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Highly soluble cassiterite in alkaline silicate-rich fluids: implication for tin mineralization

QINXIA WANG, RENZHI ZHU AND HUAIWEI NI SR.

University of Science and Technology of China

Presenting Author: xw960109@mail.ustc.edu.cn

Tin is generally assumed to be carried as Sn chloride complexes in magmatic-hydrothermal fluids. However, abundant Sn was found in chloride-poor but silicate-rich fluid inclusions in tin-mineralized pegmatites such as that from the Ehrenfriedersdorf Complex. We therefore measured the solubility of cassiterite in $Na_2Si_3O_7$-H_2O and $Na_3AlSi_5O_{13}$-H_2O fluids by direct observation of single crystal cassiterite dissolution with a hydrothermal diamond anvil cell. Experimental results indicated that a significant amount of cassiterite could be dissolved in alkaline silicate-rich fluids, and the solubility was positively correlated with both the concentration of silicate solute and temperature. For $Na_2Si_3O_7$-H_2O fluids at ~680°C from 24 wt% to 45 wt% silicate, Sn concentration at cassiterite saturation increased from 0.5 wt% to 1.3 wt%. For $Na_3AlSi_5O_{13}$-H_2O fluids at ~715°C from 12 wt% to 52 wt% silicate, Sn concentration at cassiterite saturation increased from 0.4 wt% to 0.9 wt%. The difference between the two compositions indicated that cassiterite dissolution was also aided by alkalinity of fluid. In situ Raman spectra collected on fluid suggested complexation of Sn with silicate monomers as well as dimers. Alkali-silicate complexes can therefore serve as effective ligands for Sn mobilization, which allows Sn to be scavenged by fluids in the absence of halogens. Cooling of tin-carrying fluid would lead to the precipitation of silicate solute, and both thermal and chemical changes would cause the unloading of Sn in the form of cassiterite. Our study put forwards an alternative agent for Sn mobilization and mineralization.