U-Pb and Sm-Nd geochronology of the Permian intrusives in South Tyrol

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Permian intrusives cover an area of about 200km^2 in the northern realm of the Southalpine domain. The investigated intrusions namely the Brixen granodiorite, the Ifinger granite and the Kreuzberg granite are all aligned along the Periadriatic Lineament. Robust geochronology (U-Pb, Sm-Nd) provides the opportunity for a better understanding of geodynamic evolution of the Southalpine domain. The Brixen granodiorite was sampled intensively since a wide spread different rock types occurs. The southern rim of the intrusion mainly consists of gabbroic-dioritic rocks which could not be dated because of the lack of zircons, although this area of the intrusion is thought to be the oldest part. The major part of the magmatic body consists of rocks of granitic-granodioritic composition with the assemblage of K-feldspar + plagioclase + biotite + quartz + accessories (zircon, apatite, ilmenite, ± monazite) and therefore is extremely suitable for age determination. The NW rim consists of granitic rocks and pegmatites, which seem to represent the latest stage of the magmatic activity. In this area several unusual types of intrusions namely a garnet + fayalite-bearing granite and a two mica - andalusite - cordierite granite were found. The granite was dated using Sm/Nd garnet - whole rock geochronology. From the pegmatites, monazites were measured using the laser-ICP-MS at the University of Vienna which yielded concordant ages of 296 ± 38 Ma, due to late-stage alteration of monazite. The Ifinger and the Kreuzberg granodiorite ages were obtained using zircons. For the Kreuzberg intrusion, zircons from a drilling core taken near Sinich (Meran) were used. Zircon ages from the different intrusions show ages from 294 ± 11 Ma (Kreuzberg, 15 data points) to 279 ± 7 Ma for the Brixen granodiorite. Latter data is supported by the Sm/Nd data which yielded ages of 280 ± 3 Ma. Laser-ICP-MS measurements at the University of Graz also revealed that the garnet and the whole rock are extremely enriched in Nd (sample A: wr = 27.5 ppm, grt = 16.5 ppm; sample SK2: wr = 9.5 ppm, grt = 5.85 ppm). Interestingly, garnets from sample SK2 also show very high amounts of Li in the range of 470 – 640 ppm! The data we obtained correspond very well with literature data. Rottura et al. (1997) obtained Rb/Sr biotite, K/Ar biotite and Th/Pb allanite ages in the range of 273 ± 3 Ma for several intrusions, including Brixen, the Ifinger and the Kreuzberg granitoids. Del Moro & Visona (1982) give intrusion ages for the area of Brixen ~ 280 Ma which are also in excellent agreement with our data. The fact that the three investigated intrusions (Kreuzberg, Ifinger and Brixen) show an age range of 294-279 Ma implies a complex geodynamic model which will be elaborated in the near future.

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Rottura et al. (1997): Lithos, **45** (1998): 329-348.

Differential along- strike retreat of the lower plate: a possible explanation of large scale vertical axis rotations of the upper plate-examples from the Carpathians and the Eastern Alps

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Results from recent paleomagnetic studies indicate major, joined vertical axis rotations of Eastern, Central and Southern Alps in Oligocene (32-28Ma, 25-23Ma) and in Late Miocene to Pliocene times (5-3Ma). Two possible models for repeated large scale vertical axis rotations related to orogeny are presented.

Model A:
During oceanic subduction the downgoing plate is subject to the slab-pull force resulting from the negative buoyancy of the cooler, denser oceanic lithosphere of the sinking slab. In case the slab-pull force is laterally changing due to differing amounts of oceanic crust, roll back rates of the lower plate should also differ laterally along strike of the subduction zone. It is speculated that the overlying plate rotates during subduction, filling the space that was opened by the retreating lower plate.
Such a model can be used to explain large rotations in the Carpatho-Pannonian region and was also proposed for explanation of vertical axis rotations in the Apennines.

Model B:
At the stage of continent-continent collision no oceanic crust is available for subduction. Thick to thin skinned thrusting that affects the upper plate units and the lower plate derived units of the foreland basins, is possibly compensated by thickening of the mantle lithosphere of the downgoing continental slab. As the mantle lithosphere is even denser than the deeper situated upper mantle, slab retreat may support thrusting by diminishing friction values at the basal thrust plane as the lower plate is retreating and the contact between lower and upper plate gets loose. In case of laterally differing values of thickened mantle lithosphere, possibly caused by oblique collision and consequently differing retreat rates the upper plate should show a large scale vertical axis rotation while thrusting.
In the Eastern, Central and Southern Alps several vertical axis rotations can be observed at continent-continent collision stadium and are interpreted using model B. Applied on the observed counterclockwise rotation of Eastern, Central and Southern Alps which is dated to 5Ma to 3Ma retreat of lower plate should be more intense towards East and less towards West. Possibly such a situation can be seen in the tomographic images (profile CC‘ of Lippitsch et al. (2003) picturing the European lower plate lithosphere at the north-eastern edge of the Eastern Alps. The slab of European continental crust is reaching 200km into the upper mantle, dipping vertically to overturned. At the western limitation of the Eastern Alps the European lower plate lithosphere can be studied from seismic images derived from TRANSALP-project. No slab of European continental lithosphere can be observed there.

Lippitsch, R., Kissling, E. & Ansorge, J. (2003): Upper mantle structure beneath the Alpine orogen from high-resolution teleseismic tomography. - J.Geophys. Res., **108**(B8): 2376: doi: 10.1029/2002JB002016.