Dating Alpine brittle deformation with hydrothermal monazite

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Alpine clefts (open fissures) are tectonically formed cm- to meter-sized voids that become filled with hydrothermal fluid. Interaction of cleft-filling fluid with wall rock results in mineral dissolution/precipitation, alteration of the wall rock, and repetitive crystallization of minerals on the cleft walls. Dating monazite from such clefts thus provides a possibility to attribute an age to an exhumation-related brittle structure. Moreover, unlike thermochronometers, the ^{232}Th-^{208}Pb system of monazite is not affected by diffusion and yields a crystallization age.
Two cleft monazites and minerals from the cleft wall have been studied using an electron microprobe at the University of Copenhagen. U-Th-Pb isotope analyses of monazite were subsequently performed on a Cameca IMS1280 SIMS instrument at the Swedish Museum of Natural History (Nordsims facility).

Deformation in the study area located in the Baltschieder Valley, Aar Massif, Switzerland, has been subdivided into three main events: (D1) main thrusting including formation of a new schistosity; (D2) dextral transpression; and (D3) local crenulation including a new schistosity. The two younger deformational structures are related to a subvertically oriented intermediate stress axis, which is characteristic for strike slip deformation. The inferred stress situation is consistent with observed kinematics and the opening of such clefts. Therefore, the investigated monazite-bearing cleft formed at the end of D2 and/or D3, and dextral movements along NNW dipping planes.

The two investigated, millimetre-sized hydrothermal monazites from a late D2 cleft are characterised by high Th/U ratios typical of other hydrothermal monazites. Despite mineralogical changes in the cleft wall, the bulk chemistry of the system remains constant at the decimetre scale. Thus the mineralogical changes require redistribution of elements via a fluid over distances of a few centimetres. ^{232}Th/^{208}Pb monazite ages are not affected by excess Pb and yield growth domain ages between 8.03 ± 0.22 Ma and 6.25 ± 0.60 Ma. These crystallization ages are younger than ^{40}Ar/^{39}Ar ages obtained on white mica from ductile shear zones of the Aar Massif in the Grimsel area and younger than ^{40}Ar/^{39}Ar-dated 13.7 ± 0.1 Ma to 11.0 ± 0.1 Ma old phyllonites (mylonites) outcropping near Baltschieder. Monazite crystallization in brittle structures is in this case coeval or younger than 8 Ma old zircon fission track data, and hence occurred at temperatures below 280°C.

Mesozoic stratigraphy and general structure of the Julian Alps (eastern Southern Alps, NW Slovenia)

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The study area is part of the zone of overlap between the Southern Alps and the Dinarides. This zone is to the north bounded by the Periadriatic Fault and extends south to the South Alpine front, where the Southern Alps are in a direct thrust contact with the