**SILICON IN MARS’ CORE: A PREDICTION BASED ON MARS MODEL USING NITROGEN AND OXYGEN ISOTOPES IN SNC METEORITES.** R. K. Mohapatra 1, S. V. S. Murty 2, 1Max-Planck-Institut für Chemie, Becherweg 27, D 55128 Mainz, Germany (ratan@mpch-mainz.mpg.de) 2Physical Research Laboratory, Navarangpura, Ahmedabad 380009, India.

**Introduction:** Chemical and (oxygen) isotopic compositions of SNC meteorites have been used by a number of workers to infer the nature of precursor materials for the accretion of Mars [1-4]. The idea that chondritic materials played a key role in the formation of Mars has been the central assumption in these works. Wänke and Dreibus [1] have proposed a mixture of two types of chondritic materials, differing in oxygen fugacity but having CI type bulk chemical composition for the non-volatile elements, for Mars’ precursor. But a number of studies based on high pressure and temperature melting experiments do favor a CI type bulk planet composition for Mars, as it predicts a bulk planet Fe/Si ratio much higher than that reported from the recent Pathfinder data (e.g., [5]). Oxygen forms the bulk of Mars (~40 % by wt., e.g., [1]), and might provide clues to the type of materials that formed Mars. But models based on the oxygen isotopic compositions of SNC meteorites predict three different mixtures of precursor materials for Mars: 90% H + 10% CM [2], 85% H + 11% CV + 4% CI [3] and 45% EH + 55% H [4]. As each of these models has been shown to be consistent with the bulk geophysical properties (such as mean density, and moment of inertia factor) of Mars, the nature of the material that accreted to form Mars remains ambiguous.

**The N and O isotopic model:** We have adopted a new approach to this study, which involves the isotopic compositions of nitrogen (\(\delta^{15}\)N) and oxygen (\(\Delta^{17}\)O) in SNC meteorites. As we have shown earlier [6], the nitrogen and oxygen isotopic systematics of Mars mantle derived from the SNC data (\(\delta^{15}\)N = –30‰ [6]; \(\Delta^{17}\)O = 0.321±0.013‰ [7]) are consistent with a mixture of EC and OC type precursor materials for the planet. A similar result is obtained if one considers \(\Delta^{17}\)O and radiogenic chromium (\(\varepsilon^{53}\)Cr) data for the SNCs [8]. Moreover, such a mixture is also consistent with the bulk planet Fe/Si ratio for Mars as predicted from the moment of inertia factor obtained from the Mars Pathfinder data [5]. We would like to point out here that the relative contributions of EC and OC in our earlier calculations [6] were based the \(\Delta^{17}\)O of EH and H. But as we have already pointed out, one cannot actually resolve such a mixing proportion from those involving the other types of EC and OC by the N and O isotopic systematics. Therefore we repeated the calculations by using the mean values for the EC [9] and OC [10], which suggested the EC:OC ratio to be 74:26 (Fig. 1). We also tried to further resolve the possible mixing proportions between EC and OC by using the bulk planet Fe/Si for Mars predicted by Bertka and Fei [5] as a constraint. But such an exercise did not prove encouraging.

![Fig. 1. The nitrogen and oxygen isotopic systematics of Mars, in relation to those of different types (inset) of chondrites (after [6]). Mars is consistent with a mixture of EC and OC in a ratio of 74:26 (main plot).](image)

Therefore we derived the bulk chemical composition for Mars by mixing 74% EC and 26% OC, and investigated the consequences of such a model. The bulk planet Fe of 24.7 wt % and Fe/Si ratio (by wt.) of 1.39 obtained from the above mixture are consistent with the ranges given by Bertka and Fei [5]. It is possible to reproduce the bulk chemical composition (major oxides) of the martian mantle (Table 1) and its mean density as suggested by the SNCs [1] if one accommodates a small fraction (~0.08) of the planet’s Si in the core. The core predicted by the present model thus has 6.7 wt % of Si, a density of 6.5 g/cc and accounts for 23 % of the planet’s mass. The moment of inertia factor of 0.368 ± 0.003 calculated for Mars, by assuming a crust with thickness of 20 to 50 km and density of 2.7 to 3 g/cc, is consistent with the value predicted from the Mars Pathfinder data [11].

**Si in martian core:** Si has commonly not been invoked as a light element in the core of Mars [12] although its presence in the terrestrial core has often been suggested from geochemical arguments [13]. Wänke and Dreibus [14] have pointed out that the depletion of Si in Earth’s mantle-derived rocks as compared to samples from Mars can be explained by the
SILICON IN MARS’ CORE: R. K. Mohapatra and S. V. S. Murty

presence of 14.4 wt % of Si in Earth’s core. Although, the presence of significant Si in Earth below core-mantle boundary is a matter of debate at the present, recent results from high pressure and temperature melting studies [15] and theoretical studies based on ab initio calculations and seismic data [16] suggest as low as 8 mol % of Si in Earth’s outer core. Iron silicide as a possible host phase for Si in the core has thus been the focus of a number of experimental and theoretical studies. The results from Guyot et al. [17], based on both experimental and theoretical observations, show that significant amounts of Si can be dissolved in Fe between the pressures 8 and 15 GPa. A number of similar studies have also shown that at pressures below 25 GPa liquid iron can accommodate significant amounts of Si in solution, while at pressures above 25 GPa it (Si) may exsolve from the solution [13]. The expected pressure at the core-mantle boundary of Mars for the present model is about 20 GPa, which falls within the regime of significant Si solubility indicated by the above studies. Therefore, we cannot neglect the possibility of Si being present as a light element in the martian core. The partitioning of Si into the martian core would require a reducing environment to prevail during the core-mantle separation, which is supported by the reducing nature of the martian mantle as has been recently pointed out [18-19]. The possible partitioning of Si into the core is also compatible with the chemical data on the opaque phases (metal bearing) in enstatite chondrites. A recent study [20], for example, has shown up to 12.5 wt % of Si in such phases.