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Reconstruction of fault zone evolution from 40Ar/39Ar white mica, zircon and apatite fission track, and apatite U/Th-He thermochronology: 65 million years of fault activity along the Lavanttal Fault Zone (Eastern Alps)?

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By applying distinct thermochronological methods with closure temperatures ranging from ∼450° to ∼40°C we reveal the thermochronological evolution of the Lavanttal Fault Zone (LFZ) and the adjacent Koralm Complex (Eastern Alps).The LFZ is generally described to be related to Miocene orogen-parallel escape tectonics in the Eastern Alps. 40Ar/39Ar dating on white mica, zircon and apatite fission track, and apatite U/Th-He thermochronology were carried out on host rocks and fault- related rocks (cataclasites and fault gouges) directly adjacent to the undeformed host rock.

The main part of 40Ar/39Ar muscovite ages provided in this study is in accordance to the ages described from the adjacent Koralm Complex. The related plateau ages are therefore interpreted to represent the cooling of the host rocks during Late Cretaceous times (80-90 Ma). Muscovites derived from cataclastic shear zones show Argon release spectra characterized by reduced incremental ages for the first heating steps. This probably indicates Argon loss along the grain boundaries during shearing and lattice distortion. Samples from fault-related catclasites are characterized by a plateau age of ca. 78 Ma and highly reduced incremental ages, respectively, far below the protolith cooling ages described above. This indicates lattice distortion and related Argon loss during cataclastic shearing, and incomplete subsequent resetting. As the incremental ages are in parts highly erratic statements about the timing of shearing remain speculative.

Zircon fission track ages range between 77.6±5.5 and 64.8±4.6 Ma both within fault- and host rocks. Although all four fault/host rock sample-pair ages do overlap within the 1 error, there is a clear trend of descending ages to the fault rocks.

Apatite fission track protolith ages range between 51.1±2.3 in the central Koralm massif, and 37.7±4.3 Ma along its western margin, ages from fault- related rocks vary between 46.6 ± 4.7 and 43.3 ± 4.2 in the central part, and 43.6 ± 2.1 and 34.3 ± 1.8 Ma along the western margin. Single grain ages are variable within fault core rocks and range from 76.5±12.3 to 3.6±1.3 Ma. These samples do not pass the chi-square test and can be decomposed into two age clusters. The dominant age components yield a weighted mean of 56.1±4.3 Ma and 8.6±2.6 Ma. Samples from the fault cores show significantly reduced mean track lengths (MTL). There is a clear relationship between single grain ages, MTL and Dpar values. Therefore the smallest Dpar values are associated with the youngest single grain ages and the shortest MTL´s.

Referring to the (U-Th)/He analysis a trend of decreasing ages from the host rock toward the damage zones and fault cores can be observed. The weighted mean age from the host rock is 11.8±3.2, from the damage zones 7.4±1.5 and 6.2±1.3 Ma and 4.7±0.5, 5.7±1.3 and 4.8±2.0 Ma from the fault cores.

Thse thermochronoloical ages document that the exhumation and cooling of the Koralm massif was mainly completed at the end of the Cretaceous. Argon release spectra from muscovites in cataclastic shear zones show in parts highly reduced incremental ages. Rejuvenation of zircon fission track ages along the LFZ indicates a first phase of fault activity around 65 Ma and is most probably related to the subsidence evolution of the Central Alpine Gosau basins. Recognition of this displacement event is hampered by the fact that the spatial distribution of Late Cretaceous structural elements coincide frequently with Miocene extrusion-related structures. Fault zones within the Eastern Alps commonly regarded to have formed during the lateral extrusion event in Miocene times

may therefore represent reactivated structures that formed during a Late Cretaceous event of orogen extension. Continuous displacement along the LFZ until Pliocene times is indicated by single grain apatite and U/Th-He ages.