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Fluid inclusions of the Horní Slavkov Sn-W ore deposit, Bohemian Massif, Czech Republic: evidence for non-magmatic source of greisenizing fluids?

Dolníček, Zdeněk*, René, Miloš** and Prochaska, Walter***

*****Department of Geology, Faculty of Science, Palacký University, 17. listopadu 12, 771 46 Olomouc, Czech Republic

******Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, V Holešovičkách 41, Prague 8, Czech Republic

*******Chair of Geology and Economic Geology, Montanuniversität Leoben, Peter-Tunner-Strasse 5, 8700 Leoben, Austria

The Horní Slavkov ore deposit is one of the important occurrences of Sn-W mineralization bound to greisenized apical parts of the Variscan granitoid plutons in the Saxothuringian Zone of the Bohemian Massif. There is developed a number of post-magmatic alterations in topaz-alkali feldspar granites of the Krudum granite body (age of ca. 330 Ma) in the vicinity of Horní Slavkov, including feldspatization, greisenization and argillization. Greisenization was accompanied by crystallization of Li-micas and economic ore minerals (cassiterite, wolframite). Brittle deformation during post-magmatic stage gave rise to a suite of mineralogically distinct veins (barren quartz, quartz-cassiterite, quartz-wolframite, quartz-arsenopyrite, quartz-fluorite and quartz-hematite).

The fluid inclusion study involved petrography, microthermometry and crush-leach analyses of selected mineral phases from both rock samples (greisens) and veins. Primary fluid inclusions hosted by quartz, cassiterite, topaz and apatite from both greisens and related early veins (barren quartz, quartz-wolframite, quartz-cassiterite) are two-phase (L+V) showing three modes of homogenization which occurred within similar temperature ranges (312–405 °C, 361–408 °C, and 359–404 °C for homogenization mode to liquid, to vapour and critical, respectively). Inclusions hosted by quartz and fluorite from younger veins show systematic decrease of homogenization temperatures ranging 217–354 °C, 90–185 °C, and <100 °C for quartz-arsenopyrite, quartz-fluorite and quartz-hematite mineralizations, respectively. The eutectic temperatures ranging between -28 and -39 °C are consistent with chloridic aqueous fluids containing besides NaCl also divalent-metal chlorides. The melting temperatures of last ice indicate low bulk salinity of all fluid inclusions (0.0 to 7.1 eq mass% NaCl). In some high-T_h primary inclusions melting of clathrate was observed indicating the presence of 5–12 mol% CO_2 in these inclusions. In T_h-T_m plot, the microthermometric data define two types of trends – subhorizontal (consistent with simple cooling of a fluid phase) and diagonal (indicative for mixing of fluids with contrasting temperatures and salinities). The available fluid inclusion data indicate that greisenization was related to activity of near-critical aqueous solutions at temperatures of ~350–400 °C and pressures of ~300–600 bars.

The mineral separates from both greisens and veins have been analyzed for selected cations and anions using crush-leach method. The topaz and cassiterite (both mineral phases are essentially free of secondary low-temperature fluid inclusions) leachates show higher K/Na, Mg/Na, Ca/Na, F/Cl and NO_3/Cl molar ratios and lower Li/Na ratio then paragenetically younger quartz samples. In addition, topaz and cassiterite samples exhibit extreme variability in I/Cl (4.8×10^{-6} M to 308×10^{-6} M) and Br/Cl (0.8×10^{-3} M to 8.9×10^{-3} M) in comparison with quartz samples showing intermediate and less variable values (I/Cl = 42×10^{-6} M to 97×10^{-6} M, Br/Cl = 2.3×10^{-3} M to 5.6×10^{-3} M). All the data are negatively correlated in the I/Cl vs. Br/Cl plot implying mixing of at least two sources with contrasting I/Cl and Br/Cl signatures. The halogen data are incompatible with an idea of orthomagmatic source of fluid salinity as our data are lying outside of range reported for magmatic fluids. The

data can be easily compared to the post-Variscan post-tectonic fluids of the Bohemian Massif, which are interpreted in terms of mixing of various surficial sources (including evaporated seawater, “shield brines”, and halite-dissolution fluids). The external source of at least a part of fluids at the Horní Slavkov ore deposit is suggested also from hydrogen stable isotope data showing a great variability of δD values significantly exceeding the typical “magmatic” range.

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