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The effect of sodium on the solubilities of metals in silicate melts

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ABSTRACT

We have studied experimentally the effects of variable Na_2O concentrations on the solubility of four metals (Fe, Co, Ni, and Pd) in silicate melts of anorthite-diopside eutectic composition. Experiments were done at fixed temperatures of 1300 °C for Pd and 1400 °C for Ni, Co, and Fe. In the Fe solubility experiments, Na losses were severe. Therefore, a new experimental device (crucible-supported loop technique or CSLT) was designed to prevent Na losses of experimental charges primarily for experiments at low oxygen fugacities. The CSLT was tested extensively, and it was demonstrated that high Na partial pressures could be kept in a semi-closed crucible for at least 20 h. In experiments on Co solubilities, the CSLT was tested with reversed experiments.

The Fe and Co solubilities clearly decrease with increasing Na_2O contents. The Ni solubility is independent of Na_2O contents up to 4.5 wt%. At oxidizing conditions, a small decrease in Ni solubility with increasing Na content was found. Palladium shows a mixed behavior, decreasing solubility with increasing Na_2O, up to about 4 wt%. At higher Na contents, Pd solubility is independent of Na content.

The increase of FeO activity coefficients with increasing Na content found in this study may provide an explanation for decreasing FeO with decreasing degrees of partial melting in experimentally produced mantle melts (Hirschmann et al. 1998), as melts at low melting degrees are Na-rich.

Keywords: Melt properties, new technique, thermodynamics, experimental petrology