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Fission track dating in fault zones: an example from the Eastern Alps

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One of the implications of the frictional nature of fault slip is that significant amounts of heat should be generated during earthquakes and aseismic creep, which may additionally result in the formation of frictional melts and pseudotachylites. The formation of a network of fractures along faults may tap into hydrothermal fluid sources and initiate a system of hydrothermal fluid circulation and fluid-rock interaction. We plan to use the ability of fission tracks to record the thermal history of a rock to measure the amount of heat transfer in fault zones, which should cause measurable changes of fission track ages and track lengths. These effects should be extremely localized and restricted to within a few centimeters to meters within a fault zone. Additionally, these fission track studies will provide a general cooling and exhumation history of the fault zone and adjacent units, based on mineral pair (apatite-zircon) technics. For a case study we have chosen the Lavanttal fault situated in the eastern part of the Eastern Alps. This is a NW- trending strike slip fault and part of the Pöls-Lavanttal fault system, separating the Middle Austroalpine basement complexes of the Koralpe and Saualpe. Along the Lavanttal segment, dextral offset of approximately 10 km was deduced from displaced lithological units. Vertical offset is 4-5 km, with the eastern block up. Near its southern termination, the Lavanttal fault cuts and offsets the Periadriatic fault by about 20 km. Parts of the Lavanttal fault are characterised by the formation of cataclasites and fault gouges up to a thickness of severals tens of meters. 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 struc-

ture 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. For this study fission track dating of apatite and zircon was carried out on host rocks and cataclasites directly adjacent to the undeformed host rock. Sample material was taken from drill cores transecting the Lavanttal fault and the western margin of the Koralm Complex. For reference, samples from the central part of the Koralm Complex were dated as well. These data show zircon fission track protolith ages ages of 77,6 +/- 2,5 Ma. Zircons from a cataclasite related to a low- angle fault gave fission track ages of approximately 70,3 +/- 3,3 Ma. Apatite fission track ages from the central part of the Koralm Complex are in the range of approximately 48 to 51 Ma both for the protolith and the fault rock. Along the Lavanttal Fault, the zircon fission tracks gave ages of approximately 75 Ma, the related fault rocks 68,3 - 69,6 Ma. Apatite fission track ages range from 40-45 Ma both within the host rock and the related fault rocks. However, in highly sheared domains the track length within fault rock- related apatites is shorter than within host rock- related apatites, and show a smoother length distribution. In these parts the apatite fission track ages range from 34,3 to 36,3 Ma. Microstructures indicate a strong alteration of the host rock close to distinct cataclastic shear zones, transformation of feldspars within the shear zones and neoformation of clay minerals in highly sheared domains. The occurrence of hydrothermal veins within the host rock indicates the presence of hydrothermal fluids. These preliminary results are interpreted to indicate an event of cataclastic deformation along the Lavanttal fault and related low-angle faults around 70 Ma, subsequent to cooling of the Koralm Complex below 200°C (zircon fission track closure temperature) around 75-77 Ma. The regeneration of the zircon fission track ages is interpreted to be primarily related to the circulation of hydrothermal fluids along and adjacent to the fault zone. Subsequently, the Lavanttal fault zone and the adjacent Koralm Complex were exhumed as a whole and cooled below 100°C (apatite fission track closure temperature) at 40-45 Ma. Despite some distinct domains, shear localisation, additional shearing-related heat generation and/or convective/advective hydrothermal activity was not resolved by apatite fission tracks.