Effect of T, fO$_2$, volatiles and composition on the solubility of cassiterite (SnO$_2$) in evolved granites

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Experiments were performed at 600-850 °C, 2 kbar and at different fO$_2$ (Ni-NiO to Co-CoO) on F-bearing natural peraluminous melt and also on F-free and F-bearing synthetic granitic melts of peralkaline, subaluminous and peraluminous compositions. Normative corundum content in these melts varied from 1.0 wt.% to 3.2 wt.% C along with varying amount of fluorine (from 0 wt.% F to 4.9 wt.% F in melt) and chlorine (from 0 wt.% to 0.4 wt.%) in the melt, in order to examine the cassiterite (SnO$_2$) solubility in these melts as a function of T, fO$_2$, halogens and corundum content. A SnO$_2$ crystal was placed in the granitic melt (glass). The dissolution behavior of the SnO$_2$ crystal was examined. All experiments were conducted in cold seal pressure vessels for 5 hours to 24 hours. Bulk composition, F and Cl in the starting glasses and in the run products (silicate melt or glass) were determined by electron microprobe and ICP-AES. Concentration of SnO$_2$ was analyzed using electron microprobe. The oxygen fugacity of most of the experiments was measured using hydrogen sensor capsule technique of Chou (1987a). Various diffusion (concentration) profiles were analyzed from glass-crystal (SnO$_2$) interface towards glass boundary. The SnO$_2$ concentration calculated at the SnO$_2$-glass interface is the SnO$_2$ solubility.

At Ni-NiO buffer, the solubility of SnO$_2$ in peraluminous melts containing 1.12 wt.% F increases from 0.32 wt.% to 1.20 wt.% SnO$_2$ with increasing temperature from 700°C to 850°C, respectively. At Ni-NiO buffer, SnO$_2$ solubility increases from 0.35 wt.% SnO$_2$ to 0.55 wt.% SnO$_2$ at 750°C and from 1.05 wt.% SnO$_2$ to 1.10 wt.% SnO$_2$ at 850°C, with an increase from 0 to 1.12 wt.% fluorine in the melt. A significant increase in SnO$_2$ solubility is noticed at 800°C and 2 kbar when the F-content in subaluminous melt is > 2.3 wt.%. At ~NNO, 800 °C and 2 kbar, SnO$_2$ solubility in a subaluminous melt increases significantly from 2.23 to 4.17 wt.% SnO$_2$ with increasing F-content of the melt from 2.4 to 4.6 wt.% F, respectively. At the same experimental conditions, SnO$_2$ solubility in the subaluminous melt (with 2.4 wt.% F) in melt can be predicted as log C$_{SnO2}$ = 6.09 – 6.26.10^3/T, where C$_{SnO2}$ and T are concentration of SnO$_2$ (wt.%) and temperature (K), respectively. At NNO, 850°C and 2 kbar, SnO$_2$ solubility in peraluminous melts also increases from 1.05 to 1.25 wt.% SnO$_2$ with increasing chlorine content from 0 to 0.4 wt.% Cl in melt, respectively.

Our results, combined with those of Linnen et al. (1996), suggest that chlorine is at least as important as fluorine for controlling SnO$_2$ solubility. At reducing conditions (Ni-NiO buffer), tin is incorporated as Sn^{2+} and SnO$_2$ solubility increased from 0.47 to 1.10 wt.% SnO$_2$ with increasing normative corundum content (excess alumina) from 0.1 to 2.8 wt.%. At oxidizing conditions (Ni-NiO+2 to +3), tin is mainly incorporated as Sn^{4+} and the effect of excess alumina seems to be significantly lower than at reducing conditions.

References: (1) I-Ming Chou (1987a): In: Ulmer, G.C. and Barnes, H.L. (Ed.), *Hydrothermal Experimental Techniques*. John Wiley & Sons Ltd., New York, pp. 61-99.
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