EVOLUTION OF CRUSTAL FLUIDS IN A SHEAR ZONE DURING RETROGRADE METAMORPHISM, REGIONAL UPLIFT, AND COOLING (THE KAŠPERSKÉ HORY GOLD DEPOSIT, MOLDANUBIAN UNIT, BOHEMIAN MASSIF)

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The Kašperské Hory gold deposit is located in the high-grade metamorphosed Moldanubian Unit in the southern part of the Bohemian Massif, Czech Republic. The hydrothermal mineralization was formed in several successive stages of fluid movement through a regional shear zone during Hercynian retrograde metamorphism, regional uplift and cooling.

Stage 1 mineralization is represented by several structural types of quartz veins that developed within the shear zone during retrograde extensional-shear deformation under ductile/brittle transition conditions. Some types of veins that formed during stage 1 mineralization contain abundant oligoclase and muscovite. Oxygen isotope thermometry (muscovite-quartz and oligoclase-quartz) reveal temperatures in the range of 640–580 °C and 680–460 °C respectively, similar to temperatures derived from arsenopyrite thermometry. Calculated H and O isotope compositions for the fluids ($\delta^{18}O$ 10.5–11.0 ‰; δD -40 to -50 ‰) indicate that the fluids were in equilibrium with rocks of the metamorphic host sequence. The $^{39}Ar/^{40}Ar$ data for vein muscovites of stage 1 range between 331 and 325 Ma and do not represent the time of vein formation but rather a cooling age (< ~330 °C) of the hydrothermal system. Stage 2 is characterized by the presence of abundant Co + Ni sulphoarsenide with composition of cobaltite–gersdorfite corresponding to ~550 °C. Oxygen isotope thermometry for scheelite–quartz pairs yielded temperatures in the range from 440 to 390 °C, similar to arsenopyrite thermometry of arsenopyrite II.

Fluid inclusions representing stage 1 and stage 2 mineralization are small (< 5 μm) and affected by subsequent quartz deformation and recrystallization. Optical study and micro-Raman analyses indicate CO_2-rich fluids with densities corresponding to pressure decrease from 450 to ~200 MPa during the evolution of individual structural types of quartz veins. A small amount of water could have been leaked from the inclusions during ductile deformation.

Four ^{187}Re-^{187}Os ages on molybdenite indicate two periods of molybdenite deposition, one at 342 to 345 Ma and younger period at 310 Ma. It is difficult to precisely mesh these ages with $^{40}Ar/^{39}Ar$ ages obtained from stage 1 mineralization, because in all cases the $^{39}Ar/^{40}Ar$ data represent cooling ages and can be disturbed by subsequent periods of hydrothermal activity and shearing. Mineralogical studies indicate molybdenite deposition at early stage 3 mineralization.

Stage 3 mineralization, largely occurring as a relatively younger phase within quartz veins, is the mineralization of economic importance. The mineral assemblage molybdenite, high-temperature phase similar to cosalite, native Au and Bi, hedleyite and maldonite indicate temperatures of 380 to 260 °C. Ore minerals are frequently associated with minor calcite. Fluid inclusions in this calcite and also numerous fluid inclusion planes crosscutting several older quartz grains, are of the H_2O type, with salinities between 0.5 and 8.0 wt. % NaCl equiv., and Th between 170 and 300 °C.

Stage 4 mineralization is represented by carbonate filling of youngest brittle fractures and steep faults. Carbonate is locally accompanied by minor adularia, fluorite, galena and pyrrhotite. Fluid inclusion data and the presence of open spaces features indicate pressures below 25 MPa. This hydrothermal stage was formed during and/or after the terminal stages of the uplift of the Moldanubian unit at ~295 Ma.

This study was supported by the U.S.-Czech Science and Technology Joint Fund under Project No. 94017.