

Evaluating Crustal Contamination Effects on the Lithophile Trace Element Budget of Shergottites

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The origin of the incompatible trace element (ITE) enriched compositions of shergottites has been a point of contention for decades [1-2]. Two scenarios have been proposed, the first is that enriched shergottite compositions reflect an ITE-enriched mantle source, whereas in the second, the ITE enrichment reflects crustal contamination of mantle-derived parent magmas. Evidence supporting the first scenario is that the ITE-enriched shergottite compositions are consistent with the outcomes of magma ocean crystallization [3], and that Os-Nd isotope relationships for shergottites cannot be explained by realistic crustal contamination models [4]. In contrast, Cl and S isotopes are consistent with shergottite magmas interacting with Mars crust [5,6], and La-Ce-enriched olivine-hosted melt inclusions and interstitial glass are found in depleted shergottite Yamato 980459 [7]. These findings indicate that some level of crustal interaction occurred but the question of whether ITE-enrichments in some bulk shergottites reflect crustal contamination remains open.

Recently, a Mars crustal breccia meteorite has been found, NWA 7034 and its paired stones, that is our best analogue to an average of Mars ancient crust [8-10]. This allows for better constraints on crustal contamination of shergottite magmas. We modeled magma-crust mixing and assimilation-fractional crystallization (AFC) using ITE-depleted shergottite compositions and bulk NWA 7034 and its clasts as end-members. The results of these models indicate that crustal contamination can only explain the ITE-enriched compositions of some bulk shergottites under unusual circumstances. It is thus likely that the shergottite range of compositions reflects primarily mantle sources.

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