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Use of Pt-Melt Equilibration and Electrochemical Experiments to Constrain the Effect of Cl on NiO Activity in Silicate Melts

Nickel activity influences Ni partitioning between crystalline and melt phases and so influences magma evolution. Thus, improving understanding of Ni activity can improve modeling of magma evolution in planetary interiors. We have used two types of experiments to determine whether Cl at natural concentrations might have a significant effect on NiO activity.

We have completed Pt-melt equilibration and electrochemical experiments at 1-atm pressure to look at the effect of Cl on the chemical activity of NiO in silicate melts. In 1-atm experiments, Cl is rapidly lost from silicate melts. To overcome this problem in the Pt-melt experiments, we examined the diffusion profile of Ni into the Pt wire that holds the experimental sample, presuming that Ni concentration in the Pt wire adjacent to the melt reflects the final activity of NiO in the Cl-free melt whereas the diffusion profile deeper in the Pt reflects conditions earlier in the experiment when Cl was present. We compared our experimental results to a computational diffusion model in order to place constraints on the Cl-influenced activity of NiO at the start of our experiment.

Additional constraints were provided by electrochemical experiments, using a Cypress Model CS- 1090 potentiostat, in which changing activity of NiO in the melt is measured in-situ as a function of the voltage at which NiO is reduced. We tracked the shift in voltage required to reduce the NiO in the melt throughout the first thirty minutes of the experiment while Cl was being lost, placing further constraints on how much influence the Cl has on NiO activity in the melt.

Results suggest that any effect of Cl falls within the limits of the expression below.

Percentage change in the NiO activity coefficient $\leq \pm 2.3$ times wt %Cl.

Thus, the effect of Cl on NiO activity at natural Cl concentrations is sufficiently low as to not greatly impact previous modeling efforts that ignored Cl effects.