GEOCHEMICAL DIVERSITY OF SHERGOTTITE BASALTS: MIXING, FRACTIONATION, AND MARS SURFACE BASALTS

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Introduction: The chemical compositions of shergottite meteorites, basaltic rocks from Mars, provide a broad view of the origins and differentiation of these martian magmas. Following earlier studies [1,2], we revisit inter-element correlations in the bulk compositions of shergottites, with data on many meterorites found and analyzed since [2]. Some earlier inferences cannot be supported, and new regularities in bulk compositions have emerged.

Classification: In the past, Al was treated as an incompatible element, which is true for most but not all shergottites. Shergottites with Al > 5% wt have essentially the same Al contents regardless of abundances of other incompatible elements (e.g., Th, Ti). These *high-Al shergottites* represent melts saturated in plagioclase, and are distinct from both *olivine-phyric shergottites* [3] and *low-Al shergottites*, which are dominated by pyroxenes (e.g. Shergotty).

Geochemistry: Abundance ratios of highly incompatible elements (e.g., Th, La) are comparable in all the shergottites. Abundances of less incompatible elements (e.g., Ti, Lu, Hf) in olivine-phyric and low-Al basalts correlate well with each other, but the element abundance ratios are not constant; this is consisten with mixing between two components, one depleted and one enriched. High-Al shergottites deviate from these trends, consistent with silicate mineral fractionation. The depleted component is similar to the Yamato 980459 magma; ~67% crystal fractionation from a magma like this would yield a melt with trace element abundances similar to QUE 94201. The enriched component is like the parent magma for NWA 1068; ~30% crystal fractionation from it would yield a melt with trace element abundances similar to the Los Angeles shergottite. This component mixing is consistent with radiogenic isotope and oxygen fugacity data. Nearly all the diversity of shergottites can be represented as mixing of these components with subsequent crystal addition or fractionation.

These geochemical relations for shergottites are consistent with the compositional diversity of many of the Gusev Crater basalts, analyzed on Mars by the Spirit rover (although with only a few elements to compare). However, other Mars basalts are not consistent with the shergottite geochemistry, like Wishstone rock at Gusev [4], and the Gale crater basalts [5]. Their compositions imply that basalt source areas in Mars include significant complexities, notably in the abundances of alkali metals, that are not represented among the shergottites, and hence in their mantle source areas.

References: [1] Wänke H. et al. 1981. Phil. Trans. Roy. Soc. A303, 287. [2] Treiman A.H. 2003. MaPS 39:1849. [3] Goodrich C.A. 2002 MaPS 37:B31. [4] Ming D. et al. 2008. *JGR:P* 113:E12S39. [5] Schmidt M.E. et al. 2014. *JGR:P* 119:64-81.