# Experimental constraints on the origin of SNC meteorites and the composition of the Martian mantle

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High-pressure melting experiments on a chondritic model Martian mantle composition (Homestead L5) were performed between 2-9 GPa in a multi-anvil device over a temperature interval that ranged from near solidus to near liquidus conditions. From these experiments we have determined a P-T phase diagram and major and trace element compositions of partial melts which may be relevant to the origin of Martian parent magmas. One of our primary findings is that the super-chondritic $CaO/Al_2O_3$ of Martian parent magmas can be produced by partial melting of model Martian mantle at pressures ≥5 GPa or depths of ≥425 km in Mars.

This finding is consistent with a differentiation scenario in which early Mars had a magma ocean that extended to depths >425 km. At the bottom of the magma ocean partial melt coexisted with garnet, olivine and pyroxene and as result the magma ocean acquired a super-chondritic $CaO/Al_2O_3$ composition. At higher levels within the magma ocean olivine and orthopyroxene crystallized and then sank to the bottom, concentrating CaO and $Al_2O_3$ in the melt column. The fractionated magma ocean cooled, solidified, and became the source region for SNC parent magmas by later episodes of shallow mantle, low-pressure partial melting.

Our experimental melt compositions indicate that there is a mismatch between a model Martian mantle with Mg#=75 and Martian parent magma source regions if they are generated at high pressure. A remedy for this apparent inconsistency might require a bulk Martian mantle composition and Mg# closer to that of H-chondrites.

# Geochemical and isotopic constraints on the protolith of ultra high pressure eclogitic rocks from the Tso-Morari crystallines, Ladakh Himalaya, India

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Eclogitic rocks occur as lenses within the Puga gneisses of the Tso-Morari crystalline complex. Coesite inclusions within garnet has been reported from these eclogitic rocks indicating ultra-high pressure (UHP) metamorphism at >28 kb. The eclogitic rocks display restricted variation in $SiO_2$ abundances (~ 45 to 48 wt%) indicating basaltic composition. Total alkali versus silica (TAS classification) indicate their transitional nature between alkaline and tholeiitic basalt. Rare earth element patterns display enriched characteristics with fractionated patterns $(La/Yb)_N$ = ~2 to 6. The $^{87}Sr/^{86}Sr$ ratios for the eclogitic rocks vary widely between 0.70884 and 0.73721 probably indicating interaction with host granitic gneiss with $^{87}Sr/^{86}Sr$ ratio of 0.92547. Eclogite multi-element patterns resemble those of the OIB – E-MORB, although large ion lithophile elements (LILE: Rb, Ba, K) display erratic behavior. La, Ce, LILE and $^{87}Sr/^{86}Sr$ ratio appear to have been perturbed by secondary processes. Whole rock epsilon Nd values (t = 0) vary from +3.3 to +8.3, indicating derivation from depleted mantle sources. Trace element and Nd-isotopic characteristics of these eclogites resembles those of the adjoining N-MORB - OIB rocks of the Zildat ophiolitic mélange but the $^{87}Sr/^{86}Sr$ ratios for the Tso Morari eclogites is much higher than the ophiolitic rocks. The latter have undergone blue schist facies metamorphism. However, our view regarding protolith for the Tso Morari eclogites differs from the widely held view that these eclogites may be metamorphosed products of the rift related Permian Panjal volcanics and its extension (Phe volcanics) in eastern Ladakh. Although major and trace element characteristics of the Phe volcanics do resemble with the Tso-Morari eclogites, its epsilon Nd (t = 0) are very different, it varies from –2.7 to –7.8, indicating their derivation from highly enriched sources. Preliminary $^{40}Ar/^{39}Ar$ data on the separated white mica from one of the samples gives three dates: 72.1±1.1 Ma; 85.2±0.6 Ma and 100.8±0.9 Ma, significance of these ages is not yet clear. We suggest that Tso-Morari eclogites, presently occurring as lenses in the host gneisses, probably represent fragmented dykes related to the N-MORB - OIB type magmatism of the Neo-Tethyan ocean that have traversed through the northern margin of the Indian plate represented by the gneisses of the Tso Morari crystalline complex.