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Mineralization related to possible deep penetration of meteoric waters in late Alpine brittle faults developed during exhumation

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The role of fluids during faulting and fracturing is investigated for structures related to Miocene to recent exhumation of the central western Swiss Alps. Our study considers a transect from the Simplon fault westward to the Dent Blanche Nappe "depression", running approximately parallel to the Alpine mountain belt. Late Alpine tilting and differential exhumation allows access to at least 10 km of vertical section, with the largest Neogene exhumation occurring in the footwall of the Simplon fault zone to the east, where amphibolite facies "middle" crust is now exposed. Meteoric fluids have previously been shown to infiltrate the latest brittle deformation structures near the western end of the transect (Henry et al., 1996). However, the depth of penetration, the fluid flux and pervasiveness of infiltration of the meteoric waters into the rising Alpine nappe stack are poorly constrained. Our transect is chosen to cross the estimated paleo-mixing zone between a surficial hydrostatic, unconfined fluid regime and the deeper metamorphic, highly confined and most probably overpressured fluid regime within the ductiley deformed crust.

The study considers the mineralization associated with these brittle deformation structures in order to study the deep paleo-fluid-circulation. Fieldwork provides constraints on the orientation, kinematics, and possible relative age of the main structural features along this transect, together with the necessary information on the mineralization associated with the latest generations of Alpine faults, tension gashes and major regional joint families. Successive mineral parageneses are characterized relative to the brittle deformation history and in relation to the adjacent hydrothermally altered wall-rocks.

Structural and textural characterization of vein fillings and fault rocks involves a combination of optical and electron microscopy, stable isotope analysis and radiometric dating of selected late secondary minerals.

The data collected until now - the first ones of this type from the studied area – show some differences in the style and type of mineralization. The western end of the transect is characterized by fault surfaces with dominant hematite mineralization and entirely cataclastic behavior. Small hydrothermal zircons (up to 50 μm) were found in the hematite framework close to the fault surfaces. The eastern portion of the transect is characterized by quartz-calcite (Qtz-Cc) veins in both the hangingwall and the footwall of the Simplon fault zone. The Qtz-Cc veins in the hangingwall are strongly fractured and apparently without any preferred orientation, while in the footwall Qtz-Cc veins are highly deformed and parallelized with the mylonitic fabric. Fractures crosscutting the foliation are filled by Qtz-Cc material, together with variable amounts of ankerite.

Future studies will aim to determine the age of the vein materials using the U/Pb method on zircons, K/Ar and Ar/Ar on phyllosilicates and U-series methods on carbonate material, while the stable isotope composition (δ18O, δ13C, δD) of coevally precipitated minerals will provide important information on the fluid source(s) and on the degree of water-rock exchange, as well as allowing oxygen-isotope thermometry.