MAKING SENSE OF MERCURY ISOTOPIC AND ABUNDANCE VARIATIONS IN METEORITES

M. M. M. Meier[1,2], C. Cloquet[1], B. Marty[1]. [1]CRPG CNRS Nancy, Univ. Lorraine, Nancy, France; [2]ETH Zurich, Zurich, Switzerland.

Introduction: The analysis of Hg in meteorites has long been dominated by Neutron Activation Analysis (NAA) studies, which seemed to indicate huge variations in Hg abundance and isotopic ($^{196/202}$Hg) composition. These were later shown to be, at least partly, due to interference problems [1]. Since the first ICP-MS analysis of Hg in Allende (CV) and Murchison (CM) by [2], which showed no Hg isotopic variation within uncertainties, Hg has been studied predominantly in terrestrial environments, where it has been shown that Hg undergoes both mass-dependent (MDF) and mass-independent (MIF) isotopic fractionations. MIF results in Δ^{199}Hg/Δ^{201}Hg ratios characteristic of the process inducing the fractionation. Until this year [3,4], these effects have never been studied in meteorites. We present additional Hg isotopic data for Tagish Lake (C ungr.), Allende (CV), Almahata Sitta (ureilite) and a few more meteorites, and discuss a first-order model to explain the variation of Hg isotopes and abundances in meteorites.

Methods: Hg concentrations were measured using a Milestone SRL Direct Mercury Analyzer (DMA-80). Isotopic analysis was done with a cold-vapor extraction system ([5]; Hg dissolved in <32% HNO_3) feeding into a MC-ICP-MS (Thermo Neptune+).

Results & Discussion: In the CI chondrite Orgueil, isotopically anomalous Hg (Δ^{199}Hg = ~0.25‰, Δ^{201}Hg = ~0.15‰ [3]) is present at a concentration exceeding the upper limit on the abundance in the solar photosphere [6] by a large margin. Step heating experiments show that most of the Hg in Orgueil is released at temperatures 300-400°C, and thus unlikely to be related to terrestrial contamination. Many meteorites, however, release a large fraction of their Hg at lower temperatures (<150°C), including the L3.7 chondrite Mezö-Madaras. At least for Mezö-Madaras, the isotopic composition of the Hg released in the 150°C step is identical to the Hg released in higher temperature steps. A similar experiment with the H5-chondrite Tieschitz failed due to the much lower Hg concentration found in our Tieschitz sample, compared to literature values [7]. This strong variation between individual samples of the same meteorite has also been observed for Orgueil [3,4], Allende [2,3,4] and Murchison [2,3], and suggests that the distribution of meteoritic Hg is inhomogeneous on the ~gram scale. Nevertheless, the high Hg abundances observed in meteorite samples (combined with low solar photospheric abundance) require the evaporation and re-condensation of Hg from the interiors of relatively large (R>50 km) parent objects. We show this based on relatively simple models of parent body heating. Evaporation and re-condensation of Hg under equilibrium (closed-system) conditions can explain the observed isotopic fractionation (and Δ^{199}Hg / Δ^{201}Hg ratio) of Hg in Orgueil and other carbonaceous chondrites altered at low temperatures, including Paris (CM2.7), Tagish Lake (C2 ungr.), Kainsaz (CO3.2) and Murchison (CM2).

References: [1]Lauretta D. et al., 1999, *Earth & Planetary Science Letters* 171:35-47. [2]Lauretta D. et al., 2001, *Geochimica et Cosmochimica Acta* 65:2807-2818. [3]Meier M. M. M., et al., 2015, *LPSC* 46, #1101. [4]Wiederhold J., Schönbächler M., 2015, *LPSC* 46, #1841. [5]Estrade N. et al. 2009, *Geochimica et Cosmochimica Acta* 73:2693-2711. [6]Grevesse N. et al., 2015, *Astronomy & Astrphysics* 573:A27. [7]Caillet Kommarovski C. et al., 2012, *Earth & Planetary Science Letters* 349-350:261-271.