ISOTOPE CLUES ON THE ORIGIN OF MG/SI VARIATIONS IN CHONDRITES AND PLANETARY BODIES

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Introduction: The variations of Mg/Si and Al/Si ratios in meteorites and planetary bodies have so far remained rather enigmatic. In principle, the variations in Mg and Si isotope ratios in meteorites and planets should reflect the conditions for the processing of early solar system material whereby evaporation, condensation or gas-condensed phase reactions should affect the isotope composition of these two elements. New Si and Mg isotopes data for various classes of chondrites and for terrestrial materials obtained by MC-ICPMS at the ETH Zurich sheds new light on this question. While the δ^{30}Si values of chondrites is positively correlated with Mg/Si ratios [1], the δ^{26}Mg values of various types of chondrites and terrestrial samples (both basalts and peridotites) remain constant [2, 3]. In principle, several processes could explain these observations.

Discussion: If the observations in Mg and Si isotopes were to be explained by evaporation, then we would expect that the bodies with high Mg/Si ratios should have heavier δ^{30}Si values or δ^{26}Mg values starting from a solar composition, which is not observed. The constant δ^{26}Mg values in bulk chondrites for variable Al/Mg ratios would require Mg loss under relatively high pressure environments. In addition, the maximum δ^{30}Si difference observed between the Earth and chondrites requires that the difference in δ^{26}Mg values would not be resolvable with the current level of precision obtained for Mg isotope measurements (0.1‰, 2SD). Similarly, if we attempt to explain the Mg and Si isotope observations in meteorites and the Earth by fractional condensation, the predicted trend for Mg and Si isotopes does not fit the observations because the refractory components with a high Mg/Si should have high δ^{30}Si values (or δ^{26}Mg values), in contrast with the observations. A third model for explaining the observations in Mg/Si, Al/Si, Mg and Si isotopes is to have a reaction between condensed silicates and gas at high temperatures. For example, the reaction of forsterite with SiO_g leads to the formation of enstatite (e.g. [4]) with a low Mg/Si ratio, leaving the Mg isotopes unaffected and providing an explanation for the positive trend between δ^{30}Si values with Mg/Si ratios. In addition, this model explains the covariation between Mg/Si and Al/Si in enstatite, ordinary, and CI chondrites [5], whereby Mg and Al remain inert during this reaction.

References: [1] Fitoussi C. et al. 2009. *Earth and Planetary Science Letters*, 297: 77-85. [2] Bourdon B. et al. 2010. *Geochimica and Cosmochimica Acta*, in revision. [3] Teng F.Z. et al. 2010. *Geochimica and Cosmochimica Acta* in press. [4] Palme H. 2000. *Space Sci. Rev.*, 92: 237-262. [5] Jagoutz E. et al. 1979. Proc. Lunar Planet. Sci. Conf. 10th, pp. 2031-2050.