

## **Oxidation in CSPV experiments involving H<sub>2</sub>O-bearing mafic magmas: Quantification and mitigation**

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### **ABSTRACT**

A difficulty in performing high-temperature (>900 °C) experiments on near-liquidus hydrous mafic melts in gas-medium cold-seal pressure vessels (CSPV) is the tendency for H<sub>2</sub>O in the fluid phase to dissociate and H<sub>2</sub> to diffuse through capsule material, leading to progressive oxidation of sample material. Negative consequences include premature stabilization of Fe-Ti oxide phases and commensurate deviation of the liquid line of descent toward silica enrichment. Moreover, time-variance of an intensive variable equal in importance to temperature or total pressure is an unwanted feature of any experimental study. Methodologies commonly employed to mitigate the oxidation problem, not without their own drawbacks, include incorporating CH<sub>4</sub> into the pressurizing gas, limiting run duration to 24 h, enclosing samples in Au-alloy capsules, and incorporating solid buffering assemblages to serve as indicators of  $f_{\text{O}_2}$  excursion. Using the Co-Pd-O system as a  $f_{\text{O}_2}$  sensor, we investigated progressive oxidation of basaltic andesite at 1010 °C and  $P_{\text{H}_2\text{O}} = 150$  MPa. Our time-series of 12, 24, 36, 48, and 60 h run durations reveals that oxidation occurs at a very high rate (~3–4 log unit change in  $f_{\text{O}_2}$  in 48 h). Both the variability of  $f_{\text{O}_2}$  and magnitude of dehydration-oxidation are considered unacceptable for phase equilibria work. Incorporation of additional CH<sub>4</sub> serves only to offset the progressive oxidation trend toward a lower absolute range in  $f_{\text{O}_2}$ . Ultimately, rapid oxidation in CSPV hinders the chemical equilibration of experimental charges. To mitigate the issue, we propose the following solution: Incorporation of a substantial mass of Ni metal powder as an O<sub>2</sub> getter to the outer capsule successfully: (1) slows down oxidation; (2) stabilizes  $f_{\text{O}_2}$  at the nickel-nickel oxide (NNO) buffer after ~20 h; and (3) allows compositions to approach equilibrium. Runs much longer than 48 h may require one or more steps involving quenching and re-filling the pressure system with CH<sub>4</sub>.

**Keywords:** Experimental petrology, oxygen fugacity, rates of oxidation, crystallization, chemical equilibrium