Magmatic to hydrothermal transition at the Elatsite porphyry Cu-Au-(PGE) deposit, Srednogorie zone, Bulgaria

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It has been known for a long time that the formation of porphyry-type copper deposits is related to volatiles released from upper crustal magma reservoirs. Primary magmatic volatiles are highly efficient in sequestering economic metals from the crystallizing magma and transporting them to the place of ore mineral precipitation. In the Elatsite deposit, assemblages of co-existing silicate melt inclusions, saline brine inclusions and vapor inclusions in early magmatic-hydrothermal quartz veins offer a unique chance to reconstruct the compositional evolution of the melt and volatile phase. Co-existence of fluid inclusions with silicate melt inclusions suggests that they represent the primary magmatic volatile phase released from the crystallizing magma.

Scanning electron microprobe cathodoluminescence (SEM-CL) was used for the textural correlation of successive quartz types and fluid inclusion assemblages. Recrystallized silicate melt inclusions, brine and vapor inclusions occur as primary and pseudosecondary assemblages. Brine inclusions consist of liquid (50-70 vol%), vapor, crystal of halite and sylvite. Additionally, they may contain another transparent grain (anhydrite) and 2 opaque phases (typically a triangular plate of chalcopyrite and a small red plate of hematite). Vapor inclusions consist of at least two phases (liquid and vapor) with a dominating vapor bubble and an opaque daughter phase. The calculated salinities of the brine inclusions are up to 55 wt% NaCl equivalent. No microthermometry data could be obtained from the vapor inclusions because of their small liquid content. In order to rehomogenize the silicate melt inclusions, quartz crystals were heated to 730°C under 150 MPa confining pressure for 120 hours and quenched subsequently. After the heating experiments several composite inclusions consisting of silicate glass and brine or vapor were observed in numerous assemblages. We interpret these to be formed by heterogeneous entrapment of silicate melt and brine or silicate melt and vapor. This provides a clear evidence for the co-existence of the three immiscible phases in the system.

LA-ICPMS data of brine inclusions show that they are Cu-rich, Cu concentrations reach maxima of 9122 ppm. Pb and Zn content are up to 2000 ppm and 3300 ppm, respectively. The concentration of Cu, Pb and Zn in the recrystallized silicate melt inclusions are highly variable (Cu 3-3657 ppm; Pb 11-797 ppm; Zn 5-1153 ppm). The elevated concentrations of these fluid compatible elements in the SMI can be explained by the heterogeneous entrapment of fluid with the melt.