

Valence state partitioning of vanadium between olivine-liquid: Estimates of the oxygen fugacity of Y980459 and application to other olivine-phyric martian basalts

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ABSTRACT

The valence state of vanadium (V^{2+} , V^{3+} , V^{4+} , and V^{5+}) is highly sensitive to variations in redox conditions of basaltic magmas. Differences in valence state will influence its partitioning behavior between minerals and basaltic liquid. Using partitioning behavior of V between olivine and basaltic liquid precisely calibrated for martian basalts, we determined the oxidation state of a primitive (olivine-rich, high Mg no.) martian basalt (Y980459) near its liquidus. The behavior of V in the olivine from other martian olivine-phyric basalts (SaU005, DaG476, and NWA1110) was documented. The combination of oxidation state and incompatible-element characteristics determined from early olivine indicates that correlations among geochemical characteristics such as f_{O_2} , LREE/HREE, initial $^{87}\text{Sr}/^{86}\text{Sr}$, and initial ϵ_{Nd} observed in many martian basalts is also a fundamental characteristic of these primitive magmas. These observations are interpreted as indicating that the mantle sources for these magmas have a limited variation in f_{O_2} from IW to IW+1 and are incompatible-element depleted. Moreover, these mantle-derived magmas assimilated a more oxidizing (>IW+3), incompatible-element enriched, lower-crustal component as they ponded at the base of the martian crust.

Keywords: Shergottite, olivine, vanadium, valence state partitioning