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While Oxygene Isotope Stage (OIS) 2 and Holocene palaeoclimate and palaeoenvironments are relatively well documented in the Eastern Alps, little is known about the MIS 3 („Middle-Würmian") in this region. A tunnel prospection campaign carried out by the Brenner Eisenbahn GmbH (Projekt Unterinntaltrasse) in the Lower Inn Valley of Tyrol (Austria) yielded a large number of drill cores. They offer the unique opportunity to study sediments of the OIS 2 and older. Our project focuses on the investigation of four long cores from the river terrace at Unterangerberg near Wörgl.
The drill cores reveal that the Unterangerberg terrace consists of long sequences of clay/silt, intercalated with sand, gravel, diamictic beds, and peat layers. The fine-grained sediments partly contain organic material and striated drop stones, pointing to a lacustrine or glacio-lacustrine environment. This three-dimensional information offers the possibility to establish a facies model of the terrace and to spatially reconstruct the lake genesis and its sedimentary filling.
Chronological information was obtained from radiocarbon (charcoal and other plant macro remains) and luminescence (fine grain polymineral samples) samples collected in the lake sediments. The radiocarbon results show that the sedimentation of a large portion of the cores is older than ~55 ka. For the younger samples, the recently published IntCal09 calibration curve makes it possible to calculate calibrated 14C ages.
Initial luminescence tests show that the quartz signal in these samples is very weak and close to saturation. Therefore, feldspar was chosen for further analyses and the 4-11 µm polymineral sediment fraction was analysed using a modified SAR protocol. Preheat tests and dose recovery tests of seven samples analysed so far were positive. OSL and radiocarbon data indicate that the lacustrine sediments from the Unterangerberg river terrace were deposited during the last glacial period, i.e. during MIS 3, possibly reaching back to MIS 5. Further investigation will focus on quantified sedimentological analyses, pollen and macro-remain analyses, along with further dating, to identify regional sedimentation patterns and potential palaeoclimatic signals.

Unravelling the polymetamorphic (Variscan vs. Permian) history of the Michelbach Complex (Deferegger Alps, East Tyrol) by using REE-phosphates (monazite, xenotime)

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Monazite is common in metapelitic rocks in a wide range of *P-T* conditions from the greenschist-facies on (Spear & Pyle 2002). The chemical distribution of elements in REE phosphates like monazite ($CePO_4$) and xenotime (YPO_4) therefore provides useful information about the metamorphic evolution of rocks. For instance, chemical zoning in monazite allows it to distinguish between different episodes of growth phases. Between coexisting monazite and xenotime there is a temperature-dependent exchange of LREE and (HREE, Y) and the miscibility gap between the REE + Y exchange allows determining geothermometric conditions (Heinrich et al. 1997, Gratz & Heinrich 1997).
An extremely powerful application of monazites is the possibility of geochronological investigations by using U-Th-Pb electron microprobe dating (Montel et al. 1996). Therefore, it is possible to link the obtained mineral chemical and geothermometric data to age constraints.
In the metapelites of the Michelbach Complex monazite frequently occurs as accessory mineral. Coexisting xenotime was only found in the sillimanite-zone of the Michelbach Complex. In all analyzed monazites two different substitutions occur: all monazites show the exchange
$(U, Th)^{4+} + Ca^{2+} <--> 2REE^{3+}$ (brabantite vector)
in the cores and in the rims. The exchange
$(U + Th)^{4+} + Si^{4+} <--> REE^{3+} + P^{5+}$ (huttonite vector)
is present in the sillimanite -zone only in the cores.
In contrast to monazites from the andalusite-zone monazites from the sillimanite-zone show considerable zoning with respect to their major elements and REE, like Ca, Si, Ce, P, Sm and Th. Correlating these zoned areas with geochronological data shows that the zones can either be related to the Variscan event with an age around 330±50 Ma or to the Permian HT overprint with an age of 240±50 Ma.
The occurrence of two different ages in only one mineral grain is thought to be the consequence of resetting the U-Th-Pb system of certain micro-domains due to the infiltration of fluids at high temperatures (Parrish 1990). Monazites from the andalusite-zone only show single ages because no chemical zoning occurs. Although most ages are around 320±50 Ma, which can be related to the Variscan event a few monazites also yielded Permian ages of 250±50 Ma.
Geothermometric calculations using coexisting monazite and xenotime yielded temperatures of 600 to 650 °C for the metapelites of the sillimanite-zone. In the andalusite-zone unfortunately no coexisting monazite-xenotime pairs were found.
This study shows that linking textural, chemical, petrological and geochronological data allows the reconstruction of polymetamorphic histories of rocks.

Gratz, R. & Heinrich, W. (1997): Monazite-xenotime thermobarometry: Experimental calibration of the miscibility gap in the binary system CePO4-YPO4. - Am. Mineral., **82**: 772-780.
Heinrich, W., Andrehs, G. & Franz, G. (1997): Monazite-xenotime miscibility gap thermometry: I. An empirical calibration. - J. Metamorphic Geol., **15**: 3-16.
Montel, J.M., Foret, S., Veschambre, M., Nicolett, C. & Provost, A. (1996): Electron microprobe dating of monazite. - Chem. Geol., **131**: 37-53, Amsterdam.
Parrish, R.R. (1990): U-Pb dating of monazite and its application to geological problems. - Can. J. Earth Sci., **27**: 1431-1450,

Ottawa, Ontario.
Spear, F.S. & Pyle, J.M. (2002): Apatite, Monazite and Xenotime in Metamorphic Rocks. - (In: Kohn, M.J., Rakovan, J., & Hughes, J.M. (Eds.): Phosphates: geochemical, geobiological and materials importance, Reviews in Mineralogy & Geochemistry), Mineral. Soc. Amer., **48**: 293-335.

Petrology of the polymetamorphic metapelites from the Michelbach Complex (Defereggen Complex, East Tyrol)

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The Austroalpine crystalline basement south of the Tauern Window is characterized by a polyphase metamorphic evolution. The dominant Variscan metamorphic imprint between 390 and 300 Ma was followed by a Permian HT/LP overprint at 270±30 Ma (Schuster et al. 2001).
In order to distinguish between these events petrographical, mineral chemical and geochronological studies were carried out on the metapelites of the Michelbach Complex. This basement unit is located in the Defereggen Alps to the south of the Defereggen-Antholz-Vals Line.
The Michelbach Complex reached, similar to areas like the pre-Alpine Strieden Unit in the Kreuzeck Mountains (Hoke 1990), sillimanite- and andalusite-grade conditions during the Permian metamorphism. Petrographic investigations revealed that it can be subdivided into two zones: the andalusite-zone in the north-western part of the area of investigation and the sillimanite-zone in the south-east.
The mineral assemblage of the andalusite-zone is characterized by garnet + biotite + muscovite + plagioclase + staurolite + andalusite + quartz. In the sillimanite-zone a similar mineral assemblage occurs but with decreasing contents of staurolite and the occurrence of fibrolitic sillimanite instead of andalusite. Further differentiations of the two zones are reflected in the mineral chemical compositions of the coexisting minerals.
Staurolite and Garnet show two generations of crystal growth: old porphyroblastic and younger, smaller idiomorphic grains. The old garnets show continuous as well as discontinuous growth zonations. The garnet cores (garnet-I) are thought to have grown during the Variscan event and the garnet rims (garnet-II) are thought to represent the subsequent Permian HT/LP overprint. The formation of garnet-II occurs contemporaneous with the breakdown of staurolite according to the reaction staurolite + muscovite <--> garnet + fibrolite + biotite. The breakdown of garnet-I most likely occurs according to the reaction garnet + muscovite <--> kyanite/sillimanite + biotite + quartz, which might have been taken place during the Variscan retrograde, decompressional stage. Therefore, at first kyanite (Variscan?) grew and later on fibrolitic sillimanite (Permian).
Similar interpretations concerning the different stages of mineral growth can be done using other minerals such as monazite or plagioclase, which also show considerable chemical zoning.
Electron microprobe dating of monazite yielded Variscan ages in the sillimanite- and the andalusite-zone of 330±50 Ma and Permian ages of 240±50 Ma. The latter are supported by a garnet crystallisation age from a pegmatite located within the sillimanite-zone which was determined by the Sm-Nd method and yielded 253±7 Ma. Ar-Ar and Rb-Sr data of muscovites from the sillimanite-zone range from 190 to 206 Ma. These young ages are interpreted as cooling ages associated with the Permian event (Schuster et al. 2001).
P-T calculations yielded comparable results. The conditions for the metapelites of the andalusite-zone are close to the *P-T* conditions of the alumosilicate triple point according to Pattison (1992) with 450-550 °C and 0.35-0.50 GPa. Samples of the sillimanite-zone yielded slightly higher *P-T* conditions of 590-650°C and 0.51±0.08 GPa.

Schuster, R., Scharbert, S. Abart, R. & Frank, W. (2001): Permo-Triassic extension and related HT/LP metamorphism in the Austroalpine - Southalpine realm. - Mitt. Ges. Geol. Bergbaustud. Österr., **45**: 111-141.
Hoke, L. (1990): The Altkristallin of the Kreuzeck Mountains, SE Tauern Window, Eastern Alps - Basement Crust in a Convergent Plate Boundary Zone. - Jb. Geol. B.-A., **133**, 5-87.
Pattison, D.R.M. (1992): Stability of Andalusite and Sillimanite and the Al2SiO5 Triple Point: Constraints from the Ballachulish Aureole, Scotland. - Journal of Geology, **100**, 423-446.

Sedimentologische Untersuchung der Bohrung Wattens (Tirol)

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Die übertieften Täler der Alpen, insbesondere deren Bildung und Sedimentinhalt, stehen schon lange im Fokus der Quartärforschung. Generell besteht ein Grundkonsens, dass subglaziale Prozesse maßgeblich für die Übertiefung von schon prä-existenten fluviatil angelegten Tälern sind. Da die großen Alpinen Täler wichtigen strike-slip-faults folgen (z. B. Inn-, Enns-, Salzach-, Gail- und Drautal), die im Miozän aktiv waren und partiell gegenwärtig noch als aktiv angesehen werden, ist ein Beitrag von endogenen Prozessen an der Übertiefung d. h. durch Subsidenz in pull-apart Becken, durchaus möglich. Der Schlüssel zur Lösung dieser wichtigen Frage zur Morphogenese der Ostalpen liegt in der detaillierten Analyse der jeweiligen Sedimentfüllungen.
Für das Inntal ist die Bohrung Wattens (östlich von Innsbruck) die Schlüsselstelle zum Verständnis der Talübertiefung. Diese Spülbohrung wurde im Rahmen einer wasserwirtschaftlichen Untersuchung im Jahr 1989 abgeteuft um den geologischen Aufbau und nutzbare tieferliegende Aquifere im Inntal zu erkunden (Weber et. al.