

## **Vanadium micro-XANES determination of oxygen fugacity in olivine-hosted glass inclusion and groundmass glasses of martian primitive shergottite Yamato 980459**

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### **ABSTRACT**

The redox condition of magma determines the stability and composition of crystallizing and volatile phases in martian meteorites, reflecting the evolution of the martian interior. In the current study, direct analyses on the oxidation states of V, Cr, and Fe were performed based on the X-ray absorption near-edge structure (XANES) measurements equipped with a micro-sized X-ray beam. We first applied the micro-XANES ( $\mu$ -XANES) technique to the olivine-hosted glass inclusion and groundmass glass of martian meteorite Yamato 980459 (Y98), which is interpreted as representing a primary melt composition. Mass-balance calculations and XANES spectra comparisons indicated that, while chromite and pyroxene affected Cr and Fe *K*-edge XANES spectra, the contribution of these minerals was minimal for V. The pre-edge peak intensity of V *K*-edge XANES enabled the estimation of the oxygen fugacity for inclusion and groundmass glasses. The calculated oxygen fugacity ( $f_{O_2}$ ) of the glass inclusions was near the Iron–Wüstite (IW) buffer ( $IW-0.07 \pm 0.32$ ) for the glass inclusion, whereas it was 0.9 log units more oxidized ( $IW+0.93 \pm 0.56$ ) for the groundmass glasses. This result suggests that the redox condition of the parent magma of Y98 evolved during magma ascent and emplacement. Since Y98 is interpreted to have evolved in a closed system, our finding suggests that fractional crystallization and/or ascent of magma potentially induces the  $f_{O_2}$  increase. This study shows that the  $\mu$ -XANES technique enables us to determine the  $f_{O_2}$  by only measuring a single phase of glassy compounds, and thus, it is useful to discuss the redox condition of volcanic rocks even if they do not crystallize out several equilibrium phases of minerals.

**Keywords:**  $\mu$ -XANES, oxidation states, oxygen fugacity, Yamato 980459, shergottite