovered (seven species) occurring in light brown and grey bioclastic limestones. Except for rare brachiopods, crinoid remains represent the only fossils in these sediments. Crinoid fauna of southern Montenegro has so far been known only from papers published at the beginning of the 20th century by Martelli (1905, 1906), which the author considered to be of Ladinian age. After his publications, other authors have just mentioned crinoid remains from different kinds of sediments, but have not determined the fauna. In the studied locality the crinoids occur as disarticulated elements in thin marly layers between nodular fine-grained calcareous algae bearing bioclastic limestones embedded in the so-called "flysch" of the Tudjemili Formation. Crinoids are represented mostly by columnals and rare attachment disks and are accompanied by rare brachiopods (spiriferids and coenothyrids). Another special type of limestone is represented by slided blocks of reefal mounds, composed of calcareous sponges, *Olangocoelia otti* BECHSTÄDT & BRANDNER, *Tubiphytes* sp. and microbial crusts. This type of facies is very similar to occurrences in the Middle Anisian of the Eastern Dolomites (Italy).

The following species of crinoids have been determined: *Encrinus liliiformis* LAMARCK, *Silesiacrinus silesiacus* (BEYRICH), *Carnallicrinus carnalli* (BEYRICH), *Eckicrinus radiatus* (SCHAUROTH), *Holocrinus dubius* (GOLDFUSS), *Holocrinus* cf. *meyeri* HAGDORN & GLUCHOWSKI and *Qingyanocrinus kueichounensis* (DUBATOLOVA & SHAO). Except *Encrinus liliiformis* LAMARCK, all other species are registered for the first time in Montenegro. The composition of the fauna would indicate an Upper Pelsonian/Lower Illyrian age but could be older as it is overlain by an early Pelsonian ammonoid fauna of the *B. balatonicus* Zone. The determined fauna makes it possible to correlate Middle Triassic limestones of Sutorman with other localities of the same age found in Austria, Germany, Italy, Poland, China etc. that contain similar crinoid faunas.

LANDSLIDE DISPLACEMENT MONITORING BY MULTIPLE-APERTURE INTERFEROMETRY: A CASE STUDY IN THE ITALIAN DOLOMITES

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multi-aperture interferometry (MAI), DInSAR, displacement, COSMO SkyMed, GPS

Over the past two decades, the capabilities of differential synthetic aperture radar interferometry (DInSAR) for detecting and quantifying ground surface deformation have been demonstrated by a large number of research applications. As detailed analyses and continuous monitoring of surface deformation are necessary, e.g. for research on earthquakes, glaciers and landslides, 3D displacement information are required. Based on the near-polar imaging systems and the side-looking configuration of space-borne radar systems, conventional single-orbit DInSAR can only provide 1D displacements along the line of sight (LOS) of the satellite path. Due to technological limitations, designing and launching non-polar SAR space-borne satellite cannot be expected in the near future. Consequently, a number of attempts have been performed to develop new techniques aiming to extract 2D displacements using the available SAR data.

One such method is amplitude offset tracking (OT) which is able to extract 2D (along- and cross-track) displacements. However, this technique has some limitations due to the reduced sensitivity to along-track deformation (i.e. sensitivity to pixel size and dependency of cross-correlation accuracy to the size of correlation windows). Another method is multi-aperture interferometry (MAI) which is based on split-beam InSAR processing, using forward- and backward-looking interferograms and the phase difference between two SAR pairs. Hereby, 2D displacements can be extracted. In comparison to DInSAR, MAI is less affected by atmospheric artifacts, and phase distortions due to the flat-earth and the topography are more easily removable. In addition, MAI is nearly twice as accurate as OT.

We present our findings from applying MAI on the Corvara landslide, a large and complex earthflow located in the Italian Dolomites. Time-series of high resolution COSMO SkyMed (CSK) data in HIMAGE mode and descending direction covering the period from 2013 to 2015 were used. The results of MAI are compared to OT results, as well as in-situ differential GPS measurements that were taken at the same time as the CSK acquisitions.

CONSTRAINTS ON THE LOCATION OF THE EARTHQUAKE 1348 OF CARINTHIA / FRIULI / VILLACH DERIVED FROM ITS ESI-2007 ENVIRONMENTAL INTENSITY

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1348 earthquake, environmental intensity, Carinthia, Villach, Friuli

The earthquake of 1348 is one of the strongest recorded earthquakes in the Alps with an epicentral intensity of $I_0 = 9-10$ (MCS) and an estimated macroseismic magnitude of $M_w = 6.6-7.0$. While most authors and catalogues agree on the epicentral intensity no agreement exists on the location of the epicenter. This is reflected by a variety of earthquake names such as Villach, Friuli, or Carinthia.

Assessments of the severity of the earthquake so far exclusively used historical descriptions of damage to buildings. This appears remarkable as the event triggered one of the largest rockfalls in the Eastern Alps and historical sources describe various earthquake effects to the natural environment. We explore these effects to provide an intensity assessment in terms of the ESI-2007 scale relying on secondary effects such as hydrological anomalies, ground cracks, and slope movements:

(a) Reported hydrological anomalies from Villach include both temporary (sulphureous emissions, water color, turbidity) and permanent changes (spring temperature, drying of springs, formation of new springs). (b) Ground cracks of dimensions that "a man would sink down to his belt" are reported from the urban area of Villach. (c) Historical and geological evidence exists for 10 earthquake-triggered rockfalls with volumes between 10^6 and 10^8 m³ which occurred on locations at Dobratsch, Gerlitzten, and Veliki vrh. In addition, rockfalls at two locations in the Southern Tyrol are associated with the 1348 event. Large rockfalls therefore occurred in an area of at least 3000 km².

The described effects support an assessment of the local intensity $I(\text{ESI-2007}) = X$ at Villach. The assessment is supported by at least three sites where a single environmental effect has occurred. Comparison with the effects of the 1976 Friuli earthquake further shows that intensity strongly attenuates with increasing distance from the epicenter leading to a decrease of 2-3 intensity degrees at about 50 km distance. This comparison indicates that either the epicenter of the event must have been located close to Villach, or the epicentral intensity must have been significantly larger than $I = X$ when assuming an epicenter at a larger distance from Villach, e.g., in Friuli.

PETROGRAPHIC CORRELATED MODEL

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Petrophysics, petrographic coded model concept

A demand for comprehensive petrophysical data occurs for a variety of applications in geosciences, petroleum- and geotechnical engineering. Experimental and theoretical research of physical properties for different lithologies is needed to get an overall picture. Accomplishment of physical rock properties and their influences through systematic studies will be combined into a matrix with important information for wealth of applications.

This talk will show the first results of systematic directional laboratory measurements of petrophysical properties like electrical and elastic properties, porosity and permeability and thermal conductivity for rock types from Austria. These measurements will be determined for sedimentary, metamorphic and plutonic lithologies to receive a petrographic coded model concept.

Samples of different carbonate, sandstone, gneiss, quartzite, serpentine, basalt and other volcanic rocks were obtained. Sampling was carried out in open pits, from both the Eastern Alps and the surrounding Basins. Measurements of dry- as well as saturated samples are executed. Saturation of samples is done with a solution of 1g NaCl and 1l distilled water. The principle of Archimedes and a helium pycnometer are used to determine the effective porosity of samples. Ultrasonic device is used to measure the compression and shear wave velocity of dry and brine-saturated samples. A self made calorimeter is used to measure the heat capacity. For measurements of the specific electrical resistivity a 4-point-light instrument of LGM Lippmann is used and therefore samples get saturated with a solution of 20g NaCl and 1l distilled water.

With knowledge of various properties and a resulting systematic matrix geoscientists can get easily an idea of influencing factors on the different properties. For our data set a considerable useful interpretation tool should be provided by different model calculations. At the moment measurements are carried out for the first set of samples. Analysis will start in the next month. Further interpretations of petrophysical properties including thin sections will lead to a petrographic code with a deeper understanding of the influencing properties. Hence insights and conclusions of our data cannot be given until the first sample portion got analysed.

TERTIARY TECTONICS IN ALPINE CORSICA (FRANCE): THREE-STEPS EVOLUTION FOR THE EXHUMATION OF THE CORTE SLICES

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Alpine Corsica, Corte Slices, Blueschists facies metamorphism, exhumation processes

The Corte area in central Corsica hosts a stack of continental units that represent a portion of the European paleomargin involved in the subduction and accretion to the orogenic wedge during the Alpine orogeny. A complex polyphased history had been identified starting from meso- and micro-structural analysis and the study of the metamorphism. The deformation structures have been divided into three phases: the D1 phase is characterized in the field by sheath folds and, in thin section, by a foliation S1 along which HP/LT phyllosilicates were recrystallized. The D2 phase consists of isoclinal folds recognized in all the litotypes at all the scale of observation. To the F2 folds a well developed foliation S2 is associated; the mineral phases recrystallized along this foliation were in equilibrium in the greenschists facies. During the D1 and D2 phases several top-to-the-W shear zones were developed. The D3 phases produced open and closed asymmetrical E-verging folds; in the field the S3 foliation is classifiable as a disjunctive cleavage without evidence of recrystallization. The D1 and D2 phases are the result of the continental subduction and the following collision during the convergence between the European plate and Adria plate, while the D3 phase is generated by the collapse of the orogenic wedge in an extensional regime.

The main result of this study is the assessment that the exhumation processes started when the Corte Slices are deformed at the blueschists-facies conditions, i.e. during the late stage of the D1 phase.

Although the isotopic dating are not yet available, the age of the youngest deformed formation postdates the onset of the subduction and the accretion to the orogenic wedge at the Late Eocene, while the seal deposits lying above the Corte Slices are Burdigallian in age.

THE EVOLUTION OF THE EUROPEAN PALEOMARGIN DURING THE CLOSURE OF THE ALPINE TETHYS: EVIDENCE FROM THE ALPINE CORSICA

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Alpine Corsica, turbiditic deposits, eocene angular unconformity

The convergence between Europe and Adria plates, started in the Late Cretaceous and resulted in the E-immersing intra-oceanic subduction of the Ligure-Piemontese Basin, in turn followed by the subduction of the European continental margin and the continental collision with Adria plate.

In the Alpine chain the structures related to the evolution of the European margin from its involving in the subduction processes to its exhumation are preserved, and the interpretation of them allowed us to reconstruct the tectonic events.

In the area between Corte and Venaco, located in the central area of the Corsica island, it is possible to observe a complete transect from the undeformed European margin, to the west, known as Hercynian Corsica, to the metamorphic units, to the east, which represent the exhumed part of the orogenic wedge during the Alpine orogeny. The Hercynian Corsica is mostly constituted of Permo-Carboniferous basement intruded by Monzogranites covered by a Mesozoic, mainly carbonate, sedimentary succession unconformably topped by Eocene siliciclastic turbidite deposits. The metamorphic units are of two types: the continental-derived units (Lower Units) that have the same lithostratigraphy of the Hercynian Corsica but are affected by blueschist facies metamorphism, and the Schistes Lustrés Complex, made by units of both continental and oceanic derivation and affected by blueschist-eclogitic facies metamorphism.

The unconformable relationships between the Eocene deposits with the older formations over them are found both in the unmetamorphosed Hercynian Corsica and in the metamorphic Lower Units. The unconformity at the base of these deposits is the result of the sedimentation of the siliciclastic turbidite deposits on a basement segmented by high-angle normal faults. These faults are here regarded as the result of the extension caused by the flexural bending of the lower plate next to the subduction. The faulting of the margin and the consequent tilting of blocks left depocenters that are filled by breccias and turbiditic deposits before being subducted.

HEAT TRANSFER IN SEDIMENTARY DEPOSITS: EFFECT OF CHANGE IN WATER SATURATION CONDITIONS ON THE THERMAL PROPERTIES OF SOILS INTERESTED BY VERY SHALLOW GEOTHERMAL SYSTEMS

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heat transfer, soil thermal properties, very shallow geothermal energy

In the near future the population living in urban areas is expected to increase. This worldwide trend will lead to a high concentrations of infrastructures in confined areas, whose impact on land use and shallow subsurface must be well evaluated. Since shallow geothermal energy resource is becoming increasingly important as renewable energy resource, due to its huge potential in providing thermal energy for residential and tertiary buildings and in contributing to reduce greenhouse gas emission, the number of installed geothermal systems is expected to continue to rise in the near future.

Leading questions concern the short and long-term effect of an intensive thermal use of the shallow subsurface for heat generation, cooling and thermal energy storage and how to improve the performance of ground heat exchangers.

This research, belonging to ITER Project, funded by European Union, focuses on improving heat transfer efficiency of very shallow geothermal systems, as horizontal collector systems or special forms, interesting the first 2 m of depth from ground level (<http://iter-geo.eu/>). A key challenge is to understand how to enhance the heat transfer of the sediments surrounding the pipes, negatively affected in case of unsaturated soil conditions.

Given the heterogeneity of sedimentary deposits in alluvial plain and the uncertainties related to the estimation of thermal parameters for unconsolidated material affected by thermal use, physical-thermal parameters (i.e. moisture content, bulk density, thermal conductivity...) were determined in laboratory for sand and loamy sand samples under different degree of water content. In addition, preliminary results from a field test site located within an urban area are also shown.

The first outcomes consist of (i) a reference database taking into account the effect of change in water saturation conditions on the thermal properties of soils interested by very shallow geothermal systems, (ii) a collection of reliable data for model parameterization and (iii) suggestion on how to modify in a natural way the soil mixture in order to improve its thermal behaviour.

SHEAR WEAKENING FOR DIFFERENT LITHOLOGIES OBSERVED AT DIFFERENT SATURATION STAGES

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shear weakening, compressional wave velocity, shear wave velocity, shear modulus

For this study, samples from five different lithologies (Grey Berea Sandstone, "Bunt"- sandstone, "Dachstein"- limestone, "Haupt"-dolomite and "Neuhauser"-granite) were selected to determine mass, porosity, permeability, compressional and shear wave velocity at various saturation stages. Hence, the shear modulus μ , the bulk compressional modulus k and Lamé parameter ν was calculated to find out if shear weakening exist for the dataset.

Shear weakening means that the shear modulus of dry and brine saturated samples is not the same, although it is assumed that the shear modulus should be unaffected by saturation. Samples were at first dried at 70°C and then at 105°C to recognise if drying temperature is an important factor for shear weakening. It was obvious that it is important.

Shear weakening can mainly be observed for limestone and granite samples, but also occurs for Berea Sandstone and dolomite samples. Porosity values for limestone samples changed over time, so it can be said that pore space did not remain unaffected. For limestone samples changes between grain contacts or a rock-fluid interaction can be an explanation. Shear weakening for granite samples was mainly observed after 70°C drying and after 105°C drying the effect disappeared almost. It can be said that this samples were not dry and this caused shear weakening. It can also be observed that air humidity do not cause shear weakening.

THE INFLUENCE OF LENGTH FOR THE OPTIMAL SIGNAL TO DETERMINE THE SHEAR WAVE VELOCITY

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shear wave velocity, Akaike Information Criterion Picker

Compressional (v_p) and shear (v_s) wave velocity are important for the interpretation of datasets concerning mainly lithology and porosity. Many geomechanical parameters, like for example shear modulus or bulk modulus can be calculated from v_p and v_s . It is easier to determine compressional wave velocity than shear wave velocity. Nevertheless, both values are needed for calculations as well as model calculations and interpretation. Compressional and shear wave velocity were determined in the laboratory with an ultrasonic device (input signal: 80kHz) and the onset of v_p and v_s was detected with the Akaike Information Criterion Picker (AIC). A local minimum of the AIC is associated to the onset of the shear wave. Especially for lithologies with higher porosities, this local minimum is sometimes not clearly to identify.

Grey Berea sandstone samples (porosity about 23%) and "Bunt"-sandstone samples (porosity about 24%) are considered homogenous and were therefore selected for this study. Cores with different lengths of about 2.2cm, 3cm, 4cm and 5cm and diameter about 2.5cm were drilled. Different lengths were chosen to see if all samples show no local minimum in the AIC for the v_s onset. It was observed for "Bunt"-sandstone that samples with a length of 4cm deliver the best result. A local minimum can be seen and shear wave can be clearly determined. Shear wave velocity for Grey Berea sandstone was not so obvious.

Compressional wave velocity from Grey Berea sandstone samples is about 2400m/s and for "Bunt"-sandstone it is about 2600m/s. Shear wave velocity for "Bunt"-sandstone is about 1500m/s. It is important to know that core length has an influence on the v_s onset, hence sample preparation can be optimized. For "Bunt"-sandstone samples with a length lower than 4cm a signal superimposition could be an explanation.

LATEST IMPROVEMENTS AND REMAINING CHALLENGES IN TOOLS FOR ROCKFALL AND SHALLOW LANDSLIDE HAZARD ANALYSIS

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hazard analysis, rockfall, shallow landslides, modelling

Hazard analysis without the use of simulation models is unthinkable in the 21st century. However, despite the progress made in such tools, the hazard expert will still have to interpret model results and come up with an objective analysis. A comprehensive hazard analysis should ideally be based on a combination of a thorough inventory of historical events and silent witnesses in the field, an objective and scientific sound definition of hazard scenarios, a comparison of several modelling approaches and an in-depth analysis of the modelling results, accounting for the limitations of the used model.

In that process, the model should, according to my opinion, not be used for providing final answers, but for assisting in asking the right questions, which eventually lead to the final answers. In this presentation, we will address the above-mentioned points underpinned with examples from the praxis. These examples provide an excellent basis for comparing real-life events with results of different modelling tools and expert interpretations. In doing so, we will shortly review the improvements made over the last decades in rockfall simulation models and objectively evaluate the applicability of several rockfall models in the practice.

Special focus will be on the model Rockyfor3D (RF) and RAMMS-Rockfall (RAMMS). The two models are very different. In simple words, RF uses simple physics for describing rock-slope interactions, a wide range of stochastic approaches and a highly detailed approach for the modelling the barrier effect of trees. RAMMS uses complex physics for describing rock-slope interactions including real rock shapes, a stochastic approach for the initial release orientation of simulated rocks only and a generalised approach for modelling the effect of forests (homogeneous drag layer).

Regarding shallow landslides, we will focus on a range of disposition and runout models, which were applied to well-documented shallow landslides throughout Switzerland, which provide the possibility to compare real-life and modelled starting areas, runout zones and landslides pressures on buildings.

COMPARISON BETWEEN HOLOCENE AND MODERN EROSION RATES IN THE CATCHMENT OF THE 300 MW BASPA II HYDROELECTRIC POWER PLANT (INDIA, NW HIMALAYA)

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Himalaya, tectonics, climate, erosion, palaeo-lake

300 MW Baspa II is India's largest private hydroelectric facility that has been built exactly on top of a relict rock avalanche (Baspa Valley, NW Himalaya, India). The Baspa River is an important left-hand tributary to the Sutlej River. Geologically, the hydroelectric installation is located in the Higher Himalayan Crystalline, just above the active Karcham Normal Fault, which is reactivating the Early Miocene Main Central Thrust, one of the principal Himalayan faults. The area is seismically active and mass-movements are common. Around 8200 years before present the Baspa River was blocked behind this rock avalanche dam, which created a c. 260 m deep palaeo-lake. The whole palaeo-lake was completely filled with sediments in about 3100 years, making the Sangla palaeo-lake a very rare example of a mass-movement dam with exceptional long duration.

The archive of the lacustrine sediments have been used to reconstruct environmental changes as well as seismic activity during its existence. At least five levels of soft-sediment deformation have been recorded in the exposed part of the lacustrine sediments of Sangla palaeo-lake, including brecciated laminae, overturned laminae, folds, faults and deformation bands, separated by undeformed deposits. They are interpreted as seismites, indicating at least five earthquakes within ca. 2500 years of sedimentary record, strong enough to cause liquefaction.

The special location of the hydroelectric power plant on top of the palaeo-lake represents an extraordinary opportunity to evaluate the short-term, river load and hydrological parameters measured during the planning and operational stages of Baspa II with the long-term parameters from the palaeo-lake sediments from the catchment. The Early to Mid-Holocene erosion rates of the Baspa catchment estimated from the volume and duration of deposition of the lake sediments are at $0.7\text{-}1.0\text{ mm yr}^{-1}$, almost identical with the modern erosion rates calculated from river gauge data from Baspa II.

DETAILED MORPHO-LITHOLOGICAL MAPPING OF THE TSCHIRGANT ROCKSLIDE - ROCK AVALANCHE DEPOSIT (TYROL, AUSTRIA) AND IDENTIFICATION OF EMPLACEMENT PROCESSES

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rock avalanche, emplacement processes

In order to understand the emplacement dynamics of the Holocene Tschirgant rock avalanche (Tyrol, Austria), we systematically investigated the spatial distribution of lithological units, interrelationships of deposit morphology and sedimentology, as well as interactions with runout path topography and sedimentary valley fill. Lithological field mapping shows that the source stratigraphy was preserved in that the initial sub-vertical configuration of lithological units (as encountered in the source area) was translated into a radial, sub-horizontal geometry of broken, highly fragmented, spread, and sheared granular mass during rock avalanche deposition. Furthermore, strong connections between emplacement processes and deposit facies, as well as clear evidence of runout path materials influencing facies development was discovered through the detailed sedimentological studies.

Morphological mapping showed that two different emplacement modes of rock sliding and rock avalanche spreading occurred in this event. Since longitudinal ridge axes on the central rockslide deposit point straight back to the source scarp, these sliding blocks travelled along the main rockslope failure direction without being deflected by runout path topography. On the rock avalanche part, on the other hand, the ridge axes are oriented obliquely to the main failure direction and hence evidence motion change to radial spreading. However, distinct ridges are present exclusively in competent lime- and dolostones (Wetterstein Fm), whereas weaker siliciclastic-carbonate beds (Raibl Group) do not form pronounced ridges. Yet, the tendency of longitudinal feature formation is present in these units as well since clayshale marker beds are offset parallel to the local spreading direction.

Overall, the Tschirgant deposit impressively demonstrates the variant mechanical factors of rock mass properties and runout path conditions in the emplacement dynamics of large rockslides and rock avalanches.

TECTONOMETAMORPHIC EVOLUTION OF THE TSCHIGOT GRANODIORIT (TEXEL COMPLEX, ITALY)

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Texel Complex, Eastern Alps, Magnetic susceptibility

West of the Tauern Window the Eoalpine High-Pressure Belt (EHB; Thöni and Jagoutz, 1993) consists of two tectonic units: the Texel (including eclogites and the Tschigot granodiorite) and the Schneeberg unit. Due to the Eoalpine high-pressure event the Texel unit (TU) is attributed to the Koralpe-Wölz nappe system (Schmid et al. (2004). The westernmost part of the TU is dominated by a large, km-scale intrusion, the Tschigot Granodiorite. The rim of the intrusion displays a strong foliation with elongated feldspar porphyroclasts, while towards the central parts magmatic fabrics are still partly preserved. The Tschigot Granodiorite and the hosting paragneisses share a common deformation history (Spalla, 1989). In addition, basaltic dykes can be observed which are crosscutting the host rock and show no evidence for deformation.

For this study, the magnetic fabric of basaltic dyke- and granodioritic orthogneiss -samples were investigated to control the observations made in the field. Between the two sample sets, a considerable difference regarding the AMS fabrics could be determined. While the Tschigot Granodiorit shows a magnetic foliation (30° toward NW) and lineation (5 - 20° toward W), which perfectly corresponds to the structural field data, the mafic dykes shows no evidence of ductile deformation structures. Instead, the magnetic fabric of all mafic dykes yields a magmatic flow pattern so they did not experience the Eoalpine deformation together with the surrounding rocks.

We dated the granodioritic orthogneiss and the mafic dyke by U-Pb LA-ICP-MS on Zircon. Interestingly both samples yield similar concordia ages: 450.0 ± 1.3 Ma (granodiorite) and 462.3 ± 2.1 Ma (basalt). While the U-Pb age for the granodiorite is quite robust and in agreement with the Rb-Sr age previously published by Zantedeschi (1991), the U-Pb age of the mafic dyke contradicts the absence of Eoalpine deformation. Probably the zircons dated are inherited from the surrounding gneiss. To control the age a whole rock $^{40}\text{Ar}/^{39}\text{Ar}$ analysis based on infrared (CO_2) laser was performed on the mafic dyke. No proper plateau age could be measured, but the results implicated that the dykes are younger than 30 Ma.

TEXTURAL ATTRIBUTES FOR THE DESCRIPTION OF THE NATURALLY FRACTURED TENSLEEP FORMATION, TEAPOT DOME, WYOMING

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Seismic attributes, fractures, Teapot Dome

Seismic anisotropy describes the dependence of velocity on direction or upon angle. Variation in seismic velocity with direction may reflect lateral changes in facies, the presence of faults or fractures, or differences in pore fillings, among many factors that may influence velocity. In principal seismic data can be used to estimate volumetric azimuthal anisotropy. We use textural attributes based on the Grey Level Co-Occurrence Matrix (GLCM) to describe anisotropy effects within the Teapot Dome dataset (Wyoming, USA). The grey level co-occurrence matrix (GLCM), initially described by Haralick et al. (1973) as a tool for image classification, is a measure of how often different combinations of pixel brightness values occur in an image. This method has widely been used for classification of satellite images, and magnetic resonance and computed tomography images. In the field of seismic data interpretation, the GLCM has been used for description of facies, reservoir properties, and fractures. In most cases a simplified GLCM algorithm is used that allows calculation only in several directions or gives an average value of all directions. We developed a workflow that allows the calculation of GLCM based attributes in 49 directions. Based on this we can describe fracture azimuth and dip with a resolution of 22.5°. Furthermore, we can give a volumetric estimation of fracture intensity. The developed workflow is applied to a dataset from Teapot Dome, Wyoming, where a naturally fractured reservoir is present. For verification of the proposed method the results are compared to image log interpretations of four wells within the reservoir.

FELSSTURZEREIGNISSE IN DEN GEMEINDEN OBERTRAUN UND OHLSDORF; SICHERUNGSMÄßNAHMEN UND AUFTRETENDE UMSETZUNGSSCHWIERIGKEITEN

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Der Beitrag soll zwei Felssturzereignisse vom August 2014 bzw. Jänner 2015 aus dem oberösterreichischen Salzkammergut vorstellen.

Der Felssturz vom August 2014 fand in Obertraun am Hallstättersee statt. In der Nacht fiel ein Felsblock aus einer Steilwand auf ein direkt darunter gelegenes Wohngebäude und wurde dieses zerstört.

Im Zuge einer Geländebegehung wurden eine weitere Gefährdung hinsichtlich Felssturz- und Steinschlaggefahr im Bereich der Steilwand für mehrere Gebäude festgestellt. Im weiteren Verlauf wurde eine Detailkartierung der betroffenen Felswand vorgenommen und wurde ein Sicherheitskonzept für die unterhalb der Felswand gelegenen Häuser ausgearbeitet.

Der Felssturz in Ohlsdorf ereignete sich im Jänner 2015 im Bereich einer Konglomeratwand an der Traun. Der Abbruch fand unmittelbar an ein Siedlungsgebiet anschließend und oberhalb eines beliebten Wanderweges entlang der Traun, statt.

Der Felssturz umfasste Abschnitte oberhalb von Erosionsbuchten. Im Zuge von Geländebegehungen wurden nach dem Felssturz weitere absturzbereite und potentiell hinsichtlich Absturz gefährdete Abschnitte im Bereich der Konglomeratwand identifiziert. Eine Umsetzung von Sicherungsmaßnahmen wurde bisher nicht angegangen.

Aus geologischer Sicht erscheint nach stattgefundenen Felssturzereignissen, die fachliche Bewertung einer etwaigen weiteren Gefahr, die Beurteilung und Festlegung von Sofortmaßnahmen (mit Evakuierung von Gebäuden, Betretungsverboten etc.), die Geländeerhebung und Ausarbeitung und Umsetzung von Sicherungsmaßnahmen sehr wesentlich.

Der gegenständliche Beitrag soll aufzeigen, wie eine Ausarbeitung und Umsetzung von Sicherungsmaßnahmen im Regelfall stattfinden, weiter sollen Schwierigkeiten dargestellt werden, welche im Zuge von erforderlichen Umsetzungen entstehen können.

SEMI-AUTOMATED LANDSLIDE MAPPING BASED ON MULTISPECTRAL SATELLITE IMAGERY: TWO AUSTRIAN CASE STUDIES FROM THE LAND@SLIDE PROJECT

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landslide mapping, remote sensing, monitoring, automation, object-based

The vast availability of multispectral remote sensing data promotes research in the field of semi-automated landslide mapping. Decision makers and experts require tools that produce reliable landslide maps (1) regardless of input data resolution and area of interest, and (2) without the need for substantial user intervention. Such a tool would allow the creation/update of landslide databases which support susceptibility modelling and hazard zonation, as well as the digital documentation of landslide events.

Within the Austrian research project Land@Slide (FFG-ASAP), we develop robust landslide mapping routines based on various multi-temporal satellite images, ranging from high resolution (HR) Landsat data to very high resolution (VHR) WorldView-2/3 imagery. Development is conducted in line with previously acquired user requirements and specified mapping scenarios. The method of choice is object-based image analysis (OBIA) which has been recognized to be a new paradigm in remote sensing. This study will present results for two test areas:

(1) The first study in the Montafon, a region in the south of Vorarlberg, Austria, focuses on area-wide mapping of landslides. We use OBIA techniques to develop an effective mapping routine for post-event WorldView-2 and GeoEye-1 VHR images.

(2) The Fürweg landslide at Haunsberg (province of Salzburg) is one of the most famous landslides in Austria. The whole landslide body was reactivated in 1999. Until 2003, several parts of the landslide, particularly the southern part (Fürweg South), have been active, but large parts have been again covered by vegetation. The evolution of the landslide is mapped using Landsat time series HR data and object-based change analysis.

Based on these two case studies, the potential and limitations of semi-automated landslide mapping from multispectral satellite imagery are discussed. The semi-automated landslide maps are assessed with reference data; mapping routines are evaluated against user requirements. The improved mapping routines will feed into a landslide web service, the main output of the Land@Slide project.

CONSIDERATIONS ON THE AGE OF THE VERRUCANO GROUP OF SOUTHERN TUSCANY, ITALY

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Verrucano, redeposition, Fusulina limestones, U-Pb detrital zircon age

The Tuscan Verrucano Group is constituent of the Mid Tuscan Ridge: a linear belt, composed of several discretely uplifted, low to medium grade metamorphic core complexes, deformed and metamorphosed (HP-LT) during middle and late Tertiary subduction and subsequent exhumation, characterizing the internal Zone of the N-Apenninic fold and thrust belt (Brogi & Giorgetti 2012). The Verrucano Group present in the southern part of the Mid Tuscan Ridge is stratigraphically interposed between late Palaeozoic offlapping shallow-marine siliciclastics and transgressive early Mesozoic carbonates and evaporites. It is interpreted as continental rift fill at the base of the Alpine cycle: proximal to distal fluvial, partly litoral siliciclastics, deposited in the semiaride climate zone (Perrone et al. 2006). Its relative age founds on heavily recrystallized, fossiliferous reddish carbonate pebbles, exclusively found as accessories in conglomerate boulders of the basal and proximal Verruca Formation at Ferriera (263m) (Monticiano-Roccastrada Area) (Engelbrecht 1997). Coccozza et al. (1975) attributed its poorly preserved microfossil content - foraminifera - to the Early and early Middle Triassic.

Revision at the point of discovery and micropalaeontological age determination of new samples from the same type of pebbles (diameter up to 36cm) - reddish carbonates - yielded better preserved material with two fusulinid-associations of Late Carboniferous to Early Permian and Early Permian ages (Engelbrecht et al. 1989). Due to the facts that microfossils of Triassic age could not be ascertained by Engelbrecht (1997) and that microfossils figured in Coccozza et al. (1975) may also be of Permian age (E. Fluegel, pers. comm. March 1983), the depositional age of the S-Tuscan Verruca Formation may very probably be Late Permian. U-Pb age determinations in detrital zircons revealed 280 Ma as maximum depositional age of the S-Tuscan Verruca Formation (Sirevaag et al. 2016).

References:

- Brogi, A. & Giorgetti, G. (2012): *Tectonophysics*, 526-529: 167-184, Amsterdam.
Coccozza, T. et al. (1975): *Riv. Ital. Paleont.*, 81/4: 425-436, Milano.
Engelbrecht, H. (1997): Diss., Faculty of Geosciences, LMU Munich.
Engelbrecht, H. et al. (1989): *Riv. Ital. Paleont. Strat.*, 94/3: 361-382, Milano.
Perrone, V. et al. (2006): *Geol. Soc. London, Spec. Publ.* 262: 1-43.
Sirevaag, H. et al. (2016): *Gondwana Research*, <http://dx.doi.org/10.1016/j.gr.2015.12.006>

CHARACTERISATION OF AN ANCIENT OCEAN CONTINENT TRANSITION EXPOSED IN THE ERR-PLATTA NAPPES IN SE SWITZERLAND: CONTROLS ON PRESERVATION AND REACTIVATION

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OCT, Err-Platta nappes, reactivation

Studies in the Alps suggest that remnants of former Ocean-Continent Transitions (OCT) can be preserved even in internal parts of mountain belts. In the past, these units have been erroneously interpreted as either mélanges related to subduction channels or to result from polyphase penetrative Alpine deformation. Good examples have been described from the eclogitic Piemonte units in the Western Alps and in Corsica [Beltrando et al., 2014], leading to the question of what may have controlled the preservation of these structures. In our study we used the example of the Err-Platta nappes that expose remnants of the OCT of the former Alpine Tethys. The aim of our presentation is to: 1) define the characteristic features of an OCT across a fossil magma-poor rifted margin, and 2) show the control of the rift-inherited structures during the subsequent reactivation of the OCT.

The characteristics of OCTs at magma-poor rifted margins are the juxtaposition of serpentized mantle and crustal rocks and pre-rift sediments limited by brittle extensional detachment faults sealed by syn- and post-tectonic sediments locally associated with magmatic rocks. Thus, in contrast to proximal margins, where lithologies are continuous layer cakes, OCTs are characterized by non-continuous layers and isolated blocks. To identify extensional detachment faults in mountain belts, different fingerprints can be found such as characteristic fault rocks (gouges and cataclasites) that bear a mantle derived fluid signature, or the occurrence of massive breccias that contain clasts of the underlying exhumed basement.

Using field examples, we will show how Alpine structures selectively reactivated some inherited structures of the OCT, while others remained undeformed and were preserved in the nappe stack. How far the complex morphology, fault architecture and rheology of OCTs control the reactivation is still unclear, however, it appears that serpentization fronts, or former extensional detachment faults may have played a key role during the reactivation of the rifted margin. This study allows us to reconsider "mélange zone" described in many collisional orogens, and to test, using diagnostic criteria and field observations, if they could represent former OCTs.

References:

Beltrando et al. Earth Science Reviews (2014)

ÇORAKYERLER, THE LAST STAND OF THE TURKISH GREAT APES

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Çorakyerler, Late Miocene, Turolian, Large mammals, Paleoenvironment, Turkey

The Turkish locality of Çorakyerler is mainly known for being the youngest locality in the region with hominoids. But twenty years of excavation have also yielded over 3000 specimens of mammals including hominoids represented by 5 individuals. This offers a unique possibility for studying the circumstances just before the extirpation of the Miocene apes in Turkey at the beginning of the Turolian.

Recently, the locality was suggested to be at least 8.5 Ma old, implying that the ecosystem surrounding the hominoids survived well into the Turolian, a period characterized by its open, savannah-like landscapes. At 8.5 Ma, the fauna would correlate to the later part of MN 11. Although the fauna, and particularly the micromammals, clearly indicates a Turolian age, the suggested age is not in line with the faunal evidence. Some of the species found are mostly known from MN 10. Moreover, the large mammal fauna indicates a forested environments with, apart from the hominoids, taxa like *Tetralophodon*, *Microstonyx* and *Ancylotherium*. By contrast, open environment taxa are rare. *Gazella* and the large giraffid *Bohlinia*, for instance, are both represented by one specimen only, and last year a single mandible of the porcupine *Hystrix* was found. The small mammal assemblage, however, seems more indicative for an open landscape.

Reinterpretation of the magnetostratigraphy places Çorakyerler around ~8.9 Ma, which does fit its character of an earliestmost Turolian (beginning MN 11) type fauna. This date, placing the MN 10/MN 11 boundary in Anatolia somewhat earlier than in western Europe, also confirms that the opening of the landscape developed from east to west. Thus, the picture emerges of the apes surviving in the forested surroundings of a lake, with the plains closing in. These plains were also the hunting ground for the raptors responsible for the accumulation of the micromammals. Although the apes did not survive the change in biota, Çorakyerler provides an interesting analogue for the ecosystems in which our ancestors lived before they entered onto the African plains in the Pliocene.

FIRST INSIGHTS INTO THE TECTONOMETAMORPHIC EVOLUTION OF SUBDUCTED CONTINENTAL CRUST – LU-HF GEOCHRONOLOGY OF AN ECLOGITE SAMPLE IN THE SEVE NAPPE COMPLEX IN NORTHERN JÄMTLAND, SWEDEN

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Lu-Hf geochronology, eclogite, subduction, Scandinavian Caledonides, Seve Nappe Complex

The Seve Nappe Complex (SNC) in the Scandinavian Caledonides represents the distal part of the margin of Baltica, which was subducted to depth of UHP metamorphism during the Caledonian orogeny. In contrast to the ages determined for the Western Gneiss Complex in Western Norway (ca. 400 Ma) which is interpreted to represent the subducted Baltican basement, the ages in the SNC and related nappes are overall older (ca. 500–430 Ma). As the ages in the SNC are quite diverging it is difficult to reveal the tectonometamorphic history of this unit. Therefore we plan to date samples from different localities within the SNC with Lu-Hf geochronology in order to make it easier to compare the ages.

The sample we present is an eclogite from Tjeliken, Northern Jämtland. There the SNC can be divided into three tectonic units, an Eastern, Middle and Western belt. The locality of Mt. Tjeliken is situated in the Eastern Belt. Thermodynamic modelling of this eclogite yielded 25–26 kbar at 650–700 °C (Majka et al. 2014). Previous dating produced diverging ages of 460 ± 4 Ma (Sm-Nd mineral isochrones, Brueckner & Van Roermund 2007) and 446 ± 1 Ma (U-Pb zircon dating, Root & Corfu 2012). We present Lu-Hf whole-rock-garnet-ages of this eclogite, in order to further evaluate the age of HP metamorphism in this sample. The HP assemblage of our sample is garnet + omphacite + Ti-phases and retrograde minerals are amphibole, chlorite and plagioclase. The garnets preserved a prograde growth zonation concerning major elements and lutetium. An isochron from two garnet separates and two whole rocks (tabletop digestion and PARR bomb digestion) yielded an age of 457.9 ± 1.0 Ma, with a MSWD of 0.73. The fact that Sm-Nd and Lu-Hf dating yielded identical ages within error suggests fast subduction. The U-Pb zircon age probably reflects a post peak-metamorphic stage.

Brueckner & Van Roermund 2007. *Journal of the Geological Society, London*, 164, 117–128.

Majka et al. 2014. In: Corfu et al., eds., *New Perspectives on the Caledonides of Scandinavia and Related Areas: Geological Society of London Special Publication 390*, p. 369–384.

Root & Corfu 2012. *Contributions to Mineralogy and Petrology*, 163, 769–788.

SATTELKAR – VOM BLOCKGLETSCHER ZUR GROßMASSENBEWEGUNG

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Nachdem das ewige Eis der Tauern langsam aber doch seinen Aggregatzustand ändert, werden mächtige Schuttablagerungen den Erosionsprozessen überantwortet. So hat sich seit 2005 im Sattelkar eine Massenbewegung mit großer Vehemenz in Bewegung gesetzt, schreitet seither in periglazialen Ablagerungen rück und hat mit mittlerweile mehr als 13 ha Fläche und Geschwindigkeiten von rd. 10 m/a ein durchaus bedeutsames Ausmaß erreicht. Nach einem 200 m hohen Steilabfall in einen Murstrom transformiert, stellen die Materialumlagerungen für den örtlichen Obersulzbach und vorhandene Infrastruktur ein maßgebliches Gefährdungspotential dar. Als tiefst liegendes von 4 Karen ist ein genauerer Blick auf Prozess, Entstehung, Entwicklung und Risiko von breiterem Interesse. Im Kurzvortrag sollen dazu Ein- und Ausblicke präsentiert werden.

MG-METASOMATISM DURING SUBDUCTION: TWO EXAMPLES FROM UHP CRUSTAL LITHOLOGIES OF THE WESTERN ALPS UHP METAMORPHISM, WHITESCHISTS, TALCSCHISTS, ANTIGORITE BREAKDOWN

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UHP metamorphism, whiteschists, talcschists, antigorite breakdown

Mg-metasomatic rocks (e.g. whiteschists, leucophyllites) derived from post-Variscan granitoids are widespread in the Alps and the presence of features in common indicates that the genetic process is likely similar in the entire range of the Alps. This process assumes the presence of highly channelized fluids, derived from ultramafic rocks previously interacting with seawater, that infiltrate the continental crust along shear zones. The infiltration can occur during rifting, continental subduction and/or continent–continent collision (Ferrando, 2012).

Syn-subduction Mg-metasomatism produced by the influx of external fluids generated by antigorite breakdown from subducting oceanic serpentinites is well recorded in two UHP crustal lithologies from the Western Alps.

The first example is represented by the typical UHP whiteschists of the Brossasco-Isasca Unit (Dora-Maira Massif). Some whiteschists, derived from xenoliths of pelitic composition within metagranites, still preserve relics of the former pre-metasomatic mineral assemblage equilibrated during prograde Alpine metamorphism (ca. 600°C and 1.6 GPa; Compagnoni & Hirajima, 2001). Microstructural evidence indicates that the Mg-metasomatism occurred at 1.7–2.1 GPa and 560–590 °C and possibly continued up to 2.8 GPa and 650°C in the presence of MgCl₂-brines (Ferrando et al., 2009).

The second example is from coesite + chloritoid + garnet ± glaucophane talcschists used to produce four quernstones unearthed in the ruins of a villa rustica belonging to the Roman imperial period (Costigliole Saluzzo, Western Alps; Groppo et al., 2016). These Mg-metasomatic rocks, recording peak conditions of 480–510°C and 2.7–3.1 GPa, belong to a still unmapped UHP Unit of the Western Alps. The former protolith is likely a Fe-rich metapelite, and relics of chloritoid still rich in Fe within garnet indicate that Mg-metasomatism occurred during prograde Alpine metamorphism (P < 2.5 GPa).

Compagnoni R., Hirajima T. (2001): *Lithos*, 57, 219–236.

Ferrando S. (2012): *Terra Nova*, 24, 423–436.

Ferrando, S., Frezzotti, M.L., Petrelli, M., Compagnoni, R. (2009): *J. Metamorphic Geol.*, 27, 739–756.

Groppo C., Ferrando S., Castelli D., Elia D., Meirano V., Facchinetti L. (2016, first on line): *Eur. J. Mineral.*, doi: 10.1127/ejm/2016/0028-2531

LONG RANGE TERRESTRIAL LASER SCANNING (TLS) FOR THE DEFORMATION MONITORING OF ALPINE SLOPES

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Lidar, Terrestrial laserscan, change detection, landslides, geomorphological processes

Terrestrial laser scanning (TLS) is an emerging method for spatial deformation monitoring of natural slopes and constructions. The method is established for short ranges up to 300 m and permits to detect surface displacements in the range of sub-centimetres. Deformation monitoring of large alpine rock slopes is more challenging because of generally long measurement distances, the rough terrain, and sometimes complex slope deformation behaviour. In addition, the steep and often inaccessible terrain requires a careful planning of the data acquisition campaign in order to avoid scan shadows. With an increasing range the positional uncertainties of the point measurements are increasing due to the widening and elongation of the laser footprint and high local surface roughness (fractured rock mass, vegetation). These factors influence the quality of registration and the distance measurement and must be considered when the measured deformations are interpreted. We present methods and workflows for the use of TLS data for 3D deformation monitoring. This comprises data acquisition, registration, quality assessment, and the identification and quantification of surface deformations. The registration of scans from different epochs is performed by matching stable areas with an iterative closest point (ICP) algorithm. This approach does not require the exact determination of the scan position and the use of external targets, and thus saves a lot of time during data acquisition. In order to be able to distinguish between real changes and measurement uncertainties, a level of detection (LOD) is computed for each distance measurement. The LOD considers spatially variable positional uncertainties (dependence to object geometry and range), local surface roughness and registration errors. Distances greater than the LOD are automatically detected as real change and analysed with regard to their deformation behaviour. A robust 3D distance measurement approach, developed to cope with high surface roughness and scan shadows is applied to quantify mass relocations of erosion, rockfall, debris flows and to generate difference maps. Image correlation methods are used to generate displacement maps of slides showing the magnitudes and directions (3D vectors) of movements. The applied TLS methods and workflows provide sound basis for geomorphological and kinematic interpretations of the investigated slope deformations.

HINWEISE AUF PERMISCHE UND TRIASSISCHE METAMORPHOSEPHASEN IM TAUERNFENSTER DURCH DIE CHEMISCHE U-TH-PB DATIERUNG VON AKZESSORISCHEN URANINIT-MIKROKRISTALLEN

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Uraninite, Geochronology, Tauern Window, Permian Metamorphism

Im Tauernfenster sind prominente magmatische Ereignisse im Altpaläozoikum und Devon nachgewiesen, ebenso eine variszische Regionalmetamorphose (Von Quadt 1992, Eichhorn et al. 2001, Kebede et al. 2005). Im Karbon und Perm intrudierten verbreitet Granite (Eichhorn et al. 2000), welche heute als Orthogneise (Zentralgneise) vorliegen. Eichhorn et al. (1995) diskutieren erstmals auch eine permische Metamorphose aufgrund von U-Pb Altersbestimmungen an Titanit. Wegen der penetrativen alpidischen Regionalmetamorphose im Tertiär und der damit verbundenen Rücksetzung vieler Geochronometer ist es schwierig, die prä-Tertiäre thermische Entwicklung des Tauernfensters im Detail zu rekonstruieren. Infolge der alpidischen Metamorphose könnten viele Spuren älterer niedrigtemperierter Ereignisse verlorengegangen sein.

Es ist somit nützlich nach speziellen Geochronometern Ausschau zu halten, welche auf niedriggradig gebildeten Mineralen basieren, gleichzeitig aber eine hohe Robustheit gegenüber einer regionalmetamorphen Überprägung aufweisen. Ein Mineral, das diese Anforderung erfüllen könnte, ist der Uraninit. Wie aktuelle Untersuchungen zeigen, ist Uraninit in vielen Gesteinen des mittleren Tauernfensters in Form von Mikrokrystallen (1-10 μm) präsent. Zum Teil liegen diese als sekundäre Bildungen in metamikten Uran-reichen Zirkonen vor.

Die Bleigehalte in den Uraninit-Mikrokrystallen geben Hinweise auf ein permisches und ein triassisches thermisches Ereignis. Permische Uraninitalter um 270 Ma fanden sich bevorzugt in Zentralgneisen mit karbonischem Protolithalter (Felbertauern Augengneis, K1-Gneis der Scheelitlagerstätte Felbertal), die Triasalter (200-220 Ma) in Zentralgneisen mit vermutetem permischen Protolithalter (Granatspitzgneis, Aplitgneis Reichenspitze), sodass sich in beiden Fällen anscheinend Metamorphoseereignisse abbilden.

Die Uraninitalter erweitern den geochronologischen Kenntnisstand für das Tauernfenster beträchtlich. Während eine permische Regionalmetamorphose im ostalpinen Grundgebirge heute unbestritten ist (Schuster und Stüwe 2008), blieben entsprechende Hinweise im Tauernfenster (Eichhorn et al. 1995) bisher eher unbeachtet. Das Vorhandensein einer permischen Metamorphose im Tauernfenster wird nun durch die Uraninitalter erneut wahrscheinlich gemacht. Die Krustenaufheizung steht vermutlich im Zusammenhang mit der Intrusion der permischen Zentralgneiskörper und ist wohl ebenso wie im Ostalpin als extensionales Ereignis zu interpretieren.

Neu sind die durch die Uraninitdatierungen gewonnenen Hinweise auf ein triassisches thermisches Ereignis im Tauernfenster.

WURF_LIVE: DEMONSTRATION OF A STOCHASTIC NUMERICAL ROCKFALL CODE IN 3D

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Rockfall, Computer Modelling, Stochasticity, Ray Tracing

Rockfall is a natural phenomenon with a characteristic kinematic signature which distinguishes it among other types of mass movements. It can significantly contribute in the geomorphological evolution of natural slopes and the formation of talus deposits. On the other hand it poses a great risk to human activities and constructions in mountainous areas and quarries.

Numerical modelling can assist in, a better understanding of the phenomenon, the selection of case specific risk mitigation strategies and the design as well as optimization of any necessary protective structures. Although the law of physics controlling rockfall, at first might seem completely determining the process, immediately significant complexity and uncertainty arise in defining the necessary parameters and their distribution over a natural terrain with an appropriate spatial resolution. Random behaviour is a challenging feature of rockfall, which must be investigated in a modelling approach.

Wurf_ is a numerical code, implemented in python, that simulates rockfall trajectories and kinematics in full three dimensional space. At its initial stage of development, it adopts a lumped mass approach to describe a boulder as a projectile and implements a ray tracing computational algorithm to precisely calculate impacts with a terrain, represented by a TIN model. It accounts for random behaviour, arising from parameters such as the exact projectile's shape and slope's roughness, by stochastically varying the orientation of the impact surface. Upon impact detection, kinematics are determined through Goldsmith's solution for a collinear impact of a sphere on a planar surface. Coefficients of restitution are being calculated through hyperbolic functions, according to size and the kinetic energy of the projectile.

The few unknown variables controlling the response of the model, can be estimated through a back analysis of data derived from physical experiments. So far the code has been calibrated against a campaign of drop tests conducted at Austrian and Canadian quarries, exhibiting a remarkable predictive ability for its simplicity.

SEASONAL CHANGE DETECTION OF THE STEINLEHNEN LANDSLIDE BY MULTI-TEMPORAL LONG-RANGE TERRESTRIAL LASER SCANNING (TYROL, AUSTRIA)

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deep-seated rockslide, terrestrial laser scanning, monitoring, change detection

The recent development in terrestrial laser scanning (TLS) operating in the long-range domain, allows for operational monitoring of environmental changes such as landslides in high temporal frequency. We observed the landslide Steinlehn located in Sellrain (Tyrol, Austria), which is composed of several parts with different activity. In June 2003, acceleration up to several metres per day of one of these parts has been documented. After that event, the movement rates decreased considerably. Following up this observation our research aims at the investigation of the landslide's current movement rates within one year by separating and dating landslide accelerations, geomorphological processes, and changes due to vegetation growth. Between November 2014 and November 2015 five TLS acquisitions have been conducted with the long-range TLS Riegl VZ-6000. First results identify an active part with displacements in order of centimetres per year. In the long-range domain, footprint size and distortion due to incidence angle and range effects have a larger impact on registration, accuracy and detail of object representation. Thus, for landslide monitoring the uncertainties in the error-budget make it difficult defining a threshold for the minimum detectable change occurring between two measurements. In our test case vegetation has been filtered and geomorphological processes such as rockfalls and debris flows, have been detected and assigned to specific periods of time within the year of measurement. The presented results contribute to the knowledge of potentials and limitations regarding activity- and movement-measurements as well as geomorphological questions by using long-range-TLS. The results help estimating the hazard potential within the landslide Steinlehn. For additional validation and continuity of the time series, further TLS measurements are planned during summer 2016.

CHANGES IN FLORAL COMPOSITION AND $\delta^{13}\text{C}$ IN THE KUNGURIAN OF TREGIOVO (CISURALIAN, SOUTHERN ALPS)

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Cisuralian, Kungurian, $\delta^{13}\text{C}$, fossil plant

The Tregiovo Basin (Trento province, Southern Alps, Italy) is already well known for its plant macroremains, vertebrates and invertebrates footprints, conchostracans and palynomorphs. It is filled by the Tregiovo Formation, a sedimentary succession enclosed between the volcanic Ora and Gargazzone formations, which are radiometrically dated 274.1 ± 1.6 Ma and 276.5 ± 1.1 Ma, respectively. This implies that the Tregiovo Formation is middle Kungurian in age. Two new fossiliferous levels, bearing abundant and diverse plant assemblages (more than 1000 rock slabs), were found. The two plant assemblages come from finely laminated sediments, interpreted as lacustrine deposits rich of organic matter (ca. 1% TOC). The comparison between the two plant assemblages shows a clear floral change in the quantitative composition. The Lower Assemblage A is characterized by the dominance of conifers (more than 80%, e.g., *Hermitia*, *Feysia*, *Quadrocladus*, *Dolomitia*), and by the occurrence of sphenophytes (*Annularia*), ginkgophytes, pteridosperms (e.g. *Peltaspermum*), taeniopterids and sphenopterids. The Upper Assemblage B is also dominated by conifers, which however decrease in abundance (around 60%) in favour of ferns and seed ferns, (e.g. *Peltaspermum* and sphenopterids), that account for more than 30%, in contrast with 6% in Lower Assemblage A. Other accessory elements are taeniopterids and ginkgophytes. This clear change in the floral composition is paralleled by an increasing abundance of bisaccate pollen. Preliminary stable isotopic analyses revealed a clear trend of the $\delta^{13}\text{C}$ of bulk organic matter towards more negative values (VPDB). Thus, the two floras are characterized by a different $\delta^{13}\text{C}$, and more precisely, the $\delta^{13}\text{C}$ of Upper Assemblage B is more negative than that of Lower Assemblage A. Whether this isotopic shift has to be attributed to a global perturbation of the atmospheric $\delta^{13}\text{C}$, or to a local environmental factor (e.g., different floral composition) will be the object of future investigations.

EUSTATIC CYCLES ACROSS THE P-T BOUNDARY: EVIDENCE FROM THE NW TETHYAN SHELF (WERFEN FORMATION) AND THE PERI-TETHYAN REALM (BUNTSANDSTEIN)

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P-T boundary, sequence-stratigraphy, eustatic cycles, Tethyan shelf, peri-Tethyan realm

The Werfen Formation is characterised by repeated lithological changes recording substantial shifts of shorelines and thus, the sea-level history of the NW Tethyan shelf. Highstands are documented by the maximum expansion of marine limestones, whereas lowstands are documented by the maximum progradation of terrestrial to coastal environments. Applying sequence-stratigraphic procedures, maximum expansions of marine strata are considered maximum flooding surfaces (mfs) and maximum progradations of terrestrial strata are considered maximum regression surfaces (mrs). Consequently, the Werfen Formation records three T-R sequences, most probably of 3rd order. Starting with the Bulla Member (Bellerophon Formation) sequence 1 has its mfs in the Mazzin Member and terminates with the mrs in the Andraz Member. Sequence 2 has its mfs in the Seis Member and terminates with the mrs at the top Campil Member and sequence 3 has its mfs in the Val Badia Member and terminates with the mrs at the top San Lucano Member.

Likewise, the Buntsandstein is characterised by repeated changes in lithologies recording substantial shifts of shorelines and thus, the sea-level history of a semi-enclosed inland sea that covered the Central European Basin (CEB). Highstands are documented by the maximum expansion of brackish-marine clastics and limestones and lowstands are documented by the maximum progradation of terrestrial clastics. A basin-scale correlation reveals pronounced stratal pattern architectures of three T-R sequences, most probably of 3rd order. Sequence 1 starts in the upper Fulda Formation (Zechstein), has its mfs in the Calvörde Formation and terminates with the mrs in the upper Calvörde Formation. Sequence 2 has its mfs in the Bernburg Formation and terminates with the mrs in the lower Volpriehausen Formation and sequence 3 has its mfs in the upper Volpriehausen Formation and terminates with the mrs in the Solling Formation.

The correlation of latest Permian - early Triassic T-R sequences indicates synchronised sea-level records of the Tethyan and peri-Tethyan realms. This point to: a) the CEB was covered by a brackish-marine inland sea, b) the inland sea and the Tethyan shelf sea were controlled by eustatic cycles, and c) both were connected via a gate in southern Poland.

STRUCTURAL RECORD OF LOWER MIOCENE WESTWARD MOTION OF THE ALBORAN DOMAIN IN THE WESTERN BETICS, SPAIN

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Western Betics, Strike-slip corridors, Thrust and lateral ramps, Slab tearing

In the framework of the Africa–Europe convergence, the Mediterranean system presents a complex interaction between subduction rollback and upper-plate deformation during the Tertiary. The western end of the system shows a narrow arcuate geometry across the Gibraltar arc, the Betic–Rif belt, in which the relationship between slab dynamics and surface tectonics is not well understood. The present study focuses on the Western Betics, which is characterized by two major thrusts: 1) the Internal/External Zone Boundary limits the metamorphic domain (Alboran Domain) from the fold-and-thrust belts in the External Zone; 2) the Ronda Peridotites Thrust allows the juxtaposition of a strongly attenuated lithosphere section with large bodies of sub-continental mantle rocks on top of upper crustal rocks. New structural data show that two major E-W strike-slip corridors played a major role in the deformation pattern of the Alboran Domain, in which E-W dextral strike-slip faults, N60° thrusts and N140° normal faults developed simultaneously during dextral strike-slip simple shear. Olistostromic sediments of Lower Miocene age were deposited and deformed in this tectonic context and hence provide an age estimate for the inferred continuous westward translation of the Alboran Domain that is accommodated by an EW lateral (strike-slip) ramp and a N60° frontal thrust. The crustal emplacement of large bodies of sub-continental mantle may occur at the onset of this westward thrusting in the Western Alboran domain. At lithosphere-scale, we interpret the observed deformation pattern as the subduction upper-plate expression of a lateral slab tear and its westward propagation since the Lower Miocene.

DEFORMATION MECHANISMS IN A CONTINENTAL RIFT UP TO MANTLE EXHUMATION. FIELD EVIDENCE FROM THE WESTERN BETICS, SPAIN

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Necking, Mantle exhumation, Hyper-stretching, Ronda Peridotites, Western Betics

The identification of the structures and deformation patterns in magma-poor continental rifted margins is essential to characterize the processes of continental lithosphere necking. Brittle faults, often termed mantle detachments, are believed to play an essential role in the rifting processes. Ductile shear zones in the deep crust and mantle are nevertheless rarely identified and their mechanical role remains to be established. The western Betics (Southern Spain) provide an exceptional exposure of a strongly thinned continental lithosphere, formed in a supra-subduction setting during Oligocene-Lower Miocene. A full section of the entire crust and the upper part of the mantle is investigated. Variations in crustal thickness are used to quantify crustal stretching that may reach values larger than 2000% where the ductile crust almost disappears. Opposite senses of shear top-to-W and top-to-E are observed in two extensional shear zones located close to the crust-mantle boundary and along the brittle-ductile transition in the crust, respectively. Where the ductile crust almost disappears, concordant top-to-E-NE senses of shear are observed in both upper crust and serpentinitized mantle. Late high-angle normal faults crosscut the previously hyper-stretched domain, involving both crust and mantle in tilted blocks. Three successive steps can be thus identified in the progressive necking of the continental lithosphere in the section of the Western Betics: i/a mid-crustal shear zone and a crust-mantle shear zone, acting synchronously but with opposite senses of shear, accommodate ductile crust thinning and ascent of subcontinental mantle; ii/hyper-stretching localizes in the neck, leading to an almost disappearance of the ductile crust and bringing the upper crust in contact with the subcontinental mantle; and iii/high-angle normal faulting, cutting through the Moho, with related block tilting, ends the full exhumation of the mantle in the zone of localized stretching. The presence of a high strength sub-Moho mantle is responsible for the change in sense of shear with depth. Whereas mantle exhumation in the western Betics occurred in a backarc setting, this deformation pattern controlled by a high-strength layer at the top of the lithosphere mantle makes it directly comparable to most passive margins whose formation lead to mantle exhumation.

INVESTIGATION OF SUBMARINE LANDSLIDE ACTIVITY OFF NEW ZEALAND WITH THE SEA FLOOR RIG MARUM-MEBO200

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robotic drilling, bore hole logging, submarine land slide

The MARUM-MeBo (abbreviation for Meeresboden-Bohrgerät, the German expression for seafloor drill rig) is a robotic drilling system that is developed since 2004 at the MARUM Center for Marine Environmental Sciences at the University of Bremen in close cooperation with Bauer Maschinen GmbH and other industry partners. The MARUM-MeBo drill rigs can be deployed from multipurpose research vessel like, RV MARIA S. MERIAN, RV METEOR, RV SONNE and RV POLARSTERN and are used for getting long cores both in soft sediments as well as hard rocks in the deep sea.

The first generation drill rig, the MARUM-MeBo70 is dedicated for a drilling depth of more than 70 m (Freudenthal and Wefer, 2013). Between 2005 and 2015 it was deployed on 16 research expeditions and drilled more than 2.5 km into different types of geology including carbonate and crystalline rocks, gas hydrates, glacial tills, sands and gravel, glacial till and hemipelagic mud with an average recovery rate of 74 %.

We used the development and operational experiences of MARUM-MeBo70 for the development of a second generation drill rig MARUM-MeBo200. This drill rig is dedicated for conducting core drilling down to 200 m below sea floor. In October 2014 it was successfully tested on the new research vessel RV SONNE in the North Sea.

In this presentation we show drilling and borehole logging results of the first scientific expedition with the MARUM-MeBo200 conducted in March/April 2016 on the research vessel RV SONNE (SO247). The scientific target of this expedition was the investigation of the submarine landslide activity at the Hikurangi Margin off New Zealand. During 12 deployments we drilled altogether 514 m in hemipelagic sediments with volcanic ashes as well as in muddy and sandy slide deposits. The average core recovery was about 54%. The maximum drilling depth was 105 m below sea floor. Borehole logging was conducted using an autonomous probe analyzing for spectrum gamma ray and electric inductivity.

References: Freudenthal, T and Wefer, G (2013) Drilling cores on the sea floor with the remote-controlled sea floor drilling rig MeBo. *Geoscientific Instrumentation, Methods and Data Systems*, 2(2). 329-337. doi:10.5194/gi-2-329-2013

3D COUPLED FLUID- AND HEAT FLOW MODELLING OF THE SUBSURFACE OF BERLIN, GERMANY

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geothermal energy, 3D coupled thermal modeling, hydraulic boundary conditions, subsurface utilization

The goal of this study is carry out a quantitative and qualitative analysis of the modifications of the fluid flow- and geothermal field induced by implementing newly available hydraulic data (groundwater recharge rates, surface waters and groundwater wells) into an existing 3D coupled fluid- and heat flow model.

The study area is located in the Northeast German Basin, showing an infill of several kilometers of sediments. Herein, sedimentary units of particular interest in this succession are namely the Middle Buntsandstein and Sedimentary Rotliegend, both displaying favorable hydraulic properties for geothermal exploration.

Previous studies already showed how the geothermal field is mainly controlled by contrasts in the thermal and hydraulic conductivity between the different model units. Here, the highly thermally conductive Permian Zechstein salt and the lowly hydraulically conductive Rupelian clay majorly shape the distribution of subsurface temperatures. These are coupled with the thermal and hydraulic boundary conditions prescribed, where the latter largely controls the nature and vigor of fluid flow, e.g. forced convective cooling of the deeper subsurface. This study therefore aims to analyze the influence of the hydraulic boundary conditions and properties on heat transport processes and associated subsurface temperature predictions.

Analysis results are visualized in form of temperature maps at fixed depths as well as for target horizons and isotherms of interest for geothermal prospect. Additionally, the dynamics of the fluid flow field are shown via stream tracer maps.

MAPPING AND STRUCTURAL GEOLOGICAL STUDY OF A META GABBRO NAPPE AT SOUTHERN SWEDEN, GÖTEBORG

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Sweden, Mapping, structural geological, meta gabbro nappe

The geology in SW Sweden is strongly influenced by the sveconorwegian orogeny (1.1- 0.9 Ga). During this deformational event the Idefjorden Terrain was aggregated on the Baltic Shield and large crustal units have been sheared on Baltica and stacked on each other. These crustal units are built up mainly of meta-sediments (ca. 1.67 Ga) which have been intruded by several magmatic suites (ca. 1.5-0.9 Ga) of felsic as well as mafic to ultramafic composition.

During field work northwest of Kungälv (SW Sweden) a nappe pile at Tjuvkils Huvud (A. Friebel) and Nordön (N. Meyer) has been mapped. It consists of a meta-gabbro nappe that has been sheared onto a meta-sedimentary unit. During this tectono-metamorphic event the meta-sediments as well as the meta-gabbro have experienced a metamorphic overprint, whereas the latter has been deformed into several boudins. Furthermore at the base of the meta-gabbro several lenses of meta-granodiorite have been included along the shear plane.

Field results indicate that the shearing was followed by another compressional deformational event. During this process the whole complex was bent as recognized by rotation of the stretching lineation from SE (ca. 100/15) at Tjuvkil Huvud to SW (ca. 210/20) at Nordön. Furthermore the meta-sedimentary unit shows a rotation of foliation direction whereas even migmatization textures have been rearranged parallel to the observed stretching lineation. This study aims to model the base of the meta-gabbro nappe by tectonic data collected during the field work and on the basis of geological profiles. Furthermore the different lithologies are analysed microscopically with special focus on shear sense indicators as well as mineral and stretching lineation. Moreover the grade of the metamorphism was determined to reconstruct the p-T-conditions during this deformation.

MICROFACIES AND CARBON ISOTOPE ANALYSES ON PERMIAN-TRIASSIC BOUNDARY MICROBIALITES FROM ARMENIA

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Permian-Triassic Boundary Microbialites, Lower Triassic, Microfacies Analyses, Carbon Isotope Studies

After the End-Permian mass extinction, which was the most severe biotic crisis in Earth's history, microbial communities colonized the space left vacant after the disappearance of skeletonised metazoans. These microbial communities formed the so-called Permian-Triassic Boundary Microbialites (PTBMs), which flourished during four phases in the Lower Triassic and were abundant in low-latitude, shallow marine carbonate shelves in the Palaeotethys and Neotethys. In some sites they co-occur with so-called Calcium Carbonate Crystal Fans (CCFs).

The PTBMs from southern Armenia were formed in a distal open marine setting on a pelagic carbonate ramp in the Palaeotethys. These PTBMs flourished during two microbial growth phases in the Griesbachian, whereas the PTBMs formed during the first microbial growth phase co-occur with CCFs. The microbialites, predominantly thrombolites and less common dendrolites, vary in size between 5 cm to 1.5 m. The biggest microbialite has a total height of around 12 m and a top head diameter of up to 8 m. This microbialite shows an asymmetrical growth that indicates a steady bottom current.

Microfacies analyses revealed that the PTBMs show a number of different growth forms and internal structures and that PTBMs and CCFs were formed above the sediment surface. Moreover, the PTBMs and CCFs are embedded in a bioclastic wackestone that mainly contains ostracods, foraminifers, microgastropods, thin-shelled bivalves, ammonoids and sponges.

Carbon isotope studies, which were performed on both the microbialites and the surrounding sediment, revealed that the microbialites that formed during the first microbial growth phase are up to 2.3‰ more positive than the surrounding sediment. In contrast, the $\delta^{13}\text{C}$ values of the microbialites that formed during the second microbial growth phase and the surrounding sediment are nearly the same, with a maximum difference of 0.4‰. This isotope signature could be the result of microbial activity.

ACCRETION AND COLLISION IN THE NEOPROTEROZOIC MOZAMBIQUE BELT OF EAST AFRICA: THERMAL BUDGET AND TECTONIC STYLES

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East African Orogens, Tectonic Styles

The East African orogen extends ca. 6000 km north-south along Africa's east coast and formed by closure of oceanic domains (Mozambique Ocean) between ca. 900 and 550 Ma. The northern part, the Arabian Nubian Shield (ANS), is predominantly juvenile crust that assembled during a protracted period of island-arc and microcontinent accretion. To the south of the ANS, the Eastern Granulite – Cabo Delgado Nappe Complex (EGCD) of southern Kenya, Tanzania and Mozambique was an extended crust that formed adjacent to the Mozambique Ocean. Inversion of previously extended crust and collision of Gondwana fragments resulted in 650–620 Ma Mozambique Orogeny. Oceans still persisted after 620 Ma between East Antarctica, India, parts of the Congo–Tanzania Cratons and the Zimbabwe–Kalahari Craton. They closed during the 600–500 Ma Kuungan collisional orogeny that involved Archean and Paleoproterozoic crustal fragments now exposed in southern Tanzania, Zambia, Malawi, Mozambique, Madagascar and Antarctica. Three distinctly different geotectonic settings are distinguished. The ANS is an accretion orogen, the EGCD formed by inversion of a previously extended continental margin, the Kuungan Orogen is a continental collisional belt. All of the orogen portions experienced different P-T evolutions and show different style of tectonics, strongly related to the prevailing heat budget in the individual orogeny segments. Thin-skinned tectonics characterizes the convergent phase of accretion within the ANS. Heat enters the orogeny during post-convergence extension resulting in a beta-shaped P-T loop. The extended margin of the EGCD was covered by wet sediments that prevented heat loss through insulation. Heat was accumulated during extension and subsequent convergence; an ultra-high-temperature orogen evolved with granulites showing isobaric cooling textures. Minor rheology stratification of the hot crust resulted in complex vertical flow pattern as typically developed in subduction orogens. The Kuungan collisional orogen is a pile of cold and buoyant continental crust. Exhumation velocities exceed time required for thermal equilibration and inconspicuous P-T loops evolved with a strong branch of isothermal decompression.

CONTINENTAL SLIVERS IN THE ZERMATT-SAAS OPHIOLITE – DO THEY REPRESENT EXTENSIONAL ALLOCHTHONS?

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ophiolite, rifting, extensional allochthon, Alps

Alpine ophiolites are remnants of Mesozoic basin floor. It is not in all cases clear if they represent slow-spreading oceanic crust or hyperextended continental lithosphere. Key evidence for this question comes from slivers of continental rocks, up to several km long, which occur in the upper part and along the top of the Zermatt-Saas Zone, an eclogite-facies ophiolite complex formed from Jurassic-age oceanic crust in the Swiss-Italian Alps. Examples are the Monte Emilius, Etirol-Levaz, and Theodul Glacier slivers. The continental slivers have earlier been interpreted as extensional allochthons, emplaced on exhumed mantle rocks of the ocean-continent transition by Jurassic, pre-oceanic, extensional detachment faulting. This inference was based on their structural position, similar ages of the metamorphic overprint in the slivers and the “true” ophiolites, and Jurassic zircon domains found in the Etirol-Levaz sliver.

Recently published Lu-Hf garnet dating of eclogites from the Theodul Glacier sliver (56.5 ± 2.7 and 58.2 ± 1.4 Ma) and the Etirol-Levaz sliver (61.8 ± 1.8 Ma and 52.4 ± 2.1 Ma) yielded new constraints for the origin of the slivers. Of these four ages, three are older than and one is similar to the oldest Lu-Hf ages from the underlying Zermatt-Saas ophiolites. Therefore it appears that most of the material forming the continental slivers was subducted before the underlying ophiolites, which rather speaks against the extensional allochthon interpretation. Another problem is that the slivers are formed exclusively by pre-Mesozoic continental basement rocks with evidence for Permian magmatism, and are devoid of Mesozoic, pre-rift sedimentary cover. In contrast, extensional allochthons in modern ocean-continent transition zones mostly include pre-rift sediments because they are truncated at the base of the crustal section, not at the top. Third, extensional allochthons are floored by fault gouges, cataclasites, and serpentinite mylonites, which makes them prone to detachment from the mafic/ultramafic basement when the plate enters a subduction zone. They should therefore be frontally accreted instead of being subducted. For these reasons, the continental slivers more likely originate from the northwestern margin of the Margna-Sesia microcontinent (Cervinia) than from extensional allochthons. It remains open if the Zermatt-Saas ophiolite represents oceanic or hyperextended continental lithosphere.

RECONSTRUCTING THE FIRST SIGNS OF MEDITERRANEAN OUTFLOW IN THE GULF OF CADIZ USING BENTHIC FORAMINIFERA AND THE “ELEVATED EPIFAUNA” GROUP

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Mediterranean Outflow Water, early Pliocene, benthic foraminifera, elevated epifauna, stable isotopes

The onset of the Mediterranean Outflow Water (MOW) takes place after the opening of the Gibraltar Strait (5.33 Ma). Its impact on oceanography and climate in the present day is widely studied but its role in the early Pliocene is not well explored yet.

Quantitative analysis of benthic foraminifera has been performed on sediment samples from the lower part of IODP Hole U1387C (IODP Expedition 339) in order to reconstruct paleoenvironmental changes in the Gulf of Cadiz during the late Miocene-early Pliocene. The records reveal a shift from reduced oxygenation in the late Miocene to a better ventilated setting during the early Pliocene likely related to the first evidence of Mediterranean-Atlantic exchange.

Increased abundances of the functional benthic foraminiferal group “elevated epifauna” have been directly related to the MOW in the Gulf of Cadiz since they are adapted to settle on substrates above the sediment surface to catch food particles from strong bottom currents. In our study, the elevated epifauna is represented by *Planulina ariminensis*, *Cibicides lobatulus* and *C. refulgens*. However, our early Pliocene records reveal that peak abundances of *C. lobatulus* and *C. refulgens* are well correlated with allochthonous shelf taxa and grain-size maxima, suggesting downslope transport to deeper settings. To clarify this issue, stable isotope analyses ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) have been performed on shells of shelf dwellers, deep water taxa and elevated epifauna from the Pliocene sediments and present-day samples from the southern and western Iberian Margin. Results indicate that some elevated epifaunal elements have a broad bathymetric range and are not always autochthonous to deeper settings. In the early Pliocene Gulf of Cadiz, characterized by frequent turbidite deposition, *P. ariminensis* would thus remain the only reliable indicator of MOW.

TRIASSIC RADIOLARITE COMPONENTS FROM THE MÉLANGE COMPLEXES OF THE WESTERN TETHYAN REALM AND THEIR PROVENANCE

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Triassic, radiolarites, western Tethyan realm

The Middle to early Late Jurassic mélangé complexes in the northwestern Tethyan realm contain blocks of Triassic oceanic crust, radiolarites and open marine limestones. Radiolarites from the Hallstatt Mélangé (Eastern Alps), the Meliata Mélangé (Western Carpathians), and ophiolitic mélangés of the Dinaridic Ophiolite Belt and the Mirdita Zone are compared.

We describe the microfacies and present biostratigraphic data from radiolarite and from basalt-radiolarite blocks with preserved autochthonous sedimentary cover. The radiolarians yield Late Anisian to Late Norian ages for the oceanic realm from which the ophiolite and radiolarite blocks derived. Together with limestone blocks, the provenance areas of the components are determined as the distal shelf and the ocean floor of the Neo-Tethys. In the course of ophiolite obduction, the components were transported by mass movements into newly formed trench-like basins in front of the propagating nappe stack. These basins were later incorporated in the nappe stack forming the typical features of a syntectonic mélangé. Radiolarian data confirm Late Anisian formation of the Neo-Tethys Ocean, parts of which became closed in the Middle Jurassic. The data clearly speak in favour of one Neo-Tethys Ocean, from which the ophiolites derived as far-travelled nappes.

Litho- and microfacies analysis and age dating of the components and of the matrix sediments in all mélangés gives clear evidence that:

1. Spreading in the Neo-Tethys started in the Late Anisian.
2. Mélangé formation is contemporaneous with the obduction of the ophiolitic nappe stack, dated as Middle Jurassic. They were formed in response to the closure of the western part of the Neo-Tethys Ocean and contain everywhere a very similar component spectrum.
3. Upper Anisian – Ladinian radiolarites were deposited both in distal shelf settings and in the oceanic realm. The occurrence of Middle Triassic radiolarites without the underlying ocean floor is no proof for the existence of Middle Triassic ocean floor. Only uppermost Ladinian and Upper Triassic radiolarites undoubtedly indicate their provenance from an oceanic realm.

SLOW DIRECTIONAL EVOLUTION, CRYPTIC SPECIATION, AND THE IMPACT OF ENVIRONMENTAL CHANGES ON ASSEMBLAGE COMPOSITION IN MIDDLE TO LATE MIOCENE MEDITERRANEAN AND PARATETHYAN PLANKTIC FORAMINIFERAL GENUS ORBULINA

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Orbulina universa, *Orbulina suturalis*, Mediterranean, Paratethys, cryptic species

The status of species belonging to the Middle Miocene to recent genus *Orbulina* can not be explained satisfactorily with existing taxonomic classification schemes. Genetically defined cryptic species as shown from modern Oceans can also be expected for the geological past. In order to combine ascertainable data from an early phase of the genus evolution to a coherent general view, we investigated Middle to Late Miocene *Orbulina* specimens on morphological and geochemical properties. This include biometric analyses (test size and thickness, pore sizes of adult and neanic stages, sizes of areal apertures) and stable isotope analyses ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) for successive time intervals from two different paleoceanographic settings. We found all combinations of neanic and adult structural properties (cancellate to non-cancellate) that made it impossible to identify separate species by different wall structures alone. The classification of planktic foraminifera on the base of wall structure is therefore not a useful taxonomic tool for the genus *Orbulina*. However, the combination of selected biometric and isotopic parameters allows the separation of distinct "populations". Mediterranean and Paratethyan *Orbulina* show distinct isotope signals, particular heavier $\delta^{13}\text{C}$ values in the Paratethys. Among Mediterranean *Orbulina*, different habitats or vital effects are documented by distinct stable isotope compositions in *O. suturalis* and *O. universa*, especially in $\delta^{13}\text{C}$ values. The observed temporal trends in neanic and adult shell structures towards smooth or non-cancellate surfaces point to an ongoing slow directional speciation in Mediterranean *Orbulina*. This trend is interrupted by recurrences of primary morphologies such as *O. suturalis* and cancellate wall structure during periods of environmental change. Based on the sole occurrence of *O. suturalis* in the Paratethys, the different combination of shell structures of adult and neanic stages compared with the Mediterranean samples, the larger apertures, and in combination with the particular isotopic shell composition (1‰ $\delta^{13}\text{C}$ specific offset), it is very likely that the Paratethyan *O. suturalis* represents a further cryptic species in the *Orbulina* plexus.

MICROSTRUCTURAL MAPPING AT THE GLACIOTECTONIC WISSOWER BACH SYNCLINE (NE RÜGEN, GERMANY)

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microstructure, glaciotectonic, thrust fault, Island of Rügen

Germany's largest island Rügen (SW-Baltic Sea) is famous for its long chalk-steep coast. The Wissower Bach syncline structure on the Jasmund peninsula (NE Rügen) is one focus area for our microstructural studies to understand the complex glaciotectonic environment in that area, comprising folds and thrust faults from the Weichselian Pleniglacial.

At the southern limb of the syncline a SW-dipping thrust fault between Cretaceous chalk and the Pleistocene till below has been sampled. Beside micromorphological investigations the soft sediment thin sections were analysed with the help of a microstructural mapping method, where the long axes of clasts between 0.01 and 0.8 cm were classified into differently oriented microfabric domains (see Phillips et al., 2011).

Within the till bounding the fault, three different main fabrics were distinguished, from which the S1 fabric (general dip to N as opposed to the fault) can be separated out into the sub-fabrics S1a (gently inclined) and S1b (steep). The S2 domain is always oriented perpendicular to S1. Furthermore, S2 implies steeper and more gently inclined sub-domains, as well. The earlier formed S1 fabric is dislocated (sinistral) by the younger S2 fabric, implying a normal-fault movement to the south at the tectonic contact. The third fabric S3 is nearly vertical. These domains could be interpreted as steeply inclined shears, on the one hand, or anastomosing sub-vertical foliation developed in response to dewatering of the till, on the other hand.

An overall sense of compressional movement to the north could be determined together with a south-directed extension, which could imply a late-stage reactivation and "gravitational sliding" at the southern limb of the syncline as the ice retreated.

A three-dimensional model of

the microfabric system at the chalk-till contact has been constructed to visualise the orientation in relation to the macroscopically identified structures and the direction of thrusting.

References:

Phillips, E. R., van der Meer, J. J. M. & Ferguson, A. (2011): A new 'microstructural mapping' methodology for the identification, analysis and interpretation of polyphase deformation within subglacial sediments. - *Quaternary Science Reviews*, 30: 2570–2596.

A CLUSTER OF REPEATING SEISMICITY AROUND MOHO-DEPTHS IN UPPER-AUSTRIA

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Austria, Lower-crustal seismicity, Earthquake clusters, Waveform correlation

In this work we investigate a previously unknown cluster of unusually deep earthquakes located in the vicinity of Arnberg, Upper Austria. The events were initially detected by seismological services/research institutions in Austria and adjacent countries in August, 2008. Depth estimates varied around 10-20 km, magnitudes published were in the range of 2.0-3.0 with only the strongest event above 3.5.

Geologically, the region is positioned in the Molasse Basin, between the NW-SE striking Bohemian Massif (approx. 80 km to the NE) and the mostly E-W striking Alps (approx. 80 km to the S), with until then little natural seismicity reported, but active geothermal production in place at the German border around Braunau/Ried (Austria).

We gathered available data from surrounding networks and relocated the events using a non-linear probabilistic approach for location determination (NonLinLoc), combined with a published 3D-velocity model of the region, which had been used in previous studies covering Austria.

Our results consistently show a dense cluster of events with depth at approx. 40 km, which within the max. observed errors of +/-8 km, is significantly deeper than expected. Further, these results are in the range of published estimates of local Moho-depth, putting the source of the events in the lower crustal region or below. Phase onset analysis supports event depth at or around the Moho. Lateral errors were about +/-2.5 km in NE-SW-direction, and +/-5 km along NW-SE.

For most of the events, complete waveforms show cross-correlation coefficients well above 0.8, which lead us to search available data for additional, previously undetected events using a master event. Two additional major periods of activity of the same cluster could be verified (2008 & later again in 2012).

While our results as to relative locations, and the near-identical wave-patterns indicate a source of highly similar physical origin and character at or around Moho-depths, possible mechanisms and conditions causing these events currently remain subject of investigation.

PETROLOGY AND GEOTHERMOBAROMETRY OF THE VEITSCH MN-DEPOSIT (STYRIA, AUSTRIA)

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Manganese ores, Veitsch, geothermobarometry, Mn-allanite

The rock samples investigated in this study were collected from the manganese ore deposit of Veitsch (Styria, Austria). The area is located in the eastern section of the Northern Greywacke Zone (Upper Austroalpine), which had been overprinted by eo-Alpine greenschist-facies metamorphism. The manganese ores of Veitsch occur within the so-called ore bearing limestones („Erzföhrende Kalke“), as flat dipping, s-concordant lenses with an average thickness of 1.5 m and they consist mainly of rhodochrosite. The Mn-ore is very fine-grained and consists mostly of rhodochrosite. In addition subordinated kutnahorite and calcite, as well as different silicates (Mn-chlorite, spessartine, friedelite, Mn-serpentine, tephroite, sonolite, pyroxmangite and quartz) occur. Sulfides, mostly Co-Ni sulfides (the linnaeite-group, cobaltite, co-pentlandite and jaipurite), as well as chalcopyrite, sphalerite, pyrite and galena were identified in the majority of the thin sections. In addition, some veins occur which contain accessory Mn-allanite (androsite-Ce, ferriandrosite-Ce, manganiandrosite-Ce as well as four hitherto unnamed species). All examined allanites have very high Mn contents and one can also distinguish between V-rich and V-poor Mn allanites. In order to capture the full spectrum of the rare earth elements and trace elements, LA-ICP MS analysis was carried out. The rare earth elements probably originated from dissolved monazite. The solubility of monazite, and the subsequent formation of allanite, was most likely facilitated by a fluid during eo-Alpine greenschist-facies metamorphism. Geothermobarometric calculations were performed with the THERMOCALC v.3.33 program. The phases involved in these calculations were tephroite, pyroxmangite, pyrophanite, rhodochrosite, CO₂, rutile and quartz. Using ideal mixing models for these phases isobaric $T-X(\text{CO}_2)$ -diagrams, as well as $P-T$ -diagrams at constant a_{CO_2} were calculated. Latter diagrams were correlated with the observed phase assembly in the samples. The diagrams suggest that the fluid which co-existed during the formation had a very low CO₂-content (<0.1) which varies slightly from sample to sample. Moreover, the diagrams indicate that the temperature of the metamorphism at a pressure of 3 kbar is likely within a temperature range from about 380°C to 430°C well in agreement with previous estimates.

HIGH-RESOLUTION STRATIGRAPHIC CORRELATION AND BIODIVERSITY DYNAMICS OF MIDDLE AND LATE ORDOVICIAN MARINE FOSSILS FROM BALTO-SCANDIA AND POLAND

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Ordovician, Biodiversity, Extinction, Origination, Baltoscandia

The Middle and Upper Ordovician rocks of Baltoscandia have been divided into spatially distinct, composite litho- and biofacies units called confacies belts. A precise regional correlation of outcrops and boreholes located in different confacies belts has always been problematic due to the pronounced biogeographical and lithofacies differentiation. Correlation between sections in the graptolite-rich black shales of the Scanian confacies and the carbonate-rich North Estonian confacies belts has been particularly difficult. To overcome these problems we used Constrained Optimization (CONOP9) and Horizon Annealing (HA) to construct a high resolution correlation model and composite range chart compiled from the stratigraphic range data of 554 chitinozoan, conodont, ostracod, and graptolite species from 38 drill cores and outcrops in Poland and Baltoscandia. We also used the CONOP composite as a timescale in which to calculate biodiversity, extinction, and origination rates through the Middle and Late Ordovician. Our data show that overall biodiversity forms a broad but uneven plateau from the base of the Uhaku to the late Kukruse Baltic stages, followed by a distinct drop in the Haljala Stage mainly due to a steep decline in conodont diversity. Two distinct diversity peaks occur in the Keila and Rakvere Baltic stages, with a dramatic decline at the basal Oandu Stage associated with the $\delta^{13}\text{C}$ isotope excursion that correlates with the North American GICE event. Fossil diversity declines from the Nabala through Vormsi stages, with a slight rebound in the middle Pirgu. The main Late Ordovician extinction begins in the mid – late Pirgu Stage. Chitinozoan diversity exhibits peaks in the Lasnamagi and lower Keila stages, drops through the Oandu, and then gradually declines across the rest of the Ordovician. Conodonts have a main diversity peak in the lower Uhaku, a smaller peak Kukruse, and then decline gradually through the Late Ordovician with a slight rebound in the Mid to Late Katian global Stage. Graptoloid diversity exhibits a main peak in the Kukruse (Sandbian) followed by decline, a smaller peak in the late Keila, a decline thereafter. Our ostracod data indicate an uneven climb in diversity through the mid Pirgu followed by a very steep decline.

KLEINERE UND GRÖßERE (NATUR)KATASTROPHEN IN KÄRNTEN

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Landesgeologie, Kärnten

Zu den Aufgaben der Landesgeologie in Kärnten gehört es u.a. bei den Naturkatastrophen als erste Fachexperten vor Ort zu sein. Obgleich Rutschungen und Felsstürze größerer Dimensionen medial mehr Aufmerksamkeit erhalten, sind es vor allem Kleinrutschungen und Steinschläge, die in Unwetterperioden durch ihre Vielzahl die Landesgeologen beschäftigen. Im Vortrag werden die Aufgaben des Landesgeologen im Katastropheneinsatz anhand von Fallbeispielen erläutert.

GEOTECHNICAL BOREHOLE INVESTIGATIONS FOR ASSESSING THE INFLUENCE OF UCG ON THE SURROUNDING ROCK MASS

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Underground coal gasification, UCG, borehole logging

Geotechnical and geophysical measurements have been conducted in the areas around two underground coal gasification (UCG) trials in Poland. General focus of the EU funded RFCS research and development project is to assess the risk of UCG in operating mines and other areas of high vulnerability.

During the project a large number of underground and laboratory measurements have been conducted. Monitoring data have been collected underground before, during and after actual UCG trials. The first trial was performed under the RFCS project HUGE2 and the second under a project financed by the Polish Government.

The most important aspects are related to the impact of UCG on the environment, i.e., parameters of rock strata, water and air, underground workings, and surface. The results shall be included into a risk assessment methodology, and recommendations given for mine management and mining authorities.

DMT focused on geologic 3D modeling of the underground strata around the two georeactors, including the layout of the existing mine infrastructure, geologic setup and tectonic structures. After lithologic correlation of the rock strata, a structural model as well as a block model were set up. By additional drill holes and geophysical well logging the level of detail of the models could be increased. A number of different geophysical well logging methods have been applied to investigate the situation before and after the UCG trials. Especially geotechnical core logging and optical scanning of the newly drilled boreholes gave substantial information on the in-situ rock mass conditions. With the investigations, changes in the geotechnical characteristics of rock strata surrounding the georeactors between the conditions before and after the UCG trials have been revealed.

THE FREYENSTEIN SUBORDINATED FAULT SYSTEM – SHEAR ZONE AND FAULT DEVELOPMENT ALONG THE SOUTH BOHEMIAN BATHOLITH (AUSTRIA)

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Bohemian Massiv, Shear Zone, Late Variscan Deformation

This work describes the ~ 500 m thick ductile Freyenstein Shear Zone and brittle Freyenstein Fault at the border between the South Bohemian Batholith (SBB) and the Moldanubian Nappes (MN). The area is built up by granites of Weinsberg-type (WBG), which are interlayered by numerous dikes (fine- to medium-grained granites, aplitic dikes, fine-grained granodiorites and pegmatites) and paragneisses of the Ostrong Nappe System.

The Freyenstein Shear Zone is a ductile crustal-scale amphibolite-greenschist facies shear zone at the eastern edge of the SBB. The mylonitic foliation is dipping to the SE with about 60°. Shear-sense criteria like clast geometries, SC' structures as well as microstructures (mica fishes, domino tilting) show normal faulting top to S/SW with steep (ca. 50°) angles. The Freyenstein Shear Zone records a polyphase history of deformation and crystallization: Mylonitized mineral assemblages in deformed granitoides, which consist of pre- to syntectonic muscovite-porphyroclasts and biotite as well as dynamically recrystallized potassium feldspar, plagioclase and quartz, can be observed. The lack of syntectonic chlorite crystals points to metamorphic conditions of lower amphibolite-facies. In a later stage fluid infiltration under lower greenschist-facies conditions locally lead to sericitization of feldspar and syn-mylonitic chloritisation of biotite. The shear zone is reactivated as brittle/ductile NE-SW striking normal fault with top to the north sense of shear (at about 30°) and locally sinistral strike-slip.

The Freyenstein Shear Zone belongs to a system of shear zones and faults in the Moldanubian Superunit and is located at the border between the SBB and MN ductily deforming both. Therefore, it plays an important role in exhumation processes of last stage SBB (synkinematic) intrusions during orogenic extension. Rb/Sr biotite ages in the WBG indicate late Variscan cooling ages (Pennsylvanian) along the shear zone.

MULTIPHASE STRUCTURAL AND THERMAL EVOLUTION OF A CONTINENTAL MARGIN DURING OBDUCTION OROGENY: INSIGHTS FROM THE JEBEL AKHDAR DOME, OMAN MOUNTAINS

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burial, temperature, shearing, ophiolite, passive continental margin

The Oman Mountains are world famous for their exceptionally well-exposed Cretaceous ophiolite sequence, including the overridden Neotethyan passive margin. During obduction the associated sedimentary basin was forced to deep burial. After ophiolite emplacement, the subduction zone of the Oman Mountains ceased, and farther North the Makran subduction zone initiated. This change in tectonic regime resulted in preservation of the embryonic stage of a collisional orogen immediately after ophiolite obduction. Eurasia-Arabia collision in the Cenozoic led to large-scale dome structures, which have subsequently been incised by steep valleys exposing the entire passive margin sequence. Past studies focused on the tectonic evolution of the orogen (e.g. Glennie et al., 1973; Loosveld et al., 1996), the initial subsea obduction and its associated metamorphism (El-Shazly and Sisson, 1999; Hacker and Mosenfelder, 1996), and reconstruction of the obducted nappes (Béchenec et al., 1988; Searle, 2007). Few studies address the associated sedimentary basin, its response to obduction on the passive continental margin (Boote et al., 1990; Cooper et al., 2013) or the tectonically induced fault and fracture geometries (Hilgers et al., 2006; Holland et al., 2009; Virgo et al., 2013). Even though first order models of relative age relationships of structures within the basin exist, we lack a comprehensive understanding of how obduction manifests itself in the structural record. In particular, relative timing of obduction related shearing and burial related veins is still unknown. This knowledge is required for understanding both, obduction dynamics, and consequences of rapid burial of a sedimentary package during early phases of mountain building. Here, we focus on the northern flank of the mountains, where deep burial and proximity to the subduction zone results in the most pronounced shearing. We present combined results of meter-scale structural mapping with thermal reconstructions of burial, exhumation (zircon (U-Th)/dating), as well as numerical basin modeling. Maximum burial temperatures of 225 - 240 °C for Natih B rocks reflect maximum burial of about 7 to 8 km (Grobe et al., 2016), which is much less than expected from previous work (e.g. Searle, 2007).

Due to length regulations the detailed references will be presented at the conference.

AUSLEGUNG EINER FLEXIBLEN HANGMURENBARRIERE UND DEREN BE-TRACHTUNG NACH DER BELASTUNG DURCH EIN NATÜRLICHES EREIGNIS

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Hangmuren, Shallow Landslides, Murgangbarriere, Flexible Barriere, Grossfeldversuch

Die Entwicklung von flexiblen Hangmurenbarrieren ist eine noch junge Disziplin. Wichtige Schritte zu einem Bemessungskonzept und zu einer Standardisierung konnten jedoch schon in den Jahren 2008 – 2012 gemacht werden. Hierfür wurden umfangreiche Grossfeldversuche mit dynamischen Belastungen bis 150 kN/m^2 und komplett verfüllten Barrieren durchgeführt. Für die Bemessung von Schutzsystemen ist ein umfangreiches Prozessverständnis erforderlich. Es war eine Herausforderung bei den durchgeführten Versuchen ein Gemisch aus Wasser und Feststoff zu erzeugen, das in der Lage ist auf realistische Geschwindigkeiten bis zu 11 m/s zu beschleunigen. Die gewonnenen Resultate wurden für die Bemessung und Entwicklung von standardisierten flexiblen Hangmurenbarrieren verwendet.

Die Hauptstrasse A83 im Schottischen County Argyll and Bute im Bereich „Rest and be Thankful“ musste in den Jahren 2007 und 2008 durch schwerwiegende Hangmuren für längere Zeit gesperrt werden. Auf Grundlage der zahlreichen Grossfeldversuche auf 2 verschiedenen Versuchsanlagen wurde im Jahr 2009 in Schottland die erste standardisierte Hangmurenbarriere installiert. Im Dezember 2015 wurde die Barriere durch Hangmuren mit einem Volumen von ca. 300 m^3 verfüllt. Die Hangmuren konnten erfolgreich gestoppt werden, so dass die Strasse nicht gesperrt werden musste.

Wir zeigen die Gefährdungssituation im Bereich der Hangmurenbarriere, die Möglichkeiten zur Bemessung und analysieren das Ereignis vom Dezember 2015. Das Ereignis bestätigt die Praxistauglichkeit von standardisierten flexiblen Hangmurenbarrieren und eröffnet damit weitere Möglichkeiten für deren Einsatz.

PROVIDE FORAMINIFERS AND OSTRACODS EVIDENCE FOR MARINE INCURSIONS IN WESTERN AMAZONIA DURING MIOCENE TIMES?

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ostracoda, foraminifera, freshwater adaptation, Solimoes Formation, Miocene

During the Miocene epoch, a huge wetland covered western Amazonia, which holds a well-recognised aquatic fauna (especially endemic molluscs and ostracods). One of the most controversially discussed issues concerns the existence of marine incursions and their effect on this ecosystem ("Pebas system"). Sedimentological (e.g., tidal rhythmites), ichnological (e.g., *Thalassinoides* burrows) and palaeontological (e.g., mangrove-related pollen, dinoflagellate cysts, foraminifers) indications were used to infer episodic marine influences. However, these evidences permit differing interpretations. The current study focusses on sediment layers where foraminifers co-occur with typical, *Cyprideis*-dominated Pebasian ostracod faunas. We investigated samples from Brazil (core 1AS-10-AM; ~62 km SW Benjamin Constant) and Peru (outcrops around Porvenir; ~55 km S Iquitos). The ostracod assemblages of these samples comprise in total 26 species (*Cyprideis*: 13 species; *Perissocytheridea*: 5 species; *Rhadinocytherura*: 3 species, *Alicenula olivencae*, *Cypria* sp., *Pellucistoma curupira*, *Skopaeocythere tetrakanthos*, ?*Macrocypris* sp.). Foraminifers are represented only by two species of the genera *Ammonia* and *Elphidium*. While *Cypria* and *Alicenula* are freshwater dwellers, the other ostracod taxa as well as *Ammonia* and *Elphidium* are typical for marginal marine settings. We performed stable isotope analyses ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) on valves of *Cyprideis* (*C. machadoi*, *C. multiradiata*, *C. sulcosigmoidalis*), *Perissocytheridea acuminata*, *A. olivencae*, *P. curupira* and on tests of *Ammonia* and *Elphidium*. All measurements furnished well depleted $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ ratios, which clearly point to a freshwater environment. We conclude that: i) there is no geochemical evidence for a marine influx; ii) marine-derived ostracods and foraminifers successfully adapted to freshwater conditions in the Pebas system; and, iii) palaeoenvironmental reconstructions based on such highly endemic biota are problematic.

A NEW, DETAILED TECTONIC MAP OF SUBDUCTION-EXHUMATION STRUCTURES IN THE CENTRAL TAUERN WINDOW

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Tauern Window

We present a new tectonic map of the central Tauern Window based on a compilation of existing geological maps and literature. To this we added numerous details that are significant for understanding the subduction-exhumation history of high-pressure units in the central part of the Window.

Changes include the following features: (1) subdivision of the oceanic Glockner nappe system into the Glockner nappe s. str. containing HP-assemblages and the Rauris nappe which does not; (2) subdivision of the continental Modereck nappe system into the Modereck nappe s. str. and the underlying Trogereck nappe; only the former unit experienced HP-metamorphism during Alpine orogeny.

This re-interpretation reveals along-strike and orogen-perpendicular discontinuities in the structure of the tectonic units: (1) the Rauris nappe is the lower oceanic unit and wedges out to the west; (2) the Glockner nappe s. str. is the upper oceanic unit, overlying both Eastern and Western Tauern basement domes, but wedging out to the north; (3) the Modereck nappe system units are sandwiched between the oceanic Glockner and Rauris nappes, but wedge out to the west and north. This reveals a recumbent sheath-like fold structure (the Seidlwinkl fold) that closes to the N, in accord with top-N shear-sense indicators that syn- to post-date HP-assemblages (blueschist-facies).

The Modereck nappe system represents the Mesozoic distal margin of the European Plate. Its HP- (blueschist-facies) assemblages in Mesozoic sediments as well as in the adjacent Glockner nappe s. str. reveal that both units were brought into contact at subduction-zone depths. The Seidlwinkl fold clearly overprints this subduction-related nappe contact. It also emplaced both units onto the lower-grade Rauris unit. Therefore we interpret the Seidlwinkl fold as a structure that formed during the exhumation of the HP-units from deep (ca. 60 km) to shallow crustal levels within the Tertiary subduction channel.

MEDITERRANEAN OUTFLOW WATER AT THE PLIOCENE/PLEISTOCENE TRANSITION: NEW STRATIGRAPHIC CONSTRAINTS FROM IODP SITE U1389 (GULF OF CADIZ, IODP EXPEDITION 339)

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Mediterranean Outflow Water, Pliocene, stratigraphy, IODP

IODP Hole U1389E, at present located in Mediterranean Outflow Water (MOW) at 640m water depth in the northern Gulf of Cadiz, represents a key-site for the understanding of changes in MOW contribution to the North Atlantic during the transition from the Pliocene warm house climate to the Pleistocene ice house climate. Integrated geophysical, micropalaeontological and geochemical proxy records of the recovered sediments imply major changes in MOW intensity over the studied interval. However, to consider these data in a broader paleoceanographic and paleoclimatic context, a well-constrained age model is essential. New bio-, chemo-, magnetostratigraphic data and XRF core-scanning suggest that the shipboard age model for the site has to be reconsidered as major changes in the depositional environment have not been recognized in the original, comparably low resolution data-sets.

While the new, high-resolution biostratigraphic data confirm the overall time frame of 2.6 to 3.6 Myrs for the studied interval, they also indicate that the last occurrence of *Discoaster tamalis* in the succession should be reconsidered. In addition, the first occurrence of *Neogloboquadrina atlantica* (sin) has been identified. New palaeomagnetic data constrain the Gauss normal chron and its subchrons more accurately. Finally, a high-resolution $\delta^{18}\text{O}$ -record of the planktic foraminifer *Globigerinoides ruber* allows the identification of many marine isotopic chrons by correlation with Mediterranean reference records, further refining the stratigraphic framework.

Cyclic patterns are recognized in the Ca/Ti- and Zr/Al-ratios. A preliminary cyclostratigraphic analysis of these records in well-recovered intervals suggests an interplay of obliquity and precessional forcing resulting in an increase of MOW activity at ~2.7 Ma, close to the Pliocene/Pleistocene boundary.

This study contributes to project P25831-N29 of the Austrian Science Fund (FWF) and is financially supported by grants of ECORD and the Max Kade Foundation.

HT-MTES: SEASONAL HEAT STORAGE IN ABANDONED COAL MINES

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High Temperature Mine Thermal Energy Storage

The goal of this R&D project is to create a technically economically feasible conceptual model for a High Temperature – Mine Thermal Energy Storage (HT-MTES) for the energetic use of a mine on the example of the Prosper-Haniel coal mine in Bottrop, Germany.

At the end of 2018, the last operative hard coal mine in Germany (Prosper-Haniel), is going to be closed down, plugged and abandoned. Large amounts of subsurface infrastructure, resembled mainly by open parts of former galleries and mining faces are going to be flooded after the mine is closed down and therefore have the potential to become an enormous geothermal reservoir for seasonal heat storage. During the summer non used heat from solar thermal power plants, garbage incineration, combined heat and power plants (CHP) or industrial production processes can be stored within dedicated drifts of the mine. During the winter season this surplus heat can be extracted and directly utilized in single construction complexes and in city areas, which are not connected to the existing district heating grid.

For the implementation of such a HT-MTES within a former hard coal mine, the corresponding infrastructure measures and appropriate circulation applications have to be developed. Precondition for this development is the presence of a still active and fully open mine, which is resembled by the Proper-Haniel hard coal mine (accessible till the end of 2018). An investigation of the most relevant geotechnical, hydrogeological and geophysical parameters of the Prosper-Haniel hard coal mine is going to be performed. As a foundation for the implementation of a seasonal heat storage the undisturbed rock temperatures range between 30°C and well over 50°C within the galleries and mining faces that are going to be flooded, after the mine is fully closed down. The total mining area consists of 165 km² and the subsurface galleries have a total length of 141 km, at a maximum depth of more than 1200 m. Prosper-Haniel is accessible via four vertical shafts and a conveyor system leading into the mine. These open shafts and drifts allow a comparatively easy accessibility and technical feasibility of a HT-MTES.

GBA THESAURUS – MORE THAN A CONTROLLED VOCABULARY FOR GBA ASSOCIATES

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Geodata, Linked Data, web application, INSPIRE, SKOS

The open accessible Thesaurus of the Geological Survey of Austria (GBA) was designed as a knowledge representation of the Geological Survey. The regarded geological vocabularies are organized as concepts in six domains, >Geologic Time Scale<, >Geologic Units<, >Geologic Structures<, >Lithology, Minerals<, and >Tectonic Units<. The content is provided bilingual in German and English as used in GBA publications and maps. To increase the content quality, all concepts are formatted as SKOS concept and are bound to a Uniform Resource Identifier (URI), a unique web address. Related to the standards of W3C, RDF, SparQL the content of the GBA Thesaurus is published machine-readable. Each concept of the GBA Thesaurus contains a description followed by a reference list directly linked to the online catalogue of the GBA library. Links to the related pdfs are also available, provided that they are open source. Where possible, the concepts are specified by semantic relationships as broader, narrower, or related concepts within the domain. Further the concepts are available as "Linked Data" and if possible semantically linked to other web resources as INSPIRE, GeoSciML, DBpedia, etc. The Thesaurus is used as a base for further web applications and modules. One of this modules is the DataViewer, an integrated and very powerful tool visualizes already harmonized concepts of geological maps. Further details related to the DataViewer are presented at the Pangeo by Christine Hörfarer et al.

The GBA Thesaurus does not claim to be any standard. Nevertheless, it offers geologists, students and all other interested people an excellent opportunity to find geological terminology and the related definition for further correct use. Additional links to high quality data resources and integrated web applications make the GBA Thesaurus to a powerful tool for geologists requiring controlled vocabulary.

THE SALLU BULO MESOTHERMAL GOLD DEPOSIT IN SOUTH SULAWESI, INDONESIA

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mesothermal, gold, vein, Latimojong, Lamasi

We describe a mesothermal gold deposit hosted by greenschist facies rocks in the late Cretaceous Latimojong metamorphic complex. The structural evolution includes the accretion of the Lamasi ophiolite onto sedimentary sequences by major north-northwest thrusting. At Salu Bullo, four north-south trending ore bodies dipping with high angle to the east are exposed, with typical quartz-stockwork, breccia and disseminated veins. Mineralized zones are typically associated with pinch-and-swell vein systems varying in width between <1 and 30 meters, commonly parallel in fissures along 1.5 km length. Quartz veins and breccias can be observed both in meta-sediment and meta-volcanic rock. Gold contents are typically elevated in breccia and stockwork zones, in proximity to impermeable hematite-rich mudstone and silicified rocks.

A number of features discriminate the Sallu Bullo gold prospect from typical mesothermal deposits: (1) veins are hosted by fine-grained meta-sedimentary and meta-volcanic rocks; (2) high intensity of carbonatization (siderite + ankerite), chloritization and albitization; (3) mineralization formed through compressional deformation and fault reactivation; (4) high Au/Ag ratio (8.5:1 to 9:1); (5) formation at moderate temperature. The composition of Fe-rich chlorite indicates that it formed at a wide range of temperatures, i.e. from 175 to 350°C with Fe/Fe+Mg ratio from 0.26 to 0.38 and Si from 5.69 to 6.24. However, the abundance of a Cu-Ag-As-Sb-(Hg) mineral association is noteworthy.

Gold occurs (1) primarily as fracture filling within early sulfides and (2) as round cogenetic inclusions within sulfides, mainly in pyrite. All microscopically visible gold occurs as inclusion or as crack filling rather than as free grains in quartz. Grain sizes of gold ($\text{Au}_{85-88}\text{Ag}_{12-15}$) range from submicroscopic (<2 μm) to 30 μm . In addition, mineralized veins contain chalcopyrite and fahlore assemblages, often associated with covellite, galena, sphalerite and marcasite. A Cu-Ag-As-Sb-(Hg) mineral association comprising tetrahedrite, luzonite/famatinite and argentite/acanthite, is frequently associated with gold-bearing veins. Mercury is present as a minor element in tetrahedrite intergrown with chalcopyrite and pyrite; some samples carry mercurian tetrahedrite with up to 17.28 wt % Hg. On the basis of ore relationships, it is suggested that early ore minerals (pyrite) and gold were mantled by a later assemblage of Cu-Ag-As-Sb-(Hg) minerals.

POLYPHASE DEFORMATION IN THE EASTERN GREYWACKE ZONE

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Greywacke Zone, nappe emplacement, polyphase deformation

The Eastern Greywacke Zone (GWZ) between Bruck / Mur and Gloggnitz is an imbricate structure of four major tectonic units resting on the Troiseck-Floning complex. From tectonic footwall to hangingwall these tectonic units are the Veitsch Nappe, Silbersberg Nappe, Kaintaleck Nappe and Noric nappe. All of them contain late Paleozoic to Permo-Mesozoic sediments. The southern boundary of the GWZ is a steep belt where individual nappes have thicknesses of few meters to some hundred meters. By contrast the thick hangingwall Noric Tirolic nappe is an imbricated thrust and fold belt with three major thrusts mapped in the study area (Hinterhofgraben, Rotsohlgraben). These thrusts are the Scheickl Thrust, the Rotsohl Thrust and a frontal imbricate zone at Aschbach. Early formed higher temperature structures appear dominantly in the south of the profile and include subgrain rotation and grain boundary migration deformation mechanism. Shear sense derived from microstructures and quartz C-axes pattern which display combination of basal C <a> and prism <a> glide show top to the SW sense of shear with a local component of strike slip. In general, coaxiality of flow increases northwards. This higher temperature fabric is overprinted and incorporated into a brittle fold-and-thrust belt. This deformation might have re-oriented earlier formed fabrics. Brittle thrust fabrics show general northward displacement whereas individual thrusts propagated to high crustal levels. Localized W-E and N-S strike slip zone overprinted the thrust related fabrics. Considering that available geochronological data that show general cooling of the upper Austroalpine nappes was in the range between ca. 130-100 Ma we speculate that the early formed higher temperature fabric evolved during nappe stacking prior to the well-known eo-Alpine event. Brittle thrusting includes in-sequence and out-of-sequence thrusts and likely occurred prior to deposition of Gosau sediments that are incorporated into W-E strike slip zones nearby the study area. Profile restoration on over-regional scale is constrained by zircon age data from Permo-Mesozoic sedimentary units. This allows palinspastic restoration of tectonic units previous to Alpine nappe stacking.

HIPERCORIG: A DIRECT PUSH CORING TOOL FOR EXTENDED REACH IN UNCONSOLIDATED ON- AND OFFSHORE FORMATIONS AND ITS AVAILABILITY

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drilling, coring, soft sediment

Drilling and sampling is a key process to access and sample geological and environmental records in the subsurface. Nevertheless, appropriate probing tools – unlike many other high-tech facilities – are commonly not in the hands of Earth scientists. Therefore, the access to coring and sampling is complicated and often hampered by unfit equipment and is thus very costly, e.g. for oilfield or mineral exploration style deep coring.

Currently, a new downhole direct push tool is under development for unconsolidated formations (e.g. sediments etc.) that will be able to bridge a critical gap between such cost-intensive deep commercial type drilling and the basic, hand-powered tools usually deployed by academic institutes.

The instrument called HiPerCoRig is based on a downhole percussion system and will be used to recover continuous samples from soft to non-consolidated sediments such as from lacustrine or estuarine deposits, up to depths of 100 meters and possibly more. With further adaptation it will be an extended reach tool for probing and sampling also environmental probes from depth, overcoming today's limits there of top-drive hammers, as they exponentially lose their efficiency through the drill string with increasing depth.

In order to minimize deployment cost and allow for cost efficient transportation on- and off-road, a number of critical design measures include a small and modular and containerized system with minimal weight and size components for easy logistics. Furthermore, the whole system will require for set up and operation only minimal expertise, machinery and manpower.

Interested parties are invited to use the instrument and will have access through project-wise formal applications. Cost for using HiPerCoRig will be kept to a minimum by charging only a maintenance fee that will be pooled to cover repairs and improvements. The German Scientific Earth Probing Consortium, GESEP will act as independent advisory board and handle applications to ensure best possible utilization at minimal charges. The coring rig system will be based at GZB in Bochum, Germany. The Deutsche Forschungsgemeinschaft, DFG is funding the development and purchase.

FIVE YEARS OF TLS ROCKWALL MONITORING AT THE KITZSTEINHORN (3.203 M), HOHE TAUERN, AUSTRIA: IDENTIFYING THE INFLUENCE OF GLACIAL THINNING ON ROCKFALL IN GLACIAL HEADWALLS

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Rockfall Inventory, Terrestrial Laserscanning, Glacier Retreat, Long-term Monitoring, Kitzsteinhorn

Since 1880 mean annual air temperatures in Austria have risen by 2 °C. This increase is more than twice the average global warming of 0.85 °C. As a result glacier retreat has evolved into one of the most visible consequences of climate warming in the European Alps. The rate of retreat has increased since the 1980s, with much of the volume loss being reflected by the lowering of the glacier ice surfaces and the exposure of fresh, frequently oversteepened rock surfaces. The potentially destabilizing effect of glacial thinning on the adjacent headwalls has so far rarely been considered by extensive monitoring campaigns and its contribution to recent rockfall activity is largely unknown.

The presented study addresses this research gap by compiling a detailed rockfall inventory based on a five-year terrestrial laserscanning monitoring campaign carried out in the summit region of the Kitzsteinhorn (3.203 m), Hohe Tauern Range, Austria. The monitoring campaign was started in July 2011, since then the headwalls of two glacial cirques were scanned at an interval of two to three months during the snow-free summer season. The scanned rock faces predominantly consist of calcareous mica-schist and differ in terms of height, slope inclination, slope aspect, and discontinuity orientation. The rock faces are underlain by permafrost, their combined surface area is approximately 100.000 m². All investigated rock faces are situated directly adjacent to the Schmiedingerkees cirque glacier, which has retreated and thinned significantly in recent decades (downwasting rate approx. 1m/a).

Analysis of the obtained data shows the dramatic impact of glacial thinning on adjacent headwalls: about 66 % of the detected rockfall release zones and 80 % of the detected rockfall volumes were triggered from areas located less than 20 m above the current surface of the Schmiedingerkees glacier. Overall, more than 100 rockfall release zones were identified. The total rockfall volume exceeded 1.000 m³, the largest rockfall events reached volumes of several hundred cubic meters. With continuing warming, the significance of rockfall from deglaciating headwalls as a considerable threat to man and infrastructure is expected to grow throughout the foreseeable future.

MIOCENE OYSTER REEFS AS MAJOR CARBONATE FACTORIES

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carbontae, oyster, Miocene, reef

We present the first analysis of population structure and cohort distribution in a fossil oyster shell bed based on more than 1121 shells of the giant oyster *Crassostrea gryphoides* (Schlotheim, 1813). Data derive from Terrestrial Laser Scanning of a Lower Miocene shell bed covering 459 m². Within two transects, individual shells were manually outlined on a digital surface model and cross-checked based on high-resolution orthophotos, resulting in accurate information on center line length and area of exposed shell surface. A growth model was calculated, revealing this species as the fastest growing and largest *Crassostrea* known so far. Non-normal distribution of size, area and age data hints at the presence of at least four distinct recruitment cohorts. The rapid decline of frequency amplitudes with age is interpreted to be a function of mortality and shell loss. The calculated shell half-lives range around few years, indicating that oyster reefs were geologically short-lived structures, which could have been fully degraded on a decadal scale.

Crassostrea gryphoides reefs were widespread and common along the Miocene circum-Tethyan coasts. Given its enormous growth performance of ~150 g carbonate per year this species has been an important carbonate producer in estuarine settings. Yet, the rapid shell loss impeded the formation of stable structures comparable to coral reefs.

ESTIMATING THE PROVENANCE OF FRESH SUBMARINE GROUNDWATER DISCHARGE IN FRENCH POLYNESIA: A COMBINATION OF GEOCHEMICAL METHODS AND GIS

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fresh submarine groundwater discharge, nutrients, GIS, (geo-)chemical tracers

In many coastal areas, fresh submarine groundwater discharge (FSGD) provides an important link between land and sea. It supplies land-derived nutrients and other chemical species to coastal marine waters and ecosystems. Consequently FSGD bears the potential to directly influence health and functioning of marine ecosystems and could be particularly relevant on tropical islands where intensive hydrologic cycling on land meets sensitive marine ecosystems. In order to evaluate the susceptibility of FSGD to anthropogenic influences (e.g. fertilizer application) it is necessary to reconstruct its recharge area.

Here we present first results from a field study on Tahiti and Mo'orea (French Polynesia) where we sampled FSGD at 12 locations. Additionally, we sampled ocean (lagoon) water, streams, rain, terrestrial springs and wells to define the chemical endmembers. We analyzed these samples for major ion, nutrient, and trace metal concentrations and determined $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of nitrate, $\delta^2\text{H}$ and $\delta^{18}\text{O}$ of water and $^{87}\text{Sr}/^{86}\text{Sr}$ ratios. The combination of these parameters with a GIS analysis allows localizing the recharge area contributing to the FSGD.

First analyses show that freshwater samples from the two visited islands are very dilute with specific conductivities of around $200 \mu\text{S cm}^{-1}$. Except for Si (some samples reaching concentrations above $1100 \mu\text{mol L}^{-1}$), nutrient concentrations are low. Nitrate concentrations in fresh water samples reach $157 \mu\text{mol L}^{-1}$ and $22 \mu\text{mol L}^{-1}$ on Tahiti and Mo'orea, respectively. However, seawater in the lagoons around the islands is entirely depleted in nitrate which renders even dilute inputs from the islands potentially relevant for marine ecosystems. Silica in FSGD from Tahiti and Moorea could be an important silica source for the pacific waters surrounding the remote islands.

We aim to understand in which hydrological settings FSGD transfers terrestrial nutrients and chemical constituents from land to marine ecosystems most effectively. We use Tahiti and Moorea as case study of pristine islands and plan to compare the results to a study site subjected to higher anthropogenic pressure. This understanding will ultimately lead to an improved assessment of the vulnerability of coastal marine ecosystems to increasing anthropogenic pressure.

SEQUENCE STRATIGRAPHY AND FACIES VARIABILITY OF THE MUDSTONE-DOMINATED LOWER CRETACEOUS SUCCESSION IN THE EASTERN LOWER SAXONY BASIN, GERMANY

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mudstones, sequence-stratigraphy, XRF-core-scanning, Lower Saxony basin

Fine-grained sedimentary rocks predominantly composed of silts and clays (mudstones) are currently a popular topic within industry and academia. Of particular interest is to better constrain the pervasive facies variability present within these rocks. Despite their apparent homogeneity at core and outcrop scale, mudstones can actually be highly heterogeneous when examined in detail.

We used geochemical and palynofacies analyses to delineate the facies variability present within the mudstone-dominated Lower Cretaceous succession in the eastern LSB. In addition, the data-set is used to establish a sequence stratigraphic framework based on X-ray fluorescence (XRF) chemostratigraphy and palynofacies within apparently homogeneous mudstone successions.

Our study is based on three scientific drill cores (Scharnhorst 3, Scharrel 10 and Frielingen 9) which were drilled during 2012–2014. Because of their close geographical location and similar palaeoenvironmental setting, these cored sections can be considered as one complete, 510-m-thick composite section covering the late Berriasian to earliest Aptian interval. All cores have been analysed for major and minor elements (Al, Si, S, K, Ca, Ti, Mn, Fe) by X-ray fluorescence (XRF) core scanning analysis at 1 cm resolution. The resulting trends for each element were analysed in terms of facies variability and to capture relative shifts in shoreline trajectories. For example, elemental ratios indicative of coarser clastic input (e.g., Si/Al and Ti/Al) are used to decipher proximal to distal trends within the studied sediments. In order to better understand the nature of geochemical variations, XRF core scanning analyses are compared with palynofacies results.

INTERAKTIVES ROHSTOFFINFORMATIONSSYSTEM IRIS - NUTZBARE LOCKER- UND FESTGESTEINE IN ÖSTERREICH

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Lockergesteine, Festgesteine, Baurohstoffe, Informationssystem

Ziel der Arbeiten ist die Erweiterung des bestehenden, interaktiven Rohstoffinformationssystems IRIS um Informationen zu natürlichen Vorkommen von Kiesen, Sanden, Tonen und Natursteinen in Österreich mit genetisch-qualitativer Gliederung in Rohstoffbezirke und interaktiver kartographischer Darstellung im Internet. Mit dem Vorhaben soll der offene Zugang zu geologischen Informationen betreffend die natürlichen Vorkommen von Baurohstoffen erleichtert werden und ein zukunftsorientiertes Grundlagen-Instrumentarium im Spektrum der heimischen Rohstoffvorsorge geschaffen werden.

In dem Projekt werden die Vorkommen von Kiesen, Sanden, Tonen und Natursteinen nach geologischen Kriterien in Rohstoffbezirke eingeteilt und beschrieben. Damit geht eine Aktualisierung bestehender Datenbestände zu Art, Verbreitung und Eigenschaften der Vorkommen und eine Homogenisierung und Verbesserung des Wissensstandes einher. Die Gliederung in Rohstoffbezirke erfolgt nach räumlichen, genetisch-stratigraphischen und qualitativen geologischen Gesichtspunkten. Die Beschreibung der einzelnen Bezirke berücksichtigt Alter, Form, charakteristische Eigenschaften und Verwendungshinweise sowie Besonderheiten der Vorkommen, typische Lokalitäten werden beispielhaft angeführt. All diese Informationen ergänzen das bestehende interaktive Rohstoffinformationssystem IRIS, auf welches für das Inventar klassischer Rohstoffe wie Erze, Kohle und Industrieminerale über die Homepage der Geologischen Bundesanstalt (www.geologie.ac.at) bereits öffentlich und frei zugegriffen werden kann. Aufbauend auf vorliegenden Ergebnissen der Rohstoffforschung erfolgt eine Verdichtung der geologischen Informationen und ein Abgleich verschiedener Datenbestände bei Bundes- und Landesdienststellen. GIS-Software, relationale Datenbank-Technologie und Statistik-Werkzeuge werden zur Harmonisierung und Verknüpfung der österreichweiten Datenebenen eingesetzt. Kooperation und Kommunikation mit Forschung, Landesgeologie und Wirtschaft sind wesentliche Projektbestandteile. Die Studie erfolgt im Rahmen der Initiative GBA-Forschungspartnerschaften Mineralrohstoffe und ist noch im Gange.

EINE GEOLOGISCHE REISE DURCH DIE ÖSTERREICHISCHEN WEINBAUGEBIETE

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Weinbaugebiete, Geologie, Sortenverteilung

Anhand von Ergebnissen geologischer Detailuntersuchungen, von Analysenergebnissen und von Boden- und Gesteinsprofilen werden Charakteristika, markante Eigenheiten und naturräumliche Unterschiede der österreichischen Qualitätsweinbaugebiete bzw. der DAC- (Districtus Austriae Controllatus-) Regionen dargestellt. Aus Literaturangaben erfolgt eine Ergänzung von klimatischen Parametern und der regionalen Sortenverteilungen.

VERTICAL VS. INCLINED TESTING OF FALLING ROCK PROTECTION SYSTEMS

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falling rock protection kit, approval testing, laboratory scale

Since the ETAG 027 provides two different test arrangements for approval testing of falling rock protection kits, the question occurred if both methods show the same results concerning a kit's reaction on a standardized energy impact.

To answer this question the two test arrangements were transmitted to laboratory scale and a commercial falling rock protection kit was modelled relating to the defined scale factors.

For this purpose in a first step, the deformation characteristics of the kit's main single components were determined and converted to model scale. To receive additional data for model calibration, in a second step, the modelled kit was subjected to several MEL-tests while the stiffness of the used interception structure was adapted until an adequate similarity to the real scale test results was achieved. Vertical testing did this.

For the comparative test series, the inclined test arrangement was defined by a reference slope angle of 30°. This equals the conditions of the Austrian test site at the Styrian Erzberg, where the real scale tests of the modelled kit had been performed.

After model calibration, four tests of two impacts each were performed on both test arrangements. In this process, the first impacts accorded with the maximum energy level. They were placed in the centre module of the kit, but at different positions inside the module. The second impacts accorded with the service energy level and hit the kit always in the centre of the right outer module. Overall, 16 energy impacts were realised in laboratory scale to compare the system's reaction using different test arrangements.

Even though the objective of the tests was the comparison of two different test arrangements based on the approval-criteria of ETAG 027, the test series delivered further information about the system's behaviour due to non-standardized impact positions and the possibility of multiple impacts by lab-scale testing.

GEOLOGY “TO GO“ - GEOLOGISCHE ENTSCHEIDUNGSFINDUNG - RASCH UND TROTZDEM RICHTIG

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Die Tätigkeit der Tiroler Landesgeologie umfasst nahezu das gesamte denkbare Spektrum geologischer Themenbereiche und Einsatzmöglichkeiten. Vielfach sind die Landesgeologen als Amtssachverständige und Prüfgutachter in Behördenverfahren, aber auch als Sachverständige der Einsatz- und Krisenstäbe im Falle drohender oder ablaufender Naturereignisse und Katastrophen tätig. Häufig sind sie auch Berater der Landes- und Kommunalpolitik.

Fast ausnahmslos ist mit dieser Tätigkeit auch eine hohe Verantwortung verbunden. Die fachlichen Beurteilungen der Landesgeologen haben vielfach weitreichende Auswirkungen auf die finanzielle Situation, sowie nicht selten auch Einfluss auf Gesundheit und Leben der Betroffenen. Eine fachliche Fehleinschätzung kann nicht nur verheerende Auswirkungen auf Dritte haben, sondern bei grober Fahrlässigkeit auch zu umfangreichen Schadenersatzforderungen und zur gerichtlichen Belangung des Amtssachverständigen führen. Nicht nur im Krisenfall, sondern auch im Rahmen der Behördenverfahren müssen dabei die fachlichen Urteilsfindungen trotz der vorstehend genannten Zwänge unter großem Zeitdruck und trotzdem mit größter Gewissenhaftigkeit getätigt werden.

Um unter diesen Rahmenbedingungen stets rasch und fachlich richtig entscheiden zu können ist es nötig, dass die Tiroler Landesgeologie durch exakte Befundungen die Grundlagen dafür schafft (vereinfacht gesagt: „Grundlagenforschung“). Dies geschieht teils durch die Landesgeologen selbst, teilweise werden Fachinstitute der Universitäten oder Ingenieurbüros für Geologie oder auch andere Fachinstitutionen beauftragt. So wurden in den letzten 25 Jahren kleinere und teilweise auch große Projekte (Großquellenhydrogeologie, Großraumhydrogeologie, Umwelttektonik, Erdbebentätigkeit, etc.) vergeben. Gerade in den letzten Jahren konnten auf diese Weise auch wichtige Erkenntnisse zu den Grundwasserverhältnissen des Inn- und Zillertales einschließlich quartärgeologischer Neuergebnisse und zu den bisher in der Literatur als Bergstürze bezeichneten Gebieten Fernpass, Tschirgant und Köfels erzielt werden. Für Fernpass (Entstehungsgrund: Gipskarst) und Köfels ((Entstehung durch Meteoriteneinschlag/-explosion konnten dabei die gängigen Bergsturztheorien nicht bestätigt werden. Beide stellen somit keine Bergstürze dar. Für das Gebiet Tschirgant am Ausgang des Ötztals konnte als Erklärung eine Kombination aus Felssturz, Gipskarst und kalkalpiner Deckentektonik erkannt werden.

Ein Großteil der „Grundlagenforschung“ der letzten Jahre betrifft somit die von der Landesgeologie in ihrem wahren Ausmaß erkannte Gipskarstproblematik, aber auch alle möglichen Aspekte im Zusammenhang mit Massenbewegungen aller Art oder im Zusammenhang mit Permafrost.

REFLECTIONS ON LANDSLIDES IN WESTERN TYROL

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Landslide, Mass Movement, Rockfall, Tyrol

Geologists from the Department for Geology act as the Tyrolean Government's technical appraisers and consulting experts on a wide range of projects of different scales. Tyrol, with its steep mountain slopes, narrow valleys and extremely varied geological setting poses an extraordinary challenge for geological questions.

Decisions based on fundamental expert opinions should only be made if the genesis of the assessment area is well understood. Verifications in the outfield show that this is not always the case. Therefore, the Tyrolean Department of Geology conducts fundamental research in partnership with research institutions and planning offices of engineering geology to obtain a reliable information base for professional decisions.

Recent studies have shown that it is necessary to research the genesis of the landscape around the "Fernpass" area, the estuary of the Oetztal River and the region around Koefels (Oetz Valley) due to reasonable doubts about the origin of the particular landscapes from landslides. Comprehensive geological field work and analyses illustrate that in all three cases a genesis by large-scale land-sliding processes is disproved based on many contradictions.

The "Fernpass" area is part of a remnant valley floor. The sparsely occurring blocks resembling a landslide area are products of an intense and still active solution of sulfate karst disjoining the superposed dolomitic rocks. Numerous sinkhole depressions characterize this region. The assumed landslide scarp area represents a typical alpine cirque.

The landscape around the estuary of the Oetztal River into the Inn is the product of a structural-geological induced rockfall from the Tschirgant onto the Inn- and Oetztal glacier during the late glacial period. After glacier ice melting the rockfall masses accumulated on the underlying solid rocks of the Northern Calcareous Alps which were exaggerated by intense sulfate karst.

The area of Koefels is an area with regional subordinated rockfalls and two mass movement areas. The ruined landscape is marked by deep fractures in the Augengneiss basement and the occurrence of pumice. An appropriate explanation for this morphology is the explosion of an extraterrestrial object in the atmosphere resulting in an impact from its fragments. This event must have happened in postglacial times.

H- UND O-ISOTOPENVERHÄLTNISSE UND TEMPERATUREN VON THERMALEM GRUNDWASSER IM GNEIS DES AHORNKERNS BEI HINTERTUX, TUXERTAL, ÖSTERREICH

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Thermalwasser Hydrogeologie Isotopen Zillertal

In Hintertux (Tuxertal, Zillertal) am NW-Rand des Tauernfensters befinden sich die höchsten europäischen Thermalquellen auf 1500 m ü. A. In unmittelbarer Nähe verbindet der Tuxbach-Überleitungsstollen zwei Täler, und transportiert Schmelzwasser des Tuxer Ferners zum Stausee Schlegeisspeicher. Der Stolleneingang liegt im Tuxertal auf 1810 m und führt 7 km bis zum Ausgang im Zemmgrund auf 1785 m ü. A. wobei er unter einer maximalen Gebirgsüberdeckung von 1.230 m liegt. Seit dem Bau dieses Stollens 1969–1973 sind die Felstemperaturen von maximal 18,3 °C durch die Bewetterung und Schmelzwasserführung zurückgegangen. Allerdings treten an vielen Stellen Wässer aus dem Gneis der Tunnelwände und haben noch heute bis zu 14 °C.

Um die Genese und Migration dieser Wässer besser zu verstehen und einen möglichen Zusammenhang zu den Hintertuxer Thermalquellen zu beleuchten, wurden in mehrjährigen Messreihen die Feldparameter und H- und O-Isotopenverhältnisse untersucht. Als lokale Referenz wurde an mehreren Messstellen im Tuxertal zwischen 640 m und 2.560 m Höhe der Niederschlag gesammelt. Zeitgleich wurden in Hintertux die Thermalquellen und weitere Quellen zum Vergleich untersucht.

Die Isotopenverhältnisse sämtlicher Proben befinden sich auf der lokalen Niederschlagsgeraden womit ein möglicher Einfluss und Zutrag von fossilen Wässern als gering zu bewerten ist. Für die Wässer des Überleitungsstollens ist eine Korrelation zwischen der elektrischen Leitfähigkeit und der Isotopensignatur festzustellen. Die Temperaturen lassen sich wie prognostiziert mit den Schüttungen und der Überdeckung korrelieren. Die chemischen Signaturen der Gneiswässer wurden mit den oberflächlichen Quellen verglichen um deren möglichen Beitrag zu verifizieren.

REGIONAL SEASONALITY INCREASE VS. GLOBAL ARIDIFICATION – PALEOCLIMATIC IMPLICATIONS FROM CENTRAL ASIAN LATE OLIGOCENE-EARLY MIOCENE PALEOSOL SEQUENCES

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paleosols, weathering, calcretes, stable isotopes, continental deposits

Central Asia is the most extensive mid-latitude arid zone in the northern hemisphere showing a strong seasonality in precipitation with relatively wet winters and dry summers. The initiation of its aridification is supposed to be one of the most prominent climate changes in the Northern Hemisphere during Cenozoic times. Sedimentary basins in Central Asia provide the opportunity to document the regional Cenozoic climate history in terrestrial environments and how it varied over millions of years. One of those sedimentary basins, the Ili Basin in the Northern Tien Shan Mountains, exposes several hundred meters of Cenozoic strata with well-developed paleosols. These are supposed to record the physical, biological and chemical conditions that prevailed at the time of their formation. Our study presents data from calcrete-bearing paleosols in a 160 m thick Cenozoic sedimentary sequence in the Kendyrlisai Valley in southeastern Kazakhstan. High resolution geochemical data, including alteration indices, carbonate content and $\delta^{13}\text{C}$ values of pedogenic carbonates are used to identify changes in pedogenic calcrete formation, weathering intensity, annual precipitation and seasonality to evaluate the impact of the Central Asian aridification on a regional scale of Kendyrlisai Valley soils. The paleoclimatic results are complemented by U-Pb age determinations on the carbonate nodules. Our data suggest pronounced seasonality in late Oligocene to Early Miocene times with elevated amounts of wet season precipitation and pronounced aridity in the dry season. The increase in rainfall may be related to the regional uplift of mountain belts as the Tien Shan and Jungarian Alatau in late Oligocene-early Miocene times which gave rise to an orographic barrier and lead to a pronounced release of air moisture isolating Central Asia from the Westerly moisture sources.

HYDROGEN/CARBON DIOXIDE ENERGY STORAGE IN THE GEOLOGICAL UNDERGROUND – PETROPHYSICAL, GEO- AND FLUID CHEMICAL EFFECTS IN THE SANDSTONE RESERVOIRS

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hydrogen, carbon dioxide, reservoir quality, μ -CT, storage

This study is part of the R&D projects H2STORE and HyINTEGER which are funded by the German government. The topics of these projects are the geo- and fluid chemical reactions in reservoir sandstones induced by H₂ and/or CO₂ storage. Therefore also petrophysical variations, as indicator for reservoir qualities, are of special interest. Such variations are induced by the chemical reactions and can influence the fluid migration pathways. To evaluate potential rock modifications static autoclave experiments lasting for 4-7 weeks are conducted at simulated reservoir temperature and pressure conditions on Permian, Triassic and Tertiary sandstones which has been exposed to H₂ and/or CO₂ and synthesized reservoir fluids. The sample material and the information about the reservoir fluid compositions used for these experiments were provided by industrial partners. Before and after the experiments geo- and fluid chemical analyses are conducted by ICP-MS/OES analyses and the surfaces of the minerals are analysed by digital microscopy, AFM and FE-SEM techniques to evaluate any mineral alteration. The element distribution of sample regions of special interest are analysed by EDX and WDX. The computer tomography is used to generate μ -CT scans of sandstone cubes with high resolutions rates. They are also used for fluid flow simulations through the segmented pore network and the numerical modelling of petrophysical parameters. The advantage of this non-destructive method is the comparison of the identical sample and the achieved data sets before and after the experiments. Nitrogen permeability and helium porosity characterisation of sandstone plugs before and after the experiments are also conducted. By this wide range of analytical methods and modelling, dissolution of pore filling carbonate and anhydrite cements in Permian and Triassic sandstone samples, triggered by CO₂, was confirmed. Also the experiments using hydrogen are implying the dissolution of carbonate, anhydrite and barite cements in the Permian and Triassic reservoirs. These results are of great importance regarding the modification of the reservoir quality induced by H₂/CO₂ injection into potential geological storage sites.

SYNSEDIMENTARY TECTONICS AND MASS WASTING ALONG THE ALPINE MARGIN IN LIASSIC TIME

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synsedimentary tectonics, Neptunian dykes, debrites, Adnet Scheck breccia

An intriguing case study of drowning successions of huge Triassic carbonate platforms and synsedimentary block tectonics is exposed along the saw-cut wall sections of quarries around the village of Adnet close to Salzburg. The deeply submerged, inherited relief of a drowned reef mound gave rise to pronounced Liassic facies differentiation, i.e. (1) deposition of grey spiculitic cherty limestone and marl beds in the former shelf basin, and (2) red nodular limestones, and red condensed limestones rich in ammonites and Fe-Mn crusts over the slope and top of the former reef mound. Faulting, tilting and submarine erosion of Hettangian drift deposits at the lower slope was followed by repeated down-slope gliding, shearing and multiple opening of fissures with different generations of sediment infill. Renewed tectonics from Late Pliensbachian to Middle Toarcian created deep reaching vertical fissures and triggered multiple mass flow events. At the upper and middle slope the so-called Adnet Scheck breccia, which is a special debrite deeply eroding and incising into well-bedded condensed hemipelagic limestone strata, was deposited. Further down-slope the Scheck breccia evolves into more matrix-rich nodular breccias. Basin sections reveal intercalations of mudflow deposits and were affected by various magnitudes of sliding and mass flow events forming complex mass transport deposits. The down-slope transition of Scheck breccias into nodular breccias and finally into pebbly mudstones indicates a drastic change in the flow properties. Cohesive Scheck flows are limited in lateral and down-slope extent, whereas the turbulent pebbly mudstone flows reveal long run-out distances due to hydro-planing. Scoured debris tongues of Scheck type testify deep erosion. Our observations show that collapse of scour sidewalls is a new mechanism to explain enrichment of semi-consolidated sediment and lithified rock blocks at top of the flow. The main driving force in Scheck type flows is a thin muddy layer at the base, whereas the main body tends to freeze and pluck the flow.

References

Henrich, R. (2016) Synsedimentary tectonics and mass wasting along the Alpine margin in Liassic time. In: G. Larmarck et al. (eds.), *Submarine Mass Movements and Their Consequences, Advances in Natural and Technological Hazards Research* 38: 449-459.

DEFORMATION BEHAVIOUR OF FELDSPAR IN GREENSCHIST FACIES GRANITOID MYLONITES FROM THE AUSTROALPINE BASEMENT TO THE SOUTH OF THE WESTERN TAUERN WINDOW, EASTERN ALPS

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alps, microfabrics, feldspars, EBSD

The aim of this study is the investigation of the deformation behaviour of feldspars at mid-crustal conditions. Due to the abundance of K-feldspar and plagioclase their deformation behaviour is crucial for the long-term rheology of the continental crust. It is strongly controlled by the interaction of brittle, dissolution-precipitation and crystal-plastic mechanisms. Here we present the record of mylonitic pegmatites from the Austroalpine basement to the south of the western Tauern Window. These pegmatites are of Permian age and thus record the Alpine deformation history. The chemical and structural characteristics of the feldspar microfabrics are analysed via polarisation microscopy, scanning electron microscopy (SEM) and electron backscatter diffraction (EBSD). The pegmatites are relatively Ca-poor and thus consist mainly of albitic plagioclase, K-feldspar, quartz and white mica. In addition tourmaline, garnet and accessories like monazite can occur. The matrix of these pegmatites is often composed of fine-grained quartz and albite, which may either be intimately mixed or clearly separated. In the latter case alternating ribbons of these minerals define a foliation. Quartz in these ribbons shows a strong crystallographic preferred orientation (CPO), which corresponds to deformation by dislocation creep under greenschist facies conditions. Albite ribbons in contrast only exhibit a shape preferred orientation and show no CPO. In a few samples low-strain patches of albite show a CPO that is probably inherited from the original host grain. Fragments of K-feldspar and/or tourmaline are aligned in this foliation and frequently show strain shadows of albite, K-feldspar and quartz. K-feldspar porphyroclasts often have serrated grain boundaries to matrix albite grains. New grains of K-feldspar and albite occur in intragranular zones within K-feldspar clasts. Some of the "new" K-feldspar grains show only small misorientations to their host. No crystallographic relationship of albite grains within or bordering to K-feldspar porphyroclasts is observed.

These microfabrics show that deformation of feldspars in these rocks is mainly controlled by brittle behaviour and dissolution-precipitation creep. Crystal-plastic deformation in feldspars occurs only localised, as seen for example by bent porphyroclasts.

THERMALWASSERREGIME KLAMMKALK ZWISCHEN TAXENBACH UND DER LIECHTENSTEINKLAMM

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Klammkalk, Thermalwasser, Tauernfenster

Am Nordrand des Tauernfensters im Salzburger Pongau und Pinzgau sind einige wenige Thermal- bzw. Warmwasservorkommen bekannt. Sie liegen in den verkarstungsfähigen Gesteinen der penninischen Klammkalkzone südlich angrenzend an das Salzach-Ennstal-Mariazell-Puchberg (SEMP)-Störungssystem. Neben Thermalwässern, die im Triebwasserstollen des Kraftwerks Schwarzach auf Höhe Lend bei der Kraftwerkerrichtung angefahren und im Rahmen einer Tiefbohrung bei Lend erschlossen wurden, zählen dazu auch freie Austritte temperierter Quellwässer im südlichen Bereich der Liechtensteinklamm zwischen St. Johann und Großarl.

Auswertungen regionaler Störungsmuster lassen vermuten, dass die Wasserführung an WSW-ENE-streichende Störungen gebunden ist, wobei die Wässer im Salzbachtal und jene der Liechtensteinklamm parallel verlaufenden Störungen zuzuordnen sind. Ein direkter hydraulischer Zusammenhang der beiden Systeme ist nicht erkennbar. Die hydrochemische Zusammensetzung der Wässer variiert vor allem im Sulfatanteil, wobei die Wässer im Bereich Taxenbach vergleichsweise höhere Sulfatgehalte aufweisen. Tritiummessungen an den Quellen der Liechtensteinklamm aus dem Zeitraum 2001 bis 2015 lassen auf ein mittleres Wasseralter von ca. 12 Jahren schließen, während auf Basis vorhandener Isotopendaten der Wässer in Taxenbach und Lend hier offenbar deutlich kürzere Verweilzeiten vorliegen.

Basierend auf der Zusammenschau aller verfügbaren geologischen, hydrogeologischen, hydrochemischen und isotopenhydrologischen Daten wird im Poster ein konzeptionelles Modell des Thermalwasserregimes der Klammkalkzone präsentiert.

THE MULTIFUNCTIONAL GEOLOGIC DATASETS OF AUSTRIA (1:1.500.000) – INCLUDING A NEW CLASSIFICATION SCHEME FOR “TECTONIC BOUNDARIES”

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fault data base, Alpine geodynamics, Austria

Austrian geology has been studied for more than a century and the results have been published in several geological maps on different scales. In order to understand tectonic evolution in such a complex environment as the Alps, the knowledge about the occurrence and emplacement of lithologic and tectonic marker units as well as the movement along major fault systems is the key for the development of kinematic models.

We present here the first approach to combine different aspects of Austrian geology in a cohesive multifunctional dataset at the scale 1:1.500.000. This dataset is based on published geological maps of Austria and includes lithologies, tectonic units and tectonic features. It is published as a Web Map Service at the Geological Survey of Austria and should serve as a common source for structured regional geodynamic knowledge.

The lithology layer includes bedrocks and synorogenic igneous rocks of the Variscan and Alpine orogens, as well as sediments of the Cretaceous Gosau-Group and from Cenozoic basins. In addition, the layer of tectonic units comprises hierarchically structured units from orogen/lithospheric plate down to nappe systems. In the layer of tectonic lines and boundaries, we collected information about the location, orientation, timing and kinematic constraints of faults published in various sources. This lead to a platform where, for the first time, at least basic information about major tectonic boundaries (fault systems) in Austria and its surroundings is given in a searchable way.

This multifunctional dataset can be adapted and extended with additional data such as the attributes for nappe boundaries, the metamorphic grad of tectonic units at different times or the chronostratigraphic information for the lithological units.

The terms and names used in this Web Map Service are defined and available in the Online Thesaurus of the Geological Survey of Austria (<https://www.geologie.ac.at/services/thesaurus>).

KOHLENDIOXID IN WASSER MIT ALKALINITÄT

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Kohlendioxid, Alkalinität, Hydrochemie, Wasser

Kohlendioxid kommt in der Atmosphäre zu 0,03 Vol% bzw. mit einem Partialdruck von $3,7 \times 10^{-4}$ atm frei vor. Auf Grund der Wechselwirkung zwischen der Atmosphäre mit der Hydrosphäre findet man Kohlendioxid in Form von Kohlensäure und deren Salze auch im Wasser.

Es werden die theoretischen Grundlagen für das chemische Gleichgewicht zwischen Kohlendioxid und Wasser mit einer bestimmten Alkalinität in allgemeiner Form dargestellt. Löst sich Kohlendioxid in Wasser mit Alkalinität bildet es die zweibasige Kohlensäure, die in 2 Stufen dissoziiert. Vom chemischen Gesichtspunkt aus gesehen sind nur wenige einfache chemische Gleichgewichte zu berücksichtigen um das gesamte System exakt zu berechnen. Mit Hilfe kombinatorischen Methoden zeigt sich, dass es 48 mögliche mathematische Beziehungen zwischen den Parametern existieren. Da es 6 unabhängige Parameter gibt aber nur 4 mathematische Gleichungen, hat das System 2 Freiheitsgrade. Dadurch können immer 2 Parameter vorgegeben werden und die Dritte berechnet bzw. als 3D-Fläche dargestellt werden. Von den 48 Beziehungen werden die wichtigsten grafisch gezeigt und diskutiert. In weiterer Folge kann durch Nullsetzen der Alkalinität auf das System Kohlendioxid in reinem Wasser geschlossen werden.

Reference:

G.Hobiger, Kohlendioxid in Wasser mit Alkalinität – Berechnung und grafische Darstellung der chemischen Gleichgewichte, 2015, Springer, Berlin, Heidelberg
DOI: 10.1007/978-3-662-45466-4

KOHLENDIOXID IN WASSER MIT ALKALINITÄT

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Kohlendioxid, Alkalinität, Hydrochemie, Wasser

Kohlendioxid kommt in der Atmosphäre zu 0,03 Vol% bzw. mit einem Partialdruck von $3,7 \times 10^{-4}$ atm frei vor. Auf Grund der Wechselwirkung zwischen der Atmosphäre mit der Hydrosphäre findet man Kohlendioxid in Form von Kohlensäure und deren Salze auch im Wasser.

Es werden die theoretischen Grundlagen für das chemische Gleichgewicht zwischen Kohlendioxid und Wasser mit einer bestimmten Alkalinität in allgemeiner Form dargestellt. Löst sich Kohlendioxid in Wasser mit Alkalinität bildet es die zweibasige Kohlensäure, die in 2 Stufen dissoziiert. Vom chemischen Gesichtspunkt aus gesehen sind nur wenige einfache chemische Gleichgewichte zu berücksichtigen um das gesamte System exakt zu berechnen. Mit Hilfe kombinatorischen Methoden zeigt sich, dass es 48 mögliche mathematische Beziehungen zwischen den Parametern existieren. Da es 6 unabhängige Parameter gibt aber nur 4 mathematische Gleichungen, hat das System 2 Freiheitsgrade. Dadurch können immer 2 Parameter vorgegeben werden und die Dritte berechnet bzw. als 3D-Fläche dargestellt werden. Von den 48 Beziehungen werden die wichtigsten grafisch gezeigt und diskutiert. In weiterer Folge kann durch Nullsetzen der Alkalinität auf das System Kohlendioxid in reinem Wasser geschlossen werden.

Reference:

G.Hobiger, Kohlendioxid in Wasser mit Alkalinität – Berechnung und grafische Darstellung der chemischen Gleichgewichte, 2015, Spinger, Berlin, Heidelberg
DOI: 10.1007/978-3-662-45466-4

DER EINFLUSS DES CATCHMENTS AUF DAS ABFLUSSVERHALTEN BEIM HOCHWASSEREREIGNIS VOM 02. JUNI 2013, AUFGEZEICHNET IN HÖHLEN UND KARSTQUELLEN IM LAND SALZBURG

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Karst, Grundwasser, Hochwasser, Einzugsgebiet, Monitoring

Für karsthydrogeologische Forschungszwecke werden verschiedene Höhlen und Karstquellen im Land Salzburg mit Dauermesseinrichtungen beobachtet. Dabei wird mit einer Drucksonde der Wasserspiegel in regelmäßigen Abständen (von Fall zu Fall unterschiedlich, zwischen 5 und 60 Minuten) aufgezeichnet. Meist wird auch die Temperatur aufgezeichnet, in Ausnahmefällen auch die elektrische Leitfähigkeit.

Das Hochwasser im Juni 2013 überschritt im Land Salzburg in mehreren Einzugsgebieten das 100-jährige Ereignis. Dabei zeigte sich bereits im Oberflächenabfluss, dass die nördlichen Landesteile stärker betroffen sind.

Anhand von fünf Karstsystemen wird der Einfluss der Einzugsgebietshöhe auf das Abflussverhalten im Hochwasserereignis vom 02. Juni 2013 dargelegt. Hierbei zeigt sich, dass hinsichtlich der Ereignisintensität eine starke Höhenabhängigkeit vorliegt. Drei der Systeme (Kitzsteinhorn mit den Kesselfallquellen, Leoganger Steinberge mit dem Lamprechtsofen, Tennengebirge mit der Winnerfallhöhle) zeigten am 02. Juni 2013 wenig bedeutende Hochwasserereignisse. Bei den Systemen Untersberg (Fürstenbrunner Quellhöhle) und Hagengebirge (Bärenhöhle im Bluntautal) hingegen wurde am 02. Juni 2013 den bisher höchste Abfluss aufgezeichnet.

Der Grund dafür, dass es in höheren Einzugsgebieten nicht zu Extremabflüssen kam, war die um 2000 m liegende Schneegrenze.

Dieses Fallbeispiel zeigt, dass alpine Einzugsgebiete in Zusammenhang mit dem Alpenvorland ausgesprochen sensibel auf klimatische Änderungen reagieren. Eine nur wenige hundert Meter höher liegende Schneegrenze hätte zu einer noch viel größeren Katastrophe geführt. Die gegenständliche Klimaentwicklung hingegen verspricht nahezu unaufhaltsam Temperaturanstiege.

THE DATAVIEWER MODULE – A NEW PERSPECTIVE ON SPATIAL DATA (ILLUSTRATED BY MAP SHEET 88 ACHENKIRCH)

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Geodata, Data Management, web application, SKOS, INSPIRE

As geoscientific data cannot be used successfully if the basic structure and interpreted results are not understandable for everyone within a certain community, a comprehensible (transparent) knowledge representation is an important precondition. The Thesaurus of the Geological Survey of Austria²⁾ – the “GBA-Thesaurus” – represents a controlled vocabulary and fulfills this functional requirement (as presented at the Pangeo 2016 by Vicky Haider). The available open access service interface allows building external applications that evolve from the GBA-Thesaurus.

Therefore, it was possible to develop the GBA DataViewer module. It is a tool - based on the INSPIRE data model for geology¹⁾ - designed specifically to search and analyze harmonized geoscientific spatial data. It consists of: (1) a map display shown via ArcGIS web services and an attached leaflet to show the geometry, (2) a concept area with semantic data from Thesaurus queries using SPARQL endpoint, (3) a filter bar with SQL queries directly from the relational data base using an ashx-handler. The purpose of this application is to provide geologists a possibility to explore the database, to understand the advantages of a sophisticated structured database, and to move from the display of geological maps towards a view of geodata. Ultimately, its benefits are the improvement of both, the quality and the harmonizing process of datasets. In addition, by providing a live access to the process of harmonizing geological data, it may be useful for a compilation of geological data all over the country and for error identification in geological map data. In future prospective, it should be possible to detect, define, and visualize cross-bordering geological features by using the GBA-Thesaurus and DataViewer to support a common transboundary cooperation regarding geoscientific challenges.

This poster presentation visualizes the possibilities and advantages of querying structured geoscientific spatial data, shown by the example of the dataset concerning the map sheet 88 Achenkirch.

¹⁾ INSPIRE Thematic Working Group Geology (2013): D2.8.II.4 INSPIRE Data Specification on Geology – Technical Guidelines. European Commission Joint Research Centre.

²⁾ GBA-Thesaurus link: <http://resource.geolba.ac.at/>

INFLUENCE OF DEPTH AND CLAY CONTENT FOR TWO BOREHOLES FROM THE VIENNA BASIN; FOCUSING ON THE ROCK PHYSICS TEMPLATE

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Petrophysics, Formation Evaluation

This study investigates the influence of depth and clay content for two boreholes of the Vienna Basin focusing on the Rock Physics Template (RPT). Because physical properties of rocks depend on lithology a formation evaluation including clay volume analysis was done to determine the different lithologies. Furthermore elastic properties (compressional- and shear wave velocity, velocity ratio), porosity and density were investigated on depth and clay volume. Subsequently RPTs with the influence of depth and clay volume were generated. The influence of clay content on the RPTs showed good results, which correlate with past investigations. The influence of depth on the RPTs is only given for a part of the investigated lithologies.

CONSTRUCTION OF TYPICAL FACIES MODELS AND THE THREE-DIMENSIONAL DISTRIBUTION OF THEIR PETROPHYSICAL PARAMETERS - A FOUNDATION FOR UNDERSTANDING 3D SEISMIC FACIES

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Petrophysics, Seismic

In 3D seismic interpretation geological bodies are mainly interpreted based on the 3D seismic facies. These facies are often hard to classify, because seismic facies are often different than geological facies. To understand the mismatch of both a master thesis within the FFG project GeoSegment3D is done. The thesis is divided into two parts.

In the first part the geometry and facies of different geological bodies (river, salt dome, fan, volcano etc.) were taken from literature. Based on this result a three dimensional model (3D seismic interpretation and modelling software) of each depositional environment was constructed.

The second part investigates the influence of petrophysical parameters (compressional- and shear wave velocity, density, specific electrical resistivity) on each geological body. Therefore, following aspects were considered: spreading of the parameters, trends due porosity, clay content and pore fluid change and depth influence. A correlation between the parameters (e.g. density-velocity) was done.

As a result, multiple models are built to show a range of different facies of geological models and discuss the possible mismatches.

THE HAZARD POTENTIAL OF THE MAKRAN SUBDUCTION ZONE

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tsunami, subduction, worst case

The Makran Subduction Zone is located within the Arabian Sea (Northern Indian Ocean) and marks the boundary between the Arabian and the Eurasian plate. The hazard potential is enigmatic as the only documented and recorded tsunamigenic earthquake (MW 8.1) within the subduction zone occurred in Nov 1945. However, thermal modelling (Smith et al. 2013) suggests a wide potential seismogenic zone, apparently capable of generating very significant (>MW 8.5) tsunamigenic earthquakes. Furthermore, submarine slumping is another tsunami trigger which has to be taken into account.

We used the modelling results as a hypothesis and mapped extreme wave event deposits along the coastline of Oman, bordering the Arabian Sea. We were able to document extensive boulder fields along rocky parts of the coastline. These boulders are decorated with marine sessile organisms such as e.g. oysters or barnacles testifying for an intertidal setting of the boulder prior to dislocation. The organisms remain were used for radiocarbon dating assuming that the death of the organism was related to the relocation of the boulder. Storm-induced boulder movement is possible as the coastline is subject to infrequent tropical cyclone impact. However, boulder movement was not observed during the strongest storm on record in 2007. The dating exercise revealed a cluster of dates around 1000 AD, coinciding with a potential earthquake event known from a historic Persian text dating to the year 1008 AD.

Archaeological evidence, mainly pottery artefacts found along the sea shore near the capital area Muscat/Oman also indicate a catastrophic event which may be correlated to the 1008 AD earthquake and tsunami inundation. The boulder deposits as well as the archaeological remains testify for a maximum tsunami runup of 15m, exceeding by far the inundation as observed in 1945. We define this as the worst case scenario for the Makran Subduction Zone. However, the return period is rather large (>500 years).

References:

Smith, G. L., McNeill, L. C., Wang, K., He, J., & Henstock, T. J. (2013). Thermal structure and megathrust seismogenic potential of the Makran subduction zone. *Geophysical Research Letters*, 40(8), 1528-1533.

THE PETROLOGY OF CONTACT ZONES BETWEEN MAGMATIC CHROMITITE LAYERS IN THE LOWER CRITICAL ZONE OF THE BUSHVELD COMPLEX, SOUTH AFRICA

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Bushveld Complex, Chromite, Ore deposits, Layered intrusions

The Bushveld Igneous Complex (BIC) in South Africa is the principle source for Platinum Group elements as well as Chromium and Vanadium. The pronounced magmatic layering and the exceptional continuity of these layers, makes it of great interest for the scientific community. The Critical Zone of the Rustenburg Layered Suite (RLS) contains numerous economically important layers which occur in the form of massive chromitites. There are different theories of how chromitite layers could have formed in such a continuous manner. Those include: magma mixing, pressure and/or oxygen fugacity increase, mechanical thickening by slumping or transport of chromitite rich slurries [a]. Detailed studies of contact zones between chromitite seam and adjacent footwall and hanging wall [b] showed significant changes and anomalous features. These observations were used to understand the formation of chromitite layers and answer open questions regarding non-equilibrium processes, element mobility and interactions between layers during formation.

This study focuses on the mineralogy, texture and geochemistry of contact zones of the LG6 and MG2 layers of the lower critical zone, which have not been studied in detail so far. Investigations were done on thin sections prepared from drill core samples. Cores were drilled in the Thaba Mine, Western Bushveld Complex and samples from drill core ZK135 were provided by Cronimet Chrome Mining SA (Pty) Ltd

Textures and mineral composition were studied (e.g. by microprobe) to identify even subtle modifications along and adjacent to contact zones. Individual chromitite seams and their footwall and hanging wall contacts can vary strongly in mineral texture and composition from very sharp to gradational transitions. For example, the increased occurrence of anhedral, inclusion rich chromitites may hint to rapid initial crystallization at a thermal boundary layer and subsequent textural maturation during solidification [c]. Furthermore, higher amounts of hornblende intergrown with plagioclase occur in these zones which may give better insights on the crystallization history of the cumulus and intercumulus phases.

[a] Naldrett et al. (2012) *Miner Deposita* 47/3, 209-232; [b] Veksler et al. (2015) *J. Petrol.* 56, 1229-1250; [c] Vukmanovic et al. (2013) *Contrib. Min. Petrol.* 165, 1031-1050

REWORKED MIDDLE JURASSIC SANDSTONES AS A MARKER FOR LATE CRETACEOUS BASIN INVERSION IN CENTRAL EUROPE?

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Middle Jurassic, Upper Cretaceous, Schmilka, Lausitz Block, zircon U-Pb geochronology, Provenance

For this case study Upper Cretaceous (Turonian-Coniacian) sandstones of the Elbtal Group at Schmilka (Saxony, Germany) were analysed regarding their U-Pb detrital zircon record. These sandstones represent deposits from a narrow strait of the sea linking the northern Boreal shelf to the southern Tethyan areas. It was bordered by the West-Sudetic Island in the north and the Mid-European Island in the south. The main sedimentary input came from the north (Lausitz Block, southern West-Sudetic Island). The U-Pb analyses of the Cretaceous detrital zircons gave unexpected results. Although the general age spectra resembles age clusters typical for the Bohemian Massif, the Cretaceous rocks lack the expected 540 – 560 Ma ages typical for the Lausitz Block, which is interpreted to be the main source area for the sediments. In addition, we found a significant change in the detrital zircon age spectra in the uppermost sample of the section at Schmilka: In the Lower Coniacian a major input of Meso- and Paleoproterozoic grains was obtained. Comparable ages are generally scarce in the working area and are only reported as sporadic detritus within the Lausitz Block and the Bohemian Massif.

Based on additional analyses of Jurassic and Triassic sandstones from Germany and published ages for southern Scandinavia and Bohemia, we present a possible explanation for the above mentioned results. We interpret the detrital zircon record of the Jurassic Dogger sandstones of Germany as “marker ages” for the European Cretaceous Basin inversion.

WO DIE WIENER MAMMUTS GRASTEN – NATURGESCHICHTE(N) VERMITTELN ALS ÖFFENTLICHKEITSARBEIT

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Public Relations, Outreach, Book, Natural Sciences, Geology, Palaentology

Keine Frage; Öffentlichkeitsarbeit ist wichtig und wird zunehmend wichtiger. Statt Orogen nur „Gebirgsbildung“ zu sagen, genügt schon lange nicht mehr. Gefragt sind breit angelegte Ansätze, die mit Witz und Charme verkauft – pardon, an den Mann, die Frau – gebracht werden wollen.

Am Beispiel des Buches „*Wo die Wiener Mammuts grasten – Naturgeschichtliche Entdeckungsreisen durch das heutige Wien*“ (Metro-Verlag, 2016) wird gezeigt, dass für die Kommunikation (erd)wissenschaftlicher Themen, ein breiter Mix aus dem gesamten Bereich der Naturwissenschaften mit Querverbindungen zu den Geisteswissenschaften geeignet ist ein breit(er)es Publikum anzusprechen. Als Format hat sich das Feuilleton erwiesen, wie es etwa in der „Wiener Zeitung“ im „EXTRA“ samstags gepflegt wird.

Grundlage der 17 in diesem Buch veröffentlichten Beiträge ist neben der fundierten Recherche und einer unkonventionellen Kombination von Fakten aus den unterschiedlichsten Bereichen der humorvoll, witzige Zugang zur Materie. Alfred Komarek fand dafür bei seiner Eröffnungsrede unter dem Thema „*Randnotizen*“ im Rahmen der Buchpräsentation am 27. April 2016 folgende Worte: „... sie [=die Autoren] *haben jedoch ihre exakte Forschungsarbeit ungeniert mit der subjektiven Wirklichkeit historischer Zeitungsberichte verbandelt, taten vergnügte Zeitsprünge, entdeckten Hintertüren, Verbindungen, Verwandtschaften. Und vor allem: die hehren Diener der Wissenschaft hatten ihr lausbübisches Vergnügen daran.*“

In der schnelllebigen Zeit der social media, wo tweets und SMS mit einer auf wenige Zeichen reduzierten Botschaft (in Echtzeit) suggerieren damit auch schon die wesentlichen Inhalte zu kommunizieren, bekommen breit (er) angelegte Geschichten, deren Länge in etwa einer Seite in einer großformatigen Tageszeitung entspricht, eine neue Bedeutung.

Im Sinne unseres Kommunikationsansatzes werden die im Untertitel genannten Worte „Naturgeschichte“ und „Entdeckungsreise“ als richtungsweisend postuliert. Wesentliche Elemente sind neben der subjektiv gefärbten erzählerischen Komponente des Vermittlers, vor allem die Neugierde und die individuellen Interessen des Zuhörers. Vor allem durch einen breiten Ansatz im Bereich kann fast jeder Zuhörer bei seinem persönlichen Interessensgebiet „abgeholt“, im Sinne von angesprochen, werden.

Als zusätzliches Elemente werden Zitate historischer Zeitungsartikel und biographische Details der auftretenden, sprich handelnden Personen verwendet.

Um mit Komarek zu schließen: „*Diese Mischung ist ziemlich unwiderstehlich für Leserinnen und Leser.*“

DIE BIBLIOTHEK DER GEOLOGISCHEN BUNDESANSTALT ALS QUELLE ZENTRALER INFORMATIONSSRESSOURCEN

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Geoinformation, Library, Database, GIS-Application, Webservice

Die Bestände der Bibliothek der Geologischen Bundesanstalt (GBA) werden durch einen Katalog (<http://opac.geologie.ac.at>) basierend auf der Software adlib (Bibliotheksmodule) der Firma Axiell ALM (www.adlibsoft.de) erschlossen. Wichtigstes Alleinstellungsmerkmal der Bibliothek der GBA ist die direkte Verknüpfung von Bibliotheksdatensätzen mit gescannten Dokumenten (Artikel, Bücher, Karten) im durchsuchbaren PDF-Format.

Mit Stand 25. April 2016 sind 49.793 PDFs integriert. Dazu kommen weitere 26.622 Artikel, die von Zeitschriften der European Geosciences Union (EGU) periodisch übernommen werden (www.egu.eu/publications/open-access-journals/), darüber hinaus wird hier auch auf die Abstracts der General Assembly der EGU zugegriffen; für die Jahre 2009 bis 2015 sind dies 94.705 Abstracts.

Neben den für Bibliothekskatalogen üblichen Suchoptionen wurde an der GBA eine **geographische Suche** entwickelt. (<http://gisgba.geologie.ac.at/geonames/>). Hier werden ausgehend von den in GeoNames (www.geonames.org/) vorhandenen Ortsnamen die Einträge im Katalog abgeglichen und auf einer Karte dargestellt.

Als weitere Entwicklung konnte basierend auf dem Sammlungsmodul der Firma Axiell ALM eine Verknüpfung zwischen dem an der GBA vorhandenen paläontologischen Typenmaterial („Objekte“) und den Bibliotheksdatensätzen realisiert werden. Somit wird bei Suchabfragen auch der Name mit Inventarnummer der zu der jeweiligen Arbeit an der GBA vorhandenen Fossilien gezeigt.

Die Daten der Bibliothek stellen einen wichtigen Bestandteil des Datennetzwerkes der GBA dar und sind an mehrere, webbasierte Anwendungen geknüpft:

GBA Thesaurus (<http://resource.geolba.ac.at/>)

Die Zitate zu den Konzepten der Themenbereiche Geologische Zeitskala, Geologische Einheiten, Geologische Strukturen, Lithologie, Minerale und Tektonische Einheiten sind, wenn vorhanden, direkt auf Einträge im Bibliothekskatalog verlinkt.

Geologische Manuskriptkarten 1:75.000 der Monarchie

Die rund 480 an der GBA von 1873 bis ca. 1938 erstellten Manuskriptkarten wurden bibliothekarisch erfasst, hochauflösend gescannt, georeferenziert und stehen über ein Webservice zur freien Verfügung.

https://gisgba.geologie.ac.at/gbaviewer/?url=https://gisgba.geologie.ac.at/ArcGIS/rest/services/image/AT_GBA_GMK75/ImageServer

Profilschnitte

Die Zusammenstellung von Profilschnitt-Abbildungen aus Geologischen Karten, Kartenerläuterungen, Schriftenreihen und Einzelpublikationen im GBA-Bibliotheksservice greift ebenfalls auf bibliothekarische Daten der Bibliothek zu.

https://gisgba.geologie.ac.at/gbaviewer/?url=https://gisgba.geologie.ac.at/ArcGIS/rest/services/AT_GBA_PROFILE/MapServer

Geologische Karten 1:50.000

Die Geologische Karte 1:50.000 ist die wichtigste Publikation der GBA. Die verfügbaren Kartenblätter wurden hochauflösend gescannt und georeferenziert. Über eine Verknüpfung besteht ein Zugriff auf die bibliothekarischen Daten der Bibliothek.

https://gisgba.geologie.ac.at/gbaviewer/?url=https://gisgba.geologie.ac.at/arcgis/rest/services/image/AT_GBA_GK50/ImageServer

OPTIMIZED ENERGY RECOVERY FROM GEOTHERMAL WELLBORES

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Energy Recovery

Even though Deep Geothermal Energy Recovery is favourable over other renewable energy sources, there exist some drawbacks which must be overcome in order to render this energy source competitive. However, the recovery sites are almost invisible and energy can be produced 24 hours a day, and 365 days a year at zero emission, moreover, they are fully independent from wind and weather.

The most important criterion which is hindering success in many geothermal projects is the productivity/injectivity of the wellbores drilled. Even with the necessary temperature in place, and successful penetration of the geological unit, the amount of energy to be recovered is far from being economic.

On the other hand we know from oil and gas drilling that „radial drilling projects“ a fairly new technology to drill out from an existing and cased wellbore may essentially contribute to the inflow performance. Another option left in order to increase productivity is Hydraulic Fracturing. Knowing well that public acceptance is not given anymore and in some European countries there is even a ban on this technology, the Chair of Petroleum & Geothermal Energy Recovery has developed a new technology over the last years which is called „Bio Enhanced Energy Recovery“. In order to further optimize energy recovery the chair also has developed a simulation program that allows calculations in terms of energy conservation from the reservoir to surface.

MYRMEKITE FORMATION IN ULTRAPOTASSIC QUARTZ-MONZONITES

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myrmekite, metasomatism, microstructure, Jihlava-Pluton

Myrmekite formation in the ultrapotassic Quartz-Monzonites of the Variscan Jihlava-Pluton (Czech Republic) was correlated with the cooling history and sub-solidus evolution of the pluton. Detailed petrographic characterization by polarization microscopy was combined with electron microprobe analysis at high lateral resolution using field-emission-gun electron microprobe (FEG-EPMA).

A lack of hydrated phases in the primary mineral assemblage of the Jihlava-Pluton indicates magma emplacement in a hot and dry, deep-crustal environment. During exhumation, the original paragenesis was altered in presence of fluids under amphibolite-facies conditions.

Typically, myrmekites replace primary magmatic, perthitic alkali feldspar by a matrix-rod intergrowth of plagioclase and quartz. Element mapping revealed chemical zoning of the plagioclase with an increasing albite content towards the reaction front, where the myrmekite replaces the alkali feldspar. Areal analysis on BSE images revealed that the modal proportion of quartz in the myrmekites is positively correlated with the anorthite content of the plagioclase forming the matrix. From the corresponding mass balance considerations it is inferred that silica and aluminium were conserved across the reaction front whereas potassium was removed, and sodium and calcium were supplied to the reaction site in an open-system configuration. Given the extent of the chemical mass transfer involved it appears likely that myrmekite formation was mediated by the presence of fluids. The extent of fluid activity strongly influences the geometry and the internal chemical zoning patterns of the myrmekites. Barium, which is present in the reactant alkali feldspar, is not incorporated in the myrmekite and is therefore passively enriched within the alkali feldspar ahead of the myrmekite reaction front. Enhanced fluid participation lead to accelerated propagation of the reaction front, which resulted in an irregular shape of the myrmekites and formation of relict alkali feldspar with up to 2.99 w% barium. Typically, different myrmekite generations occur with the oldest generation being more coarse-grained than the younger ones. This is strong evidence for intermittent myrmekite growth probably related to short pulse of fluid access starting at relatively high temperatures and occurring at successively lower temperatures during the sub-solidus cooling history of the pluton.

THE NORIAN “FISH SHALES” OF THE WIESTAL („SEEFELD-FORMATION“, UPPER TRIASSIC, SALZBURG, AUSTRIA)

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Upper Triassic, Norian, Seefeld-Subformation, fossil ganoid fish fauna, Wiestal

In the Wiestal-region north-east of Hallein (Salzburg, Austria), the upper part of the Hauptdolomit-Formation (Northern Calcareous Alps, Norian, Upper Triassic) contains dark grey laminated, bituminous dolomitic limestones of the Alaunian Seefeld-Subformation. This up to 10 m thick succession was deposited in tectonically induced, small-spaced depressions under restricted, anoxic conditions of bottom waters near the water/sediment interface. The basins were surrounded by the widespread carbonate platform of the Hauptdolomite- and Dachstein-Formations. The Wiestal-site contains individual-rich assemblages of small- to large-sized ganoid fishes in at least five distinct fossil horizons. The mainly neopterygian fish fauna show perfect preservation, isolated embedding or fossilisation in complete swarms, even partly preserved isoorientation of fish bodies. Almost a few thousand specimen found during the field seasons 2012 to 2014 can be assigned to the “classical” neopterygian genera composed of *Paralepidotus*, *Legnonotus*, *Pholidophorus* as well as rare *Dandya* and *Semiolepis*. Furthermore, it provided three specimens of the palaeopterygian *Saurichthys deperditus* and one specimen of the pycnodont *Eomesodon hoeferi*. A single scale of a large-sized crossopterygian, a well-preserved lobster-like crawfish and m-sized gagate derived from disarticulated wood are attributed to very rare associated findings. As the fish-bearing horizons show significant differences in their fish faunule including almost all growth stages of the highly variable species *Paralepidotus ornatus*, new implications regarding taxonomy, sedimentology, taphonomy and palaeoecology have risen. Until now, the origin of the documented fossil mass mortality within the flat depressions is still under discussion. One possibly scenario could be a local toxification of the complete water body due to algal blooms that led to a quick death and fast embedding both of single specimens and complete fish swarms.

NEUE ERGEBNISSE ZUR GEOLOGIE UND TEKTONIK DES WETTERSTEINMASSIVS (NEUKARTIERUNG DER KARTENBLÄTTER DER GEOLOGISCHEN KARTE VON BAYERN 1:25.000, 8531/8631 ZUGSPITZE & 8532/8632 GARMISCH-PARTENKIRCHEN)

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Geologische Landesaufnahme von Bayern, Wettersteingebirge, Blatt 8531/8631 Zugspitze, Blatt 8532/8632

Die Neukartierung der Gradabteilungsblätter der Geologischen Karte von Bayern 1:25.000 8531/8631 Zugspitze und 8532/8632 Garmisch-Partenkirchen wurde im Rahmen des EU-kofinanzierten Projektes „Informationsoffensive Oberflächennahe Geothermie von Bayern“ (www.lfu.bayern.de/geologie/hydrogeologie/iogi) in den Jahren 2012 bis 2014 durchgeführt. Das insgesamt 188km² große Gebiet umfasst neben Großteilen des Wetterstein-Zugspitz-Massivs nördlich der österreichisch-bayerischen Grenze auch Teile des Estergebirges (Wank), des Labergebirges (Ammergauer Alpen: Kramerspitz, Daniel) sowie das Ehrwalder Becken. Die Geologie dieses „prominentesten“ deutschen Hochgebirges zeichnet mit einem breiten lithologischen Spektrum aus mitteltriassischen (Virgloria-Formation) bis unterkretazischen Gesteins-Einheiten (Schrambach-Formation) beinahe die gesamte mesozoische, prä-alpine Historie nach. Dementsprechend vielfältige geologische Beobachtungen lassen sich zwischen dem nur 700 m hochgelegenen Garmisch-Partenkirchener Talkessel und der 2.964 m hohen Zugspitze machen. Neben dem vorwiegend nordvergenten Faltenbau sticht vor allem eine nordgerichtete Überschiebungszone hervor, die den Gebirgssockel des Wettersteinmassivs von der Schneefernerkopf-Zugspitz-Nordwand von den Einheiten im Garmischer Talkessel trennt. Eine weitere nordgerichtete Überschiebungsfrent wird im Bereich der Naidernach auf Blatt Zugspitze von einem W-E-verlaufenden Sekundärtal nachgezeichnet. Diese großräumigen tektonischen Strukturen stehen im Zusammenhang mit der kalkalpinen Deckenstapelung und der alpinen Orogenese. So reicht beispielsweise das auf die bajuvarische Lechtal-Decke überschobene Tirolikum (Inntal-Decke) noch bis auf den Südrand der Kartenblätter. Die eindrucksvolle Meilerhütten-Breccie mit ihrer bislang ungeklärten, aber andiskutierten sedimentologischen Genese erlaubt Einblicke ins Tertiär, als das Alpen-Orogen zwar „im Aufstieg“ begriffen war, die damalige Landschaft jedoch mit der heutigen Morphologie nicht verglichen werden kann.

Morphologisch prägend waren vor allem die pleistozänen Eiszeiten mit dem durch den Loisach-Gletscher breit ausgeschürften Talkessel von Garmisch-Partenkirchen sowie dem übertieften, durch den vom Zugspitzblatt kommenden Lokalgletscher ausgehobelten Reintal. In diesen Zeitbereich fallen die Schachen-, Kreuzeck- und Längenfeld-Breccien, bei denen es sich um pleistozäne, präwürm- bzw. würmzeitliche Diamiktite handelt. Und als „jüngstes“ geologisches Schlaglicht wären die großen Bergstürze von Eibsee, Thörlen und Gatterkopf zu nennen. Insbesondere der Eibsee-Bergsturz als größter Bergsturz von Bayern veränderte nach Ende der letzten Eiszeit vor ca. 3.700 Jahren die damalige Landschaft rund um den Eibsee bis nach Grainau hinein durchgreifend.

NEUE ERGEBNISSE ZUR GEOLOGIE DER ALLGÄUER ALPEN (NEUKARTIERUNG DER KARTENBLÄTTER DER GEOLOGISCHEN KARTE VON BAYERN 1:25.000, 8627 EINÖDSBACH UND 8727 BIBERKOPF)

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Geologische Landesaufnahme von Bayern, Allgäuer Alpen, Blatt 8627/8727 Einödsbach / Biberkopf

Die Neukartierung der Gradabteilungsblätter der Geologischen Karte von Bayern 1:25.000 8627 Einödsbach und 8727 Biberkopf wurde im Rahmen des EU-kofinanzierten Projektes „Informationsoffensive Oberflächennahe Geothermie von Bayern“ (www.lfu.bayern.de/geologie/hydrogeologie/iogi) in den Jahren 2012 bis 2014 durchgeführt. Das insgesamt 126 km² große Gebiet umfasst Teile der Allgäuer Hochalpen zwischen Biberkopf und Mädelegabel, dem Fellhorn im Zentrum und dem Oberstdorfer Talkessel im Norden. Das bei Bergwanderern beliebte, sowohl touristisch erschlossene, aber auch ursprüngliche und landschaftlich ungemein reizvolle Gebiet birgt eine komplexe Geologie zwischen verfalteten, obertriassischen bis unterkretazischen Schichten zweier kalkalpinen Deckenkomplexe (Allgäu- und Lechtal-Decke), der Arosa-Zone, Rhenodanubischem Flysch, Ultrahelvetikum und helvetischen Serien. Eine zentrale Frage ergab sich in der Zuordnung der „kalkalpinen Randschuppe“ („Subalgovikum“). Dieses liegt als schmaler Streifen kleiner tektonische Fenster nahe der kalkalpinen Deckenstirn knapp 1 km SE' von einem ähnlich situierten Streifen tektonisch isolierter Bereiche von Arosa-Zone. Ein übergeordneter Blick über die westlichen nördlichen Kalkalpen offenbart, dass nicht nur die Arosa-Zone gegen E immer mehr ausdünnst und letztendlich komplett unter kalkalpinen Decken verschwindet, sondern auch ihr Gehalt an ophiolithischen Gesteinen von W nach E stetig abnimmt. Mit der Vorstellung, dass dies in einem primären Auskeilen des Arosa-Akkretionskeils von W nach E und damit einem Ausdünnen eingescherter ozeanischer Krustenteile in gleicher Richtung zusammenhängen mag, lassen sich auch die fensterartigen Vorkommen zwanglos in dieselbe tektonische Kinematik und damit der Arosa-Zone zuordnen. Dies erspart nicht nur die Postulation eines unter der Allgäu-Decke liegenden „Subalgovikums“, sondern auch die Frage, warum räumlich so eng beieinander positionierte und in gleicher tektonischer Position und in derselben Streichrichtung liegende tektonische Fenster zu zwei tektonisch völlig verschiedenen ostalpinen Einheiten gehören sollten.

Die prä- und synorogenen Sedimentfolgen unterschiedlichster Faziesräume zwischen kalkalpinem und helvetischem Bereich spiegeln die komplexe Ablagerungsgeschichte über einen beinahe 150 Millionen Jahre währenden Zeitraum wieder. Sie erzählen eine spannende Geschichte von überwiegend marinen, subtropischen Ablagerungen während der Trias, schnellem Absinken des Beckens und Tiefseesedimenten im Jura, Subduktion ganzer Ozeane und Deckenstapelung während der Kreide und letztendlich Aufstieg zum Hochgebirge im Tertiär. Den letzten „Schliff“ erhielt das Gebiet durch Vorgänge während des Quartärs, von dessen unterschiedlich alten Vereisungsphasen jedoch nur Reste der jüngsten Kaltzeit – der Würm-Eiszeit – erhalten sind.

CLIMATE-TECTONIC INTERACTIONS IN THE ST. ELIAS OROGEN: NEW GEOCHEMICAL AND GEOCHRONOLOGICAL PROVENANCE DATA FROM SURVEYOR FAN SEDIMENTS, GULF OF ALASKA

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Alaska, provenance, sediment, tectonic, climate

The formation of the Cenozoic Alaskan St. Elias orogen, the highest coastal mountain range on Earth, coincides with major climatic and tectonic events. Absence of onshore sediment traps allows fast transport of orogenic sediments to the ocean, making the Miocene to Pleistocene Surveyor Fan depositional system, Gulf of Alaska, a promising sedimentary archive for onshore processes. We present results of a single grain geochemical provenance study of heavy minerals using main element geochemistry, U-Pb geochronology of zircon together with REE and trace element fingerprinting, and $^{40}\text{Ar}/^{39}\text{Ar}$ dating of hornblende and mica on sediments of four IODP 341 expedition sites on the distal and proximal Surveyor Fan, the continental slope and shelf. Deciphering the provenance of these sediments will give indications on the temporal and spatial interplay of tectonic and climate and their influence on rates and locations of exhumation and denudation in the evolving orogen.

U/Pb age spectra of zircons from Miocene to Pleistocene sediments all show a prominent peak between ca. 50 and 60 Ma, the youngest zircons being $25.3 \text{ Ma} \pm 0.6 \text{ Ma}$, the oldest $1305.8 \pm 38.1 \text{ Ma}$ of age. REE and trace element measurements indicate granodiorite and tonalite sources. REE and trace element spectra of the 50 to 60 Ma zircons resemble published REE patterns of zircons from the Sanak-Baranof plutonic belt in the Chugach Metamorphic Complex (CMC). Geochemical compositions of hornblende show strong similarities to hornblende known from a metamafic belt in the CMC and only minor variations with time of deposition. Microprobe data of garnets indicate derivation from granites or gneisses and amphibolites of metamorphic conditions between amphibolite and granulite facies which are prominent lithologies in the CMC.

Our first results imply derivation of the sediment, via the Bering glacier, from a long-standing sediment source in the area of the CMC present and throughout different phases of glacial extent and tectonic processes. Miocene samples indicate input from coal bearing strata known onshore as the Kulthieth Formation in the Yakutat terrane. Shipboard clast and other data point towards additional input also from the eastward lying Seward glacier and longshore transfer into the Surveyor Fan system.

MUREN MONITORING SYSTEM AM LATTENBACH

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Monitoring, Muren

Der Lattenbach, Bez. Landeck (Tirol) besitzt ein 5,3 km² großes Einzugsgebiet, in welchem die tektonische Grenze zwischen Silvrettakristallin und den Nördlichen Kalkalpen verläuft, wodurch er für großräumige Massenbewegungen prädestiniert ist.

Die Aufzeichnungen von zahlreichen Hochwasser- und Murereignissen gehen am Lattenbach bis ins Jahr 1907 zurück. Technische Schutzbauten konnten den Erosionsbereich im Mittellauf zwar stabilisieren, großflächige Hangbewegungen führen jedoch zu einer Beschädigung bzw. Zerstörung dieser Bauwerke.

Im Sommer 2002 wurde ein Monitoringsystem mit den Messfeldern Dawinalpe, Dawinkopf, Grins und Pians eingerichtet. Funktionierte das Monitoringsystem zu Beginn nicht zufriedenstellend, konnte durch zahlreiche Neuerungen und Ergänzungen das System maßgeblich verbessert und erweitert werden.

Im August 2015 traten innerhalb von 8 Tagen 3 Murenereignisse auf, wobei die ersten 2 Muren in der Nacht vom 9. auf den 10. August auftraten, die dritte Mure am 16. August.

Durch eine kontinuierliche Geschwindigkeitsmessung mit einem Hochfrequenz Radar konnte erstmalig die Ermittlung des Abflusses über die Gesamtdauer der Murgänge im Sekundenintervall erfolgen, der durchflossene Querschnitt wurde mit den Daten eines 2D Laser ermittelt.

Der erste Murgang begann am 9. August kurz nach 20:00 MEZ. Am Beginn wurden Abflusstiefen von mehr als 150 cm erreicht, die mittlere Abflussgeschwindigkeit lag bei 4 m/s, die maximale bei 6 m/s. Die Abflussspitze wurde am Anfang des Murgangs mit über 60 m³/s erreicht. Die Murfracht kann mit rund 16000 m³ für die Dauer von 30 Minuten angegeben werden.

Der zweite Murgang trat bereits rund 3 Stunden später auf. Er weist 2 markante Abflussspitzen im Abstand von 20 Minuten auf. Die erste erreicht einen Spitzenabfluss von rund 50 m³/s, die zweite einen von rund 40 m³/s. In mehreren Schüben passieren rund 25000 m³ Murmaterial den Abschnitt.

Der Murgang am 16. August zeigt ein anderes Abflussmuster. Es fehlt die ausgeprägte Abflussspitze zu Beginn, obwohl ein rascher Anstieg auf rund 1 m Abflusstiefe erfolgt. Diese Tiefe wird über längere Zeit beibehalten, bis sie langsam abfällt. Die Dauer des Murganges ist rund die Hälfte der vorherigen Muren mit rund 15 Minuten. Die mittleren Geschwindigkeiten überschreiten 2 m/s nicht, der Abfluss erreicht am Beginn des Murganges rund 15 m³/s. Die Murfracht beträgt etwa 8000 m³.

GRUNDWASSERALTER - MITTLERE VERWEILZEITEN IN AUSGEWÄHLTEN GRUNDWASSERKÖRPERN

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Grundwasseralter, Mittlere Verweilzeiten, Isotopen, Grundwasserkörper

Die WRRL verlangt, dass die Verschlechterung des Zustands aller Grundwasserkörper verhindert wird und dass der gute Zustand bis zum Jahr 2015 zu erreichen ist. Des Weiteren sind alle signifikanten und anhaltend steigenden Belastungstrends umzukehren. Zu diesem Zweck und im Hinblick auf die einzuhaltenden Fristen sind von den Mitgliedstaaten erforderliche Maßnahmen zu setzen. Lassen die natürlichen Gegebenheiten keine rechtzeitige Verbesserung des Zustandes der Wasserkörper zu, so ist es in begründeten Fällen zulässig, die Fristen bis 2027 zu erstrecken.

Aber auch aus der Sicht der Maßnahmenpakete, wie sie derzeit im ÖPUL-Programm vorgesehen sind, stellt die Möglichkeit einer zeitlichen und inhaltlichen Zielprognose – wann können Maßnahmen wirksam werden? – eine wesentliche Argumentationshilfe bei der Überzeugungsarbeit hinsichtlich der politischen Umsetzung von Maßnahmen im Gewässerschutz (v. a. Nitrat) dar. Aufgrund unterschiedlich langer Verweilzeiten des Grundwassers im Untergrund kann die Wirksamkeit von Maßnahmen, die den chemischen Zustand des Grundwassers verbessern sollen, nicht sofort gemessen werden. Für die Evaluierung muss ein entsprechender Zeithorizont berücksichtigt werden.

Eine Abschätzung der Mittleren Verweilzeit des Grundwassers bzw. die Erkundung der natürlichen Gegebenheiten der Grundwasserkörper im Hinblick auf ihre Reaktionsgeschwindigkeit bzw. -trächtigkeit ist mit Hilfe des Einsatzes von mehreren unterschiedlichen, sich ergänzenden Isotopenmethoden und in Zusammenschau mit den hydrologischen, hydrogeologischen und hydrochemischen Rahmenbedingungen möglich.

Die Abschätzung der Mittleren Verweilzeiten liefert darüber hinaus eine Evaluierung der hydrogeologischen Konzepte der Grundwasserkörper, z.B. in Bezug auf die Interaktion zwischen Oberflächengewässern und dem Grundwasser oder die Höhe von Einzugsgebieten, was wiederum eine Basis für praktische Umsetzungen wie Einrichtungen und Bemessungen von Wasserschutzgebieten, Festlegung von Entnahmekonsensmengen etc. darstellen kann.

In mehreren Grundwasseralterberichten gibt das Umweltbundesamt im Auftrag des BMLFUW einen statistisch flächenhaften Überblick über die mittleren Verweilzeiten in den obersten genutzten Grundwasserstockwerken in Österreich.

Ein zusammenfassender Bericht gibt einen Überblick über die Ergebnisse aus den bisherigen Grundwasseralter-Studien (Stand Dezember 2015) und dient als Erläuterung zur GW-Alter-Karte 1:500.000 mit mittleren Verweilzeiten in ausgewählten Grundwasserkörpern. Details sind den jeweiligen Endberichten zu entnehmen.
<https://www.bmlfuw.gv.at/wasser/wasserqualitaet/grundwasseralter.html>

KARSTDOKU: LITERATURDATENBANK DER KARSTHYDROLOGISCHEN UNTERSUCHUNGEN IN ÖSTERREICH

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Karst

Die österreichischen Karstgebiete stellen bedeutende Grundwasserspeicher dar. Da etwa die Hälfte des Trinkwasserbedarfs aus diesen Gebieten gedeckt wird, nehmen Untersuchungen, die sich mit den dort auftretenden speziellen geologischen und hydrogeologischen Verhältnissen beschäftigen, einen besonderen Stellenwert in der wasserwirtschaftlichen Planung ein. Dieser herausragenden Bedeutung wird auch im Umweltkontrollgesetz (BGBl. Nr. 152/1998) Rechnung getragen, indem die Dokumentation der karsthydrologischen Arbeiten ausdrücklich festgeschrieben wird.

Ausgehend von dieser Vorgabe hat das Umweltbundesamt bis dato zwei zusammenfassende Berichte veröffentlicht. Der erste Bericht umfasst den Zeitraum von den 50er Jahren bis zum Jahr 1991 (UMWELTBUNDESAMT, 1992), der zweite behandelt den Zeitraum 1992-1997 (UMWELTBUNDESAMT, 2001). Die Recherchen für diese Berichte waren entsprechend dem damaligen Stand der elektronischen Datenverarbeitung zum Teil sehr zeitaufwändig. Dennoch erfassen die beiden Berichte eine große Anzahl an Studien, die mittels einheitlicher Stammdatenblätter beschrieben werden: Sie beinhalten die wichtigsten Eckpunkte wie Autor(en), Titel, Untersuchungszeitraum, Untersuchungsgebiet, Bundesland, ÖK-Blatt, ggf. Kurzbeschreibung und eine kleine Übersichtskarte mit dem Untersuchungsgebiet.

Seit 2008 stellt das Umweltbundesamt WissenschaftlerInnen und der interessierten Öffentlichkeit, die sich im Bereich der angewandten Karsthydrologie auch zukünftig einen Überblick über relevante Untersuchungen in Österreich verschaffen wollen, eine Literaturdatenbank zur Verfügung. Diese ist für jedermann frei zugänglich und bietet die Möglichkeit, gezielt nach den oben genannten Kriterien zu suchen. Zu vielen dieser Arbeiten sind zusätzliche Detailinformationen wie z.B. Abstract, Standort der Arbeit etc. ersichtlich, sofern diese von der Autorin bzw. dem Autor zur Verfügung gestellt werden. Außerdem besteht für AutorInnen die Möglichkeit, vorhandene Einträge selbst zu aktualisieren oder ihre eigenen Arbeiten einzutragen, um sie der Öffentlichkeit zu präsentieren.

Die Datenbank stellt somit eine zeitgemäße und nachhaltige Erfassungsmethode von karsthydrologischen Arbeiten im gesamten Bundesgebiet dar. Nicht zuletzt soll diese Datenbank eine lebendige, stetig wachsende, umfassende und aktuelle Übersicht der österreichischen karsthydrologischen Untersuchungen sein, die eine wertvolle Unterstützung für alle darstellt, die sich mit diesem Thema beschäftigen.

Um die Datenbank so aktuell wie möglich zu halten, sind Sie herzlich eingeladen, Ihre Arbeit auf der Homepage des Umweltbundesamtes einzutragen: <http://www.umweltbundesamt.at/karstdoku>.

AGE AND STRUCTURE OF THE STOLZALPE NAPPE – EVIDENCE FOR VARISCAN METAMORPHISM, EOALPINE TOP-TO-THE-WNW THRUSTING AND TOP-TO-THE-ESE NORMAL FAULTING (GURKTAL ALPS, AUSTRIA)

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Stolzalpe Gurktal structure Variscan Eoalpine

In the Gurktal Alps (Austria,) the Drauzug-Gurktal nappe system represents the uppermost tectonic part of the Upper Austro-Alpine nappe stack. The Stolzalpe Nappe (s. str.) is its uppermost unit. It consists of interbedded metasedimentary rocks of the Spielriegel Complex, overlain by metavolcanic rocks of the Kaser-Eisenhut Complex. Both are covered by the Pennsylvanian clastic Stangnock Formation. In the investigated area, located at UTM-map sheet Radenthein (NL-33-04-06), the Stolzalpe Nappe tectonically overlays the Stangnock Formation belonging to the Königstuhl Subnappe, also part of the Stolzalpe Nappe.

In this contribution, we present new geochronological and structural data constraining the Variscan and Alpine evolution of the Stolzalpe Nappe. A LA-ICPMS U/Pb zircon age pins the volcanism of the Kaser-Eisenhut Complex to 448 ± 12 Ma (Upper-Ordovician to Llandoveryan). A Lower Pennsylvanian 316 ± 3 Ma $40\text{Ar}/39\text{Ar}$ white mica age in metasedimentary rocks of the Spielriegel Complex and Raman microspectroscopy thermometry on carbonaceous material indicates a peak-temperature of $\sim 350^\circ\text{C}$ during Variscan times.

The Variscan deformation produced the complex, large-scale, isoclinal fold pattern (D1, NW-SE trending axes), superimposed by ENE-verging asymmetric open folds (D2). These structures are discordantly covered by post-Variscan sedimentary rocks.

Asymmetric WNW-verging tight folds with NNE-SSW fold axis, indicating WNW-ESE shortening, overprint the Variscan structures. As indicated by S-C-C'-type fabrics (with striation and fibrous quartz) and asymmetric clast-geometries, this shortening event (D3) is associated to brittle-ductile top-to-the-WNW thrusting in the contact between the Stolzalpe Nappe (s. str.) and the Königstuhl Subnappe. The thrust likely runs in graphitic schist and anthracitic phyllite. Normal faulting, reactivation of former structures as normal faults, and C'-type shear planes crosscutting the older structures, indicate a change in tectonic regime to WNW-ESE extension, dominated by top-to-the-ESE shearing (D4). Combined with Upper Cretaceous $88-92 \pm 1$ Ma $40\text{Ar}/39\text{Ar}$ white mica ages in the footwall (Permo-Mesozoic cover of the Bundschuh Nappe) and Raman microspectroscopy thermometry peak values of $\sim 300^\circ\text{C}$, this deformation is attributed to the Eoalpine event. Neopalpine shortening is very limited to isolated open folds with E-W axes (D5).

SPODUMENE BEARING PEGMATITES IN THE AUSTROALPINE UNIT (EASTERN ALPS): NEW FIELD OBSERVATIONS AND GEOCHRONOLOGICAL DATA

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Spodumene, Pegmatite, Permian, Austroalpine, Genesis

The genesis of pegmatites in the Austroalpine unit is still a matter of discussion: One school of thought bring forward the argument for a development of spodumene bearing pegmatites by fractionation of granitic parent plutons (Göd, 1989; Mali, 2004), whereas another school explains barren pegmatites as products of anatexis of metapelitic country rocks (Stöckert, 1987; Thöni & Miller, 2000; Ertl et al., 2010). In the first case the absence of co-genetic fertile granites render the model problematic, whereas in the second case the formation of suitable Li-enriched pegmatitic melts is not yet understood. According to Schuster & Stüwe (2008) the pegmatites formed during lithospheric extension in Permian time, which caused basaltic underplating, high temperature / low pressure metamorphism and intense magmatic activity. In an ongoing project the relation of the barren and spodumene bearing pegmatites, their genesis and the distribution of the fractionated pegmatites is investigated.

New Sm/Nd data prove a Permian age for spodumene bearing pegmatites. A pegmatite located at Hohenwart mountain (Niedere Tauern) yield 264.3 ± 2.7 Ma, another one from Lachtal (Niedere Tauern) is 268.8 ± 2.8 Ma, and for a pegmatite from Mitterberg (Übelbach valley) 266.5 ± 2.8 Ma were determined. Field observations show that Permian pegmatites occur in three different domains: (1) Networks of narrow pegmatitic dykes, pegmatitic patches and larger feldspar dominated pegmatites formed by accumulation occur in aluminosilicate bearing, garnet rich micaschists and gneisses with indications of initial anatexis. (2) Inhomogeneous leucogranites with a mineral assemblage of feldspar, quartz, muscovite, garnet and tourmaline. Transitions to pegmatites appear as a few kilometres long and a few hundred meters wide bodies. (3) Distinct pegmatite dikes usually with discordant contacts to schistosity of the country rocks and local appearance of spodumene and beryl. New spodumene bearing pegmatites were discovered at Falkenberg (Judenburg, Styria), Katzbachgraben (Gleinalpe, Styria) and Millstätter Seerücken (Karinthia). More than 150 trace elements measurements on cm-sized magmatic muscovites show an increase of Li, Rb, Cs, Sn, Nb, and Ta starting from pegmatitic patches and feldspar dominated pegmatite dikes, via leucogranitic bodies to discordant pegmatite dikes. Further investigations will deal with the processes of melt production, melt accumulation and fractionation.

ANALYSIS AND RECONSTRUCTED MODELING OF THE DEBRIS FLOW EVENTS 2012, 2013 IN AUSTRIA WITH NUMERICAL SIMULATION MODELS

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debris flow, event analysis, numerical simulation

An extreme accumulation of heavy rainfall events, most of which were of a small spatial extent, led to flooding across the entire province of Styria from June to August 2012 and the entire province of Salzburg from May to June 2013. High intensity debris flows and landslides occurred in the geologically unstable Greywacke zone. Numerous immediate response measures were already undertaken on the day of the event's occurrence. The aim of the very detailed event documentation and –analysis was to understand the extreme process sequence and to reconstruct and simulate the debris flow itself two-dimensionally. The catchment area Lorenzerbach (Event 2012) with a catchment area of 5.84 km² and the catchment Sattelbach (Event 2013) with 1.40 km² are situated in the greywacke zone. Both catchments are prone to debris flows. Due to the data basis the retroactive accounting of such debris flow events is difficult. The recorded phenomena were compiled in the course of the event documentation and the input values were determined for the calculation. Because of the complexity of the particular process, it was only possible to state one band width with almost all necessary input values. It is nevertheless only possible to conclude the applicability (possibilities and borders) of these simulation models through a retroactive accounting of such events. The washout zone in the upper catchment area, the estimated debris flow load, the analysis of the debris flow sampling as well as the reconstructed (swing markers?) and the deposit areas respectively could be basically classified as significant input values. Flow resistances in the form of buildings were integrated into the model on the basis of laser data. The bed load input from the upper reach up to the apex of the debris cone is taken into consideration in the form of sectional material input. The results of the flow depth show a relatively high accordance with the reconstructed flow heights.

GEOLOGISCHE 3D-MODELLIERUNG IM WIENER U-BAHN-BAU

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Landesgeologie, Pangeo

Einleitung

Derzeit findet im Wiener U-Bahn-Bau die Planung für das Projekt U2-Verlängerung/U5-Neubau zwischen Wienerberg und Hernals statt. Dazu wird von der Fachabteilung Grundbau der Stadt Wien im Auftrag der Wiener Linien ein intensives Erkundungsprogramm ausgeführt (115 Bohrungen bis 60m mit bodenphysikalischen, chemischen, technischen und geologischen Untersuchungen). Teil der Planung ist ein geologisches 3D-Baugrundmodell, das von iC consulenten auf der Grundlage der projektspezifischen Bohrungen und Bohrprofilen aus dem Baugrundkataster erstellt wurde.

Geologie

Der Großteil des Stadtgebietes von Wien liegt im Wiener Becken, einem pull-apart-Basin, das sich im Neogen zwischen den Alpen und Karpaten entlang eines NE-SW-streichenden, sinistralen strike-slip-Störungssystems gebildet hat. Die Beckenfüllung in der Paratethys besteht aus marinen bis limnisch-fluviatilen Sedimenten des Badenium, Sarmatium und Pannonium. Im Pleistozän bildeten die Schotter der Donau eine mehrstufige Terrassenlandschaft von der ältesten (höchsten) Laaerbergterrasse (Prägünz), über die Stadterrasse (Riss) bis zur jüngsten, von der rezenten Donau überformten Praterterrasse (Würm).

Die neue U-Bahn-Trasse liegt im Bereich der pleistozänen Terrassen und wird in Tieflage in den quartären und neogenen Sedimenten verlaufen.

Angewandte Methoden und wesentliche Ergebnisse

Für die geologische 3D-Modellierung wurde das Programm Leapfrog Geo eingesetzt. Die Definition der Modellschichten beruht auf der lithostratigrafischen und lithogenetischen Klassifizierung der Bohrprofile. Angetroffene Grundwasserstände, ein Pegel-Grundwasserspiegel der Stadterrasse und Störungen werden ebenfalls dargestellt.

Grundlage der Modellierung bildet das geologische Konzept, erstellt aus der Auswertung aller verfügbaren Daten. Wesentliche Inhalte dieses Konzeptes sind der Internaufbau der pleistozänen Terrassen und der Terrassenabhängige. Dazu gehören die Differenzierung eines Zwischenniveaus (Arsenal-/Stadterrasse), die Ausscheidung mächtiger Solifluktions-/Schwemmfächersedimente an den Terrassenabhängigen und die Definition eines pleistozänen Alserbaches und Wienflusses. Sedimentpetrografische Untersuchungen der Schotter (Kornverteilung, Lithologie) erlauben genetische Zuordnungen. Erste Altersdatierungen der Stadterrasse (OSL/IRSL) liegen vor. Die Ton- und Gesamtmineralogie lässt eine Differenzierung zwischen neogenen und quartären Proben, sowie Trends innerhalb des Neogens erkennen. Stratigrafische Untersuchungen definieren die Pannon-Sarmat-Grenze und ein Pannon-Profil.

Alle Untersuchungsergebnisse sind in das 3D-Modell eingeflossen, das für Planung und Ausführung herangezogen wird und eine Visualisierung und Prognose der geologischen Verhältnisse entlang der Trasse ermöglicht. Im Detail erlaubt es eine Darstellung der komplexen Schichtabfolgen und ihrer räumlichen Lage in Bezug zu den einzelnen Bauwerken (Tunnel, Stations-/Weichenschächte), die allen Projektbeteiligten zur Verfügung gestellt werden kann.

PROJECT OF NEAR-REAL-TIME GENERATION OF SHAKEMAPS AND A NEW HAZARD MAP IN AUSTRIA

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Shakemaps, seismic hazard map

In case of strong earthquakes, target-orientated prevention and effective crisis management can not only reduce and avoid damages but also save lives. To achieve this goal, a project for automatically generation of Shakemaps and a new version of the Austrian hazard map, was initiated at ZAMG (Zentralanstalt für Meteorologie und Geodynamik) in 2015. The first goal of the project is set for a near-real-time generation of Shakemaps following strong earthquakes in Austria and close border regions, in order to provide rapid, accurate and official information to the governmental crisis management. Using methods and software newly developed by SHARE (Seismic Hazard Harmonization in Europe) and GEM (Global Earthquake Model), which allows a transnational analysis at European level, we expect to have a new generation of our national hazard maps.

METAMORPHIC REACTION RIMS: A POTENTIAL GEO-FLUIDO-METER

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metamorphic reaction, rim, olivine, water, volatiles

Mineral coronas and metamorphic reaction rims are a common feature in many metamorphic rocks that contain pressure-temperature information and may record the time span of their development. In this study, we show that reaction rims may also allow us to detect and quantify the presence of small amounts of fluids during metamorphic reactions.

Rim growth experiments were performed between periclase (MgO) single crystals and quartz (SiO₂) powder at 1200°C and 1.5 GPa for 4h in presence of various bulk water contents ranging from 0 wt% to 10 wt% H₂O.

All experiments produced polycrystalline double layers showing the sequence periclase|forsterite|enstatite|quartz. The total rim thickness increases with increasing water content from $1.2 \pm 0.5 \mu\text{m}$ at nominally dry conditions to $19.0 \pm 1.1 \mu\text{m}$ after addition of 1 wt% H₂O at identical P-T-t conditions. Simultaneously, the amount of water present during the reaction affects the enstatite/forsterite thickness ratio that decreases from 0.59 ± 0.13 to 0.33 ± 0.10 . By combining our results with temperature corrected enstatite/forsterite thickness ratios from Gardés et al. (2012), we observe a linear decrease of the enstatite/forsterite thickness ratio at 1200°C and 1.5 GPa between nominally dry conditions and 2 wt% H₂O:

$$\Delta x_{\text{En}}/\Delta x_{\text{Fo}} = -0.17x_{\text{H}_2\text{O}} + 0.55 \quad (R^2 = 0.93)$$

with $\Delta x_{\text{En}}/\Delta x_{\text{Fo}}$ being the enstatite/forsterite thickness ratio and $x_{\text{H}_2\text{O}}$ the amount of water (wt%). This correlation holds to a maximum bulk water content of 2 wt% H₂O. Further addition of water, at least up to a bulk water content of 10 wt%, has within uncertainty no detectable effect on the observed thickness ratio.

Consequently, thickness ratios of layers in multilayered metamorphic rim structures are a potential sensor, which allows us to quantify small amounts of fluids present during metamorphic events.

Gardés E, Wunder B, Marquardt K, Heinrich W (2012), Contrib. Mineral. Petrol. 164, 1-16.

EFFECTS OF CORE CLEANING ON VARIOUS PROPERTIES

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Soxlet Extraction, core cleaning, petrophysical properties, toluene

My work focuses on the effect of core cleaning for various petrophysical properties. For this study, 5 different rock samples from different depths and regions from Upper Austria and Salzburg are selected. 5 samples are used to measure petrophysical properties before and after the core cleaning, additionally 3 Gray Berea Sandstone samples are selected for the study. Measured parameters are: mass dry, length, diameter, grain density, permeability and compressional wave velocity on dry rocks; mass saturated, mass under buoyancy, electrical resistivity and compressional and shear wave velocity for saturated rocks. The samples are saturated with brine (1 g NaCl and 1 litre distilled water). Afterwards the samples were dried with 70°C. The mass and the grain density were determined again. Then the core cleaning with the Soxhlet extractor occurred. Used for the cleaning was toluene (fast, effective and reliable). After the cleaning process the same petrophysical methods were applied. The data are compared in detail. Differences can be seen for: compressional and shear wave velocity, electrical resistivity, grain density and permeability. The results showed that core cleaning depends strongly on the rock type. Except the values for the 3 Gray Berea Sandstone samples remained constant.

EVENT DOCUMENTATION OF THE DEBRIS FLOW EVENT AT SATTELKAR, OBERSULZBACHTAL, SBG.

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debris flow, permafrost, event documentation

In times of climatic change, debris flow events from potential periglacial environments are of special interest for engineering hazard assessment. In this contribution, we document and analyze a large debris flow event occurring on July 31st, 2014, in the Obersulzbach-valley, Sbg. The event originated after heavy rainfall from a cirque valley in the headwaters of the Obersulzbach, a region that probably is affected by discontinuous permafrost. Field investigations and comparison of pre- and post-digital elevation models show that around 70,000 m³ of sediment were mobilized from the cirque and around 100,000 m³ were eroded along the transit reach. Analysis of the aerial pictures from different periods of the last 13 years revealed an ongoing movement of material in the cirque. A measurement campaign was started to monitor temperature and changes of the topography. The results of this study shall contribute to an improved understanding of debris flow initiation in high alpine regions.

PARAMETERIZATION OF NUMERICAL SIMULATION TOOLS FOR DEBRIS-FLOWS

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debris flow, simulation tool, parameterization

Numerical simulation tools are widely used to support debris-flow hazard assessment in engineering practice. Even though the true nature of the process is simplified by employing an equivalent fluid concept, the parameterization (i.e. identification of the magnitude of friction parameters) of simulation tools like FLO-2D, RAMMS-DF, or DAN-3D still poses a major challenge. This study investigates the possibility of model parameterization by laboratory investigations of sample material for rheologic modeling approaches and from back-calculation of observed debris flow events in the past for rheologic and Voellmy-type approaches. Our results show laboratory investigations only have limited potential to support model parameterization due to a sample bias and a scaling bias. Hence, back-calculation of model parameters from well-documented case studies is the most promising way to identify the range friction parameters for engineering practice.

DIMENSIONAL GEOPHYSICAL MODEL AND DYNAMICS OF THE ACTIVE LANDSLIDE- AN EXAMPLE OF THE JASTRZĘBIA GÓRA CLIFF (NORTHERN POLAND)

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Electrical Resistivity Tomography, Photogrammetry, landslide, Jastrzębia Góra

Digital photogrammetric analysis and electrical resistivity tomography (ERT) techniques were used to identify the structure of landslides and determine its dynamic in Jastrzębia Góra cliff (northern Poland). Two photogrammetric high-resolution models were generated from LiDAR data and compared. This way, the dynamics of the surface of the landslide analyzed. The differences between the grids of digital elevation models were used for determination of vertical movements of the grid points within the landslide area. The differences were visualized as a shaded relief map. Additionally, three geomorphological cross-sections were made. The differential DEMs (2010–2013) for the most dangerous part of the landslide allowed us to recognize the areas that have a particular deformity. To detect the sliding surface and estimate the thickness of the sliding material, several transversal and longitudinal ERT profiles were obtained. The electrical images of subsurface supported by stratigraphical data from boreholes were integrated with the information from the DEMs. As a result of geophysical structure diagnosed landslides and determined the depth of the slip zone.

FROM CRYSTALLIZATION TO POST-CUMULUS RECRYSTALLIZATION – CHROMITITES IN LAYERED INTRUSIONS

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layered intrusions, chromitites, Bushveld Complex

Layered Intrusions are of great scientific interest, as they offer insights into fundamental petrological concepts, but are also of economic importance, hosting some of the world's largest deposits of chromium, vanadium and platinum group elements. Although they have been studied for more than 100 years, the processes of formation and mineralization of layered intrusions in general and chromitites in particular remains enigmatic and are still part of an ongoing scientific debate: A huge variety of different, partly contradictory models exist (e.g. [1] and references therein).

Our study focuses on petrographic, mineralogical and geochemical observations of cumulus and intercumulus phases. Five profiles of chromitites and their pyroxenitic host rocks of the Lower and Middle Group of the Western Bushveld were investigated in detail. Core sample material was provided by Cronimet Chrome Mining SA (Pty) Ltd. Mineral phases within chromitites have a more primitive composition compared to those minerals in the hanging wall and footwall pyroxenite. This indicates intrusions of new magma with possible mixing. Plagioclase chemistry (intercumulus phase) varies throughout the whole profile, which suggests that plagioclase crystallized in a non-equilibrium state. Similar chemical variations were recently observed in the UG2 chromitite of the Western and Eastern Bushveld Complex [2,3] which were interpreted as repeatedly magma mixing events followed by fractionation and post-cumulus recrystallization. Crystal size and shape of chromite varies throughout all chromitites. Crystal size distribution measurements were conducted to quantify these changes. The chemical and textural observations indicate complex combinations of magma mixing, fractionation and post-cumulus recrystallization.

References

[1] Namur et al. (2015) in Charlier et al. Springer, 75-152. [2] Kaufmann et al. (2014) DMG Meeting Abstract. [3] Veksler et al. (2015) J. Petrol. 56, 1229-1250.

GEODYNAMIC CONSTRAINTS ON MANTLE FLOW PATTERNS BENEATH THE ALPS

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geodynamics, numerical modelling, geophysics

The geodynamics of the Alps remains matter of debate and over the last decades many of the geophysical studies have highlighted the potential structure of the Alps at depth (from tomography, seismic anisotropy etc), with more data to come from the AlpArray project. Yet, interpreting this data in a dynamic manner is non-straightforward and requires 3D geodynamics models. Moreover, different tomographic models have come up with different solutions and it is unclear which of those fit the data best.

Here we employ 3D geodynamic models of the upper mantle and crust of the Alps and surrounding regions to study several scenarios of the present-day configuration of slabs and lithosphere at depth to understand whether differences in slab polarity or geometry cause differences in the mantle flow patterns.

Our model setup consists of two plates, Adria and Europe, both composed of an upper crust, lower crust and lithospheric mantle. The interface geometries are taken from the Eu-crust07 model. Below the lithosphere, three end-members configurations of the slab have been tested: (1) one slab attached, (2) one slab partly detached below the western Alps and (3) two slabs with opposite vergence. The densities of the different layers have been constrained by a gravity inversion method. The three slab geometry lead to distinct mantle and surface velocity patterns as well as in different crustal stress fields. We will show a detailed comparison of the various end-member models, and highlight in which areas the differences are largest and future which would thus be ideal target areas for future seismological studies.

CONTINENTAL RED CLAYS ON CARBONATE SUBSTRATE - THE COMPLEX STORY OF THE LATE CENOZOIC VÖRÖSTÓ FORMATION (SOUTHERN BAKONY MTS., HUNGARY)

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weathering, provenance, bauxite, geochronology, Hungary

The Vöröstó (=Red Lake) Formation, a red clay mixed with bauxite pebbles covers locally the karstified surface of Triassic carbonates in the Southern Bakony Mountains, Hungary. This continental assemblage was deposited in an extremely long-lasting apparent stratigraphic gap. Sequences covering Vöröstó Formation are dated mid-Miocene to Quaternary.

Pebbles, rock fragments and the clay matrix were studied by sediment petrographic methods, XRD, SEM, and whole-rock geochemistry. Further, heavy mineral assemblages and the zircon single-grain U-Pb age distributions from both the bauxite pebbles and the red clayey matrix were analysed separately.

The coarse fraction of the Vöröstó Formation consists of well-rounded, mostly oolitic, hard bauxite-pebbles, likewise hard, angular to subangular ferricrete fragments and dolomite clasts embedded in a clay-mineral rich matrix (kaolinite, illite, smectite) mixed with silt to fine-sand sized quartz grains and very rare altered feldspar grains. The heavy mineral suite of the pebbles and the matrix are markedly different. The matrix contains a variegated heavy mineral assemblage with staurolite, garnet, pyroxene, ilmenite and epidote being present beside ultrastable heavy minerals zircon, rutile and tourmaline. The zircon U-Pb age spectra are composed of distinct components reflecting Ordovician, Variscan, Paleogene (40 to 27 Ma) and Middle Miocene (18 to 10 Ma) ages. In contrary, the bauxite pebbles are rather poor in heavy minerals, and only contain the ultrastable species. The U-Pb age spectra of bauxite pebbles contain the same pre-Mesozoic age components additional Triassic ages, while the Cenozoic ages are missing.

Based on their lithology, micromorphology, heavy mineral assemblage and the lack of young zircon ages the hard bauxite pebbles are considered to have been eroded from some of the older **Cretaceous bauxite deposits** of the Bakony Mts. A probably significant part of the matrix is derived by re-deposition and break down of debris from the **Paleogene bauxite deposits**, as they contain variegated extraclasts and characteristic, euhedral, volcanogenic zircons with Paleogene U-Pb ages. The presence of partly decomposed feldspar grains and the wide age range of Miocene zircons indicate that the continental red clay landscape in the Bakony accumulated air-borne ashes during the entire period of the **Carpathian-Pannonian Neogene volcanic activity**.

DER EINFLUSS VON SALZEN AUF DAS VERHALTEN DES CHIRLEȘTI MUDFLOWS

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Chirlești, Mudflow, Ton, Salz, Scherfestigkeit

Der Chirlești-Schlammstrom ist ein nach Niederschlagsereignissen auftretender Schlammstrom in den rumänischen Buzău-Subkarpaten. Seit seinem ersten Auftreten 1953 stellt dieser eine Bedrohung für mehrere Haushalte, die Buzău-Brașov National Road 10 und eine Eisenbahntrasse dar. Die Region wird durch paläogene Flysch-Kalksandsteine und dem vereinzelt auftretenden Schlammvulkanen charakterisiert. Die Oberfläche des Ablagerungsfächers ist mit zahlreichen Salzkrusten unbekanntes Ursprungs überzogen. Daher wurden im Rahmen dieser Arbeit die Effekte der natürlich vorkommenden Salze auf die geotechnischen Eigenschaften des Materials untersucht und es wurde versucht, genauere Kenntnisse über die beteiligten Minerale und Tonminerale zu gewinnen.

Die Untersuchungsmethoden umfassten Röntgendiffraktometrie, Röntgen-Fluoreszenz-Analysen, Simultane Thermoanalysen, Korngrößenanalyse, Atterberg'sche Zustandsgrenzen und Rahmenscherversuche.

Durch die Extraktion der Salze konnte festgestellt werden, dass diese 0,39 % der Gesamtmasse ausmachen. Die extrahierten Salze setzen sich aus Glauberit - $\text{Na}_2\text{Ca}-(\text{SO}_4)_2$ (39 %), Thenedarit - $\text{Na}_2\text{Ca}(\text{SO}_4)_2$ (38 %), Löweit (13 %), Gips (7 %) und Anhydrit (3 %) zusammen. Diese extrahierten Salze wurden im Labor den natürlichen Proben zugesetzt. Somit konnten künstliche Mischungen mit unterschiedlichen Salzgehalten (0,0%; 0,4%; 0,8%; 4,0%) hergestellt werden.

Bei den vorhandenen Tonmineralen handelte es sich um Smektit (52 %), Illit (19 %), Kaolinit (16 %) und Chlorit (13 %) sowie geringe Mengen von quellfähigem 18Å-Vermiculit. Die Untersuchung der Fließ- und Ausrollgrenze sowie der Plastizität nach Atterberg ergab, dass es sich beim Material um mittelplastische Tone handelt.

In Abhängigkeit des Salzgehaltes konnte nachgewiesen werden, dass sich das in der Mure befindliche Salz sehr stark auf die hygroscopischen Eigenschaften des Materials auswirkt und die Periodizität des Chirlești-Mudflows maßgeblich beeinflusst. Weiter konnte festgestellt werden, dass der Salzgehalt die Scherfestigkeit darin beeinflusst, dass die Kohäsion mit steigendem Salzgehalt abnimmt, der Scherwinkel jedoch steigt. Außerdem weichen die Scherfestigkeit und die Restscherfestigkeit mit zunehmendem Salzgehalt immer stärker voneinander ab, was durch die Sensitivität zum Ausdruck kommt, welche mit zunehmendem Salzgehalt steigt. Dies bedeutet, dass die Festigkeit von bereits in Bewegung geratenem Material deutlich geringer ist als jene von in Ruhe befindlichem und dass dieser Effekt mit zunehmendem Salzgehalt umso deutlicher wird.

TRANSIENT HEAT TRANSPORT MODELING AND ITS IMPLICATIONS ON DESIGN AND OPERATION OF THERMAL HEAT PUMPS

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heat, transport, modeling, transient

In Austria, an increasing number of thermal heat pumps create backfeed water that show temperature anomalies and compromise downstream wells or interfere with third-party installations. In those cases heat transport models are often required to evaluate the spatial extent and the absolute anomalies of the temperature plumes. In comparison with conventional one- or two-dimensional iterative approaches, numerical transport models have a number of advantages regarding the calibration of the modelled scenarios. Several parameters like hydraulic gradient, conductivity, dispersivity and pumping rate are quite sensitive to the spreading of the anomaly plumes. We have shown that variations of those parameters in hydraulically heterogeneous settings result in significant variations of the predicted plume extents between these two methods.

Heat pumps can render an improved service if implemented as combined heating-and-cooling facilities with temporally alternating regimes of cold and warm backfeed water, respectively. Transient numerical models can help to optimize the design and the operation of heat pumps to minimize the negative impacts on aquifers or to even level out reverse anomalies of secondary heat pumps. Iterative modeling approaches are required to identify the best configuration of well locations, pumping rates and operation schemes. Two case studies are presented to illustrate the buffering of seasonally alternating backfeed loads.

Such effects to reduce temperature impacts on groundwater bodies can be used to think networks of decentralized heat pumps to supply for example low-temperature heating grids in urban areas. There is an immense potential of thermal energy as an abundant distributed energy source that is currently inhibited by the protection of usage rights based on steady-state and two-dimensional modeling approaches. An active management of thermal energy can contribute a sustainable and low-impact energy supply that can be particularly useful for district heating in large cities.

ALPARRAY COLLABORATIVE RESEARCH INITIATIVE ADDRESSING FUNDAMENTAL QUESTIONS OF ALPINE OROGENY

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AlpArray, orogeny, geodynamic driving forces

In all aspects, the Alps are by far the best documented orogen. Yet, the more we learn the more clear it appears that Alpine orogeny and likely orogenic processes in general may only be understood in a 4D-space-time frame and currently we are still far from mastering this challenge. Within their only 1000km lengths from Nice to Vienna, the Alps exhibit an extraordinary variation in structure along strike and from surface to great depth. The modern well-accepted mountain building concept calls for a material flux carefully balanced by mantle flow, plate convergence, subduction and obduction, crustal delamination, surface topography evolution, uplift and erosion. From an evolutionary point of view, structures and presently dominating tectonic processes in the Eastern, Central and Western Alps document significantly different past and present orogen evolution within a single mountain belt. Furthermore, the late Alpine orogenic evolution is intimately linked with the geodynamic forces expressing themselves in Northern Apennines evolution.

The Alpine data set provides a basis to relate subduction processes with Penninic nappes evolution and overthrusting of Austroalpine lid, collision and oceanic slab break-off with build-up of topography, and post-collisional slab rollback and isostatic rebound due to erosional unloading to exhumation of deep European basement structures such as Tauern and Aar massiv. Temporal and spatial variations and relative importance of these processes and their relation to the overall convergence between the Adriatic/Africa and European continental plates, however, are still poorly understood and remain matters of debate. While the AlpArray Seismic Experiment will provide new geophysical information of unprecedented resolution and reliability, discussions and interdisciplinary earth science research among AlpArray community targeted at key questions will lead to a better understanding of collisional orogeny in general and Alpine evolution in particular.

VOM DATENFRIEDHOF ZUM WERTSTOFF – ROHSTOFFGEOLOGISCHE INFORMATIONEN IN DER SÄCHSISCHEN LANDESGEOLOGIE

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Sachsen, Rohstoffdaten, Erz, Spat

Rohstoffvorkommen und deren Gewinnung spielen in Sachsen seit Jahrhunderten eine große Rolle. Erzen und Spaten kommt dabei eine besondere Bedeutung zu, begründete doch vor allem der Bergbau auf Silber den Reichtum des Landes. Die Aufgabe, das Wissen über Bodenschätze und Bergbau zu sammeln und zu erhalten, wird im Freistaat von verschiedenen Institutionen wahrgenommen, z.B. vom Geologischen Dienst Sachsens als Teil des Landesamtes für Umwelt, Landwirtschaft und Geologie (LfULG), vom Sächsischen Oberbergamt und vom Sächsischen Bergarchiv.

Nach der Schließung aller Erz- und Spat-Bergwerke nach der politischen Wende im Jahr 1990 wurden die Erz- und Spatvorkommen Sachsens mit dem Anstieg der Weltmarktpreise seit 2006 wieder für Unternehmen und Investoren interessant. Dabei wurden fundierte Informationen, Daten, Bohrkerne und Proben zu verschiedenen Vorkommen über Geo-Consulter und Bergbaufirmen u .a. beim Geologischen Dienst verstärkt nachgefragt. Daraus entwickelte sich nach einer Idee des Geokompetenzzentrums Freiberg e.V. das Projekt ROHSA 3 (Rohstoffdaten Sachsens), das die Erschließung, Sicherung und Verfügbarmachung sächsischer Rohstoffdaten, wie z.B. Bohrungen, Analysendaten und Berichte zu Rohstofferkundungen, zum Ziel hat.

Nach der Konzeptionsphase startete im Jahr 2013 das Pilotprojekt ROHSA 3.1 als Schlüsselprojekt der Sächsischen Rohstoffstrategie. Mit Ressourcen des Freistaates Sachsen werden bis Ende 2016 die Rohstoffdaten in einem ca. 740 km² großen Gebiet im Erzgebirge erschlossen. Die Recherche, Bewertung und Digitalisierung der interessierenden Unterlagen und Daten erfolgt sowohl in sächsischen als auch bundesweiten Archiven. Bisher wurden rund 2,5 Mio. Seiten von Dokumenten digitalisiert, über 200 Bohrungsdaten neu erschlossen und zehntausende geophysikalische und geochemische Daten datenbanktechnisch erfasst.

Die Bearbeitung erfolgt durch eine Projektgruppe unter Leitung des LfULG. Begleitet wird ROHSA 3 durch einen Projektbeirat, in dem Vertreter der Verwaltung sowie Partner aus der Wirtschaft und dem universitären Forschungsbereich aktiv mitarbeiten.

Das Pilot-Projekt ROHSA 3.1 erfährt bundesweit enormes Interesse. Auf der Grundlage der ersten Ergebnisse und Erfahrungen sowie der Anforderungen der Datennutzer laufen derzeit die Planungen für das Folge-Vorhaben ROHSA 3.2 (2017-2018).

4D-MODELLING OF FAULT KINEMATICS ALONG A PERIADRIATIC FAULT CROSS SECTION DEDUCED FROM (U-TH)/HE AND FISSION-TRACK ANALYSES

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Mauls, fault kinematics, fission track, 4D-modelling

N-S-sections illustrating upper crustal structure of the western Tauern Window have been published (Brandner et al. 2008; Schmid et al. 2013) according to geological reconnaissance of the Brenner Basistunnel (BBT). Crossed Austroalpine nappes (N-S) are allocated to Silvretta-Seckau System, Ophiolite-bearing Penninic units as well as Subpenninic nappes of Venediger Duplex and its hanging wall. The southernmost part cuts across Southern Alpine rocks. Major fault zones (N-S) – Tauern Northern Boundary Fault, Deferegggen-Antholz-Vals Fault, Malsertal Fault and Pustertal Fault – are pierced nearly perpendicularly (strike) at different angles of either simple or overtilted northward dip.

This study focuses on the intensely compressed transition zone between Austroalpine rocks and indenting Southern Alpine units nearby Mauls (Italy) with its roughly orogen-parallel fault system.

Specification of distinguishable uplift rates valid for fault-delimited tectonic units along a set of sections will increase fundamental understanding of local tectonic history. Therefore quantification of vertical movement within delimitable periods is derived from differential cooling paths of recent adjacent blocks. Subsurface samples have been collected in the course of BBT-excavation. Cooling path modelling assembles three age-temperature pairs per sample: Zircon (ZFT) and Apatite (AFT) fission track as well as (U-Th)/He analysis cover an adequate temperature range.

Recent time-temperature models such as proposed by Schneider et al. (2015) suggesting cooling rates of 10,7 to 16,7 KMy^{-1} for Venediger Duplex rocks, are mainly based on surface samples. Pomella et al. (2012) include compiled data and present consistently young (early Miocene) ZFT-ages within Meran Mauls Basement and around Mauls besides Variscan Rb/Sr and K/Ar ages.

We aim for an enhancement of tectonic and kinematic arrangement by interpreting new thermochronologic data embedded in preexisting models. Therefore, we work on

- modelling time-temperature paths derived from subsurface samples,
- refining polyphase behavior of fault zones and corresponding kinematics,
- optimizing N-S-sections as well as generating E-W-sections.

Latest acquired ages show that expected results will represent a substantial kinematic record for reconstructing fault behavior within the uppermost crustal 10 km. A 4D model incorporating generated and prior data will be proposed as an indication for the transition zones tectonic evolution.

IMPLEMENTATION OF TERRESTRIAL LASER SCANNING AS A SUPPLEMENTARY TOOL IN 3D GEOLOGICAL MAPPING AT THE STATE GEOLOGICAL SURVEY IN NORTH RHINE-WESTPHALIA, GERMANY

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t-LiDAR, 3D-mapping, point-cloud, fracture-analysis

Close range terrestrial laser scanning (TLS) and virtual outcrop data has recently received a rapidly increased utilisation in geological research. At the State Geological Survey of North Rhine-Westphalia (Geologischer Dienst NRW), the implementation of TLS becomes a routine tool supporting many aspects of geological mapping and surveying. Combined with highly accurate differential GPS, it enables geoscientists to produce 3D virtual models of a range of geological objects including surface outcrops, caves, cliffs, quarries, landslides etc.

A key benefit of TLS is the rapid and accurate data collection over wide areas without making direct contact to the recorded objects and therefore the ability to safely analyse outcrop sectors that are not readily accessible to the geologists' traditional field techniques or to outcrops that are only temporarily available such as outcrops in road construction sites. In times where geoscientists field work is limited, supplementing traditional field techniques with modern 3D field tools such as TLS serves to protect human resources and enhances the quality of primary geological data acquisition.

At the geological survey a focus of TLS is on the preservation of progressively decomposing geological heritage sites and important but only temporarily exposed outcrops as a 3D virtual model. Following data acquisition, TLS data is commonly processed into high-resolution three-dimensional geo-referenced point clouds. Different point cloud processing algorithms are utilised to extract a range of geometric analysis and classification options. TLS point cloud derived intensity values combined with photo-realistic imagery for example is used to remotely classify and interpret lithologies and fabrics beyond the geologists' traditional field observations. Another key application is the semi-automatic analysis and characterization of exposed surfaces such as fractures and bedding planes within an outcrop. Important parameters such as orientation and frequency of exposed surfaces can be quantified and extracted from the point cloud and are the basis for further analysis. The different results are visualized in maps, sections and views from various perspectives.

This combination of geometrically accurate TLS data, continuously improving point cloud processing algorithms and traditional geological field mapping techniques has significant implications for the improved collection of geological data, particularly of complex 3D geological outcrops.

STRUCTURE AND COMPOSITION OF A FAULT ZONE IN CLAY ROCKS: CONSTRAINTS FROM MICROSTRUCTURAL AND GEOCHEMICAL INVESTIGATIONS OF CORE SAMPLES (MONT TERRI, SWITZERLAND)

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clay rock, fault zone, geochemistry, microfabric, tectonic veins

Investigations of fault rocks are crucial to evaluate the sealing properties of host rock formations used for the storage of gas and oil and for the deposition of heat generating radioactive waste. Claystone is considered as a geological barrier. However, its sealing capability can be reduced if the claystone is cut by brittle faults.

Our study is focusing on the microfabrics and element mobility of fault rocks exposed in the Mont Terri rock laboratory in NW Switzerland. The microfabrics were investigated using SEM and optical microscopy. Geochemical and phase analyses were carried out using XRD, XRF and ICP-MS. In addition, organic (TOC) and inorganic carbon (TIC), total sulphur (TS) as well as the cation exchange capacity (CEC) were determined.

The studied fault zones in clay stones are characterized by closely spaced planar fabrics, which often show slickenside striations. Under the microscope, the fault zone is pervasively reworked and often accompanied by calcite veins and calcite enriched zones. Discrete secondary microshears are segmenting the faulted claystones into duplex like bodies. Palaeo-fluid activity inside the fault zone is indicated not only by calcite veins, but also by stylolites, which result from pressure solution affecting preferably the calcite fragments and veins.

The geochemical composition of intact wall rock and fault rock is different concerning the amount of Ca, Mn, TIC and Sr. CEC, determined by Cu(II)-triethylenetetramine method, showed for clayey intervals values between 8.5 - 12.0 meq/100 g. In the area of calcite-rich layers, the CEC drops to 4.8 - 7.0 meq/100g. TOC is generally < 1 wt%, elevated TIC can be correlated with the calcite-rich layers, but distinct peaks are also visible inside the fault zone.

In a next step, the obtained geochemical profiles will be correlated with microseismic and geoelectrical data in addition to in-situ permeability tests performed by BGR. The combined micro- and macrostructural data will help to reconstruct the deformation history and to constrain the permeability and potential fluid paths of clayey fault zones.

FELSSTURZ AN DER A9 PYHRNUTOBAHN, WALD/SCHOBERPASS: EREIGNISANALYSE, SICHERHEITSMANAGEMENT UND GEFAHRENANALYSE

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Infrastruktur, Felssturz, Sicherheitsmanagement, 3D-Modellierung, Gefahrenanalyse

Entlang der A9 Pyhrnautobahn, nahe Wald/Schoberpass, ereignete sich Ende Juli 2012 ein Felssturz. Weitere im Ablösebereich verbliebene Felsmassen stellten eine latente Gefährdung für den darunter gelegenen Bereich im Talboden inklusive der A9 Pyhrnautobahn dar. Nach der Umsetzung von Sofortmaßnahmen wurde umgehend ein Sicherheitsmanagementplan erarbeitet, der bis zur Herstellung baulicher Schutzmaßnahmen konsequent umgesetzt wurde. Wesentlicher Bestandteil des Sicherheitsmanagements war eine laufende geotechnische Beurteilung der Versagenswahrscheinlichkeit basierend auf den Messergebnissen eines geodätischen Monitoringsystems. Eine differenzierte Betrachtung unterschiedlicher geotechnischer Versagensszenarien ermöglichte eine gezielte räumliche und zeitliche Sperre von aktuellen Gefährdungsbereichen.

Schutzmaßnahmen wurden auf Basis von 2D-Steinschlagmodellierungen geplant und umgesetzt. Letztendlich wurden Art und Umfang von Überwachungsmaßnahmen für den erweiterten Gefahrenbereich definiert, die im Wesentlichen aus einem geodätischen Monitoring sowie einer jährlichen Begehung bestehen.

Sowohl das geodätische Monitoring als auch die Geländebegehungen lieferten Hinweise auf anhaltende Bewegungen, worauf 2015 beschlossen wurde, den betroffenen Abschnitt auf einer Länge von etwa einem Kilometer einer Gefahren- und Risikoanalyse zu unterziehen.

Die Gefahrenanalyse wurde für die Prozesse Steinschlag und Murgang durchgeführt.

Grundlage für die Analyse der Steinschlagaktivitäten war eine 3D-Modellierung mittels Rockyfor 3D. Hierfür wurden alle relevanten Parameter im Rahmen einer geologisch/geotechnischen Kartierung erhoben. Des Weiteren wurden der Wald und die vorhandenen Schutzbauten in die Modellierung miteinbezogen. Die Szenarien (10, 30 und 100 jährlich) und die Intensitäten wurden nach dem schweizerischen Modell ASTRA festgelegt.

Für den Prozess Murgang wurde eine 2D-Modellierung mit dem Programm RAMMS durchgeführt. Auch hierfür wurden die Grundlagendaten im Gelände aufgenommen bzw. bei den zuständigen Stellen erhoben. Die Jährlichkeiten und Intensitäten wurden ebenfalls nach ASTRA festgelegt. Allerdings wurden die Jährlichkeiten in Anlehnung an die Vorgehensweise der WLV an ein österreichisches System (10, 30 und 100 jährlich) angepasst.

Als Grundlage für die Modellierungen diente ein Geländemodell aus einem Laserscan mit einer Auflösung von 20 cm. Diese Auflösung wurde an die Anforderungen der Modelle angepasst (Steinschlag 2 m, Murgang 1 m). Die Ergebnisse der Gefahrenanalyse flossen in weiterer Folge in eine Risikoanalyse ein.

ERFASSUNG DER HYDROGEOLOGIE AUSGEWÄHLTER TALFLURABSCHNITTE DES OBERINNTALS (TIROL, AUSTRIA) MIT HILFE BIDIREKTIONAL GEKOPPELTER 2D-OBERFLÄCHEN- UND 3D-GRUNDWASSERSTRÖMUNGSMODELLE

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Hydrogeologie, Hydrogeologisches Modell, bidirektionale Modellkopplung, Oberflächenströmungsmodell,

Die Talflur des Oberinntals von der Schweizer Grenze im Engadin bis zur Einmündung der Melach westlich von Innsbruck ist seit langem ein interessanter Untersuchungsraum für hydrogeologisch - wasserbautechnische Fragestellungen. Aus jüngerer Zeit liegen zahlreiche Ergebnisse geologisch - hydrogeologischer Erkundungen und numerischer Grundwassermodelle vor, die im Zuge geplanter Infrastrukturprojekte (insbesondere verschiedene Wasserkraftwerke und Grundwassererschließungen) umgesetzt wurden und eine umfangreiche Grundlagenbasis für spezielle Talflurabschnitte des Oberinntals darstellen.

Die Kombination geologisch - hydrogeologischer Kartierungen mit direkten / indirekten Erkundungen (u.a. Bohrungen, bodengeophysikalische Untersuchungen) ergaben grundlegende Einblicke in den Aufbau der quartären Porengrundwasserkörper verschiedener Talflurabschnitte des Oberinntals und ermöglichten die Ableitung geologischer Modelle. Wasserwirtschaftliche Erhebungen und Monitoringdaten komplettierten die jeweiligen geologischen Modelle und erlaubten die Ableitung der jeweils zugehörigen hydrogeologischen Modelle. Diese bildeten ihrerseits die wesentliche Grundlage für verschiedene darauf aufbauende numerische 2D-Oberflächen- und 3D-Grundwasserströmungsmodelle hydrogeologisch besonders relevanter Talflurabschnitte des Tiroler Oberinntals.

Das überwiegend entlang tektonischer Störungen verlaufende glazial stark übertiefte Tiroler Inntal wurde postglazial durch fluvioglaziale Kiese überschottet, die verbreitet von gering mächtigen holozänen Ausanden überdeckt sind. Die fluvioglazialen Inntalsedimente bilden den typischerweise sehr mächtigen und hoch durchlässigen Quartärquifer des Tiroler Inntals, in dem ein mächtiger Grundwasserbegleitstrom des Inn ausgebildet ist. Im flachen Inntalboden herrscht eine starke hydraulische Kopplung zwischen den oberflächennahen Grundwasserpotentialen und den lokal stark variierenden Wasserständen des Inn, der zahlreichen in der Inntalflur verlaufenden Gießen und vieler anderer geohydraulisch relevanter Oberflächengewässer.

Daher wurden für die Simulationen der vorhabensbedingten hydrogeologischen Auswirkungen numerische Modelle eingesetzt, die jeweils ein zweidimensionales hydrodynamisch - numerisches Oberflächenströmungsmodell (2D-HNM) und ein dreidimensionales Grundwasserströmungsmodell (3D-GWM) umfassten, die mit Hilfe eines bidirektionalen Leakageansatzes knotenweise unmittelbar aneinander gekoppelt wurden. Mit Hilfe dieser bidirektional gekoppelten 2D-Oberflächen- und 3D-Grundwasserströmungsmodelle wurden für den Istzustand und für verschiedene Bau- und Betriebszustände umfangreiche stationäre und instationäre Simulationen für unterschiedliche Jahreszeiten und Hochwasserereignisse (inkl. HQ100) durchgeführt.

Exemplarisch werden dieser bidirektional gekoppelte Modellansatz und wesentliche Modellergebnisse anhand aussagekräftiger Grundwassergleichen-, Flurabstands- und Differenzpläne für den dicht besiedelten und bereichsweise durch sehr geringe Grundwasserflurabstände gekennzeichneten ca. 11 km langen Oberinntalabschnitt Telfs - Inzing erläutert, in dem die Innsbrucker Kommunalbetriebe AG (IKB) das Regionalkraftwerk Mittlerer Inn (RMI) plante.

THE DRILL CORE ANALYSIS OF THE FUTURE? - BY MEANS OF THE HYPERSPECTRAL IMAGING SPECTROMETER HYSPEX, XRD AND ASD IN PROXIMITY OF THE MÝTINA MAAR, CZECH REPUBLIC

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Hyperspectral Remote Sensing, Imaging Spectroscopy, Geology, Drill Cores, Mýtina maar

The study used samples from a recently discovered maar system in Mýtina, Czech Republic in the seismic prone Eger graben system to compare different analysis techniques in order to create a surface cover map which includes the volcano-clastic overprint. It uses remote sensing techniques to accomplish this goal. Hyperspectral images are increasingly in demand for surface mapping purposes and a range of different expert systems are being established. To identify surface cover materials, their performances have to be qualified and verified. In this work, several steps were taken: 1) samples from 7 drill cores from the adjacent area were analyzed by X-Ray diffractometry (XRD) and the hyperspectral imaging spectrometer HySpex. 2) Soil samples from the area were measured in the laboratory by HySpex and in-situ by an analytical spectral device (ASD). 3) The measured data was analyzed by a material characterization algorithm (MICA) and the results were compared to the results from the XRD-analysis, which serves validation purposes. 4) A spearman-rank correlation was carried out to not only compare the results qualitatively but also semi-quantitatively. 5) The MICA-results of the in-situ and laboratory measured spectra of the soil samples were compared. This comparison provides the possibility to create a volcanic map based on the in-situ soil in the area of Mýtina. A good correlation of the detected minerals by the two methods was found. We also found a correlation in the semi-quantitative analysis - regarding the soil samples - keeping in mind that the minerals which lack identifiable features in the visible to short wave infrared range (e.g. quartz, feldspar) could not be considered in this correlation. The comparison of the in-situ and laboratory-measurements of the soil samples showed a lack of mineral detection and instead a detection of vegetation or no detection at all. This is due to the method of analysis. Our work developed an operable process chain which simplifies the analysis of drill cores, drill core samples and soil samples. It provides the basis for a spatially extensive analysis of hyperspectral data and thereby a hazard assessment regarding the affected area by a maar eruption.

GEOGENE GEFÄHRDUNGEN IN BERGBAUBETRIEBEN

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Im Bauchladen der Verwaltungstätigkeiten der Landesgeologen befinden sich im Stoß „Mineralrohstoffgesetz“ alle jene Dienste, die sich mit der geologischen Beurteilung von Sachverhalten im Zusammenhang mit „Genehmigungen-Überprüfungen-Heimsagungen“ von Bergbaubetrieben befassen. In diesen Bereichen ist es die Aufgabe der geologischen Amtssachverständigen, die Bergbaubetriebe auf ihren sicheren Abbau hin zu beurteilen und gegebenenfalls Maßnahmen zur Wiederherstellung eines zulässigen Zustandes vorzuschreiben.

Anders als bei anderen gewerblichen Betrieben werden Bergbaubetriebe schon von Gesetzes wegen häufiger einer regelmäßigen Überprüfung durch Behördenorgane unterzogen, da sie aufgrund der mannigfaltigen geogenen Gefahren wie Böschungsbruch, Steinfall, Blockgleiten usw. einem höheren Gefährdungspotential ausgesetzt sind.

Wir erinnern uns an Zeitungsmeldungen über Unfälle in Steinbrüchen und Schottergruben, wo es zu ernsten bzw. tödlichen Verletzungen der Bergleute gekommen war. Neben menschlichem Fehlverhalten sind es doch immer wieder die geogenen Rahmenbedingungen, die zum Versagen von Felswänden oder Böschungen führen. Betroffen sind zumeist die Arbeitnehmer, die entweder die gefährliche Situation unwillentlich aktiv herbeigeführt oder die Bedrohung durch Unwissenheit nicht rechtzeitig wahrgenommen haben.

Im Rahmen dieser Auseinandersetzung mit dem Thema sollen nicht nur die Tätigkeiten des Landesgeologen im Zuge seines Amtssachverständigendienstes skizziert, sondern auch an Hand von Beispielen typische geogene Gefahren aufgezeigt werden. Maßnahmen zur Vermeidung dieser Bedrohungen runden die Betrachtung ab.

AUSGEWÄHLTE KAPITEL ZUM EINSATZ SPEZIELLER BODENGEOPHYSIKALISCHER VERFAHREN

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Seismik, Geoelektrik, Georadar, spezielle geophysikalische Verfahren, Infrastrukturprojekte

Im Zuge zahlreicher Infrastrukturprojekte kommen aufgrund spezieller Fragestellungen hinsichtlich des Baugrunds neben gängigen Methoden der geologisch-hydrologisch-geotechnischen Baugrunderkundung auch bodengeophysikalische Verfahren zum Einsatz. Dabei werden in unseren Breiten überwiegend Seismik, Geoelektrik und Georadar eingesetzt.

Bei der Seismik werden Schwingungsaufnehmer (Geophone) in regelmäßigen Abständen in den Boden platziert und in ebenso kontinuierlichen Abständen seismische Wellen erzeugt. Als seismische Quellen kommen je nach Anforderung und Gelände ein Fallgewicht (Vakimpak), Hammerschlag oder Kleinstsprengungen zum Einsatz. Aufgrund der unterschiedlichen Ausbreitungsgeschwindigkeiten der seismischen Wellen in den verschiedenen Böden und Gesteinen können geologische Einheiten unterschieden werden. Die Eindringtiefe reicht von dm (hochauflösend) bis mehreren 100 m (Tiefenseismik).

Bei der Geoelektrik werden in regelmäßigen Abständen Elektroden (Eisenspieße) in den Boden eingebracht und elektrischer Strom eingespeist, der den spezifischen Widerstand der beteiligten Gesteinsmaterialien misst. Aus dem Widerstand kann die elektrische Leitfähigkeit abgeleitet werden, die für toniges Material sehr hoch ist und bei grobkörnigen ungesättigtem Material niedrig.

Das Bodenradar (Ground Penetrating Radar, abgekürzt GPR) benutzt hochfrequente, elektromagnetische Wellen und arbeitet nach dem Prinzip der Echosondierung, um Untergrundinformation zu erfassen. Georadar reagiert auf wechselnde elektromagnetische Eigenschaften des Untergrundes (Dielektrizitätskonstante ϵ). Mittels einer der Problemstellung (Eindringtiefe, Zielgröße) angepassten Energiequelle (Radarantenne) werden elektromagnetische Wellen im Untergrund erzeugt. Maßgeblich für das Reflexionsvermögen ist dabei der dielektrische Kontrast der aufeinander folgenden Materialien. Mit einer konstanten Sender-/Empfänger-Konfiguration werden die Signale in einer kontinuierlichen, einfach überdeckten Reflexionsmessung aufgezeichnet. Die Antenne wird händisch oder von einem Fahrzeug im Schritt-Tempo entlang der zu untersuchenden Strecke gezogen. Das Reflexionssignal des Untergrundes kann von derselben Antenne wieder empfangen und mit der Aufnahmeapparatur weiterverarbeitet werden. Durch Aneinanderreihen der in rascher Folge aufgenommenen Reflexionssignale (scans) ergibt sich ein kontinuierliches Reflexionsbild, das unmittelbar auf einem Plotter oder Bildschirm dargestellt werden kann (Radargramm).

Diese Methoden unterliegen einer stetigen technischen Entwicklung, die vor allem im Bereich des Auflösungsvermögens und der Darstellung große Fortschritte in den letzten Jahren erzielt hat. Anhand verschiedener Beispiele aus dem Alpenraum soll dargestellt werden, welche geophysikalischen Verfahren bei unterschiedlichen Anforderungen und Rahmenbedingungen angewandt wurden und wie das Ergebnis zum Nutzen des Projekterfolgs beigetragen hat.

DEMISE OF THE DACHSTEIN PLATFORM IN THE TRANSDANUBIAN RANGE (HUNGARY) AND ITS RELATION TO THE TRIASSIC-JURASSIC BOUNDARY EVENTS

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Triassic-Jurassic boundary, carbonate platform, carbon isotope anomaly

Significant carbon isotope fluctuations are known from the Triassic-Jurassic boundary (TJB) interval, at a time of major environmental changes. The majority of the available isotopic data originates from open marine settings and relatively little is known from shallow marine environments, despite the existence of extensive Late Triassic carbonate platforms in the Tethys. One of the best known examples is the Dachstein platform, whose growth terminated at the end of the Triassic.

Here we present new stable isotopic and carbonate sedimentological data from the Transdanubian Range in Hungary. Previously, the TJB in the Transdanubian Range was regarded as a tectonically controlled platform drowning event or attributed to emergence caused by a significant sea level fall. However, recent recognition of global biotic change and environmental perturbations at the TJB call for an assessment of their possible role in the demise of the Dachstein platform.

Oxygen and carbon isotopic composition of bulk carbonates were measured in sections at Kőris-hegy (Bakony Mts.), Tata (Tata Horst), and Vöröshíd (Gerecse Mts.) The three sections represent a latest Triassic inner to middle platform transect in paleogeographic sense. Other sections, Pisznice and Tölgyhát (Gerecse Mts.), yielded additional sedimentological data which permit to characterize a sedimentary regime shift from carbonate platform to carbonate ramp across the TJB. The sharp discontinuity surface separating the Dachstein Limestone from the overlying Jurassic limestones is interpreted as a submarine, or perhaps polygenetic hardground at the TJB. The lowermost Jurassic beds attest a fundamental change in the carbonate factory.

A sudden negative carbon isotope shift at the TJB, and a gradual rebound to more positive values characterize the lowermost Jurassic carbonates. Chemostratigraphic correlation with other sections is ambiguous, in the lack of a global reference curve. In the Transdanubian Range, the initial carbon isotope excursion is not preserved due to the gap.

Our results allow a discussion of possible roles of submarine erosion, perhaps partly related to acidification, and an abrupt change in carbonate production related to the end-Triassic extinction of several groups in the platform system. These environmental and biotic factors offer an alternative explanation of the demise of the Dachstein carbonate platform.

FIRST WATER – ISOTOPE – MAP (δ 18O, δ 2H, 3H) OF AUSTRIA: APPLICATIONS, EXTREMES AND TRENDS

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water, isotope, map, Austria

The isotopic ratios of oxygen and hydrogen in water ($^2\text{H}/^1\text{H}$ and $^{18}\text{O}/^{16}\text{O}$) are important tools to characterise waters cycles. Tritium formed by natural cosmic radiation in the upper atmosphere and in the last century by tests of thermonuclear bombs, is an ideal age-marker during the last 60 years.

To determine the origin and mean age of waters in many scientific projects and in those concerning water supply and engineering in the last 45 years on more than 1,350 sites more than 40,000 isotope measurements were performed in Austria.

The median value of oxygen-18 of all sites is $\delta^{18}\text{O}$ -10.7 ‰ and for hydrogen-2 $\delta^2\text{H}$ -75 ‰. As the fractionation is mainly temperature dependent the lowest negative values are observed in winter precipitation (oxygen-18 as low as $\delta^{18}\text{O}$ -23 ‰) and in springs in the mountain regions ($\delta^{18}\text{O}$ -15.1 ‰). In contrast the highest values were observed in summer precipitation (up to $\delta^{18}\text{O}$ - 0.5 ‰) and in shallow lakes in the Seewinkel close to the Hungarian border (up to $\delta^{18}\text{O}$ + 5 ‰).

The median of all deuterium-excess values is d-excess = 9.4 ‰. The lowest negative value of -7.4 ‰ was measured in the surface water sample of a gravel pit in the Leibnitzer Feld (Southern Styria). The highest d-excess value of 15.7 ‰ is documented from a mountain spring at the southern border of Austria.

The median value of all 1,120 sampling sites of decay corrected (2015) tritium measurements is 6.2 tritium units (TU). This is somewhat smaller than the median value of all precipitation stations with 7.2 TU. The tritium concentration increases in the summer up to 10 – 11 TU and decreases in winter down to 3 – 4 TU. A mean tritium concentration in aquifers smaller than approximately 3.5 TU indicates that a large amount of this water is older than 60 years. Waters with approximately more than 12 TU contains still tritium from the 1960s and 1970s originating from thermonuclear bomb experiments in the atmosphere. In Austria the highest tritium values can be observed in the rivers Danube and March which show periodic or permanent tritium contamination up to 70 TU coming from nuclear power plants in the neighbouring countries.

EXPLORING THE OLIGOCENE PALEOENVIRONMENT OF ETHIOPIA

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Paleoenvironment, Biogeochemistry, East Africa, Biomarkers

Ethiopia is a region with strong ecohydrological gradients due to the elevated topography of its Plateau and the incision of the east African rift valley. The age of the Ethiopian Plateau is strongly debated, ranging from the late Oligocene to early Miocene. Its uplift had significant impact on the regional ecosystem and hydrology which is studied in this project.

The environmental variations during the the last 30 million years will be reconstructed using molecular remnants of plants and microorganisms (biomarkers). In a first attempt, Oligocene samples have been taken from the well described Chilga site north of Lake Tana on the northwestern Plateau. Biomarkers have been extracted from the rock to be compared to the established fossil-record of the Oligocene. They allow us to draw a picture of the ecosystem and verify the information gained from both fossils and biomarkers.

DIE NEUE „GEOLOGISCHE KARTE DER REPUBLIK ÖSTERREICH 1:25.000“ IM UTM-SYSTEM

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Geological Maps, Geologische Karten, Geological Survey

Die Geologische Bundesanstalt (GBA) erstellt ihre geologischen Kartenwerke auf Grundlage der amtlichen topografischen Karten des Bundesamtes für Eich- und Vermessungswesen (BEV). Im September 2010 wurde die Österreichische Karte 1:50.000 (ÖK50) im BMN-System (BMN=Bundesmeldenetz) vom BEV zum historischen Kartenwerk erklärt und durch die ÖK50 im international gültigen UTM-System (UTM=Universale Transversale Mercator Projektion) mit neuem Blattschnitt ersetzt.

Am 7. April 2010 hat der Beirat und Fachbeirat der GBA mit dem Businessplan 2010-2012 auch das grundlegende Konzept für den Umstieg auf das neue topografische Kartenwerk des BEV im UTM-System, als Grundlage für das geologische Detailkartenwerk der GBA, zur Umsetzung empfohlen. Dieses Konzept sieht neben einem schleichenden Umstieg über einen Zeitraum von zehn bis 15 Jahren, indem noch maximal 21 Kartenblätter im BMN-System ausgegeben werden, auch eine Maßstabsumstellung für die neuen UTM-Blätter auf 1:25.000 vor. Die Hintergründe und Argumente für diese weitreichende Entscheidung wurden von Krenmayr (2010: Das Geologische Spezialkarten-Programm in Österreich: Umstieg auf das neue topografische Kartenwerk im UTM-System und den Maßstab 1:25.000 – Hintergründe und Strategie. – Jahrbuch der Geologischen Bundesanstalt, 150/3+4, 421-429, Wien) ausführlich dargelegt.

Ein Vorschlag für die Gestaltung der neuen geologischen Kartenblätter hinsichtlich Inhalt und Layout wurde an der GBA, beginnend im Dezember 2014, in einem mehrstufigen Produktentwicklungsprozess, in einem vielköpfigen Team (M. Bichler, H. Gebhardt, A. Gruber, H.G. Krenmayr, G.W. Mandl, M. Linner, M. Rockenschaub, R. Roetzel, M. Schiegl, R. Schuster) erarbeitet. Das Ergebnis dieses Prozesses wird im Rahmen der GeoTirol/PANGEO im Rahmen des gegenständlichen Vortrags und einer Poster-Präsentation in Form des Layout-Entwurf in der Fachöffentlichkeit zur Diskussion gestellt.

Eckpunkte dieses Gestaltungsvorschlages sind die Ausgabe als UTM-Viertelblätter (benannt nach dem UTM-Ganzblatt mit dem Zusatz „Nordwest“, „Nordost“, „Südwest“ bzw. „Südost“) in einem Faltformat A5 mit fixer Wickelfaltung (6x3; mit Aufdruck der Titelseite auf der Druckbogenrückseite) und als Nebendarstellungen ein repräsentativer Profilschnitt sowie drei Nebenkärtchen im Maßstab 1:250.000 (Verteiler der Aufnahmegebiete mit Vollzitat, tektonische Übersicht mit eigenem Farbschlüssel, geologisch-tektonische Übersicht mit dem Farbkonzept aus der Hauptkarte).

Die Entscheidung über die farbliche Gestaltung der Titelseite des neuen Detailkartenwerkes soll durch ein Publikumsvoting im Rahmen der Tagung unterstützt werden, Feedback ist aber zu allen Aspekten der neuen Kartenblätter willkommen.

INHALTE UND LAYOUT DER NEUEN „GEOLOGISCHE(N) KARTE DER REPUBLIK ÖSTERREICH 1:25.000“ IM UTM-SYSTEM: FEEDBACK ERWÜNSCHT!

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Geological Maps, Geologische Karten, Geological Survey

Rund die Hälfte der Kartierungsprojekte der Geologischen Bundesanstalt zielen bereits auf die Ausgabe als Geologische Kartenblätter im Maßstab 1:25.000, auf Basis des „neuen“ (Abschluss in 2010), amtlichen topografischen Detailkartenwerkes („Österreichischen Karte 1:50 000“) des Bundesamtes für Eich- und Vermessungswesen im UTM-System ab.

In einem mehrstufigen Produktentwicklungsprozess, der von einem vielköpfigen Team von GBA-Mitarbeitern (M. Bichler, H. Gebhardt, A. Gruber, H.G. Krenmayr, G.W. Mandl, M. Linner, M. Rockenschaub, R. Roetzel, M. Schiegl, R. Schuster, J. Ruthner) getragen war, wurden Inhalt und Layout der neuen Karten konzipiert und werden nun, mit dem gegenständlichen Poster (in Form eines vollständigen Probeblattes) und im Rahmen eines Vortrages, in der Fachöffentlichkeit zur Diskussion gestellt.

Die inhaltlichen Eckpunkte sind: Umstieg auf den Maßstab 1:25.000; Legendenstruktur und Legendentexte (Lithostratigraphie/Alter/Lithologie) wie bisher; ein repräsentativer Profilschnitt am Unterrand der Karte (bei Bedarf mit einer ergänzenden Legende, z.B. für Schichtglieder die nur im Untergrund auftreten); Nebenkärtchen 1:250.000 der tektonischen Einheiten (über den Blattschnitt der Hauptkarte ausgreifend und mit eigenem, standardisierten Farbschlüssel); Nebenkärtchen 1:250.000 mit einer geologisch-tektonischen Übersicht zur Hauptkarte (Farbschlüssel an diese angelehnt); Nebenkärtchen 1:250.000 der verwendeten Unterlagen/Aufnahmegebiete (mit Angabe der Vollzitate auf der Druckbogenrückseite).

Die Eckpunkte des Layouts sind: Ausgabe als Viertelblätter der GK50-UTM, wobei die Blattsystematik auf den Namen der UTM-Ganzblätter, ergänzt durch „Nordwest“, „Nordost“, „Südwest“ bzw. „Südost“, Bezug nimmt; Faltformat A5 mit fixer Wickelfaltung (6x3; mit Aufdruck der Titelseite und der Rückseite der gefalteten Karte auf der Druckbogenrückseite); wie bisher hochweiße Papierqualität, die kartographisch anspruchsvolle Farbnuancen erlaubt; Zitiervorschlag auf Kartenrückseite; Auslieferung in einer einfachen Plastikhülle ohne Einsteckcover; zugehörige Erläuterungen (ggf. auch für 2 bis max. 4 UTM-Viertelblätter) als eigenes Büchlein (ebenfalls A5) mit steifem Umschlag.

Die Entscheidung über die farbliche Gestaltung der Titelseite des neuen Detailkartenwerkes soll durch ein Publikumsvoting im Rahmen der Tagung unterstützt werden.

HEAVY MINERAL ANALYSIS AND GARNET GEOCHEMISTRY OF MODERN STREAM SEDIMENTS FROM THE WESTERN HOHE TAUERN (AUSTRIA)

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Heavy minerals, Garnet geochemistry, Eclogite Zone, Tauern Window, Eastern European Alps

The mineral chemistry of heavy minerals has been widely used to identify and characterise source areas. The heavy mineral garnet is a particular useful mineral in provenance research, because of its wide range of major element composition, its high importance in defining metamorphic conditions and its comparative stability during transport and burial diagenesis. In this study, we test the application of heavy minerals and garnet geochemistry for modern stream sediments collected along three rivers draining the Eclogite Zone and adjacent geological source units of the western Hohe Tauern area in the central Eastern European Alps (Krippner et al., 2015, *Sediment. Geol.*, 321, 25-38). Rock outcrops exposed in this area were also sampled for comparison with the stream sediments. The chosen area is very well investigated and provides an excellent place to constrain the relations between source rocks and sediment in first-order drainages. We also analyse the influence of grain size in detail by considering grain-size fractions ranging from coarse silt to coarse sand (32 to 1000 μm). In all grain-size fractions the heavy mineral assemblages are characterised to a variable extent by epidote, zoisite, garnet, and green calcic amphibole. An increase of apatite in the fine tail of the size distribution and an increase of green calcic amphibole and garnet in the coarse tail of the size distribution can be observed. Electron microprobe analysis of detrital garnet shows the dominance of almandine-rich garnet. Pyrope-rich garnets increase within the eclogite Zone consistent with the geological framework. Interestingly, in all samples, grossular-rich garnets are more frequent in the smaller grain sizes and pyrope-rich garnets are more frequent in the coarser grain sizes. This probably results of the inheritance of grain size from the host rock to sediment rather than being a hydraulic effect. The heavy mineral assemblages and garnet geochemical data reflect the geological setting of the study area, hence confirming the general strength of these methods in sedimentary provenance analysis. However, the data underline strong grain-size control on sediment composition, including single-grain compositional variations.

ORE MICROSCOPY AND CATHODOLUMINESCENCE STUDIES ON SANDSTONE-HOSTED KUPFERSCHIEFER-TYPE ORE FROM THE WOLFSBERG MINE DUMP, RICHELSDORF MOUNTAINS

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Kupferschiefer-type

The Richelsdorf Mountains in Hesse, Germany, represent an old mining district associated with Kupferschiefer-type ore mineralization. Dump material of sandstone-hosted run-of-mine ore from the Wolfsberg mine were studied in terms of mineralogical composition of sedimentary clasts and cement as well as ore mineralogy. The samples consist of light grey sandstone underlying the Kupferschiefer-sediment. The Central European Crystalline Rise underlies parts of the Richelsdorf Mountains and is considered as source for the metals forming the Kupferschiefer-mineralisation.

Optical microscopy, scanning electron microscopy and cathodoluminescence have been used to study thin and polished sections of sample material collected from the dump of the Wolfsberg mine situated close to the village Ida.

According to the distributions of detrital components as quartz, feldspar and lithic clasts the sandstone represents an arkose. The crystalline basement bordering the Richelsdorf Mountains can be assumed as source of these detrital clasts. The type of cements vary from sulphidic, sulphidic-carbonatic to carbonatic composition.

The carbonates that build up the matrices show a variation in the content of iron and manganese, which is apparent in different luminescence colours. The main sulphides are bornite, chalcocite, chalcopyrite, pyrite and covellite. Beside these ores a second generation of arsenic, nickel- and cobalt-ores has been detected.

The sulphides replace partially carbonates, feldspar or lithic clasts, but also mineral grains and fossils. The arsenic sulphides show zoned areas exhibiting varying contents of arsenic increasing from the rim to the centre. This indicates that hydrothermal conditions up to 200°C temperature have been achieved, which is supported by dissolved quartz and feldspar.

Secondary formed covellite occurs associated with bornite. Green coatings on hand specimen representing secondary copper minerals that have been formed during weathering.

Kupferschiefer-type ore mineralisation has been formed in multiple phases, whereas obviously the youngest stage shows hydrothermal character by replacement textures of older stages.

FROM EXCHANGE TO CLOUD: THE DGGV LIBRARY IN TIMES OF DIGITAL REVOLUTION

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Geological Publications, DGG Library, Exchange, Digitisation, Cloud

With the creation of the German Geological Society (DGG, now DGGV) in 1848 under the guidance of Leopold von Buch and Alexander von Humboldt, the establishment of the DGG Library was one of the main measures for the knowledge management of the early geologists in the German speaking area. When seeing this historically it happened in the wake of the March Revolution under the influence of the European Enlightenment - long before the German Empire started to exist. For many years, the exchange of all kinds of periodical publications and geological maps became the most important means of scientific exchange with hundreds of partners around the globe. Publication exchange continues and is very well reflected in the structure and thematic focus areas of the holdings, however, the digital revolution is having a strong impact on these activities since the beginning of the new millennium, as several partners restrict their publications to digital distribution in the Internet or stick to one of the open access publication models. With its currently six publication series the German Geological Society is employing a mixed strategy of policies. It has been one of the guiding principles from the very beginning to have the scientific community bear the costs incurred for the production, thus guaranteeing scientific and political independency. As a flanking measure, several digitisation projects are under way from the side of the Library in order to secure source materials and to enhance the accessibility of geological information, e.g., in the cloud.

SOUTH ATLANTIC SALT AND SALT-FREE SEDIMENTARY BASINS – WITNESSES OF COMPLEX PASSIVE MARGIN EVOLUTION

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passive margin, South Atlantic, salt basins, rift to drift

The salt and salt-free Cretaceous aged sedimentary basins in the South Atlantic witness a complex tectonic-sedimentary evolution of the passive margin. Recurring topics of passive margin tectonics include the processes and sequence of events from pre- to post-rift stages which eventually lead to the separation of continents. Amongst others it is the position of the continent-ocean boundary (COB) relative to the rift, sag and salt basins, which bears significance for the geometries and kinematics of breakup and basin evolution, and has been widely discussed. Similarly, the importance of seaward-dipping reflectors (SDRs) observable in parts of the South Atlantic margin to represent a valid gauge for the outermost limits of continental crust in rift basins can be questioned. It has long been recognized that salt plays a major role in the tectonic-sedimentary evolution along most passive continental margins and in the internal deformation of mountain belts. To date only a few studies used basin-to-basin comparisons across the South Atlantic. Based on regional 2D seismic lines, free-air gravity data and results from flexural isostatic backstripping and kinematic reconstructions, the work presented compares conjugated basin sets across and along the South Atlantic margins. Conspicuous changes in structural and sedimentary symmetries occur and are attributed to a shift in spreading centre locations. This also explains changes in COB locations and SDR distributions. Paleoenvironmental considerations and our kinematic reconstruction results suggest that salt basins were hydrographically isolated from the open ocean by distinct barriers acting during the drift stage. Along both continental margins, several post-rift tectonic phases, including uplift and margin tilting with associated salt tectonics and sediment deposition, eventually amplified structural differences that already developed during early stages of rift basin formation and continental separation.

TECTONIC EVOLUTION OF THE COCOS PLATE DURING THE MIOCENE: CONSTRAINTS FROM IODP EXPEDITION 344

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Cocos Plate, Cocos Ridge, East Pacific Ridge, Galapagos Hot Spot

The Integrated Ocean Drilling Program (IODP) Expedition 344 study area is located offshore the Osa Peninsula (Costa Rica). The primary objective of IODP Expedition 344 was to sample and quantify the material comprising the seismogenic zone of an erosive subduction margin. Fundamental to this objective is an understanding of the nature of the sediment and oceanic crust entering the trench. Site U1381 serves as a reference site on the subducting aseismic Cocos Ridge. It is located ~4.5 km seaward of the deformation front offshore the Osa Peninsula and Caño Island, on a local basement high. The seismic section shows a 100 m thick sediment section resting on reflective basement interpreted as Cocos Ridge igneous crust. The sedimentary section is composed of pelagic and hemipelagic sediments. A hiatus of ~11 m.y, between 1.89 and 13.5 Ma, is recorded.

Site U1414 is located ~1 km seaward of the trench offshore the Osa Peninsula and Caño Island. The seismic section shows a 400 m thick sediment section resting on igneous crust. The sedimentary section is composed of pelagic and hemipelagic sediments.

Comparison with ODP sites 1039 and 1242 provides additional constraints on the Cocos plate tectonic evolution. ODP site 1039 is located west of the Cocos Ridge and revealed a similar sedimentary record as U1414. Site 1242 is located on the eastern margin of the Cocos Ridge and, similar to U1381, shows a hiatus of ~11 m.y.

Although located close together nowadays, U1414 and U1381 reflect a totally different evolution. Based on the stratigraphic record, combined with microthermometric and stable isotope data, we suggest that U1414 was located close to the East Pacific Ridge during mid-Miocene times, whereas U1381 was located on the Cocos Ridge; both sites were separated by the Cocos-Nazca Spreading Center (CNS) at that time. The subsequent ENE movement of the Cocos Plate and the jump of the CNS to its present position brought site U1414 closer to U1381. We assume that at least during mid-Miocene times the two sites were part of two separate oceanic plates.

CRYSTALS, GRAINS OR CRACKS? CAUSES FOR SEISMIC ANISOTROPY IN ROCKS FROM THE ECLOGITE ZONE, TAUERN WINDOW, AUSTRIA

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Seismic anisotropy, Crystallographic preferred orientation (CPO), Microcrack fabric, Eclogite Zone

Crystallographic preferred orientations (CPO) and microcracks are major causes for seismic (P- and S-wave) anisotropy in rocks. To assess their relative importance we experimentally determined compressional (V_p) and shear wave (V_s) velocities on cubic samples with edge lengths of 43 mm in a triaxial multianvil apparatus using the ultrasonic pulse transmission technique. Investigated metasediment and variably retrogressed eclogite samples come from the Eclogite Zone in the Tauern Window, Austria. At successive isotropic stress states up to 600 MPa and room temperature measurements were related to the three principal fabric directions (X, Y, Z) representing the foliation (XY plane), the foliation normal (Z-direction) and the stretching lineation (X-direction). Progressive volumetric strain was logged by the individual piston displacements. Cumulative errors in V_p and V_s are estimated at <1%.

Microcrack closure contributes massively to increases in acoustic velocities and decrease of anisotropies up to 50 MPa (metasediments) and 150 MPa (eclogites), suggesting preferred orientations of cracks, and mineralogy and grain fabric influence on the mode of closure. Residual V_p anisotropies of about 6-16 % are attained at 300-400 MPa in eclogites (maximum $V_p = 8.0-8.1$ km/s, $V_s = 4.4-4.6$ km/s), about 5% at 300 MPa in a strongly retrogressed eclogite (maximum $V_p = 7.4$ km/s, $V_s = 4.2$ km/s), and about 6-17% at 200-250 MPa in the quartz-rich metasediments (maximum $V_p = 6.1-6.5$ km/s, $V_s = 4.0-4.3$ km/s). In the latter, white mica content and CPO mainly control anisotropy. Maximum wave velocities are parallel to the lineation and minimum velocities are perpendicular to the foliation in all samples. Shear wave splitting is strongest in the metasediments, and less pronounced in the eclogites. Seismic velocities and residual anisotropies in the metasediments correlate well with those computed from complete CPO measured by neutron diffraction. In the eclogites, however, experimentally determined seismic anisotropies are distinctly higher than those computed from CPO. This indicates a hitherto ignored but important contribution to seismic anisotropy, probably induced by the shape fabric of high-pressure silicates.

THE EFFECT OF SEA-LEVEL CHANGES ON FOSSIL PRESERVATION: A CASE STUDY FROM THE LOPINGIAN (LATE PERMIAN) OF THE NORTHWESTERN TETHYS

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Lopingian, taphonomy, Dolomites, Italy, N-Italy

The Lopingian is characterised by an aridisation and substantial sea-level changes. Hence, the fossil record of this time interval is strongly affected by ecological and taphonomic factors inherent to these long-term processes. Integrated sedimentological and palaeontological studies in the Bletterbach section (Dolomites, N-Italy) allow to discriminate between biological signals and preservational bias, shedding light on the effect of sea-level changes on the preservation potential of terrestrial associations of plant remains and tetrapod footprints. Flora A, composed of more humid elements with larger leaf/shoot fragments, is interpreted as a (par-)autochthonous assemblage of an intrazonal riparian vegetation, probably during a sea-level highstand. Flora B, dominated by xerophytic elements documented by smaller fragments, corresponds to an allochthonous assemblage of an azonal vegetation preserved in floodplain fines of a progradational fluvial plain associated with a sea-level lowstand. The distribution of vertebrate footprints mirrors that of the plant-bearing horizons, and their abundance and morphological diversity strongly increases in correspondence with marine transgressions. This could be related to a more diverse fauna (more complex food-web-related to more humid conditions) or more favourable taphonomic conditions. However, the most diversified fauna, recorded during the early phases of the regressive sea-level phase, is best explained by the rapid burial of footprints due to the increasing energy. Our study provides an explanation for the change in distribution and preservation of plant and animal fossils in the Bletterbach section and shows how the fossil content of continental successions is deeply influenced by sea-level changes.

PRIMARY CONTROLS ON THE DIVERSITY HISTORIES OF CENOZOIC FOSSIL MARINE PLANKTON

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plankton, evolution, Cenozoic, diversity, microfossils

Cenozoic deep-sea sediments provide a uniquely complete record of evolution for several clades of phyto- and zooplanktonic protists. Species diversity can be reconstructed either from comprehensive catalogs of distributions through time (available for planktonic foraminifera, and coccolithophores plus discoasters) or via paleobiologic style subsampling of the primary occurrence data for diatoms and radiolaria, from the NSB (Neptune) database (www.nsb-mfn-berlin.de).

Many environmental changes have been proposed as primary evolutionary controls: global climate cooling, the development of distinct polar oceans including a circumpolar Southern Ocean, substantial increases in vertical water column stratification, or partitioning of primary productivity into geographically restricted regions: marginal zones of upwelling, and broad central gyres with stable stratification and oligotrophic conditions. Temporal variation also increased as the magnitude of change between glacial-interglacial cycles grew in the late Cenozoic. Reconstructed diversity histories show that the single most important control on clade diversity was the development of new (polar) environments, associated with cooling and the origin of the Southern Ocean near the Eocene-Oligocene boundary. Shell chemistry is also important. Diatoms and radiolaria, whose shells are made of biogenic silica, developed diverse endemic polar biotas. The carbonate-shelled coccolithophores and planktonic foraminifera were largely excluded from polar regions, a pattern seen in many other groups of living marine organisms, though the reason (presumably physiologic) is unknown.

The last primary control on diversity patterns is one not previously proposed: clade age. The diatoms, who invaded the pelagic realm in the basal Cenozoic, and discoasters, a clade originating in the basal Cenozoic, radiated in the lower latitudes, while more ancient (early-mid Phanerozoic) clades (low latitude members of radiolarians; coccolithophores, planktonic foraminifera) showed only modest changes in Cenozoic diversity.

These patterns support a much debated hypothesis: that there are long-term upper bounds on diversity for clades within specific environments. In these plankton data, the time to equilibrium values are many tens of millions of years. Further, mass extinction of planktonic foraminifera and coccolithophores at the K/T boundary did not reset clade ages. Presumably, the key planktonic adaptations were retained in those taxa that survived.

NEW CONSTRAINTS ON POST-20 MA COUNTER-CLOCKWISE ROTATION OF ADRIA RELATIVE TO EUROPE

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Adriatic Microplate, Kinematic Reconstruction, Neogene Rotation

The Adriatic microplate (Adria) has been caught in the convergence of Africa and Europe since late Cretaceous time. Its boundaries are highly deformed and comprise the Alps, Apennines, Dinarides and the Calabrian Arc. The junctions of these orogens are marked by switches in subduction polarity, with Adria being the upper plate in the Alps and the lower plate in the Apennines and Dinarides. The Apennines have been the site of Oligo-Miocene roll-back subduction, "soft" collision and extensive backarc extension (Tyrrhenian and Liguro-Provencal Basins). Reconstructing the past motion of Adria is therefore key to a better understanding of the forces driving its motion, and more generally, the processes underlying the complexity of the Alpine-Mediterranean mobile belt.

We reconstructed the motion of Adria since 20 Ma by retrodeforming Neogene shortening in the Alps and by balancing Oligo-Miocene back-arc extension and shortening in the northern Apennines. In the northern Apennines, extension in the Ligurian-Tyrrhenian basins exceeds shortening by some 47 ± 14 km. Together with the shortening estimates in the Alps, this indicates that Adria has moved 113 km to the NW (Azimuth 325°) and rotated counterclockwise (CCW) by some $13 \pm 2^\circ$ relative to Europe since 20 Ma. If Moesia is regarded as a fixed (stable) part of Europe on the Dinaric side of Adria, the 13° CCW rotation implies c. 240 km of shortening in the Dinarides. This exceeds the 210 km length of the Adriatic slab anomaly underlying the southern Dinarides, which we interpret to represent the maximum shortening along this transect since slab-breakoff at c. 37-22 Ma. Therefore, we propose an 11° CCW rotation of Adria relative to Europe since 20 Ma in order to provide an optimal fit of available data from the Alps, Apennines and Dinarides. This rotation requires about 150-200 km of Neogene extension between Africa and Africa in the Ionian Sea, which remains a challenge to verify.

THE IMPACT OF RESERVOIR IMPOUNDING ON THE STABILITY EVOLUTION OF DEEP-SEATED ROCK SLIDES: A DISCRETE ELEMENT MODELLING APPROACH

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Deep-seated rock slides, first time impoundment, dam reservoir, stability evolution

In order to perform reliable forecasts of the deformation behaviour of deep-seated rock slides influenced by large dam reservoirs the kinematical processes, failure mechanisms and hydrogeological situation need to be understood profoundly. The response of a rock slide during initial impounding depends on the various factors. The kinematical type of failure, the geometry of the rock slide and sliding surface and, in particular, the geometry of the rock slide toe are considered to play a significant role regarding the sensitivity of a rock slide during initial reservoir fillings. Besides, the internal rock mass properties and shear strength properties along the basal shear zone influence the stability evolution.

The focus of this study is on the impact of a reservoir on the stability evolution of a deep-seated rock slide. Therefore, a generic rock slide model based on a case study with a well-defined geometry and a concave basal shear zone is established. By means of the Universal Distinct Element Code UDEC the reservoir-induced shear displacements along the pre-defined basal shear zone are numerically modelled. Slope displacements initiate when the shear strength properties of the basal shear zone are at or below the critical parameters for the limit-equilibrium state and continue until a balanced state of equilibrium is reached. The transition between small displacements to failure behaviour resulting in large displacements is determined by varying the friction angle of the basal shear zone. The shear strength parameters were reduced stepwise in order to study large displacements in the range of several tens of metres and the effect of internal rock mass deformation on the ability of self-stabilisation. Furthermore, the amount of shear zone strength weakening which is required to maintain ongoing slope deformation is determined.

The study aims to analyse the deformation processes related to changes in stress conditions due to reservoir impoundment and is part of a prediction and hazard assessment approach for rock slides situated along large reservoirs.

DETECTING AND QUANTIFYING DEBRIS FLOW-RELATED GEOMORPHOLOGIC CHANGES IN AN ALPINE CATCHMENT USING LIDAR AND PHOTOGRAMMETRY DATA

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Unmanned Aerial Vehicle, Structure-from-motion, Natural Hazards, Volumetric Sediment Budget, Digital Terrain

In June 2015, a debris flow event occurred near the village Sellrain in the Stubai Alps (Western Austria), covering parts of the populated valley floor with a big alluvial cone. Detailed documentation of the geomorphologic changes caused by the debris flow in the catchment play an important role for hazard mapping, mitigation measure planning and process understanding. However, traditional debris flow event documentation is mostly limited to in-situ assessment of the deposition extent and height. Data assessment in the catchment area is very time-consuming, potentially dangerous and often hampered by limited accessibility to the affected area. This leads to a lack of comprehensive information of the process extent and magnitude. In this study, we present the results of a post-event UAS-mission realised in the catchment of the above-mentioned debris flow channel. We used a custom-built fixed-wing UAS, carrying a commercial off-the-shelf sensor (Sony NEX5). During four flights, the area of interest of about 2.5 km² was mapped. Orthophotos and digital terrain models (DTM) were derived using structure-from-motion photogrammetry software (Agisoft PhotoScan). The many narrow debris source areas along the channel could be located very precisely from these orthophotos. With the assignment of the origin and size of these sources to forested and non-forested terrain, conclusions regarding the influence of the forest on the process could be drawn. Previously active zones were deduced by the comparison with older orthophotos. Terrain height changes in the catchment were calculated by subtracting the pre-event airborne laser scanning DTM from a post-event UAS-DTM. The analysis of the volumetric sediment budget showed, that approximately 265,000 m³ ($\pm 42,000$ m³) material was mobilised in the catchment, with erosion depths reaching up to 3-4 m in the lower part of the gully and 8 m in the central and upper sections. The photogrammetric reconstruction of the DTM was challenging, due to small bushes within the process zones. Other limitations included the time interval of the reference data. The results not only largely benefited the event documentation, but in succession contributed to a better process understanding.

IODP EXPEDITION 356 INDONESIAN THROUGHFLOW AND SUBSIDENCE ANALYSIS FROM THE PRELIMINARY RESULTS

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IODP 356, Indonesian Throughflow, Australia, subsidence, BasinVis 1.0

The Northwest shelf of Australia is an ideal location to investigate the dynamic topography, constraining the spatial and temporal patterns of vertical motions caused by the interaction between plate motion and convection within the Earth's mantle. The region lies across the gradient of the degree 2 geoid anomaly and on the fastest moving continent since the Eocene. Detailed stratigraphic and paleobathymetric data acquired from a recent International Ocean Discovery Program (IODP) Expedition 356 Indonesian Throughflow will allow construction of high-resolution subsidence curves since the Miocene, to improve our understanding of deep-Earth dynamics and their impact on surficial processes. It will also resolve whether the northern Australia is moving with/over a time-transient or long-term stationary downwelling within the mantle beneath southeast Asia. IODP 356 cored seven sites along the northwest shelf of Australia in the Perth (U1458-U1460), Northern Carnarvon (U1461-U1463), and Roebuck (U1464) Basins, from south to north. The lithology of the seven cores is mostly carbonate sediments, mainly packstone and wackestone, from the Miocene to recent. To calculate high-resolution subsidence curves with decompaction and backstripping techniques, the shipboard physical properties (sedimentological and stratigraphic) data are arranged into sediment densities and porosity-depth trends based on well locations, lithological features, and geologic time units. This study uses BasinVis 1.0, a MATLAB-based program for subsidence and visualization. The decompacted sediment thicknesses are also used to arrange realistic sedimentation rates.

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BASINVIS 1.0, AN OPEN-SOURCE SOFTWARE PACKAGE TO VISUALIZE SEDIMENTARY BASIN INFILL AND SUBSIDENCE EVOLUTION

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BasinVis 1.0, MATLAB, visualization, subsidence, basin modeling

BasinVis 1.0 is an open-source software package (available for download at <http://geologist-lee.com/basinvis.html>) and implemented in MATLAB® which is a multi-paradigm numerical computing environment. The software provides geologists with a streamlined tool to analyze and visualize stratigraphic setting and subsidence evolution of a sedimentary basin. For surface modeling, this program provides three local interpolation (linear, natural, and cubic spline) and two extrapolation (Kriging and thin-plate spline) methods. Quantitative subsidence analysis is performed using decompaction and backstripping techniques, respectively, for basement subsidence and tectonic subsidence. The main window acts as central hub to all functions and process stages; 1) Setup (Study Area, Stratigraphic Units, and Well Data Input, 2) Stratigraphic Setting (Stratigraphic Modeling), 3) Subsidence (Parameter Input, Subsidence Analysis, and Subsidence Modeling). To aid users in the analysis of specific regions, we provide cross-section and dip-slip fault backstripping tools. The graphical user interface guides users through the workflow and provides tools to analyze and export results. All 2D and 3D models created by using MATLAB plotting functions enables users to fine-tune the results using the full range of available plot options in MATLAB. This study demonstrates the all functions in a case study of Miocene sediments covering 30x40 km² of the central Vienna Basin. The case study models are compared to previous studies conducted in the central Vienna Basin, and match those of preceding works and in several cases provide even better model representations. Even though the use of interpolation techniques introduces some degree of uncertainty into surface models, the results are highly useful to understand overall geologic trends and characteristics of each geologic stage.

3D VISUALIZATION OF THE SEDIMENTARY INFILL AND POLYPHASE SUBSIDENCE EVOLUTION IN THE NORTHERN AND CENTRAL PARTS OF THE VIENNA BASIN (MIOCENE)

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Vienna Basin, sedimentary infill, subsidence, visualization, Miocene

This study calculates and visualizes well data acquired from the northern and central Vienna Basin for the sedimentary infill and subsidence evolution, using BasinVis 1.0. The thickness evolution of seven selected horizons are visualized using sediment distribution maps, isopach maps, and cross-sections. The subsidence analysis from wells reaching the pre-Neogene basement results in subsidence depth and rate maps of basement and tectonic subsidence of the study area. Due to the position, the Vienna Basin has a complex and polyphase evolution history from the piggy-back basin phase (Early Miocene) to the pull-apart basin phase (Middle – Late Miocene). The models visualized in this study provide detailed insights into the evolution of the Vienna Basin, which is closely related to changes in the regional stress regime and the paleoenvironmental setting. In the piggy-back basin phase, sedimentation and subsidence are minor, E-W to NE-SW trending parallel to the strike of the orogen, and restricted to small depressions in front of the Alpine thrust. In the late Early Miocene, the Vienna Basin changes to a pull-apart basin system characterized by wider sedimentation areas and fast subsidence along sinistral strike-slip faults and related listric normal faults. The depressions of the Early Miocene are filled mainly with sediments supplied through small deltaic systems entering from the Alps area. After minor sedimentation and slow subsidence during the early Middle Miocene, the development of the Vienna Basin is controlled and accelerated by NE-SW trending synsedimentary normal faults, especially the Steinberg fault, until the Late Miocene. The Vienna Basin from the late Middle to Late Miocene is characterized by E-W extensional rift-type and slowing down subsidence, which corresponds to the E-W trending extension of adjacent basins and the western parts of the Pannonian Basin system. During this time, enormous amount of sediments are supplied from the Alpine Molasse Basin area by a broad paleo-Danube delta complex.

SHORT-TERM CHANGES IN EOCENE PLANT BIODIVERSITY: THE LACUSTRINE ARCHIVE OF MESSEL (GERMANY)

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Plant biodiversity, palynology, eocene, greenhouse climate, maar lake

Several studies exist on the effects of the recent rise in CO₂ in the atmosphere and the resulting rise in global temperatures on plant communities and their diversity. Accordingly, migration and extinction of plant taxa is expected for the near future, but long-term effects of present global warming on plant biodiversity are still a matter of speculation. However, long-term greenhouse periods of the geological past may be the key for studying the reaction of plant communities to global warming on different timescales. In this respect, the deposits of the Eocene maar lake at Messel are of great importance because they provide a unique high-resolution archive for palaeoenvironment and palaeoclimate for a time interval of ~800 ka during the most recent greenhouse period on Earth.

In its lower part the lacustrine filling of the maar structure is composed of clastic sediments of the Lower Messel Formation (LMF) which were deposited during the holomictic stage of the lake. The intercalation of laminated bituminous claystones in the upper part of the LMF heralds the transition to meromictic conditions. The succeeding Middle Messel Formation (MMF) was characterized by permanent meromictic conditions which resulted in the deposition of the classic finely laminated fossiliferous oil shale.

For plant biodiversity analyses we used the quantitative palynological data from 621 samples representing the complete succession. The results clearly show changes in diversity in the paratropical rainforest. The highest diversity is found in the transitional stage represented by the upper part of the LMF because the catchment area was characterized by the combination of the re-establishing thermophilic forest, a diverse lake margin association and remaining elements of the pioneering vegetation. In the succeeding MMF a gradual decrease of species richness is obvious. Therefore, the lowest plant biodiversity can be noted at the top of the MMF. This may be due to a trend towards less humid conditions, probably in combination with a drop of the water level in the lake during the MMF. In conclusion, biodiversity changes within the vegetation were triggered by local ecological factors as well as by global climate change.

SEDIMENTS OF THE DECAYING TRANSGONDWANAN SUPERMOUNTAIN: PETROGRAPHY AND GEOCHEMISTRY OF PALAEOZOIC SANDSTONES IN NORTHERN ETHIOPIA

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Gondwana supermountain, glacial sediments, petrography, geochemistry

With the amalgamation of Gondwana in the Neoproterozoic, the East African Orogen, also called Transgondwanan Supermountain, was formed. Erosion products of this huge mountain range are mature sandstones that blanketed large parts of Gondwana during the Palaeozoic. Squire et al. (2006) proposed a superfan model of large sedimentary fans that formed during the Early Palaeozoic around the mountain range. The north-eastern edge of Gondwana – the area of the Arabian-Nubian Shield (ANS) – is, however, not well constrained in this model and the provenance of the Palaeozoic sediments there is largely unknown. Apart from the ANS as a probable source region, far-distance transport from central Gondwana (e.g. East Africa) needs to be considered. The question of local vs. far-distant origin and recycled vs. first-cycle sediments is especially interesting given the high maturity of the sandstones, untypical for postorogenic sediments, and the special weathering and transport conditions: the vegetation-free landscape in a mild climate at the beginning of the Palaeozoic, which was then interrupted by two major glaciations (Ordovician-Silurian and Carboniferous-Permian).

This study focuses on sediments of the two Gondwana-glaciations in Northern Ethiopia – a key region between potential far-distant sediment sources and the northern margin of Gondwana. Petrographic investigation shows increasing maturity from subarkose to quartz arenite in the course of the Ordovician-Silurian glaciation and from south to north, supporting the general assumption of a south-north directed transport. The sediments of the Late Palaeozoic glaciation are generally more feldspathic, spanning the whole field of subarkose composition without any obvious temporal or spatial trend. Bulk rock geochemical analysis provides a possibility to differentiate the sediments of both glaciations with a generally higher chemical maturity and higher depletion of mobile elements in the Early Palaeozoic sediments as compared to the Late Palaeozoic. Petrographic and bulk rock geochemical data from this study will be compared to literature data of Palaeozoic sandstones along the northern margin of Gondwana and statistically evaluated to identify similarities and spatial and temporal trends.

A NEW PALYNOFLORA FROM AUSTRIA: PRELIMINARY RESULTS OF POLLEN AND SPORES FROM THE CLAY PIT AT SCHAßBACH (OBERAIGEN), LAVANTTAL, CARINTHIA

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palynoflora, Langhian, Carinthia

The clay pit at Schaßbach (district Oberaigen) has been recently known for its leaf- and fish fossils. The sediments comprise silty clays and clayey silts, often with detrital micas covering sediment surfaces, and are intercalated with finely laminated clays (Papierschiefer containing the fish fossils). This sedimentary succession has been interpreted to be of Langhian age and probably belongs to the early Badenian Mühldorf Formation). The LM and SEM investigations revealed that the pollen and spores are mostly not very well preserved. They are strongly compressed, show abrasion and partly gelified pollen walls. The diversity of the palynoflora with up to now 65 taxa is not as diverse as other Miocene palynofloras. The pollen spectrum (so far three samples counted) is dominated by Pinaceae (*Pinus*, *Cathaya*, *Abies*, *Picea*, *Tsuga*) and *Taxodium* (which is also common in the macroflora), followed by angiosperm genera and families such as *Quercus* (?4 taxa), *Platanus* (2 taxa), 5 Juglandaceae taxa, *Lithocarpus*, *Fagus*, *Myrica*, *Ulmus*, *Cedrelospermum*, *Zelkova*, 3 Betulaceae, etc. Remarkable are some accessory elements such as *Liquidambar*, not yet identified Chloranthaceae, Curcubitaceae and Sapotaceae, *Ilex*, *Fraxinus*, *Ephedra* and 2 Ericaceae.

EXPERIMENTAL DEFORMATION OF NATURAL FOLIATED ROCK SALT

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experimental deformation, SPO, rock salt, EBSD

The mechanical behavior of rock salt has been extensively studied. These studies have shown that rock salt deforms by dislocation creep and pressure solution at dry and wet conditions, respectively. Deformation experiments led to the derivation of flow laws for these two deformation processes. However, structural anisotropies in the rock salt were not taken into account in most of these previous studies. Often natural rock salt shows a foliation due to a shape preferred orientation (SPO) of halite grains. Halite grain boundaries are, in many cases, associated with fluids and can therefore play an important role during deformation. Fluids enhance grain boundary migration recrystallization and are a prerequisite for pressure solution. The angle between the orientation of grain boundaries and applied stress can therefore influence the strength of rock salt. In this contribution we present results of deformation experiments of natural rock salt samples from the Asse mine, Germany. Samples with a foliation are deformed in different orientations, with the foliation parallel, perpendicular and at a 45° angle to the applied stress. In addition, for comparison, samples with no foliation are deformed as well. The experiments were conducted in a special deformation machine designed for coaxial deformation of cuboid samples. In this deformation machine the stresses in vertical and horizontal direction can be monitored. In the experiments, cuboids (6x6x3.5 cm) are deformed in plane strain (up to 35% strain) at a temperature of 345°C, atmospheric pressure and a strain rate of $\sim 10^{-7}$. The mechanical data will show how and if the mechanical behavior of rock salt is influenced by the angle between the foliation and applied stress. After the deformation experiments detailed microstructural studies (optical microscope and electron backscatter diffraction (EBSD)) will be used to determine the dominant deformation mechanisms, how the SPO evolves and if a crystallographic preferred orientation (CPO) develops during deformation.

THE INFLUENCE OF THE POST-VARISCAN NON-CONFORMITY ON POSTHIATAL LITHOFACIES ARCHITECTURE AND PETROPHYSICAL PROPERTIES OF BASEMENT AND SEDIMENTARY COVER, SPRENDLINGER HORST, GERMANY.

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post-Variscan non-conformity, outcrop analogue, Sprendlinger Horst, reservoir properties

The post-Variscan non-conformity represents the relict surface of a widespread developed hiatus in central Europe. As an outcrop analogue study, this research project aims to better understand spatial heterogeneity and relevance of this non-conformity in terms of reservoir properties. We focus on the region of the northern Upper Rhine Graben (URG) where the non-conformity crops out on the graben flanks and is overlain by a thin cover of Permian clastic sedimentary and/or volcanic rocks (Sprendlinger Horst). This succession is similar developed in the nearby northern URG at a depth of ca. 2000 m, where it acts as potential geothermal reservoir rocks. We analyzed two cored wells in the Rotliegendes of the Sprendlinger Horst around the world natural heritage "Grube Messel" which penetrate the post-Variscan non-conformity and reach depth of 68 resp. 80 m. Lithofacies types involve polymictic breccias, fanglomerates and conglomerates, lithic arkoses, feldspar rich litharenites and red mudstones and represent a proximal depositional setting.

Basement rocks are represented by granodiorite, tonalite, diorite and various dyke rocks which are overprinted by palaeo-weathering and/or alteration by burial fluid flow. In addition, petrophysical logs were carried out to test reservoir properties and comprised apparent and intrinsic permeability, effective porosity, spectral gamma ray, sonic wave velocity and magnetic susceptibility. By combining logs of lithofacies and petrophysics the sedimentary successions were correlated. The two wells were complemented by surrounding lithological well logs and used to set up a detailed 3-D model of lithofacies and their petrophysical attributes with the software *GOCAD* (Paradigm®).

LATERAL EXTRUSION IN THE EASTERN ALPS REVISITED: LEFT-LATERAL TRANSPRESSION STRUCTURES ALONG THE FORELAND BASIN OF THE EASTERN ALPS

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Alps, strike-slip faults, Molasse Basin, 3D seismic interpretation, regional geology

Lateral extrusion was defined 25 years ago as a result of collision and crustal thickening, northward indentation of the Southern Alps and lateral escape of detached wedges of the central Alpine lid towards the East. The thin-skinned thrust northern parts of the Eastern Alps were affected by the lateral extrusion of the Central Alps and were described as lateral orogenic float, a tectonic decoupling of thrust wedges and nappes between slightly deformed foreland structures and the hinterland orogenic core. E&P industrial 3D seismic surveys cover large areas of the Austrian part of the Molasse foreland basin and illuminate its complex structures. The basal foreland unconformity is defined as a result of orogenic collision and flexural crustal bending and the transgression of shallow marine Late Eocene sediments on late Cretaceous inversion structures. Advancing continental collision during Early Oligocene times caused deepening of the foreland basin and deposition of source rocks. These source rocks were redeposited by extensive submarine mass movements in the central part of the Early Oligocene basin towards the hydrocarbon kitchen below the thrust belt. The deeper marine foreland basin was filled by the Lower Puchkirchen Fm. (LPF) with its straight axial channel system. The LPF channel system continues below the Alpine thrust belt. The Upper Puchkirchen Fm. (UPF) is dominated by meandering axial channel systems. The Puchkirchen Fm. was involved in the foreland imbricates where imbricated channels form structural gas traps. A reorientation of the regional stress in Miocene times caused significant left-lateral movements, indicated by displaced Oligocene channel systems and slightly deformed foreland structures.

PALEOZOIC TECTONICS OF THE GREAT XING'AN RANG IN THE NE CHINA, EASTERN CAO B

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Orogeny, Paleozoic tectonic, NE China, CAO B

The Central Asian Orogenic Belt (CAOB) is the largest accretionary orogen in the world, which is responsible for considerable Phanerozoic juvenile crustal growth. The NE China and its adjacent areas compose the eastern segment of the CAO B, which is a key area for providing important evidence of the CAO B evolution and understanding the NE Asian tectonics. The Great Xing'an Rang is composed tectonically of the Erguna block (EB) and Xing'an block (XB) separated by the Xinlin-Xiguitu suture (XXS) in between.

The EB was traditionally considered to be composed of the Proterozoic to Paleozoic volcano-sedimentary strata and granites with a Precambrian metamorphic basement mainly outcropped in the northwestern part of the EB. The XB consists mainly of the Paleozoic granitoids and sedimentary strata covered by voluminous Mesozoic volcanic rocks and granitoids.

According to the detail petrologic, tectonic and geochronologic studies, the Paleozoic tectonic evolution has been revealed as follows:

(1) ~650-500 Ma, the oceanic crust between the EB and XB possibly started to subduct in an intra-oceanic environmental setting, as represented by the oceanic island accretions, e.g. ca. 647~540 Ma E-MORB-like Xinlin-Jifeng ophiolite (Feng et al., 2015) and ca. ~511-516 Ma OIB-like Toudaoqiao blueschist (Zhou et al., 2015).

(2) In the period of ca. 500-480 Ma, the subduction and subsequent collision between the EB and XB took place along the XXS, accompanied by the emplacement of the Xinlin-Jifeng ophiolites and formation of the Toudaoqiao blueschists. And hereafter formed the Tahe A-type granites with ages of ~480 Ma (Ge et al., 2005) at a post-collisional setting

POLYPHASE DEFORMATION IN HIGH-GRADE VARISCAN DOMAINS OF THE SE-BOHEMIAN MASSIF: IMPLICATION FOR TECTONIC EVOLUTION OF A DEEPLY ERODED COLLISIONAL BELT

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Bohemian Massif, Polyphase Deformation, Structural Evolution

A detailed structural and petrographical investigation was performed in the Moldanubian zone in the southeastern Bohemian Massif (Lower Austria). From tectonic hangingwall to footwall the nappe stack of high-grade rocks in the study area consists of granulites and gneisses (Blumau Granulite Complex) underlain by the Raabs Serie and the Drosendorf Unit. The Drosendorf Unit is a continental terrane including metasedimentary units, the Raabs Serie contains rocks with oceanic affinity and the protoliths of the Blumau Granulite Complex are calc-alkaline magmatites, likely derived from island arcs. All units display different pressure – temperature – deformation paths. In order to constrain the tectonic and metamorphic history we elaborated data on successive deformation events linked with data on prevailing deformation mechanisms and lattice preferred orientation pattern (LPO) of quartz.

UHT and/or UHP conditions in the Granulite Complex are relictically preserved but not recorded in the structural evolution. High temperature, W-E coaxial flow at ca. 800°C in granulites is derived from disc-shaped quartz, quartz C-axes distributions with extreme opening angles and dominantly prism C glide. The high-grade fabric is refolded along W-E trending fold axes that are disconform to the underlying units. The present tectonic boundaries of the Granulite Nappe are discrete mylonite zones which developed at amphibolite grade conditions. The deformation in the Raabs Serie is characterized by general top-to-the NE transport coeval to migmatization, overprinted by localized N-S shear. Internal portions of the Drosendorf Unit exhibit top-to-the NE flow at higher amphibolite facies conditions but lower grade deformation along the tectonic boundaries. Our data suggest that the different tectonic units took their current position comparably late in the Variscan history during flow along localized mylonite zones. The precursor histories display different peak metamorphic conditions that were achieved in different geodynamic settings.

EVOLUTION OF THE PALAEO-TETHYS IN THE EASTERN MEDITERRANEAN: A MULTI-METHOD PROVENANCE STUDY OF LATE PALAEOZOIC SEDIMENTS FROM THE KARABURUN PENINSULA AND THE KONYA COMPLEX (TURKEY)

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Petrography, Geochemistry, Sediment provenance, Palaeotethys, Turkey

Remnants of oceanic basins record the existence of two major oceanic realms, the Palaeozoic to Early Mesozoic Palaeotethys and (mainly) Mesozoic Neotethys. Various tectonic models for the evolution of Palaeotethys in the Eastern Mediterranean region have been published during the last decades proposing either northward subduction under Laurussia, southward subduction beneath Gondwana, or a combination of both. The Late Palaeozoic successions of Chios and Karaburun (western Turkey) and the comparable Konya Complex (central Turkey) are regarded as key areas for understanding the closure history of the Palaeotethys but sufficient provenance data are not available yet. Our main objective is to provide an extensive dataset for the siliciclastic sedimentary rocks to shed light on the origin and palaeolocation of these units and to identify changes of provenance through time. First results from detrital zircon geochronology from the Karaburun Peninsula indicate sediment supply from units located along the southern margin of Laurussia during Late Palaeozoic time. Additional methods include thin section petrography and whole-rock geochemical analysis that were already performed and conventional heavy mineral analysis and mineral chemistry are currently in progress. Common heavy minerals in sediments from the Karaburun Peninsula are apatite, tourmaline, rutile, titanite and zircon. Epidote and garnet occur on occasion. Chrome spinel is rare but present in small amounts indicating input from (ultra)mafic sources in the Karaburun sediments. Upcoming results from single grain analysis of rutile, garnet and chrome spinel are expected to reveal more information on the nature of possible source rocks.

PROVENANCE OF PALAEO-TETHYS-RELATED SEDIMENTS FROM THE KARABURUN PENINSULA, WESTERN TURKEY: INSIGHTS FROM DETRITAL ZIRCON GEOCHRONOLOGY

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Detrital zircon, Sediment provenance, Palaeotethys, Karaburun Peninsula, Turkey

The Late Palaeozoic to Early Mesozoic evolution of the Palaeotethyan realm in the Eastern Mediterranean region is a highly discussed topic. In this regard, the Karaburun Peninsula in western Turkey and the closely related Greek islands of Chios and Inousses are considered as key areas as they exhibit virtually unmetamorphosed Palaeozoic and Mesozoic sedimentary rocks. However, the lack of provenance data from this region (except Chios) hampered a well-founded discussion of various proposed geotectonic models. To close this gap, new data of detrital zircon U–Pb ages from Late Palaeozoic to Early Mesozoic sediments of the Karaburun Peninsula were used to determine maximum depositional ages and identify possible source areas. The studied siliciclastic sediments record detrital ages from Triassic to Archean with major input from Palaeozoic to Neoproterozoic sources. Maximum depositional ages of two formations (Küçükbağçe and Dikendağı) from the Karaburun mélangé were revised to Early Permian. Zircon age populations of Triassic sandstones are dominated by Neoproterozoic and Palaeozoic zircons with mainly Devonian and Carboniferous grains in the Gerence Formation but also Permian and Triassic ages in the Güvercinlik Formation. The age spectra and compiled data from potential source areas suggest that the detritus for the Karaburun siliciclastic rocks was mainly derived from units located along the southern margin of Laurussia during Late Palaeozoic to Early Mesozoic times.

OCEAN-CONTINENT TRANSITION AT THE MAGMA-POOR SOUTHERN NANSEN BASIN

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Nansen Basin, Arctic Ocean, Gakkel Ridge, continent-ocean transition

We study the oldest crust of the Nansen Basin formed at the slow spreading Gakkel Ridge in the Arctic Ocean and its transition to the continental northern Barents Sea margin. Our data cover the transition from the continental northern Barents Sea margin across a narrow continental margin into the oceanic Nansen Basin. The seafloor drops down more than 2 km over a distance of about 10 km and is accompanied by two large normal faults, clearly imaged in seismic data. We interpret this as the expression of a transform margin.

Farther to the north, normal faults separate individual rotated blocks. Towards Gakkel Ridge the normal faults bend and form listric normal faults which root in an undulating reflector at a depth of 0.3-1.3 s (TWT) below top basement.

The crust in the southern Nansen Basin does not resemble the style of typical oceanic crust and the continent ocean boundary might be situated several 10s of kilometers north of the transform margin as defined by deeply-reaching normal faults.

Magnetic anomalies are well developed in the Nansen Basin and interpreted by various authors to at least chron C24. An analysis of these anomalies show, that spreading velocities at the Gakkel Ridge changed over time from slow to ultra-slow spreading at present. Seismic profile BGR13-202 images ~170 km of the Nansen Basin and reaches magnetic anomaly C22 at its distal part, thus covering a time span of about 5 Myr. In this contribution, we discuss the nature of the crust and the transition from continental rifting to slow seafloor spreading. Potentially, the continent-ocean transition is formed by blocks of extended continental crust.

HIGH-RESOLUTION 3D STRUCTURAL MODELLING OF A TECTONICALLY COMPLEX SETTING DISCLOSES THE DETAILS OF THE LITHOLOGICAL CONTROLS ON THE SHAPE OF THE EIGER NORTH FACE (JUNGFRAU AREA, SWITZERLAND)

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3D Modelling, Geomorphology, Structural geology

In recent years, 3D geologic modelling yielded in an improved understanding of the architecture of complex litho-tectonic units. However most of this research has been conducted in structurally and tectonically fairly simple settings, and therefore numerous numerical software packages still fail to reproduce the 3D architecture with acceptable uncertainties of more complicated settings such as strongly deformed rock bodies.

Here, we present an example from the Eiger-Jungfrau region situated in the Central Swiss Alps, where the goal was to reconstruct a high-resolution (bins < 10 x 10 x 10 m) digital 3D model of the individual lithological units and related rock density and fault patterns. To this extent, geological maps were combined with new field observations along with structural data including the orientation of faults and lineaments. In addition, differences in rock mass strengths were estimated using Schmidt Hammer rebound values and patterns of He-pycnometry (rock density) together with powder diffractometry and XRF analysis (mineralogical composition of bedrock). The analyzed units include the Hercynian crystalline basement of the Aar massif and the Mesozoic cover rocks that form an imbricated stack (Haenni & Pfiffner, 2001).

There are two major outcomes of this analysis. First, results show that overall uncertainties of the 3D model strongly depend on the quality of the available geological data. Accordingly, careful modelling paired with detailed field observations yielded in the reduction of the uncertainties on the numerical model, even in geologically and structurally complex areas. Second, the high-resolution 3D structural model paired with petrological data forms the basis to disclose the details of the lithological controls on the topographic shape of the modelled mountains.

References:

Hänni, R., & Pfiffner, O. A. (2001). Evolution and internal structure of the Helvetic nappes in the Bernese Oberland. *Eclogae Geologicae Helvetiae*, 94(2), 161–171.

UP- AND DOWN-SCALING FIELD AND SEISMIC OBSERVATIONS FROM RIFTED MARGINS

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fossil rifted margins, Alpine Tethys, Alps, seismic sections

Recent advances in the understanding of rifted margins resulted from the development of new, high-resolution seismic imaging methods, drilling at deep water rifted margins, and numerical modelling that enables to explore the physical conditions controlling the evolution of rifted margins. However, the parameters and boundary conditions used in models and seismic imaging are often not ground truth with direct observations. In the study of deep-water rifted margins, the problem is that drill hole data is expensive, rare and only available from a handful of examples worldwide. In contrast, remnants of former deep-water rifted margins have been described from the Alps or the Pyrenees, where kilometre-scale outcrops preserving primary structures of the former distal rifted margins are well exposed. Access to these large-scale outcrops provides direct observations of mantle and crustal rocks and the associated sedimentary sequences and magmatic additions formed in former distal rifted margins. The combination of mapping and detailed geochemical, thermo-chronological, structural and petrological studies enables the documentation of the relative timing of rifting and magmatic events as well as the definition of the nature of the rocks forming the crust and subcontinental mantle. The combination of mapping world-class outcrops with seismic observations of present-day rifted margins enables to up and down-scale observations and testing and calibration of rift models.

In our presentation we will review observations and data from remnants of hyper-extended domains preserved in the Alps. We will mainly focus on the description of the deformation and magmatic processes and their relation to sedimentary sequences during final rifting. Key questions are related to the strain and magmatic distribution and the bulk rheology evolution during hyperextension in the crust and sub-continental mantle. These field observations will be compared with seismic data. Up-and down scaling observations/data and bridging multiple spatial and temporal scales is a prerequisite to develop geologically meaningful models with a coherent description of the rheological, magmatic, stratigraphic and thermal evolution of deep water rifted margins.

PROPOSAL FOR A NEW SUBDIVISION OF THE NAPPE SYSTEMS OF THE NORTHERN CALCAREOUS ALPS (EASTERN ALPS, AUSTRIA).

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Eastern Alps, Northern Calcareous Alps, Nappe Systems, Geodynamic

The Northern Calcareous Alps (NCA) consist of a complex nappe stack of late Palaeozoic to Paleogene sedimentary rocks. The nappes are grouped into the Bajuvaric, Tirolic and Juvavic Nappe Systems (NS), following a proposal of the Bavarian Geologist F. Hahn (1913). The terms are still in use, although their delimitation is in discussion in some areas.

Tollmann (latest in 1985, *Geology of Austria*, volume 2) tried to trace distinct tectonic units across the NCA as a whole, following the "cylindrical" thinking of that time. Moreover, in subdividing the Juvavic NS he emphasized facial arguments in a sometimes misleading way. Therefore, his tectonic maps for the middle and eastern NCA show in some parts the presumed paleogeographic origin of, rather than the tectonic relations within, the Juvavic NS and between the Juvavic and Tirolic NS. Concerning the western NCA recent mapping has led to new discussions about the northern boundary of the Inntal nappe, including also a discussion about one of the boundaries between the Tirolic and Bajuvaric NS.

In the meantime, several authors have shown that syn- and post-tectonic sediments (especially clastics) of Jurassic and Cretaceous age can be used for tracing the deformation history as well as for characterizing tectonic units on several hierarchic levels.

Currently the Geological Survey of Austria is preparing a digital database of Geological maps (scale 1:200.000). It is used to adapt the hitherto used tectonic maps of the NCA to the recent knowledge. Several methodological approaches are combined to define clear criteria for the delimitation of tectonic units within the NCA. Special focus is on the question, if modern definitions for the traditional terms Bajuvaricum, Tirolicum and Juvavicum can be found. This will be crucial for the further use of these terms as geodynamically meaningful subunits of the Austroalpine Unit within the recent model of the Alpine orogeny.

The current state of this project will be presented as sketch maps and graphics and may be discussed at the poster session.

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The current state of this project will be presented as sketch maps and graphics and may be discussed at the poster session.

U-PB ZIRCON AGES OF THE AUSTROALPINE SECKAU NAPPE BASEMENT (EASTERN ALPS): HINTS FOR PRE-ALPINE MAGMATISM

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Seckau Nappe, Rannach Formation, LA-MC-ICPMS, U-Pb zircon ages

The Seckau Nappe in the Eastern Alps forms part of the Silvretta-Seckau Nappe System and represents the lowermost unit of the Upper Austroalpine Nappe Complex. It is built up of a pre-Alpine crystalline basement dominated by paragneisses (partly anatexitic) and amphibolites in which intrusive rocks, mainly granites and granodiorites as well as pegmatites, intruded. The so-called Rannach Formation, consisting of Permian to Mesozoic metasediments, forms the sedimentary cover of this pre-Alpine basement.

In order to clarify the timing of magmatic emplacement of the granitoids within the Seckau Nappe, as well as its tectono-metamorphic history we present LA-MC-ICPMS U-Pb zircon ages. Detrital zircons from paragneisses yield Precambrian ages between 570 ± 8 Ma and 563 ± 7 Ma and occasionally contain large amounts of older inherited cores with ages around 2 Ga. This part of the crystalline basement is likely related to the Cadomian orogeny and was later affected by two intrusive events: (1) intrusion of granitoids in the period between 506 ± 7 Ma and 494 ± 4 Ma and (2) early Variscan magmatism between 374 ± 4 Ma and 359 ± 8 Ma. During the subsequent Variscan amphibolite-facies metamorphism most of these intrusive rocks were transformed into two-mica gneisses.

Detrital zircon analyses of eight meta-sedimentary rocks from the Rannach Formation show altogether six concordant age populations. The oldest zircons show individual ages in the range from 2.6 Ga to 2.0 Ga. Further zircon ages cluster between 561 ± 9 Ma and 545 ± 11 Ma, 513 ± 5 Ma and 504 ± 16 Ma, and 482 ± 13 Ma and 461 ± 5 Ma. Variscan ages fall in the interval between 382 ± 11 Ma and 344 ± 8 Ma and the youngest zircon population represents ages in the range from 308 ± 7 Ma to 290 ± 10 Ma.

U-Pb zircon ages of the meta-granitoids of the Silvretta-Seckau Nappe indicate massive pre-collisional magmatism in the early and middle Palaeozoic. Detrital zircon ages from the Rannach Formation suggest that the sedimentary provenance is not only restricted to the Silvretta-Seckau Nappe System.

A LATE CRETACEOUS MAGMATIC ARC IN THE SOUTHERN AEGEAN (CRETE AND CYCLADES): CONSTRAINTS ON THE TECTONOMETAMORPHIC AND MAGMATIC EVOLUTION OF THE INTERNAL HELLENIDES

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Hellenides, Uppermost Unit, Geodynamic model, U-Pb dating, Structural geology

Records of Alpine orogenic imprints in the Internal Hellenides can be studied in the Uppermost Unit of Crete and on several Cycladic islands. The rocks exposed in these areas are attributed to the Pelagonian domain of central Greece.

We present new structural, petrographic and geochronological data obtained from greenschist and amphibolite-facies (Asterousia-type) rocks exposed on Crete (Melambes area and southern Dikti Mountains), Anafi and Donousa. On Anafi and Crete, greenschist-facies rocks were found at the base of the Asterousia-type sequence. New structural data combined with published K-Ar ages indicate Late Cretaceous and Palaeocene top-to-the SE shearing of amphibolite- and greenschist-facies rocks, respectively. In some exposures of the Asterousia-type rocks a secondary ill-defined NE–SW-trending mineral/stretching lineation can be observed.

U-Pb (LA-ICP-MS and ID-TIMS) dating of zircon from Asterousia-type (meta)granite yielded 76.3 ± 0.6 Ma (Melambes), while zircon from diorite intrusions near Melambes and granodiorite intrusions on Anafi yields ages at 72.2 to 74.8 Ma. The latter ages are consistent with an emplacement age of 74.5 ± 0.25 Ma for diorite from Pachia Ammos (eastern Crete, Kneuker et al. 2015). Granite underwent viscous deformation under amphibolite-facies conditions resulting in orthogneiss, while diorite and granodiorite are free from foliation. This indicates synmetamorphic intrusion of granitic magma, but late-metamorphic intrusion of dioritic magma. Mineral assemblages of diorite and granodiorite (plagioclase, quartz, apatite, titanite) are typical for I-type granitoids. Koutsovitis et al. (2012) interpreted the Anafi granodiorite as volcanic-arc granitoids based on REE patterns.

The new data combined with published results suggest the following orogenic processes in a magmatic arc setting: (1) obduction and accretion of mantle slices (serpentinite) to the Asterousia-type rocks; (2) Campanian intrusion of granitoids within a magmatic arc that underwent high-temperature/low-pressure metamorphism; (3) Maastrichtian intrusion of dykes; (4) Palaeocene ductile top-to-the SE shearing of amphibolite-facies on top of greenschist-facies rocks; (5) post-Eocene brittle thrusting of the crystalline rocks on top of the Pindos Unit; (6) clockwise rotation of the Aegean block and change in the stress field to NE–SW compression during the Oligocene to early Miocene.

Kneuker et al. 2015, *Int. J. Earth Sci.*, 104, 351–367.

Koutsovitis et al. 2012, EGU General Assembly Conference Abstracts, 13303.

SUCCESSFUL GEOTHERMAL EXPLORATION USING GEOMECHANIC PARAMETER ANALYSIS OF WELLBORE AND SEISMIC DATA

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reservoir modeling, geothermal exploration, geomechanic parameter analysis

Successful geothermal drilling target detection using reservoir modeling is based on the quality and availability of input data. The extraction and application of geomechanic data maximize geological information to optimize well path planning and to detect preferred drilling targets in fault areas and permeable reservoir zones. Pore content, porosity and permeability are in correlation to geomechanical information from seismic velocities as v_p and v_s . This paper shows a method for detection of increased permeable zones based on the extraction of geomechanical information from sonic wellbore and seismic cube data that can help to mitigate project risks.

Optimized well path planning is a major challenge in geothermal greenfield reservoir modeling due to limited data input for drilling target detection. Fault structures and promising facies areas indicated by seismic attribute anomalies are affiliated to high uncertainties due to uncertain porosity and permeability distribution. Seismic attribute anomalies do not indicate real size and their water content regarding to porosity. Increased porosity areas cannot be clearly identified by acoustic impedance variations. Therefore, successful drilling target detection for geothermal industry needs an additional indication that could be represented by geomechanic parameter analysis. First investigation results regarding to geomechanic parameter and wellbore logging data show a strong correlation between shear modulus (G) and porosity in a sandstone formation of a case study in the Northern Carnarvon Basin. This correlation is independent from depth and from facies classification. Regarding to this correlation increased porosity areas are indicated by variations of the seismic velocity ratio v_p/v_s (compressional and shear wave velocity). To keep exploration costs manageable a transformation of wellbore logging data to 3D seismic data represents an option to generate v_p/v_s variations inside 3D seismic data sets. Therefore, geomechanic parameter analysis can enhance identification of increased permeable areas in sandstone formations. Additionally, due to the strong correlation between porosity and shear modulus this method reflects its great potential for carbonate formations, too.

Focussing on this correlation a scientific research project investigates this method for drilling success forecast in geothermal reservoir modeling for the geothermal project Bruck in the Bavarian Molasse Basin in Germany.

EXTRACTION OF ERODED AREAS ON MOUNTAIN GRASSLAND FROM ORTHOPHOTOS AT DIFFERENT SCALES

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geomorphology, remote sensing, scale, UAV, close range photogrammetry

In the montane to alpine elevation zone of the Alps steep grassland is frequently affected by shallow erosion. Often small landslides or snow movements displace the vegetation together with soil and unconsolidated material. This results in bare earth surface patches within the grass covered slope. The resulting loss of soil can have negative impacts on mountain agriculture and promote natural hazards. Monitoring such eroded areas is essential for a better geomorphological process understanding, to assess past and recent evolution, and to plan mitigation measures. Recent advances in close-range and remote sensing as well as in automated information extraction from remotely sensed data improve monitoring tasks. Different sensors and platforms result in data products of different scale (accuracy and level of detail) and extent. Single erosional forms can be surveyed and mapped with a high level of detail using data from terrestrial close-range photogrammetry (ground sample distance in the order of centimetres). On the hillslope scale orthophotos acquired from a remotely piloted aircraft system (RPAS) can be used. Aerial orthophotos (from a manned aircraft) are suitable for monitoring with a larger spatial extent. We test the applicability of an automated information extraction approach for the delineation of eroded areas on grassland to orthophotos of three different scales. Terrestrial, RPAS and aerial orthophotos of a test site were acquired nearly simultaneously. An object-based image analysis workflow is used to classify the orthophoto scenes into uneroded grassland and eroded areas. A comparison of the classified data shows the effect of input data scale on the accuracy and level of detail of the delineated eroded areas. This analysis assesses the accuracy of a catchment scale to regional scale mapping of eroded areas based on the coarser resolution aerial orthophotos. This work contributes towards a better understanding of data integration from different sensors operating at different scales into a time series for spatio-temporal analysis of shallow erosion dynamics.

SCALING AND FABRICS OF OPENING MODE FRACTURES (GERM: 'RUPTUREN' AFTER BRUNO SANDER)

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Mode I fractures, Distinct Element Method

'Rupturen', such as joints, veins and dykes, typically exhibit a power-law aperture-length scaling with a power-law exponent of about 0.5. The fracture aperture is hence proportional to the square root of fracture length, a relation which is in fact predicted by linear elastic fracture mechanics (LEFM) for an isolated Mode I fracture subjected to remote tension. The existence of such a 'universal scaling law' is however a highly debated topic. High quality outcrop data illustrate that fracture aperture-length scaling may be 'non-universal' and indicate that below a certain length-scale scaling is super-linear (power-law exponent > 1). We use a numerical model comprised of a hexagonal lattice of breakable elastic beams to investigate the aperture-length scaling that emerges in thin plates subjected to remote tension. The fracture fabric varies significantly depending on the strength heterogeneity, which is introduced in the regular lattice by randomly assigning beam strengths from a Weibull probability distribution. High homogeneity leads to few long fractures, whereas in highly heterogeneous material a great number of shorter fractures is formed. The model fracture system evolution is characterised by two stages which are separated by the finite strain at which peak-stress occurs. During the pre-peak stress stage fracture aperture-length scaling is universal with a power-law exponent of about 0.5 as expected from LEFM. Shortly after the material has attained its maximum load bearing capacity, aperture-length scaling becomes non-universal, so that the average aperture-length relation plotted on a log-log graph exhibits a distinct kink. Fractures with a length less than this critical length scale exhibit super-linear aperture-length scaling, whereas fractures with a greater length exhibit sub-linear scaling. The models illustrate that the emergence of non-universal aperture-length scaling is a result of fracture clustering, which occurs after peak-stress in the form of a localised fracture zone. Given that fracture clustering is a common phenomenon in natural fracture systems, we argue that a universal scaling law may be the exception rather than the rule.

DENSITY VARIATIONS IN THE UPPER MANTLE: IMPACT OF S-WAVE DERIVED DENSITY AND TEMPERATURE DISTRIBUTIONS ON THE GRAVITY AND THERMAL FIELD

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upper mantle, density, gravity, tomography, basin modelling

Models of sedimentary basins mostly regard the lithospheric mantle as a homogeneously dense body. Tomographic and seismological studies, in contrast, indicate lateral heterogeneities in the mantle. Several studies addressed these heterogeneities by inverting seismic wave velocity from tomographic models to temperature and density. Whilst these studies have shown that sensitivity of seismic velocity to variations in temperature is larger than to variations in density (e.g. Sobolev et al., 1996), the differentiation of thermal from compositional anomalies remains difficult. We aim to solve this problem by quantifying the impact of varying mantle compositions on inverted density distributions and the calculated gravity field of the mantle above 300km depth. Therefore, we use forward calculation of s- and p-wave velocities to invert tomographic models for temperature and density, considering laboratory mineral properties and different mantle compositions (Goes et al., 2000). Thereby, we consider tomographic models on global and regional scale.

Our results indicate a significant impact on the inferred gravity field and thus on interpretations of lithospheric-scale models. Furthermore, we find that the integration of inverted density distributions may decrease uncertainties in the interpretation of gravity-constrained basin models. Additionally, for models with well constrained upper lithospheric structure, i.e. from reflection and refraction seismics, the integration of inverted density distributions in the upper mantle may help to identify compositional or thermal anomalies in the mantle.

Goes, S., R. Govers, and P. Vacher. 'Shallow Mantle Temperatures under Europe from P and S Wave Tomography'. *Journal of Geophysical Research* 105, no. 11 (2000): 153–11.

Sobolev, Stephan V., Hermann Zeyen, Gerald Stoll, Friederike Werling, Rainer Altherr, and Karl Fuchs. 'Upper Mantle Temperatures from Teleseismic Tomography of French Massif Central Including Effects of Composition, Mineral Reactions, Anharmonicity, Anelasticity and Partial Melt'. *Earth and Planetary Science Letters* 139, no. 1–2 (March 1996): 147–63. doi:10.1016/0012-821X(95)00238-8.

MACRO- AND MICRO-STRUCTURAL ANALYSIS OF PLEISTOCENE SEDIMENTS FROM THE JASMUND GLACIGENIC THRUST- AND FOLD-COMPLEX (STREIFEN 4, RÜGEN, GERMANY)

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Rügen, Jasmund, microstructural mapping, glaciectonic complex, polyphase deformation

The island Rügen is located in the south-western part of the Baltic Sea and was situated at the southern marginal zone of the Scandinavian Ice Sheet during the late Weichselian glaciation. Its north-eastern peninsular Jasmund is well known for the famous chalk-steep coastline. The studied deposits form part of a major thrust and fold complex that was developed as a result of glaciectonism associated with the highly dynamic Baltic Ice Stream. The Streifen 4 syncline of SE-Jasmund is one focus area of our microstructural studies in understanding the complicated environment of the glaciectonic complex Jasmund.

The Scandinavian Ice Sheet reworked pre-existing outcrops of Cretaceous chalk und Pleistocene deposits during the late Weichselian Pleniglacial.

This study in particular combines the macroscopic analysis of the syncline structure and the microscopic characteristics of the encountered till deposits. Macroscopic cliff mapping and structural data interpretation reveal two different (successive) stress situations:

1. a NE derived compression of the sediments, resulting in a SW-dipping syncline,
2. a SW directed ice-advance, dragging sediments towards SE.

To extract different stages of deformation, we made use of the microstructural mapping method proposed by Phillips et al. (2011). This method considers the long axes of clasts within the tills and the classification into certain micro-fabric domains.

Two older microfabric domains (S1, S2) seem to be the result of the till-deposition process and are therefore indicators of the ice-advance direction. A younger (S3) microfabric within the tills is corresponding with the SW-dipping syncline macrostructure - the youngest stage of glaciectonic deformation.

The outcome of this study is a 3D-model of different stress stages within separate tills showing their response to deposition, ice-advance and folding. Therefore the study adds a piece to the detailed history in the origin of the glaciectonically-formed peninsula Jasmund.

Furthermore, it shows the successful application of the microstructural-mapping method of Phillips et al. (2011) even in tectonically reworked till.

References:

Phillips, E.R., Van Der Meer, J.J.M., Ferguson, A. (2011): A new 'microstructural mapping' methodology for the identification and analysis of microfibrils within glacial sediments. – *Quaternary Science Reviews*. 30: 2570-2596.

APPLICATION OF SCANNING LASER-INDUCED BREAKDOWN SPECTROSCOPY IN DRILLING CORE ANALYSIS

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Drilling Core, analysis, LIBS, Mineralogy, Geochemistry, light elements

Scanning Laser-Induced Breakdown Spectroscopy (LIBS) is an upcoming technology that is relatively unknown in geosciences. It has potential for rapid non-destructive and in-situ multi-element geochemical mapping, which could in particular be useful for relatively large and unpolished samples, e.g. drilling cores. It is a type of atomic emission spectroscopy that uses a laser-generated plasma to ablate, atomize, and excite material from a sample surface. Plasma variations due to physical and chemical matrix effects, however, influence the LIBS signal, which means that raw LIBS data are to be considered primarily qualitatively. In order to achieve reliable (semi-)quantitative results, appropriate classification and calibration strategies have to be developed.

LIBS can be used to rapidly map a large number of chemical elements. In contrast to XRF, LIBS can also be used to measure light element such as Li. Furthermore, optically non-obvious but chemically significant patterns, such as element ratios (e.g. Fe/Mg) in individual mineral grains, can be recognized that can be used to reconstruct crystallization histories. Characteristic examples of LIBS applications in drilling core analysis will be presented.

DID THE GONDWANA SUPER-FAN SYSTEM REACH SAUDI ARABIA?

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Palaeozoic, Provenance, Zircon, U-Pb geochronology, Gondwana

Cambrian–Ordovician quartz-rich sandstones extend over large parts of northern Gondwana covering millions of square kilometres from Morocco in the west to Saudi Arabia in the east. Squire et al. (2006, *EPSL*, 250, 116-133) reviewed these siliciclastic sediments together with those from other palaeocontinents of former Gondwana and proposed a super-fan model. Although this model provides a good working hypothesis, it still has to be tested in many regions with respect to regional dispersal systems and their temporal evolution. This was recently done exemplarily for North Africa (Meinhold et al., 2013, *Gond. Res.*, 23, 661-665). A special feature of the Cambrian–Ordovician cover sequence of North Africa is the eastward increase of ca. 1 Ga detrital zircons, which become ubiquitous in the Ordovician sandstone cover of the Saharan Metacraton. Detrital zircons aged about 0.75–0.53 Ga, 2.15–1.75 and 2.7–2.5 are also present. Zircon grains of ca. 1 Ga and older grains were likely derived from the basement and country rocks of the Transgondwanan supermountain and transported toward the Gondwana margin by fluvial dispersal in a Gondwana super-fan system. Although sediment transport by rivers was dominant over most of the time, periods of ice-related processes (e.g., glaciers) may have accelerated erosion and transport during the Late Ordovician when large parts of Gondwana were covered by ice. In the present work, Cambrian–Ordovician sandstones of Saudi Arabia are studied in detail for their detrital zircon age populations. Sandstone samples were taken from outcrops along the northern and the southern margin of the Arabian Shield. About 950 detrital zircons were analysed by U–Pb geochronology using LA-ICP-MS. Most of the studied zircons are rounded. Well-developed magmatic zoning is visible in CL images. About 800 zircons gave concordant ages. Ediacaran–Cryogenian ages are most prominent. Some samples also contain Tonian–Stenian zircon grains, accompanied by Orosirian–Rhyacian and Neoproterozoic ages. The occurrence of ca. 800 Ma seems to be specific for some early Palaeozoic formations of Saudi Arabia. Overall, the detrital zircon ages suggest that the Gondwana super-fan system did reach parts of Saudi Arabia.

CHANGES OF SEDIMENT COMPOSITION AT THE DAWN OF ANIMAL LIFE: INSIGHTS FROM THE EDIACARAN-CAMBRIAN BOUNDARY SECTION OF THE DIGERMULEN PENINSULA (FINNMARK, ARCTIC NORWAY)

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Ediacaran, Cambrian, Siliciclastics, Ediacara-type fossils, Provenance

The Digermulen Peninsula in northern Norway is the only fossiliferous site in Scandinavia with sedimentation across the Ediacaran–Cambrian transition without a significant hiatus. Furthermore, it is the only locality in Scandinavia where Ediacara-type fossils have been found. The site is located at the edge of Baltica during the Ediacaran–Cambrian transition, where potentially the dramatic climatic turnover from icehouse to greenhouse conditions can be deduced and tied to large-scale plate tectonics. Since 2011, studies by the Digermulen Early Life Research Group have recorded significant new finds, promising to establish the site as a significant Ediacaran biota locality. The Ediacaran succession is about 1000 m thick. Ediacara-type fossils occur in the Innerelva Member of the Stáhpogiedde Formation. Discoidal fossils dominate the Ediacaran assemblage, although a potentially much greater diversity is suggested because of the recent discovery of a frond-shaped fossil. The Ediacaran–Cambrian boundary is located within the Manndraperelva Member of the Stáhpogiedde Formation, based on biostratigraphic age control, followed by the Lower Cambrian Breidvika Formation. The succession consists mainly of quartz-rich sandstones and mudrocks. Deposition took place in various environments, including fluvial, shallow marine and deeper marine settings. As shown by previous studies using palaeocurrent data, sediment supply was from the Baltic Shield toward the passive margin of Baltica in pre-Ediacaran time. At one point within the Ediacaran succession, it shifted by 180 degrees due to the newly formed Timanian orogen. This orogen formed in north-eastern Baltica during the late Neoproterozoic and caused a shift in sediment transport direction and change in source area due to the formation of the Timanian foreland basin to the east of Digermulen Peninsula. In order to track sediment supply and to test current palaeotectonic models a multi-disciplinary approach on late Neoproterozoic and Cambrian sediments of the Digermulen Peninsula has been applied. The methods include, amongst other things, thin section petrography, bulk rock geochemistry (XRF, ICP-MS, ICP-OES), bulk rock mineralogy (XRD), heavy mineral analysis, single grain chemistry (EMP, LA-ICP-MS) and zircon U-Pb geochronology.

TANTALUM MINERALIZATION IN TIME AND SPACE

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tantalum, pegmatite, granite, trace elements

Columbite-group minerals recovered from rare-metal granites and granitic rare-element pegmatites account for the majority of the production of tantalum. Each period of Ta-ore formation in Earth history is characterised by peculiar mineralogical and geochemical features. Some of the largest rare-element pegmatite bodies are located within Archean terrains and intruded ultramafic and mafic host rocks. They are highly fractionated, of LCT (Li-Cs-Ta) affinity and yield complex mineralogical compositions.

In the Paleoproterozoic, syn- to post-orogenic LCT-family pegmatites intruded variable lithologies within a variety of structural settings. Minor and trace element signatures in columbite-tantalite are similar to those from Archean pegmatites, although some are characterized by considerable REE enrichment along with Sc and Y, being transitional to NYF (Nb-Y-F)-family pegmatites. The Mesoproterozoic period is comparatively poor in rare-element pegmatites and rare-metal granites. Placer material from Colombia points to an unusual pegmatite source of NYF affinity, yielding high total REE, Sc and Th at low Li.

A major period of pegmatite formation was the Early Neoproterozoic at around 1 Ga. Pegmatite fields often display a zonal arrangement of mineralized pegmatites with respect to assumed "fertile" parent granites. Pegmatites of the Sveconorwegian and Grenville domains are usually of the NYF type. In contrast, the pegmatites of central and southwestern Africa are commonly of LCT affinity carrying spodumene, beryl and cassiterite.

The fourth major pegmatite-forming event coincides with amalgamation of Gondwana around 550 Ma ago. Pegmatites showing both LCT and NYF affinities often intruded high-grade metamorphic terrains. Rare-metal granites of NYF affinity are locally abundant. The Alto Ligonha and Madagascar provinces are characterized by abundant REE and Sc both within Ta-Nb-oxides and as separate mineral phases.

In the Phanerozoic, abundant pegmatite formation was related to Sn-W mineralized granites during the Variscan and Alleghanian orogenies. Most of the pegmatites are of LCT affinity, although NYF and some mixed types are present as well. Nb-Ta oxides from Mesozoic pegmatites and rare-metal granites are invariably rich in REE, Sc, Y and Th. In all rare-metal granites, Ta-Nb oxides are characterized by high total REE concentrations and both, negative Eu and Y anomalies in chondrite-normalized REE diagrams.

ROCKFALL AND LANDSLIDE HAZARD POTENTIAL AT MOUNT PLASSEN, UPPER AUSTRIA (EASTERN ALPS)

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rockfall, landslide, earthflow, rockspread, monitoring rockfall

Mount Plassen is situated west of the Hallstatt village (Upper Austria), and is composed of Jurassic limestone, which overlies Permotriassic fine-grained clastic rocks and evaporates (mainly part of the so-called Haselgebirge). This geotechnical predisposition causes rock spreading of the harder and rigid limestone on the weak, mainly clayey rocks. Associated to this large slope instability are rockfall and sliding processes. Further common process chains include rockfall triggering slides and/or earth flows by undrained loading of the ductile clay material. These potential fast moving earthflows and slides may endanger the houses and infrastructures in the Salzberg high valley and Hallstatt village.

Recent higher rockfall frequency at Mt. Plassen provides evidence for greater, perhaps accelerating displacement rates of the rock spread. A multidisciplinary assessment strategy was chosen to analyse the geologic conditions, to characterize the potential failure mechanisms alongside the Plassen massif and to evaluate the hazard potential of future events. Methods include field mapping (geologic, engineering geologic and geomorphologic), sampling and determination of soil parameters in active process areas, geophysical surveys (airborne geophysics and geoelectric measurements), kinematic measurements (tape dilatometer, geodetic measurements, repeated TLS surveys) and the installation of a photo monitoring.

Analyses of the data indicate that some areas of the Plassen massif are highly susceptible to sliding mechanisms whereas other areas are prone to toppling and rockfall processes. Results of this multidisciplinary approach may form the basis for further decision making such as the installation of a monitoring system or other preventive measures.

THE STRATIGRAPHIC TABLE OF GERMANY REVISITED: 2016

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The "Stratigraphic Table of Germany 2002" (STD 2002) presents 1 200 geological units, beds, formations, groups, regional stages, and regional series of the Regional Stratigraphic Scale (RSS) of Central Europe in relation to the Global Stratigraphic Scale (GSS). Alongside the recent stratigraphic terms are also some historical names (http://www.stratigraphie.de/std2002/download/STD2002_large.pdf).

The numerical ages in the table have been estimated using all available time indicators including radio-isotopic ages, sedimentary cycles of the Milankovich-band of about 0.1 Ma and 0.4 Ma duration for the Rotliegend, Zechstein, Buntsandstein, Muschelkalk, and Keuper groups, and average weighted thicknesses for the Late Carboniferous of the Central European Namurian, Westphalian, and Stephanian regional stages. Significant uncertainties are indicated by arrows instead of error bars as in the Global Time Scales 1989 and 2012 (GTS 1989, GTS 2012).

In 2015 und 2016 the German Stratigraphic Commission updated the entire STD 2002. A main topic is the inauguration of "Folgen" from the Middle Permian to the Late Triassic. Folgen are bundles of sedimentary cycles. Thus, the 7 Folgen z1 to z7 of the Zechstein Group with its 50 cycles z1.1 to z7.8 indicate a duration of about 5 Ma. The 7 Folgen s1 to s7 of the Buntsandstein with its 63 cycles s1.1 to s7.12 results in a span of about 6.3 Ma. For the ca. 38 Ma-long Keuper Group two alternatives are shown: with and without large gaps.

On the GeoTirol 2016 the STD 2016 will be available.

Reference:

- [1] STD 2002 (Deutsche Stratigraphische Kommission, ed, coordination and lay out Menning M and Hendrich A 2002) *Stratigraphische Tabelle von Deutschland 2002*: GeoForschungsZentrum Potsdam and Forschungs-Institut Senckenberg Frankfurt a. M.
- [2] GTS 1989: *A geologic time scale 1989*: Cambridge Univ. Press, 263 p
- [3] GTS 2012: *A geologic time scale 2012*: Elsevier, 1176 p
- [4] STD 2016 (Deutsche Stratigraphische Kommission, ed, coordination and lay out Menning M and Hendrich A 2016) *Stratigraphische Tabelle von Deutschland 2016*: GeoForschungsZentrum Potsdam

WIE GENAU IST DIE GEOLOGISCHE ZEITSKALA KALIBRIERT?

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Stratigraphie, Geologische Zeitskala, Fehlergrenzen

100 Stufen bilden das Grundgerüst der geologischen Zeitskala des Phanerozoikums. Mehr als 60 Stufen wurden von 1972 bis 2014 mit einem Globalen Stratigraphischen Profil und Punkt (GSSP) definiert und ratifiziert. Jeweils einen GSSP gibt es in Deutschland für die Eifelium-Stufe und in Österreich für die Hettangium-Stufe. Das Alter beider Stufen konnte mit radio-isotopischen Altersbestimmungen sehr genau ermittelt werden. Wenn es jedoch um einen GSSP herum keine gut datierten Tuffe gibt oder diese nicht gut eingehängt sind in eine hochauflösende Biozonierung, bleibt ein großer Interpretationsspielraum. So steht bei der ICS 2012 richtigerweise vor den Altern der Stufen der Frühen Kreide ein Ungefährzeichen, doch dazu passt nicht, dass ihre Alter in Millionen Jahren bis auf eine Stelle hinter dem Komma angegeben werden. Das wurde in der STD 2016 durch Rundung aller Stufenalter im Prätertiär auf 0,5 bzw. 1 Ma vermieden.

Nicht nur bei der ICS (2012) sind die Fehlergrenzen von Stufenaltern viel zu niedrig abgeschätzt. Denn fälschlicherweise wird oft die „precession“, die laborative Genauigkeit einer radio-isotopischen Altersbestimmung, als Fehlergrenze für ein Stufenalter angegeben ohne Beachtung der "accuracy", des geologischen Fehlers, der nicht berechnet werden kann. Den wahren Interpretationsspielraum spiegeln in der Späten Trias die beiden alternativen Zeitskalen der GTS (2012: 709) wider: Basis Norium 228,4 Ma und 221,0 Ma sowie Basis Rhaetium 209,5 Ma und 205,4 Ma.

Zyklisch aufgebaute sedimentäre Abfolgen werden zunehmend zur Schaffung von "floating time scales" genutzt, indem den Zyklen eine klimatisch induzierte Milankovich-Dauer zugeschrieben wird. Die Dauer einiger Stufen konnte mit Hilfe solcher Zyklen genauer abgeschätzt werden als es allein mit radio-isotopischen Datierungen möglich ist (z. B. in der Frühen Trias, Menning et al. 2005).

References:

GTS 2012: A geologic time scale 2012: 1176 p.; Amsterdam (Elsevier).

ICS 2012: International Chronostratigraphic Chart. – pocket version, www.stratigraphy.org.

Menning, M., Gast, R., Hagdorn, H., Käding, K.-C., Simon, T., Szurlies, M. & Nitsch, E. (2005): Zeitskala für Perm und Trias in der Stratigraphischen Tabelle von Deutschland 2002, zylostratigraphische Kalibrierung von höherer Dyas und Germanischer Trias und das Alter der Stufen Radium bis Rhaetium 2005. – Newsl. Stratigr., **41**, 1/3: 173–210; Berlin.

STD 2016: Stratigraphische Tabelle von Deutschland 2016; Potsdam (Deutsches GeoForschungsZentrum).

PRESENTATION OF A WEB-BASED DATABASE DESIGN FOR DOCUMENTATION AND ANALYSIS OF ROCK PROPERTIES.

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Data management, Database, Rockmechanical Properties, MySQL, PHP

With increasing data volume, due to increasing requirements for ground investigation programs for large construction projects, the demand for more efficient filing systems is more and more growing. We also have to use flexible systems to cope with varying data out of different lab and field tests depending on the project.

The chair of Engineering Geology at TUM is working on a self-made database solution to handle all needed data in a more appropriate way. We want to optimize our data management to reach a fast and easy way of collecting, documenting and analyzing our gained data. Second objective is to make our data easily accessible to project partners across broadly distributed locations.

This Database system consists of a php web interface and a MySQL database core. This setup allows online access via Internet (www). We are able to grant and constrain access to all data or only arrays of data with our user management system to guarantee the safety of project data and respect all rights and proprietorship. The database system is of modular design. The most basic module manages all data of project partners, project data and laboratory data. At this time we are able to save and work with all commonly generated specific values from unconfined compressive strength tests, brazilian tensile strength tests, point load tests, CERCHAR and LCPC abrasivity tests and ultrasonic tests. The user is able to make simple statistical analysis within our database (e.g. average calculation of one sample) and export data as csv or xls files for further analysis.

For specific questions within projects we are able to deploy and integrate further modules in our database system. At this moment, we are developing an add-on to use this database for drill test analysis. This tool correlates drilling performance and tool wear measured in the field with rock mechanical properties, and extrapolates data to estimate performance and wear in new projects.

Today we are managing 90 projects with 550 samples and almost 1350 lab tests with the base module.

CLAY MINERALOGY OF MIOCENE MUDSTONES OF THE MOLASSE ZONE, LOWER AUSTRIA

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Clay minerals, Lower Austria, Miocene, Molasse Zone

The Lower Austrian Molasse Basin has been a subject of investigation for 150 years. Apart from surface rocks and outcrops, data from several drill cores from wells provide insight into the genesis and evolution of these Miocene deposits.

In a joint project of OMV and the University of Vienna which aims at a revision of the local stratigraphy, we propose a new zonation based on clay mineralogy, heavy minerals, carbonate content, XRD and XRF data, whole rock chemistry, calcareous nannoplankton and dinoflagellate cysts.

Based on stratigraphic signals, which we could correlate through the basin, we propose the name **Traisen Formation**, formerly Oncophora/Rzehakia Beds, for the uppermost Ottnangian sand-dominated sediments in the south, and **Zellerndorf Formation** for the pelitic sediments in the north. Sediments overlying this Carbonate Minimum Interval belong to the Karpatian **Laa Formation**. We propose the working term **Robulus Schlier** for the fine grained sediments below the calcite poor Traisen Formation. The lower boundary of the pelitic Schlier-succession is marked by the **Bioturbated Sandstones**. The informal term **Basal External Sands** is used for the underlying quartz and K-feldspar rich, but mica poor sands.

The results of the qualitative and quantitative evaluation of clay minerals in five wells correlate well with the proposed formation boundaries. In wells Schaubing and Streithofen 1 the sediments of the Robulus Schlier succession exhibit distinctly lower kaolinite contents than the overlying Traisen Formation. Very reduced smectite and increased kaolinite content distinguish the Basal External Sands from Robulus Schlier in wells Streithofen 1 and Altenmarkt im Thale 1. High Smectite peaks in the Zellerndorf Formation can be explained by volcanic ash input.

DER ALBAUFSTIEG, JURASSISCHE SCHICHTSTUFEN MIT GANZ SPEZIFISCHEN GEOLOGISCH-GEOTECHNISCHEN HERAUSFORDERUNGEN BEIM BAU DES STEINBÜHL- UND BOßLERTUNNELS.

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NBS, Tunnel Alaufstieg, Jura, Karst, Gebirgskennwerte

Der Boßlertunnel (8,8 km) und der Steinbühlertunnel (4,8 km) sind Teil der NBS Wendlingen-Ulm (PA 2.2). Die 2-röhrigen Tunnel führen mit einem Höhenunterschied von etwa 360 m auf die Schwäbische Alb und durchfahren dabei die Schichten des Weiß- und Braunjuras. Potentiell druckhafte Tonsteinsfolgen oder intensiv verkarstete Kalksteine stellen Aspekte bei der Risikobewertung zu Beginn und während des Vortriebs dar. Neben der geologischen Dokumentation spielt daher auch eine ganzheitliche, vortriebsbegleitende baugeologische Beratung für die ARGE Alaufstieg eine wichtige Rolle. Erkenntnisse aus der Ortsbrustkartierung, der Karst- und weiterer Zusatzerkundung, sowie die geotechnische Auswertung von Konvergenzmessungen führten zu einer baubegleitenden Neuinterpretation der geologisch-geotechnischen Verhältnisse und zur Optimierung des Bauverfahrens. Gebirgskennwerte wurden fortgeschrieben, verkarstete Areale eingegrenzt.

SITE SPECIFIC ISOTOPIC VALUES OF RECENT CYTHERIDELLA ILOSVAYI (OSTRACODA) FROM FLORIDA AND THE SEASONAL INFLUENCE OF TEMPERATURE

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Stable isotopes, Ostracods, Neotropics, Hydrochemistry

Isotopic signatures of ostracod valves became common proxies for the reconstruction of paleoenvironmental conditions. Ostracods are known to form their valves out of equilibrium compared to a theoretical calcite precipitated under the same conditions. Studies from recent populations have revealed species specific vital effects for several ostracod species and these are assumed to vary on a local scale. Studies on the isotopic composition of recent ostracod species from several locations and the hydrochemistry of their host waters are still rare. Thus, the influences of environmental mechanisms on the differences of the vital effects of ostracods are not yet fully understood.

MESO- AND MICROSCALE VEIN STRUCTURES WITHIN THE IZU-BONIN-MARIANA FORE ARC: IMPLICATIONS FOR POST-MAGMATIC TECTONIC DEFORMATION

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Supra-Subduction Zone, Vein microstructures, Deformation, Fluid flow

The International Ocean Discovery Program Expedition 352 drilled through the outer Izu-Bonin-Mariana (IBM) fore arc in order to gain new insights into supra-subduction zones (SSZ). The recovered drill cores composed of 48-42 Ma old boninites and 52-51 Ma old fore arc basalts (FAB) reveal the entire volcanic sequence of a SSZ. FAB originate from decompression melting during the first stage of subduction initiation. Subsequently the involvement of subducting slab derived fluids result in the occurrence of boninites.

Site survey seismic data indicate predominantly west-dipping normal faults suggesting that tectonic deformation in the outer Izu-Bonin-Mariana fore arc is mainly post-magmatic. Normal faults are associated with the development of syn-tectonic sedimentary basins. Deformation within the magmatic basement was accommodated by shear along cataclastic fault zones and the formation of tension fractures, shear fractures and hybrid (tension and shear) fractures. Vein microstructures, geochemical and isotopic signatures are the subject of this study and give new insights into fluid flow and deformation of the Izu-Bonin fore arc.

Veins formed predominantly as a consequence of hydrofracturing and subordinately as a result of extension. Cross-cutting relationships of veins point to multiple fracturing followed by mineral precipitation from a fluid with isotopic seawater signature. Major vein components are (Mg-) calcite and/or various types of zeolite determined by Raman spectra. The latter result from alteration of volcanic glass. Micritic and volcanoclastic infill varies significantly with depth and is related to neptunian dikes and/or cataclastic fault zones. In veins within FAB calcite forms consistently blocky crystals without any microscopic identifiable growth direction. However, veins within boninites show additionally elongate blocky and fibrous crystals characterizing syntaxial and antitaxial growth, respectively. In contrast, veins from the Izu-Bonin rear arc and back arc (expeditions 350; 351) exhibit predominantly microstructures typically associated with extension, e.g. antitaxial fibrous veins.

Blocky calcite grains exhibit deformation microstructures in both sequences. These microstructures comprise twinning (type I/II twins), slightly curved twins, and subgrain boundaries indicative of incipient plastic deformation. The differential stresses (≥ 50 MPa) that triggered vein deformation were presumably related to IBM fore arc extension due to the retreat of the subducted Pacific plate.

NEW CONSTRAINTS FOR THE KINEMATICS OF EOALPINE SUBDUCTION ZONE FROM PETROLOGY AND LU-HF GARNET GEOCHRONOLOGY OF ECLOGITES

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Eastern Alps, Eoalpine (Cretaceous) subduction, High-pressure metamorphism, Garnet, Lu-Hf geochronology

The Austroalpine high-pressure belt of the Eastern Alps is an east-west striking zone where Cretaceous-age eclogite-facies rocks occur beneath a tectonic "suture" that does not contain apparent oceanic remnants. Three models were suggested to explain this situation: (1) continent collision after subduction of the Meliata ocean (Neubauer et al. 1999); (2) intracontinental subduction initiated within a pre-existing rift (Janák et al. 2004); and (3) ablative subduction (Roda et al. 2012). To test the various proposed scenarios we are combining the already existing data with new structural, petrological and geochronological data.

Here we present a new Lu-Hf isotopic study of eclogites from the Hohl locality in Koralpe, and from the Grünburgerbach and Wolfsberger Hütte localities in Saualpe. Two point isochrons from samples of Hohl and Wolfsberger Hütte based on one whole rock and one garnet separate yield ages of 99.2 ± 1.1 Ma and 101.7 ± 2.0 Ma, respectively. Two eclogite samples from Grünburgerbach give garnet-omphacite-whole rock ages of 100.3 ± 1.0 Ma and 101.8 ± 0.9 Ma, identical within error. The garnets in the eclogite from Hohl display a homogenous composition with no zoning of major elements, whereas the garnets of the samples from Grünburgerbach and Wolfsberger Hütte show an enrichment of Mn in the cores, which indicates prograde garnet growth during increasing P and T. The ages are therefore related to burial during subduction. More data is in progress and will be presented additionally.

These new Lu-Hf garnet ages are slightly older than the Lu-Hf garnet age data from Pohorje (~95 Ma; Sandmann et al. 2011, Thöni et al. 2008), which also date burial. Together with the existing P-T-data our results suggest a field gradient of the timing and depth of the subduction and represent important constraints for a realistic kinematic model.

Janák, M. et al. 2004. *Tectonics*, 23, TC5014, 10 pp.

Neubauer, F. et al. 1999. *Schweiz Miner Petrog*, 79:297-307.

Roda, M. et al. 2012. *J Metamorph Geol*, 30:973-996.

Sandmann, S. et al. 2011. Abstract presented at the 10th Alpine Workshop in France.

Thöni, M. et al. 2008. *J Metamorph Geol*, 26:561-581.

LATE TRIASSIC FORE-REEF EVOLUTION OF THE DACHSTEIN CARBONATE PLATFORM – ION-EXCHANGE AND BIOSTRATIGRAPHIC ASPECTS

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Triassic, Biostratigraphy, Geochemistry, fore-reef, Dachstein Carbonate Platform

The Late Triassic fore-reef evolution of Mt. Jenner in the Berchtesgaden Alps, Germany offers a rare geological archive, in which a high-resolution conodont dated slope from the Dachstein Carbonate Platform can be studied in context with sequence stratigraphic cycles.

The analysis of Laciian transgressive/regressive cycles throughout the earliest Dachstein platform progradation has revealed that mixing advection of sea-water with meteoric-water through the sediment favoured biochemical, redox-sensitive reactions on compounds and mineral surfaces, and a shallow-burial dolomite formation with high Mg/Ca-ratios in normal marine salinity, respectively. In the latest Laciian, temporary exposures of the carbonate platform caused in lowered sediment accumulation rates and drove low-energetic environments on the slope. Characteristic hopanes indicate, in these stratified layers an input of palaeosoil material with biodegraded land plants. Shifts in the sediment permeability influenced the concentration and mobility of the ions, and the flow of electrolytic charge in organisms. A first occurrence of the *Griphoporella*, *Boueina* and *Aciculella dasycladales*, in correlation with conodonts can be reported. During the Alaunian 1 to 3I, first tectonic pulses, coupled with ocean-acidification proxies caused in an aggradation of the platform, as seen in the fore-reef geometry. Corals, algae, foraminifers and calcified microbes recover and bloom in the Alaunian 3II. The Mg/Ca-concentration decreased when shell and skeleton production exploded. Salinity and microbial fermentation processes in the sediments were strongly influenced by the eustatic pulses. A strong tectonic pulse at the Alaunian/Sevatian boundary with increasing subsidence resulted in rapid platform progradation on Mt. Jenner.

This Late Triassic fore-reef architecture can be directly correlated with other high resolution Dachstein carbonate platform successions, dated by means of conodonts in the eg., Eastern Alps, Western Carpathians and Julian Alps.

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SOME BIOGEOCHEMICAL ASPECTS OF THE LATE NORIAN HALLSTATT LIMESTONES

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Triassic, Hallstatt Limestones, Biostratigraphy, Ion-exchange, Stable Isotopes

Strong tectonic pulses triggered by Late Triassic strike-slip motions destabilized the geometry on the Hallstatt margin, culminated in the late Middle Norian and decreased rapidly in the early Rhaetian. Variations in the morphology with deep fractures into the underlying sediment, 'climatic cooling' with significant shifts in stable carbon and oxygen isotopes, and eustatic pulses were coupled with changing palaeo-ocean environment proxies. Erosion of uplifted deeper continental crust-fragments in the hinterland resulted in intense remobilization of metals and rare earth elements. Lowered sediment accumulation rates, due to a decrease in the carbonate production caused in condensed environments and drove in the upper few centimetres of the hemipelagic biomicrites a shallow-burial diagenetic interaction between communities of symbiotic organism, fermentative decomposition of the organic matter, formation of authigenic biominerals, and an anaerobic oxidation of methane. In stratified layers, the increased abundance of biologically available elements and the selective uptake of (?metal and) lanthanide ions processed (?catalysed by bacteria) the replacement of calcium cations in the biomolecules of (some) deeper water organisms, which seemed to destabilize the equilibrium in the biological system and favoured most probably crystalline effects on the skeletal structures and morphogenic changes. These biochemical redox-reactions performed also low-temperature biogenic hydrate water releases, which appeared on the proximal shelf as cemented molds of burrows, or as local linings of fluid channels. The latest Alauian to earliest Sevatian tectonic pulse destabilized the hydrates, drove the formation of volcanism, and support an ocean acidification in 'silicifying' the sediment on the distal continental shelf. Gradual climatic warming effected the transgression of the sea-level, and combined with a rapid subsidence, triggered these the sudden 'recovery' of the Early Sevatian Dachstein carbonate platform reef.

MECHANISMS OF EXTREME LITHOSPHERIC THINNING IN THE ALPINE TETHYS RIFTED MARGINS: INSIGHTS FROM FIELD OBSERVATIONS AND NUMERICAL MODELING

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Rifting, Hyper-extended domain, Austroalpine nappe

The mechanisms of extreme lithospheric thinning leading to the formation of severely thinned continental crust (< 10km thick) documented in present-day passive margins remain a major question. The remnants of the Jurassic Alpine Tethys rifted margins in the Alps represent a critical place where the different levels of the pre-rift lithosphere, from the upper crust through the lower crustal level and eventually the lithospheric mantle, can be reached and studied.

This contribution aims to explore how the crust thins, which structures can accommodate the extreme crustal thinning observed and eventually how far the initial architecture of the lithosphere may control subsequent rifting development.

The Austroalpine and South Penninic nappes in SE-Switzerland and N-Italy, were only weakly affected by Alpine deformation. This situation enables us to: 1) characterize the initial pre-rift architecture of the lithosphere and 2) investigate the subsequent rift-related deformation in distinct portions of the continental lithosphere. This field-based study is combined with two-dimensional thermo-mechanical models of the lithospheric thinning addressing the importance of the initial pre-rift mechanical heterogeneities.

Our results show that the initial Permian post-orogenic event significantly modified the continental lithosphere creating an "inheritance" that had a first-order importance on the following Jurassic rifting. The control of inheritance is well shown by the complex interaction of large-offset normal faults associated with the development of anastomosing shear zones and decoupling horizons in a composite crust strongly modified by the Permian post-orogenic event. We propose that the complex, inherited crustal structure controls localization of major decoupling levels responsible for the lateral extrusion of mid-crustal layers in the necking zone and juxtaposition of "brittle" strong levels originating from the upper and lower crust in the hyper-extended domain.

Altogether these results will enable us to propose a new model for the formation of the hyper-extended rifted margins and to discuss its implications for the evolution of the Alpine Tethys margins.

DIE ROLLE DES GEOLOGEN BEI DER ÜBERWACHUNG VON GROSSEN STAUANLAGEN IN DER SCHWEIZ

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monitoring large dams, engineering geology and hydrogeology, rockfall, landslides

Bei Planung und Bau von Wasserkraftanlagen ist die Mitwirkung des Geologen eine Selbstverständlichkeit. Doch auch in der Betriebsphase hat der Geologe seinen festen Platz.

In der Schweiz stehen die grossen Stauanlagen unter der direkten Aufsicht des Bundes, welche das Bundesamt für Energie wahrnimmt. Bei grossen Talsperren, die eine Stauhöhe von mindestens 40 m oder eine Stauhöhe von mindestens 10 m und einen Stauraum von mehr als 1 Mio. Kubikmeter aufweisen, verlangt die Stauanlagenverordnung die Überwachung durch einen ausgewiesenen Geologie-Experten. Dieser hat alle fünf Jahre eine umfassende Sicherheitsprüfung durchzuführen, bei welcher er die Gefährdung der Talsperre durch gravitative Ereignisse, wie Rutschungen und Felsstürze, geotechnische Veränderungen hinsichtlich der Stabilität der Widerlager und Foundation, die Überwachung der hydrogeologischen Verhältnisse und die Veränderungen infolge Bauten Dritter im Einflussbereich der Stauanlage zu beurteilen hat. Die grossen Stauanlagen der Schweiz sind alle in alpiner und teilweise in hochalpiner Umgebung mit ausgeprägter Topographie eingebettet. Demnach sind gravitative Rutsch- oder Sturzereignisse ein häufig auftretendes und zu kontrollierendes Phänomen. Auch hydrogeologische Belange, wie die Veränderung des Porenwasserdrucks im Fundationsfels einer Talsperre infolge der Stauhaltung oder die Veränderung des Schüttverhaltens von Quellen im Einflussbereich einer Stauanlage sind vom Geologen zu kontrollieren, hinsichtlich der Sicherheit der Stauanlage zu beurteilen und bei Bedarf müssen Massnahmen vorgeschlagen werden.

Anhand zahlreicher, spannender Beispiele wird von den vielseitigen und verantwortungsvollen Aufgaben des Geologen berichtet.

AN INDEX TO ESTIMATE SEDIMENT PRODUCTION POTENTIAL OF DIFFERENT ROCK TYPES AT LARGE SPATIAL SCALES

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erosion, lithology, modeling

Erosion within a river basin is a major control of sediment transport into oceans and included as an important part in global sediment transport models (e.g. Syvitski and Milliman, 2007). Erosion is controlled by the eroding rock type and its attributes, as well as climate, tectonics, and other factors. However, at large scales the erosion potential of different rock types for a given climatic and tectonic setting (“erosivity”) is only weakly constrained (cf. Cohen et al., 2014).

Here, we estimate the erosivity based on gradient of slope of different rock types from a high-resolution global lithological map (Hartmann and Moosdorf, 2012) in areas of similar present day rock uplift rates based on published maps. Following the assumption that gradient of slope inversely correlates to stability of the rock, we calculated an erosivity index normalized to acid plutonics (mostly granite). Calibration areas include the European Alps, the Himalayas, the Mediterranean Region, the Sierra Nevada, and Taiwan. We thus cover different tectonic and climatic regimes, i.e. areas in and outside tropical latitudes, landscapes that have been affected by glacial erosion, as well as areas with different plate convergence rates. Results show significant differences of erosivity between rock types; the erosivity index is (from highest to lowest): Unconsolidated sediment (3.2), siliciclastic sedimentary rocks (1.5), basic plutonics (1.5), basic volcanics (1.4), mixed carbonate and siliciclastic sedimentary rocks (1.2), carbonate sedimentary rocks (1.0), metamorphic rocks (1.0), acid plutonic rocks (1.0 – per definition), and acid volcanic rocks (0.8).

The here presented erosivity index can be applied in large scale sediment transport modeling and similar applications as the first to be empirically calibrated with high-resolution lithology information, and high resolution slope data (ASTER GDEM) at large scale.

References:

- Cohen, S., Kettner, A.J., and Syvitski, J.P.M., 2014. *Global and Planetary Change*, 115, 44-58. DOI: 10.1016/j.gloplacha.2014.01.011.
- Hartmann, J., and Moosdorf, N., 2012. *Geochem. Geophys. Geosyst.*, 13(12), Q12004. DOI: 10.1007/s00767-014-0275-3
- Syvitski, J.P.M., and Milliman, J.D., 2007. *Journal of Geology* 115 (1), 1–19.

UPSCALING LOCAL FRESH SUBMARINE GROUNDWATER DISCHARGE OBSERVATIONS: GLOBAL FRAMEWORK AND EXAMPLES FROM JAVA, INDONESIA

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submarine groundwater discharge, upscaling, land-sea interface

Fresh submarine groundwater discharge is often used as water resource for drinking, hygiene and agriculture. At the same time, it is a transport pathway for dissolved chemical species, e.g. pollutants or nutrients, to coastal marine ecosystems. Particularly in marine ecosystems around tropical islands, submarine groundwater discharge could be a relevant contributor to the nutrient budgets (Moosdorf et al., 2015). While abundant local studies quantify fresh submarine groundwater discharge (although most clustered to very few regions of the globe), at regional or global scale the discharge of fresh submarine groundwater remains only weakly quantified. However, the few uncertain numbers of global fresh submarine groundwater discharge in the literature range around 5-10% of river discharge and suggest a significant contribution of submarine groundwater discharge to the ocean freshwater inputs.

A literature study reveals striking differences between terrestrial constraints on fresh submarine groundwater flux at the regional scale and local scale reported discharge values. It seems unlikely that the local observations are representative for regional scale groundwater fluxes. However, large scale models need local observations as evaluation. Thus, the scaling between local and regional fresh submarine groundwater flux requires additional attention.

Here, we compare large scale estimates of constraints of fresh submarine groundwater discharge with local measurements in Java, Indonesia, and discuss scaling between them. The large scale constraints are defined based on global datasets of precipitation and groundwater recharge. The local fresh submarine groundwater discharge estimates in Java are calculated based on natural tracers (radium, radon isotopes).

The results of this comparison can be used to improve the upscaling of local submarine groundwater measurements, which is necessary to understand its significance at regional and global scale.

Reference:

Moosdorf, N., Stieglitz, T., Waska, H., Durr, H.H., Hartmann, J., 2015. Submarine groundwater discharge from tropical islands: a review. *Grundwasser*, 20(1): 53-67.

VERGLEICH UND BEURTEILUNG VERSCHIEDENER GEOPHYSIKALISCHER VERFAHREN ZUR ERKUNDUNG VON LOCKERSEDIMENTEN

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Geophysik, Seismik, Geoelektrik, Bodenradar, Bohrlochmessung

Im Rahmen des Interreg IV Projektes „Natursteinressourcen in Nord-, Ost- und Südtirol: Vorkommen, Eigenschaften und Bedarf“ wurden im Großraum Innsbruck verschiedene geophysikalische Verfahren zur Erkundung von Lockersedimenten erprobt. Ziel dieser Untersuchung war es einerseits Kenntnis vom Aufbau des Untergrunds zu bekommen, andererseits sollen auch die Möglichkeiten und die Qualitäten der angewandten geophysikalischen Methoden erhoben werden. In diesem Projekt wurden folgende Methoden angewandt:

- Refraktionsseismik
- Reflexionsseismik
- 2-D Geoelektrik (Multielektrodengeoelektrik)
- Bodenradar
- Bohrlochmessung

In der Vorbereitungsphase der geophysikalischen Untersuchungen wurden im Messgebiet mehrere Kernbohrungen abgeteuft. Die geophysikalischen Messungen wurden hierbei so angelegt, dass sich alle über einer der Bohrungen kreuzen. In einer ersten Phase wurden die Ergebnisse der geophysikalischen Untersuchungen ohne Kenntnis der Bohr- und Schürfdaten ausgewertet und interpretiert, in der zweiten Phase erfolgte eine Auswertung mit Kenntnis der Bohr- und Schürfdaten. In der Folge wurden die Ergebnisse der Erstinterpretation mit jenen der Zweitinterpretation verglichen und die Eignung der eingesetzten geophysikalischen Methoden und Auswertungen beurteilt. Abschließend wurde nahe der obigen Bohrung – an geeigneter Stelle – eine weitere Bohrung abgeteuft und mittels Bohrlochmessungen erkundet und die realen Verhältnisse mit der Erst- und Zweit-Auswertung verglichen.

CRITICAL RAINFALL CONDITIONS TRIGGERING SHALLOW LANDSLIDES OR DEBRIS FLOWS IN TORRENTS - ANALYSIS OF DEBRIS FLOW EVENTS 2012, 2013 AND 2014 IN AUSTRIA

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critical rainfall conditions, debris flows, events in Austria 2012-2014

Generally, debris flows are caused by both small-scale intensive precipitation and long lasting rainfalls with lower intensity but high pre-wetting or both combined. The triggering mechanism of the debris flow events in Austria 2012, 2013 and 2014 were mass movements (rapid shallow landslides) on steep slopes in the upper catchments. Those masses slide with very high velocity into the torrent beds provoking hyperconcentrated flows or debris flows. In areas of the geologically unstable Greywacke zone, the torrents were cleared up onto the bedrock and the debris was deposited in the storage areas of existing debris flow breakers or in torrents without technical protection measures the debris caused catastrophic damage to residential buildings and other infrastructural facilities on the alluvial fan. Following the events, comprehensive documentation work was undertaken comprising precipitation analysis (rainfall data, weather radar data), identification and quantification of the landslide masses, cross profiles along the channel and of deposition in the storage areas or on the fan. The documentation and analysis of torrential events is an essential part of an integrated risk management. It supports the understanding of the occurred processes to mitigate future hazards. Unfortunately, the small-scale heavy rain events are not detected by the precipitation stations. Therefore, weather radar data (INCA-Data) analysis was used to determine the - usually very local - intensities which caused those catastrophic landslides and debris flows. Analysis results showed an agreement with the range of the previously known precipitation thresholds for debris flow triggering in the Alps.

A NEW TERRESTRIAL ARCHIVE FOR THE EOCENE GREENHOUSE OF CENTRAL EUROPE: PALYNOLOGICAL EVIDENCE FROM LACUSTRINE SEDIMENTS AT “GRUBE PRINZ VON HESSEN” (HESSE, GERMANY)

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Palynology, Eocene, Greenhouse climate, Central Europe, Lacustrine sediments.

The lacustrine sediments of “Grube Prinz von Hessen” (PvH), 5 km NE of Darmstadt (Germany), probably represent the filling of a small pull-apart basin. An equid specimen which was recovered during former mining operations in the upper part of the succession indicated a Middle to Upper Eocene age. Scientific drilling recently revealed a reference core, including 34 m of clastic sediments overlain by 54 m of finely laminated bituminous oil shale and lignites. Forty samples in 2 m intervals have been analyzed palynologically in order to obtain another record of changes in the vegetation during the Paleogene greenhouse. Mainly based on the presence of *Pistillipollenites*, a characteristic index fossil for the Lower Eocene, in the transitional zone at the base of the oil shale, the lower part of the succession at PvH is older than previously assumed. Therefore the structure has probably existed for significantly longer time (~6-8 Ma) than the nearby early Eocene maar crater of Messel (~1 Ma). It is therefore indicated that important palaeoclimatic events such as the Early Eocene Climate Optimum, the Mid-Eocene Climate Optimum and the underlying general cooling trend are covered by the sedimentary record. This offers a new chance for studying long- and short-term interaction of palaeoclimate and palaeoenvironment across the last natural greenhouse system, probably even at a larger scale than at Messel.

A succession of plant communities can be distinguished throughout the sedimentary record and is correlated to lithological changes. In the lower part of the core, which is characterized by cross-bedded sandstones and siltstones representing the initial holomictic phase a diverse association of fern and moss spores suggests a lake margin community and the recolonization of the lake vicinity by pioneering plants. With decreasing lake level the lithology changes to bituminous shale and lignites. This is accompanied by the establishment of a thermophilic swamp forest. Ongoing high resolution studies will hopefully detect subordinate changes in the vegetation.

DIE VERTEILUNG ERHÖHTER PERMEABLER BEREICHE IM MALM DES BAYERISCHEN MOLASSEBECKENS

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Malmfazies, Molassebecken, Fündigkeitsrisiko, Permeabilität, Geothermie

Durch die Entwicklung der Geothermie für die Gewinnung erneuerbarer Wärme im Bayerischen Molassebecken wird momentan erneut die Porositäts- und Permeabilitäts-verteilung des Malms im Molassebecken untersucht. Der Malmaquifer (Oberjura) ist ein karbonatischer Kluft- und Porengrundwasserleiter, der durch die Matrixporosität und Störungs- und Kluftsysteme charakterisiert ist (Birner 2013). Störungen und Klüfte bilden die Fließpfade im Speichergestein, die, wenn in einer Bohrung aufgeschlossen, für sehr hohe Fließraten verantwortlich sein können. Somit können Störungen und Klüfte einen größeren bohrlochfernen Speicher an die Bohrung anschließen und damit den Brunnenradius erhöhen. Der Speicher selbst ist durch die Matrixporosität charakterisiert, der entscheidend für die Fündigkeit einer Bohrung ist.

In der Explorations- und Vorerkundungsphase können mittels der Seismik Störungssysteme mit einem erkennbaren Versatz der charakteristischen Reflexionsmarker relativ gut interpretiert werden. Dagegen kann die Matrixporosität bislang nicht über geophysikalische Messverfahren der Dichteunterschiede in der Vorerkundung ermittelt werden. Um die Matrixporosität und somit das karbonatische Reservoir zu analysieren kann das Bohrklein und geophysikalische Bohrlochmessungen verwendet werden. An Hand des Bohrkleins kann die Mikrofazies, diagenetischer Prozesse und Tektonisierung charakterisiert werden. Die diagenetischen Prozesse werden über die Messung der Mikrothermometrie, Raman-Spektroskopie und Kathodolumineszenz an Zementen ermittelt, sowie die Mikrofazies und Tektonisierung über die Mikroskopie. Vorteile des Bohrkleins sind, dass es immer beim Bohren anfällt, einfach beprobt und direkt am Bohrplatz nach konventionellen petrographischen Methoden ausgewertet werden kann. Der Einfluss von diagenetischen Prozessen auf die Porosität zeigt sich sehr deutlich bei der Dolomitisierung, die zum einen die sekundäre Porosität bis zu 13 % erhöhen oder zum anderen keinen sekundär geöffneten Porenraum ausbilden kann (Böhm et al. 2011, Tucker & Wright 1990).

Bislang hat sich in Geothermieprojekten gezeigt, dass sich die Porosität des Malms im Raum München (1000 – 3500 m u. GOK) nach Süden in den tiefliegenden Malm (> 4000 m u. GOK) verringert. Der tiefliegende Malm zeichnet sich durch höhere Fluidtemperaturen von > 140 °C (Münchner Raum 80-110 °C) aus. Daher ist es wichtig, diese Porositätabnahme zu untersuchen um so in Zukunft durch ein neu entwickeltes Erschließungskonzept das Fündigkeitsrisiko von Geothermieprojekten in diesem Bereich durch eine verlässlichere Bohrzieldefinition zu reduzieren. Ziel ist es, Grundlagen über den Ablagerungsraum, diagenetische Prozesse und Gesteins-eigenschaften zu ermitteln, um detaillierte Aussagen über die Verteilung der Speicherqualität zu treffen.

INVESTIGATING THE SPATIAL VARIABILITY IN CARBON-ISOTOPE SIGNATURES OF BULK ROCK CARBONATES – A CHEMOSTRATIGRAPHIC CASE STUDY FROM THE CENOMANIAN-TURONIAN OF THE IBERIAN TROUGH, SPAIN

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stable isotopes, carbonates, cenomanian, turonian, chemostratigraphy

Stratigraphic trends in carbon isotopes ($\delta^{13}\text{C}$) of bulk carbonate are widely used for high-resolution correlation across major carbon-cycle events in Earth history. For instance, the Cenomanian-Turonian boundary associated with oceanic anoxic event (OAE) 2 is characterized by a high-amplitude shift towards more positive $\delta^{13}\text{C}$ values. The detailed structure of this positive $\delta^{13}\text{C}$ anomaly has been reproduced from many open-ocean and shoal-water settings worldwide and enables high-resolution correlation. In order to better constrain the variability of the isotopic signal and to assess potential effects of facies variations and intra-bed heterogeneity, the Cenomanian-Turonian positive excursion has been investigated in detail in three sections from the Iberian Trough in Spain across a proximal-distal transect. Samples derived from the Condemios, Somolinos and Fuentetoba sections comprise about 150 m of shallow-marine carbonates (Abejar Fm.) and hemipelagic marls (Picofrentes Fm.) deposited in an epicontinental seaway between the Hesperian and Ebro massifs. Independent age control is provided by ammonite biostratigraphy. Carbon-isotope stratigraphy is based on bulk carbonate analysis ($n = 319$) and trends are compared with numerous subsamples representing the intra-bed variability ($n = 157$), bivalve shell material ($n = 16$) and sparitic cements ($n = 6$). Centimeter-scale isotopic profiles from selected facies types show only a minor intra-bed variability (ranging from 0.1 and 0.9 ‰ for $\delta^{13}\text{C}$) and mostly resemble bulk rock signatures. Larger variations are observed in $\delta^{18}\text{O}$ intra-bed analyses (ranging from 0.3 to 2.4 ‰). Despite their location in a rather proximal position, the marls and limestones of the Condemios and Somolinos sections (Picofrentes Fm.) provide an excellent record of the typical chemostratigraphic pattern across the Cenomanian-Turonian boundary which enables correlation with established records on a global scale. In contrast, the shoal-water carbonates of the lower Fuentetoba section (Abejar Fm.) are characterized by a gradual shift towards more negative $\delta^{13}\text{C}$ values (reaching -3.8 ‰) in the upper Cenomanian tentatively interpreted to reflect subaerial exposure and meteoric overprinting. The overlying marls and marly limestones of the Picofrentes Formation show a pattern comparable to the Somolinos and Condemios records, although with significantly less positive $\delta^{13}\text{C}$ values.

THE GRAPHITE MINE OF ZETTLITZ, DROSENDORF (BOHEMIAN MASSIF, AUSTRIA)

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graphite, Zettlitz, Bohemian Massif, digital elevation model

Within the Waldviertel Region, organic-rich black slates of the Proterozoic Variegated Sequence host graphite deposits of economic importance. Due to the similarity of the Bites and Dobra gneiss series, new theories see the Variegated Sequence as part of the Moravian complex experiencing a Variscan metamorphic overprint under conditions of 700 – 800 °C and 8 – 11 kbar. The open pit Zettlitz deposit is the major graphite exposure in this region and more than 350.00 t graphite were mined and processed until mining activities ceased in 1967. The deposit was investigated by airborne surveying, geological mapping, geochemical investigations (AAS, XRF, ICP-MS, Leco combustion, SEM) and Raman spectroscopy on carbonaceous materials (RSCM). Drone-supported photogrammetric surveying established a high-resolution digital elevation model (DEM) of the mine. Together with structural data, the DEM estimates the present resources. Within the pit, carbonate-poor graphitic slates with a TOC up to 61 weight% are found in a normal fault-bounded block. RSCM data characterize the carbonaceous materials as well-crystallized within the amphibolite facies. Pyrite, kyanite, dravite, micas and amphibole are enriched in thin schistosity-parallel layers in a matrix of orthoclase, oligoclase, quartz and graphite. The black slates are underlain by scapolite bearing calcite marbles and overlain by thin quartzite layers and pegmatite bearing gneisses and micaschists. This association indicates the formation in a small sapropelitic basin, evolving on a coastal carbonate system. The local presence of quartzite layers indicates temporary (tempestitic?) input of fine-grained quartz into this basin. XRF and ICP-MS data show low Ni, V and Mo contents and a typical continental crust REE pattern with an extreme negative Eu anomaly. The overall low sulfur-content (2 weight%) and distinct geochemical proxies indicate a prevailing oxic environment. Pyrite accumulations in thin layers indicate short euxinic periods during the lifetime of the basin.

SUBDIVISION OF VARDAR ZONE IN TERRITORY OF KOSOVO

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Vardar zone, East & West Vardar subzone, Sava zone

In the territory of Kosovo there are defined, some regional tectonic units whose geological evolution, both in time and space is characterized by highly complex processes.

Vardar Zone, has several hundred kilometers stretch, starting from the Aegean Sea in the south to the north of Panonian basin. It is placed between Dardania massif on the east and Drenica unit on the west. In terms of the Vardar zone subdivision, there are different opinions that differ in their interpretations, so some authors support the idea that Vardar Zone consists of three geotectonic units with quite different features in their composition and by their historical development: Inner Vardar sub-zone (IVSz), central Vardar sub-zone (CVSz) and external Vardar sub-zone (EVSz) etc.

There are also authors that the Vardar zone divides in two subzones: East and West Vardar sub-zone, which idea I support to, but there are different lineation between Vardar zone and other tectonic units of the region, and also there are different opinions regarding the lineation between these subzones. The division in two subzones also is based on geological-tectonic maps and interpretation of airborne geophysical data (magnetic and radiometric) conducted during 2006-2007.

It should be emphasized that the application of local or regional geophysical study provides a valuable contribution to solving the problems of geological-tectonic and structural complex building.

Division of Vardar zone in two sub-zones in terms of geological-structural development and formational features can be explained as follows: East Vardar subzone is divided from West Vardar subzone with so-called "Sava Zone". Therefore, Ophiolites of eastern Vardar will be considered only ophiolite belt that stretches on the east of so-called "Sava Zone". At the same time this is the last remnant of oceanic crust east Vardar Ocean.

EIN VERGLEICH VON DYNAMISCHEN EINWIRKUNGEN VON MUREN AN EINEM STARREN BAUWERK UND EINER FLEXIBLEN NETZSPERRE IN EINEM KLEINMAßSTÄBLICHEN MODELLVERSUCH

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Mure, flexible Netzsperrre, Anprall

Durch die Vielzahl und auch durch neue Entwicklungen im Bereich von Bauwerkssystemen der Wildbach und Lawinenverbauung in Österreich, wurden 21 kleinmaßstäbliche Versuche durchgeführt um Vergleiche zwischen starren und flexiblen Bauwerken anstellen zu können.

Diese Versuche dienten als Machbarkeitsstudie für den Trattenbach, im Salzburger Pinzgau. Der murfähige Bach gefährdet im Unterlauf sowohl eine Bahnstecke als auch einen Straßenabschnitt. Im Zuge einer Erneuerung wurden auch „modernere“ Bauwerkstypen in Betracht gezogen.

Die Versuchsreihe zeigt eine Gegenüberstellung von flexiblen Barrieren zu herkömmlichen starren Bauwerken. Untersucht wurden die dynamischen Anprallkräfte an einer starren Sperre. Die Druckmessung erfolgte über 24 rasterförmig angeordneten Druckmesszellen. Durch diese Anordnung lässt sich ein zeitlicher und flächenmäßiger Belastungsablauf darstellen. Bei dem flexiblen Netzsperrren-Modell wurden jene Ankerkräfte gemessen die durch den Aufprall der Mure entstanden. In einem weiteren Schritt wurden die Basalöffnungshöhen der flexiblen Sperre untersucht um eine optimale Retentionswirkung zu erzielen. Aus den Versuchen lässt sich für die Dimensionierung ein empirischer Beiwert errechnen, der für die hydrodynamische Druckberechnung notwendig ist um jene notwendigen Ankerkräfte zu erhalten.

POST-VARISCAN TECTONIC EVENTS FAR NORTH OF THE ALPS RECORDED IN BRITTLE STRUCTURES

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Brittle tectonics, Fault kinematics, Intraplate deformation, Paleostress

Deformation of the earth's lithosphere is strongly localized along plate margins in which the fracture kinematic indicators of each brittle tectonic event are often obliterated by younger events through strong deformation and large rotations that make directional information ambiguous. By contrast, more stable plate interiors are potentially better recorders of fracture patterns induced by far-field tectonic stresses over large time spans. Central Europe has been located within the Eurasian plate by the end of the Variscan orogeny, affected by the Tethyan tectonic events and Alpine orogeny to the south and by the North Atlantic oceanic opening to the northwest during the Mesozoic-Cenozoic times. We investigated the fracture patterns and kinematics of the little deformed central European plate interior across Thuringia and surrounding areas in Central Germany using fault-slip data analysis and direct stress tensor inversion. Instead of the traditional approach of analyzing data subsets for individual outcrops, we considered the entire fault-slip dataset of the study area as a single site to better address the evolution of far-field tectonic stresses that were in vigor far north of the Alps. Based on superposition criteria such as relative tilt geometries between the brittle structures and successive striae on fault planes, we were able to establish a succession of brittle tectonic phases. The oldest phase represents a normal faulting regime of possibly Jurassic-Cretaceous age with a NE-SW-trending σ_3 axis. The deformation later changed to a strike-slip regime with a N-S-trending σ_1 axis, which in turn switched to a thrust faulting regime with a NE-SW-trending σ_1 axis, attributed to the Late Cretaceous-Paleocene inversion. Two younger events are characterized by a normal faulting regime with a NW-SE-trending σ_3 axis, related to the Oligocene-Miocene rifting, and an oblique thrust faulting regime with a NW-SE-trending σ_1 axis, consistent with the recent stress field as deduced from earthquake focal mechanisms and in-situ measurements. Our data hence evidence a progressive change in the direction of contraction from NE-SW to NW-SE within the European plate that coexisted with the structural evolution of the Alpine fold-and-thrust belt farther south.

HOW TO CORRELATE MIDDLE AND LOWER CRUST OF AN INVERTED PASSIVE MARGIN WITH DETACHED SEDIMENTARY UNITS IN AN OROGEN?

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rifting, passive margin, lower crust, evaporitic brine, break-up unconformity

The middle and lower crust (MLC) of passive continental margins is often preserved in thick-skinned tectonic wedges of mountain belts and is generally separated from sedimentary units. Recently, reflection seismic lines from the South American passive margin revealed boudinaged lower crust (Clerc et al., 2014, EPSL); crustal-scale normal shear zones may, therefore, potentially allow correlation with coeval sedimentary basins. In order to test this hypothesis, we studied the Permian to early Norian Meliata Ocean-related rift-characteristics of MLC and detached upper crust (UC) of the Austroalpine nappes of Eastern Alps. Further aims are to assess rift models, composition and temporal and spatial distribution of magmatism and correlation with sedimentary basins. In Austroalpine basement units, MLC includes metagabbro, mafic dykes, internally undeformed relics of high-temperature/low-pressure metamorphic complexes (ca. 0.46 GPa, 540 °C) here interpreted to represent relics of the MLC boudins. Furthermore, Permian and Triassic low-grade ductile shear zones with Ar-Ar sericite ages of 239 and 267 Ma were detected, too.

In Austroalpine units, the poorly dated rift-onset unconformity formed in Early/Middle Permian and resulted in ca. NE-SW striking halfgrabens filled with up to 1.5 km thick terrestrial clastics. In contrast to other units with thick clastic sediments, no or only thin Permian sediments on some „Middle Austroalpine“ units potentially reflects a Permian rift shoulder. First marine transgression occurred during latest Permian, carbonate deposition dominated starting with Anisian (loss of the clastic hinterland). We recently detected a break-up angular unconformity in central Northern Calcareous Alps (NCA) on top of tilted Lower Anisian Gutenstein Limestone and wedge-shaped Middle Triassic carbonates covered by Norian Dachstein Reef Limestone indicating the break-off and spreading in the Meliata oceanic tract. Rapid middle Triassic subsidence of Austroalpine sedimentary units is associated with stages of intense fluid flow and is evidenced by (1) early Anisian sedimentary iron mineralization, (2) recrystallization of evaporites (polyhalite Ar-Ar ages between 235 and 225 Ma and at ca. 210 Ma) and (3) abundant partly fault-controlled Ladinian-Carnian Pb-Zn-Ba-F mineralizations. Similar evaporitic brines also affected also the basement and formed magnesite and siderite deposits. Consequently, these peculiar features allow correlation of basemen with detached cover units.

LATE-STAGE MOTION OF ADRIA, FRAGMENTATION OF THE PERIADRIATIC FAULT AND THE STRUCTURE OF THE CENTRAL EASTERN ALPS

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Eastern Alps, Adriatic microplate, collision, orogeny, Periadriatic fault

In a new model, we explain the late-stage collisional structure of the Eastern Alps to record the effects of the mainly NNW-moving Adriatic microplate with frontal shortening along the ENE-trending Southalpine margin and NNW-directed indentation into sub-Tauern levels causing updoming of the Tauern window. Indenting Adria is confined by the transpressive NW-trending dextral NW-Dinaric-Möll Valley (DIMÖ) wrench corridor, and the NNE-trending transpressive Giudicarie fault in the west. No major change of motion direction of Adria is needed, therefore, to explain the observed structures. The location of the DIMÖ corridor has been potentially caused by lithological contrasts at lower crustal levels expressed by the SW-margin of the Pannonian fragment.

The new model allows explain the tectonic and surface structure of the central axis of the Eastern Alps. The units within the Tauern window change its strike from a dominant WSW-trend in the west to an ESE-trend in the east. The dominant WSW-trend is explained by the oblique NNW-directed indentation of Adria and the ESE-trend by clockwise rotation of the easternmost Tauern window, which is then cut by an E-W extension region.

The new model also explains the segmentation of the Periadriatic fault system (PAF) in the Eastern Alps. The mostly ESE-trending PAF, which is decorated by Oligocene tonalite lamellae, is transected by several faults, which are from west to east: (1) The sinistral, NNE-trending Giudicarie fault southerly adjacent thrust belt represent a transpressive zone. (2) The ca. 195 km long straight PAF is limited to the east by the dextral DIMÖ corridor (with ca. 4 – 6 km offset). (3) To the east, a positive flower structure straddles the PAF and the North Karawanken unit was transported over the intra-orogenic flexural Sarmatian-Pliocene Klagenfurt basin, which is cut by the dextral Lavant fault (ca. 10 – 15 km displacement). (4) East of the Lavant fault, the PAF juxtaposes the Pohorje basement in the north and the Sava fold area in the south shortened during Middle and Late Miocene times.

In this model, the location of the updomed Tauern window is the result of Adriatic indentation limited to the east by the DIMÖ wrench corridor.

INTERESTING GLASS COATINGS ON COBBLES AND ROCK FRAGMENTS FROM THE ALPINE FORELAND, SE-BAVARIA, GERMANY, AND THEIR POSSIBLE ORIGIN

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Chiemgau, metamorphic cobbles, glass-coatings

Glass-coated rounded and sharp-edged rock fragments 5 to 30 cm in size were found at a depth of 0.4 m to 0.7 m in the middle of a small rimmed crater-like structure (7 m diameter) [1]. The crater is located 2 km east of Lake Chiemsee on top of a moraine ridge formed in the last ice-age. The glass-coated rocks are gneisses and quartzites from the Alps. These glass coatings cover nearly the whole surface of the rocks, have a thickness of 0.01 to 1 mm and are transparent with a colourless to greenish hue. The majority of glass coatings are highly vesiculated and inside the rocks there is evidence for partial melting.

XRF-analyses of the whole rocks yield granitic to quartzitic compositions with SiO₂ ranging from 74 to 90 wt.-%. EDS analyses of the glass coating compositions on the rocks and cobbles show strong local variations for the same rock and there are differences between samples with 65 to 72 wt.-% and 75 to 96 wt.-% SiO₂. Based on the high SiO₂ contents of the glasses a temperature greater than 1600 °C can be inferred. The glass phase inside the rocks has a constant composition with small-scale compositional variation and differs clearly from the glass on the surface.

High potassium contents up to 15 wt.-% in the glass-coatings indicate an external melt source, e.g. soil ± organic matter.

The reasons for the presence of the two different glassy phases are presently unknown. Under discussion are a meteorite impact (impactites), a lightning strike (fulgurites) or an anthropogenic origin (e.g. formation in lime kilns).

[1] Neumair, A. & Ernstson, K. (2011): *Geomagnetic and morphological signature of small crateriform structures in the Alpine Foreland, Southeast Germany*. AGU Fall Meeting 2011, # GP11A-1023

METHODIK EINER INGENIEURGEOLOGISCHEN GEORISIKOANALYSE AM ISARHOCHUFER IM MÜNCHENER SÜDEN

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Massenbewegung Gefährdung Risiko Isartal

Das Isartal im Münchener Süden ist ein postglazial tief in quartäre Schotterterrassen bis in den neogenen Flinz eingeschnittener Canyon, an dessen Flanken Massenbewegungen verschiedenster Art und Ausmaß ablaufen. Diese umfassen Steinschläge bis Felsstürze ebenso wie die Erosion durch Rutsch- und Kriechprozesse bis hin zu Großrutschungen, wie an der Grünwalder Brücke. Aufgrund der in Bereichen sehr dichten und hangnahen Bebauung und Nutzung, wie beispielsweise in Grünwald oder Pullach, ist es erforderlich die Hänge ingenieurgeologisch und geotechnisch zu untersuchen, überwachen und im Hinblick auf den Gefährdungsgrad zu bewerten. Am Beispiel des westlichen Isarhochufers im Bereich der Gemeinde Pullach wird eine umfassende Georisikoanalyse dargestellt.

In diesem Beitrag werden Konzept und Schritte der ingenieurgeologischen Bearbeitung aufgezeigt. Eine ausführliche historische Recherche, ingenieurgeologische Detailkartierungen, Fernerkundungsmethoden, Monitoring, hydrogeologische Beobachtungen sowie geophysikalische Messungen und geotechnische Berechnungen spielen dabei eine integrale Rolle.

Die Ergebnisse finden Eingang in einen umfassenden geotechnischen Erläuterungsbericht und speziell erstellte und auf die regionale Situation angepasste Gefahrenzonenpläne. Mit deren Hilfe können Entscheidungsträger der öffentlichen Hand Fragestellungen der Bauleitplanung, Daseinsvorsorge und der Verkehrssicherungspflicht bearbeiten und zusammen mit Ingenieurgeologen belastbare Risikobewertungen erstellen. Eine Implementierung in das lokale GIS ist vorgesehen.

GRAIN SHAPE ANALYSIS OF MONOMINERALIC AGGREGATES BASED ON ENERGY DISPERSIVE X-RAY FLUORESCENCE MAPPING COMBINED WITH AUTOMATED IMAGE ANALYSIS

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EDXRF, Diffraction, Grain Size, Orientation, Automated Mineralogy

Grain size and grain shape analysis provides valuable information for understanding geological processes as well as improving mineral processing. In this study a μ -EDXRF spectrometer is used to obtain element distribution maps. The instrument is equipped with two silicon drift detectors mounted in $\pm 90^\circ$ to the Rh-X-ray tube with a polycapillary lens with a spot size of below 20 μm and operated at 50 kV and 600 μA under vacuum and a dwell time of 2 ms per pixel. Due to the polychromatic beam diffraction peaks will appear in the spectra for single crystallites according to Bragg's Law. Since diffraction depends on the angle of the crystal lattice, differently orientated crystallites will show different diffraction peaks. On the one hand this causes irritation for the element distribution maps. But, on the other hand this information can be used for separation of crystallites in monomineralic aggregates. Petrographic Analyst, a newly developed tool based on hyperspectral software, is used for mineral classification of the element distribution maps. Within one phase of interest a new classification is performed based on the diffraction data, which makes it possible to distinguish differently orientated grains within a monomineralic aggregate. This information can be used for calculation of grain size distribution for a selected phase as well as particle shape information without the need for preparing polished or thin sections.

AUTOMATED EDXRF BASED NOMENCLATURE FOR PLUTONIC ROCKS

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Plutonic rock nomenclature, EDXRF

Nomenclature of plutonic rocks is based on mineral contents. The ratios of quartz, alkali feldspar, plagioclase, feldspathoids and mafic minerals are required for a correct rock classification. Therefore, thin section microscopy and chemical analysis is used for mineral identification. Mineral quantification and modal mineralogy is a labor-intensive task. In contrast to that, energy dispersive X-ray fluorescence mapping (μ -EDXRF) is a fast and almost non-destructive method giving spatially resolved chemical information for large samples without the need for preparing thin sections. In this study a μ -EDXRF spectrometer with a Rh-X-ray source with a 17 μ m spot size and two silicon drift detectors (SDD) was operated at 50 kV and 600 μ m, providing element distribution maps. A series of plutonic rock slabs of 11 x 8 cm was mapped with a resolution of about 2000 x 3000 pixels and a dwell time of 2 ms per pixel. Newly developed hyperspectral analysis software, Petrographic Analyst, was used for mineral classification of XRF-maps providing mineral distribution maps. A supervised classification algorithm with a spectral database verified with thin section microscopy and microprobe analyses was used. On the basis of the mineral distribution maps the modal mineralogy is calculated and the rock is classified according to IUGS, plotted into a ternary diagram for granitoid, ultramafic or gabbroic rocks so that the proper rock name is obtained. Furthermore, classification according to the mafic constituents can be performed deriving the color index of the rock.

FROM EARLY CAMBRIAN ARC MAGMATISM TO JURASSIC RIFTING: TECTONIC EVOLUTION OF THE LOWER AUSTROALPINE SCHWARZHORN AMPHIBOLITE (EASTERN RÄTIKON, AUSTRIA)

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Lower Austroalpine, Jurassic rifting, pre-Alpine basement, U-Pb zircon geochronology, Rätikon

The geology of the Penninic-Austroalpine boundary in the eastern Rätikon is characterized by a north-dipping imbricate stack of very diverse rock units. The lowermost Middle Penninic Sulzfluh Nappe in the south is followed by the Upper Penninic Arosa Zone comprising flysch, mélange, ophiolite and serpentinite units. To the north, the serpentinite unit is overlain by a 4x1 km tectonic sliver of meta-diorite, known as the Schwarzhorn Amphibolite. Previous authors interpreted it either as a Penninic or an Austroalpine tectonic unit. Typical Austroalpine units with gneissic basement and Mesozoic sediment cover follow further to the North. The meta-diorite was deformed and metamorphosed in the amphibolite facies and is unconformably overlain by unmetamorphic Lower Triassic sandstone, indicating pre-Triassic metamorphism. The Lower Triassic sandstones and cataclastic fault zones in the meta-diorite are unconformably covered by Late Jurassic and Cretaceous post-rift sediments. Hence, the whole Schwarzhorn Unit represents a tilted fault block from the Jurassic rifted margin of the Austroalpine. A similar rift-related architecture is observed in the Lower Austroalpine Err and Bernina nappes further south. From lateral correlation of nappes, the Schwarzhorn Unit is most likely an extension of the Err Nappe. So far, the few geochronological data available for the basement protoliths of Lower Austroalpine units report Carboniferous and Permian intrusion ages.

Zircon dating of the Schwarzhorn Amphibolite using LA-ICP-MS gave a U-Pb age of 529⁺⁹—8 Ma, interpreted as the crystallization age of the protolith. Geochemical characteristics indicate formation of the magmatic protolith in a supra-subduction zone setting (Nilius et al. 2016). The Cambrian protolith age identifies the Schwarzhorn Amphibolite as a pre-Variscan element within the Austroalpine basement. Similar calc-alkaline igneous rocks of Late Neoproterozoic to Early Cambrian age are found in the Upper Austroalpine Silvretta Nappe nearby and in several other Variscan basement units of the Alps and are interpreted to have formed in a peri-Gondwanan active-margin or island-arc setting.

References

Nilius, N.-P., Froitzheim, N., Nagel, T.J., Tomaschek, F. & Heuser, A. 2016: The Schwarzhorn Amphibolite (Eastern Rätikon, Austria): an Early Cambrian intrusion in the Lower Austroalpine basement. *Geologica Carpathica*, 67, 2, 121-132.

PERMIAN DETACHMENT FAULTING AND SYNTECTONIC MAGMATISM CONSTRAINED BY U-PB LA-ICP-MS ON ZIRCON IN THE OROBIC ANTICLINE, ITALY

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Southern Alps, Permian, Detachment faulting, Extension, U-Pb LA-ICP-MS

The Grassi Detachment Fault is an Early Permian, low-angle extensional structure located in the Orobic Anticline. It separates the Variscan Basement in its footwall from the volcanic and sedimentary rocks of the Early Permian Collio Formation in its hanging wall. Its textures indicate a top-to-the-southeast displacement. The footwall basement consists of the Variscan Morbegno Gneiss and two granitoid intrusions, the Val Biandino Quarz Diorite (VBQD) and the Valle Biagio Granite (VBG). The former is syntectonic with respect to the detachment, whereas for the latter, the relation to the detachment is unknown. Volcanic rocks of the Collio Formation in the hanging wall may represent the extrusive part of the magmatic system.

In the study area in the western part of the Orobic anticline, several faults and shear zones are exposed: (1) The top-SE Grassi Detachment Fault. It is truncated by the unconformably overlying, post-rift, Late Permian Verrucano Lombardo towards the NW. This reflects the eroded culmination of a Permian metamorphic core complex. (2) The Sasso Rosso Fault, a steeply NW-dipping, brittle normal fault located in the footwall between VBQD and VBG. It is also sealed by the basal unconformity of the Verrucano Lombardo. (3) Several minor south-directed Alpine thrusts, duplicating the lithostratigraphy, including the detachment. (4) The Biandino Fault, a steeply SE-dipping Alpine backthrust, overprinting the detachment as well as the Alpine forethrusts.

U-Pb zircon geochronology using LA-ICP-MS yielded concordant ages of 293.2 ± 4.9 Ma for the VBQD and 286.0 ± 4.8 Ma for the VBG. These ages coincide with the beginning of the Collio volcanism and with the emplacement of mafic melts in the lower crust of the Ivrea Zone, indicating that the volcanics, granitoids and mafic intrusions belonged to a crustal-scale magmatic system. Since structural relations indicate contemporaneity of VBQD intrusion and extensional detachment faulting, it results that the Early Permian magmatism occurred in a framework of core-complex style extension.

ZUKUNFTSWEISENDES MINERALROHSTOFFKONZEPT FÜR SÜDTIROL

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Rohstoffgeologie, Bergbau, Mineralrohstoffkonzept, Südtirol

Der kommende Mineralrohstoffplan für Südtirol schreibt den 2015 ausgelaufenen Grubenplan weiter und stellt einen Fachplan des Landesentwicklungs- und Raumordnungsplan von Südtirol (LEROP) dar. Die Motivation bei der Ausarbeitung dieses Fachplanes ist ein verträgliches Gleichgewicht zwischen dem Versorgungsbedarf der Bevölkerung, der Planungssicherheit der Unternehmen, der Verfügbarkeit und Wirtschaftlichkeit in der Rohstoffnutzung und der Nachhaltigkeit und Umweltverträglichkeit in der Bewirtschaftung der lokalen Mineralrohstoffe zu erzielen. Achtsamkeit gegenüber Boden und Umwelt, sowie Schutz der Menschen und Ressourcen sind vorrangig.

Die im Januar 2016 von der Südtiroler Landesregierung genehmigten Leitlinien zum Konzept stellen den ersten Schritt zu einer überörtlichen Ressourcenplanung dar, an der sich die zukünftige Mineralrohstoffpolitik orientiert. Auf Basis von rohstoffgeologischen Erkenntnissen, welche durch die Neukartierung von Südtirol im Rahmen des Projektes CARG vorliegen, landschaftsökologische Rahmenbedingungen, Umweltaspekten sowie raumplanerischen Erhebungen, sollen diese ehrgeizigen Ziele erreicht werden.

Zentrale Punkte der Leitlinien und des Konzeptes beinhalten, dass neue Abbaugelände zukünftig in sogenannten Vorrang- und Vorbehaltsgebieten ausgewiesen werden. Diese Gebiete stellen Ressourcenschutzgebiete dar. Besondere Sorgfalt wird für mögliche Konfliktzonen, wie Siedlungsräume und Schutzgebiete gelten.

Vorranggebiete sind *Abbau- und Erweiterungsflächen an bereits bestehenden, aktiven oder inaktiven und alten Abbaustandorten*. Auch Siedlungsräume zählen zu diesen Gebieten, damit die Rohstoffe vor der Bebauung genutzt werden und nicht verloren sind.

Vorbehaltsgebiete sind *Freihalteflächen mit wertvollen Mineralrohstoffen, welche im Rahmen einer vorausschauenden Sicherung für zukünftige Nutzungen bewahrt werden*.

Um die beschriebenen Ziele zu erreichen und Abbaugelände anhand verschiedenster Eigenschaften bestmöglich und langfristig zu genehmigen, wird für die Überprüfung von Abbauprojekten ein Punktesystem mit unterschiedlichen Kriterien erarbeitet. In dieser Bewertung werden neben Abbaustandort, Rohstoffpotential und Qualität auch Kriterien wie Transportweg und Bedarf einfließen. Generell soll das Prinzip gelten, dass Genehmigungen mit größeren Vorräten und zukunftsorientierter Planung Vorrang gegenüber einer Vielzahl von kleinen Projekten gegeben wird. Neben der bestmöglichen, achtsamen Nutzung mineralischer Primärrohstoffe wird auch die zunehmende Verwendung von Recyclingmaterial als Baustoff unterstützt.

Die Kerngruppe zur Ausarbeitung der Leitlinien bestand aus Vertretern des Amt für Geologie und Baustoffprüfung, der Raumordnung und Landesplanung, der Umweltagentur, dem Landschaftsschutz, dem Amt für Umweltverträglichkeitsprüfung, dem Baukollegium und dem Amt für Industrie und Gruben. Beim Gesamtkonzept werden zudem Wirtschaftsvertreter, Umweltverbände und der Rat der Gemeinden mit einbezogen.

DER SERPENTINIT-KOMPLEX BEIM WEILER DUN UND SEIN TEKTONISCHER RAHMEN (SW´ TAUERNFENSTER, PFUNDERER TAL, SÜDTIROL)

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Serpentinit, Glockner-Decke, Tauernfenster, Blattverschiebungen, Titanklinohumit

Nördlich des Pustertals durchschneidet das obere Pfunderer Tal große Teile der penninischen Glockner-Decke des Tauernfensters senkrecht zum Streichen. Im Talschluss verzweigt sich das Tal beim Weiler Dun in zwei E-W-verlaufende Äste. In den Steilhängen nördlich über dieser Verzweigung des Pfunderer Bachs befindet sich in 1.700 bis 1.900m Meereshöhe ein linsenförmiges, konkordant in der steilen Foliation lagerndes Serpentinit-Vorkommen in Ost-West-Längserstreckung.

Nach der geologischen Karte von BAGGIO, DeVECCHI & MEZZACASA (1982) war es ca. 1.400m lang und 100-150m mächtig. Eine Neuaufnahme 1989 durch den Autor im Rahmen eines lagerstättenkundlichen Erkundungsprojektes der Fa. GRÜNIG Natursteine (Pfunders) ergab eine deutlich längere Ausdehnung. Hinzu kommt aber eine starke Segmentierung durch quer verlaufende, steilstehende Blattverschiebungen. Die bedeutendste davon ist die semi-duktilen Steinbergstörung mit ca. 250m sinistralen Versatz, die SW´ durch das gleichnamige Tal streicht, weiter östlich streicht eine weitere NW´ mit dextralem Versatz. Ein vertikaler Höhenversatz ist zusätzlich anzunehmen. Durch die Störungen begrenzt, entstand ein steilstehender, ca. 200m mächtiger Zentralkörper mit 2 jeweils nach Süden versetzten Seitenarmen, die nach Osten und Westen stark ausdünnen. Die gesamte erkundete Länge beträgt bisher 3.400m, wobei das Westende noch nicht bekannt ist. Der Serpentinit wird begleitet von Metagabbros, basaltischen Grünschiefern mit MORB-Charakter (DeVECCHI 1989) und Kalkglimmerschiefern/Kalkmarmoren, so dass man von einer Ophiolithabfolge sprechen kann. Das Entstehungsalter dieses penninischen Ozeanbodens beträgt vermutlich Unterjura bis Unterkreide und die alpidische Metamorphose erreichte die Grenze Obere Grünschiefer-/Amphibolitfazies mit etwa 550-600°C bei ca. 7 kbar (SCHULZ et al. 1994).

Der Serpentinit besteht überwiegend aus blättrigem Antigorit mit reliktschem Pyroxen (Augit, Diopsid), nur Dehnungsklüfte sind mit faserigem Chrysotil besetzt. Entlang von diskreten Kataklastizonen vertalkt das Gestein. Häufig in dünnen Lagen zu beobachten ist bis cm-großer, dunkelrotbrauner Titanklinohumit, dessen Erstbeschreibung 1855 durch Augustin DAMOUR (als péridot titanifère) an einem Fundstück aus dem Pfunderer Tal erfolgte.

Ca. 800m südlich des Serpentinites verläuft parallel ein dünner Horizont aus Dolomitmarmor- und Quarzitlinsen, der von LAMMERER et al. (1981) als Deckenscheider innerhalb der Glocknerdecke aufgefasst wird.

Der linsig-langgestreckte Duner Serpentinit nahe der Basis der Glockner-Decke in Verbindung mit weiteren Vorkommen weiter westlich im Streichen in gleicher Position (Burgum) markiert gleichfalls einen markanten Abscherungs- und Überschiebungshorizont im südwestlichen Tauernfenster.

ÜBER DAS STRATIGRAPHISCHE GRUNDGESETZ VON STENO UND DAS NATÜRLICH GESCHLOSSENE SYSTEM IN DER GEOLOGIE

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Mengentheorie, geometrische Relation, arithmetische Relation Totalordnung, Gesteins - Schichtgrenze

An einem einfachen Modell werden die mathematischen Eigenschaften des stratigraphischen Grundgesetzes dargestellt und über das Parallelenaxiom mit dem natürlich geschlossenen System in Übereinstimmung gebracht. Vom Wesen her gesehen, ist die Geologie mit der Begründung des stratigraphischen Grundgesetzes mengentheoretisch orientiert, indem mit der geometrischen Relation die Voraussetzungen zur Anwendung der Äquivalenzrelation gegeben waren. Durch den Nachweis der arithmetischen Relation im geologischen Bau von deformierten Strukturen des Deckgebirges (Subsalinar, Salinar, Suprasalinar) der Altmark wurde die Grundlage zur Darstellung des Sonderfalls einer Totalordnung nachgewiesen. Durch Salztektonek gestörte Strukturen des Typs der Altmark können vollständig durch Äquivalenzrelation in horizontaler Erstreckung mittels des stratigraphischen Grundgesetzes und durch die Totalordnung in vertikaler Erstreckung mittels des natürlich geschlossenen Systems beschrieben werden.

TRACE ELEMENT CONTENT OF SPHALERITE FROM EASTERN ALPINE PALEOZOIC SEDIMENT-HOSTED LEAD-ZINC-COPPER DEPOSITS

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lead-zinc-copper deposits, LA-ICP-MS

Silver-bearing Pb-Zn-(Cu) sulphide mineralization hosted within Paleozoic units of the Eastern Alps is known since Medieval times. Mining stopped due to the small size and the economic situation after the Second World War. The renewed interest in Pb-Zn deposits is driven by the incorporation of critical metals like Ge, Ga and In into the sphalerite lattice.

In the Austroalpine nappe system, SEDEX-type deposits occur in the Graz Paleozoic and the Gurktal nappe. In the Graz Paleozoic, Pb-Zn-Ba ores formed during the Lower Devonian in an euxinic basin structure associated with submarine alkaline volcanism. In-situ LA-ICP-MS measurements of sphalerite collected from five ancient mining sites and one exploration adit reveal a large variation of trace element concentrations with median values of 4.67 wt% Fe, 1832 ppm Cd, 138 ppm Co, 18 ppm Ag, 9 ppm Ga, 1 ppm In and 5 ppm Sb. Maximum values reach 220 ppm for Ge, 399 ppm for Ag and 83 ppm for In. Stratiform Pb-Zn-mineralization at Meiselding located in the Gurktal Nappe is classified as a metamorphically overprinted SEDEX-type deposit. Sphalerite carries up to 1900 ppm In, 250 ppm Ge, 65 ppm Ga, 282 ppm Co and 2.9 wt% Cd. The Pb-Zn mineralisation of Vellach-Metnitz in the same tectonic unit shows vein-like NW-SE striking tectonic structures. Sphalerite carries up to 65 ppm In, 924 ppm Ge, 381 ppm Ga, 679 ppm Co and 4380 ppm Cd. The Zn-Cu-Pb ores hosted by Paleozoic metavolcanic rocks next to Koprein (Karawanken Range) also represent a vein-type deposit of unknown age. LA-ICP-MS analyses of sphalerite gives up to 373 ppm In, 177 ppm Ga and 457 ppm Co; Cd ranges from 1495-3180 ppm, and Fe from 1.1-7.7 wt%.

Numerous small to medium-sized copper and "Kies" (pyrite) mineralizations are located in the Penninic and Austroalpine nappe systems. Literature data and preliminary LA-ICP-MS analyses indicate elevated concentrations of In, Sn, Sb, Co and Cu. The detailed study of trace element geochemistry in sulphide minerals from a large number of metal accumulations in different geological settings will add to the understanding of the complex metallogenic evolution of the Eastern Alps.

OPHIOLITISCHE KOMPLEX DER MIRDITA TEKTONISCHEZONE (ALBANIEN)

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Ophiolith, Mirditazone

Die Albaniden sind durch eine tektonische Linie in interne und externe Albaniden aufgeteilt und das ganze Gebirge ist durch westgerichtete Überschiebungen geprägt, welche die Grenzen zwischen den tektonischen Zonen bilden. Die internen Albaniden umfassen folgende geologisch-tektonische Einheiten (von Ost nach West): *Korabi, Mirdita, Gashi, Albano - Thesalianische Depression*.

Die externen Albaniden umfassen von Ost nach West die folgenden geologisch-tektonischen Einheiten: *Krasta-Cukali, Kruja, Jonische Zone, Sazani, Periadriatische Depression*.

Mirdita Zone

Die Mirdita Zone ist die prominenteste Einheit Albaniens und repräsentiert einen der grössten Ophiolit-Komplexe der Balkanregion. Aufgrund mehrerer petrologischer und geochemischer Beobachtungen können zwei verschiedene Ophiolitgürtel unterschieden werden:

West Typ (MORB) ist charakterisiert durch eine ultramafische Lherzolith-Harzburgit-Sequenz, gefolgt von einer plutonischen Sequenz mit Gabbros (Troktolith Typ) und einer basaltisch-vulkanischen Sequenz (MORB Typ), überlagert von Radiolariten.

Der Ost Typ (SSZ) ist mächtiger (bis 13 km) und setzt sich aus einer Harzburgit-Dunit-Sequenz, einer plutonischen Sequenz mit Gabbros (Gabbro-Norit - Plagiogranit), sowie einer vulkanischen Sequenz mit sheeted dykes und basaltischen Daziten zusammen, welche wiederum von Radiolariten bedeckt werden.

Die Obduktion der Ophiolite kann aufgrund der Alter der jüngsten pelagischen Sedimente (rotes Kalke mit *Saccocoma*, *Globochaeta alpina*, *Lenticulina* sp.), sowie $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronologie der metamorphen Gesteine im Kontakt mit den Ophiolitsequenzen („metamorphe Sohle“) auf mittlerer bis oberer Jura datiert werden.

Literatur:

Hans-Joachim Massonne, Friedrich Koller, Kujtim Onuzi P-T evolution of slivers of garnet-bearing micaschist in the sole of the Western Vardar Ophiolite Unit at Brezovica, Kosovo. Geophysical Research abstracts Vol. 18, EGU2016-7846-1, 2016, EGU General Assembly 2016

Theodoros Ntaflos, Kujtim Onuzi, Christoph Hauzenberger, A. Hugh N. Rice, Peter Proßegger, Nezir Mekshiqi and Gjon Kaza -The Mirdita Eastern Ophiolite, Albania: petrological evidence for MORB Mantle in the Tropoje peridotite massif? Geophysical Research abstracts Vol. 18, EGU2016-7846-1, 2016, EGU General Assembly 2016

OPHIOLITISCHE MELANGE DER KORÇA-REGION (ALBANIEN)

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Ophiolitick Melange

Die Albaniden sind ein geologischer Komplex, welcher die Dinariden im Norden und die Helleniden im Süden voneinander trennt. Im Zeitraum Oberjura bis Unterkreide wurde eine ophiolitische Melange gebildet.

Oberjurassische bis unterkretazische Ablagerungen (J3-Cr1) koennen in drei verschiedene Formationen gleichen Alters unterteilt werden: Es sind proximal pelagische Hangsedimente (Ton, Sandstein, vulkanische Effusiva) bis distal pelagische Hangsedimente (Sandstein-Mergelflysch) und wieder proximale Hangsedimente (Ophiolitmischung, Melange) zu unterscheiden.

Ophiolitische Melange ist in der Korça-Region sehr verbreitet (Gjanc, Leshnje, Vithkuq, Gjergjevice, Floq, Shipcke, Qafa Qarrit, Rakicke, usw.). Sie tritt im tektonischen Kontakt zwischen Ophioliten und Karbonatgesteinen auf. Oft sind sie sowohl über ophiolitischen wie auch karbonatischen Gesteinen (T3-J1) zu finden. In der ophiolitischen Konglobrekzie sind hauptsächlich ultrabasische Gesteine unterschiedlichster Grösse zu finden - von kleinen Stücken bis zu großen Blöcken. Innerhalb der ophiolitischen Melange sind Stücke von Gabbro, Vulkaniten, Amphibolit, Sandstein, Kieselschiefern, Radiolariten und selten auch von Trias-Jura Kalkstein zu finden.

Diese Formation ist von einer Mergel-Sandstein Wechselfolge J3t-Cr1v (Ujebardhe, Gjergjevice, Strelca) oder kretazischen terrigenen Ablagerungen (Polene,Voskopoje) bedeckt. Diese Formation wird in einem sedimentaer-tektonischen Prozess gebildet.

Literatur

- Onuzi K., Pirdeni A., Hoxha V.(2012)-Stratigraphische Daten (Trias-Jura) von Korcaregion (Blatt 42 Maliq, ALBANIEN) (Schriftenreihe der Deutschen Gesellschaft für GeowissenschaftenH. Hannover,2012)
- Alastair H. F. Robertson • Corina Ionescu •Volker Hoeck • Friedrich Koller • Kujtim Onuzi •Ioan I. Bucur • Dashamir Ghega,(Skoci2011)-Emplacement of the Jurassic Mirdita ophiolites(southern Albania): evidence from associated clastic and carbonate sediments(Int J Earth Sci (Geol Rundsch,DOI 10.1007/s00531-010-0603-5)
- Kujtim Onuzi & Jon Mosar GEOLOGIE IN DER BALKAN-REGION, ALBANIEN(Geologische Albanien-Exkursion 2014)

GEOLOGICAL MAPPING 1:50 000 (GG UND UTM) IN ALBANIA AND CORRELATION WITH THE NEIGHBOURING AREAS

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Geological Maps 1:50 000 scale, Albania, geological correlation, neighbouring countries

The territory of Albania consists of 103 topographic sheets 1:50 000 scale prepared by the Geographic Institute of the Army (GIA) in the Gauss-Krüger projection. Thirty-eight topographic sheets occur along the boundary with the neighbouring countries. The Geological Survey of Albania is working since many years to cover the territory of Albania with geological maps 1:50 000 scale in digital format. Each of the geological maps is accompanied by an explanatory text.

During the recent years, the European countries have converted the geological maps 1:50 000 scale into the Universal Transverse Mercator (UTM) projection. In 2010 by the IGEWE – GSA – GIA commenced a project to compile the geological maps 1:50 000 scale of Albania in the UTM projection based on the topographic sheets prepared by the Geographic Institute of the Army in cooperation with NATO experts. The territory of Albania consists of 56 topographic sheets 1:50 000 scale in the UTM projection.

The correlation of the geology and the preparation of the geological maps 1:50 000 scale and of the explanatory texts for each of the sheets will be completed for all the territory of Albania in 2012. In this way, for the interested public and private institutions are available geological maps on scale 1:50 000 accompanied by the explanatory texts.

These new geological maps 1:50 000 scale serve as a very good base for the interested public and private institutions as well as for other geoscientific studies in the field of hydrogeology, environment, geological engineering, metallogeny, seismic etc.

For the preparation of the geological maps 1:50 000 scale that occur in the boundary areas with the neighbouring countries (Montenegro, Kosova, Macedonia, Greece) there have been carried out geological correlations in cooperation with geological mapping experts from the respective countries.

ERRICHTUNG UND ÜBERWACHUNG HOHER BÖSCHUNGEN VON TUNNELAUSBRUCHDEPONIEEN BEIM BAU DES BRENNER BASISTUNNELS

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Tunnelausbruchdeponie, Einbaudichte, Hangüberwachung

Übersicht

Beim Bau des Brenner Basistunnels fallen ca. 17 Mio. m³ an Ausbruchsmaterial an, das in insgesamt fünf großen Deponien, welche sich auf das Projektgebiet verteilen, kontrolliert eingebaut wird.

Die beiden größten Deponien auf der österreichischen Projektseite, die Deponie Ahrental Süd (ca. 2,7 Mio. m³) und die Deponie Padastertal (ca. 7,7 Mio. m³) weisen Schütthöhen von ca. 35 m (Deponie Ahrental Süd) und 78 m (Deponie Padastertal) auf. Aufgrund der topografischen Bedingungen und der großen Schütthöhen ergeben sich Deponiekörper, die hinsichtlich ihrer Morphologie und Höhe aber auch aufgrund der Lage zu sensiblen Infrastrukturen und talseitigen liegenden Wohngebieten kontrolliert errichtet und überwacht werden müssen.

Ergebnisse Einbau

In der Deponie Ahrental Süd, welche sich südlich von Innsbruck am Eingang des Zugangstunnels Ahrental befindet, wurde bisher Ausbruchmaterial von Gesteinen der Innsbrucker Quarzphyllitserie eingebaut. In der Deponie Padastertal, welche sich nahe Steinach am Brenner (Wipptal) am Ausgang des Zugangstunnels Wolf befindet, wurde bisher Ausbruchmaterial von Gesteinen der Bündnerschieferserie eingebaut.

Der Einbau des Tunnelausbruchmaterials erfolgt lagenweise, die Mächtigkeit vor dem Verdichten beträgt 60 cm. Als Einbau- und Verdichtungskontrolle werden unter anderen folgende Kontrollen und Versuche durchgeführt: Dynamische Lastplattenversuche, flächendeckende kontinuierliche Verdichtungsmessungen mittels Walze, Messungen der Einbaudichte mittels Schürfgrubenverfahren und Troxlersonde.

Die Feldversuche zur Bestimmung der Einbaudichte des in-situ Materials zeigen, dass die Dichte in der Deponie Ahrental Süd (Innsbrucker Quarzphyllit) und der Deponie Padastertal (Bündnerschiefer) zwischen ca. 2,0 und 2,7 g/cm³ liegt und ein hoher Wiederverdichtungsfaktor erreicht wird.

Geodätische Überwachung der Deponiehänge

Die geodätische Überwachung der Deponiehänge erfolgt für verschiedene Schüttphasen bereits seit ca. fünf Jahren. Dabei werden mit dem Aufbau des Deponiekörpers sukzessive Messpunkte errichtet, Nullgemessen und in das Geomonitoring aufgenommen. Dadurch werden die steilen Böschungshänge beobachtet und Verformungen überwacht.

Fazit

Ziel des Vortrages ist es, die Ergebnisse und Erfahrungen beim Bau der Tunnelausbruchdeponien zu präsentieren, sowie Ergebnisse der Überwachung der Deponiehänge darzustellen.

IMPACT OF ESCAPE TECTONICS ON THE EVOLUTION OF THE AUSTRIAN-GERMAN ALPINE FORELAND BASIN

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foreland basin, Molasse, Eastern Alps, thrusting, subsidence

The Alpine foreland basin formed during Eocene collision. Two marine to continental megasequences fill the basin. The second megasequence is poorly understood, and different models have been put forward. I present a new model, based on the analysis of the Subalpine Molasse thrust belt east of the Rhine river.

The main characteristics of the Subalpine Molasse thrust belt are:

1. A frontal anticline/thrust started to develop during deposition of the older, marine portion of the second megasequence. Structural growth is documented by growth strata.
2. The thrusts in the Subalpine Molasse evolved in a break-back sequence.
3. The amount of shortening during deposition of the second megasequence reduces from 40-50 km near the Rhine valley to zero in the east in the Salzburg area.

The onset of the second megasequence in the foreland north of the Subalpine Molasse thrust belt is characterized by an angular unconformity documenting a tilt of the foreland toward the orogen, and therefore ongoing flexure of the lower plate. East of the eastern end of the Subalpine Molasse thrust belt, the deposits of the second megasequence are in a horizontal position, lower plate flexure had stopped.

In the internal part of the Alpine orogenic wedge, shortening, exhumation and E-directed stretching of the Tauern Window as a consequence of escape tectonics was active. Shortening was transferred from the Alpine front into the zone of lateral escape, causing the break-back thrust sequence at the Alpine front. Active thrusting in the Subalpine Molasse would bring the orogen closer the foreland, and increase loading of the foreland, but at a smaller rate, as material was continuously transported out of the zone of shortening by lateral escape.

The contemporaneous onset of the second megasequence of the foreland basin fill and of escape tectonics is therefore no coincidence. East of the Subalpine Molasse thrust belt, onset of lateral escape terminated shortening and thus lower plate flexure. Marine conditions in the lower part of the second megasequence, that exist also in the eastern part of the foreland basin, are therefore not dependent on flexure, but rather on reduced sediment input into the basin.

THE ZUGSPITZE CROSS SECTION AND THE STRUCTURE OF THE WESTERN NORTHERN CALCAREOUS ALPS

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fold-and-thrust belt, deformation partitioning

In a cross section of the southern part of the Northern Calcareous Alps between in the Inn and Loisach valleys across the Zugspitze, the Triassic reef complexes of the Wetterstein mountains in the north and the Mieming chain in the south are thrust onto Albian sediments. In spite of the comparable structure, the Wetterstein mountains have been correlated with the Lechtal thrust sheet. It was suggested that this unit was transported to its present-day position by a south directed backthrust. The main reason for this is that the Wetterstein mountains are in stratigraphic contact to their north-eastern foreland, and cannot be separated from the Lechtal thrust sheet. The Mieming chain, however, has been regarded to belong to the north-transported Inntal thrust sheet.

The main problem in the long-lasting controversy are the thrust models used. Previous authors tried to define thrust sheets that are completely separated by a thrust from their substratum, and were emplaced during a single shortening event. Thrusts can, however, loose offset and die out laterally. In the case of the Zugspitze, the thrust boundary of Triassic onto Albian rocks was exhumed by a younger out-of-sequence thrust that dies out toward the east, where shortening is taken up in a series of folds. Therefore, the Albian thrust in the Wetterstein mountains is continuous with the Albian thrust in the Mieming mountains, and the Lechtal and Inntal thrust sheets are not entirely separated.

Cretaceous thrusting has been associated with folds with NE- to ENE trending axes, contrasting Cenozoic shortening with WNW-trending axes. All folds in the Mieming range, the Wetterstein and Karwendel mountains have W- to WNW-axes, inspite of their position on top of a Cretaceous (Albian) thrust. A distinct change of fold axis direction is observed across the WNW-striking Höll fault. We suggest transpressive thrusting and deformation partitioning, causing the coexistence of NE-trending axes to the south and WNW-trending axes to the north of the Höll fault. Unfortunately, this eliminates the possibility to correlate shortening direction and fold axis orientation with deformation phases based on orientations.

SPELEOTHEMS DATE THE ONSET OF DSGSDS IN CRYSTALLINE ROCKS (VINSCHGAU, SOUTH TYROL)

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DSGSD, onset, Vinschgau, speleothems

The south-facing Sonnenberg slope of the central Vinschgau (Val Venosta) is widely affected (>50 km²) by deep-seated gravitational slope deformations (DSGSD) showing typical morphological structures including double-ridges, scarps, counterscarps and trenches.

The study area is characterised by three tectonic nappes of the western Austroalpine nappe stack and the low-angle Schlinig normal fault. In large parts the DSGSDs are developed within rocks of the Vinschgau shear zone, a Cretaceous intrabasement shear zone that mainly consists of mylonites and ultramylonites. The overlying Oetztal-Stubai nappe (mainly banded paragneisses) and the Matsch nappe (mainly gneisses, mica gneisses and schists) on top are only partly affected by the slope failures. Foliation dips into the slope (20-40°) and strikes in NNE-SSW to E-W direction.

Several springs along the lower section of the slope are supersaturated with respect to calcite/aragonite and/or iron oxyhydroxides, and carbonate precipitation occurs locally as tufas and fracture-filling flowstones. These carbonate precipitates within carbonate-poor crystalline rocks require extensive water-rock interactions, which are controlled by the geometry of the DSGSDs. Therefore, the oldest ²³⁰Th ages obtained on these carbonates constrain the start of a groundwater flow and consequently the onset of the DSGSDs.

A1: Deep seated gravitational slope deformations (incl. rockslides, rock avalanches, ...)

Talk

TESTING A BUCKLE FOLD MODEL IN THE THRUST BELT OF THE WESTERN NORTHERN CALCAREOUS ALPS

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Northern Calcareous Alps, thrust sequence, buckle fold model, Tirol, Allgäu

The Northern Calcareous Alps (NCA) are a typical thin-skinned fold-and-thrust belt in which thrusting was accompanied by sedimentation. Synorogenic sediments below a thrust allow to date the age of thrusting. Applying this concept shows that thrusting generally propagates from S(E) to N(W): the Aptian/Albian Lechtal thrust is followed by the Cenomanian, out-of-sequence Inntal thrust. The Allgäu- and Lechtal thrust sheets were emplaced onto the Cenoman-Randschuppe in Turonian. Finally, the NCA nappe stack reached the South Penninic Units in Turonian/Coniacian. However, growth strata in thrust-sheet-top deposits depict that shortening persisted after thrust sheet emplacement well into Cenozoic times.

Ramp-flat models are often used to visualize large scale thrust belt geometries. According to this model, upper-footwall deposits should accompany a thrust continuously. In fact these deposits are restricted to synclines in the footwall that do not affect the thrust, both the in-sequence Lechtal thrust as well as the out-of-sequence Inntal thrust. Therefore, the ramp-flat model is probably not appropriate.

Folds observed in the NCA typically show rounded hinges and are floored and cored by evaporites, which favours folding by buckling. Therefore we propose the structural evolution of the NCA thrust sheets in the following sequence:

- (1) buckle folding with amplitudes decreasing toward external folds
- (2) locking of internal folds that have reached a minimum opening angle
- (3) nucleation of a new thrust across locked folds
- (4) thrust propagation through existing and probably still growing folds.

This model could explain many peculiarities of the NCA thrust belt, such as truncation of folds by a thrust on top or at the base, pieces of hanging-wall units below thrusts and footwall folding also below in-sequence thrusts. We test the applicability of the buckle fold model within the work of two master theses located in an internal (Lechtal thrust) and an external part (Falkensteinklippe, Cenoman-Randschuppe) of the NCA thrust sheet by:

- extensive structural field analysis to elaborate a better understanding of structure evolution in time,
- retro-deformation of cross sections to demonstrate that unfolding of the thrusts does not eliminate entire folding,
- measuring and comparing fold amplitudes to corroborate decreasing amplitudes toward external folds.

TONMINERALOGIE UND INGENIEURGEOLOGIE – WIDERSPRUCH ODER ERGÄNZUNG?

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Tonmineralogie, Ingenieurgeologie

Die Tonmineralogie befasst sich mit der Zusammensetzung und den Eigenschaften von Feinkornsedimenten, Rohstoffen und Böden. Tonminerale sind häufige Bestandteile der Tonfraktion in verschiedensten Ablagerungsmilieus wie Wüsten, Meeresböden, Vulkanablagerungen usw. Ton ist ein wichtiger Bestandteil von vielen Sedimentgesteinen wie z. B. Lehm, Mergel, Sandstein, Löss - seit dem Proterozoikum bis ins Känozoikum. Die große Mannigfaltigkeit der Tonminerale und deren sehr unterschiedliche Eigenschaften sind in ihrem mineralogischen Aufbau begründet. Die unterschiedlichen Strukturen sind auf die Kombinationsmöglichkeit von nur drei Grundbausteinen zurückzuführen: Tetraeder, Oktaeder und Zwischenschicht. Durch unterschiedliche Anordnung und Kombination dieser drei Komponenten, sind alle bekannten Tonminerale definiert.

Eine besondere Eigenschaft der Tonminerale - im speziellen der Smektite - ist deren sehr geringe Teilchengröße und die Quellfähigkeit. Die Korngröße der Smektite liegt meist unter $0,2\mu\text{m}$. Aufgrund dieser Feinheit weisen sie eine sehr große Oberfläche auf. Eine weitere Besonderheit ist neben der äußeren Oberfläche die noch viel größere innere Oberfläche. Diese innere Oberfläche liegt zwischen den silikatischen Tetraederschichten und ist für das Quellverhalten von großer Bedeutung. Die innere Oberfläche von Smektiten kann bis zu 800 m^2 je g betragen.

In der Ingenieurgeologie und Bodenmechanik ist Ton ein extrem gefürchtetes Sediment, wenn es um Fragen der Belastbarkeit und Stabilität geht. Bedingt durch die kleine Teilchengröße und die starke Quellfähigkeit können die sehr geringe Scherfestigkeit und Kohäsion besonders bei Massenbewegungen zu kritischen Situationen führen. Durch die Neubildung von Tonmineralen in Störungen und Scherzonen können die Gebirgseigenschaften stark beeinflusst werden (Riedmüller, 1978).

Röntgenbeugung (X-ray diffraction - XRD) ist die wichtigste Methode zur Mineralbestimmung. Ein Röntgenstrahl wird mineralspezifisch an der Kristallstruktur gebeugt und kann zur Identifizierung genutzt werden. Besonders im Bereich der Tonmineralogie kann die Röntgendiffraktometrie durch keine andere Methode ersetzt werden (Moore & Reynolds, 1989).

Der Aufwand an sedimentpetrografischen Analysenmethoden nimmt bei klastischen Sedimenten mit abnehmender Korngröße überproportional zu, besonders in methodischer und apparativer Hinsicht.

MOORE, D.M., REYNOLDS, R.C. Jr., 1989. X-Ray diffraction and the identification and analysis of clay minerals. - 332 S, Oxford University Press, New York.

RIEDMÜLLER, G. (1978): Neoformations and Transformations of Clay Minerals in Tectonic Shear Zones. - Tschermarks Min. Petr. Mitt. 25, 219-242, Springer, Berlin, Heidelberg, New York.

MAGMATIC EVOLUTION OF MECİTLİ GRANITOID IN THE NORTH OF LAKE VAN BASIN, EAST ANATOLIA, TURKEY

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East Anatolia, Mecitli granitoid, geochemistry, petrology

Geochemistry and petrology of the Mecitli granitoids exposed in the northeast of Lake Van are presented in detail. Mecitli granitoid is igneous intrusion that shaped slab and covers an area about 80 km². Mecitli granitoid cutting serpentinites and metamorphic schists is covered by youngest volcanic rocks. Our Ar/Ar geochronologic age data revealed that Mecitli granitoid is aged 23 Ma and occurred in Miocene in contrast to known Cretaceous age. While Mecitli granitoid range in composition from subalkaline monzonite to granite, mafic microgranular enclaves (MME) having transition and subalkaline characteristics are characterized by monzogabro to quartz monzodiorite compositions.

Mecitli granitoidi and MMEs contains Quartz, Plagioclase, orthoclase, hornblende and biotite minerals. Samples of the Mecitli granitoid displays holocrystalline and hipidiyomorphik textures, whereas MMEs are characterized by fine-grained holocrystalline and ophitic texture.

Major, trace and rare earth element concretion and Sr, Nd and Pb isotopic ratios of the Mecitli granitoid and MMEs suggest that they are derived from same magma but are exposed to different magmatic evaluation processes. Multi element spider and isotopic variation diagrams of the Mecitli granitoidi and MMEs imply that source regions of these rocks had previously been enriched by a distinct subduction component and might have been with partial melting of source rocks like amphibolite and/or metabasic.

PETROLOGIC EVOLUTION OF PLATEAU VOLCANISM IN THE NORTH OF AGRI, NE TURKEY

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Eastern Turkey, petrology, volcanism, geochemistry

Plateau volcanism located in the 10 km north of Ağrı has covered an area of approximately 900 km². Lavas of the volcanism having broad compositional range from basalt to dacite erupted up to from Pliocene to Quaternary times, displaying alkali and transitional characteristics.

Mafic lavas of the plateau volcanism are mainly composed of olivine, plagioclase, clinopyroxene, orthopyroxene and opaque minerals whereas, felsic ones are consisting of plagioclase, clinopyroxene, orthopyroxene minerals within a glassy matrix. Common textures are porphyritic, intersertal, hyalopilitic and glomeroporphyritic.

The negative anomalies of HFS over LIL and LRE elements such as in Nb and Ta compositions reveal a subduction modified mantle source for Cumaçay Volcanism. Major, trace and RE element systematics indicate importance of fractional crystallization, magma mixing and crustal contamination on the crustal evolution of Cumaçay volcanics. MELTS models have also revealed that chemical differentiation from a hydrous parental mafic magma could be produced at a pressure 1-2 kbar beneath Plateau. To test the viability of the mixing/replenishment process, we conducted a least square mass balance calculation using the major element concentrations of most primitive basaltic sample and a number of evolved samples from plateau volcanism. Results of our mixing models revealed that andesitic and/or basaltic-trachyandesitic lavas of plateau volcanism might have been formed as a result of mixing between primitive basaltic and evolved dacitic lavas. We argue that this interpretation is statistically important because Σr^2 values vary between 0.4 and 0.6.

REE modelling indicates Cumaçay volcanics were products of mixing of melts from spinel and garnet lherzolite sources, with abundant contributions of melts from subduction enriched lithospheric mantle relative to asthenospheric mantle.

CARBON ISOTOPE STRATIGRAPHY ACROSS THE TRIASSIC-JURASSIC BOUNDARY: BUILDING A GLOBAL STACK FOR CORRELATION AND TRACKING CARBON CYCLE DYNAMICS

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Triassic-Jurassic boundary, carbon isotope anomaly, chemostratigraphy

The Triassic-Jurassic boundary (TJB) immediately follows the end-Triassic extinction event, which is one of the five major Phanerozoic mass extinctions. Similarly to the other four events, the TJB is also marked by one or more prominent carbon isotope excursions (CIE). Since their first recognition in three independent studies in 2001-2002, a large amount of data has been assembled which prove that CIEs are recorded in both terrestrial and marine boundary sections, marine strata of different depositional settings, and in both carbonate and organic matter. However, no systematic review of these data has been attempted to date, even though controversies persist in $\delta^{13}\text{C}$ -based stratigraphic correlation, and the processes and causes of the underlying carbon cycle perturbations remain debated.

Here we address these issues using a compilation of a global $\delta^{13}\text{C}$ dataset from sections which span at least parts of the Rhaetian and Hettangian stages. Our underlying age model uses a modified version of GTS 2012, with a notable update concerning the age of the Norian-Rhaetian boundary, leading to a shorter duration of the Rhaetian. Astrochronology is used to provide additional estimates of durations of chronostratigraphic units. Correlation of the sections is achieved through an integrated web of independent ammonoid, conodont, radiolarian, foraminiferan and palynological biostratigraphies and magnetostratigraphy.

A synoptic view of the global $\delta^{13}\text{C}$ stack allows a critical assessment of the reproducibility and global or regional significance of previously identified CIEs, including a Rhaetian precursor CIE, the latest Rhaetian initial negative CIE, the main negative CIE at the TJB, and one or more positive CIEs in the Hettangian. Clearly, not all of the above CIEs are recorded uniformly in different substrates, environmental settings or paleogeographic regions, warranting caution in the use of $\delta^{13}\text{C}$ in chemo-stratigraphic correlation.

Overall, the new global compilation will contribute to a better understanding of the processes and causes of carbon cycle perturbations across the TJB. Features of the global stack are compared with the predicted effects of previously proposed mechanisms of volcanogenic CO_2 degassing, methane release, reduction of primary productivity, changes in shallow marine carbonate production, changes in the burial rate of organic carbon and other scenarios.

A NEW LITHO- AND CHEMOSTRATIGRAPHICAL CONCEPT FOR THE MIOCENE LOWER AUSTRIAN MOLASSE BASIN (LAMB)

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Molasse, Lower Austria, Traisen Formation, CMI, Ottnangian

The Lower Austrian Molasse Basin (LAMB) situated between the Bohemian Massif, the Waschberg-Zone and the easternmost Alpine thrust units constitutes a key position for the evolution of the Eastern Alps and the Alpine foreland basin in the transition to the Western Carpathians.

There, up to 2000m thick Miocene sediments occur which are dominated by fine grained pelitic “Schlier-type” sediments and thick sand-dominated strata with a highly homogeneous composition and fossil content. Therefore, a distinction of several units remained difficult and problematic in the past.

An OMV funded project investigated drill cores throughout the LAMB and compared the results with the “surface geology” and its proposed terminology.

Profiles of carbonate content, XRD, XRF, whole rock chemistry, clay minerals, calcareous nannoplankton (CNP) and dinoflagellate cysts were investigated. The lack of good age constraints (especially microfossils) remains most challenging for such investigations.

4 stratigraphic signals can be correlated throughout the basin:

- Carbonate Minimum Interval (CMI): A calcite and fossil-poor to -free interval with increased smectite and reduced pyrite contents.
- Bioturbated Sandstone: A prominent unit of bioturbated sediments interpreted as major transgression horizon.
- Onset of Mica Sedimentation (OMS): The increasing (topwards) mica contents mark a change in lithological and chemical composition and a shift in provenance.
- Basal Kaolinite Enrichment Zone (BKEZ): Enrichment of kaolinite and several elements are related to the basal boundary to the Pre-Neogene Basement.

A new lithostratigraphy is proposed which can be used in case of poor or missing chronostratigraphical or biostratigraphical data. In this concept, the CMI marks an environmental crisis due to the narrowing (and isolation) of the LAMB during the uppermost Ottnangian with the sand-dominated **Traisen Formation** in the S and the pelitic **Zellerndorf Formation** in the north. Sediments overlying the CMI can be attributed to the Karpatian **Laa Formation**. “Schlier-type” sediments underlying the CMI represent the **Robulus Schlier** (frequently used working term). The **Bioturbated Sandstones** (working term) mark the lower boundary of the pelitic Schlier-succession. The underlying quartz and K-feldspar rich and mica poor sands were summed up as **Basal External Sands** (working term, comparable to Linz-Melk Formation but of uncertain age).

STRUCTURE OF THE ELBA ISLAND: CONSTRAINTS FOR THE TECTONIC EVOLUTION OF THE NORTHERN TYRRHENIAN SEA

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Elba, Northern Apennines, Miocene, thrust, tectonics

The Northern Tyrrhenian Sea (NTS) belongs to the hinterland portion of the Northern Apennine belt. This area was in turn affected by the formation of Apennine wedge during the Oligocene followed by nappe stacking, normal faulting, out-of-sequence thrusting, basin development and magmatism during the Miocene-Pliocene. Such complex evolution led to contrasting interpretations on the geodynamic setting of the NTS: 1) a back arc basin in which magmatism is a result of adiabatic mantle and lower crust rise¹; 2) an area under crustal shortening, where extensional features are confined to upper crustal levels and are expression of internal wedge reequilibration².

The Elba Island, located in the middle of the NTS, is invaluable to understand the tectonic evolution of this sector. Elba is characterized by a first-order nappe stack that was intruded by Late Miocene plutons and subsequently cut by brittle faults, in particular by the Zuccale Fault (ZF), which has been classically regarded as a low angle extensional fault.

Recent research conducted in Eastern Elba highlighted that shortening characterized the Middle-Late Miocene period (post 14 Ma) with out-of-sequence thrusting involving the whole nappe stack³. Furthermore the contact aureole of the Porto Azzurro pluton (5.9-6.7 Ma⁴) is affected by ductile to brittle thrust shear zones and widespread deformation, coeval with thermal peak. The brittle overprint over ductile structures is a consequence of the vanishing thermal pulse and proves that thrusting over lasted the end of thermal anomaly. This architecture is lately displaced to the East by the flat lying ZF⁴.

The reconstructed geometry holds strong implications for the Miocene-Pliocene evolution of the area. The relationships between magmatism and deformation suggest that the ductile to brittle evolution of Eastern Elba occurred during crustal shortening. In this framework the ZF can be explained, consistently with the overall deformation, as the flat portion of a large scale thrust system.

References

¹Rosenbaum, G. & Lister, G.S. 2004. *Tectonics*, 23.

²Bonini & Sani, F.(2002). *Tectonics*, 21.

³Massa, G. et alii (2016). *Geol. J.*

⁴Musumeci, G. Et alii (2015). *Tectonics*, 34.

INTENSITY PREDICTION EQUATION AND EVENT EPICENTER DETERMINATION FOR AUSTRIA

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ShakeMap, hazard, empirical model

Equations that predict intensity as a function of magnitude and distance, among other parameters, are useful tool for hazard and risk assessment.

This study aims to determine an empirical model of the ground shaking intensities (ShakeMap), as well as the epicenter of a series of earthquakes occurred in Austria between 1411 and 2014. Furthermore, the obtained empirical model will lead to further interpretation of both, contemporary and historical earthquake.

A total of 285 events, which epicenters were located in Austria, and a sum of 22.739 reported macroseismic data from Austria and adjoining countries, were used. These events are enclosed in the period 1411-2014 and are characterized by having a local magnitude greater than 3. An individual number was assigned to each reported intensity value. On the other hand, a specific number characterizes the event itself. Moreover, information about the local magnitude of the earthquake, the distance from the reported location to the epicenter, the epicentral intensity, the location of the reported intensity value, and the coordinates of the earthquake (latitude, longitude and depth), were evaluated for the computation of the model.

Further development of the model will be presented in the poster.

SUBDUCTION INITIATION, METAMORPHIC SOLE FORMATION AND ROLL-BACK PROCESSES FOR GENESIS AND EMPLACEMENT OF TETHYAN OPHIOLITES IN TURKEY

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Tethyan ophiolites, metamorphic sole, dyke emplacement, rollback, subduction initiation

Several east-west trending suture zones are separated by continental blocks, metamorphic core complexes and the sedimentary basins in Anatolia. Tethyan ophiolites and related units are exposed along these suture zones. They were generated above north-dipping intra-oceanic subduction zones (SSZ-type) in different oceanic basins and emplaced southward in late Cretaceous as a result of series of collisions of intraoceanic arc-trench systems with the continental margins. The ophiolitic units display well-preserved oceanic lithospheric sections (i.e. mantle harzburgites, cumulates, isotropic gabbro, sheeted dykes and extrusives) and are in turn underlain by metamorphic soles and accretionary melanges with local blueschist assemblages. Island arc tholeiitic (IAT) and boninitic magmas make up the crustal architecture of the Tethyan ophiolites in a forearc setting.

Subduction initiation and roll-back processes could best explain the structural and petrological relationships of the ophiolites genesis, metamorphic sole formation and subsequent dyke emplacement for the Tethyan ophiolites. During the subduction initiation, mainly OIB-like alkaline and MORB-type tholeiitic basalts were accreted to base of overriding oceanic plate and metamorphosed under amphibolite facies conditions about 96-90 Ma. Following the subduction initiation and metamorphic sole formation, old and dense lithosphere sinking into the asthenosphere rolls back and the metamorphic sole was attached to the base of the overriding plate. Hot asthenosphere flows upward into the region above the sinking plate margin. Crustal formation is fed by melts, including both boninitic (high-Mg andesites) to island arc tholeiitic magmas and leaving a refractory harzburgitic mantle tectonite. After ~2 my, post-metamorphic isolated dykes intruded the metamorphic sole and the overlying oceanic lithosphere (91 to 86 Ma). The isolated dykes cut the primary tectonic contact between the metamorphic sole and the harzburgitic mantle tectonites. This contact is interpreted to indicate a primary intraoceanic decoupling surface along which the volcanics on the top of the down-going slab were metamorphosed up to amphibolite facies and attached to the base of the hanging wall plate. The isolated dykes are not observed in the ophiolitic melange, suggesting their intrusion prior to melange formation and subsequent ophiolite emplacement onto continental margins.

COOLING EFFECT OF THE COARSE, BLOCKY TOP LAYER AT TWO DIFFERENTLY ORIENTED RELICT ROCK GLACIERS, AUSTRIAN ALPS

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rock glacier, temperature, blocky layer, aspect, convection

The thermal effects of coarse blocky top layers in alpine environments are investigated at two relict rock glaciers (Niedere Tauern Range, Austria). The mean annual ground temperature of blocky layers can be up to several degrees lower than the mean annual air temperature because dense cold air can easily infiltrate the debris during cold periods, whereas warm air is preferentially escaping. Furthermore, thermal convection of air within the debris can occur, especially during winter when the surface is snow covered. Therefore, landforms like rock glaciers enable permafrost to exist at lower elevations than expected based on air temperature. The two rock glaciers investigated in this study (SRG, DRG) are located in two adjacent alpine cirques and are comparable in size and geology although their genesis is different. A further difference between them is their orientation: SRG faces towards N-NE, DRG towards S-SW. Air- (AT), ground surface- (GST) and ground temperature (GT, at 1m depth) have been recorded over a continuous period of four years at several locations on both rock glaciers. The data show that for comparable elevations the mean annual AT is higher at DRG, but GT and GST are lower compared to SRG. One of the locations of DRG even shows a mean annual GT $<0^{\circ}\text{C}$, indicating the possibility of permafrost patches at this rock glacier. Estimates of the Rayleigh number indicate that thermal convection of air during winter time is common at both rock glaciers but more distinct at SRG. Moreover, the analysis of wind data from an automatic weather station situated on SRG suggests that wind-forced convection occurs if the wind speed exceeds a threshold of 3m/s. Numerical simulations show that convection of air in the pore space of the debris is an important process of heat transfer, whereas conduction within the rocks is negligible. The colder temperatures within the DRG are likely to be explainable by the aspect of the rock glacier, which might influence the GT as sun-exposed sites show in general a later appearance and earlier melting of continuous snow cover and therefore enable cold air to infiltrate for longer periods of time.

CAVITY DETECTION WITH FULL-WAVEFORM INVERSION AT MOUNT ERZBERG, AUSTRIA

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cavity detection, full-waveform inversion

The detection, and mapping, of subsurface cavities is an important task, primarily because the potential collapse of a cavity poses a hazard to infrastructure and residents. Cavities can be created naturally through chemical erosion. Man-made cavities include tunnels from abandoned mining, old basement structures from demolished buildings, tunnels created for illegal activities, and cavities produced through a nuclear weapon test.

Whether filled with air, or water, the material contrast of a cavity to the surrounding rock, or soil, is typically strong enough to provide a significant signal in many geophysical measurements. The challenge lies in the size-to-depth-ratio of most cavities, which is at, or below, the resolution capacity of most geophysical methods. In this project, we test several geophysical methods for their application potential in an open pit mine at Mt Erzberg, where maps indicate a ~4 m wide tunnel from abandoned subsurface mining in ~25 m depth.

This study focuses on seismic cavity detection with SH reflection seismics and P-SV elastic FWI.

The first stage of our studies is the forward-modelling of synthetic data on a smooth velocity model determining the frequencies and offsets for the acquisition. The acquisition is planned for July 2016, and we intend to present the data and a first analysis of its suitability for our study.

PERMIAN MAGMATISM AND METAMORPHISM IN THE ALPS: INSIGHTS FROM THE CAMPO UNIT (AUSTROALPINE NAPPES, N ITALY, SE SWITZERLAND)

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Austroalpine nappes, Gabbro, Contact metamorphism, Permian

The final stage of the Variscan orogeny (310-270 Ma) is characterized by an intense tectonic, magmatic and metamorphic event. During the Permian, acid and mafic intrusions were emplaced at all crustal levels and are associated to high-temperature contact metamorphism. While most of the studies focus either on the formation of Permian basins or on the lower crustal magmatic and metamorphic evolution, the characterization of the middle crust is lacking. Therefore, this study aims to unravel the processes active at mid-crustal levels during the Permian. We investigate the evolution of the Sondalo gabbro emplaced in a mid-crustal position during the Permian, exposed in the Austroalpine Campo unit. By linking structural geology, metamorphic petrology and geochronology, we constrain the P–T–t–d effects of the Sondalo gabbro emplacement on the Campo unit.

The country rock of the gabbroic intrusion is composed of Grt–St micaschists and paragneisses attesting of a Carboniferous prograde P–T path during the formation of S1 and S2. The heat brought by the Permian intrusives subsequently caused heating of the Campo unit at around 3–4 kbar/540°C. During the intrusion of the Sondalo gabbro (289–285 Ma, U–Pb ages on Zrn) a steeply N- or S-dipping magmatic foliation is developed parallel to the S2 regional fabric. Thermal peak conditions are recorded by Grt–Sil–Spl–Crd–Ilm granulitic xenoliths at ~5.5 kbar/930°C, subsequently exhumed at ~4 kbar during the formation of a magmatic foliation localized in the rim of the pluton and moderately dipping away from the centre of the pluton. In the migmatitic contact aureole, Grt–Sil–Bt–Pl–Qtz–Ilm and Grt–Sil–Crd–Spl–Bt–Kfs–Ilm residual rocks bear the new foliation (S3) and document a decompression from 6 kbar/750°C to 5 kbar/725°C and from 5.2 kbar/800°C to reach 4.8 kbar/770°C, respectively.

Altogether, our results bring new constrains on (1) the thermal and mechanical relation between the pluton and the host rock in the middle crust, and (2) on mechanisms of mafic magma transport and emplacement in the crust.

HYDROGEOLOGICAL INVESTIGATIONS IN SOUTH-EASTERN BUCKLIGE WELT, LOWER AUSTRIA

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hydrogeology, hydrochemistry, isotope hydrology, groundwater protection, Bucklige Welt

The study describes the hydrogeological situation of the Bucklige Welt region in south-eastern Lower Austria. This included the assessment of yield and dynamics of shallow aquifers as well as the quantification of hydro-chemical and isotope-hydrological parameters. Sedimentological and geochemical studies accompanied the investigation. Results provide the basis for future water supply and management actions in the region.

The study area represents a low mountain range with high plains used for agriculture and valleys mostly covered by forests. Average annual precipitation ranges between 820 and 990 mm, linearly proportional to the altitude. Hydrogeologically, the area is dominated by gneisses and schists which represent fracture aquifers of low yield (6–8 l/s/km²). Locally, quartzites and calc-schists show higher groundwater yield (10–12 l/s/km²) while mica schists and phyllites yield less groundwater (< 4 l/s/km²). The tectonic basin of Krumbach is filled with fine-grained Neogene sediments which constitute porous aquifers with 5 l/s/km² yield on average. More productive aquifers occur in alluvial valley fills.

Fracture aquifers usually exhibit small catchment areas fed by rainwater and interflow. This results in a strong dependency on weather conditions and sporadic supply shortages during dry seasons. After rain events, spring discharge can rise 2- to 4-fold within 1–3 days, going back to base flow after 2–5 days. ¹⁸O-data indicate mean groundwater residence times between 0,5–2 years (1,5 years on average).

The amounts of total dissolved solids in groundwater range between 3–5 meq/l for most rock types. Groundwater in some Neogene sediments show values of ≤ 2 meq/l, in calc-schists and marble 8–12 meq/l. After rain events, these values can drop by 12%. Heavy metal concentrations mostly lie below geogenic background values, only aluminium, iron and manganese contents occasionally exceed limits for drinking water.

Soils and weathering zones are generally ≤ 2 m thick with low storage capacity and high permeability. Only soils in valleys or weathering zones overlying paragneiss can be more fine-grained and retain more water. Thus, the aquifers are generally not covered by protective surface layers. In this context, the ubiquitous illegal deposits of household waste in creeks are cause for concern.

GIS-DERIVED RESOURCE QUALITY OF ALLUVIAL FANS, VALLEY FILLS AND DEBRIS CONES IN AUSTRIA

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aggregates, raw material quality, forecast, GIS, renewable resources

In alpine regions, alluvial fans, valley fills and debris cones represent natural aggregate resources of economic importance. Due to continual erosion, they constitute renewable sources of sand and gravel. However, not all material is equally suitable for the construction of roads or buildings. Usability depends on grain size distribution, sorting, roundness and mineral composition. These parameters in turn depend on the rock types in the provenance area, on the mode and distance of transport and on the depositional environment.

A previous study developed GIS routines to derive the morphology and geology of the provenance area of a given deposit, and explored how far results can serve as an indicator for aggregate quality. Now, these routines are applied systematically within the Austrian Alps, and deposits are described with the derived information. Altogether, over 17,600 deposits were processed and morphological parameters (surface area, altitude range, slope angle and transport distance) as well as geological information (rock types and their respective area percentages) were calculated for each provenance area. Results were then translated into aggregate quality forecasts.

To verify the forecasts, GIS results were compared to data at 215 debris dams where the composition of accumulated material is known. In addition, 59 deposits were sampled and petrographically analysed through visual determination of rock types and automatic measurements of grain geometry using a PetroScope. This instrument derives grain size, shape, angularity and sorting with the aid of optical cameras. Together, the data allow the analysis of grain geometry as function of rock type and grain size.

Results show that the litho-spectrum of gravel deposits can be predicted from provenance area geology with 80–95% accuracy on average. In addition, median grain size, sorting and shape can be reliably estimated from depositional environment, travel distance and lithological composition. Although these estimates cannot replace tests for mechanical quality, they can serve as a first selection criterion to assess the suitability of gravel resources.

BAYESIAN FUSION OF GEOPHYSICAL DATA-SETS: HOW TO INTEGRATE PASSIVE AND ACTIVE SEISMIC, STRUCTURAL AND BOREHOLE DATA FOR HIGH-RESOLUTION MODELING OF THE VIENNA SEDIMENTARY BASIN

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Bayesian inference, joint inversion, passive seismic techniques, Vienna basin

We present the workflow of a Bayesian fusion algorithm applied to geophysical data-sets. The goal of our study is to obtain a high-resolution, multi-parametric model of the Vienna basin with associated uncertainties on the retrieved parameters. Such basin has been a target of a number of studies focused on determining the elastic properties of its geological units for oil&gas and geothermal exploration. Bayesian fusion is a novel methodology which can be used to overcome the main issues related to data-sets integration. A classical approach to geophysical data-sets integration is to reconstruct images of the basin structures using different methods, and then combine these images and interpret them simultaneously. Active seismic data, geological maps and borehole data are often integrated following such scheme, retrieving the elastic properties of the sedimentary units and the geometry of their contact interfaces. However, two issues must be faced. First, different spatial coverage, due to intrinsic limitation of each method, does not allow for integration using expert knowledge only, while an analytical approach to joint inversion requires the same spatial sampling in all data-sets, a condition rarely realized in operational fieldwork. Because of this limitation, classical data-sets integration often does not quantify any uncertainties on the reconstructed model. Moreover, elastic models are usually limited to P-wave velocity models, and more elusive elastic properties (e.g. seismic anisotropy at depth) cannot be recovered due to the lack of complementary information.

Adopting a trans-dimensional Bayesian fusion methodology allows us to integrate un-evenly sampled information and estimate the uncertainties in the model parameters. The algorithm works as a standard trans-dimensional sampler, where the number of unknowns is an unknown itself. In this way, the resolution in the model is solely dictated by the data, without any dumping and/or smoothing of the solution. The algorithm is developed in a hierarchical Bayes framework and we do not need any subjective parameter to weight the data-sets in the likelihood function. In our workflow, we integrate both passive and active seismic data with published geological and geophysical data. Here, we present the details of the workflow together with examples from the Vienna basin.

UNDERGROUND SUN STORAGE - A STUDY ON PROPERTIES OF HYDROGEN ADMIXTURE IN POROUS UNDERGROUND-GAS-STORAGE FACILITIES BY MEANS OF AN IN-SITU EXPERIMENT

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Renewables, Energy, Storage, Hydrogen, Geochemistry

The increasing share of volatile renewable energies (wind, solar,...) in the energy mix comes hand in hand with an increase in demand for storage of these energies, to cover the fluctuation in the generation of these energies. A generally accepted solution of storing renewable energy is the "Power to Gas" (PtG) technology. Surpluses of electricity generation, which cannot be fed into the electrical grid due to capacity bottlenecks, can be converted into hydrogen gas via electrolysis which in turn is storable in the existing natural gas infrastructure.

The tolerance of hydrogen in the existing natural gas infrastructure is the topic of numerous international research projects. The results of this research show the possibility to transport a share of several percent of hydrogen in natural gas without causing any harm to the transportation grid and the distribution infrastructure. However, for the underground gas storage infrastructure only literature studies exist with no field experiments done yet. RAG is one of the major gas storage providers in Europe and has therefore a vital interest in positioning itself as a sustainable and economic energy service provider in a changing energy market.

To achieve these goals and to use RAG's existing infrastructure in a future energy market, the research project "Underground Sun Storage" was initiated. A competent and experienced consortium was formed, consisting of several institutes of the "Montanuniversität Leoben", the "Universität für Bodenkultur- Department IFA Tulln", the "Energieinstitut at the JKU Linz", the Verbund AG and Axiom, a process engineering company. The whole project is supported by the "Klima- und Energiefonds" of the Austrian government.

The ongoing project already yielded promising results which led to the decision of conducting the field test. As the laboratory and simulation experiments are still in progress, they will yield additional interesting results, which will also be part of the presentation. Additionally first results of the field test are already available.

DEPOSITIONAL PATTERN ASSOCIATED WITH EXPERIMENTAL TURBIDITY CURRENTS GOING THROUGH A BREAK-OF-SLOPE

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turbidite, experiments, deep marine, slope, reservoir

In turbidity current systems break-of-slopes are often associated with a channel-lobe transition zone and occur at the transition from continental slope to abyssal plain, or perched on irregular or stepped slopes. Turbiditic deposits in break-of-slope settings can form reservoirs for hydrocarbons depending on their upslope termination. In high-efficiency system, where grains are transported far into the basin, the deposits are located on the basin floor detached from the slope forming a stratigraphic trap, while in low-efficiency system the deposits are connected onto the slope making the formation of a stratigraphic trap unlikely. Therefore, the better understanding of the control factors on the systems efficiency in a break-of-slope setting is of interest for hydrocarbon exploration.

The change in flow properties of a turbidity current going through a break-of-slope are well described in several experimental studies and build a strong foundation for the work presented here. However, the link between the flow properties and the resulting depositional pattern remains poorly constrained. This study will use experiments that focus on the scaling of the depositional behavior of turbidity currents to illustrate which geometrical factors of a break-of-slope setting lead to slope-attached and slope-detached depositional patterns. The plane and the slope angle have a very distinct effect on the flow properties and the linked depositional pattern. These effects are clearly reflected in the velocity and turbulence profiles of the flows, making it possible to link the flow properties to the onset of deposition. With steeper slopes the flow velocity increases and the onset of deposition is shifted further into the basin (i.e. efficiency is increasing). Steeper plane angles will lead to a downward shift on the elevation of the velocity maximum and reduce the amount of deposition on the plane. However, the onset of deposition is observed to occur at the same position, apparently it is controlled only by the steepness of the incoming slope. The experimental results will be linked to outcrop studies of a comparable deep-marine turbidite system from the Karoo basin (South Africa).

THE GLACIALLY OVERDEEPEINED SALZACH VALLEY: CONSTRAINTS ON ITS GEOMETRY AND FILLING.

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Overdeepening, Quaternary, Glacier, Salzach Valley, Ice flow

Overdeepenings are common features in glaciated and deglaciated regions worldwide and their sedimentary fillings may act as important archives for regional environmental change and glacial history. Sedimentary fillings are also important targets of geotechnical exploration and construction including groundwater resource management, shallow geothermal exploitation, tunneling and the foundation of buildings. This is especially true in densely populated areas such as the European Alps and their foreland areas, regions which have been multiply glaciated during the last million years. However, due depths often exceeding some hundreds of meters, the overall knowledge on their geometry, formation and sedimentary content is still poor and commonly tied to some local spots.

Here we present a bedrock model of the overall Lower Salzach Valley, a major overdeepening in the European Alps. We utilized seismic sections from hydrocarbon exploration surveys and deep drillings together with topographic and modelling data to construct a 3D bedrock model. Through the existence of seismic inline and crossline valley sections, multiple drillings reaching the bedrock surface, log and abundant outcrop data we were able to create a very accurate digital bedrock topography. We furthermore analyzed the sedimentary content of the valley as recorded by driller's lithologic logs. Our results suggest that the valley highlights highs and lows of different magnitude and underground valley widths of variable extent. Data also indicates that the deepest part, reaching around 450 m below the alluvial fill, is not situated at a prominent glacial confluence but is probably related to high erodible rock. The sedimentary succession, representing massive gravels and lacustrine fines, indicate that the valley was not fully excavated during the last glacial coverage at the LGM.

Through its high model accuracy, the Salzach Valley overdeepening might be a highly suitable testing site for future numerical simulations.

PROVENANCE OF THE UPPER TRIASSIC SILICICLASTIC ASSEMBLAGES OF THE MECSEK MOUNTAINS AND VILLÁNY HILLS (TISZA MEGAUNIT, PANNONIAN BASIN): CONSTRAINTS TO THE EARLY MESOZOIC PALEOGEOGRAPHY OF TISZA

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provenance, paleogeography, geochronology, Tisza Unit, Triassic

The Tisza Megaunit in the Southern Pannonian Basin formed part of the southern margin of the European Plate in the Early Mesozoic era. Its exact paleo-position and relation to other structural blocks is widely disputed. Detrital zircon U-Pb dating, heavy mineral analysis and petrographical examination of Carnian to Pliensbachian sandstone members lead to better understanding of the provenance of clastic deposits after the Ladinian-Carnian carbonate to siliciclastic facies shift in the Southwestern Tisza Megaunit, and allows for constraining its paleogeographic relation to adjacent units. Distinct dissimilarities occur in the framework composition and the heavy mineral composition of the Upper Triassic-Lower Jurassic siliciclastics of the Mecsek and Villány subunits. Clastic deposits of Mecsek (Karolinavölgy Formation) derived dominantly from granitoids, while medium-grade metamorphic rocks contributed material to the siliciclastics of Villány (Mészhegy and Somssichhegy Formations). The detrital zircon U-Pb data form three major age components at ca. 320 (350) Ma, ca. 450 Ma and 540 to 600 Ma. We refer to these age components as "Variscan", "Ordovician" and "Cadomian", respectively. They are present in almost each sample in dominant or subordinate amounts. The framework composition and the detrital zircon age components indicate that the major sources were Ordovician greenschist to amphibolite facies metamorphic rocks for the Carnian and Pliensbachian siliciclastics of the Villány Hills. They derive from the Southwestern Tisza Megaunit, i.e. from the medium-grade polymetamorphic rocks of the adjacent Slavonian Mountains or from similar basement units. The Upper Triassic siliciclastic deposits of the Mecsek Mountains most likely derive from local basement (Variscan igneous and metamorphic complexes, and Upper Paleozoic/Lower Mesozoic siliciclastics) and/or from the Southern/Southwestern Bohemian Massif. Moreover, the latter deposits contain diluted traces of synsedimentary volcanic activity. About 200 Ma zircon U-Pb ages are interpreted as the first eruptions of the already well documented Early Jurassic distal extensions of the Central Atlantic Magmatic Province. These provenance indicators do not support an original location of the Tisza Megaunit to the east of the Bohemian Massif. In contrast, they suggest connection to the Southern/Southwestern Bohemian Massif for pre-Middle Jurassic time.

DISCONTINUITY ANALYSES USING METHODICALLY DIFFERENT IN-SITU AND REMOTE SENSING MEASUREMENTS (SIMMERING/HAIMING CASE STUDY, TYROL)

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Discontinuities, Scanlines, Borehole logs, Remote sensing, Laserscanning

Systematic discontinuity analyses are required to assess the rock-mechanical and hydrogeological properties of fractured rock slopes. Therefore, methodically different in-situ and remote-sensing measurements were applied for the investigation of a steep and rugged slope (Simmering/Haiming, Inn-Valley). The investigated slope is made up of obscurely bedded to massive dolostones, limestones and breccias in reef-facies (Wetterstein-Fm., M-Triassic). These steeply SE-dipping strata are overprinted by mainly NE-SW- and NW-SE-trending fault- and fracture-systems, and, in a regional tectonic context, to be attributed to the Inntal nappe unit.

For discontinuity analyses and fabric assessments, here surface field measurements were performed in the form of non-systematic spot-measurements and systematic scanlines in accessible areas (at the base of sub-vertical rock faces). Along the scanlines, for every discontinuity plane, a variety of geotechnical parameters were recorded (according to national standards and ISRM guidelines) for statistical analyses.

In addition to these manual surface measurements, systematic subsurface data obtained from three drillings at the toe of the investigated slope (vertical/sub-horizontally inclined boreholes, depths/length 100-270 m) are also available. Based on geological drill-core documentations and analyses of geophysical borehole-logs, the structural subsurface inventory was assessed and compared with the surface measurements.

Since the high rock faces, situated further upslope of the above mentioned outcrop measuring and drilling sites, are not accessible to directly analyse discontinuities and, in parts, are affected by potential rockfall hazards, these steep and rugged areas were investigated using terrestrial laser-scanning (TLS). The rock faces were scanned with a long-range scanner (Riegl Vz 4000) from five different scan-positions in the adjacent valley floor. The scanned area covers a total width of approx. 700m and a height difference of approx. 300m. In order to close data-gaps due to horizontally and very flatly inclined rock-surfaces, the TLS-data were combined with data obtained from an airborne laser-scanning (ALS) survey. The combined point-cloud data was processed and analysed in the GIS-software SAGA using the Laserdata LIS-extension.

Based on the different investigations performed and data thus obtained, the structural rock-mass model was refined and spatially extended for inaccessible rock faces. Furthermore, the laser-scan data can be used for slope monitoring (e.g. rockfall monitoring based on difference models).

GEOLOGICAL CHARACTERISTICS OF THE FERNPASS ROCK AVALANCHE DEPOSITS (TYROL, AUSTRIA)

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Rock avalanche, Fernpass, Radiometric Dating, Seismic, Sedimentology

The Fernpass-rockslide mobilised about 1000Mm³ of carbonate rock-debris (Seefeld-Fm., U-Triassic), which accumulated as thick proximal ridge and two rock-avalanche (RA) branches discharging thereof. One branch travelled slightly deflected for at least 10.8km (to the NE), and another, mechanically less coherent, for at least 15.5km (to the SW). It is the first landslide dated applying three different radiometric methods to individual sampling-sites: i) ¹⁴C-dating (rockslide-dammed torrent-deposits), ii) cosmogenic ³⁶Cl exposure-dating (sliding-planes at the scarp and accumulated rockslide-boulders), and iii) U/Th-dating (aragonite-cements precipitated in the RA-deposits). These data consistently indicate one failure-event at approx. 4.2 ka. Thus, the extraordinary run-out was not favoured by a contact with glacier-ice, but by a combination of: i) enormous volume, ii) penetrative dynamic rock-mass fragmentation, iii) channelling-effects in the narrow valleys, iv) undrained loading of valley-sediments. This was validated by a variety of geological and geophysical field-investigations.

Hybrid seismic measurements in the proximal accumulation-area depict a parabolic valley cross-section underneath the present-day Fernpass. This and the spatial extent of the scarp-niche indicate a steep some 100m high paleo-slope (thus evidence of a fault-related valley-deepening) and hundreds of metres thick engineering soils. Concerning the proximal RA-deposits, diving-wave tomography yielded varying seismic velocities, pointing to different lithologies and/or inhomogeneous degrees of fragmentation (slabs/blocks, finer matrix). Based on the field data compiled, the curiously deflected southern RA-branch originated from a gravitational collapse of the several 100m thick debris-ridge which makes up the proximal accumulation-area (i.e. Fernpass-apex).

The mechanical behaviour of the Fernpass RA was characterised by laminar flow-processes (indicated e.g. by Pleistocene cover-rocks transported piggy-back atop the failing debris from the source), and transversal extensions. These extensions and gravitational spreading produced distinct graben and ridge structures (medial areas, some filled with kettle-like lakes) as well as the cone-shaped Toma-hills (distal areas). Ground-penetrating-radar investigations and drillings indicate that the medial to distal RA-deposits spread upon fine groundwater-saturated substrata.

Regarding geotechnical properties, the RA-deposits appear as BIM-rocks, i.e. heterogeneous mixtures of rock-fragments of various sizes embedded in a finer matrix. The grain-size distributions, along with lithological parameters and in-situ-densities, control the hydrogeological characteristics, e.g. springs with high discharge-rates and others featuring radioactive emanations (cf. U/Th-dated cements).

THREE-DIMENSIONAL MODELLING OF SYN- AND POST-DEPOSITIONAL SAND BODIES IN THE MIOCENE-AGE FRIMMERSDORF SEAM, GARZWEILER OPEN-CAST MINE (NW GERMANY)

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Lower Rhine Basin, lignite, estuary, sand injectites

The Cenozoic-age Lower Rhine Basin is a rift basin in NW Germany, which was filled with up to 1300 m of Miocene to Pleistocene-age deposits. Within the Garzweiler open-cast mine (RWE Power AG), irregularly distributed sand bodies affect the mining of the Miocene-age Frimmersdorf Seam. An initial classification of these highly variable sand bodies revealed syn- and post-genetic causal mechanisms within a complex depositional environment.

The Miocene-age Lower Rhine Basin comprised an extensive estuary, including large swamp areas as well as the coastal environments of the North Sea. Within this depositional setting, syn-genetic emplacement of sand bodies within the peat of the present-day Frimmersdorf Seam was controlled both by river systems entering the Lower Rhine Basin from the Rhenish Massif, and by the meso-tidal processes of the North Sea. Additionally, post-depositional causal mechanisms were identified as a possible origin for sand bodies. The formation of, for example, sand sills and dykes by sand injection was initiated as a result of the combination of overpressure within the unconsolidated Frimmersdorf Sand, disequilibrium compaction of the seam, and seismic activity acting as possible triggering events.

Though the research within an active open-cast mine provides the advantage of a constantly advancing outcrop, the three-dimensional interpretation of specific sand bodies is difficult (largely due to mining processes). Therefore, a highly detailed laser scanning of an exceptionally extensive sand body, comprising chert deposits and trough cross lamination, was performed. The interpretation of seven consecutive sections (1-2 metres apart), prepared by an excavator, will provide a detailed three-dimensional overview of this specific sand body within the Frimmersdorf Seam.

Sand body orientations within the Garzweiler open-cast mine would appear to correlate with the regional fault system of the Lower Rhine Basin. More detailed work, restricted to the Garzweiler mining area, has been developed incorporating a variety of datasets, including the seam orientations and their morphology, the fault trends and inclinations (both regional and local), as well as the sulphur or ash contents of the seam. Together, these datasets have allowed a three-dimensional model of the Frimmersdorf Seam to be constructed.

PREDICTING THE SUBSURFACE TEMPERATURE DISTRIBUTION FOR THE AREA OF MUNICH: HOW BASIN-SCALE MODELS CAN PROVIDE THERMAL BOUNDARY CONDITIONS FOR RESERVOIR-SCALE INVESTIGATIONS

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Molasse Basin, Thermal Anomalies, Munich, Fluid Flow, Numerical Modelling

The German Molasse Basin is a peripheral wedge-shaped foreland basin at the northern front of the European Alps. The basin is filled with sequence of Tertiary clastic sediments and underlain by Mesozoic sedimentary successions. These Mesozoic layers include the Upper Jurassic carbonate aquifer (Malm) which is extensively used for geothermal energy production.

At depth, pronounced thermal anomalies occur in the basin, which are a target to the geothermal energy exploration in that area. In the past, local scale thermal models were used to estimate the potential extraction temperature of geothermal power plants. In those thermal models prescribed lower thermal boundary conditions were used to introduce the heat input from the deeper parts of the earth into the local to reservoir-scale model. However, these thermal boundary conditions often comprise uncertainties, since no direct measurements of the heat flux at depth exist leading to uncertain temperature predictions.

In this study, the coupled fluid and heat transport in the Molasse Basin has been investigated on basin-scale using a multiscale modelling approach to assess the origin of the pronounced thermal anomalies in that area. Furthermore, the local-scale model for the area of Munich has been extracted from the original model and used for a detailed temperature transport analysis.

The results of this study show that the thermal field of the basin is controlled by basin-wide conductive and advective heat transport which in turn is governed by the structural configuration of the basin. Moreover, this study proposes complex regional and basin-wide processes to produce the pronounced thermal anomalies in the study area. In detail, the simulations have shown that a significant part of the positive thermal anomaly around Munich is caused by lateral heat input by advective heat transport from the south. Such a lateral inflow of warm fluid into a local-scale model area would not be captured by simply assigning a lower thermal boundary condition at the bottom of a model. Hence, basin-scale models not only provide lower thermal boundary conditions, but also information about the lateral heat input for higher resolved local and reservoir-scale models.

FAULT AND FLUID SYSTEMS SUBSEQUENT TO SUBDUCTION INITIATION IN SUPRA-SUBDUCTION ZONE OPHIOLITES

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Suprasubduction Zone Ophiolites, Izu Bonin Fore Arc, Troodos Ophiolite

After years of debate most ophiolites are now believed to form within supra-subduction zones that are associated with subduction initiation. In order to reinforce this hypothesis the International Ocean Discovery Program Expedition 352 drilled through the entire volcanic sequence of the outer Izu-Bonin fore-arc to trace the processes of magmatism, tectonics and crustal accretion that are related to subduction initiation. This study in turn has important implications for the understanding of deformation mechanisms and fluid circulation within an intra-oceanic fore-arc. The four drill cores reveal fore-arc basalts and younger boninites that are extensively deformed and enriched by the occurrence of veins. These veins represent post-magmatic records of fluid flow and deformation inside the Izu-Bonin fore-arc. As a late stage analog to this, the Troodos ophiolite in Cyprus comprises a similar volcanic sequence that already underwent tectonic emplacement on top of continental crust. It is one of the best-preserved ophiolites and exposes a complete sequence of an oceanic crust hosting "Lower" and "Upper" pillow lava units, that are interpreted as a collage of volcanic-tectonic-hydrothermal cycles, largely reflecting growth and destruction of pillow lavas at, or near, a supra-subduction zone. No evidence of regional emplacement-related deformation exists. Therefore, a comparison of the Izu-Bonin fore-arc with the Troodos ophiolite will help to study fault and fluid mechanisms as well as in intra-oceanic fore-arcs and ophiolites. This comparative study is based on extensive fieldwork within the Troodos ophiolite and focuses on meso- and microscale vein structures combined with stable isotopic compositions.

ADVANCES IN CORE CHARACTERIZATION BY HYPERSPECTRAL, LIBS AND EDXRF DATA MERGING

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Core analysis, Hyperspectral, LIBS, EDXRF

Fast and spatially highly resolved chemical, mineralogical and textural characterization of half cores brings new light into the evaluation of cores for scientific purposes prior to sub-sampling.

Two dimensional scanning by LIBS (Laser Induced Breakdown Spectroscopy with 200 μm resolution), EDXRF (Energy dispersive X-Ray Fluorescence Spectroscopy with down to 20 μm resolution) and Hyperspectral imaging (VNIR, SWIR, both 25 μm , and LWIR 400 μm resolution) provides both chemical pattern as well as chemistry and hyperspectral based mineralogical information. Since neither method provides all information needed, their combination opens up new perspectives for scientific data acquisition. Evaluation and cross validation can be performed on a continuous basis or for selected targets in detail. Information of individual mineral grain sizes, shapes and orientations, paragenetic assemblages, vein types can be obtained and objectively be correlated with neighboring cores.

Based on the identified chemical anomalies and characteristic mineral assemblages sub-samples can be selected for further detailed geochemical, mineralogical and tectural investigations.

Future perspectives are partial automatization of the data analyses and evaluation process.

THE 2016 EXPEDITION TO THE BEENCHIME-SALAATIN CRATER STRUCTURE, RUSSIA.

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Impact crater, kimberlite dike, suevite, shatter cones

The Beenchime-Salaatin crater structure (BSC) in Northern Yakutia (71°3' N, 121°40' E) is ~7 km in diameter and largely covered by Quaternary deposits. The well exposed basin is embedded in mostly Cambrian sandstones, limestones and shales. It has only been studied by two authors in the 1970's. It was proposed to be an impact structure on finding of shatter cone-like structures and allogenic breccia, interpreted as impact breccia (suevite) [1]. A contrary interpretation is that this structure could be a volcanic kimberlite dyke [2]. The age estimate is only linked to the geomorphological expression of the crater rim; the BSC is variably listed from 65 Ma old [3] to 40±20 Ma old [4]. In July 2016 a two-weeks field trip to the (BSC) will be realized. The expedition team is composed of the AWI (Alfred Wegener Institute - Helmholtz Centre for Polar and Marine Research, Potsdam), the IDPMG (Diamond and Precious Metal Geology Institute of the Siberian Branch of the Russian Academy of Sciences, Yakutsk), and the MfN (Museum für Naturkunde Berlin). Field work contains sampling of possible impact breccia and country rocks as well as searching for shatter cones and mapping of geological structures. All samples will be prepared for petrographic investigation for possible shock metamorphic effects and for geochemical study by XRF analysis. The open questions for this structure are: 1) Possible impact origin; 2) Age determination, and 3) Can the impact origin be confirmed, the attempt of a reconstruction of emplacement of impact rocks and crater modification? The preliminary results should be presented at this conference.

References: [1] Mikhailov et al. (1979) The Beyenchime-Salaata meteorite crater, *Doklady Akad. Nauk* 245: 76-78 [in Russian]. [2] Pinchuk (1971) Morphology and genesis of Beenchime-Salaatin depression -Kimberlite volcanism and prospects of primary diamond content of the north-eastern Siberian platform, *Proceedings Arctic Geology Research Institute*, Leningrad: 123-126 [in Russian]. [3] Moon et al. (2001), Terrestrial impact cratering chronology: a preliminary analysis, *J. of Astronomy & Space Sciences*, 18: 191-208. [4] Earth Impact Database, 2016: <http://www.passc.net/EarthImpactDatabase/AsiaRussia.html> (03/2016).

REPEATED LAKE-LEVEL CHANGES RECORDED BY MICROBIAL MATS IN THE MIDDLE MIOCENE “SILVANA LIMESTONE” IN THE NORTHERN ALPINE FORELAND BASIN

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North Alpine Foreland Basin, Obere Süßwassermolasse, Silvana limestone, microbial mats, palaeo-caliche

The North Alpine Foreland Basin (NAFB) was a basin between the Alps in the south and the Swabian Alb in the north, formed by processes of Alpine Orogeny (Molasse Basin). It took up the sediments from the uprising Alps, but also contains a huge and laterally extensive series of non-marine carbonates along the southern margin of Swabian Alb in SW Germany. These limestones are part of the Silvana beds, or Silvana limestone (tentatively MN5, late Early to early Middle Miocene), respectively, which are named after the land snail *Palaeotachea silvana* (formerly *Cepaea* or *Helix*) and as such part of the Obere Süßwassermolasse (OSM; “Upper Freshwater Molasse”). The Silvana beds are deposited discordantly above older Miocene and Late Jurassic rocks. The Silvana beds gradually change from basal sands and marls into calcareous marls and finally pure limestones at the top. Towards the south, they interfinger with purely siliciclastic sediments of the OSM.

These non-marine carbonates on top are up to 10m thick and represent a common building stone known as “Gauinger Travertin” because of its technical properties. The limestone crops out in several quarries and is dominated by peloidal micritic limestones. Peloidal character, micritic coated grains, wrinkled and circumgranular cracks, root traces, and a generally breccia-like texture suggest that this facies is basically a palaeo-caliche sequence. The peloidal limestones are interrupted by several decimeter-thick layers of well-calcified microbial mats that include encrusted reed-like stems, which are partly in-situ. In the quarries, these repeated layers can be traced over the whole areas. Beside the microbial mats, there are a few layers that still preserve the original dispositional facies that was later overprinted by caliche formation: these contain freshwater snails, characean algae, oncooids and crustacean fecal pellets.

We interpret the whole sequence as being largely influenced by lake-level changes during the overfilled stage of the NAFB. It comprises sublittoral stages (characean, etc.) followed by littoral stages (reed and microbial mats) and final supralittoral stages expressed by caliche formation. These facies types can be traced over several kilometers, suggesting an extensive “freshwater carbonate platform” along the southern margin of the Swabian Alb.

THE DERVIO-OLGIASCA ZONE: A FOSSIL FRAGMENT OF PERMIAN MIDDLE CRUST RECORDING THERMAL AND RIFTING EVENTS.

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Passive Margin, Tectono-Thermal Evolution, Structural Geology, Metamorphism, Southern Alps

The fossil rifted margin of the Adriatic plate is exposed at the surface due to Alpine shortening. It provides an exceptional opportunity to investigate the tectono-thermal evolution of the margin before the continental break-up. South of the Insubric line, continental slices of basement are not affected by Alpine metamorphism and possibly show the original metamorphic imprint generated by rifting phases.

The Dervio-Olgiasca Zone (DOZ) situated in the northern part of the Como lake, south of the Insubric line, is a slice of Variscan basement recording a polymetamorphic history from Carboniferous to Early Jurassic (e.g. Spalla *et al.*, 2000). The DOZ is limited to the south and east by the Lugano-Val Grande Fault, a Jurassic normal fault which exhumed the deeper crustal basement (Bertotti *et al.*, 1999), and in the north by the Alpine Musso line.

The DOZ represents a well-preserved portion of the Permian middle crust, consisting mainly of micaschists and amphibolites, rotated to a vertical position. In the DOZ, a Barrovian metamorphic field gradient is recorded from Chl+Ab mineral assemblages to the south, to Ms+Bt+Grt+Sil mineral assemblages to the north. Pegmatitic dykes occur only in the higher grade portion of the DOZ. Two main foliations, at high angle to each other, often occur. The older foliation (S1) is interpreted to be Variscan (e.g. Spalla *et al.*, 2000) whereas the younger, prominent one (S2) is related to a vertical shortening affecting the previous steeply dipping foliation. The occurrence of stretched pegmatitic dykes, dated at 226 +/- 2 Ma (Diella *et al.*, 1992; Sanders *et al.*, 1996), could suggest a Triassic deformation event.

The higher grade portion of the DOZ records a tectono-metamorphic evolution with a syn-to post-main-foliation (S2) thermal event. It is more complex than previously reported and could better constrain the late to post-Variscan evolution of the Adriatic continental crust.

DER ÄUßERE SCHELF DES HELVETIKUMS ÖSTLICH DER BREGENZER ACH: REKONSTRUKTION DER ABLAGERUNGSBEDINGUNGEN DER MITTAGSSPITZ- FORMATION (BARREMIUM-APTIVM) IN VORARLBERG (ÖSTERREICH)

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Mittagsspitz-Formation, Mikrofazies, Ablagerungsmodell, Bregenzerwald, Südhelvetikum

Die Mittagsspitz-Formation ist Teil der höheren Unterkreide der Vorarlberger Säntis Decke im Hinteren Bregenzerwald. Sie besteht vorwiegend aus gebankten, fossilhaltigen Sandkalken mit kieseligen Partien. Im Südhelvetikum verzahnt sich der Schrattekalk mit der Drusberg-Formation (Einheiten werden im folgenden nach Friebe (2007, 71 ff) zitiert). In deren Hangenden setzt die Mittagsspitz-Formation ein, die geprägt ist durch den Beginn einer längeren Kondensationsphase. Die bisherigen Arbeiten über die Mittagsspitz-Formation konzentrieren sich auf das Gebiet westlich der Bregenzer Ach im Bereich der Damülser Mittagsspitze. Die gegenwärtig laufenden Arbeiten befassen sich mit der bisher wenig bearbeiteten Mittagsspitz-Formation östlich der Bregenzer Ach im Gebiet des Diedamskopfes bis südlich des Hohen Ifen. Auffallend ist hier das Fehlen der Sünerspitz-Mergelkalke und des Spatkalks, die nach Felber & Wyssling (1979, 689) Formationsglieder der Mittagsspitz-Formation sind.

Die Mittagsspitz-Formation wird in Verbindung gebracht mit Abtragung von Sedimenten der nahen Schrattekalkplattform. Tatsächlich können mit Schrattekalk-Material verfüllte Rinnen im Top-Bereich der Mittagsspitz-Formation beobachtet werden (Felber & Wyssling 1979, 694 ff). Jedoch differiert die Litho- und Biofazies der Mittagsspitz-Formation selbst deutlich von der der Schrattekalkplattform, sodass es sich nicht um Resedimente derselbigen handeln kann. So fehlen beispielsweise für den Schrattekalk typische Ooide, Korallen oder Stromatoporen in den Ablagerungen der Mittagsspitz-Formation. Diese Beobachtung zeigt, dass die Mittagsspitz-Formation zeitgleich oder früher zum jüngsten Schrattekalk abgelagert worden sein muss. Es bleibt die Frage offen, in welchem Liefergebiet erodiert wurde und in welcher Art und Weise die Mittagsspitz-Formation als allochthone Schuttkalke sedimentiert wurden. Weiterhin bleibt die genaue zeitliche Einordnung unklar.

Die hier vorgestellte Arbeit versucht mit Hilfe von sedimentologischen Detailprofilen und der Mikrofazies die Mittagsspitz-Formation östlich der Bregenzer Ach zu charakterisieren. Auf der Grundlage von Geländebeobachtungen, mikrofaziellen Beschreibungen und des Fossilinhalts sollen Rückschlüsse auf das Liefergebiet und die Ablagerungsbedingungen gezogen werden. Das Resultat der Arbeit ist die Erstellung eines Ablagerungsmodells. Des weiteren wird die Beziehung zur nahen Schrattekalkplattform und der hangenden Brisi-Formation näher beleuchtet.

Literatur

- Felber, P. & G. Wyssling (1979): Zur Stratigraphie und Tektonik des Südhelvetikums im Bregenzerwald (Vorarlberg). In: *Eclogae geol. Helv.* Vol. 72/3, 673-714.
Friebe, J. G. (2007): *Geologie der österreichischen Bundesländer. Vorarlberg. Erläuterungen der geologischen Karte Vorarlberg 1 : 100 000.* Geologische Bundesanstalt. Wien.

HYDROCHEMISTRY AND BIOFILM CALCIFICATION IN TUFA CANAL-FORMING KARSTIC STREAMS (“STEINERNE RINNEN”, SOUTHERN GERMANY)

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hydrochemistry, geomicrobiology, carbonate, tufa, biofilm

Calcium carbonate precipitation and tufa formation in karstic streams are commonly attributed to CO₂ degassing and associated rise in pH and calcite supersaturation. On the other hand, microsensor measurements have demonstrated that, wherever biofilms are present, photosynthesis controls benthic calcification in a diurnal cycle. However, the relative importance of inorganic versus biological impact on the carbonate equilibrium apparently varies between different tufa-forming settings. While in most cases tufa deposition occurs as laminated veneers of stream beds, small dams and cascades, few sites are known with so-called „Steinerne Rinnen“. These are morphologically remarkable tufa-canals up to 5 m high and 185 m long with a narrow water streamlet on their top. The formation of the „Steinerne Rinnen“ has been attributed to CO₂ degassing of the karstic water, enhanced at a morphological terrain edge, and subsequent canalization by calcite-encrusted mosses. In the present study, six „Steinerne Rinnen“ and one subterranean karstic stream have been investigated from their springs downstream to the end of the tufa deposits with respect to their hydrochemistry and biofilm calcification in comparison with other tufa-forming streams in Germany. As a result, the „Steinerne Rinnen“, which are dominated by inorganically driven calcification, reach downstream much lower calcite supersaturation if compared to karstic streams dominated by biofilm photosynthesis-controlled calcification. The subterranean karstic stream, with only few microbial cells present, shows lowest maximum calcite supersaturation. A positive correlation between calcite saturation and ions interfering with calcite nucleation and crystal growth („inhibitors“) is evident for surface streams. In the subterranean stream, a low calcite saturation index has been observed despite of moderately high inorganic inhibitor concentrations. This observation is explained by the almost complete lack of benthic microbial cells and hence absence of inhibiting biofilm exopolymers in this dark environment. In conclusion, the results suggest that the higher the inhibition, the higher the biological control on calcification. Inhibition of calcite precipitation resulting in higher supersaturation is caused either by inorganic ions (PO₄³⁻, SO₄²⁻, Mg²⁺) and/or by biofilm exopolymers.

FROM NAPPE STACKING TO EXHUMATION: CRETACEOUS TECTONICS IN THE APUSENI MOUNTAINS (ROMANIA)

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Geochronology, Cretaceous, Tectonics, Exhumation, Tisza-Dacia

New thermochronological data in combination with P-t estimates and kinematic analyses from the Apuseni Mountains provide new constraints on the tectonometamorphic evolution in the larger context of the Alps-Carpathians-Dinarides system of orogens. Time-temperature paths from the structurally highest basement nappe of the Apuseni Mountains in combination with sedimentary data indicate exhumation and a position close to the surface after the Late Jurassic emplacement of the South Apuseni Ophiolites. Early Cretaceous Ar-Ar muscovite ages from structurally lower parts in the Biharia Nappe System (Dacia Mega-Unit) show cooling from medium-grade conditions. NE-SW trending stretching lineation and associated kinematic indicators of this deformation phase (D1) are overprinted by top-NW-directed thrusting during D2. An Albian to Turonian age (110--90 Ma) is proposed for the main deformation (D2) that formed the present-day geometry of the nappe-stack and led to a pervasive retrograde greenschist-facies overprint. Thermochronological and structural data from the Bihor Unit (Tisza Mega-Unit) allowed to establish E-directed differential exhumation during early Late Cretaceous times (D3.1). Brittle detachment faulting (D3.2) and the deposition of syn-extensional sediments indicate general uplift and partial surface exposure during the Late Cretaceous. Brittle conditions persist during the latest Cretaceous compressional overprint (D4).

VOLCANIC ASHES IN JET ENGINES – ANALYZING THE MELTING DYNAMICS OF VOLCANIC ASH

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volcanic ash, jet engines, thermal boundary coatings, melting dynamics, volcanic ash characterization

Volcanic ashes pose a serious hazard to air traffic. When passing through the hot combustion chamber of aircrafts, the volcanic ash melts and subsequently sticks onto the surface of the turbine blades which are generally coated by ceramic thermal barrier coatings (TBCs) used for protection of the alloy metal frame. Once molten, volcanic ash adheres and then penetrates upon impact into the TBCs. This process can lead to a degradation of the coating, eventually causing the jet engine to fail. However, the limited understanding of this process has so far resulted in large-scale restrictions on air traffic (such as after the Eyjafjallajökull eruption 2010). Therefore, a quantitative description of the damage caused by viscous volcanic ash in jet engines is necessary.

Here, we experimentally investigate the melting dynamics of finer, milled Tungurahua volcanic ash and coarser, original Tungurahua volcanic ash with a heating microscope (optical dilatometry). Small ash cylinders are heated to up to 1600°C at ranging heating rates of 5 to 50 K/min. The melting process is quantified through four characteristic temperatures defined in previous studies: shrinkage temperature, deformation temperature, hemisphere temperature and flow temperature. These temperatures are used to determine the onset of sintering, melting, spreading and viscous flow of the ash. We observe an increase of the characteristic temperatures at higher heating rates that confirms the results of our previous studies. Moreover, comparing the melting dynamics of milled and original ash we find that milled ash shows lower shrinkage temperatures than the original Tungurahua ash but these differences progressively disappear at higher temperatures.

We will continue investigating the specific influence of grain size, bulk chemistry, crystallinity and volatile content on the melting properties of volcanic ash on TBCs. In addition, we will relate characteristic times to the characteristic temperatures of this process. The findings will be extrapolated to realistic operating conditions in jet engines to determine the degree to which the volcanic ash is molten at the time of impact on the TBCs in the jet engine. This will give a solid basis for spreading and infiltration analysis of viscous volcanic ash on TBCs.

HAZARD ZONING FOR ROCK-FALL: A NEW AND STANDARDIZED APPROACH FOR AUSTRIA ACCORDING TO ÖREK, DEMONSTRATED ON A CASE STUDY.

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Rock-fall, Hazard zoning, ÖREK

The *Österreichische Raumordnungskonferenz* (ÖROK) installed a partnership in 2011 dealing with „Risk management for gravitative natural hazards in spatial planning“. As gravitative natural hazards have a decisive influence on spatial development in the Alpine Region, standard procedures for the assessment of the relevance of these processes for spatial planning was developed ([1] ÖROK 2015). This paper describes the recommended procedure to assess the hazards imposed to permanent settlements by rock-fall in a top-down approach.

A first step to define potential conflicts between the reach of rock-fall processes and the presence of settlements is a conservative empirical assessment based on rock outcrops potentially serving as detachment zones and a maximum run-out of such rock-falls leading to a hazard indication map. This approach is based on existing cartographic information only, field investigations are not necessarily involved in this stage. To ensure a conservative result, the use of a high-resolution 1 m terrain model to identify rock outcrops is recommended. Every pixel of the terrain model showing a slope inclination of $\geq 45^\circ$ is treated as a potential detachment source for rock-fall. The reach is delineated by a geometric angle of 30° starting from the detachment points. All such maximum run-outs are summarized by a polyline depicting the potential of rock-falls reaching inhabited areas.

The next step includes a thorough examination of those areas showing conflicts between reach angle and settlements. This stage includes field investigations assessing mapping of maximum reach blocks, block size distributions, underground conditions of the transit zone and conditions of rock-outcrops acting as potential detachment zones. All these informations are subsequently integrated in a 3-D rock-fall simulation. As a result the modelling enables a delineation of areas out of reach (no rock-fall hazard), areas with potential impact energies ≤ 100 kJ (low intensity) and areas with potential impact energies > 100 kJ (high intensity).

References

[1] ÖROK (Österr. Raumordnungskonferenz) (Hrsg.) (2015): Risikomanagement für gravitative Naturgefahren in der Raumplanung. – Wien (=ÖROK-Schriftenreihe 193)

COMBINING AUTOMATED MINERALOGY AND GEOCHRONOLOGY

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provenance analysis, geochronology, LA-ICPMS, QEMSCAN, big data

Separation of mineral phases that are dateable by radiogenic isotopes is in most cases time-consuming and liable to bias. Here, we present case studies utilising QEMSCAN® automated mineralogy combined with laser ablation ICPMS, enabling higher sample throughput, faster analysis and minimal bias during sample preparation, while at the same time allowing to integrate textural and grain shape information with the geochronological data.

We present applications of dating small ($\geq 20 \mu\text{m}$) zircons in-situ in igneous rocks from Guernsey (Channel Islands) and in an UHP-metamorphic paragneiss from the Qaidam Basin (Qinghai, China). Mineral-mapping the samples with QEMSCAN not only allows automated analysis without destroying the sample and separating the minerals, but it also allows to relate the acquired ages to grain shape, the textural position and adjacent mineral phases within the host rock, and to determine paragenesis, all in the same analytical workflow. We compare the results of these case studies to published results from the same areas.

For sediment provenance analysis, we mount the whole heavy mineral fraction or the untreated bulk sediment in epoxy resin and extract the position of the minerals of interest (zircon, apatite, rutile,...) to be dated by LA-ICPMS. This saves the time for mineral separation, while preventing bias that can easily occur both with physical separation techniques and in manual mineral separation ("picking"). At the same time, the mineral scan yields mineral counts for all phases present (including hard-to-identify semi-opaque and opaque minerals and solid-solution series), together with grain size and shape information. Mineral-specific shape and size data for ten-thousands of grains per sample, from sites along a river system and its tributaries, allows for detailed analysis of sorting effects and rounding from source to sink. We present a case study from the Euphrates river and compare it with results obtained by conventional optical microscopy mineral counting.

The integration of large data sets of mineralogical and morphological data with geochronological methods and quantitative analyses opens up to new ways of characterising sample sets, in a statistically robust manner, while at the same time yielding more analyses, faster.

TECTONICS, CLIMATE AND EARTH'S HIGHEST PEAKS

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active orogens, peak elevations, erosional surface processes

Prominent peaks located in collisional orogens result from the interplay of tectonically driven uplift and climatically induced destruction of topography by erosional surface processes such as glacial carving. The glacial buzz-saw hypothesis implies that peak altitude declines with duration of glacial occupation, i.e., towards high latitudes. This is in strong contrast with high peaks existing in high latitude mountain ranges (e.g. Alaska Range). In this study we investigate landscape dissection, crustal thickness and vertical strain rates in tectonically active mountain ranges to evaluate the influence of erosion on (latitudinal) variations in peak altitude. We analyze the spatial distribution of several thousand prominent peaks on Earth extracted from the global ETOPO1 digital elevation model with a novel numerical tool. Our analysis reveals that crustal thickness and peak elevation correlate well in orogens that have reached a mechanically limited state (vertical strain rate near zero) where plate convergence is already balanced by lateral extrusion and gravitational collapse and plateaus are formed (e.g. India-Asia collision zone). Towards high latitudes, peaks of similar height are characterized by a more dissected landscape and supported by a thinner crust compared to mid-latitude mountain ranges. This implies that erosion has influenced these orogens on their crustal level. We propose that long-term glacial erosion in high latitudes may have already thinned the orogenic crust and conclude that (a) over-thickened crust in zones of plate convergence can buffer intense erosion and maintain high mountain topography over millions of years even in heavily glaciated orogens, (b) high peaks may persist or may even be uplifted due to glacial erosion and (c) glacial erosion limiting mountain topography may not work as simple as a buzz-saw applied to fluvial topography supported by a thick mountain root.

PROSPECTING FOR PREHISTORIC COPPER – FIELD OBSERVATIONS FROM A GEOARCHEOLOGICAL SURVEY IN SE BULGARIA

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copper, supergene, Medni Rid, geoarcheology, survey

The primary and secondary copper deposits of the Medni Rid highland in south eastern Bulgaria close to Burgas have been mined extensively over the last centuries. During a rescue excavation in 2008/2009 led by P. Leshtakov, amongst others remains of ore, crucibles and slagged pottery were found in Chalcolithic layers of the excavated settlement Akladi Cheiri between Chernomorets and Sozopol. These finds indicate an early metallurgical use of copper during the 5th millennium BC.

As a subproject of the Collaborative Research Center ResourceCultures (SFB 1070) at the University of Tübingen research upon ancient mining activities of the Medni Rid area was undertaken. Several historic mining sites have been prospected for remnants of ore mineralization, ceramics, slags as well as tools for processing like mortar or pestle. LiDAR data has been used to identify targets for ground truthing of geoarcheological and montane archeological interest as well as archeological settlement remains. The localization of prehistoric mines has been aggravated due to intense reworking and overprinting by mining activities from the antique to communist times. Important for prehistoric applications is the presence of oxidized secondary, supergene copper for an easy recovery of the metal and prospection of the deposits. Although the hypogene primary sulphidic ore has been intensively mined underground during the communist times most certainly the abundant surficial secondary copper mineralization played a key role in the prehistoric and ancient times as indicated by the ore finds at the Chalcolithic settlement of Akladi Cheiri. The copper mineralization in the Medni Rid is hosted by veins striking roughly northeast-southwest and east-west direction respectively. An identification of the orebodies in the field is conveniently done based on characteristic colors of the altered wall rock ranging from ochre to orange or bleached grey. Furthermore mining pits and trenches form features which are morphologically neatly divisible from its natural surroundings. Prominent ore minerals of the supergene zone include typical turquoise green minerals like malachite and chrysocolla. Secondary sulphides like chalcocite and covellite often replace relic primary chalcopyrite. Characteristic for all ore systems is abundant specular hematite and quartz.

HIGH STRAIN RATE DEFORMATION IN MARBLES – DOES IT RESET THE K/AR SYSTEM?

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⁴⁰Ar/³⁹Ar geochronology, strain localization, marble, Syros (Greece)

Interpreting isotopic ages as deformation ages when they are acquired from moderate-temperature metamorphic environments can be a challenging task. Syros Island (Cyclades, Greece) is famous for Eocene high-pressure metamorphic rocks reworked by localized Miocene greenschist-facies deformation. In this work, we investigate phengites from coarse-grained marbles, which experienced the high-pressure event, and phengites from fine-grained localized marble shear zones attributed to the low-grade Miocene deformation. Based on structural criteria, both events can be easily discriminated because of their opposing kinematics.

Laser-heating ⁴⁰Ar/³⁹Ar analysis on phengite yielded a 40 ± 1.6 Ma age for the host rock and a 37 ± 1.3 Ma age for the shear zone. Both ages are statistically indistinguishable when errors are considered. These dates correspond to the regional Eocene high-pressure – low-temperature event and not the later low grade deformation event that is responsible for the formation of the studied shear zone. Although the marble within the shear zone was deformed at fast strain rates ($\sim 10^{-10} \text{ s}^{-1}$), we observe no resetting in the isotopic system. Moreover, mineral chemistry demonstrates that (1) white mica is homogeneous and (2) there is no compositional difference between the host rock and the shear zone. This is in agreement with thermodynamical modelling, which indicates that the observed assemblage (calcite + dolomite + quartz + white mica) is stable without any composition change along the pressure-temperature path followed by the metamorphic rocks of Syros. Our case study emphasizes that phengites in highly deformed marbles do not necessarily yield deformation ages.

MICROFABRIC DEVELOPMENT AROUND GARNET INCLUSIONS IN QUARTZITE

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strain localization, microfabric, quartz deformation

During progressive deformation, the presence of a strong inclusion in a weaker matrix causes stress concentration that may result in strain localization, seen in a matrix grain-size reduction. An example of this phenomena, but rather more complex, has been observed in the Kalak Nappe Complex (Finnmark, Norway). A metadolerite dyke has been rotated to lie parallel to the penetrative regional low-angled foliation during the emplacement of the overlying nappe. The metadolerite, now only ~1.4 cm thick and lying between two quartzite layers has been retrogressed to a biotite schist with an assemblage of biotite, titanite, epidote group, garnet and quartz. Garnets are from 0.2 mm to 4 cm in size, subhedral with inclusions of predominantly titanite and rare amphibole.

During late deformation, some garnets were forced into the quartzite, resulting in the development of pronounced gouges (tectoglyphs), deepening in the direction of movement. Quartz was pushed up at the sides of the gouges and forms a distinct bow-wave at the front of isolated garnet grains. Where garnets are gouged into the quartzite, intense strain localization occurs. Both in front of and under the garnet, an up to 18 mm wide zone of quartz mylonite developed. The mylonitic foliation curves around the garnet, with a relatively sharp boundary to the adjacent quartzite that preserves an older random fabric.

Deformation in the quartz mylonite, which shows a strong crystallographic preferred orientation, seems to have occurred by (1) intense dislocation glide followed by (2) subgrain rotation recrystallization. The grain size of the ultramylonite (at the quartzite-biotite schist interface) increases with increasing distance from the present position of the garnets. This observation is consistent with an expected increasing stress gradient towards the garnet porphyroclast. Where no garnet is located at the quartzite-biotite schist boundary, strain was localized within the biotite schist as indicated by extreme grain size reduction of biotite grains while quartz remains almost undeformed. So far, the specific mechanism causing the gouging of garnets into the quartzite and the development of the tectoglyphs is unclear.

3D MAGNETORESISTIVE SENSORS AS A NEW TOOL FOR MEASURING DEFORMATION ACROSS GEOLOGICAL DISCONTINUITIES

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fault displacement monitoring, triaxial positioning sensor, global numerical repository, Alps, Mediterranean

Here we describe a new instrument for measuring deformation across any type of geological discontinuity and present the first results from three test sites located in contrasting seismogenic regions. In essence this instrument is a triaxial positioning sensor which records the displacement of a permanent magnet relative to an array of magnetoresistive detectors. The magnet is anchored to one side of a geological discontinuity while the sensing array is fixed on the opposite side. Readings are taken in milligauss and converted to distances, in μm , and rotations, in mrad. Both the operation range and resolution of the instrument can be tailored by selecting the size and shape of the magnet. The system is equipped with WiFi/3G to enable remote real time monitoring and the instrument has a data acquisition time of 50 ms. Three of these triaxial positioning sensors have been deployed to measure fault deformation in caves located in contrasting seismogenic regions across Europe. Our first test site is located in Altaquelle Cave in Lower Austria. This cave is situated to the south of the Vienna Basin in the Prealps east of the Mur while the monitored fault trends N-S and relates to the Vienna Basin Transform Fault System. Our second test site is located in Tripa tou Fournari Cave in northern Greece. This cave is situated in a narrow NW-SE trending graben neighbouring the western end of the Chortiatis Magmatic Suite while the monitored fault relates to the NE-SW trending Pefka-Asvestochori Fault System. Our third test site is located in Benis Cave in southeastern Spain. This cave is situated in the Prebetic System and its development is clearly conditioned by active normal faulting along a steeply dipping fault trending NNE-SSW. The initial results constitute the first step towards a global numerical repository for data recorded by the new triaxial positioning sensor. It is our intention to add more instruments in each of the aforementioned areas in order to be able to conduct detailed interregional and intraregional analyses. This instrument can also be used in many other situations where the monitoring of geological discontinuities is important.

INGENIEURGEOLOGISCHE ASPEKTE DES GIPSKEUERS (GRABFELD-FORMATION) VON BADEN-WÜRTTEMBERG

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Gipskeuper, Erdfälle, Hebungen, Massenbewegungen, saisonale Volumenänderungen

Der Gipskeuper, oder nach aktueller stratigraphischer Nomenklatur die Grabfeld-Formation (kmGr, 235-225 Mio. a), bildet mit einer Ausstrichfläche (ohne quartäre Bedeckung) von ca. 6,5 % der Landesfläche eine im Schichtstufenland und in den Gäulandschaften des Neckarraumes bedeutsame geologische Einheit Baden-Württembergs. Kaum eine andere geologische Einheit ist ingenieurgeologisch von einem so vielfältigen Erscheinungsbild geprägt und stellt in der praktischen Beratungstätigkeit immer wieder neue Herausforderungen an den Gutachter. Aus diesem Grunde werden aus der praktischen Erfahrung die ingenieurgeologisch relevanten Charakteristika des Gipskeupers zusammenfassend beschrieben.

Ein wesentliches Merkmal ist die sehr wechselhafte Sulfatführung (Gips und Anhydrit) mit den damit verbundenen Problemen der aktiven Gipsauslaugung (Gipskarst) und dem Auftreten von Erdfällen. Nach landesweiter Auswertung des Landesamts für Geologie, Rohstoffe und Bergbau wurden ca. 3900 Erdfälle bzw. Dolinen im Ausstrichbereich des Gipskeupers ermittelt. Das so genannte „Gipskeuperquellen“ als Überbegriff des Anhydritschwellens und des Quellens begleitend auftretender quellfähiger Tonmineralen (i.e. Corrensit) hat in den vergangenen Jahren in Baden-Württemberg wiederholt zu Sohlhebungen an Tunnelbauwerken und in Autobahneinschnitten geführt und stellt für Bauprojekte höchste bautechnische Anforderungen zur Vermeidung unerwünschter Wasserzutritte in schwell- und quellfähige Gebirgsabschnitte. Die prominenten Erdwärmesonden-Schadensfälle in Baden-Württemberg zeigen, dass misslungene, undichte Sonden hinterfüllungen gravierende Geländehebungen als Folge des „Gipskeuperquellens“ hervorrufen können und dass eine Sulfatexposition zementgebundener Sonden hinterfüllmaterialien zur Ettringit- und Thaumassitbildung führen kann, welche zumindest die mechanische Stabilität von Ringraumabdichtungen herabsetzt. Aber auch die Neigung der oberflächennahen tonig-schluffigen Verwitterungsbildungen zu Massenbewegungen ist hervorzuheben. Etwa 1,6 % der o.g. Ausstrichfläche des Gipskeupers ist von Massenbewegungen unterschiedlichen Ausmaßes betroffen. Nicht zuletzt wird auf die Neigung der tonig-schluffigen Verwitterungsbildungen des Gipskeupers zu saisonalen Volumenveränderungen hingewiesen. Diese können im oberflächennahen Baugrund ein bauwerksrelevantes Schrumpfen nach Austrocknung und Quellen nach Wiederbefeuchtung nach sich ziehen und sind im gesamten Ausstrichbereich des Gipskeupers zu beachten.

PLEISTOCENE SEAWATER DENSITY RECONSTRUCTION IN THE NORTHEAST ATLANTIC AND ITS IMPLICATION FOR COLD-WATER CORAL CARBONATE MOUNDS

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cold water corals, NE Atlantic, carbonate mounds, water mass

Carbonate buildups and mounds are impressive biogenic structures throughout Earth history. In the recent NE Atlantic, cold-water coral (CWC) reefs form giant carbonate mounds of up to 300m of elevation. The expansion of these coral carbonate mounds is paced by climatic changes during the past 2.7Myr. Environmental control on their development is directly linked to controls on its main constructors, the reef-building CWCs. Seawater density has been identified as one of the main controlling parameter of CWC growth in the NE Atlantic. One possibility is the formation of a pycnocline above the carbonate mounds, which is increasing the hydrodynamic regime, supporting elevated food supply, and possibly facilitating the distribution of coral larvae. The potential to reconstruct past seawater densities from stable oxygen isotopes of benthic foraminifera has been further developed: a regional equation gives reliable results for three different settings, peak interglacials (e.g., Holocene), peak glacials (e.g., Last Glacial Maximum), and intermediate setting (between the two extremes). Seawater densities are reconstructed for two different NE Atlantic CWC carbonate mounds in the Porcupine Seabight indicating that the development of carbonate mounds is predominantly found at a seawater density range between 27.3 and 27.7 kgm³ (σ_{θ} notation). Comparable to recent conditions, we interpret the reconstructed density range as a pycnocline serving as boundary layer, on which currents develop, carrying nutrition and possibly coral larvae. The close correlation of CWC reef growth with reconstructed seawater densities through the Pleistocene highlights the importance of pycnoclines and intermediate water mass dynamics. CWC reef formation and carbonate mound development in the NE-Atlantic is triggered by processes and dynamics of ocean gateways: 1) Mediterranean Outflow at the Strait of Gibraltar intensified 3.3–3.5 Ma leading to a gradual increase of bottom water densities, and 2) the closure of the Isthmus of Panama around 2.7 Ma or at least the onset of the meridional overturning circulation resulted in an enhanced subsurface water transport to higher latitudes in the Atlantic lowering the extinction risk of deep-sea ecosystems. The consequences of the gateway-processes established the necessary density contrast in water masses enabling active CWC reef growth in the Porcupine Seabight around that time.

AEROGEOPHYSICAL HIGH-RESOLUTION SURVEY OVER THE LANTERMAN RANGE: IMPLICATIONS FOR ROSS- AND POST-ROSS GEODYNAMICS

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Geophysics, Aeromagnetic survey, North Victoria Land, Antarctica

We are presenting new magnetic data of a high-resolution aeromagnetic survey over the Lanterman Range in North Victoria Land, Antarctica. The survey was carried out during GANOVEX XI (German Antarctic North Victoria Land Expedition) led by BGR in the 2015/16 Austral summer. A helicopter based survey with a setup of 1 – 2 km line spacing and 10 km tie lines was complemented by ground truth magnetic susceptibility readings by using a Kappameter KM-7.

North Victoria Land is subdivided in three tectonometamorphic terranes from W to E in the Wilson-, Bowers- and Robertson Bay Terrane which accreted onto the Palaeo-Pacific active continental margin of Gondwana during the Early Paleozoic Ross Orogeny. The survey over the Lanterman Range covered parts of the two western terranes which are separated by the Lanterman Fault Zone. This polyphase tectonic discontinuity is characterized by a belt of mafic and ultramafic rocks comprising metabasites with eclogite facies relics.

Preliminary results show two distinct and nearly parallel magnetic lineaments in the survey area that will be further interpreted by combined magnetic susceptibility measurements and geological field data. One magnetic lineament correlates well with the boundary between the Wilson and Bowers terranes which comprises also a metaconglomerate belt with mafic clasts. The second magnetic lineament is so far not supported by outcrops of associated highly magnetic rocks in the field. Future modeling of the data set will help to identify the specific nature and origin of this second anomaly. Similar parallel structures have been observed further to the southeast and seem to be offset by a major sinistral strike-slip fault zone of possibly post-Jurassic age.

THE ROLE OF FAULT ZONES IN CALCAREOUS ROCKS AND THE CHANGE IN RESERVOIR PROPERTIES FROM OUTCROP TO DEPTH

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Porosity, Permeability, Carbonates, Faults, Depth

We present depth correlated porosity and permeability studies of calcareous protolithes and fault rocks in the Wetterstein platform (Triassic) of the Hochschwab area.

The Hochschwab area is a karst plateau in Styria that covers an area of about 560 km². The stratigraphic sequences comprise Permian to Upper Triassic sediments, including limestones and dolostones of the Wetterstein Fm. The groundwater circulation follows an E-W directed pattern and is mainly controlled by major tectonic features. This underlines the importance of understanding these fault zones and their impact on reservoir properties. Porosity and permeability characteristics of these strike-slip faults are presented in this study and compared with appertaining protolithes.

Using the standard fault core and damage zone model we grouped samples into unfractured and fractured protolith as well as in different fault rocks, like breccias, cataclasites and stylolitic-fault rocks. Rocks of the damage zone are classified by their fracture density (m² fracture surface per m³ rock) and fault rocks according to their matrix content and differences in grain sizes.

A total of 287 samples from 10 different faults has been investigated in the laboratory using different methods for porosity and permeability measurements. Results present data for two testing mediums (water and nitrogen) and we distinguish between primary features and microfractures.

Results indicate that limestones and dolostones show different trends in the poro/perm evolution along fault zones. Also the different rock categories show complex poro/perm features within one lithology.

Depth correlated data were derived by a VINCI Coreval 700 poropermeameter and display reservoir properties for gas up to 1600m overburden. Results indicate more resistance of fault rocks to overburden than undisturbed rocks. Furthermore first attempts allow to define the ratio of pores and fractures in different samples and their impact on the depth-depended behavior.

NEW DATA ABOUT THE UPLIFT OF THE EIFEL-MOUNTAINS

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uplift, Eifel-Mountains, recent tectonic, intraplate crustal movement

As an integrated part of the geodaetic AdV project »Repeated measurements in the German main height network (DHHN)« a special, geological active part of Northrhine-Westfalia, the Eifel-Mountains, were geodaetic measured for the time period from 1983 to 2007 and the vertical movement patterns were investigated.

In the last 2 Ma the Eifel-Mountains as part of the Rhenish Massiv were uplifted rapidly, the actual landform is a peneplain with steep sloped canyonlike valleys. The sedimentary record for this uplift history is sparse. Therefore geodaetic measurement of the uplift movement are of great importance.

The uplift of the Eifel region is geologically well studied. The determined uplift rates for the last 800.000 years range from 0,06 to 0,38 mm/a. Accurate geodetic measurements in the study area for the period from 1960 to 1980 determined uplift rates in the Eifel of 0,6 to 1,2 mm/a (Mälzer et al. 1983).

In this study, quite identical movement patterns and uplift rates between 0,75 and 1,25 mm/a for the time period from 1983 to 2007 were observed. Therefore the geodetic measured uplift rates of the Eifel region are several times higher than estimated by geo-logical records. They are comparable to the recent uplift rates of the Alps. Potentially elastic deflection of the lithosphere may be a cause for the uplift of the upland regions north of the Alps. The effect of elastic deflection was so far only applied on rift basins.

The results imply an accelerated uplift of the Eifel region and also a strong, fault bound activity at the western margin of the Lower Rhine Embayment. The recent crustal movements measured during the geodetic DHHN campaign are significant. Therefore new geologic models of the recent crustal deformation are needed – models, which also take into consideration the elastic parameters of the crust.

NEOTECTONIC DEFORMATION IN QUATERNARY DEPOSITS NEAR INNSBRUCK (EASTERN ALPS)

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neotectonic activity, Quaternary, coseismic, faulting, clast fracturation

Because of tectonic indentation, the Eastern Alps are dismembered along seismically active faults. Rockslides associated with these faults in some cases were directly triggered by earthquakes. Macroseismicity mostly is of $M < 5-5.5$ (minimum for coseismic structures at surface), and deformation seems to be mainly accommodated by 'secondary' structures less clearly tied to tectonism. During glacials, most of the Eastern Alps was covered by ice streams, so glacio-seismicity might produce structures hardly distinguishable from 'non-glacial' deformation. In consequence, in Quaternary deposits, only very few structures remain that may be of genuine tectonic origin.

The Hötting Breccia (HB) – a succession mainly of lithified alluvial fans and talus along the mountain flank north of Innsbruck – largely accumulated and lithified before ~167 ka (Spötl et al., 2014). The HB commonly shows gravitational downthrow of joint-bounded blocks up to hundreds of meters in size along steep slopes. At three locations, brittle fault planes were found that record lateral displacement. In karstic cavities up to a few decimeters wide, geopetally-laminated internal deposits became multiply deformed (folds, breccias). In a post-glacial, partly lithified alluvial fan to talus succession near Innsbruck, numerous deformation structures were identified; these include lithoclasts fractured/crushed in situ, meter-scale monoclines, decameter-scale kink folds, and crushed geopetally-laminated pore fillings.

In the HB, the brittle fault planes and the multi-phase deformed cave deposits record tectonic deformation. All of the other deformation structures, however, might result from gravitational instability only. In the mentioned post-glacial succession, the lateral persistence and the scale of structures suggest gravitational instability event(s) triggered by seismicity, if not by coseismic throw deeper within at site. This is suggested by a similar inventory of deformation structures in talus successions of the Apennines that are clearly associated with active faults, and that were not covered by glaciers. Deformation structures – mainly in-situ fracture of clasts up to boulder size and soft-sediment deformation – were observed in lithified Quaternary deposits also at other locations in the Eastern Alps; in those cases, however, a separation of gravity-induced deformation, glacial loading, tectonism and glacio-tectonism is more ambiguous.

Reference: Spötl, C. et al. (2014): Zeitschrift Gletscherkd. Glazialgeologie, 47/48: 135-146.

LONG-RUNOUT ROCK/SNOW FLOWS: AN UNDERRATED TYPE OF MOUNTAIN HAZARD

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natural hazard, snow avalanche, rockfall, mass flow

In the Alps, LIDAR topography and field mapping reveal ever more mass-flow deposits that most probably descended on and with snow. Specifically, an hitherto neglected flow type is represented by two-layer rock/snow avalanches (TLA) of: (a) a lower layer of pure snow entrained along the avalanche flow path, and (b) an upper layer of unsorted rock debris. TLA are triggered by impact of rockfalls or rock avalanches onto slopes covered with granular snow; after impact, within a short distance downslope, the twofold layering develops by snow entrainment along the avalanche front while the rock debris rides passively piggyback. Observations of several TLAs in the past few years and numerical modeling suggest that the rock debris carried atop the moving mass markedly prolongs avalanche runout. Notwithstanding potential physical explanations for this type of avalanche, another question is how to recognize their 'fossil' deposits not available for direct observation.

A difficulty in identifying fossil rock/snow mass flows is that a major determinant of flow behaviour – the snow – is vanished by melting; its former presence thus must be deduced from the distribution of rock debris only. In addition, rock/snow flows not necessarily all were TLAs. The presented criteria for identification of fossil rock/snow flows are neither claimed to be complete nor to be strictly diagnostic for any case: (1) superlong runout relative to rock debris volume, (2) overall low thickness (one clast to a few clasts) of unsorted rock debris not explained by debris-flow transport, and/or (3) laterally highly variable thickness to patchy distribution of rock debris, (4) lateral spread of thin veneers to 'litters' of rockfall cobbles to boulders near the snout of a presumed rock/snow flow, and (5) evidence for highly mobile flow, as recorded by local interruptions of rock-debris veneers fitting with topographic obstacles. With time and progressive overprint by other geomorphic processes, however, reconstruction of rock/snow flows and in particular of TLAs will get ambiguous. Large parts of the present Alps are covered with snow over three to five months of the year, i.e., the probability for rockfalls and rock avalanches to hit snow-covered slopes is high.

INTERHEMISPHERIC TELECONNECTIONS – LATE PLIOCENE CHANGE IN MEDITERRANEAN OUTFLOW WATER LINKED TO CHANGES IN INDONESIAN THROUGHFLOW AND ATLANTIC MERIDIONAL OVERTURNING CIRCULATION?

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Global teleconnections, Mediterranean Outflow Water, Atlantic Meridional Overturning Circulation, Pliocene

The origin and potential impact of changes in the flow of Mediterranean Outflow Waters (MOW) on Atlantic Meridional Overturning Circulation form a long-standing question of oceanographers (Reid, 1979). Late Pliocene changes in the distal advection of MOW were reconstructed on orbital timescales for N.E. Atlantic DSDP/ODP Sites 548 off Brittany and 982 on Rockall Plateau and compared to West Mediterranean deep-water records of Alboran Sea Site 978 (Khélifi *et al.*, 2014; Grunert *et al.*, *in prep.*). Neodymium isotope (ϵ_{Nd}) values more positive than -10.5/-11 reflect diluted MOW that spread almost continuously into the N.E. Atlantic up to Rockall Plateau between 3.7 and 2.6 Ma. On the basis of Mg/Ca and $d^{18}O$ of epibenthic foraminifers we estimated changes in MOW temperature, salinity, and density. Oscillations of these properties between 3.6 and 2.9 Ma are closely coherent at more proximal Site 548 and distal Site 982, thereby lending clear support to the significance and robustness of these records. From 3.4–3.3 Ma, they rose from 2°–4°C, ~1 psu, and $>1.5 \text{ kg m}^{-3}$, respectively, in harmony with a coeval rise in sea surface salinity and deep-water density at Mediterranean Site 978 and increased summer aridity (pollen record of Fauquette *et al.*, 1998). MOW intensification may have been triggered by a major switch in the waters passing the Indonesian Throughflow, a switch that culminated near 3.3 Ma and resulted in a slight cooling of the equatorial Indian Ocean (Karas *et al.*, 2009) and possibly, in a reduction of the African monsoon. In turn, the enhanced Mediterranean salt export probably triggered a unique long-term strengthening of Upper North Atlantic Deep Water formation, that followed with a phase lag of ~120 ky.

Fauquette, S., Guiot, J., Suc, J.-P., 1998. *Palaeo. Palaeo. Palaeo.* 144, 183–201.

Karas, K., Nürnberg, D., Gupta, A.K., Tiedemann, R., Mohan, K., and T. Bickert, 2009. *Nature geoscience* 2, 434–438.

Khélifi, N., Sarnthein, M., Frank, M., Andersen, N., and D. Garbe-Schönberg, 2014. *Marine Geol.*, 357, 182-194.

Reid, J, 1979. *Deep-Sea Res.* I 26, 1199–1223.

DESIGN PARAMETERS FOR MIDDLE DEEP BOREHOLE EXCHANGER STORAGE SYSTEMS

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Karst Aquifer, Heat Extraction and Storage, Middle Deep Geothermal Energy

To dimension a geothermal array it is necessary to explore the geophysical and geological conditions of the subsurface. The project engineering of that realized geothermal array is shown in terms of acquisition of the critical design parameters and the transfer into the execution design. Optical Frequency Domain Reflectometry was applied to investigate the final design parameters. The linear borehole heat exchanger systems were installed using percussion drilling. In total 3.600 m BHE were completed in 9 wellbores consisting of 2 BHE groups. The thermal profile has conductive heat transfer in the upper section and convective in the lower karstified well bore section.

The talk will compare the designing approach (1 GWh/a heat extraction and 0,4 GWh/a cooling load) with the obtained performance after the first 2 years of full operation in heating and cooling this particular hotel complex. The systems were dedicated to supply the 25 x 12,5 m outdoor swimming pool e.g.. The annual utilization of the geothermal energy was determined to be 6.600 h. The impact of the earth's heat utilization on the thermal underground balance will be demonstrated by the evaluation of repeated enhanced geothermal response tests in one of the 400 m deep BHEs.

DESIGN PARAMETERS FOR MIDDLE DEEP BOREHOLE EXCHANGER STORAGE SYSTEMS

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Underground heat storage, BTES, middle deep geothermal drilling

The design of Medium Deep Borehole Heat Exchangers (BHEs) as High Temperature Borehole Thermal Energy Storage requires an optimization process. The talk presents the combined results of different numerical parameter studies like borehole spacing, length, number, heat transfer parameters etc.. The influence of different design parameters on the storage performance will be defined. And the impact of operational times on the storage effectivity will be demonstrated. There is a strong influence of the studied parameters on the efficiency and the specific heat extraction rate of such storage systems. Depending on the selected parameters, the storage efficiency ranges between about 20 % and 70 % in the 10th year of storage operation. The average specific heat extraction rate for the preset extraction time of 4380 hours reaches values from about 40 W·m⁻¹ to more than 90 W·m⁻¹ in the 10th year of operation, which correlates to an annual specific heat extraction of about 175 KWh to more than 390 KWh per meter of BHE.

CHARAKTERISIERUNG DER THERMALWASSERSYSTEME DES GONGHE-GUIDE BECKENKOMPLEXES, NORDÖSTLICHES QINGHAI-TIBET PLATEAU (CHINA)

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Thermalwasser, Gonghe-Guide Becken, Tiefe Geothermie, Aufschlussanaloge

Der Gonghe-Guide Beckenkomplex ist Teil des nordöstlichen Qinghai-Tibet-Plateaus und weist eine durchschnittliche Geländehöhe von ca. 3000 m auf. Der Beckenkomplex zeichnet sich durch eine erhöhte hydrothermale Aktivität aus und umfasst drei hydrothermale Gebiete: (1) Qiabuqia, (2) Guide und (3) Xinghai. Aufgrund des hohen geothermischen Gradienten von 5.1 bis 7.3 °C pro 100 m (Yan et al., 2013) ist das im Beckensystem hauptsächlich aus Graniten und Granodioriten aufgebaute Grundgebirge grundsätzlich zur petrothermalen Erzeugung von Strom und Wärme geeignet. Das petrothermale Pilotkraftwerk in Qinghai musste jedoch aufgrund von Scalingproblemen vorerst stillgelegt werden (Wang et al., 2014). Zur Erfassung der Beschaffenheit der Thermalwassersysteme im Gonghe-Guide Beckenkomplex, wurden daher insgesamt 20 Thermalquellen und 13 geothermale Brunnen und drei kalte Quellaustritte als Referenz beprobt. An allen Probenahmestellen wurden sowohl in-situ Parameter als auch Probenmaterial für weitere hydrochemische Analysen genommen. Mittels optischer Emissionsspektrometrie mit induktiv gekoppeltem Plasma (ICP-OES), Ionenaustauschchromatographie und einer Isotopenanalyse (Wavelength-Scanned Cavity Ring-Down Spectroscopy) wurde eine Typisierung der Proben durchgeführt. Die Beprobungstemperaturen liegen in einer Spanne von 6,8 °C bis zu 91,9 °C (Siedepunkt im Gonghe-Guide-Beckenkomplex). Anhand der Analysedaten lassen sich die Proben in insgesamt fünf Wassertypisierungen gliedern, die eine Mischungslinie von kalten, oberflächennahen Ca-HCO₃-Wässern hin zu Na-Cl-Wässern zeigen. Da die Ursache der Thermalwasseraustritte nicht endgültig geklärt ist, wurde zusätzlich zur hydrogeologischen Probenahme eine Aufschlussanalogiestudie der kristallinen Gesteine am Beckenrand durchgeführt. An dem dort gesammelten Probenmaterial sind unter anderem petrophysikalische Kennwerte ermittelt, sowie mittels Dünnschliffanalyse und Röntgenfluoreszenzanalyse (RFA) eine petrographische und geochemische Charakterisierung durchgeführt worden. Die radiogene Wärmeproduktion, die als mögliche Ursache der Thermalwässer gilt, wurde anhand der RFA-Analysedaten für die beprobten Aufschlussanaloge bestimmt.

RECONSTRUCTION OF A TERRESTRIAL ECOSYSTEM FROM THE MIDDLE JURASSIC OF SARDINIA

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palaeoecology, palaeoenvironment, plant fossils, palynomorphs, sedimentology

Sardinia was during the Middle Jurassic a part of the Corsica-Sardinia block and located on the north-western edge of the Tethys (about 25–35° N), very close to the margin of the European plate. This would suggest that the area was characterized by a mixed flora with Euroasiatic and North African (Gondwana) elements. These colonized an archipelago formed by small emerged islands, surrounded by a thin belt formed by transitional sediments, passing from continental to marine. This makes Sardinia of particular interest for paleobiogeographic studies merging paleobotanical, palynological and sedimentological data. More than 1000 plant macroremains from different museological collections belonging to the Genna Selole Formation were studied; the plant fossils are divided according to their lithofacies. Lithofacies A corresponds to a fine-grained siltstone facies, while lithofacies B corresponds to a coarser, sandstone facies. Preliminary results show a dominance of leaf fragments of *Ptilophyllum* and an abundance of the fern *Coniopteris* in both lithologies while *Carpolithes* is more abundant in the silty lithofacies and *Nilssonia* in the sandy lithofacies. The sporomorphs yielded by the Jurassic sediments of Sardinia belong to club mosses and lycophytes (e.g. *Obtusisporis*, *Neoraistrickia*), horsetails (e.g. *Calamospora*), ferns (e.g. *Cyatidites*, *Dictyophyllidites*, *Todisporites*), ginkgophytes (e.g. *Callialasporites*), seed fern (e.g. *Alisporites*), cycadophytes (e.g. *Cycadopites*) and conifers (e.g. *Araucariacites*). Club mosses and lycophytes are recorded only as palynomorphs but are missing in the macroflora record. The palynological associations of the northern Sardinia assemblages reflect freshwater to brackish environments and support a vegetation growing under warm, humid climate. The microfloras of eastern Sardinia originate from riparian, floodplain and coastal vegetation. Hygrophytic ferns (*Cyathidites*, *Dictyophyllidites*, *Todisporites*, *Osmundacidites*, etc.), seed ferns (*Alisporites*, *Brachysaccus*, *Vitreisporites*) and cycadophytes (*Cycadopites*) are abundant. The conifers are typical of swamps like Taxodiaceae (*Cerebropollenites*) or of coastal areas such as Cheirolepidaceae (*Classopollis*). Open forests of Podocarpaceae (*Podocarpidites*) and Pinaceae (*Pinuspollenites*) growing on the Palaeozoic reliefs were present as well.

CHARACTERIZATION OF ORGANIC COMPOUNDS IN KUPFERSCHIEFER-TYPE BLACK SHALES FROM THE FORMER MANSFELD-SANGERHAUSEN MINING DISTRICT; CENTRAL GERMANY

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organic compounds, trace elements, black shale, Kupferschiefer

Kupferschiefer-type ore mineralization hosts economic base metal resources and is commonly associated with the basal black shale layer of the Permian Zechstein. Nevertheless, the base of the black shale layer (local miners term "Feine Lette"), a few cm thick, finely laminated horizon in this sediment is known for its high concentration of organic matter and partially significant portion of ore minerals. In order to examine possible correlations between occurrence of distinct organic compounds and elevated contents of trace elements (e.g. Cr, V and Mo) twelve organic matter-rich samples from the basal facies of black shale from several localities of the Mansfeld Mining District were analysed microscopically and geochemically. Furthermore, three samples from the Sangerhausen Mining District were taken from the organic matter-rich black shale overlying the Weißliegend sandstone directly and were analysed additionally for comparison.

Microscopic investigations were used to determine the mineral composition, as well as the structure of organic matter and associated ore mineralisation. The organic compounds were extracted from solid samples by Soxhlet extraction and were qualitatively identified by gaschromatography. In addition HPLC was used to determine the more polar components with special attention to the diverse polycyclic aromatic hydrocarbons (PAH). Additionally, the content of trace elements and metals (e.g. Cu, Pb, Zn) contained in the solvent extracts have been analysed by ICP-MS and the initial sample powder was measured by handheld XRF (NITON).

Results reveal remarkable differences between the Mansfeld and Sangerhausen samples. As expected, the total amount of organic matter was a slightly higher in the Mansfeld samples. Additionally, microscopic investigation illustrates recognizable high amounts of framboidal pyrite, following the alignment of the band-like structure of the organic matter in the Mansfeld samples. Furthermore, qualitative analysis of organic compounds by gaschromatography showed that n-alkanes ranging from C₁₀ – C₂₄, with a dominance of C₁₁ – C₁₈, naphthalene (including methyl-, ethyl-, dimethyl- and trimethylnaphtalene), isoprenoids and phenanthrenes are the dominating compounds and HPLC measurements highlighted the variety of PAH in these samples.

SLAB ROLLBACK OROGENY IN THE ALPS INFERRED FROM THE STRATIGRAPHIC EVOLUTION OF THE SWISS MOLASSE BASIN

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Orogenesis inferred from sedimentation

The sedimentological evolution of foreland basins has been related to orogenic processes, where continent–continent collision resulted in the build up of topographic loads and the downwarping of the foreland plate. These mechanisms have also been used to explain the Oligocene to Miocene evolution of the Molasse foreland basin, situated on the northern side of the Alps. Continuous flexural bending of the subducting European lithosphere as a consequence of topographic loads alone would imply that the Alpine topography would have increased at least between 30 Ma and ca. 5–10 Ma when the basin accumulated the erosional detritus. However, the constant spacing between alluvial megafans since 22 Ma, paired with provenance information suggests that the Alpine drainage basins have not changed their size nor their morphometric properties, at least until c. 10 Ma at the latest. Accordingly, larger topographic loads cannot be invoked to explain the continuous deflection of the foreland plate during the same time span. Alternatively, a scenario where horizontal forces cause a downward dragging of the foreland plate could be used to explain the decoupling between basin depth and topographic loads. However, such a scenario would be associated with large compressional forces within the entire foreland plate. This is not in agreement with the occurrence of normal faults dissecting the foreland plate, and the observation of synsedimentary breccias on the hanging wall adjacent to these faults during the flysch and molasse stages of foreland basin evolution. This suggests that the foreland plate has been under transtension and not transpression. We suggest that slab rollback, driven by the gravitational pull of the European slab, provides a mechanism to explain the increasing deflection of the Molasse foreland basin in the absence of larger topographic forcing, and it agrees with the geologic record that the subducting European plate did not move south while the overriding Adriatic plate shifted north. Such a mechanism explains the formation of the Alps through the delamination and accretion of crustal rocks from the subducting plate, yielding in the stacking of the Alpine nappes and in the uplift of the external massifs along steep faults.

PETROPHYSICAL HETEROGENEITIES IN SILICICLASTIC RESERVOIR ANALOGS

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siliciclastics, fluid flow, diagenesis, bounding surface

Homogeneous porous sandstones are target horizons for geothermal and hydrocarbon reservoirs due to their high permeabilities. However, their sedimentary and structural heterogeneity may alter flow properties. We analyzed the permeability anisotropies and associated diagenesis of sedimentary and structural fabrics in eolian Rotliegend sandstones and highlight the importance of diagenetic alterations within sedimentary fabric. Results are compared with weakly lithified marine sands, demonstrating the importance of cross-bedding and bounding surfaces on flow.

While deformation bands are known to reduce reservoir permeability by one to three orders of magnitude, the differing degrees of cementation within cross-bedding inhibit flow more effectively. Cross-bedding is best cemented in coarse-grained and uncoated beds. The impact of erosion-derived bounding surfaces is quantified in two Rotliegend outcrops in Germany and the UK.

There is no general correlation recognizable between the different sampling sites whereas porosity and permeability are clearly linked at each site. This can be assigned to mineralogical composition and paragenetic sequence. In the data sets 2nd order bounding surfaces have led to a porosity loss of up to 5 %. Low vertical permeabilities (\varnothing 0.63 mD) decrease by on average 79.4 – 95.2 %, compared to vertical permeabilities across the undisturbed cross-bedded sediments. Horizontal permeabilities of 110 mD evidence the heterogeneous character of the sandstones. Third order surfaces instead show minor increases in porosity of approximately 1 % but without any unambiguous trend. Vertical permeabilities (\varnothing 130 mD) are 7.7 – 26.9 % higher across such bounding surfaces than in normal cross-beds.

The heterogeneity of the bounding surface permeabilities is ascribed to short-term erosion succeeded by differing depositional and diagenetic alterations. At 2nd order surfaces these are transported clay clasts originating from lacustrine areas and eodiagenetic calcite reducing porosity and/or permeability. Such surfaces may inhibit flow if they form a lithological contrast, but generally appear to have a minor impact due to lateral heterogeneity. Our studied third order bounding surfaces impose no negative effect on permeability. Overall, differently cemented cross-bedding has the highest impact on flow and deformation bands may reduce flow, but their lateral continuity needs to be taken into account.

NEOGENE MULTIDIRECTIONAL EXTENSION IN THE ADRIA-EURASIA COLLISION ZONE OF NORTHERN ALBANIA

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Neogene tectonics, Mediterranean tectonics, Albania, Montenegro, Multidirectional extension

The fold-and-thrust belt of the Dinarides and Hellenides records the convergence of the Adriatic and Eurasian plates since their collision in the Late Cretaceous. Albeit at small rates, convergence continues at present, involving active continental subduction of Adria. The transitional area between Dinarides and Hellenides in northern Albania is marked by a distinct change in kinematics. While the northerly adjacent Dinarides experienced almost exclusively head-on contraction, widespread extension affected the Hellenides further south. Commonly, it is assumed that this extension was triggered by slab-rollback in the Aegean Sea, which to the north is confined along the orogen-perpendicular Shkodër-Pejë-Fault (SPF) that accommodated top-SSE normal fault motion. GPS-studies suggest ongoing southward-motion of Albania with respect to Eurasia (Jouanne et al., 2012). This supports the assumption that displacement is predominantly taken up along the SPF, likely in conjunction with a clockwise rotation around a vertical pivot near Shkodër (Handy et al., 2014).

Recent field work around the SPF in northern Albania, Kosovo and Montenegro has provided better insight into the timing and kinematics of this extensional phase. Outcrop-scale fault-slip data as well as map-scale considerations imply that extension was multidirectional, i.e. non-plane strain. In the Neogene basins around Kukës and Burreli, Pliocene to Quaternary deposits are clearly affected by normal faults of various strike, supporting the assumption that multidirectional extension is spatially more widespread than assumed thus far and active at present. Along with this Neogene extension, we repeatedly found evidence for Neogene to recent contraction along the coast of Northern Albania and Montenegro. These Neogene contractional tectonics involve sediments as young as Serravallian, which give a maximum age bracket for the onset of this contractional deformation. As a result of this, several emerging anticlines in the Kruja-Dalmatian zone show wind-gaps and therefore clearly affected the course of Rivers during ongoing growth (e.g. Small Drini river, Madurečka river and associated tributaries).

Jouanne et al. (2012). *GPS constraints on current tectonics of Albania*. *Tectonophysics*, 554+557, p.50–62.

Handy et al (2014). *Tectonics related to rotation at the western end of the Skutari-Pec normal fault*. 20th CBGA Meeting 2014, Tirana, Albania. P. 126-127.

NEW DATA ON THE CONCHOSTRACAN FAUNA OF THE CONTINENTAL PERMIAN–TRIASSIC TRANSITION IN THE EASTERN DEAD SEA REGION OF JORDAN

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Permian, Triassic, Conchostraca, trace fossils, Jordan

Conchostracans and invertebrate trace fossils dominate the continental Permian–Early Triassic fauna in Jordan. While the Permian Umm Irna Formation became recently known for blattoid insects and a single *Palaeoxyris* shark egg, the discordantly overlying Early Triassic Ma'in Formation frequently contains single and mass occurrences of conchostracans. Since conchostracans are the most frequent elements of this continental fauna, they provide highest potential for biostratigraphy. For conchostracan study, five localities were recently sampled from the Ma'in Formation, which is subdivided in the Himara and Nimra Members. The about 26 m thick Himara Member consists of purplish coloured alternations of thinly bedded sand-, silt-, and lime-rich claystone. The roughly 25 m thick Nimra Member differs from the latter by flaser bedded, red and green silt- and claystones, and cross-bedded, fine, white sandstones.

First findings of conchostracans starting 5 m above the basal discordance of the Ma'in Formation were obtained in three sections of the Himara Member. Due to morphological comparisons, the size and shape of these valves resemble *Euestheria*, which might correspond to *Euestheria gutta* known from Early Triassic occurrences in Germany, Russia and China. Moreover, the studied sections in Jordan contain a *Fuersichichnus*, *Phycodes*, *Cruziana*, *Rusophycus*, and *Lockeia* ichnofauna, which is very similar to the ichnofauna in Early Triassic continental deposits of the Bernburg Formation (Buntsandstein Group) in central Germany.

In two localities of the overlying Nimra Member a conchostracan fauna consisting of *Rossolimnadiopsis* was recorded for the first time. Intercalations with layers containing lingulid shells suggest occasional marine influence. Supposedly, the shells were transported by storm waves from the sea into nearshore coastal freshwater pools or lakes.

The new findings of *Rossolimnadiopsis* indicate a very narrow biostratigraphic interval, since other occurrences of *Rossolimnadiopsis* were only known from Central Russia in continental deposits of Late Permian to Early Triassic age. Such a correlation is additionally strengthened by further occurrences of this form in Early Triassic deposits of Germany and India. Consequently, subsequent studies should focus on the Early Triassic conchostracan fauna of the Ma'in Formation in order to better use the great potential of conchostracans for regional to interregional biostratigraphic correlations.

NEW DATA ON ROSSOLIMNADIOPSIS FROM THE MA'IN FORMATION OF THE EASTERN DEAD SEA REGION IN JORDAN AND ITS IMPLICATIONS FOR CONCHOSTRACAN BIOSTRATIGRAPHY

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Conchostraca, *Rossolimnadiopsis*, Ma'in Formation, Early Triassic, Jordan

During current field campaigns, the Permian–Triassic continental deposits of the eastern Dead Sea region in Jordan were sampled bed-by-bed for conchostracans (Crustacea: Branchiopoda). The most intriguing fossil material was obtained from the Early Triassic Ma'in Formation between Wadi Mukheiris and Wadi Mujib. In dark grey, laminated siltstones of the Nimra Member the morphologically prominent conchostracan genus *Rossolimnadiopsis* was identified at the locality FS-J3 (31°32'23.1" N, 035°33'20.5" E). Its valve morphology is characterised by a very large size, a round shape, a concave bending of the dorsal margin, and an outward bended semi-circular flange at the transition between the posterior and dorsal margins. Based on the distinct morphology of the semi-circular flange, the new material is determined as a new species of *Rossolimnadiopsis*. The genus *Rossolimnadiopsis* was hitherto only known by a few specimens from the East European platform in Russia. The holotype of *Rossolimnadiopsis marlierei* comes from the Obnora Formation in the Moscow syncline, which is referred to the late Vyatkian in the Russian regional scale and most possibly correlates with the Late Permian (Changhsingian) age. More recently, *Rossolimnadiopsis* sp. was also recorded in the Vokhma Formation of the Vokhmian Regional Stage (Early Triassic, Induan) in the Zhukov Ravine section of the Moscow syncline. Additionally, a form described as '*Pseudoasmussiata*' from the Early Triassic Panchet Formation in India shows a concavely bended dorsal margin, which suggest it also belongs to *Rossolimnadiopsis*. The new data indicate a wide palaeogeographic distribution of Early Triassic *Rossolimnadiopsis*. These occurrences unambiguously demonstrate the very high value of conchostracans for biostratigraphic correlations of continental deposits.

“UNTER DEM SALZ” – EIN ALTERNATIVES KONZEPT ZUR ENDLAGERUNG WÄRMEENTWICKELNDER RADIOAKTIVER ABFÄLLE

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Endlagerung, radioaktive Abfälle, Thüringer Becken, stratiforme Zechsteinsalze, Rückholbarkeit

Die Suche nach einem Endlager für hochradioaktive Abfälle in Deutschland konzentrierte sich bisher auf permzeitliche Salinare, die im norddeutschen Becken Salzstöcke und Salzmauern bilden. Die Nutzung von flach lagernden Salzfolgen schien aufgrund großer Tiefenlage bzw. zu geringen Mächtigkeiten homogener Salzkörper ungeeignet. Alternativ bieten horizontal lagernde Wechselfolgen von Tonen und Salzen sehr gute Eigenschaften hinsichtlich einer Abdichtung von Gasen und Flüssigkeiten tieferliegender Horizonte. Hiervon ausgehend wurde ein Konzept entwickelt, das die Endlagerung hochradioaktiver Abfälle unterhalb ausreichend mächtiger Salzfolgen vorsieht. Als Rahmenbedingungen für die Identifikation geeigneter Standorte werden folgende geologische Mindestanforderungen vorausgesetzt:

- Ausreichend mächtige Salzfolgen von mehr als 200 Meter in flacher Lagerung
- Tiefe der Salzsichten nicht wesentlich unterhalb von 1000 Metern
- Metamorphes/granitische Grundgebirge für standfeste Kavernen
- Keine kritischen Gaskonzentrationen (CH_4/CO_2) im Umfeld des Endlagers
- Fehlende bis geringe seismische Aktivität in der gesamten Region
- Ausreichender Abstand zu größeren Störungszonen
- Größere Distanz zu subrezenten Vulkangebieten

Weiterhin sind raumplanerische Aspekte wie geringe Besiedlungsdichte und eine Lage außerhalb von Schutzgebieten zu berücksichtigen. Anhand dieser Rahmenbedingungen lassen sich für eine Vorauswahl Gebiete in Südniedersachsen, Nordhessen, Thüringen und Nordfranken eingrenzen. Aufgrund der Verfügbarkeit ausreichender Daten aus Bohrungen und geologischen Aufnahmen können beispielhaft mehrere Teilregionen des Thüringer Beckens näher betrachtet werden. Hier besteht die Chance, dass ein Maximum der Mindestanforderungen eingehalten wird. Kavernen im Kristallingestein bieten hinsichtlich Standfestigkeit und Wärmeleitfähigkeit auch in mehr als 1000 m Tiefe gute Bedingungen für die Lagerung wärmeentwickelnder Abfälle. Eine Rückholbarkeit ist auch nach Jahrhunderten möglich. Die flachlagernden Wechselfolgen aus mehreren hundert Metern Salzen und Tonen des Zechstein garantieren einen dichten Abschluss zur Erdoberfläche in der Vertikalen. Fluidbewegungen an Störungszonen werden durch die abdichtende Wirkung der Salze unterdrückt. Standorte mit mehreren Kilometern Distanz zu größeren Störungszonen bieten darüber hinaus eine zusätzliche Sicherheit. Für das Wirtsgestein wird eine niedrige Permeabilität erwartet. Der Zeitraum für eine Abdichtung der Klüfte durch Sekundärmineralbildungen bei geringer tektonischer Aktivität war ausreichend lang.

GEOPHYSIK IN DER GRUNDWASSERERKUNDUNG

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Geophysik, Hydrogeophysik, Grundwassererkundung, Geoelektrik, Seismik

Der Wasserverband Völkermarkt – Jaunfeld versorgt mehrere Gemeinden mit Trink- und Nutzwasser, welches u. a. über eine Tiefbrunnenanlage im Jaunfeld gewonnen wird. Die Ergiebigkeit des Tiefbrunnens mit einer Schüttung von max. 9 l/s ist unzureichend. Um einen zusätzlichen Brunnen mit höherer Produktionsleistung zu errichten, wurden geophysikalische Untersuchungen durchgeführt. Einerseits wurden mehrere Refraktionsseismikprofile aufgenommen um die Struktur des Untergrunds beschreiben zu können. Andererseits wurden geoelektrische Untersuchungen durchgeführt, um Grundwasserleiter von Grundwasserstauer aufgrund einer relativen Korngrößenverteilung zu unterscheiden. Die Refraktionsseismikprofile brachten aufgrund fehlender Kontraste der seismischen Geschwindigkeit ein für die Hydrogeologie schwer zu interpretierendes Ergebnis. Erst die hohe Qualität der 2D Geoelektrik ergab ein gut zu interpretierendes Abbild des Untergrunds. Es wurden mehrere postglaziale Paläoflussbette auskartiert und als mögliche Brunnenstandorte ausgewiesen. Bereits bei der ersten Brunnenbohrung wurden grobklastische Sedimente als Füllung dieser Paläoflussbette angetroffen. Dieser neue Brunnenstandort liefert nun mit bis zu 50 l/s eine deutlich höhere Produktivität als der alte Brunnen.

Die Wasserversorgung im Lavanttal wird zurzeit über 83 Quellen aus der Koralpe und Saualpe abgedeckt. Durch mehrere niederschlagsarme Perioden in den letzten Jahren – vermutlich im Zusammenhang mit Veränderungen unseres Klimas – kam es immer wieder zu Engpässen in der Versorgungssicherheit. Auch der industrielle Siedlungsdruck macht alte Brunnenstandorte durch fehlende Schutz- und Schongebiete problematisch. Eine erste Brunnenbohrung 2014 brachte überraschenderweise ein sehr flaches Einfallen des nordwestlichen Beckenrands des Lavanttal Beckens als Ergebnis. In einer Kohleexplorationsbohrung aus dem Jahr 1950 wurde in ca. 4 km beckenwärts vom Beckenrand eine Tiefe von 680 m aufgeschlossen, ohne jedoch den Beckenuntergrund anzutreffen. Im April 2016 wurde im Auftrag des Wasserverbands Verbundschiene Lavanttal eine reflexionsseismische Übersichtsaufnahme durchgeführt. Mit Hilfe dieses Reflexionsseismikprofils liegen nun erste Ergebnisse der Geometrie und der Sedimentauflage des NW-Randes des Lavanttals bei St. Margarethen vor. Auf Basis dieser Ergebnisse kann nun gezielt die Position und Tiefe eines Brunnenstandortes ausgewiesen oder weitere Erkundungsmaßnahmen empfohlen werden.

MITTEN IM SCHADENSZENTRUM - DIE ROLLE DER (LANDES)GEOLOGEN BEI VERDACHTSFLÄCHENERKUNDUNG UND ALTLASTENSANIERUNG

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Geologie, Umweltschutz, Verdachtsflächen, Altlasten

Der ohnehin weitgefächerte Aufgabenbereich der Landesgeologen ist, zumindest für das Bundesland Steiermark, seit 1990 um eine zusätzliche, spannende und herausfordernde Komponente erweitert worden.

Mit 1990 wurde das Altlastensanierungsgesetz (AlsaG) in Rechtskraft erhoben und seit diesem Zeitpunkt werden die Agenden zur Umsetzung des Gesetzes in diesem sehr speziellen Fachbereich laufend von Geologen im Landesdienst abgewickelt bzw. fachlich begleitet.

Das sehr spezielle Betätigungsfeld der Verdachtsflächenerkundung und Altlastensanierung ist naturgemäß eng mit dem Untergrund und somit der Geologie verknüpft – finden sich doch die potentiellen Schadstoffe in dem „uns eigenen Substrat“ wieder.

Im Zuge der Projektabwicklungen zur Verdachtsflächenerkundung und Altlastensanierung sind wir Landesgeologen vor allem mit vertieften Kenntnissen über Regionale Geologie aber auch Genese des Untergrundaufbaues, fachspezifischen Hintergrundwissen und oft auch Ortskenntnis ein wichtiger Inputgeber, um ein Modellverständnis für Schadstoffakkumulation und -ausbreitung zu erarbeiten. Ein weiterer, wesentlicher Aspekt hierbei ist auch die Hydrogeologie, da bei einem Großteil der Schadensfälle das Schutzgut Grundwasser betroffen ist. Aufgrund der ausgedehnten und wasserwirtschaftlich intensiv genutzten Grundwasservorkommen in der Steiermark ist die Betrachtung der Auswirkungen und der Ausbreitung von Schadstoffen im Grundwasserabstrom von Altlasten von eminenter Bedeutung.

Doch weit über den geologischen Rahmen hinaus sind wir hier auch im chemisch technischen Bereich gefordert, da ohne ein Grundlagenwissen bezüglich der auftretenden Kontaminanten eine fachlich fundierte Projektbegleitung nicht möglich ist. Letztendlich stellen wir aber auch oftmals die Schnittstelle bzw. den Dolmetsch für die Juristen, Chemikern, Kulturtechnikern etc. dar.

Somit sollen die Ausführungen die Rolle der Landesgeologie auch in Bezugnahme auf den aktiven Umweltschutz in direkter Umsetzung eines Bundesgesetzes (AlsaG) aufzeigen und näher beleuchten.

AUTOMATED SEM-EDS METHODS IN SUPPORT OF EMP-MONAZITE DATING AND P-T PATH RECONSTRUCTION IN THE POLYMETAMORPHIC GARNET MICASCHISTS OF THE AUSTROALPINE SAUALPE ECLOGITE UNIT

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garnet metapelites, SEM mineral liberation analysis, EMP monazite dating, polymetamorphism

Polymetamorphic micaschists from the Austroalpine Saualpe Eclogite Unit display complex microstructural and mineral-chemical relationships. Numerous complete thin sections were studied by automated scanning electron microscopy with spare phase search (SPL) for monazite and energy dispersive spectral mapping (GXMAP) of garnet. The spectral maps allow to resolve garnet semi-quantitative Fe-Mg-Mn-Ca zonation trends in various combinations and to define locations of electron microprobe analyses. Two garnet porphyroblast generations and several monazite populations have been revealed in the low-Ca and high-Al-metapelites. The EMP Th-U-Pb monazite dating identified low-Y Cretaceous (80-100 Ma), and high-Y Permian (250-270 Ma) and Carboniferous (310-320 Ma) age groups which are variably distributed in the samples. Coronas of apatite and allanite around large Permian monazites signal a retrogressive stage. Garnet 1 porphyroblasts enclosing mica, plagioclase and quartz display increasing XMg and constant XCa at decreasing Mn contents. They crystallised during a M1 prograde metamorphism at increasing pressure and temperature up to ~650 °C/6 - 8 kbar. Carboniferous and Permian monazite crystallised along the margin of garnet 1. This microstructure in combination with the retrogressive monazite coronas suggest a Carboniferous-to-Early-Permian age for the M1 event, not yet reported from the unit. The M2 event with garnet 2 postdates the corona formation around Permian monazites. Garnet 2 displays complex zonations trends with high Mg and Ca contents at always low Mn contents. This can be sorted into trend Grt2-1 with increasing XCa at decreasing XMg, then trend Grt2-2 with increasing XCa at increasing XMg, and finally Grt2-3, with decreasing XCa at increasing XMg. Garnet 2 crystallised at the well-known Cretaceous eclogite event (Thöni et al. 2008). Maximum temperatures at 750 °C/14 kbar were passed during decreasing pressure. Cretaceous monazites then crystallised in large grains and also in satellite structures (Finger et al. 2016). The two prograde metamorphic events in the Saualpe Eclogite Unit are related to continental collisions under different thermal regimes.

Finger F, Krenn E, Schulz B, Harlov DE, Schiller D, 2016. *American Mineral.* 101, 1094-1103.

Thöni M, Miller C, Blichert-Toft J, Whitehouse, MJ, Konzett J, Zanetti A, 2008. *J. Metam. Geol.* 26, 561-581.

DATING APOPHYLLITE FROM THE DECCAN VOLCANIC PROVINCE (INDIA)

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geochronology, apophyllite, Dekkan Volcanic Province

The Deccan Volcanic Province (DVP) formed between 67.5 and 60.5 Ma ago, but the main part of tholeiitic lava erupted within only 500,000 years or less at about 66 Ma. Originally it covered an area of approximately 1.5 million km² with a thickness of up to 3000 m. Primary cavities containing up to cm-sized idiomorphic crystals of secondary minerals are frequent in the basalts. At several locations the individual lava flows show a specific zoning with respect to the size and mineralogy of these cavities. Besides celadonite, quartz, heulandite, calcite, stilbite, mesolite, and others apophyllite is present. Apophyllite (K,Na)Ca₄Si₈O₂₀(F,OH)·8H₂O refers to a group of phyllosilicates with a chemical composition suitable for geochronological dating by the K-Ar and Rb/Sr methods. Often apophyllite is associated with stilbite, overgrowing quartz, prehnite or celadonite and locally also chalcedony filaments (probably formed by bacteria). Dated apophyllite crystals from Mumbai, Nashik, Jalgaon and Junnar are cm-sized, idiomorphic, limpid and chemically homogeneous crystals. They are characterized by distinct Rb (45 -161 ppm) and Sr (0.8 to 3.0 ppm) contents and Rb/Sr ratios of 40-860. Calculated with associated stilbite or calcite they yield ages between 20±1 and 58±1 Ma and initial ⁸⁷Sr/⁸⁶Sr ratios of 0.7068±1. However, ages determined from cavities in the same level of individual lava flows yield similar age values. Ages determined from single apophyllite crystals are reproducible with the Rb-Sr method but the maximum values of a stair step Ar-Ar age spectra are significantly lower (JAL13-K, 49±1 and 39±1 Ma respectively). Homogenization temperatures of fluid inclusions in apophyllite crystals from Jalgaon are in the range of 140-250°C.

The existing data indicate that meteoric water entered the basalts and caused hydrothermal formation of secondary minerals in cavities heterochronously between 58 and 20 Ma, dependent on the locality, the individual lava flow and position within the lava flow. Early products (e.g. quartz, celadonite, prehnite) partly formed during initial cooling but others (e.g. apophyllite, stilbite) might have also formed during later local events of increased fluid activity or reheating. According to the literature temperatures of about 80-150°C can be expected for the formation of apophyllite, stilbite and heulandite.

PALEOSEISMOLOGICAL INVESTIGATIONS ON THE NORTH ANATOLIAN FAULT ZONE FOR PIPELINE FAULT CROSSING DESIGN PURPOSES.

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North Anatolian Fault Zone, Paleoseismological Investigations, Pipeline Crossing

Seismically active fault zones pose major challenges for any infrastructure project that would have to cross such tectonic features, if the earthquake magnitude is big enough that surface rupture has to be expected. The North Anatolian Fault Zone (NAFZ), a major right-lateral strike slip fault, forming the tectonic boundary between the Eurasian Plate and the Anatolian Block, fulfills this criterion. It is one of the seismically most active fault zones in the world and produced a series of eight $M > 7$ earthquakes in the 20th century with fault offsets exceeding 10m in places during one event. The fault zone extends from the Karliova Triple Junction in Eastern Turkey in WNW direction over a distance of approx. 1600km to the Aegean Sea, West of Turkey. Due to the extend and orientation of the fault zone any infrastructure crossing the northern half of Turkey from East to West would have to cross the NAFZ in one or the other location. So does the TANAP gas pipeline, which traverses the whole of Turkey between the Turkish-Georgian and the Turkish-Greek border, intersecting the NAFZ in two locations. The TANAP project is an approx. 1800 km long, 56/48 inch pipeline system, currently under construction. It represents the Turkish section of an intercontinental pipeline system that intends to transport natural gas from the Caspian region via Turkey to Europe.

The paper addresses paleoseismological investigations for the eastern pipeline crossing of the NAFZ, west of Erzincan, a city which was totally destroyed during the disastrous M 7.8 earthquake in 1939. The paper will highlight the methodology (a) to accurately locate the most recent active strand of the fault zone along the pipeline alignment and (b) to determine the relevant fault parameters required for the design of the pipeline fault crossing including geomorphological mapping, paleoseismological fault trenching works and probabilistic fault displacement hazard analysis. It will also provide the results of these investigations followed by a brief overview of the final engineering solutions for the fault crossing design.

INGENIEURGEOLOGISCHE ANALYSE EINER FELSGLEITUNG IM STEINBRUCH FRAUENMÜHLE BEI METTEN (NIEDERBAYERN)

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Felsgleitung, Granitverwitterung, kinematische Analyse, Stabilitätsanalyse, Reibungsparameter

Im Frühjahr 2008 ereignete sich im ehemaligen Granitsteinbruch Frauenmühle bei Metten (Niederbayern) eine Felsrutschung, bei der sich ein Block mit einem Volumen von ca. 50 m³ aus einer der Steinbruchwände löste. In der vorliegenden Arbeit wurde die Situation im Steinbruch genauer untersucht, um Ursachen und Mechanismen der Rutschung sowie weitere Gefährdungsbereiche zu ermitteln.

Hierfür wurde eine Aufnahme des gesamten Steinbruchs durchgeführt, bei der v.a. die Verwitterung des Granits im Gesteins- und Gebirgsmaßstab im Vordergrund stand. Es zeigte sich, dass der Zweiglimmergranit nur im Fußbereich relativ frisch ist (Vs2 nach Scholz, 2003) und die Verwitterung zur Geländeoberfläche hin deutlich zunimmt. In den obersten Metern dominieren stark verwitterter Fels (Vs5-6), Grus und Residualboden. Der Granit bildet ein orthogonales Kluftsystem, von dem aus die Verwitterung angreift. In Oberflächennähe entstehen dadurch die typischen „Wollsäcke“ mit kompaktem Kern und stärker verwitterter, zum Teil grusiger Kluftfüllung. In einzelnen Klüften tritt ein hochplastischer Ton auf. Zur Beurteilung der geotechnischen Eigenschaften wurden für verschiedene Verwitterungsstufen fels- bzw. bodenmechanische Kennwerte erhoben.

Für die Ausbruchwand wurde auf Basis einer Trennflächenaufnahme mithilfe von DIPS (Rockscience) eine kinematische Analyse durchgeführt. Hierbei konnten kritische Klufttrichtungen und Verschneidungen identifiziert werden, die in der bestehenden Wand sowohl planares Gleiten als auch Gleitkeilbildung ermöglichen könnten. Durch die Berücksichtigung von Lage, Erstreckung und Ausbildung wurde neben dem bereits abgerutschten Block ein weiterer Bereich identifiziert, in dem es durch eine ungünstige Verschneidung mehrerer Haupttrennflächenscharen zu einem Versagen kommen könnte.

Eine Betrachtung der Felsgleitung selbst legt nahe, dass es sich um planares Gleiten auf einer mittelsteil aus der Wand fallenden Trennfläche handelte, in der sich im Ausbruchsbereich stark verwitterter Granitgrus findet. Aus diesem Grund wurde mit Hilfe der rekonstruierten Blockgeometrie und der ermittelten Reibungsparameter eine Stabilitätsanalyse für verschiedene Kluftausbildungen (glatte Gleitbahn, Granitgrus im Anrissbereich, hochplastischer Ton als Kluftfüllung) durchgeführt. Die Ergebnisse stützen die Vermutung, dass die Zerstörung ehemaliger Felsbrücken durch fortschreitende Verwitterung, verbunden mit starker Durchnässung, das Versagen verursacht hat. Gleichzeitig könnte die geringe Scherfestigkeit der tonigen Kluftfüllungen bereits bei geringer Neigung zum Versagen weiterer Steinbruchbereiche führen.

THE LOWERMOST TECTONIC UNITS OF THE CRETAN NAPPE PILE IN THE TALEA ORI, CRETE, GREECE - MESOSCOPIC AND MICROSCOPIC DEFORMATION RECORD OF THE HP-LT METAMORPHIC ROCKS

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quartz-microfabrics, Crete, Talea Ori, HP-LT metamorphism

The lowermost tectonic units of the Cretan nappe pile are exposed in the Talea Ori mountains at the central northern coast of Crete, Greece. There, the structural position of high-pressure low-temperature metamorphic phyllites and quartzites occurring to the north of the overturned lowermost carbonatic units of the Plattenkalk nappe has been discussed controversially. These rocks have been associated either to the base of the Plattenkalk nappe or to the overlying Phyllite-Quartzite nappe. Here we present a new structural mapping and microstructural characterization of these rocks.

New field data support the interpretation of the structure as a large-scale south-vergent anticline with the overturned limb dipping to the north and fold axis plunging to the east. Phyllites and quartzites occurring in the center of the anticline are characterized by a prevalent slaty cleavage, shear bands, a locally developed crenulation cleavage, kink bands and abundant quartz veins. The quartz veins are clearly associated to the ductile deformation of the rocks. The vein quartz microstructures are characterized by micro-shear zones, short-wavelength undulatory extinction and localized recrystallization, suggesting high-stress crystal plastic deformation at temperatures of about 300-350°C. These characteristic deformation structures are likewise observed in the phyllites and quartzites to the north of the overturned Plattenkalk units. The contact to the carbonatic rocks of the Plattenkalk units is mostly characterized by steeply dipping normal faults and extensional shear bands with the northern block being down faulted. Fold axes are typically oriented WE and foliations in the Talea Ori are dipping to the north and north east, with systematic variations consistent to the large-scale anticline structure. We therefore suggest that the phyllites and quartzites both in the centre of the anticline, as well as to the north of the carbonatic Plattenkalk units belong to a structurally lower unit. This assumption has important implications, as the base of the Plattenkalk nappe has been so far considered as the lower most known unit of the Cretan nappe pile, with the basement being unknown. The units structurally below the carbonatic Plattenkalk units provide information on the original substratum and probably on the detachment conditions before exhumation.

CRUSTAL ARCHITECTURE AND U-PB GEOCHRONOLOGY OF THE KIZILDAĞ (HATAY) OPHIOLITE, SOUTHERN TURKEY

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U-Pb SIMS, Zircon, Oceanic crust, Rock-melt interaction, Forearc

The Late Cretaceous ophiolites of southern Turkey form two approximately E-W trending subparallel belts. The ophiolites of the southern belt originated within the Southern Neotethys and include the Troodos ophiolite (Cyprus), and also the Baer-Bassit ophiolite (northern Syria), the Antalya (Tekirova), Kızıldağ (Hatay) and Koçali ophiolites (southern Turkey). The northerly belt includes the Göksun ophiolite, the Berit metaophiolite, the İspendere ophiolite, the Kömürhan ophiolite and the Guleman ophiolite.

The Kızıldağ (Hatay) ophiolite exhibits a well-preserved oceanic lithospheric section that includes mantle tectonites, ultramafic to mafic cumulates, isotropic gabbros, a well-developed sheeted dyke complex, plagiogranites and extrusive rocks. The mantle tectonites are intruded by pyroxenitic and mafic dykes at several different structural levels. Mafic dyke intrusions are very common towards the upper part of the tectonite section (within the transition zone), where they display rock-melt interaction features. The mantle harzburgites and dunites were have been impregnated by feldspar and clinopyroxene as a result of mafic magma percolation. The melt products are heterogeneous, local and discontinuous. The cumulate rocks are ductilely deformed, probably in response to syn-magmatic extension during sea-floor spreading. Variable-sized xenoliths of ultramafic rocks occur within the cumulate rocks, which is suggestive of episodic magma chamber replenishment. The sheeted dyke complex includes isotropic gabbro screens and plagiogranite intrusions. Both tholeiitic and boninitic-composition rocks make up the extrusive section.

U–Pb zircon SIMS dating is currently being used to constrain the crystallization ages of different parts of the crustal pseudostratigraphy. The ages range from 94.4 to 90.6 Ma: i.e. a gabbro screen within the sheeted dykes: 90.6 ± 6.4 Ma; a plagiogranite cutting the sheeted dykes: 93.29 ± 0.94 Ma; a pegmatitic gabbro dykes within the transition zone: 93.0 ± 1.5 Ma & 92.33 ± 0.81 Ma; cumulate gabbros: 94.4 ± 0.97 Ma & 94.2 ± 2.5 Ma; and an isotropic gabbro: 94.2 ± 2.2 Ma. The new data suggest that the crustal section of the Kızıldağ ophiolite formed within 4-5 My at most. The field relations, geochemistry and U-Pb age data for the crustal rocks suggest that island arc tholeiitic (IAT) and boninitic magmas were being generated and intruded contemporaneously within a forearc setting above a north-dipping subduction zone within the Southern Neotethys.

REMOTE DETECTION OF SUBSURFACE CAVITIES

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cavities, GPR, 2D resistivity, magnetic, Erzberg

The detection, and mapping, of subsurface cavities is an important task, primarily because the potential collapse of a cavity poses a hazard to infrastructure and residents. Cavities can be created naturally through chemical erosion. Man-made cavities include tunnels from abandoned mining, old basement structures from demolished buildings, tunnels created for illegal activities, and cavities produced through a nuclear weapon test.

Whether filled with air, or water, the material contrast of a cavity to the surrounding rock, or soil, is typically strong enough to provide a significant signal in many geophysical measurements. The challenge lies in the size-to-depth-ratio of most cavities, which is at, or below, the resolution capacity of most geophysical methods. In this project, we test several geophysical methods for their application potential in an open pit mine at Mt Erzberg, where maps indicate a ~4m wide tunnel from abandoned subsurface mining in ~25m depth.

This study focuses on radar, electric, and magnetic field measurements.

GPR investigations were carried out with a 30MHz antenna covering an area of 136x18m. The depth of penetration for this data is ~25 m. Radar data shows to be most reliable and best single solution for this kind of task. Though marginally detectable at this depth, a structure in the expected position was identified; Improvement of resolution through better data processing is in progress. In addition, some new, formerly unknown possible cavities were discovered.

Next, a 2D resistivity survey was performed with 138 electrodes in Wenner configuration. The result shows a high resistive area that correlates with the new identified feature from radar data. The observation target itself could not clearly be isolated; the weak point is, again, the penetration depth, in this case due to the limited lateral extension of the accessible area.

Three magnetic profiles were carried out, measuring total magnetic field and gradient, in order to detect iron installations like rails and cables in the tunnel. All profiles show lateral continuation and a small anomaly, probably caused by the built-in fitments. However, the results are superimposed by larger sources of magnetic interference and relatively difficult to interpret.

QUANTIFIZIERUNG DES KLIMAWANDELEINFLUSSES AUF DEN BODENWASSERHAUSHALT AN ALPINEN GRÜNLANDFLÄCHEN

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Climate change, lysimeter, grassland, seepage water, water balance

Aufgrund der in den vergangenen Jahrzehnten beobachteten und für die nächsten Jahrzehnte prognostizierten erhöhten atmosphärischen CO₂-Konzentrationen und Temperaturen (siehe zum Beispiel österreichischer Sachstandsbericht Klimawandel 2014) ist mit Veränderungen im Boden- und Pflanzenwasserhaushalt zu rechnen. Um mögliche Auswirkungen des veränderten Klimas auf den Bodenwasserhaushalt in alpinen Gebieten besser zu verstehen, wurden sechs hochpräzise Lysimeter im Rahmen des an der HBLFA Raumberg-Gumpenstein (Steiermark, Österreich) entwickelten Lysi T-FACE Konzeptes in ein Freilandexperiment integriert, bei dem in unterschiedlichen Kombinationen einerseits an den Lysimetern Freiluft mit CO₂ angereichert wird, andererseits Infrarotstrahler die Flächen zur Untersuchung von Effekten erhöhter Temperaturen beheizen. Die Lysimeter sind wägbar und mit einer Sickerwasserfassung sowie TDR-Trime-Sonden und mit Temperaturerfassung kombinierten Tensiometern in Tiefenstufen von 10 cm, 30 cm, 50 cm und 140 cm ausgestattet.

Erste Ergebnisse der aus den wägbaren Lysimetern errechneten Sickerwassermenge liegen für das Jahr 2014 an der unbehandelten Referenzparzelle bei 477 mm/Jahr. An der mit CO₂ angereicherten (+300 ppm) und beheizten (+3 °C) Parzelle liegt hingegen der Sickerwasserabfluss bei 356 mm/Jahr und somit um 121 mm niedriger als an der Referenzparzelle. Im Jahr 2015 war die Differenz der Sickerwasserflüsse derselben Lysimeter mit 115 mm ähnlich wie 2014. An beiden Lysimetern wurden 2015 jedoch deutlich geringere Sickerwassermengen verzeichnet als 2014, sogar am unbehandelten Lysimeter mit 336 mm weniger als am begasten und beheizten Lysimeter im Jahr 2014. Da die Niederschlagsmengen 2014 und 2015 sehr ähnlich waren (982 mm bzw. 963 mm), dürfte dies ein Effekt der höheren sommerlichen Temperaturen des Jahres 2015 verglichen mit denen des Jahres 2014 sein (Durchschnittstemperatur Juni bis August 2014 16,9 °C, 2015 hingegen 19,1 °C). Der Einfluss der Lufttemperatur auf die Verdunstungsmenge und damit die Sickerwassermenge zeigt sich also sowohl beim Vergleich der unterschiedlich behandelten Lysimeter als auch beim Vergleich unterschiedlicher Jahre an den einzelnen Lysimetern. Da der experimentelle Ansatz neben dem begasten und beheizten Lysimeter auch solche umfasst, die nur begast oder nur beheizt werden, kann der Einfluss erhöhter Lufttemperaturen sowohl Kombination mit erhöhter CO₂-Konzentrationen als auch abgegrenzt davon quantifiziert werden.

PLATINUM-GROUP ELEMENT-BEARING COPPER-NICKEL-COBALT MINERALIZATION IN THE HABACH GROUP, TAUERN WINDOW, SALZBURG

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platinum-group elements, Tauern Window, rhenium sulfide

The Habach Group, forming part of the Subpennine nappe system exposed in the Tauern Window, comprises a complex metamorphosed sequence of Pre-Permian magmatic and sedimentary rocks. From an economic point of view, it is host to the famous Felbertal scheelite deposit, in addition to emerald and base metals. A small Cu-Ni orebody hosted by chlorite schist, amphibolite and metasediments has been intermittently explored until 1939 in the Haidbach valley south of Mittersill. Anomalous concentrations of platinum-group elements (PGE) reported previously initiated a detailed microscopical and geochemical investigation of the underground mine.

Sulfide mineralization occurs as layers, up to 50 cm thick, oriented parallel to the foliation, and as disseminations in epidote-chlorite-rich schist. Major ore minerals comprise pyrite, pyrrhotite, chalcopyrite and pentlandite. Massive ore carries between 0.2 and 5.5 wt.% Cu, 0.2-1.5 wt.% Ni and 500 – 3000 ppm Co. Precious metal concentrations reach up to 1 ppm Pt, 2.5 ppm Pd, 23 ppm Ag, 0.3 ppm Re and 0.4 ppm Au. In addition some of the minor metals reveal elevated concentrations, most notably As, Se and Te. Elevated concentrations of Cr are noteworthy, reflected by the chemistry of chlorite and the occasional presence of chromian spinel included in sulfides.

Reflected light and electron microscopy confirm the presence of a large number of rare-metal-bearing minerals that usually occur included in the major sulphides. They comprise Ni-Fe-Co sulfarsenides (gersdorffite, cobaltite, arsenopyrite), sphalerite, molybdenite, hessite Ag_2Te , empressite AgTe , Pd-melonite $(\text{Ni,Pd})(\text{Te,Bi})_2$, kotulskite PdTe , merenskyite $\text{Pd}(\text{Te,Bi})_2$, sudburyite $\text{Pd}(\text{Sb,Te})$, testibiopalladite $\text{PdSb}(\text{Sb,Te})$, hexastibiopanickeelite $(\text{Pd,Ni})(\text{Sb,Te})$, Pd-Ag telluride, sperrylite PtAs_2 , irarsite IrAsS , rheniite ReS_2 , Re-Pb-sulfide, and gold. Most of these minerals form euhedral or subhedral inclusions, reaching up to 100 μm in size (Ni-Co-Fe sulfarsenides). Platinum-group minerals reach up to 30 μm in their longest dimension. The abundance of discrete euhedral small grains of Re sulfides included in Fe-Cu sulfides is highly unusual. These minerals are not associated with any of the PGE-bearing phases. The Haidbach mineralization is interpreted as a stratiform sulphide accumulation in basic metavolcanic rocks having affinities to MORB-type basalt. Most primary textures are obscured by strong hydrothermal and metamorphic overprint, as well as polyphase deformation.

PROGRESS IN DIGITAL MAPPING OF SHALLOW MASS MOVEMENTS BY USING A COMBINATION OF ORTHOPHOTOS, LIDAR- AND UAV-DERIVED INFORMATION

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landslides, geomorphology, mapping protocol, validation, Vorarlberg

High-resolution orthophotos, LiDAR-derived and UAV (unmanned airborne vehicle)-based elevation data provide an unprecedented wealth of digital information which, in combination, can be used for manual and automated geomorphological mapping. The hypothesis is that the recognition, delineation and interpretation of geomorphological features in a digital environment (ArcMap 10.2 and the 3D ArcScene) require well-defined instructions to get accurate maps. We tested and validated a geomorphological mapping protocol for expert-derived digital mapping of shallow mass movements in a small area near the village of Au (Vorarlberg, Austria). Our data include DEM-derived Land-Surface Parameters such as openness and slope angle (including an RGB composite) and aspect, a hill-shade map (1 m resolution) and multi-temporal infrared and true colour orthophotos (10-25 cm resolution). In addition, images obtained by an UAV flight (survey in 2015) were combined into a high-resolution orthophoto mosaic and a digital surface model at 3 cm resolution with the 'Structure-from-Motion' procedure. Vector data, such as contour lines, and a public-domain digital geological map completed the database. Fifteen students in Earth Sciences and fifteen professionals in the field of geomorphology, natural hazards and GIS were asked to construct three maps at different levels of detail for a representative 250x250m area. The participants were also asked to fill out a feedback questionnaire. The maps and legend are tiered: at Level I the process groups Fluvial and Mass Movement are mapped; types of landforms and deposits are mapped for these process groups at Level II; small features and early signs of shallow mass movements are mapped at the third, most detailed Level III. Preliminary results indicate that both students and experts maps show most agreement at Level I; the Level II maps shows less agreement, in particular for mass-movement units, while the Level III maps vary most between all workers. The conclusion is that a protocol should provide very detailed instructions on which - and how - digital data to be used at each level of mapping. The results, then, can be used in the validation of automated mapping procedures and to support the generation of hazard and risk maps.

DEFORMATION AND METAMORPHISM OF THE ECKERGNEISS COMPLEX (HARZ MOUNTAINS, GERMANY)

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granulite facies metamorphism, Variscan age, Rhenohertzynian zone

The Eckergneiss Complex in the Harz mountain range represents the only high-grade polymetamorphic unit of the Rhenohertzynian zone that is part of the Variscan orogenic belt in Northern Germany. It consists mainly of a metasedimentary series of cordierite gneiss, mica schist, quartzite and rare amphibolite. The tectonometamorphic history of the Eckergneiss Complex is unresolved. The peak granulite facies metamorphism of the unit has either been related to the oldest deformation phase D1 or it is described as static overprint following D1. Relative and absolute ages of metamorphism and deformation are unknown. It also remains unclear if the Eckergneiss Complex is emplaced in the course of the intrusions of the adjacent Harzburger Gabbro and Brocken Granite or solely via tectonic processes.

We have studied the tectonometamorphic record of the unit based on structural field data, microstructural investigations, PT-estimations and monazite dating by the U-Th-total Pb method using an electron microprobe. According to our data, the N-dipping main foliation, the NE-SW striking, subhorizontal stretching lineation and isoclinal folding are assigned to D1 under amphibolite facies metamorphism. D1 grain boundary migration recrystallization microstructures of quartz are largely obliterated by successive annealing. Also static microstructural features of plagioclase and the occurrence of anatectic melts point to a high T metamorphic overprint, which we allocate to the granulite facies metamorphism. Deformation phase D2, which is characterized by tight folds and locally a second foliation in some fold hinges, overprinted the D1 foliation and also the granulite facies metamorphism. Afterwards, a D3 deformation phase developed gentle and open folds.

U-Th-total Pb dating of monazite yield reliable ages between 322 ± 7 Ma and 309 ± 5 Ma. Hence, the data indicate that granulite facies metamorphism is of Variscan age and thus significantly older than the adjacent intrusions, which show early Permian post-Variscan ages. As only a faint and narrow contact aureole has been observed an exhumation of the Eckergneiss Complex by magmatic transport is unlikely. Instead a tectonic exhumation into the low-grade metamorphic Rhenohertzynian nappe stack is suggested prior to the emplacement of the Harzburger Gabbro and the later Brocken Granite.

TIMESCALES AND GEOCHEMICAL EVOLUTION OF MID-TRIASSIC MAGMATISM IN THE SOUTHERN ALPS: A HIGH RESOLUTION ZIRCON PETROCHRONOLOGY STUDY

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Triassic, Dolomites, Predazzo, Geochronology, Zircon

Middle Triassic magmatism in the Southern Alps comprises widespread felsic volcanoclastic deposits, basaltic lava flows and irregularly distributed plutonic complexes. The origin, petrogenesis and tectonic setting of this Middle Triassic magmatic flare-up as well as the temporal and genetic relationship between the volcanic and plutonic rocks remain poorly understood. Felsic volcanic ash layers from the Lombardian Alps and Dolomites (Northern Italy) intercalated with Middle Triassic fossiliferous sedimentary successions have previously been applied to correlate the stratigraphic record over hundreds of kilometres [1].

Previous work mainly based on field observations and geochronology studies concluded that mid-Triassic magmatism initiated with silicic products [2]. Related thin ash layers, crystal-rich tuffs and bentonites can be observed in stratigraphic sequences throughout the Southern Alps. More mafic products occur further up-section in the form of shallow intrusions and basaltic lava flows. In the Dolomites such volcanic products reach maximal thicknesses and the short-lived magmatic episode is constrained by age data on tuff layers [3]. Related intrusive bodies (e.g., Monzoni, Predazzo) were emplaced during or immediately after the climax of the effusive episode as indicated by U-Pb zircon age of a late granite at Predazzo [4].

Here we present a detailed stratigraphic framework and a comprehensive zircon petrochronology data set that constrain the timing as well as the chemical and isotopic evolution of this magmatic province. High-precision zircon U-Pb geochronology provides absolute tie-points for felsic ash layers that also bracket and thus constrain the timing of effusion of basaltic lava flows. This stratigraphic and geochronologic framework further allows linking volcanic deposits with stratigraphically unconstrained plutonic complexes.

Zircon trace element and hafnium isotopic data additionally provide clues on the origin and geochemical evolution of this magmatic flare-up.

[1] Brack, P. & Rieber, H. (1993) *Eclogae Geologicae Helvetiae* 86 (2), 415-527.

[2] Castellarin, A., et al., (1988). 146 (1-4), 79-89.

[3] Mietto, P., et al., (2012) *Episodes* 35 (3), 414-430.

[4] Brack, P., et al., (1997) *Geology* 25(5), 471-372.

GROUNDWATER HYDROCHEMISTRY IN METAMORPHIC ROCKS AND QUATERNARY DEPOSITS OF HIGH-ALPINE SLOPES (UPPER KAUNER VALLEY, (AUSTRIA))

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hydrochemistry, isotopes, water-rock interaction, Ötztal-Stubai Basement Complex, Austria

This contribution presents results from geological studies and hydrochemical investigations of spring and tunnel inflow waters in metamorphic rocks of a high-alpine area. The slopes around the Gepatsch reservoir in the Upper Kauner Valley (Austria) consist mainly of paragneiss with intercalations of orthogneiss and amphibolite belonging to the Ötztal-Stubai Basement Complex. The fracture surfaces of these folded and jointed bedrocks are typically coated with Fe-(hydr)-oxides and chlorites, but also with carbonates. Sulphides occur dominantly as accessory minerals but also locally as small veins. The bedrock is mostly covered by different Quaternary deposits consisting of reworked fragments of metamorphic rock types. A characteristic feature of the study area is the occurrence of several deep-seated, well-investigated rockslides.

Detailed field surveys and subsurface investigations (tunnels, drillings, and numerous in-situ tests) indicate that the groundwater preferentially flows within zones of highly weathered bedrock, brittle fracture zones, deep-seated rockslides, and in permeable Quaternary deposits. Some of the spring and tunnel inflow waters are characterised by remarkably high amounts of total dissolved solids (up to more than 1000 mg/l). The pH of these waters is predominantly neutral to slightly alkaline. $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values indicate no fractionation or evaporation processes and Tritium and $\delta^{18}\text{O}$ data indicate a rather young groundwater age. Ca and Mg are the major cations and SO_4 and HCO_3 are the dominant anions. Electric conductivity of the water increases with increasing Ca, Mg and SO_4 concentrations. Low $\delta^{34}\text{S}$ values indicate that sulphate dissolved in the spring waters originates from the oxidation of sulphides. The dissolution of carbonate fracture fillings and the oxidation of widespread pyrite are regarded as the main processes that lead to the observed groundwater chemistry.

Furthermore, the gravitational rock disintegration processes (which here mainly affect the paragneiss and generate fresh fracture surfaces to substantial depths within the aquifers) are supposed to favour the chemical processes leading to groundwater characterised by high amounts of total dissolved solids.

SYSTEMATISCHE TRENNFLÄCHENAUFNAHME IN GEKLÜFTETEN GRANODIORITGNEISEN ZUR GEBIRGSCHARAKTERISIERUNG UND ERMITTLUNG VON IN-SITU BLOCKGRÖßENVERTEILUNGEN

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Scanline, Blockgrößenverteilung, Gebirgsklassifikation, Kühtai, Längental

Eine umfassende geometrische Charakterisierung des Trennflächennetzwerkes bildet häufig die Grundlage zur Ermittlung der In-Situ Blockgrößenverteilungen (ISBD) sowie der Anwendung von verschiedenen Gebirgsklassifikationssystemen im geklüfteten Gebirge. In dieser Studie werden Eingabeparameter zur Bestimmung der In-Situ Blockgrößenverteilungen und Gebirgsklassifikationssystemen (z.B. GSI, RMR, ...) direkt anhand von Geländeerhebungen in Form von Scanline-Aufnahmen ermittelt. Für die Auswertung der Scanline-Daten wurde ein umfangreiches MATLAB-Skript programmiert, das eine schnelle und objektive statistische Auswertung ermöglicht und sich auch an anderen Untersuchungsgebieten einsetzen lässt. Die systematischen Trennflächenaufnahmen fanden an diversen Gebirgsaufschlüssen im Längental im Kühtai (Tirol, Österreich) statt. Lithologisch bestehen die angetroffenen Gesteine vorwiegend aus geklüfteten Granodioritgneisen, welche dem Ötztal-Stubai-Komplex zugeordnet werden können. Die ISBDs wurden neben den Oberflächenaufschlüssen, auch anhand von Bohrkernaufnahmen aus RQD- bzw. Jv-Werten abgeschätzt. Somit konnten Veränderungen mit der Überlagerungshöhe untersucht werden. Die Anzahl der Kluftscharen, deren Orientierungen, Kluftabstände sowie die Spurlängen stellen die maßgebenden Faktoren für geometrische Berechnungen des Kluftnetzwerkes dar. Zusätzlich wurden mittels eines empirischen Ansatzes die Spitzenreibungswinkel der Trennflächen aus den Trennflächenbeschaffenheiten abgeschätzt.

In Kombination mit der mittleren Blockgröße, konnte der GSI abgeschätzt und mit Geländeeinschätzungen anhand von gängigen Vergleichstabellen überprüft werden. Weitere gängige Gebirgskennwerte wie RMI, RMR oder Q wurden anhand von zusätzlichen geotechnischen Laborversuchen bestimmt.

Diese Studie demonstriert die Vielfalt an Erkenntnissen, die aus systematischen Scanline-Aufnahmen im Vergleich zu klassischen und subjektiven ingenieurgeologisch-geotechnischen Aufnahmen von Aufschlüssen erhalten werden können und präsentiert neue geometrische und mechanische Parameter, die das Gebirge der Granodioritgneise im Ötztal-Stubai Kristallin charakterisieren.

ENERGIE UND KLIMA: FAKTEN UND TRENDS

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Energie, Klima, Fakten, Trends

Energie: Seit 1970 ist der Primärenergieverbrauch weltweit um 70 % gestiegen. Während die höchsten Steigerungsraten in diesem Zeitraum beim Erdöl und Erdgas lagen, ist ab dem Jahr 2000 ein starker Anstieg bei der Kohleförderung, vornehmlich in China, festzustellen. Im Jahr 2013 betragen die CO₂-Emissionen durch die Verbrennung fossiler Energieträger weltweit ca. 35,1 Gt (10⁹ t). Für den Zeitraum bis 2030 wird ein weiterer Anstieg beim Primärenergiebedarf um ca. 50 % von ca. 12,7 auf ca. 18,2 Gt Erdöläquivalente (Gtoe) projiziert.

Klima ist eine statistische Beschreibung der mittleren Wetterbedingungen an einem Ort in einem 30-jährigen Zeitraum. Das Klima hat sich in der Erdgeschichte immer geändert. Es ändert sich heute und auch in der Zukunft. Seit Beginn der Industrialisierung vor etwa 200 Jahren greift der Mensch jedoch zunehmend in das natürliche Klimageschehen ein.

Klima wird von unterschiedlichen Faktoren gesteuert. Ein wichtiger Faktor ist die Zusammensetzung der Erdatmosphäre. Bedingt durch den stetig steigenden Verbrauch an fossilen Energieträgern sind im Zeitraum vom Jahre 1800 bis 2013 die CO₂-Gehalte in der Atmosphäre um 43 % von 280 ppmV auf 400 ppmV (10⁻⁶ Volumenanteile) gestiegen. Erhöhte CO₂-Gehalte in der Atmosphäre verstärken den sogenannten Treibhauseffekt und resultieren in einem Anstieg der globalen Durchschnittstemperaturen.

Höhere Durchschnittstemperaturen wiederum führen zu mehr Energie im System Erde und damit zu einer höheren Dynamik und zu einer verstärkten Variabilität des Wetters. Extreme Wetterereignisse wie Hitzewellen, Dürren, Tiefwasserstände, Waldbrände, Stürme, Sturmfluten, Starkregen, Starkschnee, Hochwasser und Überschwemmungen treten häufiger auf.

Fazit

Zielführende Schritte für einen Erhalt der menschlichen Lebensgrundlagen, auch für zukünftige Generationen, sind:

- eine nachhaltige Nutzung und der Schutz von Natur und Umwelt,
- Klimaschutz durch Reduktion der Treibhausgasemissionen bis hin zur Klimaneutralität von Wirtschaft und Gesellschaft,
- Boden- und Grundwasserschutz
- die Entkopplung von Wirtschaftswachstum und Rohstoffverbrauch sowie
- eine Reflexion der gängigen Wachstums- und Konsummuster.
- Erhalt der Biodiversität, der Ökosysteme und ihrer Dienstleistungen,
- Ressourcenschutz fossiler Rohstoffe,

PETROGRAPHY AND GEOCHEMISTRY OF EARLY PALEOZOIC SILICICLASTICS FROM SW MARGIN OF THE EAST EUROPEAN PLATFORM: IMPLICATIONS FOR PROVENANCE AND TECTONIC SETTING

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siliciclastics, petrography, geochemistry, provenance, Early Paleozoic

Petrography and bulk rock chemical analyses were combined to investigate the provenance and tectonic setting of Middle Cambrian to Late Silurian siliciclastics from SW margin of the East European Platform. Mean values of matrix content in the investigated sandstones is decreasing up the stratigraphic profile from 0.7 modal% for Middle Cambrian and Early Ordovician (Tremadocian) through 33.8 modal% for Late Ordovician (Hirnantian) to 43.6 modal% for Late Silurian rocks (Ludfordian). Therefore, three groups of investigated sandstones were distinguished: 1) MC-EO - Middle Cambrian and Early Ordovician quartz arenites, 2) LO - Late Ordovician diamictites and 3) LS - Late Silurian wackes. MC-EO samples are characterized by high quartz content and mostly devoid of feldspars typical for quartzose and transitional recycled orogen provinces. LO group samples show considerable admixture of feldspar and lithic fragments of mainly metamorphic and sedimentary origin typical for transitional, recycled as well as dissected arc province most probably related to collisional suture and fold-thrust belts.

In terms of main and trace element chemistry, the MC-EO siliciclastics (including sandstones, mudstones and siltstones) are typical of passive margins. The LO detrital sediments straddle the boundary between passive and active margin deposits, whereas the LS deposits plot within field characteristic for active-margin sandstones.

The results suggest that during the Middle Cambrian and Early Ordovician investigated siliciclastics were deposited on a passive continental margin of Baltica. Important change from passive to active margin tectonic setting took place during Late Ordovician (Ludfordian) times. The Late Silurian wackes were most probably deposited in a foreland basin situated in front of Caledonian orogeny formed in response to collision of Baltica with Avalonia.

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VISENIAN FORAMINIFERAL ASSEMBLAGE FROM THE EASTERN PART OF THE UPPER SILESIAN BLOCK (SOUTHERN POLAND) - PRELIMINARY RESULTS

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Visenian foraminifera, Carbonate platform, Benthic foraminifera, Upper Silesian Block

The studied foraminiferal assemblage has been sampled in the Czernka Valley – situated 4 km NW from Krzeszowice in the vicinity of Kraków (southern Poland). The grey, massive limestones outcropping here represents carbonate platform deposits which are widely distributed along the eastern edge of the Upper Silesian Block during this time. This structure was a part of the Brunovistulian terrane (e.g. Buła et al., 1977) situated in the southern margins of Laurussia during the late Paleozoic (e.g. Kalvoda, 2001 and references herein). Deposits outcropped in Czernka Valley are represented by bioclastic sediments mostly packstones and grainstones. Among the fossils disintegrated shales of brachiopods, bivalves, *Rugosa* corals, echinoderms and gastropods can be observed. The diversity of foraminifera assemblage has been identified in the whole section. The foraminiferal assemblage contains taxa as: *Ammodiscus* sp., *Archaeodiscus* sp., *Archaeodiscus moelleri*, *Climacammina* sp., *Cribostromum obliquum*, *C. strictum*, *Eostafella parastruvei*, *Endothyra omphalota*, *Endothyranopsis crassus*, *Howchinia* sp., *Millerella rossica*, *Ozawainellidae* sp., *Paleotextularia* sp., *Plectogyra spira*, *P. valida*, *P. similis* and *Tetrataxis* sp. The studied foraminiferal assemblage indicates on Visenian age. Based on coincidence of taxa as: *Archeodiscus*, *Climacammina*, *Tetrataxis* compare with foraminifera described from areas as Belgium – Dinant, France – Avesnois (Conil & Lys, 1964) as well as a Czech Republic – Bohemian Massif, Moravia (Kalvoda, 2002). Above mentioned taxa indicates on *Neoarchaediscus* Interval Zone, which represents middle part of the Late Visenian. This interval corresponds to V3b (Belgian division) and *Gnathodus bilineatus* conodont zone (Kalvoda, 2002). The sedimentation of these carbonate rocks took place in the shallow, littoral zones occurred in the environment of lagoon (external, internal zone) or shallow shelf - as postulated by Tomáš and Zając, (1996). Deposited sediments are rich in numerous and taxonomically diversified fossils which could be redeposited basinward.

IRIDIUM AND OTHER ELEMENTAL VARIATIONS ACROSS THE TRIASSIC–JURASSIC BOUNDARY IN SECTIONS AT KUHJOCH AND KENDLBACH, NORTHERN CALCAREOUS ALPS, AUSTRIA

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Triassic; Jurassic, Mass-extinction, Iridium, CAMP

Samples from strata spanning the Triassic-Jurassic boundary in the classic sections at Kuhjoch and Kendlbachgraben were studied by NAA, XRF and combustion analysis to determine Ir levels and associated geochemistry. The results are compared to previously determined carbon isotope stratigraphy at these sections. Ir concentrations in the Kössen Formation at Kuhjoch are very low (< 10 pg/g) until the top of the formation, reaching levels of 26 pg/g, in the T-bed at the top of the Eiberg Member. The Tiefengraben Member of the Kendlbach Formation is enriched in Ir in general relative to the strata below. The shift to higher levels is abrupt at the base of the member, coinciding with a decrease in carbonate content. Concentrations of 60 to 80 pg/g are typical through the entire thickness of the Schattwald Beds and into the gray Tiefengraben strata, peaking at 145 pg/g. Above 560 cm from the Tiefengraben base, concentrations decline from 50 pg/g to ~30 pg/g. The analyses from the Kendlbachgraben section compare well with those from Kuhjoch, with similar difference in Ir concentration between the Kössen and Kendlbach formations. In both sections, the initial increase in Ir corresponds to the initial carbon isotope excursion. Concentrations of redox-sensitive elements indicate transient reducing conditions during deposition of the uppermost Kössen Formation, but oxidizing conditions during Tiefengraben Member deposition. Enrichment of Ir at the top of the T-bed is associated with a redox boundary, but the cause of other variations is undetermined. The Al/Ti ratio indicates more intense weathering during deposition of the lowermost 20 cm of the Tiefengraben Member, but otherwise consistently humid to sub-humid climate prevailed during deposition. The primary control on Ir concentration in the sampled section is formation lithology, although there are variations within the Tiefengraben Member that are independent of carbonate content and likely related to continuing CAMP eruptions, potentially through outgassing.

IMPROVING MCMC PERFORMANCE WITH DETERMINISTIC CONSTRAINTS

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McMC, resolution matrix, multi variate updating scheme, inversion

Large non-linear inverse problems, including seismic traveltimes tomography, full waveform inversion, and electrical resistivity tomography, are often solved with local deterministic inverse methods due to their computational efficiency. However, deterministic approaches yield only a single solution and offer little insight on the ambiguity and uncertainty of this solution. In contrast, probabilistic inverse methods provide a full overview of the posterior distribution. However, they are computationally very expensive and require smart methods to sample the relevant parts of the model space, only. Markov-chain Monte-Carlo (McMC) inversion is one of those methods. It generates a chain of models applying a small random perturbation to the last member of the chain. The chance for this new model to become accepted into the chain is determined by its likelihood.

With increasing complexity and therefore more inverse parameters, the chance of creating models with a high likelihood is decreasing drastically. This results in high computing times and may even lead to computationally non solvable problems.

In this study, we modify the MC perturbations using constraints from the resolution matrix, which is a tool to measure the dependency of model parameters in linear inverse problems. We exploit this dependency to create multi-variate perturbations that, in average, increase the likelihood of the perturbed models and improve the mixing properties of the chain. We evaluate the performance of different multi-variate updating schemes with a test suite of 500 models, sampled from a McMC that was run on synthetic seismic travel-time data.

COOLING EPISODES DURING TWO BILLION YEARS OF ACCRETION AND COLLISION IN TANZANIA DERIVED FROM $40\text{Ar}/39\text{Ar}$ THERMOCHRONOLOGY

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Mozambique Belt, Usagaran Belt, Tanzania, $40\text{Ar}/39\text{Ar}$ thermochronology

Paleoproterozoic to Neoproterozoic / early Cambrian orogens accreted and collided with the Archean Tanzania Craton and finally assembled to form the East African Mozambique Belt. Available geochronological data (mainly U/Pb zircon) suggest three periods of orogenic activity. The Usagaran orogen is an accreted terrane that docked onto the Tanzania Craton in the Paleoproterozoic (ca. 2 Ga). The Eastern Granulite terrane represents an extended Neoproterozoic continental margin (ca. 800 Ma) that was inverted between 650 and 620 Ma (Mozambique Orogeny). The Western Granulite terrane contains Archean fragments and took its final position during the Kuungan Orogeny at about 550 Ma. Most of the orogen fragments experienced high- to ultra-high grade metamorphism now exposed in deeply eroded crust. Although the individual mountain building phases are well constraint from high-temperature chronology fundamental questions remain: Were there periods of exhumation between mountain building phases and to which degree did successor orogenies overprint their precursor orogenies? To elaborate on this topic we performed low-temperature chronology ($^{40}\text{Ar}/^{39}\text{Ar}$ on hornblende, white mica and biotite) on samples taken across the orogens. Data are either interpreted as regional cooling or activity of ductile shear zones formed at conditions close to relevant Ar-retention temperatures. Our age spectra cluster at ca. 2070 Ma (Tanzania Craton), 1870 Ma (Usagaran spectrum), 1300-1400 Ma (Kibaran spectrum), 620 Ma (Mozambique spectrum), 500 Ma (Kuungan spectrum). Some highlights derived from our data include: (1) The Usagaran terrane and the Tanzania Craton margin experienced granulite facies metamorphism with slices of eclogite. Those eclogite were exhumed into already cool crust at ca. 1900 Ma. (2) A previously unrecognized Kibaran orogenic phase overprinted mildly the Usagaran orogen at around 1300 Ma. (3) Both, the Mozambique and the Kuungan orogenies were followed by phases of exhumation. (4) The thermal effect of Mozambique and Kuungan thick skinned thrusting on their corresponding footwall units was of limited extend.

IMPACT OF MASS MOVEMENTS ON HYDROGEOLOGICAL SYSTEMS: AN EXAMPLE FROM CARINTHIA, AUSTRIA

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hydrogeology, mass movements, Sattnitz, conglomerates, dewatering dynamics

The Turiawald plateau in the Western Sattnitz is built up by massive conglomerates underlain by Miocene fine clastic sediments that act as an aquiclude. Nearly no overland flow occurs and most of the infiltrating water flows towards three captured springs whose catchments differ highly with regard to the occurrence of mass movements. Roach spring is located about 750 meters NW of the conglomerate plateau at the foot of a large-scale mass movement. Pleier spring, in the north of the plateau, is mainly influenced by rockfalls and small scale mass movements, and Hojoutz spring is supposedly unaffected by such features. At these springs, water level, water temperature (WT) and electrical conductivity (EC) were measured over several years.

To determine the dewatering dynamics and the mass movement's influence, hydrograph analysis was conducted and natural tracers and specific recharge events were evaluated.

Hojoutz spring, representing the flow dynamics of the conglomerate plateau, shows the lowest discharge variability and the slowest recession, but also fast responses to recharge events. The WT varies seasonally only between 7.7-7.8 °C with a varying time shift, the EC ranges between 309-355 $\mu\text{S}/\text{cm}$, clearly responding to precipitation events. In contrast, Roach spring shows high discharge variability and the highest recession coefficients, but a delayed response to recharge events (2 to 4 days). The WT seasonally varies by 0.3 °C with a time shift of 4 to 6 months to the AT, and the EC is the lowest (290-325 $\mu\text{S}/\text{cm}$). Pleier spring shows a fast response to recharge events, the recession coefficients range between the other two springs. The WT seasonally varies by 1 °C and shows a time shift of about 2 months, while the EC ranges between 300-330 $\mu\text{S}/\text{cm}$.

It can therefore be concluded that the mass movements cause additional aquifer components impacting massively the flow dynamics of Roach spring and, in some respect, of Pleier spring. They cause a longer retention of the water and a delayed response of the discharge to recharge pulses. Both influenced springs show a shallower water circulation and thus a higher vulnerability to pollution from the surface.

SPATIAL CHARACTERISTICS OF LANDSLIDES TRIGGERED BY MW 7.8 GORKHA EARTHQUAKE IN NEPAL 2015

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Earthquake, landslide, Nepal

On 25 April 2015, an earthquake with Mw 7.8 and a Mercalli intensity of IX (violent) struck Nepal. Its epicenter was located 77 km northwest of Kathmandu near Barpak village in Gorkha district of the west-central Nepal. The focus of this Gorkha earthquake was about at depth of 15 km (considered shallow and therefore more damaging) and the main shock was followed by two major aftershocks with magnitudes of Mw 6.7 and Mw 7.3. The 2015 continuous seismic sequence in the central Himalaya was the biggest series of events after the 1934 Nepal-Bihar great earthquake. Consequences of the Gorkha earthquake were extremely devastating. It killed 8,964 (and 21,952 injured) humans and huge economic losses are draining the scarce resources of the country. The earthquake triggered a large number of landslides with various types, including highly disrupted shallow slides, rock falls, and large-scale avalanches (an avalanche on Mount Everest, killed at least 19 and another huge avalanche in the Langtang Valley killed about 350 people). Post-earthquake landslides were interpreted from satellite (and Google Earth) images to construct a coseismic landslide inventory database, which was verified by field visits in selected routes. Based on image interpretation and fieldwork data, more than 4312 coseismic landslides were recognized and mapped. First approximation of landslide inventory indicate that coseismic landslides tend to occur in steep to moderate slope gradients and at higher elevated slopes and that they were shallow-seated and delivered dry debris. Spatial localization of landslides is found in close proximity to fault/thrust zones and steep hill-slopes. The Gorkha earthquake caused fewer landslides than feared. Fault ruptures without breaking surface likely explain the low number of landslides. However, next rainstorms may trigger numerous landslides as mountain slopes are already weakened by the 2015 earthquake and its aftershocks. Thus, further modelling will try to correlate earthquake magnitudes and coseismic landslides. Risk of further earthquakes is high and requires GPS monitoring and further geological investigations.

LARGE-CRYSTAL CALCITE SPAR FABRICS CONTROLLED BY VERTICAL GROWTH AND CELL DIVISION: THE GREEN MICROALGA *Oocardium stratum* (DESMIDIACEA)

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Oocardium stratum, cell division, calcification, CaCO₃ supersaturation, calcite fabrics

The desmid alga *Oocardium stratum* calcifies in large-crystal calcite spar fabrics, but details of calcification remained unclear. We observed calcification over more than one year at a selected spring that sheds a moderately mineralized Ca²⁺-HCO₃⁻ water low in magnesium, sulfate, sodium, and chlorine. From 2015-02 to 2016-03, spring temperature ranged from min 7.7° to max 10.2°C. Over the observation period, the creek was never frozen.

That *Oocardium* calcification is at least in part controlled by the alga is shown by the fact that other microorganisms (e.g., diatoms, cyanobacteria, filamentous zygnemataleans, unspecified bacteria) induce calcites of much smaller crystal size and different shapes. *Oocardium* colonized artificial substrates only after diatoms or other microbes had colonized and at least minimally calcified it. Once settled, the alga forms mucilage threads which are covered by a 'calcite tube' (outer width 25-30 microns) that consists of a single crystal. Upon cell division followed by dichotomous upward growth, each of the daughter cells retains the crystal orientation of the calcite tube that housed its parent cell. In this way, upward-widening single crystals (up to ca 10 mm high, 5-8 mm wide) originate that result from growth and viability of the algal cells.

With little seasonal variation, the habitus of initial *O. stratum* calcites varies with CaCO₃ oversaturation: crystal-skeletal fabrics form at *low* supersaturation, more massive calcite fabrics form at *high* supersaturation. This result, contrary to what is known for abiotic crystallization, is backed by corresponding differences in total calcification rate at check sites along the creek, and by the downstream changes in relevant water-chemical parameters. Because the calcite tubes consist of single crystals, abandoned *Oocardium* calcite tends to further crystallize abiotically; this involves recrystallization combined with competitive growth ('combispar fabric'), i.e., it follows principles of abiotic crystallization. The end of this process is a dense, coarse-sparry calcite fabric of fan-shaped crystals that may comprise discrete laminae. *O. stratum* remained viable the entire year over, but diatoms became more abundant during winter. Over the year, different patches showed different *Oocardium* cover at different times. The reasons for this patch dynamics are not yet fully clear.

RECRYSTALLIZATION OF QUARTZ AFTER HIGH-STRESS CRYSTAL PLASTICITY IN NATURAL SHEAR ZONES

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crystal plasticity, recrystallization, microfabrics, stress relaxation

This study presents quartz microfabrics developed by recrystallization at relaxing stresses after high-stress crystal plasticity in natural shear zones at the base of the seismogenic zone. Quartz-rich fault rocks from the Deferegggen-Antholz-Vals (DAV) shear zone in the Eastern Alps and the basal thrust of the Silvretta nappe, Switzerland/Austria, are analysed by polarized light microscopy, scanning electron microscopy and transmission electron microscopy (TEM). Quartz microfabrics from the Silvretta basal thrust show branching zones of small recrystallized grains (average diameter 6 μm) cutting through coarse deformed original host grains. New grains show an almost random crystallographic orientation with large scatter around the original host orientation. In TEM, a high amount of low angle grain boundaries (LAGBs) are observed. Grains are partly bound by high angle grain boundaries (HAGBs) and LAGBs. In samples from the DAV shear zone, strings of recrystallized quartz grains in conjugate orientations cut through host grains. The new grains have a marked shape and crystallographically preferred orientation (SPO and CPO, respectively). The CPO is characterized by low misorientation angles to the host crystal and by high Schmid factors for basal $\langle a \rangle$ glide. In TEM, smoothly curved to straight HAGBs decorated by fluid inclusions bound recrystallized grains.

Both microfabrics record a switch from high-stress crystal plasticity to recrystallization at relaxing stresses. The development of new grains is dominantly by subgrain rotation and migration of LAGBs in areas of high strain developed during high-stress crystal plasticity and subsequent strain-induced grain boundary migration. We propose that new grains develop at almost random crystallographic orientations during nucleation and growth at high rates of stress relaxation (i.e. at low stress), as indicated by the quartz shear zones of the Silvretta basal thrust associated with pseudotachylytes. In contrast, at lower rates of stress relaxation (i.e. nucleation and growth at still high stress levels), new grains develop with CPO characterized by high Schmid factors for the favourable glide system, as observed for the DAV shear zone. The microfabrics give important information on the deformation and stress histories of natural shear zones.

P-T SNAP-SHOTS INTO THE METAMORPHIC EVOLUTION OF ROCKS: FORWARD MODELLING OF OROGENIC METAMORPHISM („POCKET“ OROGENY) OF METAPELITES USING PISTON CYLINDER EXPERIMENTS

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Piston cylinder experiments, forward modelling, orogenic P-t path

The metamorphic evolution of a rock can be deciphered using three approaches: 1.) the practical geothermobarometric approach (inverse modelling), 2.) the theoretical pseudosection approach (forward modelling) and 3.) the experimental approach. Whereas with the first two approaches it is possible to constrain several stages of the P - T - X evolution but how do we know what assemblage is actually present at desired P - T conditions and hence the experimental approach allows the detailed investigation of a distinct P - T condition of a rock. Therefore, experimental investigations should be viewed as a forward modelling technique and allow to put additional constraints on the evolution of a rock under defined P and T conditions and hence represents a snapshot of a P - T point of the evolution of a given rock! For this purpose, simple experiments using natural rocks as starting materials can easily be conducted. The disadvantage of this method lies in the complex chemical compositions of natural rocks and the deviation from chemical end-member systems. Therefore these experiments need to be evaluated not only 1.) in terms of their ability to reproduce the natural observations but also 2.) in their ability to reproduce theoretical calculations. In this study experimental investigations of orogenic metamorphism of metapelites (quartzphyllites with $\text{Grt}_1 + \text{Ms}_1 + \text{Ch}_1 + \text{Bt}_1 + \text{Rt}$) was investigated. Four different P-T conditions were chosen to represent a clockwise P - T loop: 400°C, 0.8 GPa, 600°C, 1.2 GPa and 500°C, 0.4 GPa. An experiment with a duration of 16 days was conducted, where all four P - T conditions were run subsequently. The experiment yielded the mineral assemblage: $\text{Grt}_{2,3} + \text{Sta} + \text{Ms}_2 + \text{Bt}_2 + \text{Chl}_2 + \text{Ilm}$. In addition four separate experiments will be conducted to identify the characteristic mineral assemblages at each of these P - T conditions. Pseudosection modelling using DOMINO-THERIAK yields very good agreement between calculated and observed assemblages except for calculated chloritoid and observed staurolite. This study also shows that forward modelling using whole-rock experiments allows the comprehensive characterization of peak-metamorphic assemblages.

CORE-COMPLEX FORMATION AS DRIVING FORCE IN LANDSCAPE EVOLUTION

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Metamorphic core complex, transient landscapes, χ -transform

Metamorphic core complexes (MCCs) are large scale geological features that globally occur in high strain zones where rocks from lower crustal levels are rapidly exhumed along discrete fault zones.

The uplift is accompanied by vertical and horizontal motions, which represent the driving forces of landscape development and thus control the adjustment of drainage systems.

Nevertheless, drainage systems and their characteristic metrics in regions shaped by MCCs have only been sparsely investigated to determine distinctions between different MCC-types (A-type, B-type, C-type). They however, should significantly differ in their topographic expression that evolves by the interplay of tectonic forcing and erosional surface processes.

In this study, we analyze drainage systems of several prominent MCCs, and compare their drainage patterns and channel metrics to constrain their geodynamic setting. We extracted drainage networks and basins and calculated Strahler orders to explore asymmetries in the drainage pattern and to detect evidence for horizontal advection of rivers and catchments. We computed longitudinal river profiles and applied the χ -transformation approach to uncover spatially variable uplift rates and to constrain the state of landscape adjustment at active MCCs.

A-type MCCs show a drainage pattern, which is partly parallel to the stretching and elongation direction, potentially developing from grooves of the detachment. The χ -profiles indicate a pronounced disequilibrium over the watersheds. The B-type MCCs show preferences for a radial oriented drainage pattern along lateral terminations. The χ -maps and profiles point to a symmetrical behavior of the uplift event. A clear preferred direction for further stream piracy can be described along detachment zones. In contrast, C-type MCCs have a highly asymmetric drainage morphology. The asymmetry is caused by tilting of the hangingwall block and a lateral offset of the streams during the geodynamic evolution. The drainage pattern develops perpendicular to the trunk streams, which are subparallel to confining faults.

Early results of our analysis show the high potential of employing morphometric tools in combination with methods from structural geology to determine the type of MCCs, to reveal timing and rates of uplift and to constrain the state of landscape adjustment at active MCCs.

THE DEEP STRUCTURE OF ALPINE-TYPE OROGENS: HOW IMPORTANT IS RIFT-INHERITANCE?

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Alpine-type orogens, rift inheritance, reactivation

As collisional belts are commonly thought to result from the closure of oceanic basins and subsequent inversion of former rifted margins, their formation and evolution should in theory be closely interlinked with the initial architecture of former rifted margins. In the meantime, observations from present-day magma-poor rifted margins progressively reveal the complexity of hyperextended domains (including severely thinned continental crust (<10 km) and/or exhumed serpentinitized mantle with minor magmatic additions) between unequivocal continental and oceanic domains. In order to evaluate some aspects of the relative role of rift-inherited hyperextension and collisional processes in building Alpine-type orogens, we compare the deep structure of the Pyrenean and Alpine belts.

The Pyrenees and Western to Central Alps respectively result from the inversion of a Late Jurassic to Mid Cretaceous and an Early to Mid Jurassic rift system eventually floored by hyperextended crust, exhumed mantle or proto-oceanic crust. The rift-related pre-collisional architecture of the Pyrenees shows many similarities with that proposed for the Alps; although the width of the hyperextended and in particular of the proto-oceanic domains is little constrained. Remnants of these domains occur in the internal parts of the two orogens, but they are largely affected by orogeny-related deformation and show a HP-LT to HT-MP metamorphic overprint in the Alps. Yet, the overall crustal and lithospheric structure looks surprisingly comparable, as revealed by recent high-resolution tomographic images across the Pyrenees (PYROPE) and the Alps (CIFALPS).

Eventually, based on the comparison between both orogens we aim to discuss: (1) the nature of rheological weaknesses inherited from hyperextension controlling the location of decoupling levels during orogeny, (2) the nature of orogenic roots (lower crust vs. former hyperextended domains) and the implications for restorations, and eventually (3) the nature and major role of buttresses in controlling collisional processes.

HETTANGIAN-SINEMURIAN MACROFOSSIL CHEMOSTRATIGRAPHY REVISITED: FILLING THE GAPS OF UNDERSTANDING POST-TRIASSIC ENVIRONMENTAL CHANGE

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macrofossil, carbon isotopes, oxygen isotopes, Jurassic, palaeoclimate

The latest Triassic saw one of the most significant reductions in biotic diversity of the last 540 million years and was associated with environmental perturbations that impeded biota from a full recovery for millions of years. This recovery interval is covered in detail by organic carbon chemostratigraphy, but comprehensive, robust, isotopic records from biogenic carbonates are currently not available.

Here we show a new, biostratigraphically well defined Hettangian-Sinemurian data set based on > 1,300 carbon and oxygen isotope ratio measurements of macrofossils from UK outcrops. This data set covers environmental signals in the European Epicontinental Sea through the earliest Jurassic recovery interval in unprecedented detail. After an earliest Hettangian positive carbon isotope shift, bivalve calcite records a pronounced (2-3 ‰) decrease of $\delta^{13}\text{C}$ values, most of which is confined to the "pre-planorbis" beds but lasts throughout the entire Hettangian. The Hettangian-Sinemurian boundary is associated with a positive carbon isotope shift of up to 2 ‰ that lasts throughout the Sinemurian and is superimposed by smaller-scale fluctuations. A sub-million year duration for these smaller-scale isotopic swings is likely but can currently not be confirmed due to imprecise age estimates for Sinemurian ammonite biozones and partly insufficient sample resolution.

Oxygen isotope ratios of bivalve calcite run parallel to the carbon isotope trend throughout the Hettangian, resulting in a net decrease of ~ 2 ‰ in this interval. No important shift at the Hettangian-Sinemurian boundary interval or long-term Sinemurian change are observed, however.

DETECTION OF SHALLOW LANDSLIDES, TRIGGERED BY EXCEPTIONAL METEOROLOGICAL EVENTS, BY MEANS OF HIGH RESOLUTION MULTISPECTRAL REMOTE SENSING: EXAMPLES BASED ON OPEN DATA FROM WESTERN AUSTRIA.

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multitemporal remote sensing, susceptibility landslide modelling, extreme precipitation events, landslide rapid

In recent years a series of extreme precipitation events triggered mass movements in many parts of Austria which caused major economic loss, infrastructure's damage and threat to the life of the affected local population. In such cases a rapid mapping and localisation of the hit areas could be fundamental in order to offer a comprehensive overview of the hazard extension to the disaster management authorities.

However often in case of a catastrophe the adverse meteorological conditions and the incomplete visualisation of the whole hazard area offered by the aerial photos scenes, impose severe limitations to the complete identification of the landslides.

On the other hand, the use of satellite based semi-automatic mass movement detection methods could improve the completeness of landslide inventory which lead to a better understanding of the on-going processes. Thanks to a series of free available data such as TERRA-ASTER and SENTINEL-2, with high temporal resolution, the detection of shallow landslides within a week of a catastrophic event could soon become a reality. Furthermore, the great advantage of hosting in house the GEORIOS archive, which can be used as a validation accuracy tool, offers the opportunity to perform change detection landslide mapping for retrospective studies.

The application of high resolution multispectral remote sensing, by mean of pixel-based classification algorithms, to two well-known catastrophic events such as Bregenzerwald (August 2005) and Sellrain (June 2015) will be presented. The main conclusions will be drawn on the use of event-dependent process data as plausible entities in the context of more realistic landslide susceptibility modelling.

END-TRIASSIC LOSSES AND EARLY JURASSIC (TOARCIAN) EXTINCTION OF THE LAST TWO SPIRE-BEARING BRACHIOPOD ORDERS (SPIRIFERINIDA AND ATHYRIDIDA)

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extinction, Toarcian, end-Triassic, brachiopods

Brachiopods were severely hit by several mass extinctions which fundamentally shaped their long evolutionary history. After the devastating end-Permian extinction, the fate of the four surviving orders differed significantly during the Triassic and Jurassic. Two orders, the rhynchonellids and terebratulids are extant today, whereas spiriferinids and athyridids, which possess spiral brachidia, suffered heavy losses at the end of Triassic and became extinct in the Early Jurassic Toarcian event. Although the doom of the spire-bearing orders has been thought to be related to physiological traits, extinction selectivity across the end-Triassic and Toarcian event has not been rigorously assessed previously, and the reasons for their demise at the later and lesser Toarcian event, rather than at the first and greater end-Triassic crisis remained unexplored. Using primarily the Paleobiology Database, we constructed diversity curves, estimated taxonomic rates, and assessed the temporal changes in geographic distribution of the two spire-bearing and two other orders in the Triassic-Jurassic interval. After shared trends and similar origination rates in the post-Permian recovery leading to a Late Triassic diversity maximum, the end-Triassic extinction was selective and preferentially hit the spire-bearers. In contrast to the rebound of rhynchonellids and terebratulids, spire-bearers failed to recover in the Early Jurassic and their repeated selective extinction at the Toarcian event led to their final demise. The end-Triassic event also terminated the worldwide geographic distribution of spire-bearers, confining them to the Western Tethys, whereas the other groups were able to re-establish their cosmopolitan distribution. The morphologically diverse spire-bearers represent specialized adaptation, which further increased their extinction vulnerability compared to the other groups with conservative biconvex shell morphology. Another key difference is the physiological disadvantage of fixed lophophore and passive feeding of spire-bearers, which became critical at times of increased environmental stress. The spire-bearing spiriferinids and athyridids were “dead clades walking” in the Early Jurassic and their disappearance in the Early Toarcian represents the last major, high-level extinction event for the brachiopods.

EXTREMELY SLOW, CONTINUOUS GROWTH OF BASEMENT FOLDS– OBSERVATIONS FROM SYNOROGENIC DEPOSITS OF THE CENOZOIC ILI BASIN (CENTRAL TIAN SHAN/SOUTHERN KAZAKHSTAN)

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intraplate deformation, syntectonic deposition, growth strata, continental deposits

The intramontane Ili Basin in south-eastern Kazakhstan was established in the Late Eocene and is filled with up to 4,5 km thick continental deposits of late Paleogene to Quaternary age. Basin formation is related to intra-plate deformation as a distal effect of India-Asia collision. Shortening of the crust resulted in a complex pattern of basement folds and thrusts which grew over time to form plateaus and mountain ranges. Syntectonic deposits were caught in subbasins of a broken foreland basin between the mountain ranges.

Alluvial fans, fluvial plains, partly evaporitic mud flats and large freshwater lakes form a very complex pattern of depositional systems. Parts of the basin were exhumed during ongoing convergence and allow facies and architecture of the succession to be investigated. The Cenozoic strata are best exposed in some large dry valleys on the southern slopes of the Katutau and Doyantau mountains in a couple of km-scale gentle folds. Marginal alluvial fan deposits interfinger with playa mudstones, lacustrine marlstones and fluvial deposits. Continuous alluvial fan progradation from Late Eocene to Pliocene was interrupted by base-level rises, expressed by fluvial deposition (Middle Oligocene) and a pronounced lake-transgression in the earliest Miocene. Distribution and facies of the deposits are strongly controlled by the intrabasinal Koybin Anticline, a basement fold with a steep northern and very shallow southern limb. The influence of anticline growth on sedimentation is expressed by 1) thinning of units, 2) unconformities, 3) enhanced formation of calcretes in alluvial deposits, 4) disabled shifting of fluvial channels, and 5) fixed position of the lake margin. As all units of the Ili-basin stratigraphy occur on both sides of the Koybin-Anticline and were almost all controlled by the growth of the structure, a continuous, extremely slow uplift is evident from Oligocene to late Miocene time. Quaternary pediment deposits, resting with a sharp unconformity on the folded section, are also slightly folded. The observed slow growth of the Koybin anticline contrasts sharply with the very young Aktau Syncline. Folding of this anticline shows no clear influence on Eocene to Late Miocene sedimentation, but rotated a Quaternary valley-fill into vertical position.

DISCHARGE BEHAVIOR OF ALPINE WATERSHEDS INFLUENCED BY RELICT ROCK GLACIERS: EXAMPLES OF THE NIEDERE TAUERN RANGE, AUSTRIA

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relict rock glacier, rainfall-runoff model, discharge behavior, alpine watershed, Niedere Tauern Range

Relict rock glaciers are apparent sediment accumulations in crystalline mountain regions influencing the runoff in alpine watersheds as a result of their discharge behavior. However, little is known about their impact on the streamflow further downstream. More than 560 mostly relict rock glacier-related landforms have been identified in the Styrian part of the Niedere Tauern Range (Austria). Large parts of the area are drained through these landforms (27% above 2000 m a.s.l.). The catchment of a single relict rock glacier (Schöneben Rock Glacier, SRG), and two catchments with relict rock glaciers in their headwaters were investigated with a simple lumped-parameter rainfall-runoff model to shed light on this issue. The model parameters of the SRG catchment are in agreement with the existing conceptual understanding of the discharge dynamics, indicating considerable storage and buffer capabilities. Moreover, the parameter configuration of the SRG catchment is used to simulate the runoff of ungauged relict rock glacier catchments in the area. This allows the application of a semi-distributed approach to quantify the impact of relict rock glacier-influenced headwaters on the downstream runoff. The results suggest that the contribution ranges from about a quarter to more than four times its areal share. The highest impact is observed during the late snow melt period and in the late summer. The findings highlight the relevance of these sediment accumulations in relation to water management issues, in particular concerning altering meteorological conditions due to climate change.

STRATIGRAPHIC SIGNALS AROUND THE SANTONIAN-CAMPANIAN BOUNDARY CARBON ISOTOPE EVENT

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Cretaceous, carbon isotope event, Santonian, Campanian

The Cretaceous to Paleogene Gosau Group of the Northern Calcareous Alps (Austria) provide sections that allow the integration of various stratigraphic signals from macro- and microfossils to chemostratigraphy and magnetostratigraphy. Sections in the area of the Gosau valley, e.g. the Postalm section (Upper Austria - Salzburg) expose a Santonian to Maastrichtian succession of neritic to bathyal sediments. At the Postalm, the Santonian-Campanian boundary interval comprises a deepening succession from a sandy conglomerate with a hardground on top, overlain by grey to yellowish shelf marls grading into red marly limestones. The base of the Campanian can be defined by magnetostratigraphy, i.e. the reversal from Chron C34n (the Long Cretaceous Normal Polarity-Chron) to C33r. A 1 m thick interval of unusual high magnetic susceptibility values is present at the end of chron C34n (latest Santonian). Carbonate carbon stable isotopes show a positive excursion near the boundary, i.e. the Santonian-Campanian boundary event (SCBE) which is actually within the upper Santonian section interval below the reversal.

Oxygen isotopes show a negative excursion slightly below the Santonian-Campanian boundary, followed by a trend to more positive values. Together with the magnetic susceptibility data, sequence stratigraphy interpretations and global correlations a sea-level lowstand can be inferred to occur just at the boundary, preceded by a rather short-duration sequence of late Santonian age, and a longer sequence of early Campanian age.

Two of the main suggested plankton biomarkers to pinpoint the Santonian-Campanian boundary, i.e. the first occurrence of the nannofossil *Broinsonia parca parca* and the last occurrence of the planktonic foraminifer *Dicarinella asymetrica* occur in close proximity to the reversal. Strontium isotope stratigraphy indicates a value of 0.707532 for the base of the Campanian in the Postalm section.

POLYPHASE AU-AG-AS-CU-BI MINERALIZATION IN THE OROGENIC GOLD DEPOSIT ROTGÜLDEN, AUSTRIA

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gold deposit, geochemistry, geothermobarometry, sulfosalts

The Alpine gold deposit Rotgülden is situated within the Silberek Formation in the Eastern Tauern Window. It is bound to dolomite marbles and calcareous schists and comprises of four types of mineralisation: 1) Impregnations within dolomite marbles in the footwall of the main ore body, 2) Stock-work mineralisation bound to the main fault zone rich in chalcopyrite, sulfosalts and gold, 3) Massive arsenopyrite-rich pockets ("Derberzkörper"), and 4) High-grade gold zone poor in arsenopyrite ("Kupferkies Kaverne"), which is the focus of this contribution.

Different ore mineral assemblages can be distinguished: 1) Pyrite veinlets with Fe-rich members of the siderite-magnesite series in fine crystalline dolomite marble, 2) Arsenopyrite, chalcopyrite, pyrrhotite, galena and sphalerite; pseudomorphs of magnetite after hematite formed at the contacts in Fe-bearing marbles, 3) Transition from fine grained (0.05-0.2mm) to coarser grained (5-7mm) marble, where the sulphides crystallised together with quartz and sparry calcite; sulfosalts (gustavite, pavonite, pyrargyrite, stephanite, fahlores), matildite, bismuth, gold and electrum formed along micro-cracks, 4) Late replacement of pyrite by magnetite. During this event the removal of silver took place in the sulfosalts resulting in formation of acanthite in micro-cracks.

Arsenopyrite and chlorite geothermometry have been applied to constrain the formation temperatures. Arsenopyrite yielded a mean temperature of ~370°C, but there exist two different stages based on mineral chemistry. The different calibrations of the chlorite thermometer gave variable results ranging from 240°C up to 360°C. The sphalerite geobarometer gave pressures of ~1.5 kbar.

The sulfosalts studied can be classified as members of the lillianite homologous series, pavonite homologous series, fahlores and others. They are displayed in the ternary system $(\text{Bi,Sb})_2\text{S}_3\text{-PbS-(Cu,Ag)}_2\text{S}$ and its subsystems. Gold occurs in different mineral assemblages together with 1) arsenopyrite, 2) chalcopyrite, 3) pyrrhotite and 4) sulfosalts. Gold is normally rich in silver (40-70 at% Ag), but higher gold contents (up to 70 at% Au) were found in cores of gold grains.

VARIABILITY OF INTERMEDIATE AND DEEP WATER MASS CIRCULATION DURING THE LAST 20 KA: AN APPROACH ON MID-SLOPE CANYON SEDIMENTS

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Argentina, Contourite, Sortable Silt, Turbidite

Submarine canyons, like the Mar del Plata Canyon offshore Argentina/Uruguay, are major conduits of sediment transport from shallow to deep marine systems. There is still a general lack of understanding in the interaction between down-slope (e.g. turbidite deposition) and along slope processes (e.g. contourite deposition) influencing the sedimentation pattern in submarine canyons. Especially when using canyon floor sediments as a paleoceanographic archive, it requires more integrated research. Since the canyon head is situated at a mid-slope position, the Mar del Plata Canyon is well suited to investigate all intermediate and deep water masses shaping the continental slope off Argentina. The sedimentary record of the sediment cores from the canyon thalweg revealed turbidite beds and contourite deposits fed by the adjacent water masses crossing the canyon. Despite the influence of the corrosive Southern Sourced Deep Water (SSDW) we were able to produce a Holocene to Last Glacial record using eight AMS-14C ages and XRF Fe/K records to correlate the gravity cores. Methodological approaches of our study include X-ray radiographs, XRF elemental ratios and grain size distribution. We focused on the terrigenous sortable silt (SS) mean size and percentage of the contourite related sediments to assess relative bottom current strength. With the compiled dataset we expect the exclusive impact of the deep Southern Ocean Water (deep SOW) in the lower canyon area deeper than 3000 m water depth during the Last Glacial Maximum (LGM) and Termination I. At these times the increased strength of the deep SOW has enhanced sediment deposition within the canyon and has periodically released turbidity currents, when porewater pressure was exceeded. A significant increase in SS mean size was observed during Northern Hemisphere (NH) meltwater events (e.g. Younger Dryas). The distal core on the northern canyon flank (GeoB13823, 3780 m) displayed several over-spill turbidites during Termination I. We assume that the SSDW flow may have shifted the suspended sediment cloud onto a lower terrace. In contrast, at the onset of the Holocene, NADW started to spread into deeper layers of the South Atlantic, resulting in a lower sediment supply and only occasional turbidity currents (GeoB13861, 3715 m).

AUSTRIAN EMPIRICAL SEISMIC GROUND MOTION MODELS AND SITE EFFECTS

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GMPE, ShakeMap, Site Effect, Vs30

To calculate proven local ShakeMaps (maps of ground motion and shaking intensity) and a new hazard map of Austria we are looking for adapted Ground Motion Prediction Equations (GMPE) up to a magnitude 6. Austria is an area with moderate seismicity with long return periods of strong earthquakes. There is good coverage of instrumental data up to Mw of 4,5. Stronger events can be found close to the border in the Southern Alps.

We show derived models for the Peak Ground Accelerations (PGA), Peak Ground Velocity (PGV), Peak Ground Displacement (PGD), Arias Intensity and Pseudo Spectral Accelerations (PSA) at various frequencies.

Local site conditions have an influence on the ground motion. For the first time we present a Vs30 map of Austria and discuss the connection with the seismic site effect.

HYDROMECHANISCH GEKOPPELTE NUMERISCHE SIMULATION UND VERGLEICHENDE THERMO-TRIAxIAL VERSUCHE AN SANDSTEIN

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Hydromechanisch gekoppelte numerische Simulation

Gebirgsspannung und Porendruck beeinflussen sich direkt und gegenseitig. Diese Beeinflussung wird als Fluid-Structure-Interaction (FSI) bezeichnet und kann z.B. in hydromechanisch gekoppelten Modellen simuliert werden. Es wurde dazu ein hydromechanisch gekoppeltes Modell in MATLAB programmiert (basierend auf Alberty et al. 1999, 2002, Rühaak et al., 2014) und die Interaktion zwischen variierender Gebirgsspannung (hauptsächlich Vertikalspannung) und Porendruck berechnet. Als Eingangsparameter für das Modell dienen petrophysikalische und felsmechanische Kennwerte, gemessen an oligozänen Fontainebleau-Sandsteinen, die sich unter anderem aufgrund des hohen Quarzgehaltes (>99%) und der homogenen Korngrößenverteilung sehr gut als Referenz- oder Kalibriermaterial eignen.

Die Nutzung von Eingangsdaten eines solch homogenen und natürlichen Materials erleichtert es, die numerischen Simulationen mit Daten aus gekoppelten hydromechanischen Laborversuchen zu validieren. Hierzu wurde an zylindrischen Proben der Maße 64 mm im Durchmesser und 128 mm Länge eine Testserie unter den im Modell simulierten Spannungsbedingungen durchgeführt. Die Validierungsversuche sind am Thermo-Triaxial Felsprüfstand (Thermo-Triax) der Technischen Universität Darmstadt erfolgt. An diesem Prüfstand lassen sich Horizontalspannungen bis 60 MPa, Vertikalspannungen von 600 MPa und ein Porendruck von bis zu 50 MPa nachstellen. Der Porendruck wird durch zwei angeschlossene Volume-Pressure-Controller (VPC) aufgebracht. In jedem VPC ist ein Porenfluidreservoir von 200 ml verbaut, das bei stabilen Porendruckbedingungen Porenfluid mit einer maximalen Durchflussrate von 2 ml s⁻¹ (Pei et al. 2015) entweder aufnehmen oder abgeben kann.

Alberty, J., Carstensen, C., Funken, S. A. (1999): Remarks around 50 lines of Matlab: short finite element implementation. *Numerical Algorithms* 20, 117-137.

Alberty, J., Carstensen, C., Funken, S. A., Klose, R. (2002): Matlab Implementation of the Finite Element Method in Elasticity. *Computing* 69, 239-263.

Pei, L. Rühaak, W., Stegner, J., Bär, K., Homuth, S., Mielke, P., Sass, I. (2015): Thermo-Triax: An apparatus for Testing Petrophysical Properties of Rocks Under Simulated Geothermal Reservoir Conditions. *Geotechnical Testing Journal*, Vol. 38, No. 1, pp. 119-138, doi:10.1520/GTJ20140056.

Rühaak, W., Bense, V. F., Sass, I., 2014. 3D hydro-mechanically coupled groundwater flow modelling of Pleistocene glaciation effects. *Computers & Geosciences*, 67:89 – 99.

URAN IM GRUNDWASSER

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Uran, Grundwasser, GZÜV

Kurz nach Einführung eines Parameterwertes für Uran in der Trinkwasserverordnung von 15 µg/l wurden im Rahmen eines Sondermessprogramms der Gewässerzustandsüberwachungsverordnung (GZÜV, BGBl. II Nr. 479/2006 i.d.g.F.) im Jahr 2013 erstmalig österreichweit Proben von insgesamt 1.940 Grundwassermessstellen auf ihren Urangehalt gemessen. Diese Untersuchungen zeigten, dass bundesweit insgesamt 33 Messstellen den Parameterwert der Trinkwasserverordnung von 15 µg/l überschreiten. Das entspricht 1,7 % der Messstellen. Analysiert wurden oberflächennahe Grundwasserkörper und Tiefengrundwasserkörper.

Die Ergebnisse zeigen auch, dass die Grundwasserqualität in Österreich nach derzeitigem Kenntnisstand großflächig nicht nennenswert durch Uran beeinträchtigt ist. Überschreitungen des Parameterwertes der Trinkwasserverordnung sind im Wesentlichen auf Einzelfälle beschränkt. Dies kann in einigen Regionen Österreichs aufgrund des geologischen Untergrundes natürliche Ursachen haben. In anderen Fällen, zum Beispiel im burgenländischen Seewinkel, lassen sich die Urankonzentrationen im Grundwasser nicht unmittelbar auf natürliche Ursachen zurückführen. Um bei Überschreitungen wirkungsvolle Maßnahmen setzen zu können, ist es jedoch notwendig, die Ursachen der erhöhten Urangehalte im Grundwasser genau zu kennen.

Erste Schritte in der Ursachenforschung wurden bereits gesetzt. Im Rahmen eines Projekts im Auftrag des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft wurden mögliche Eintragspfade für Uran ins Grundwasser untersucht und das Mobilitätsverhalten von Uran im Untergrund analysiert. Grundlage dafür waren umfangreiche Erhebungen zur Geologie, Hydrogeologie, Bodenbeschaffenheit, Hydrochemie und zu spezifischen Kennwerten der belasteten Grundwassermessstellen.

Der derzeitige Kenntnisstand sowie offene Fragen zu diesem Thema wurden bei einem Erfahrungsaustausch mit ExpertInnen der Geologischen Bundesanstalt, der Universität Wien, der Agentur für Ernährungssicherheit und des Joanneum Research diskutiert. Die Erkenntnisse daraus wurden in einem Bericht zusammengefasst. Zudem wurden die im Rahmen des Sondermessprogramms ermittelten Urangehalte in den Grundwässern Österreichs in einer Karte 1:500.000 dargestellt: <https://www.bmlfuw.gv.at/wasser/wasserqualitaet/uran-GW.htm>

Weitere Untersuchungen, sowohl hydrochemischer als auch mineralogischer Art an Grundwässern und Gesteinen, sind hier entsprechend den Ausführungen im Kapitel „Empfehlungen“ nötig. Seit 2015 werden deshalb auch an allen Grundwassermessstellen der GZÜV zumindest einmal jährlich periodische Untersuchungen auf Uran durchgeführt und darüber hinaus ist ein Forschungsprojekt in Planung.

GEOLOGICAL AND GEOTECHNICAL ASPECTS OF LANDSLIDES IN A GEOTHERMAL FIELD (KAMOJANG, INDONESIA)

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landslides in a geothermal field

Like many other geothermal fields in Indonesia, Kamojang area is located in high relief volcanic terrain where mass movements happen frequently. Thermal water alters the volcanic rocks in many ways, mostly leading to a decrease of mechanical strength and increase of slope instability in the resulting hydrothermal rocks. Landslides cut off the roads, pipelines, injection wells and even geothermal well pad. We complemented the existing geological and geotechnical database by our field data, in order to enhance the understanding of landslide mechanisms in the study area.

Before detailed site studies, a landslide risk map was provided, resistivity data from a survey at 3 locations along an important road (between KWK-A to KWK-C) were reprocessed. Identification of rocks and minerals were made by using hand lens, and will be enhanced by petrographic microscope and XRD. Faults, joints, and discontinuities were measured and analyzed using the Dips 6.0 software. Disturbed and undisturbed soil samples were taken, and analyzed in laboratory to obtain their index properties and other engineering properties through several tests: direct shear, unconfined compressive test, Proctor test, and triaxial permeability measurement. Stability analysis is then performed using all data and Slide 5.0 as well as Phase2 8.0 software programs, and the results are compared.

Major hardrock lithologies in the study area are andesite ash, lava, breccia and tuff. The residual soils can be classified as Clayey Sand (SC) and Inorganic silt (MH). All sorts of clay minerals are present; kaolinite, halloysite, trydimite, smectite and mixed layer minerals. According to present data, peak cohesion and peak friction angle vary between ca. 2.0 and 31 kN/m² and from 33 to 46°, resp. Limit equilibrium Factor of Safety repeatedly came out in the numerical analysis as low as 0.4 or 0.5. This begs the question why only a very limited number of slopes have actually failed. High rainfall, esp. during November and December (between 2425 and 2630 mm) are certainly the main triggering factor, but most likely cohesion is not taken account of properly in the standard analysis. Therefore, the spatial and temporal variations of this factor has to be better understood.

GEOLOGY AND GEOTECHNICAL ASPECT OF LANDSLIDE IN GEOTHERMAL FIELD, STUDY CASE; GEOTHERMAL AREA OF KAMOJANG, INDONESIA

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Geotechnical, Landslide, Clay, Geothermal, Hydrothermal Alteration, Slope Stability

Like many other geothermal fields in Indonesia, Kamojang area is located in high relief volcanic terrain where mass movements happen frequently. Thermal water alters the volcanic rocks in many ways, mostly leading to a decrease of mechanical strength and increase of slope instability in the resulting hydrothermal rocks. Landslides cut off the roads, pipelines, injection wells and even geothermal well pad. We complemented the existing geological and geotechnical database by our field data, in order to enhance the understanding of landslide mechanisms in the study area.

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PENETRATION PREDICTION IN TBM-TUNNELING – IMPROVED PROGNOSIS WITH THE MODIFIED GEHRING MODEL ('ALPINE MODEL')

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TBM tunneling, TBM performance, penetration prediction, penetration test, Gehring model

Investigations on performance prediction in mechanized tunneling with tunnel boring machines (TBM) are of major importance - especially in these days where TBMs made large infrastructure projects such as Alpine Transit Routes possible. Precise estimation of achievable penetration rates is inevitable to allow proper calculations on the construction time and excavation costs in advance of a tunnel project. This contribution aims to improve the existing penetration prediction model of the Austrian tunnel expert Dr. Karlheinz Gehring by performing on-site penetration tests. Besides the *Gehring model* (Gehring 1995), the commonly used *CSM prediction model* (Rostami 1997) is considered in the analysis. During a penetration test, the TBM is operated under defined conditions that enable the comparison of different tunnel projects, machine types and geological environments. The results are force-penetration graphs that are subsequently compared with the predicted values of both models.

Analysis of 30 penetration tests reveal that neither the *Gehring model* nor the *CSM model* reflect the actual relation between applied force and resulting penetration properly. The models seem to be build up by an inappropriate mathematical function since *Gehring* uses a linear function through the origin and the *CSM model* is calculated by a potential function. However, the best fitting could be achieved by a linear function with a certain y-axis offset that is set by the point of subcritical penetration at 3 mm/rev (threshold of rock crushing and effective rock chipping). The **magnitude of the offset** is characterized by **geotechnical parameters of excavated rock** and appears to highly depend on the Brazilian tensile strength and the LCPC breakability coefficient. In contrast, the **slope** of the line seems to be independent of rock properties but rather be defined by **rock mass properties** like primary stresses or discontinuities. Therefore, the existing correction factors for discontinuity pattern - k_2 for the *Gehring model* and RFI (rock fracture index) for the *CSM model* - are validated in this work as well.

The mathematical incorporation of these findings into the existing *Gehring model* is an important step towards a better penetration prediction in TBM tunneling with the newly suggested **Alpine model**. However, further validation at several tunnel projects is mandatory.

DYNAMIC REORGANISATION OF ALPINE RIVER CATCHMENTS ANALYSED WITH A χ -MAP

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Alps, erosion, uplift, geodynamics, rivernetwork

The drainage network in the Alps is an inherited network from the combined forces of erosion and Alpine tectonics that created differential uplift. River courses are therefore subject of ongoing evolution. This causes significant changes in erosion and deposition patterns that induce a feedback on the geodynamics itself. Migration of the drainage divide and capture of other river catchments leads to a positive feedback and forms dominating river systems.

We analysed the topography of the Alps using a steady state river channel proxy approach (Willett et al., 2014). The according χ -value integrates drainage area below each point to a common baselevel (Perron and Royden, 2013). Comparing χ -values reveals the current state of the reorganisation of the river network. With the elevation information we created a minimum topography map per catchment to compare this independent variable with our result.

Our study revealed that most of the observed drainage reorganisations are currently going on in the Danube catchment. It loses catchment area against the Rhine in the west and Adda/Adige in the south. Rivers draining to the tectonic external side to the north or northwest respectively loose catchment to rivers draining to the southern tectonic internal side. The western Alps that show a recent rapid uplift from thermochronometric ages (Fox et al., 2015) show only minor river course reorganisation on the χ -map even though the minimum topography map is similar to the rest of the Alps.

THE COSMOGENIC RECORD OF MOUNTAIN EROSION TRANSMITTED ACROSS A FORELAND BASIN: SOURCE-TO-SINK ANALYSIS OF IN SITU ^{10}Be , ^{26}Al AND ^{21}Ne IN SEDIMENT OF THE PO RIVER CATCHMENT

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Erosion, Po basin, Alps, Tectonics

We analyze the source-to-sink variations of *in situ* ^{10}Be , ^{26}Al and ^{21}Ne concentrations in modern sediment of the Po river catchment, in order to investigate how the cosmogenic record of orogenic erosion is transmitted across a fast-subsiding foreland basin. The *in situ* ^{10}Be concentrations in the analyzed samples range from $\sim 0.8 \times 10^4$ to $\sim 6.5 \times 10^4$ at/g_{QTZ}. Corresponding denudation rates range from 0.1-1.5 mm/yr in the Alpine source areas and from 0.25-0.5 mm/yr in the Apenninic source areas. The highest ^{10}Be -derived denudation rates are found in the western Central Alps (1.5 mm/yr), where also recent uplift rates are among the highest. From these data, we constrain a total sediment flux leaving the Alpine and the Apenninic source areas of ca. 35 Mt/yr that is notably higher than present-day estimates of sediment export (~ 10 Mt/yr at the Po delta).

We observe a high variability in ^{10}Be concentrations and ^{10}Be -derived denudation rates in the source areas. In the Po Plain, little variability is observed, and at the same time, the average source area-derived ^{10}Be concentration from both the Alps and the Apennines is preserved in sediment of the Po Plain. We also find that the transmittance of the source area's cosmogenic signal to the lowlands is not significantly perturbed by sediment trapping in deep glacial lakes and moraine amphitheatres south of the Alps. Similar ^{10}Be -derived denudation rates measured upstream and downstream of the postglacial Lake Maggiore suggest that denudation rates prior to lake formation were similar to today. In the Po Plain, the measured $^{26}\text{Al}/^{10}\text{Be}$ ratios exclude major modifications of the source-derived ^{10}Be signal because of the addition of deeply buried material, whereas the ^{21}Ne signal may indicate recycling of previously eroded sediment or an additional, but barely resolvable accumulation of cosmogenic nuclides during surficial floodplain transport.

Our results demonstrate that the cosmogenic record of mountain erosion is effectively transmitted from the source areas to the sediment sink, even across a strongly subsiding foreland basin. This record is poorly influenced by a range of potential geological and anthropogenic sources of bias, and is largely independent from upstream sediment interception and sediment storage in the floodplain.

FAULTING AND FAULT REACTIVATION IN RESTLESS CALDERA VOLCANOES: FIRST RESULTS FROM DISTINCT ELEMENT METHOD (DEM) NUMERICAL MODELS

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DEM, caldera, faulting, numerical

Large caldera collapses with cataclysmic eruptions of over 1000 km³ of magma ('super-volcanoes') constitute a major hazard to humanity, and still-active calderas often lie adjacent to or under large population centres. After collapse, the magma systems powering the volcano commonly recharge: this re-supply of magma at depth causes uplift of the subsided part of the caldera and leads to faulting and new eruptions at the surface. Over several years to 100's of years this post-collapse deformation can manifest as numerous 'unrest episodes' of meter-scale uplift and subsidence that are punctuated by faulting and eruption.

An acute problem for accurate assessment of hazard potential is the persistent uncertainty and debate about how caldera collapse is triggered, how it evolves, and how it is structurally accommodated. Researchers have consequently turned to physical and numerical models of caldera collapse to gain further insights into the initiation, development, and final geometry of caldera structures. New numerical modelling techniques such as the Distinct Element Method (DEM), are currently providing increased insight into these critical questions.

The principle advantage of using the DEM over more commonly used continuum models (e.g. Finite Elements) to model large strain volcanic deformation is that it can not only precisely calculate displacements, stresses, and strains based on realistic rock properties, but it can also directly and accurately model the initiation, growth, rupture, and reactivation of complex discontinuities like faults.

We generate realistic models of restless calderas, including pre-collapse inflation (tumescence), followed by collapse and later by resurgence (characteristic for restless calderas), and analyse the model results. We investigate if faults formed during previous stages of the evolution of a restless caldera are reactivated during a subsequent stage, as well as the development of structures during different stages of caldera unrest and what effect various pre-stage structures and magma chamber geometries may have. We then evaluate whether surface displacements obtained from the faulted inflation/deflation models are comparable to equivalent elastic models. Our models help shed light on the mechanics at work underneath active calderas, and with comparisons to surface deformation at active volcanoes, will enable more accurate forecasting of volcanic eruptions.

SACCOCOMA MICROFACIES FROM THE UPPER JURASSIC CARBONATE GRAVITY FLOW DEPOSITS: EXAMPLE FROM THE NAWOJOWA GÓRA QUARRY, KRZESZOWICE GRABEN (SOUTHERN POLAND).

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Calciturbidite, Saccocoma, Facies analysis, Upper Jurassic, Krzeszowice Graben

Sedimentological observations associated with microfacies studies conducted on the Upper Jurassic limestones exposed in the abandoned quarry at Nawojowa Góra revealed the presences of abundant planktonic Saccocoma crinoids. The occurrence of this crinoids species in the studied unit is recorded for the first time. Tectonically, the investigated outcrop is located in the southern, narrow faulted zones following the boundaries of the Krzeszowice Graben. The main components documents high diversity reflected by bimodal grain size distribution of coarse saccocomid remains and very fine well-sorted peloids. The bimodality of a grain composition results from the variation in hydrodynamic conditions. These detrital elements occurs in the packstone-wackstone sequence and structurally representing Bouma sequences intervals Tab or Tb. Silification zone, which separates individual units are expressed by elongated, strata-parallel nodules with strait tops and strongly irregular bottom. Futhermore, silification within laminated Saccocoma interval (Tb- of Bouma sequeces) is less clearly visible. This whole sequences (in the upper part) is grading into wackstones with distinct burrows. The top of analysed unit is covered by olistholiths-bearing debris flow deposit, which is separated from the underlying sediment by a thin layer of greenish marl. Overlying carbonate clasts represents microbial-Crescentiella limestones with randomly distributed cherts. The different facies observed in the investigated outcrop display features typical for carbonate turbidites represented here so-called Saccocoma-calciturbidites. Similar sequences, which are mainly dominated by fragments of planctonic crinoids, overlying by debris flows, are known from the few outcrops in the area of the Krzeszowice Graben. Their presences reflects synsedimentary tectonic activity along the steep tectonic controlled scarps.

LONG-TERM MONITORING OF A GEOTHERMAL COLD STORE AND A HEAT STORE LOCATED IN THE NORTH GERMAN BASIN: INCREASED ABUNDANCE OF SULFUR OXIDIZING BACTERIA (SOB) INDICATED OXYGEN INGRESS

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sulfate reducing bacteria (SRB), sulfur oxidizing bacteria (SOB), microbially induced corrosion (MIC), scaling,

Biofilms can influence the mineral formation and the material resistance against corrosion. In two geothermal plants with different salinity and temperature, organisms of the sulfur cycle contributed to process failures. In a cold store, the increase in sulfur oxidizing bacteria (SOB) led to a filter clogging, while at the cold side of a heat store, the increased diversity and abundance of sulfate reducing bacteria (SRB) indicated microbial influenced corrosion (MIC).

The shallow cold store was monitored for several years, including two phases of filter clogging caused by extensive slime formation. The first clogging event went along with a bacterial biocenosis in the fluid dominated by iron oxidizing (FOB) and sulfur oxidizing bacteria (SOB) related to the genera *Gallionella* and *Thiothrix*. Sulfur oxidizers related to *Sulfuricella* dominated during the second event. The increased abundance of SOB suggested a temporary ingress of oxygen that could not be detected by the physico-chemical monitoring of fluids during the first clogging event; whereby, an oxygen concentration of 1 mg/l was determined in fluids of the second clogging event. This substantiated the assumption that an increased abundance of SOB is a strong indication for oxygen availability in this geothermal cold store. We assume that the over-exploitation of the cold store and thereby caused water-level fluctuations in the wells are the reason for the oxygen ingress.

The microbial biocenosis in highly saline fluids produced from the cold well of a deep geothermal heat store was characterized during regular plant operation and immediately after plant downtime phases. SRB and fermentative *Halanaerobiaceae* dominated during regular plant operation, whereas after shut-down phases, the detection of SOB indicated oxygen ingress into the well. Enrichment of SRB and SOB during stagnant conditions was consistent with higher concentrations of dissolved organic carbon (DOC), sulfate, and hydrogen sulfide in the produced fluids. The sulfur isotopic signature of the mineral scales indicated microbial influence on scale formation. The interaction of SRB and SOB during plant downtimes might have enhanced the corrosion processes occurring in the cold well of the heat store.

UNTERSUCHUNGEN ZUR VERBESSERUNG DER HANGMURENBEURTEILUNG

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Hangmuren, Gefahrenkarte, Beurteilung, Grunddisposition

Die Ausbruchswahrscheinlichkeiten von spontanen Rutschungen und Hangmuren werden in der Schweiz heute in der Regel auf der Basis der AGN-Methodik von 2004 beurteilt. Dies führt zu nachvollziehbaren Beurteilungen, wobei noch erhebliche Unsicherheiten im Bestimmen der Anrissmächtigkeiten sowie der Auslaufbereiche und der Energien bestehen.

Im Auftrag des Bundesamtes für Umwelt (BAFU) wurde durch eine Projektgruppe der Arbeitsgruppe Geologie und Naturgefahren (AGN, eine Arbeitsgruppe der SFIG-GSGI, Schweizerische Fachgruppe für Ingenieurgeologie) die Frage der Verbesserung der Beurteilungsmethodik untersucht. Dabei stand insbesondere eine vertiefte Feldansprache und -beurteilung im Zentrum der Arbeiten.

Unter den prozessbeeinflussenden Faktoren (Grunddisposition und spezifische Förderfaktoren) werden die geologischen resp. hydrogeologischen Faktoren, wie die Wasserführung und Durchlässigkeitsdiskontinuitäten in Fest- und Lockergestein oft zu wenig gut berücksichtigt oder sind nicht bekannt. Zusammen mit der WSL (Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft WSL) wurde das Hangmuren-Erfassungsblatt WSL für die Ereignisaufnahmen und die Datenbankerfassung hinsichtlich geologischer und hydrogeologischer Erfassung optimiert.

Eine an der École polytechnique fédérale de Lausanne (EPFL) entwickelte Methode zur Bestimmung der Korngrößenverteilung der Feinfraktion und der Plastizität von Lockergesteinen (Methode GEOLEP) wurde auf ihre Feldtauglichkeit erfolgreich überprüft. Für diese Methode werden lediglich ein einfacher Grabstock und ein kleiner Laborkoffer benötigt.

Die durchgeführten Untersuchungen zeigen, dass für die Beurteilung der Hangmurengefährdung die geologisch-hydrogeologische Grunddisposition und die Hangneigungen eine entscheidende Rolle spielen. Aufgrund grosser Unterschiede der einzelnen Gebiete und teilweise geringer Datendichte bestehen noch grössere Unsicherheiten bezüglich der Interpretation der Daten und der Anwendbarkeit der Methode.

Auf der Stufe Gefahrenkarte bietet die Methodik AGN 2004 eine gute Grundlage für die Beurteilung der Ausbruchgebiete und deren Ausbruchswahrscheinlichkeiten. Beim Vorhandensein von gut erhobenen Ereignisdaten ist eine Beurteilung der Ausbruchgebiete mit dieser Methode bereits heute recht zuverlässig.

Die Beurteilungsgenauigkeit der Ausbruchgebiete wird z. B. durch einfache Handsondierungen mit der GEOLEP-Methode bezüglich Mächtigkeit und Aufbau der potentiell mobilisierbaren Schichten stark verbessert. Die Korngrößenverteilung der Deckschichten erlaubt eine Abschätzung der Durchlässigkeitskontraste im Lockergestein und in Bezug auf den unterliegenden Fels.

Die Verbesserung der Beurteilung der Intensitäten und der Ausbreitungsbereiche von Hangmuren mit der Methode GEOLEP konnte dagegen noch nicht mit Sicherheit aufgezeigt werden.

GRUNDWASSERERKUNDUNG IN DEN NÖRDLICHEN KALKALPEN BAYERNS IM HAUPTDOLOMIT DER OBERTRIAS

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Hauptdolomit, Kluftgrundwasserleiter, Trinkwasserversorgung, Kalkalpin

In Bad Reichenhall und in Reit im Winkl konnte die Trinkwasserversorgung aus Bohrbrunnen im Hauptdolomit der Obertrias gesichert werden. Beide Projekte sind im Rahmen der Grundwassererkundung in Bayern durchgeführt worden. Die wissenschaftliche Auswertung der Ergebnisse erfolgte an der Universität Marburg und am Institut für Angewandte Geologie der Universität Wien. Eingeschlossen sind Erkenntnisse aus der hydrogeologischen Landesaufnahme des Bayerischen Landesamts für Umwelt.

Der im Kalkalpin weit verbreitete, für einen Grundwasserspeicher wegen des Fündigkeitsrisikos als unergiebig eingestufte Hauptdolomit, hat sich unter bestimmten hydrogeologischen Voraussetzungen als höffig erwiesen. Von übergeordneter Bedeutung ist eine jungtertiäre tektonische Beanspruchung des Hauptdolomits, die zu Dehnungsstrukturen an Scherbewegungen geführt hat. Es entstanden offene Klüfte, die sich nach Dimension und hydrogeologischer Funktion in 3 Ordnungen einteilen lassen:

Die 1. Ordnung bildet mit Großklüften bis zu 1m den effektiven Grundwasserspeicher für eine Trinkwassergewinnung. In ihnen erfolgt der Hauptwasserumsatz. Entlang hangparalleler Auflockerungen können zusätzlich tiefgreifende, offene Kluftsysteme angelegt werden, die als Zwischenspeicher und Grundwasserneubildungsbereiche wirksam sind.

Die Klüfte 2. Ordnung liegen im Millimeterbereich und bilden hydraulische Brücken zwischen den Großklüften, die untereinander nicht direkt in Verbindung stehen. Bei entsprechender Kluftdichte ist zudem von einer nutzbaren Speicherwirkung dieser Klüfte auszugehen.

Die Klüfte 3. Ordnung, die im Mikrobereich den Hauptdolomit durchziehen, führen zum kleinstückigen Zerfall im Verwitterungsbereich sowie zum Aufbrechen im Gesteinsverband. Das Kluftwasser ist aufgrund der geringen Kluftweiten vorwiegend höher mineralisiertes Haftwasser, das mit Tritiumalter von bis zu 20 a relativ hohe Verweilzeiten aufweist. Bei höheren hydraulischen Druckgradienten können diese Haftwässer mobilisiert werden. Aufgrund der Verdünnung sind sie jedoch nur bei geringeren Wasserdurchsatzraten hydrochemisch relevant.

Der in den Bohrbrunnen messbare hydrostatische Druck erfordert hydraulische Hochgebiete. Im Entlastungsbereich entstehen gespannte, mitunter artesisch gespannte Grundwässer. Die stabilen Wasserisotope belegen die Höhenlage der Niederschlageinzugsgebiete.

Im Hauptdolomit treten neben reinen Dolomitwässern auch Mischwässer mit höheren Kalk- und/oder Sulfatanteilen auf. Im 3-Stoff-Diagramm Ca-Mg-SO₄ lassen sich die verschiedenen Wässer differenzieren und somit Hinweise auf ihre möglichen Einzugsgebiete gewinnen.

Bei entsprechenden Voraussetzungen liegt im Hauptdolomit ein Potential von Grundwasser, das eine hohe Trinkwasserqualität aufweisen und den Anforderungen einer Trinkwasserversorgung in vollem Umfang entsprechen kann.

SYNCHRONOUS FORMATION OF GARNET, ZIRCON AND MONAZITE IN AMPHIBOLITE-FACIES ROCKS DURING PROGRADE FLUID INFILTRATION – AN EXAMPLE FROM THE VENETIA KLIPPE, LIMPOPO BELT, SOUTH AFRICA.

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P-T-t fluid, U-Pb-Hf isotopes, Limpopo, South-Africa

Results from petrology in combination with (in-situ) geochronology and isotope data of minerals and rocks from the Venetia Klippe of the Limpopo Belt indicate that the U-Pb and Hf isotope system homogenized on the decimetre scale under prograde amphibolite-facies conditions of $\leq 645 \pm 25^\circ\text{C}$ and $\leq 7.0 \pm 1.1$ kbar, i.e. in the presence of an aqueous fluid. For a metabasite sample, homogenization is supported by isotope analyses of metamorphic zircon, garnet, and whole rock, which yield a six-point Lu-Hf isochron age of 2039.7 ± 3.4 Ma, with initial $^{176}\text{Hf}/^{177}\text{Hf}$ of 0.28126 ± 0.00001 , and a U-Pb zircon age of 2042 ± 10 Ma. The occurrence of a few inherited magmatic zircon cores with ages up to 2705 Ma, and with significantly lower initial $^{176}\text{Hf}/^{177}\text{Hf}$ of 0.28112, however, indicate that homogenization was incomplete. For a chlorite-biotite-garnet schist isotope homogenization is reflected by within error identical zircon and monazite U-Pb ages of 2045 ± 10 Ma and 2041 ± 8 Ma, respectively, and by a zircon-garnet-whole rock Lu-Hf isochron age of 2083 ± 63 Ma, with an initial $^{176}\text{Hf}/^{177}\text{Hf}$ of 0.28140 ± 0.00003 . Contemporaneous formation of metamorphic zircon, monazite and garnet in the schist is not only supported by the isotope data, but also by the finding of chlorite and biotite inclusions in all three minerals, and by inclusions of metamorphic zircon in garnet. The inclusion textures and the identical initial $^{176}\text{Hf}/^{177}\text{Hf}$ support the conclusion that metamorphic zircon grains precipitated from an aqueous fluid phase, after dissolution of zirconium-bearing phases elsewhere, followed by a major HFSE transport, and Hf isotope homogenization. This fluid perhaps was Ca-bearing, as is suggested by the fact that garnet in the schist sample is the only Ca-bearing phase, and that metamorphic monazite, dating the metamorphic peak, is partially replacement by apatite. The fact that the metamorphic zircon rims in the metabasite sample have significantly lower initial $^{176}\text{Hf}/^{177}\text{Hf}$ than expected from the Lu-Hf isotope analyses of relic zircon cores and whole rock additionally hint that Ca-HFSE-bearing fluids infiltrated from surrounding quartzo-feldspathic gneisses, which had much lower $^{176}\text{Hf}/^{177}\text{Hf}$ at the time of metamorphism.

VISCO-ELASTIC FULL WAVEFORM INVERSION OF CONTROLLED-SOURCE SEISMIC DATA FROM THE SAN ANDREAS FAULT OBSERVATORY AT DEPTH

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seismic, visco-elastic, waveform inversion, San Andreas fault

We apply visco-elastic full waveform inversion (FWI) to a 50-km-long controlled-source refraction/reflection seismic survey at the San Andreas Fault (SAF) to obtain high resolution P-wave and S-wave velocity models for the SAF Observatory at Depth (SAFOD) drill site near Parkfield. The profile consists of 63 explosive sources and a fixed spread of 912 3-component receivers.

Traveltime models from Ryberg et al. (2012) and Hole et al. (2006) are used to derive velocity starting models for FWI. Attenuation is estimated from Q_p and Q_s t^* -tomography models after Bennington et al. (2008). Density is estimated from P-wave velocity using Gardner's (1974) relation. Preprocessing includes the muting of noisy traces, the estimation of spatio-temporal weighting factors to exclude Rayleigh waves, which otherwise mask the comparatively low-amplitude body wave signals, and a 3D-to-2D-conversion, which is carried out separately for P- and S-waves and their coda. The separation of P- and S-wave arrivals is based on travel-time and polarization analysis.

The forward-modeling is based on a time-domain visco-elastic FD-algorithm of Robertsson et al. (1996). Topography is considered using the image method. The inversion is performed in the frequency-domain using the multi-scale approach.

As a first step, we derived individual source wavelets for the different shots at the low frequencies (3-6 Hz). Further, sensitivity kernels and inversions for elastic parameters for the low frequencies are carried out.

The project is funded by the German Research Foundation (DFG) and is part of the International Continental scientific Drilling Programme (ICDP).

LACUSTRINE STROMATOLITES FROM THE MIOCENE WUDAOLIANG GROUP (TIBETAN PLATEAU, PR CHINA)

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stromatolites, Miocene, stable isotopes, rare earth elements, biomarkers

Microfabrics and geochemical signatures of lacustrine stromatolites are valuable indicators of palaeoenvironmental changes in continental settings otherwise rare in fossils. The investigated stromatolites are part of the carbonate-dominated Miocene Wudaoliang Group (23.5–13.5 Ma) which unconformably overlies Oligocene conglomerates and sandstones (Yaxicuo and Fenghua Shan groups) in the Wudaoliang and adjacent basins. These lithostratigraphic groups were deposited in lake basins which developed in the Tibetan Plateau, due to the Oligocene-Miocene uplift and climate shift. While the lower part of the Wudaoliang Formation hosts marls with scattered fresh to brackish water ostracods, its upper part is dominated by dolomites and limestones with intercalated stromatolites. However, it is unknown whether these stromatolites formed in a freshwater setting, saline halite lake or soda lake. Furthermore, synsedimentary Pb-Zn deposits in the adjacent Tuotuohe Basin suggest a possible hydrothermal impact also in the Wudaoliang Basin at this time. Preliminary microscopic observations revealed that the stromatolitic fabric is composed of dense and porous laminae. The dense laminae contain microcrystalline calcite and microbial peloids. The porous laminae exhibit a spongy fabric with upright oriented microcrystalline tube-like structures enclosing elongated or angular voids. To date, it is unclear whether the latter represent former algal or cyanobacterial filaments, exopolymer fabrics or traces of evaporite crystals. No skeletal fossils were observed, only elongated faecal pellets 80 x 400 μm in size, possibly of the brine shrimp *Artemia*. Stable isotope analyses show a co-variation of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$, which may either reflect hydrologically closed conditions of the lake basin and/or mixed sampling of primary microcrystalline precipitates and diagenetic microspar. A comprehensive mineralogical, geochemical, stable isotope and biogeochemical analysis is intended to constrain the depositional environment and microbial community composition of the stromatolites. In summary, our preliminary investigations suggest a saline, possibly hypersaline setting for the stromatolite formation. There is no indication of a freshwater setting at the time of stromatolite formation. However, the hydrochemical lake type as well as a possible hydrothermal influence remain to be elucidated. A high-resolution sampling of homogenous carbonate phases required for isotope analyses and rare earth element analyses is underway to answer these questions.

EUROPIUM, CERIUM ANOMALIES AND ENVIRONMENTAL CHANGE FROM THE TRIASSIC-JURASSIC BOUNDARY IN SOUTH QIANGTANG DEPRESSION, NORTHERN TIBET

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Europlum anomaly, Cerium anomaly, T-J boundary, hydrothermal event

The continuous marine strata from Suobucha Formation (Rheanian to early Toarcian) to early Toarcian Quse Group, in south Qiangtang depression (PR China), were deposited during the Qiangtang block drifted from Gondwanaland toward Eurasia, and represented the passive continental margin of eastern Mesozoic Tethyan realm, which is well-preserved but reported by few international publications. The Suobucha Formation is dominated by carbonates while the Quse group are series of black shale deposition, and they recorded a major environmental change occurred across this important boundary, and also provided us an approach to study what was responsible for the Triassic-Jurassic extinction in the eastern Tethyan realm. Geochemical sampling from lithological section, with an interval of 1 meter, totally 33 Jurassic shales and 50 Triassic limestones were sampled for trace elements and rare earth elements compositional analysis. The results shown a sharp negative anomaly of Cerium in the top layer of the Suobucha Fm. limestones, with a δCe value of 0.47~0.59, and slightly negative δCe (0.9) for the bottom layer of Quse shales, indicated an acidification of seawater. Furthermore, positive Eu fluctuations also occurred in the end Triassic, possibly suggesting that there were hydrothermal activities in the south Qiangtang depression. LREE/HREE at the limestone-shale lithological boundary has a significant leap. Whether and how the CAMP(Central Atlantic Magmatic province), possibly the most notable hypothetic event in Triassic-Jurassic, had an impact on our research area remained unknown, but by making a contrast to the REE compositions of the Late Triassic Nadi Kangri Formation tuff and volcanic rocks in Qiangtang basin, with an obvious depletion of Eu, we preliminarily conclude that the end-Triassic volcanic eruption in Qiangtang basin is the main cause for the environmental change.

U-PB-AGES OF MAGMATIC AND DETRITAL ZIRCON OF THE DÖHLEN BASIN - GEOLOGICAL HISTORY OF A PERMIAN STRIKE-SLIP BASIN IN THE ELBE ZONE (GERMANY)

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Döhlen Basin, U-Pb-Th geochronology, zircon, pyroclastic rocks, Variscides

The post orogenic evolution of Variscan Central Europe is characterized by the formation of many intracontinental basins. The lowermost Permian Döhlen Basin is located in the Elbe Zone (Germany) and is bordered by metamorphics of the Erzgebirge and also numerous Variscan extrusives. The basin can be considered as evidence for major rearrangements of stress fields during the post-Variscan reactivation in Europe.

Eleven samples of magmatics and sediments have been analyzed with respect to their U-Th-Pb and geochemical composition. Of three magmatic samples, we analyzed 170 zircon grains. The Unkersdorf Tuff of the Unkersdorf Formation gave an age of 294 ± 3 Ma (Upper Asselian to Sakmarian) whereas a trachyandesite of the same formation was dated 293 ± 5 Ma (Sakmarian). The Wachtelberg Tuff (uppermost Bannewitz Formation) showed an age of 286 ± 4 Ma (Artinskian to Lower Kungurian). Additionally, 984 detrital zircon grains of the Niederhäslich Formation and the Bannewitz Formation have been analyzed. All sediments but two yielded two distinct age groups: 295-340 Ma and 530-750 Ma as well as minor amounts of Precambrian zircon ages. Geochemical data points to a setting with developing strike-slip basins. Our data suggests a c. 10 Ma lasting basin formation during the second post-Variscan volcano-tectonic activity, accompanied with basic to intermediate melts. The second youngest formation (Niederhäslich Formation) consists predominantly of basement material, which implies low volcanic activity and erosion mainly of basement material. On the contrary the uppermost Bannewitz Formation features strong evidence for volcanic activity circumferential the basin area.

The present study strongly suggests a rapid basin development and shows further how the evolution of the Döhlen Basin is evidence for several post-Variscan activation phases in Central Europe. Our study also demonstrates how basin development can be determined by radiometric data of detrital zircon grains.

FLUID DRIVEN PROCESSES IN THE CRUST - THE FORMATION OF ANORTHOSITIC DYKES IN THE TROODOS OPHIOLITE CYPRUS

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Fluids in the crust, experimental petrology, Troodos Ophiolite

The Upper Cretaceous SSZ ophiolite of Cyprus includes rare anorthositic dykes. Normative bulk compositions range around 90% plagioclase. Rocks have been petrographically described and were investigated in great detail for their major- and trace element composition. Isotope compositions of Hf and Sr reveal their relation to the upper pillow lavas of the effusive ophiolite sequence. Melting experiments of such compositions show that even under fluid-saturated conditions, temperatures required for whole-sale melting are well above 1250 °C at 500 MPa, which is unrealistic for a derivative melt. The working hypothesis is that the dykes may represent the solute of a magmatic fluid that exsolved from an H₂O-saturated basaltic melt at shallow crustal levels. Fluids exsolving from a silicate liquid at magmatic temperature and medium pressure can be quite enriched in silicate and oxide solutes, comparable in composition to silicate melts. Controlled decompression-crystallization experiments are performed to test this proposition. A tholeiite glass from the upper pillow lavas of Cyprus is doped with excess H₂O (10 wt.%) and several trace elements whose partitioning behaviour may be diagnostic of fluid-melt equilibrium. The charges are equilibrated in Pt capsules at 1 GPa and 1150°C, decompressed isothermally to 250 MPa, slowly cooled at 250 MPa to 650°C (0.3 °C/min), then quenched. Experimental products return three pyx generations in an apparent glassy matrix; a low-Ca opx followed by a high-Ca cpx, and finally by a subcalcic pyx generation with X_{CaTs} component as high as 15 %. The interstitial material, seemingly a glass, is greatly enriched in CaO and Al₂O₃, Na₂O-poor, almost FeO-MgO free, and it is peppered with volatile bubbles. EPMA totals suggest a H₂O-content as high as 12 wt.%. In terms of composition, the glasses are very close to the compositions of the anorthosite dykes. We argue that the dykes may represent escape channels, of magmatic fluids that exsolved from basaltic melts at depth and precipitated their solute as calcic plag and potentially CaTs-enriched pyx during passage to the upper crust. The primary agent that triggered fluid saturation, may have escaped, or may have been consumed by alteration reactions.

FORMATION OF DOME AND BASIN STRUCTURES: RESULTS FROM SCALED EXPERIMENTS USING NON-LINEAR ROCK ANALOGUES

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analogue modeling, dome-and-basin structure, non-cylindrical folds, prolate deformation, bulk pure constriction

We used power-law viscous rock analogues to simulate dome-and-basin folding of rocks undergoing dislocation creep. The viscosity ratio, m , between a single competent layer and incompetent matrix was 5, and the stress exponent, n , of both materials was 7. The samples underwent layer-parallel shortening under bulk pure constriction.

Increasing initial layer thickness, H_i , resulted in a decrease in the number, N , of domes and basins and an increase in amplitude, A , arc-length, L , wavelength, λ , and layer thickness, H_f . Samples deformed incrementally show progressive development of domes and basins until a strain of $e_{y-z} = -30\%$ is attained. During the dome-and-basin formation the layer thickened permanently, while A , L , and λ increased. A dominant wavelength was not attained. The normalized amplitude ($\bar{A} = A/\lambda$) increased almost linearly reaching a maximum of 0.12 at $e_{y-z} = -30\%$. During the last increment of shortening ($e_{y-z} = -30 - -40\%$) the domes and basins did not further grow, but were overprinted by a second generation of non-cylindrical folds. Most of the geometrical parameters of the previously formed domes and basins behaved stable or decreased during this phase. The normalized arc-length ($\bar{L} = L/H_i$) of all domes and basins produced varies from 6 to 9, and thus is significantly higher than the \bar{L} -values of 2D cylindrical folds.

SEDIMENTARY CHARACTERISTICS AND CARBON-ISOTOPE CHEMOSTRATIGRAPHY OF A LATE JURASSIC CARBONATE RAMP: THE KIMMERIDGIAN SHALLOW-WATER DEPOSITS OF THE LOWER SAXONY BASIN (NORTHERN GERMANY)

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Lower Saxony Basin, Kimmeridgian, Microfacies, Stratigraphic architecture, Carbon isotopes

During the Kimmeridgian, sedimentation in the Lower Saxony Basin was characterized by shallow-water deposits composed of alternating limestones, marls and claystones. Stratigraphic uncertainties caused by the absence of open marine marker fossils and prevalence of sedimentary gaps hamper a precise age assignment and correlation of these successions on a regional and global scale. Here, we provide new sedimentological and chemostratigraphic data for two sections (Langenberg and Bisperode sections), with particular focus on microfacies and stratigraphic architecture analysis coupled with high-resolution carbon-isotope stratigraphy. A total of 14 carbonate microfacies types (MF-types) are assigned covering mid-ramp to back-ramp settings. Based on the stratigraphic variation of MF-types and their stacking pattern, A/S cycles (accommodation space to sediment supply and/or sediment production) of different hierarchies (small-scale and mid-scale) are distinguished. Based on integration with information on facies proportion (which indicate facies changes in each cycles) and semi-quantitative microfacies data, an overall change in depositional facies towards more proximal conditions can be observed from the base to the top in both sections. Carbon-isotope stratigraphy based on bulk carbonate is used for both intra- and interbasinal stratigraphic correlation. The chemostratigraphic correlation on regional scale reveals that (1) higher-amplitude as well as rather subtle trends in the carbon isotope record are preserved at both localities, (2) values in both curves gradually decrease with stratigraphic height and, (3) both the mid-scale cycles and the small-scale cycles correlate very well with the chemostratigraphic correlation framework. Furthermore, a first tentative carbon-isotope correlation between the Langenberg record and existing carbon-isotope records from European basins further highlights the potential of carbon-isotope stratigraphy for the correlation of Mesozoic shoal-water deposits. Additionally, strontium isotope data based on investigation of pristine low-Mg calcite shells (brachiopods and oysters) will be used to refine the stratigraphic age. Bulk geochemistry parameters including carbonate and total organic carbon (TOC) content, as well as clay mineral fraction will provide additional information and complement the sedimentological data.

WÜRMEISZEIT UND DIE RÜCKZUGSSTADIEN IM ALPENRHEINTAL

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Würmzeit

Korrelation von ^{14}C -Datierungen aus Bohrprofilen mit Glazialstadien und -schwankungen, Klimaphasen, archäologischen Kulturen und Biozonen.

Die Korrelationstabelle bildet den Kern der vorliegenden Daten und Folgerungen. Anlass dazu gaben viele unpublizierte Projektberichte von Sondierbohrungen und Tunnelaufnahmen im Archiv des BTG, die ^{14}C -Altersdaten von fossilen Holzfunden enthalten und stratigraphisch korrelierbar sind. BTG-Projektgeologen haben die Holzproben gesichert, zur Datierung vorbereitet und archiviert (Finanzierung weitgehend BTG-intern).

Die ersten Holzfunde wurden in den 1970er Jahren am Radiocarbonlabor des Physikalischen Instituts der Universität Bern und bis 2015 (Bohrung 2/15, Posterprofil) zusätzlich am Labor für "Ion Beam Physics" an der ETH Zurich datiert. Sämtliche gemessenen ^{14}C -Altersdaten, auch die Literaturzitate, wurden auf Jahre BP (1950) standardisiert (braune Balken in den Tabellenspalten b—d mit Fehlerbereich 2σ) und in der Spalte a den kalibrierten Altern cal. Jahre BP gegenübergestellt (Kalibrationskurven nach Stuiver 1998 bzw. INTCAL04). Geographisch umfassen die datierten Fundpunkte die Projektgebiete des BTG mit Schwerpunkten im Alpenrheintal, Sarganserbecken, Seeztal-Walenseebecken und Linthtal, sowie in den Bündner Tälern. Für die vorliegende Korrelationstabelle wurden v.a. BTG-Daten und ergänzend dazu zitierte Alter (siehe Literaturverzeichnis) aus den erwähnten Tälern der Nordalpen inkl. Zürichseebecken berücksichtigt. Die Zuordnung der Glazialstadien auf der Karte basiert auf eigenen Arbeiten und René Hantkes Lebenswerk "Eiszeitalter" 1978 - 1983 und fokussiert auf den **Sarganser-Stand** (Spalte d).

Resultate:

Die ausseralpinen Rückzugsstadien (Spalte b) und das alpeninterne Stadium **Koblach-Feldkirch-Weesen** (Spalte c) beschränken den **Sarganser-Stand** auf Älteste Dryas oder jünger. Die **internerer Stadien** (Prättigau) bedingen ein Minimalalter Bølling/Allerød.

Der **Sarganser-Stand** belegt einen Rückzugshalt (gestaffelte randglaziale Schotterterrassen ohne Vorstossmoränen) an der Wende Älteste Dryas/Bølling. Entsprechende Schotter sind bis weit in die Surselva und das Prättigau hinauf verfolgbar. Das **Stadium Koblach-Feldkirch** (mehrere Moorprofile mit basalen Pollenspektren der Ältesten Dryas) stellt einen Glazialvorstoss mit ausgeprägten Moränenwällen innerhalb der Ältesten Dryas (? Heinrich1-Event) dar. Der Rückzug vom Feldkirch-Stadium zum Sarganser-Stand ist altersäquivalent zum klassischen Gschnitz-Stadium (Tirol, Ivy-Ochs 2006). Gleichzeitig breitete sich im Mittelland die jungpaläolithische Kultur des Jung-Magdalénien (Leesch/Leuzinger 2012/2016) aus, allerdings ohne dem Gletscherrückzug in die Alpentäler unmittelbar zu folgen. Dies taten auch die eiszeitlichen Grosssäuger nicht.

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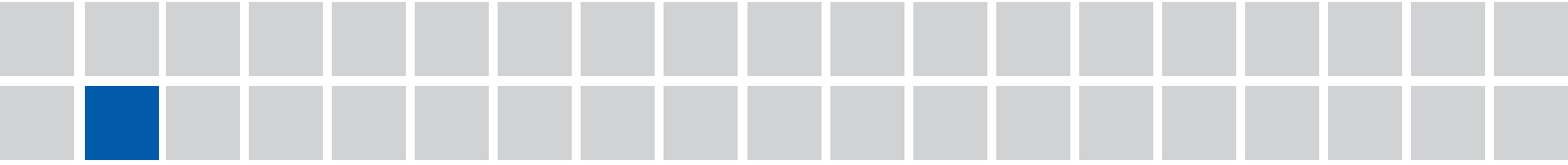


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