temperature (L-T) deformation structures in the DCS metamorphic core complex. Exhumation of the high-grade metamorphic rocks from deep to shallow crustal levels is evident by the temporal transition from shearing and amphibolite facies-grade mylonitization in the lower to middle crust, through retrograde ductile-semi-brittle faulting within greenschist facies in the middle crust and brittle faulting near the surface. The thermochronologic studies have shown at least three stages of exhumation and cooling from Late Oligocene to Pliocene, e.g., 28-13 Ma, 13-4 Ma and 4-0 Ma, respectively. New results in the sheared granitic rocks and schists have shown high- and low-temperature fabrics as well as superimposed fabrics. Quartz and calcite microstructures and c-axis lattice-preferred orientations (LPOs) suggest that crystal-plastic slip and dynamic recrystallization are the dominant deformation mechanisms. The strong Y-maxima or single girdle LPOs of quartz from the mylonites and ultra-mylonites formed due to high ductile shear strains under amphibolite facies conditions deep within the crust, the development of these strong LPOs representing prism on and rhomb slip. During exhumation, basal slip was likely to become the more favored system, but the inherited strong H-T fabrics mean that prism slip likely continued in these strongly deformed rocks with a strong LPO. LPOs of calcite show a monoclinic symmetry in the marble consistent with the observed grain fabric symmetry and related to a simple shear strain path during the late-stage normal faulting.

These fabrics resulted from pure and simple shearing deformation under different deformational conditions. The c-axis LPO patterns of quartz and calcite from the mylonitic rocks are consistent with the meso-structure and microstructural observations of an early stage of H-T pure shearing, a late stage of simple shearing and their superimposition. A general shearing with more pure than simple shearing components has dominated high-grade deformation in the deep to middle crustal level. The above structural, thermochronological, microstructural and microfabric associations were generated in the tectonic framework of the Indian-Eurasian collision. The final low-grade metamorphic exhumation stage for the highly sheared rocks is attributed to the rotation-related east-west extension possibly related to clockwise block rotation of southeastern Tibet.

Constraints on progressive deformation from structural, microstructural and microfabric analysis of metamorphic rocks from the Rechnitz metamorphic core complex, Eastern Alps

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The Penninic windows are exposed along the central axis of the Eastern Alps, which comprise huge masses of Mesozoic metasediments and locally some ophiolites. The Rechnitz metamorphic core complex (RMCC) is nearly fully located within contemporaneous sediments of the Pannonian basin at the transition zone between Eastern Alps and the Pannonian basin. Two tectonic units with a ductile thrust fault in between can be distinguished within the RMCC: (1) a lower unit mainly composed of Mesozoic metasediments, and (2) an upper unit with mainly ophiolite remnants. Both units are metamorphosed within greenschist facies conditions during earliest Miocene followed by exhumation and cooling. The internal structure of the RMCC is characterized by the following succession of structure-forming events: (1) blueschist relics formed due to subduction (D1), (2) ductile nappe stacking (D2) of an ophiolite nappe over a distant passive margin succession (ca. E-W to WNW-ESE oriented stretching lineation), (3) greenschist facies-grade metamorphic annealing dominant in the lower unit, and (4) ductile low-angle normal faulting (D3) (with mainly NE-SW oriented stretching lineation), and (5) ca. E to NE-vergent folding (D4).

Microfabrics and microstructures are related to mostly ductile nappe stacking respectively to ductile low-angle normal faulting and late-stage micro-folds are observed. These mylonitic metamorphic rocks, wherein major foliations, kinematic indicators (D2 or D3). The various criteria consistently indicate bulk dextral shearing related along at the southern S-dipping boundary of the lower to upper units. These progressive development of microstructures broadly indicate deformation under greenschist facies conditions (D3). Microfabrics analyses of quartz and calcite are demonstrated by c-axis lattice preferred orientation patterns (LPOs) by Electron Backscatter Diffraction (EBSD) analyses. These LPO patterns mostly result from pure and simple shear deformation under different deformation conditions. Structural, microstructural and textural analysis of quartz suggest that medium-temperature shearing (D2) is overprinted by low-temperature deformation (D3 and/or D4). Despite moderate shearing of calcites as indicated by the microstructures, strong LPOs were developed during deformation. The LPOs obtained most show an orthorhombic symmetry with respect to the shear plane, which resulted in dominant pure shear in the interior of ductile low-angle normal faulting and monoclinic symmetry with a

simple shear path along uppermost margins (D3 and D4). Microfabrics and LPO patterns in calcite are sensitive to final stages of deformation, therefore, the LPO patterns of calcite documents the kinematic character of faulting during late-stage exhumation rather than previous ductile nappe stacking. The D3 deformation event in the RMCC complex is responsible for the development of the lowest temperature microstructures and microfabrics or overprinted microfabrics, and these structures and microfabrics may be associated with the late stages of exhumation. It seems probable that the RMCC has undergone a component of late coaxial and non-coaxial deformation during the exhumation, which led to subvertical thinning in an extensional deformation regime.

TOPO-EUROPE: An integrated solid earth approach to Continental Topography and Deep Earth – Surface Processes in 4D

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Topography influences various aspects of society, not only in terms of the slow process of landscape evolution but also through climate (e.g. mountain building). Topographic evolution (changes in land, water and sea level) can seriously affect human life, as well as terrestrial geo-ecosystems. To quantify topography evolution in space and time, understanding of the coupled deep Earth and surface processes is a requisite. The TOPO-EUROPE initiative of the International Lithophere Program (ILP) addresses the 4-D topography of the orogens and intra-plate regions of Europe through a multidisciplinary approach. TOPO-EUROPE initiates a number of novel studies on the quantification of rates of vertical motions, related tectonically controlled river evolution and land subsidence in carefully selected natural laboratories in Europe. From orogen through platform to continental margin, these natural laboratories include the Alps/Carpathians-Pannonian Basin System, the West and Central European Platform, the Apennines-Tyrrhenian-Maghrebian and the Aegean-Anatolian regions, the Iberian Peninsula and the Scandinavian Continental Margin. TOPO-EUROPE integrates European research facilities (e.g. EPOS) and know-how essential to advance the understanding of the role of topography in Earth System Dynamics. The principal objective of the network is twofold. Namely, to integrate national research programs into a common European network and, furthermore, to integrate activities among TOPO-EUROPE institutes and participants. Key objectives are to provide an interdisciplinary forum to share knowledge and information in the field of the neotectonic and topographic evolution of Europe, to promote and encourage multidisciplinary research on a truly European scale, to increase mobility of scientists and to train young scientists.

Modellierung von geothermischen Doubletten und einfacher Nutzungsszenarien - Variantenstudie und Sensitivitätsanalyse mit Hilfe der numerischen Simulation (Programmpaket FEFLOW)

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Die Nachhaltigkeit der Nutzung geothermischer Energie hängt sehr wesentlich mit den geologisch-hydrogeologisch-geothermischen Eigenschaften des Untergrundes und mit der Betriebsweise der Nutzungen zusammen. Ein wesentliches Werkzeug zur Analyse der möglichen thermischen und/oder hydraulischen Auswirkungen auf den Untergrund stellt die numerische Modellierung der thermischen Prozesse dar.
Um die prinzipiellen Systemabhängigkeiten und Parametereinflüsse zu erkennen erfolgten Variantenstudien mit dem Programmpaket FEFLOW. Mit Hilfe dieser szenarienhaften Simulationen ist eine Abschätzung der Einflüsse der verschiedenen Eingabeparameter und Randbedingungen in Sinne einer Sensitivitätsanalyse möglich.
Die Ergebnisse dieser Variantenstudien sind eine wichtige Basis für die Simulation von bestehenden bzw. geplanten geothermischen Nutzungen.