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Changes in fluid composition in metamorphic veins along a cross section through the Central Alps, Switzerland

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The classical Alpine fissure veins are large cavities lined by occasionally giant quartz crystals and many other euhedral mineral assemblages. They occur in regionally metamorphosed terranes in the upper crust and record important information about the composition and evolution of metamorphic fluids, and fluid sources and mass transfer during crustal fluid-rock interaction (Oliver & Bons, 2001). Detailed fluid inclusion studies of Alpine veins along a cross section through the Central Alps have established that the fluid composition shows a distinct evolution with increasing metamorphic grade, where consecutive zones are dominated by (1) heavier hydrocarbons, (2) CH4, (3) H_2O-NaCl, and (4) H_2O-CO_2-NaCl (Mullis et al., 1994). This study addresses the chemical evolution of fluids in Alpine fissure veins in the Central Swiss Alps by integrating field work, fluid inclusion studies (microthermometry and LA-ICPMS microanalysis of individual fluid inclusions), and geochemical modeling.

The field locations were selected along a cross section through the Central Alps that covers different lithologies and metamorphic conditions. This includes vein systems in the Aar massif (Gauli glacier, Gerstenegg vein in the Grimsel power station, Tiefen glacier), the Nufenen and Griess pass, the Bedretto valley, the Cavagnoli region and a tunnel near Faido. Fluid inclusion studies have been completed for the localities in the Aar massif, the Cavagnoli region and the Faido tunnel. It was possible to analyze a considerable number of elements with LA-ICPMS, including Na, K, Rb, Cs, Li, Ca, Mg, Sr, Ba, Mn, B, As, Sb, S, Pb and Zn. The fluid inclusions from the Aar massif are low-salinity aqueous two-phase, whereas the Cavagnoli and Faido samples dominantly contain aqueous-carbonic fluid inclusions. While the Gauli samples contain fluid inclusions with 4.5-5.0 wt% equivalent (eqv.) NaCl, those from the Gerstenegg and Tiefen glacier have a considerably higher salinity of around 10-11 wt% eqv. NaCl. This difference in salinity is correlated with consistently higher concentrations of elements that are largely complexed by chlorine such as the alkali and earth alkaline metals, and divalent transition metals (Yardley, 2005). Consequently, the fluid inclusions from the Gerstenegg and Tiefen glacier yielded consistent data for Pb, Zn and Ag on the order of few ppm, whereas the concentrations of these metals were mostly below the detection limit in the Gauli samples. The aqueous-carbonic fluid inclusions from Cavagnoli and Faido show rather low salinities in the range of 0.4-3.4 wt% eqv. NaCl and correspondingly low concentrations of alkali and earth alkaline metals. Reflecting their higher metamorphic grade, they contain significantly higher amounts of ore metals and sulfur. Following completion of the chemical dataset, the measured fluid compositions will be compared with results from multicomponent-multiphase fluid-mineral equilibria modeling to evaluate the status of fluid-rock equilibrium along the metamorphic gradient.

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