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SULFUR ISOTOPIC CONSTRAINTS ON THE NATURE OF SULFUR IN PRIMITIVE MELTS ON MARS USING IN SITU ANALYSIS OF SULFIDES IN MARTIAN METEORITES.

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Shergottites represent mafic to ultramafic melts derived from the Martian mantle and are possibly the best samples available for determining its sulfur isotope composition. Bulk analyses of shergottites exhibit $\Delta^{33}S$ and ^{34}S values that range from, -0.05‰ to 0.2‰ and -1.0‰ to 1.0‰, respectively[1,2]. Previous studies of the bulk S isotope compositions of the primitive meteorites Yamato(Y) 980459 and Tissint do not show mass-independent fractionation (MIF)[1,2]. These results differ from Martian polymict breccia NWA 7034[3] and nakhlites[4-7], which show strong evidence of MIF-S assimilated during eruption, and other achondrites with MIF-S associated with planetesimal cores and core-mantle boundaries[8]. Such challenges the idea that terrestrial primordial melts possibly host nebular MIF-S[8].

Here, we present secondary ion mass spectrometry analysis of sulfides in Martian meteorites (Y 980459, Tissint, Gadamis 001 and NWA 11300) to further constrain the nature of primordial sulfur on Mars (Figure 1). Results reveal anomalous $\Delta^{33}S$ signatures in all four meteorites that are of greater magnitude compared to the bulk analyses[1,9].

Anomalous $\Delta^{33}S$ values in Y 980459 are linked to sulfides in the mesostasis and are likely associated with sulfur assimilated during late-stage melt interaction with the Martian crust. The anomalous $\Delta^{33}S$ signatures in LREE enriched shergottites Gadamis 001 and NWA 11300 can also be linked to crustal assimilation. The $\Delta^{33}S$ anomalies in Tissint are associated with sulfides included in olivine, pyroxene, and maskelynite. Such represent a primary melt signature and imply that Mars had an early formed MIF-S mantle reservoir. These findings refine sulfur isotope systematics in Martian meteorites, revealing crustal assimilation of atmospherically processed S and presence of an early MIF-S reservoir in the Martian mantle.

[1] Franz et al., (2014), *Nature, 508*(7496), 364–368; [2] Franz et al., (2019), *MAPS, 54*(12), 3036–3051; [3] Lorand et al. (2020), *MAPS, 59*(9), 2523–2544; [4] Farquhar et al. (2007), *EPSL, 264*(1), 1–8; [5,6] Dottin et al. (2018a,b), *GCA, 239*, 186–197, *224*, 276–281; [7] Greenwood et al., (2000), *GCA, 64*(6), 1121–1131; [8] Dottin et al., (2020), *EPSL, 534*, 116073;[9] Franz et al. (2021), *LPSC*.

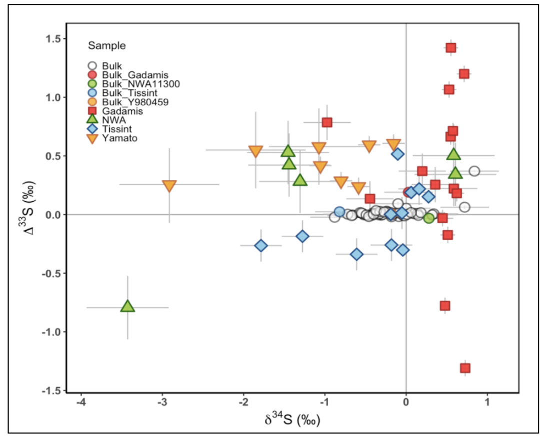

Figure 1. Sulfur isotope compositions of shergottites based on SIMS measurements. The $\delta^{34}S$ values range from -2.91‰ to -0.15‰ in Y 980459, -1.79‰ to 0.28‰ in Tissint, -2.27‰ to -0.35‰ in Gadamis 001, and -3.43‰ to 0.61‰ in NWA 11300. Corresponding $\Delta^{33}S$ values vary from 0.24‰ to 0.61‰, -0.34‰ to 0.52‰, -1.31‰ to 1.42‰, and -0.79‰ to 0.53‰, respectively. White circles represent sulfur isotope compositions of shergottites measured through bulk analysis (data from Franz et al., 2014, and Franz et al., 2019).