

EXTREME CADMIUM AND THALLIUM ISOTOPE FRACTIONATIONS IN ENSTATITE CHONDRITES

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Introduction: The extinct ²⁰⁵Pb-²⁰⁵Tl decay system ($t_{1/2} = 15$ Myr) features two volatile elements and may hence be useful for studying volatile loss in the early solar system. Analyses of the Pb-Tl system are best combined with measurements of Cd isotope compositions to monitor stable isotope fractionations from evaporation and condensation [1,2]. In this study, we measure Pb, Tl and Cd abundances and isotopic compositions in bulk samples of enstatite chondrites. To date, results have been obtained for Indarch (EH4), Abee (EH4), St. Mark's (EH5), MAC 02839 (EL3), PCA 91020 (EL3) and Khairpur (EL6). Data for additional samples will be available at the meeting.

Results: The Pb, Tl and Cd abundances of the samples display considerable and systematic variability. In particular, the EL3 and EH4 enstatite chondrites have much higher volatile element contents (of about 40-100 ppb Tl, 300-900 ppb Cd) than the EH5 and EL6 samples, which record more intense thermal metamorphism and feature ~5 ppb Tl and ~10-20 ppb Cd. The Pb abundances also show a similar offset between samples of petrologic types 3 & 4 vs. 5 & 6, but two of the meteorites (Indarch, St. Mark's) have Pb isotope compositions, which are indicative of pervasive contamination by terrestrial Pb.

The most extreme stable isotope fractionations were found in two EL chondrites (PCA 91020, Khairpur), which are depleted in light Cd isotopes and display $\epsilon^{114/110}\text{Cd}$ values of about +70 (relative to a bulk silicate Earth with $\epsilon^{114/110}\text{Cd} \approx 0$). Moderate Cd stable isotope effects with $\epsilon^{114/110}\text{Cd}$ values of about +8 were furthermore identified for MAC 02839 and St. Mark's. Only Indarch and Abee feature essentially unfractionated Cd, relative to carbonaceous chondrites, with $\epsilon^{114/110}\text{Cd} \approx +3$. In contrast, only a single sample (PCA 91020) displays a clearly fractionated Tl isotope composition characterized by $\epsilon^{205}\text{Tl} \approx +22$, whereas all other meteorites have $\epsilon^{205}\text{Tl}$ of between -2.9 and +0.8, similar or identical to the bulk silicate Earth value of -2.0 ± 0.5 .

Discussion: The data obtained so far indicate that stable isotope fractionations are commonplace for Cd in enstatite chondrites. This is in accord with the results of earlier work [3], which found that Cd isotopes are an excellent monitor of parent body processes that effect the abundances of volatile elements. The only meteorite to display both large Cd and Tl stable isotope effects is the highly shocked (S5) sample PCA 91020 [4], possibly suggesting that Tl may be readily mobilized during shock metamorphism. Due to the presence of stable isotope fractionation for Cd and, at least in some samples, Tl, together with the terrestrial Pb contamination of two meteorites, it will be challenging to construct a ²⁰⁵Pb-²⁰⁵Tl parent body isochron for enstatite chondrites.

References: [1] Baker, R. G. A. et al. 2010. *Earth and Planetary Science Letters* 291:39-47. [2] Andreasen, R. et al. 2009. *Geochimica et Cosmochimica Acta* 73:13 Abstract #A43. [3] Wombacher, F. et al. 2008. *Geochimica et Cosmochimica Acta* 72:646-667. [4] Rubin, A. E. et al. 1997. *Geochimica et Cosmochimica Acta* 61:847-858.