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Experimental techniques for determining tin solubility in silicate melts using silica capsules in 1 atm furnaces and rhenium capsules in the piston cylinder

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Abstract

The reactivity, oxygen fugacity, volatility, and wetting properties of tin complicate experimental work in tin-bearing systems. Open-graphite and vitreous-carbon crucibles may be used for preparing tin-rich glass starting materials. Such glasses are prepared by fusing mixtures of stannous oxalate with oxides, crushed rocks, or silicate gels. Decomposition of SnC_2O_4 into $CO+CO_2$ and SnO provides a reducing atmosphere for the incorporation of Sn^{+2} into the silicate melt, while Sn^{+2} provides an effective flux. Such melts can incorporate Sn far in excess of any reasonable abundance of this element in natural silicate magmas. Experiments where constant bulk composition is required are best conducted in sealed crucibles because SnO is lost as gas. Evacuated silica tubes may be used for such purposes if saturation in SiO_2 is desired; however, oxygen fugacity cannot be independently controlled. Rhenium metal is a useful crucible material for relatively reduced Sn-bearing experiments (below oxidation to ReO_2), and the coexistence of metallic Sn and stannic oxide controls oxygen fugacity. Adverse mechanical properties inherent to Re, such as work-hardening and embrittlement, are addressed by the use of thick-walled capsules in the piston-cylinder apparatus. Such capsules behave elastically at temperatures of geological interest (~1100 °C), producing higher sample pressures than those provided by the surrounding solid media. These high sample pressures are found to partially relax in week-long experiments. Sealed graphite, sintered SnO_2, and Re-foil capsules are plausible crucible materials for Sn-bearing experiments, but may only be used if their porosity and brittleness can be moderated.

Keywords: Tin solubility, cassiterite, rhenium, piston cylinder