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Fluid composition and mineral equilibria in low grade metamorphic rocks, Bündnerschiefer, Switzerland

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The composition of fluid inclusions (FI) hosted in quartz veins from low-grade metamorphic rocks of the Bündnerschiefer (two locations near Thusis and Schiers that represent subgreenschist and lower greenschist facies conditions, respectively), Swiss Alps, was determined by combination of microthermometry and LA-ICPMS microanalysis. Elongate-blocky quartz and euhedral quartz crystals were sampled form two sets of veins, which are foliation-parallel and open fissure veins that crosscut the main foliation. The host rocks are organic-rich metapelites, that in places contain relatively high amounts of carbonate. Several metamorphic temperature indicators were used to determine the temperature and pressure during metamorphism of the host rocks. These included the Kübler index (Kübler & Jaboyedoff 2000), Raman spectroscopy on carbonaceous material (Beyssac et al., 2002), Na-Mg and Li-Mg fluid solute geothermometry (Giggenbach, 1988; Kharaka & Mariner, 1989) and mineral assemblages. The geothermometers point to equilibrium temperatures around 320±20 °C (Thusis) and 250±20 °C (Schiers). The results of pseudosection modeling show very close agreement with the pressure-temperature conditions that were derived from conventional geothermobarometry.

The FI bulk salinity and homogenization temperatures are 4±0.2 wt% eqv. NaCl and 122-140 °C for Thusis, and 2±0.2 wt% and 82-86 °C at Schiers. Most of the important rock-forming elements have been successfully determined in individual FI, with consistent concentrations obtained for well-constrained fluid inclusion assemblages. The FI contain measurable concentrations of Na, K, Rb, Cs, Li, Ca, Mg, Al, Mn, Sr, Ba, B, As, B, Zn, Pb, Cu and S. Typical concentrations are 30-40 ppm Al, 5-7 ppm Mg, 300-400 ppm Ca, 3-5 ppm Mn, and 300-350 ppm S for FI from Thusis. Concentrations for most elements are roughly half an order of magnitude lower for FI from Schiers. The total element concentrations are lower compared with data from similar metamorphic vein settings (Yardley et al., 1993; Yardley, 2005). This likely reflects the lower salinity of fluids in the Bündnerschiefer veins, which exerts a major control on those elements that are complexed by chloride. Combining fluid inclusion isochores with independent geothermometers results in pressure estimates of 2.8-3.8 kbars for Thusis, and around 3.4 kbars for Schiers. The geothermal gradient decreases from the southern location (27-22 °C/km: Thusis) to the northern location (19 °C/km: Schiers), in agreement with their position during metamorphism. The fluid composition data, in conjunction with metamorphic indicators and petrological modeling, demonstrate that fluid-rock equilibrium was attained during metamorphism and vein formation. Fluid composition and pressure-temperature conditions remained essentially unchanged during the evolution of the vein systems. The veins evolved as rock-buffered closed systems, due to the low permeability of the organic-rich metapelites.

References:
Beyssac, O., Goffé, B., Chopin, C. Rouzaud, J.N. 2002. Raman spectra of carbonaceous material in metasediments: a new geothermometer. J. Metam. Geol. 20, 859-871.
Giggenbach, W. F. 1988. Geothermal solute equilibria. Derivation of Na-K-Mg-Ca geoindicators. Geochimica et Cosmochimica Acta 52, 2749-2765.
Kharaka, Y.K., Mariner, R.H. 1989. Chemical geothermometers and their application to formation waters from sedimentary basins. In: Naeser, N.D., McCulloh, T.H. (eds.) Thermal History of Sedimentary Basins. New-York, Springer-Verlag, 99-117.
Kübler, B., Jaboyedoff, M. 2000. Illite crystallinity. Concise review paper. Compt. Rend. Acad. Sci. Ser. IIA Earth Planet. Sci. 331, 75-89.
Yardley, B.W.D. 2005. Metal concentrations in crustal fluids and their relationship to ore formation. Econ. Geol. 100, 613-632.
Yardley, B.W.D., Banks, D.A., Bottrell, S.H., Diamond, L.W. 1993. Post-metamorphic gold-quartz veins from N.W. Italy: The composition and origin of the ore fluid. Mineral. Mag. 57, 407-422.