rungen können sowohl als Stauer aber auch als bevorzugte Wasserwegigkeiten sowie eine Kombination aus beiden ausgebildet sein.
Das Untersuchungsgebiet umfasst die tektonischen Einheiten Grauwackenzone (Upper Austro-Alpine) and Semmering-Wechsel complex (Lower Austro-Alpine) im Bereich Semmering – Rax. Die Gesteine zeigen unterschiedliche Arten an Störungen von brittle faults über verschiedene Arten von Kataklasiten bis fault gouges.
Die hydraulische Charakterisierung wurde mit Hilfe von hydraulischen Packer Tests durchgeführt, welche eine teufenspezifische Abtrennung und Betestung der Einheiten ermöglicht. Packer Tests ermöglichen eine Abtrennung von Zonen mit deutlicher tektonischer Beanspruchung wie erhöhte Klüftigkeit oder Einschaltung von fault gouges und/oder Kataklasiten. Die Testintervalle liegen zwischen 30 und 130 m in Bohrungen mit Maximalteufen bis 300 m. Der Kataklasitanteil innerhalb der Testsequenzen variiert zwischen 0% und 80% und die hydraulischen Durchlässigkeiten liegen Werte zwischen von 6,7E-05 m/s und 1,1E-10 m/s
Die Ergebnisse der hydraulischen Untersuchungen zeigen eine leichte Abnahme der hydraulischen Durchlässigkeiten mit zunehmender Teufe. Unter Berücksichtigung des Kataklasitanteils (in%) zeigt sich v.a. in den Gesteinsschichten des Semmering-komplexes, dass über 15% Kataklasitanteil die hydraulische Durchlässigkeit unter 2E-07 m/s liegt. Die Medianwerte der hydraulischen Durchlässigkeiten liegen zwischen 9,2E-08 m/s and 1,2E-09 m/s. Zusätzlich wurden Untersuchungen an einer großen Störungszone (Talhofstörung) durchgeführt. Hierfür wurden entlang einer Scan-Line orientierte Stechzylinder mit Probenmaterial der Kernzone in verschiedenen Raumrichtungen zur Bewegungsfläche genommen. Die Stechzylinder wurden im Labor in Triaxialzellen auf die hydraulische Durchlässigkeit getestet. Die Durchlässigkeitswerte schwanken zwischen 1,7E-07 m/s und 4,2Ee-11 m/s, was einem gering bis sehr gering durchlässigen Untergrund entspricht. Als Haupteinflussfaktoren für die geringe Durchlässigkeit zeigten sich der Muskowitgehalt, der Anteil an Feinstfraktion (Tongehalt ~ 15%) und die Orientierung zur Bewegungsfläche. Im Wesentlichen decken sich die Ergebnisse mit den Packertestergebnissen, allerdings ist zu berücksichtigen, dass es sich hierbei um unterschiedliche Skalenbereiche handelt, welche für eine Interpretation berücksichtigt werden müssen. Generell bestätigen die Daten des Aufschlusses die leichten Abnahmen der hydraulischen Durchlässigkeit mit der Teufe.

The investigation of fault zone heterogeneities by fission track and apatite (U-Th)/He analysis: the Lavanttal fault (Eastern Alps).

Wölfler, A., Rabitsch, R. & Kurz, W.

Institute of Applied Geosciences, Graz University of Technology, Rechbauerstr. 12, A-8010 Graz, Austria; andreas.woelfler@tugraz.at, robert.rabitsch@tugraz.at, walter.kurz@tugraz.at

Quantitative assessment of heat generation and heat transfer along faults is of primary importance in understanding the dynamics and structural history of faulting, as well as in constraining the heat budget and thermotectonic evolution of orogenic processes. These effects are extremely localized and restricted to within a few centimeters to meters within a fault zone. For a case study we have chosen the Lavanttal fault situated in the eastern part of the Eastern Alps. This is a NNW- trending, dextral strike slip fault and part of the Pöls-Lavanttal fault system, separating the Middle Austroalpine basement complexes of the Koralpe and Saualpe. Indirect evidence for the time of activity of this fault is given by the development of pull-apart basins (Lavanttal basin, Obdach basin) formed at right-handed oversteps along the fault. The nature of the Lavanttal basin is probably an oblique graben structure formed in a transtensional regime. From this, the Lavanttal fault is assumed to be active since the Early Miocene with peaks in activity between 18-16 Ma and 14-12 Ma.
Zircon fission track ages range between 77.6±5.5 and 64.8±4.6 Ma and apatite fission track ages are between 51.1±2.3 and 37.7±4.3 Ma, both within host rock and the related fault rocks respectively. There is a trend of descending ages toward the fault rock, but mostly the ages do overlap within 1ó error. With respect to apatite single grain ages and particularly apatite (U-Th)/He ages we can demonstrate fault activity in Late Miocene and probably Early Pliocene times. The applied methods are state of the art and the obtained results underline the importance of using multiple low-temperature thermochronometers in elucidating details of the thermal history of fault rocks which have previously remained undetected. Furthermore we demonstrate quite precise thermal history models which record a late Miocene cooling event that is also documented in the sedimentation of the Western Styrian basin, and correlates with denudation pulses in the Alpine system.

Thermobarometry and experimental constraints of Permian contact metamorphism at the southern rim of the Brixen Granodiorite

Wyhlidal, S.[1], Thöny, W.F.[1], Tropper, P.[1] & Mair, V.[2]

[1]Institute of Mineralogy and Petrography, University of Innsbruck, Innrain 52, A-6020 Innsbruck; [2]Amt für Geologie und Baustoffprüfung, Eggentalerstrasse 48, I-39053 Kardaun (BZ), Italy; Stefan.Wyhlidal@uibk.ac.at, Werner.Thöny@uibk.ac.at, Peter.Tropper@uibk.ac.at, volkmar.mair@provincia.bz.it

The Permian Brixen Granodiorite is located in the area south of the SAM (Southern Limit of Alpine Metamorphism) near the Periatriatic Lineament in the NE part of the Southalpine basement and comprises a series of tonalitic, granitc and granodioritc intrusions which were emplaced during the Permian (280 Ma) into the country rocks of the Variscan Brixen Quarzphyllites. The depth of the intrusion was less than 10 kilometers (P d"0.3 GPa) and solidus temperatures were 670-720°C. Only a small, about 200-300 meters wide, contact aureole is still present in the south of the intrusion and yielded an increase in temperatures from 500°C to 610°C from the outer to the innermost contact area. The contact aureole of this investigation is located at the southern rim of the Brixen Granodiorite near the village Franzensfeste/Fortezza (S-Tyrol). Approaching the contact with the granodiorite, four different zones can be differenced within the contact aureole, based upon mineralogical and textural features. Approximately 200 m from the granite contact, the outer contact aureole (zone I) occurs. The rocks from this zone are characterized by two texturally and chemically different generations of micas and the appearance of cordierite. Zone II is characterized by cordierite-biotite pseudomorphs of garnet. The inner contact aureole (zone III) is characterized by the first occurrence of andalusite. In the innermost area (zone IV), ca 10 m from the granite contact, spinel and corundum occur.
The experimental study was done to compare the natural mineral assemblages of hornfelses at the southern rim of the Brixen granodiorite with mineral assemblages produced experimentally under the same *P-T* conditions. The experiments were preformed in a hydrothermal apparatus at 0.3 GPa and different temperatures (580°C, 650°C) using two natural quartzphyllite samples as starting materials. At a temperature of 650°C the amounts of H_2O present, was varied (without H_2O, H_2O = 1.8 µl and H_2O = 5 µl H_2O). Cordierite and biotite were observed in all run products and show the same X_{Mg} values when compared to those in the

natural hornfelses. At a temperature of 650°C (H_2O = 5µl) K-feldspar (X_{ab} = 0.16), plagioclase (X_{an} = 0.33) are part of the stable mineral assemblage in the run products and have also similar mineral compositions, compared to feldspars from the inner area of the contact aureole. Furthermore, alumosilicate and melt could also be observed in the 650°C experiments. In contrast, garnet is still present in all run products as a residual phase most likely due to kinetic reasons, and thus the garnet-breakdown reaction garnet + muscovite + quartz + H_2O = cordierite + biotite which can be observed in the hornfelses did not take place in the experiments. Overall, these experiments provide additional *T* constraints on the Permian contact metamorphic event in the Southalpine domain.

Multi-equilibrium Variscan thermombarometry and age costraints on the pre-variscan evolution of the Southalpin basement (Brixen Quartzphyllite)

Wyhlidal, S.[1], Thöny, W.F.[1], Tropper, P.[1], Klötzli, U.[2] & Mair, V.[3]

[1]Institute of Mineralogy and Petrography, University of Innsbruck, Innrain 52, A-6020 Innsbruck; [2]Department of Lithospheric Research, University of Vienna, Althanstrasse 14, A-1090 Wien; [3]Amt für Geologie und Baustoffprüfung, Eggentalerstrasse 48, I-39053 Kardaun (BZ), Italy;
Stefan.Wyhlidal@uibk.ac.at, Werner.Thöny@uibk.ac.at, Peter.Tropper@uibk.ac.at, Urs.Kloetzli@univie.ac.at, volkmar.mair@provincia.bz.it

The Southalpine basement is composed of monotonous quartzphyllites and occurs in the south of the SAM (Southern Limit of the Alpine Metamorphism) zone and hence was only affected by Carboniferous Variscan metamorphism ca. 330 Ma ago. Peak metamorphic conditions were determined in samples from the Brixen area and yielded T of 450-550°C and P of 0.5-0.65 GPa (Ring & Richter 1994).

In the course of a FWF project concerning the Permian contact metamorphic event in the northernmost Southalpine basement, quartzphyllite country rocks, showing only evidence for a single Variscan metamorphic overprint, were sampled near the small villages of Waidbruck and Spiluck near Brixen (S-Tyrol). These samples contain the mineral assemblage muscovite + chlorite + albite + biotite + garnet + quartz ± K-feldspar. Calculated Variscan equilibrium P-T conditions with the program THERMOCALC v. 3.23 (R. Powell, written comm.) yielded a range of 0.53-0.59 GPa and 521-551°C. Calculations of pseudosections with the software THERAIK–DOMINO (de Capitani 1994) using the thermodynamic database and solution models of Holland & Powell (2002, written comm.) yields similar P-T conditions for the assemblage muscovite + chlorite + plagioclase + biotite + garnet + quartz + ilmenite ± K-feldspar and slightly lower conditions for the assemblage muscovite + chlorite + garnet + quartz + ilmenite ± K-feldspar.

Laser ablation ICP-MS U-Pb zircon geochronology on single grains yielded three different Precambrian concordia ages. The youngest age group yielded a concordant U-Pb age of 640 ± 17 Ma and represents most likely evidence for the Cadomian (Pan-African) orogeny and can be interoperated as maximum sedimentations ages. The second group yielded ages of 835 ± 32 Ma and the oldest group yielded an age of 2023 ± 31 Ma. These ages may be interpreted as a possible affinity of the Southalpine basement to Godwana tectonic elements (Neubauer 2002). These results are in well agreement with ages of detrital zircons of the late Ordovician Uggwa Formation of the Carnic Alps reported by Neubauer (2002).

In contrast to quartzphyllite complexes of the Eastern Alps astonishingly neither Cambrian/Ordovician (570-450 Ma) nor Carboniferous (360-340 Ma) age groups on single zircons could be observed.

De Capitani, D. (1994): Gleichgewicht-Phasendiagramme: Theorie und Software. - Beiheft zum European Journal of Mineralogy, 72 Jahrestagung der Mineralogischen Gesellschaft, 6, 48.

Neubauer, F. (2002): Evolution of late Neoproterozoic to early Paleozpic tectonic elements in Central and Southeast European Alpine mountain belts: review and synthesis. - Tectonophysics, **352**: 87-103.

Ring, U. & Richter, C. (1994): The Variscan structural and metamorphic evolution of the eastern Southalpine basement. - Journal of the Geological Society, London, **151**: 755-766.

Neotectonic control on landscape evolution in the Little Hungarian Plain

Zámolyi, A.[1, 2], Székely, B.[3, 1], Draganits, E.[4] & Timár, G.[1]

[1]Space Research Group, Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, ELTE, Budapest, Hungary; [2]Department of Geodynamics and Sedimentology, University of Vienna, Austria; [3]Christian Doppler Laboratory for Spatial Data from Laser Scanning and Remote Sensing, Institute of Photogrammetry and Remote Sensing, Vienna University of Technology, Austria; [4]Institute for Engineering Geology, Vienna University of Technology, Austria;
andras@zamolyi.info

The deep structure of the Little Hungarian Plain (LHP) and adjacent areas is dominated by tectonic processes related to the lateral extrusion of the Eastern Alps and the acceleration of northward movement of the Carpathians. Subsidence in the Little Hungarian Plain in the Lower Miocene is mainly accommodated along major high-angle normal faults without significant pull-apart component. The reactivation of these Neogene structures contributes to a major part to the pattern of active faulting within the region. Joó (1998) measured recent vertical crustal movements with values up to -2.2 mm/a in the northern and with -0.6 mm/a in the southern part of the LHP interpeting this as an evidence for faulting. Based on structural field data, the recent stress field is found to be influenced by strike-slip faulting linked to normal and thrust faults. Our investigations focus on the control of active faulting on the geomorphology and drainage system in this very low-relief area. The study area is located in the westernmost part of the Little Hungarian Plain and belongs to the catchment of the Danube River. The channel pattern of the Leitha, Répce, Rábca, Ikva and Wulka rivers were analysed in order to detect a possible relation between channel geometry and on-going tectonic activity. Exactly georeferenced historical maps of the Second Military Survey of the Habsburg Empire that record the channel patterns and geomorphologic situation around 1840 were used for channel geometry extraction. This provided the basis for the calculation of river sinuosity values using several window sizes. Calculated river sinuosity values show surprisingly strong local variations, considering the low relief and lithologic homogeneity of the area. The spatial distribution of the pronounced sinuosity variations coincides with the location of Late Miocene faults, well-known from seismic sections. Ongoing active tectonic activity at these faults is further indicated by the local earthquake record and geomorphic features. The surface expression of these Late Miocene faults cannot be derived from industrial seismic surveys, since approximately the upper 300 m are generally muted. However, high-resolution digital elevation models (e.g. ALS DTM data) allow detection of micro-topographic changes at the surface that are probably related to neotectonic features. Combined analysis of river sinuosity values and data derived from high-resolution digital elevation models improve the mapping of the faults at the surface.