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Development of a Cr oxybarometer for Glasses: An XAS Study

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Oxidation states are the result of the oxygen fugacity (f_{O2}) in a system and measuring the oxidation states of planetary materials allows use to determine the oxygen fugacity present during formation [1]. Measuring oxidation states in planetary materials is made possible through multivalent elements such as Fe, and Cr, whose valencies in melts are controlled by the prevailing redox conditions of the system. However, Fe oxybarometers are ineffective at low f_{O2} (<IW) due to a lack of redox change. The transition of Cr^{2+} to Cr^{3+}occurs at lower f_{O2} making Cr a better oxybarometer candidate for many planetary samples [2-5]. To utilize Cr oxybarometry, we have experimentally synthesized a suite of glasses with multiple compositions at varying f_{O2}s to be used as a X-ray Absorption Spectroscopy (XAS) calibration set. This technique will allow for the in-situ measurement of f_{O2} in returned samples.

Synthetic glasses representing a range of planetary relevant compositions (basalts to basaltic andesites) were doped with 0.1 wt % Cr_2O_3 and synthesized at f_{O2} of IW-2, IW, QFM, and air. Mössbauer was used to collect background measurements of Fe and XAS was used to measure Fe and Cr. XAS measurements of the Cr reveal a strong dependence of melt Cr^{2+}/Cr^{3+} with f_{O2} (Fig. 1). Chromium shows two pre-edge peaks related to Cr^{2+} and Cr^{3+}, similar to what is seen for Fe. Significant main edge differences exist as a function of f_{O2} as well. High SiO_2 compositions are being run to extend the calibration.

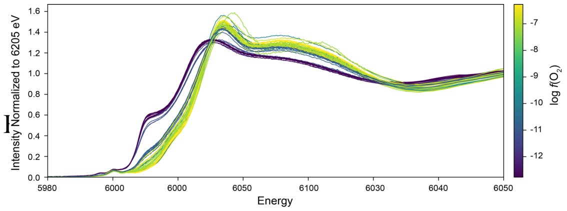

Figure 1. XAS spectra of Cr as related to f_{O2}

[1] Frost (1991) *Rev. Min*. 25: 1-9. [2] Papike *et al* (2005) *Am. Min*. **90**: 277-290. [3] Murck & Campbell (1986) *GCA* **50:** 1871-1887. [4] Berry *et al* (2003) *Am. Min*. **88:** 967-977. [5] Karner et al (2007) *Am. Min*. **92:** 1238-1241.