Magma ocean or superplume origin for Mars meteorite source mantle?

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The origin of super-chondritic CaO/Al_2O_3 in shergottite meteorites and their calculated parent magmas has been explained by phase equilibria experiments that require derivation from a mantle source region depleted by majorite fractionation at high pressure in a global magma ocean or in a deep, partially molten, superplume. These experiments also show that the martian meteorite source region must have significantly less FeO than the Dreibus-Wänke bulk martian mantle composition. Good matches to isotopic and trace element data are also obtained in this formulation. In the magma ocean version of this model, the resulting differentiation imposes a planet-wide geochemical signature that excludes any other mantle lithologies that do not possess the initial low FeO content or the elevated CaO/Al_2O_3 ratio after early majorite removal.

However, the measurements by the Mars Exploration Rovers of surface rocks that have been interpreted as basaltic (from Gusev crater) do not have superchondritic CaO/Al_2O_3. If these rocks are indeed largely unaltered basaltic samples, then their existence argues against a global, extensive magma ocean. It is conceivable that the current inventory of shergottite meteorites came from only a few volcanic centers on Mars, possibly all part of Tharsis. Thus it is quite reasonable to suggest that our sampling of the igneous reservoirs on Mars is incomplete. In fact, it is remarkable that the small and limited sample set has allowed such broad inferences to be made about the nature of the martian interior.

One possibility is that a deep “superplume” early in Mars' history produced the geochemical reservoirs that are unquestionably reflected in the compositions of the shergottite meteorites. In this view, many processes invoked as occurring in a global magma ocean, and especially early majorite fractionation to impart superchondritic CaO/Al_2O_3, may have taken place, but to a more limited extent and only within the plume. Such a feature may operate in a similar fashion to the geophysical models of Kiefer and coworkers. Other mantle regions unaffected by the plume could, at least potentially, retain a chondritic value.

Coupled Li and B isotope variations in Aegean-Western Anatolia arc lavas: Evidences for δ^7Li fractionation in subducted slabs

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The Central Aegean-Western Anatolia region is characterized by evolving subduction-related volcanic activity since at least Early Miocene. The region is currently undergoing active extension, and the geochemical character of igneous activity has changed markedly over time, from calc-alkaline, shoshonitic and U-K products to alkali basalts. Therefore, this region is an outstanding natural laboratory for observing the fate of subduction signals during the transition from subduction-related to intraplate volcanic activity, traced by the temporal evolution of boron and lithium isotope systematics, which can trace how changing slab fluid inputs modify and hybridize the subarc mantle source.

Western Anatolia supra subduction rocks are characterized by progressive δ^7Li lowering of younger products, resulting in a remarkable Li isotopic variability at ~15‰ (δ^7Li from +8 to -7‰), unique among all igneous rock suites thus far observed. The δ^7Li is positively correlated with $^{87}Sr/^{86}Sr$ and negatively correlated with $^{143}Nd/^{144}Nd$, even if these isotope ratios have very small variations. Also, the Li isotopes show positive correlations with the typical geochemical tracers of slab fluid phases (as B/Nb, B/Be or Pb/Ce ratios) and especially with B isotopes, which vary correspondingly: δ^{11}B from 0 to -15‰.

The straightforward B-Li isotopic correlation observed in this suite indicates that this variability, inherited by B-Li isotope fractionation of the slab-released fluids, is recorded in the B and Li signatures of the mantle wedge source, ruling out a diffusion-induced Li isotopic disequilibrium in the source as possible explanation for the δ^7Li values of these rocks.

Therefore, significant Li isotopic fractionation can occur during subduction processes, and Li isotope variability can be preserved in the magma sources under certa*in situ*ation, such as the peculiar geodynamic setting of the investigated region (low-angle, slow, hot subduction, thin mantle wedge).

These findings contrast strongly: i) with observations in most modern subduction systems, where Li isotopic signatures are generally indistinguishable from those of other mantle-derived lavas; ii) with recent modeling postulating that Li isotope signature in slab released fluids is unquestionably heavy.