Comparative Controls on Planetary Redox States: Insights from the Earth and Mars

CHRISTOPHER D. K. HERD[1]*

[1]Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, AB, Canada, T6G 2E3 (*correspondence: herd@ualberta.ca)

The oxygen fugacity (fO_2) determined by analysis of planetary basalts provides a mechanism to infer the redox states of planetary mantles. Whereas the Earth's interior may be readily investigated, studies of other terrestrial planet interiors rely on planetary samples, especially meteorites. Nevertheless, comparative studies provide insights into planetary interior formation and evolution.

The fO_2 of basalts and other eruptives on Earth, coupled with constraints on mantle source redox conditions (e.g., bulk V/Sc [1]) demonstrate that the range of asthenospheric fO_2 is relatively restricted and that the fO_2 of eruptives is influenced by tectonic setting (review by [2]).

Although biased towards young, relatively unaltered/unweathered igneous eruptives [3], the ~50 shergottites (martian basaltic meteorites) provide constraints on the redox conditions of their mantle sources. In general, the REE and radiogenic isotope geochemistry of the shergottites can be explained by early (~4.5 Ga) formation of incompatible element enriched and depleted reservoirs in their mantle sources (review by [4]). Correlative with long-term incompatible element enrichment is higher fO_2 [e.g., 5]; in general, the correlation holds (often represented by La/Yb vs. fO_2). However, olivine-bearing shergottites (those with olivine phenocrysts or oikocrysts) trace a trend with steeper slope in La/Yb vs. fO_2; furthermore, bulk V/Sc correlates with fO_2, with olivine-bearing shergottites forming a distinct suite relative to the remaining basaltic shergottites. These observations suggest that the olivine-bearing shergottites are derived from a distinct set of mantle sources.

Taken with recent results of *in situ* analysis of Gusev basalts [6], it is apparent that Mars' mantle may be characterized by early-formed 'redox reservoirs' that have escaped remixing. The Earth and Mars thus represent contrasting examples of planetary interior evolution.

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