FURTHER CONSTRAINING THE CHLORINE ISOTOPE COMPOSITION OF THE SOLAR NEBULA: MAIN GROUP IRON METEORITES

A. M. Gargano¹, Z. D. Sharp¹, and L. A. Taylor² ¹Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131 (agargano@unm.edu, zsharp@unm.edu), ²Planetary Geosciences Institute, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996 (lataylor@utk.edu).

Introduction: The δ37Cl value of the bulk Earth is approximately 0‰ [1, 2]. Lunar samples (-0.7 to +13‰), and Martian meteorites (-4 to +8‰) have a much wider range of Cl isotope compositions [3-6]. The high δ37Cl values in lunar samples are explained by volatilization of lunar magma, whereas the low δ37Cl values in the olivine phyrictic shergottites (-2 to -4‰) are explained by the direct incorporation of nebular HCl [3, 4, 6]. Chondrites however, are more limited in δ37Cl values, clustering from -2 to +1‰, with the exception of two ordinary chondrites with low δ37Cl values between -4, and -5‰ (Parnalle LL3.6 and NWA 8276 L3.00)[1, 3, 7]. These low δ37Cl values in ordinary chondrites are consistent with the direct incorporation of nebular HCl, whereas higher δ37Cl values are explained by the incorporation of HCl ice (HCl•H2O) during the accretion of respective chondrite parent bodies [1, 3, 4]. Here, we present preliminary data on the chlorine isotope compositions of main group iron meteorites (Campos Del Cielo, Canyon Diablo, Grant, Odessa and Cranbourne) in order to further constrain the δ37Cl value of the solar nebula, and the sources of volatiles to the terrestrial planets.

Results: We measured the chlorine isotope composition of the water-soluble fraction (WSF), and struturally-bound fraction (SBF) of selected main group iron meteorites. Iron meteorites were dissolved in concentrated nitric acid to obtain the SBF. Samples were prepared and analyzed following a modified methodology outlined Sharp et al., 2007 using IRMS on a Delta+XL [2]. Both the WSF, and SBF were prepared and analyzed separately. The δ35Cl values of both fractions ranged in chlorine isotope values from -6 to -3.1‰, with no apparent relation between the fractions (Fig. 1).

Discussion: The snow-line is the region in space where volatiles such as water condensed out of the solar nebula. This region separates the terrestrial volatile-poor planets, from the jovian volatile-rich planets [8, 9]. The source of volatiles to the terrestrial planets is commonly assumed to be chondritic in origin from the late delivery of volatile-rich material from beyond the snow-line [10-13]. Beyond the snow line, at temperatures between 140-160K, HCl•H2O forms, and produces a +3 to +6‰ chlorine isotope fractionation, as HCl•H2O preferentially incorporates the heavy chlorine isotope [1, 14]. If chondritic material were to incorporate chlorine from HCl•H2O, it is expected to overprint the nebulosity chlorine isotope composition to higher δ37Cl values.

The δ37Cl value of the solar nebula has been proposed to be light (-5‰), with chondritic variations explained by interactions with heavy HCl•H2O from beyond the snow-line [1, 3, 4]. The chlorine isotope composition of primitive iron meteorites suggest a nebular origin, with light δ37Cl values ranging from -6 to -3.1‰. These results support the idea that the solar nebula had a low δ37Cl, approximately -6‰ or less. If we assume the predominant control on chlorine isotope fractionation in the early solar system to be the formation of HCl•H2O, then these data suggest that incorporation of HCl•H2O in chondritic material was widespread, and that iron meteorites formed inside of the snow-line.