The role of sulfides in the fractionation of highly siderophile and chalcophile elements during the formation of shergottite meteorites

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We report LA-ICP-MS analyses for (highly) siderophile and chalcophile elements (Co, Ni, Cu, As, Se, Ag, Te, Pb, Bi, and the platinum-group elements, PGE) of magmatic sulfides from martian shergottite meteorites. The analyzed samples include one incompatible trace element- (ITE-) enriched basaltic shergottite (Zagami), and three ITE-depleted olivine-phyric specimens (Y-980459, Dar al Gani 476 and Dhofar 019) that formed from similar mantle/magma sources.

The sulfides in shergottites have been modified by melting/volatilization during impact-related ejection on Mars and alteration on the Earth. However, they preserved their magmatic PGE signatures. The CI chondrite-normalized PGE patterns reproduce the published whole-rock data, which indicates that sulfides exerted a strong control on PGE during shergottite genesis. However, depletions of Pt (and Ir) in sulfides suggest that these elements are also concentrated by discrete phases such as Pt-Fe-(Ir) alloys that may have enhanced stability in reduced and FeO-rich martian magmas. A Pt-rich PGM was observed in a sulfide assemblage from Dhofar 019. However, its origin may be related to sulfide melting/volatilization during meteorite ejection.

In the olivine-phyric shergottites, positive relationships exist between petrogenetic indicators (Mg-number) and siderophile-chalcophile elements in sulfides. These variations extend to incompatible elements like Te and Pd. The whole-rock concentrations of Pd derived from mass-balance calculations decrease by one order of magnitude in the order Y-980459, DaG 476 and Dhofar 019, and overlap the trends in published whole-rock data. Sulfide saturation as function of mantle melting or magma fractionation may have been the controlling factors of the siderophile and chalcophile element signatures of the analyzed olivine-phyric-shergottites.