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Atmosphärische Effekte in der Geodäsie

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Geodätische Weltraumverfahren wie VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging) oder GPS (Global Positioning System) und Schwerefeldmissionen wie GRACE (Gravity Recovery and Climate Experiment) und GOCE (Gravity Field and Steady State Ocean Circulation Explorer) werden in vielfältiger Weise von atmosphärischen Effekten beeinflusst: Die Ausbreitungsgeschwindigkeit der Signale von Satelliten oder extragalaktischer Radioquellen wird in der Ionosphäre und der neutralen Atmosphäre signifikant verändert, was einen limitierenden Faktor für die Genauigkeiten von SLR, GPS und VLBI darstellt. Andererseits bewirken Luftdruckänderungen an der Erdoberfläche Deformationen der festen Erde im Zentimeterbereich, die bei der Auswertung der geodätischen Weltraumverfahren berücksichtigt werden müssen. Zusammen mit den globalen Windgeschwindigkeiten verändern die Luftdruckvariationen die Erdrotation, und sie beeinflussen die Messung des Erdschwerefeldes mit GRACE und GOCE.
Im Rahmen des Global Geodetic Observing System (GGOS) der IAG (International Association of Geodesy) sollen nun alle Komponenten - Geometrie/Kinematik, Erdrotation und Schwerefeld der Erde - übergreifend behandelt werden. Eine wesentliche Rolle spielt dabei die konsistente Modellierung aller atmosphärischen Effekte. In der Präsentation wird auf diese Einflüsse in der Geodäsie eingegangen, und es wird gezeigt, wie mit Daten des numerischen Wettermodells des ECMWF (European Centre for Medium-Range Weather Forecasts) die benötigten Größen berechnet werden können.

Lithofacies and depositional environment in the upper Hall Formation, Alpine Molasse basin, Upper Austria

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Oil and gas is being explored in the Upper Austrian Molasse since the 1950ies. The mature basin comprises several prospective stratigraphic intervals. The upper part of the Miocene Hall Formation is one of the areas of investigation that gains more and more in importance, as it has not been targeted systematically and is thought to still have potential. The presented study focused on detailed sedimentary examinations of core data. In combination with seismic interpretation the study led to a revised depositional model helping to predict facies distribution and possible trapping configurations.
The studied sections record tide- to wave-influenced deltaic deposition with five facies associations being defined. They range from lower deltaplain to distal prodelta environment. First sequence stratigraphic approaches were done, revealing changes in deposition by relative sea-level change. Seismic imaging, wireline measurements and ichnologic analyses contributed further aspects to the interpretation.
The deltaic deposition consists of five environments: distal prodelta, proximal prodelta, reworked deltafront, proximal deltafront and the lower delta plain. The distal prodelta is characterized by thick-bedded fine-to medium-grained sandstone fans of turbidity origin. They are inter-bedded by laminated to disorganized mudstones. The ichnogenera are restricted to muddy intervals and comprise single *Taenidium* and *Planolites*. The deposits of the proximal prodelta environment are marked by domination of laminated mudstones. They intercalate with thin beds of cross-laminated turbidity sandstones which are occasionally wave-reworked. Furthermore, single thick-bedded tempestite sandstones occur. The trace fossil suite comprises major *Taenidium, Planolites, Teichichnus* and escape structures. Wide-spread deposits of reworked and redeposited deltafront sands are medium-grained, normal-graded and massive to structured in habit. They show fluid escape and lack in ichnofabrics. The proximal deltafront environment is characterized by flaser-bedded fine sandstones that intercalate with laminated mudstones. The deposits display coarsening-upward trends and show moderate to intense bioturbation by *Taenidium* and *Planolites* mainly. The deposits refer to reworked mouthbar deposits. The lower delta plain environment is marked by massive, normal-graded, coarse- to medium-grained sandstones, thick sequences of laminated mudstone/ sandstone and slumped muddy sandstones. They record deposition in the „terminal" distributary channel which was place of tidalite formation occasionally.
The facies evolution from lower to upper Hall Formation points to the shallowing of the Paratethyan basin in the Burdigalian. In Eggeburgian times, that development cumulated in the formation of a tidal- and wave-influenced deltaic system. This system is sourced by clastics from the active Alpine orogeny. In contrast to earlier Burdigalian times with contributor-feeder channels further in the west (Inn/Traun Valleys), this system seems to be fed mainly from the Salzach valley. It prograded to the northeast forming various potential reservoirs.

Diagenetic alteration in sandstones of the gas-, water-, and transition- zone of a gas reservoir, Molasse Zone, Austria

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Sandstones of the studied Miocene gas reservoir are resedimented deposits from the southern slope of the Austrian Alpine Molasse Basin. Reservoir rocks are heterogeneous medium- to coarse grained sandstones containing large clasts of shales and carbonates. The gas reservoir has been produced and is now used for underground gas storage. To better understand the mineralogy of the reservoir sandstones with respect to the different zones (gas-, water- and transition zone) and the effect of drilling fluids to the formation, multiple analyses were carried out.
Diagenetic alterations in the sandstones are feldspar overgrowths on detrital K-feldspar grains; authigenic quartz overgrowths;

framboidal pyrite formation, later dissolution and octahedral pyrite formation; calcite- and dolomite cementation; authigenic clay mineral formation and an early formation of glauconite (mainly as rims).
The focus was to characterise the authigenic clay fraction (excluding shale clasts) in the different zones. Samples of the gas-bearing, the transition, the secondary watered and the initial water zone were analysed.
X-ray diffraction analyses of the clay fractions showed that there are clear zone-dependent differences. Increasing crystallinity of smectite, chlorite and illite from the gas-bearing to the initial water zone and an increase in the clay mineral content could be observed. Most important is the fact, that there are no expandable clay minerals in the gas-bearing zone. This changes in the transition zone where smectites are developing.
There is a considerable effect of the rising water level (due to gas production) on the authigenesis of clay minerals in the pore space. Within a few years of the start of water infiltration new clay minerals are forming. Existing ones start to recrystallise and expandable clays appear in the transition zone where primarily none were present.
The drilling mud had little interaction with the reservoir rocks. Expandable clay minerals showed different behavior from the outer rim (about 1cm) of the cores towards the center. Smectites adsorbed potassium from the drilling mud which resulted in a decrease of the interlayer spacing. Barite originating from the drilling mud infiltrated the outermost 2 mm of the cores with a decrease from the margin to the center.

Hochmetamorphe Keuperfazies („Aigerbach-Formation") und unterjurassische Kontinentalrandfazies („Kaserer-Formation"), zwei Schlüssellithologien bei der geologischen Prognose für den Brenner-Basistunnel

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Das Prognoseprofil des Brennerbasistunnels wird im zentralen Bereich der Aufwölbung des Tauernfensters durch zwei Zentralgneis-Antiformen, der Tuxer Antiform und der Zillertaler Antiform geprägt. Im Übergangsbereich zwischen Unterer Schieferhülle und Oberer Schieferhülle (die beiden Begriffe werden rein deskriptiv verwendet) gelang die Auflösung des komplexen Baues von mehrfachen liegenden Faltenstrukturen und Teildecken durch die konsequente Ausscheidung der Aigerbach-Formation und der Kaserer-Formation. Die beiden lithostratigraphischen Bezeichnungen werden hier noch informell verwendet.
Die **Aigerbach-Formation** (Typprofil im Aigerbach bei St. Jakob im Pfitschtal) besteht aus einer bunten Wechselfolge siliziklastischer, karbonatischer und evaporitischer Lithologien in amphibolitfazieller metamorpher Überprägung. Lagerungsverhältnisse (am Top der Seidlwinkel Dolomite mit bestimmbaren mitteltriassischen Crinoiden) als auch $\delta^{34}S$ Werte der Gipse und Anhydrite die in der Mehrzahl zwischen 14.5 und 19‰ VCDT liegen, weisen der Formation eindeutig karnisches Triasalter zu.
Gips und Anhydrit können beim Tunnelvortrieb Erschwernisse darstellen, die prognostizierten Vorkommen auf Tunnelniveau – allerdings nur schmale Zonen - gelten als Risikozonen. Die Lösungszonen („Dolomitsand" und Rauhwacken) stellen ein wissenschaftlich interessantes Phänomen der seichteren und tieferen Verwitterungszone dar, weshalb in diesem Beitrag darauf näher eingegangen wird. Das bessere Verständnis der Lösungs-/Fällungsprozesse erleichtert die Prognose auf Tunnelniveau.

Die **Kaserer-Formation** und deren stratigraphischen Position wurden gerade in letzter Zeit sehr unterschiedlich interpretiert: Lammerer (Mem. Sci. Geol., **54**: 183-184, 2002) plädiert für triassisches Alter, Thiele (In: Oberhauser, Hrsg.: Der Geologische Aufbau Österreichs, 300-314, 1980) und Rockenschaub et al. (Geo.Alp **4**: 31, 2007) für ein Unterkreidealter. Die sequenzstratigraphische Bearbeitung nördlich und südlich des Alpenhauptkammes lässt nun aber ein unterjurassisches Alter als wahrscheinlich erscheinen. Wir interpretieren die Kaserer-Formation mit ihrer stark deformierten Triasbasis als proximale, klastische Entwicklung am europäischen Kontinentalrand, die mit Teilen der sogenannten „Tulfer-Senges-Einheit" als distale Faziesgruppe zu korrelieren ist. Unterlagerung mit Triasresten und Überlagerung mit mächtigen Kalkmarmoren (ähnlich jenen der Hochstegenkalkmarmore der Unteren Schieferhülle) südlich des Pfitschtales legen ein unterjurassisches Alter nahe.

Mafic K, Mg-rich magmatic rocks from western Mühlviertel (Austria) and adjacent part of the Šumava Mts. (Czech Republic)

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In framework of new geological mapping in the „Dreiländerecke"-area in the western Mühlviertel and adjacent southern Bohemia, supported by the Czech Geological Survey and Geological Survey of Austria, two distinct types of mafic K, Mg-rich granitoids were distinguished and petrographically, mineralogically and chemically defined.
Mafic K-Mg-rich granitoids termed durbachites (or the Rastenberg type in Austria) are one of typical Variscan magmatic rock of the Moldanubicum. One large and several small bodies of typical durbachite (SiO_2 around 60-65%) appear in the Czech territory to the north of the Vltava valley and are well known (the „Kní•ecí Stolec" or „•elnava" intrusion). Several smaller bodies of extreme basic and mafic varieties of durbachite were newly found on both the Czech and Austrian sides of the state border, N of the town of Schwarzenberg: pyroxene-biotite melasyenite (<50% SiO_2) and amphibole-biotite melasyenite (50-55% SiO_2). Both varieties contain phenocrysts of Kfs (about 3x1 cm) in a matrix of oligoclase, flogopite (xMg=0.58-0.67), and clinopyroxene (xMg=0.74-0.78) or diopside (xMg=0.67-0.80). Their chemistry is particularly interesting: 47 to 61% SiO_2, 5.5 to 8.5% FeO_{tot}, 4.0-13.7% MgO, 2.3-6.7% CaO, 1.0-2.0% Na_2O and 4.7-7.7% K_2O, 200-700 ppm Cr, 70-260 ppm Ni, 300-450 ppm Rb, 280-500 ppm Sr, 250-600 ppm Zr.
Several ultramafic dykes appear in the western exocontact of the Køistanov granulite massif near the village of Zbytiny. The dyke rocks are medium- to fine-grained, composed mainly of flogopite (xMg 0.65-0.80) and diopside (xMg=0.75-0.85). Actinolite-like amphibole (xMg=0.70-0.75) and clynopyroxene (xMg=0.81-0.83) appear only locally. Amount of feldspars variegated, being enriched in domains representing accumulation of residual, fluid-enriched portion of the melt. Quartz was found occasionally within the very fine-grained matrix. Long columnar apatite and small grains of zircon are common. Typical chemical composition (45-54 wt% SiO_2, 8-11 Al_2O_3, 0.3-1.3 wt% Na_2O, 11-17 wt% MgO 3.3-5.5 wt% K_2O, 1.2-2.4 wt% P_2O_5, 500-1000 ppm Cr, 200-600 ppm Ni)) is rather unusual and differs from neighbouring durbachites.