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The knowledge of the exact position and extent of various topographic features has increasing importance in geosciences. This is especially true if the features are or can be related to possible natural hazards like landslides, snow or rock avalanches, torrential precipitation discharge, etc. The dynamic character of some surface processes demands high accuracy DTMs (digital terrain models) for the detection and possibly for forecasting events of the aforementioned phenomena.

A very effective and straightforward way of topographic data acquisition is Airborne Laser Scanning (ALS, also known as LiDAR). High precision DTMs , derived from LiDAR data via sophisticated processing, has typically 1 m horizontal resolution or higher, while the vertical accuracy is on the order of ±10 cm depending on the LiDAR point density and the terrain slope. The determination of ground surface is possible even for forested or densely vegetated areas. This is an important benefit of LiDAR compared to other DTM generation techniques. The resulting vast amount of high-resolution digital elevation data makes it possible to outline microtopographic features that are often related to active tectonics, to recognize precursors of future mass movements or areas with increased erosion.

Our contribution deals with case studies from areas of the Austrian federal states of Burgenland and Vorarlberg. Neotectonic features are detected in the Seewinkel, an extremely flat area that also host playa lakes, and in the Leitha Mts., that has a unique tectonic position at the boundary of the Eastern Alps and the Pannonian basin. The latter tectonic boundary is neotectonically active and the movements can also be traced in microtopographic features. Further examples are shown from Vorarlberg, both from a high-relief area of Montafon, near to the Silvretta block and a medium relief area where active fluvial incision is combined with tectonic activity, causing major landslides (locality Doren). In both cases the microtopography provides evidence for active geomorphic processes. In the case of Doren multitemporal LiDAR data are available that show the post-event evolution of the landslide mass and the reaction of the fluvial system on the creeping material.

The analysis of LiDAR DTMs together with the necessary field observations and on-the-spot verification of the results provide comprehensive knowledge on microtopography and often lead to conclusions that may contribute to deeper understanding concerning natural hazard issues, like slope stability and tectonic activity.

Tectonic geomorphic microstructures in an Airborne Laser Scanning DTM in the Seewinkel Area, Little Hungarian Plain

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Our study area, the NW corner of the Little Hungarian Plain, at the junction of the Eastern Alps, the Pannonian Basin and the Western Carpathians, is a neotectonically active region forming the transition zone between the Eastern Alps and the partly subsiding Little Hungarian Plain. The on-going deformation is verified by the earthquake activity in the region. A part of the area, east of Lake Neusiedl, the so-called Seewinkel, has been measured by ALS technique, resulting in a DTM with 1 m horizontal resolution and vertical accuracy better than 10 cm. This area is an extremely flat vineyard region dominated by alluvial gravel deposits of uncertain age (Riss/Würmian?). The lack of significant outcrops renders structural geologic mapping of the area difficult.

Potential neotectonic structures of the DTM have been evaluated together with geological maps, regional tectono-geomorphic studies, geophysical data, earthquake foci, as well as geomorphic features and Quaternary sediment thickness values of the juxtaposed Parndorf plateau. The combined evaluation of these data supports the recognition of several tectonic features in the DTM that have a relief less than 2 m and therefore would not be visible in other datasets. The length of these linear geomorphic structures ranges from several hundred meters up to several kilometers. The most prominent of them forms a linear, elongated, 15 km long, 2 m high NE-SW trending ridge with gravel occurrences of average grain size of up to 5 cm on its top. We conclude that this feature is linked on a regional scale to the Mönchhof fault, which previously has been recognized in seismic sections only.This multi-disciplinary case study shows that ALS DTMs are extremely important for tectono-geomorphic investigations, they are even essential for the accurate location of neotectonic structures, especially in low-relief areas.

Influence of the Bohemian Spur on the evolution of the Eastern Alps

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The Bohemian Massif projects below the Eastern Alps and the Vienna Basin as a basement promontory often referred to as the Bohemian Spur. This salient defines a large concave to the SE segment of the European margin which is interpreted as a lower-plate margin of the Magura Basin. Based on academic and industry reflection seismic data in the NW Pannonian Basin, the Bohemian Spur can be traced much further to the SE than previously thought. In the easternmost Eastern Alps, in the area of the South Burgenland Swell, the European crystalline basement has not been penetrated by exploration wells. However, the Penninic outcrops of the Rechnitz Window group, interpreted as a metamorphic core complex, clearly indicate the presence of the Bohemian Spur underneath. The top Penninic surface was mapped in the subsurface on a sub-regional scale by seismic data and it can be used as a proxy for the extent of the underlying Bohemian Spur.

As the southwestern edge of the Bohemian Spur was controlled by a transform fault, this suggests that the Spur itself developed as a marginal ridge, very similarly to well-known examples of the equatorial Atlantic region. Thus, the extension of the Bohemian Spur to the SE as a pelagic swell with a conceptually predictable Jurassic facies succession, is interpreted to be the Czorsztyn

Ridge of Carpathian geology separating the Magura and the Pieniny (Meliata) oceanic basins. The above findings and interpretations have important impact on the Mesozoic paleogeography and subsequent tectonic evolution of the Eastern Alps.

Remnants of Moldanubian HP-HT granulites in the eastern part of the Bavarian Forest (south-western Bohemian Massif)

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The Bavarian Forest in the SW Bohemian Massif is characterised by penetrative late-Variscan LP-HT regional metamorphism to anatexis and voluminous granite plutonism. Due to this late-Variscan tectonothermal reactivation between 330 and 315 Ma („Bavarian phase" of the Variscan orogeny sensu FINGER et al. 2007), it is difficult to establish correlations between the Bavarian Forest and the major Moldanubian units further N and E (Gföhl unit, Variegated unit, Ostrong unit), which were not affected by the Bavarian tectonothermal phase.
Distinct felsic rocks in the eastern part of the Bavarian Forest that strongly resemble the ca. 340 Ma old Moldanubian HP-HT granulites of the Gföhl unit, provide an important clue for correlations. These rocks crop out in the Aubach valley near the Kropfmühl graphite deposit, NE of Passau. They consist mainly of quartz, K-feldspar (partly strongly perthitic) and plagioclase. Small pink garnet (up to 5 mm) is a minor (3-5 %) but ubiquitous constituent. It carries distinct inclusions (exsolutions) of tiny rutile needles that indicate a HP-HT history. In some samples relics of kyanite can be found, variably replaced by green spinel, sillimanite and muscovite. The late-Variscan LP-HT metamorphic overprint during the Bavarian phase caused resorption of the garnet coupled with the formation of plagioclase and spinel. Geochemical data indicate a felsic granitic protolith. Major and trace element contents show strong similarities to the typical leucogranitic granulites of the Gföhl unit (JANOUSEK et al. 2004).
To examine the relationship with the granulites of the Gföhl unit, we have studied zircons by means of the electron microprobe, and dated individual growth zones using the SHRIMP method. Elongated to kidney-shaped zircon with rounded surfaces and tips, as well as compact, multi-faceted crystals are common. Most zircons show a typical zonation in the CL image with an inner, oscillatory zoned domain interpreted to represent zircon from the granitic protolith, and a high-CL rim zone, interpreted as metamorphic overgrowth. While the inner zone is characterised by significant P and Y contents (0.1-1 wt.%) and moderate to high U contents (200-1100 ppm U), indicating growth in a fractionated granite magma, the high-CL rim zone is always low in U, P and Y. Partial recrystallisation of the inner zone is indicated by local fading of the oscillatory zoning and the presence of transgressive or concordant recrystallisation patches in CL images. SHRIMP analyses in rim zones cluster around 340 Ma, and thus yield the well established age of granulite facies metamorphism in the Gföhl unit. Core analyses are variably affected by recrystallisation but, in general, point to an Ordovician or Silurian formation age of the granitic protolith.
All lines of evidence thus strongly suggest that the felsic granulites from Aubach are analogues to the Moldanubian HP-HT granulites as exposed e.g. in the Cesky Krumlov area.

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Monazite geochronology from the Permian contact aureole of the Brixen granodiorite

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Within the Brixen granodiorite and the surrounding Southalpine quartzphyllite basement, monazite is ubiquitous and thus provides an excellent opportunity to obtain age data about the Permian contact metamorphic event. In the course of this study, samples were taken along a profile from the granodioritic intrusion into the contact metamorphic quartzphyllites from the adjacent Southalpine basement. Five samples, showing characteristic mineralogical and mineral chemical evidence for an increasing thermal overprint, were investigated. Additional to the monazite dating done at the Universities of Salzburg and Innsbruck, monazites and zircons from some of the samples were measured at the University of Vienna using the laser-ICP-MS.
Most of the monazites were dated using the electron microprobe. The limitations of this method lie in the whole rock chemistry and the uplift rate of the rocks. The lack of allanite for example may implicate a low Ca content of the whole rock and/or a rather fast post-Permian uplift rate of this area.
Two different generations of monazites were analysed with the electron microprobe in the hornfels samples from the contact aureole. An older generation of monazites shows average ages of 336.8 ± 16.8 Ma (48 data points) and low yttrium contents of about 1.0 wt.% Y_2O_3. These monazites seem to have formed contemporaneously with the Variscan garnets in the quartzphyllites. The second monazite generation shows consistently high contents of yttrium of about 2.6 wt.% Y_2O_3 and thus yield Permian ages of 267.5 ± 18.5 Ma (36 data points) corresponding to the age of the contact metamorphic event. The high yttrium contents can be related to the breakdown of garnet caused by the contact metamorphic overprint, which leads to a substantial modal increase of monazite/xenotime approaching the contact. The high Y-contents also indicate temperatures of 630-650°C, which agrees well with *T* data from the inner contact aureole. These monazite ages also correspond well with the U-Pb data obtained with the laser-ICP-MS on monazites, which yielded ages of 296 ± 31 and 331 ± 22 Ma.
The contact aureole of the Brixen granodiorite represents a petrologically well defined contact zone where four different zones regarding to the intensity of the thermal overprint can be distinguished. The fact that two generations of monazite occur throughout the entire contact aureole implies a wide temperature range of monazite stability from 500°C on.