Origin and evolution of the greisenizing fluid at the East Kemptville tin deposit, Nova Scotia, Canada[1]

W. E. Halter[2], A. E. Williams-Jones[3] and D. J. Kontak

The process responsible for greisen-hosted tin mineralization at East Kemptville was investigated using petrographic, chemical, and fluid inclusion analyses of samples from a single deep drillhole (90-1) in the western part of the deposit (Baby zone). Based on their trace element chemistry, the greisens intersected in the hole appear to have all formed from a single leucogranite protolith. Alteration developed as symmetrically zoned halos around central fractures as a result of the interaction of a fluoride-rich orthomagmatic fluid with evolved leucogranite. During alteration, K feldspar was first replaced by albite. With further alteration, albite was replaced by muscovite resulting in the formation of quartz-sericite greisen. Ore minerals are locally present in this zone. Closer to veins, muscovite is replaced by topaz and quartz, producing a quartz-topaz greisen with which the most intense mineralization is associated. This latter greisen is enriched in F, Fe, S, Zn, and Sn, suggesting that these elements were added by the mineralizing fluid. Next to the vein, dissolution of pyrrhotite, sphalerite, and cassiterite characterizes quartz-greisen in which the concentration of ore-forming elements (Sn, Fe, S, F, Zn, Cu) is lower than in the quartz-topaz greisen. Microthermometric measurements of fluid inclusions in quartz from the various alteration zones show that this alteration sequence was formed by only one greisenizing event and that temperature was approximately constant (450°C). The fluid responsible for greisen formation was an NaCl-brine, containing subordinate and variable concentrations of Fe, Mn, and K.

Measured eutectic temperatures of fluid inclusions are lowest in quartz-topaz greisen as a result of an increase in the Fe concentration due to pyrrhotite dissolution. Oxygen fugacity, which was calculated from the CO_2/CH_4 ratio in gases released by crushing fluid inclusion-rich samples, displays a corresponding minimum since pyrrhotite dissolution releases Fe^{2+}. The distribution of pyrrhotite and the fluid inclusion data indicates that pyrrhotite was precipitated close to the vein during early stages of the alteration and reprecipitated farther out as alteration progressed. This suggests that alteration zones moved away from the vein and widened with time.

The salinity of fluid inclusions varies between 27 and 41 wt percent NaCl equiv and increases linearly with increasing distance from the vein, even in the absence of Na-bearing phases. It, therefore, follows that sodium was transported toward the fracture (vein) down a chemical potential gradient. This occurred through compensated infiltration, i.e., a regime in which flow was dominantly parallel to the fracture but individual aliquots of fluid followed complex paths back and forth between the fracture and the rock.

Cassiterite precipitated in quartz-topaz greisen in response to a pH increase of the mineralizing fluid due to its interaction with the wall rock. Other components affecting cassiterite solubility were either constant (temperature) or acted against its precipitation (f_{O_2} and a_{Cl^-}).

---

[1]*In:* Economic Geology, v. 93, 1998, p. 1026-1051

[2]Present address: Université de Lausanne, Sciences de la Terre, CAM, BFSH 2 CH-1015 Lausanne, Switzerland; email: Whalter@cam.unil.ch

[3]Department of Earth and Planetary Sciences, McGill University, 3450 University Street, Montreal, Quebec, Canada H3A 2A7