TOWARDS HIGH PRECISION IN SITU TRIPLE OXYGEN ISOTOPIC ANALYSIS WITH SHRIMP SI

L.M. Loiselle[1], T.R. Ireland[1], P. Holden[1], J.N. Ávila[1], and P. Lanc[1]
[1]Research School of Earth Sciences, The Australian National University, Canberra ACT 2601, Australia.

Introduction: Oxygen isotope systematics are fundamental to our understanding of the Solar System [1]. In particular, triple oxygen isotope analyses are the cornerstone of meteorite classification and are quintessential measurements in establishing genetic relationships amongst differentiated meteorites. While these measurements are classically obtained using laser fluorination, here using olivine grains from three achondrite bodies (Mars, Earth and main group pallasites (PMG)) we demonstrate using *in situ* ion microprobe triple oxygen isotope analysis that we can resolve the small $\Delta^{17}O$ offsets of each planetary body.

Methods: A grain mount of known olivines from Mars (Chassigny), Earth (San Carlos) and main group pallasites (Brenham) were prepared and coated with ca. 50 nm gold. Compositional homogeneity of the olivine grains was verified with SEM EDS prior to isotopic analysis. *In situ* isotopic analysis was performed using Sensitive High-mass Resolution Ion Microprobe – Stable Isotope (SHRIMP SI) at The Australian National University (ANU).

Results: Triple oxygen isotope compositions of the measured olivine grains are presented in Figure 1. The oxygen isotopic data obtained for Mars and the main group pallasites (PMG) are consistent with the results of triple oxygen isotope measurements acquired using conventional 'bulk' techniques (e.g., $\Delta^{17}O$ offsets reported by [2,3-5] shown as dashed lines in Figure 1). Additionally, we demonstrate that we can routinely achieve this level of precision over multiple analytical sessions.

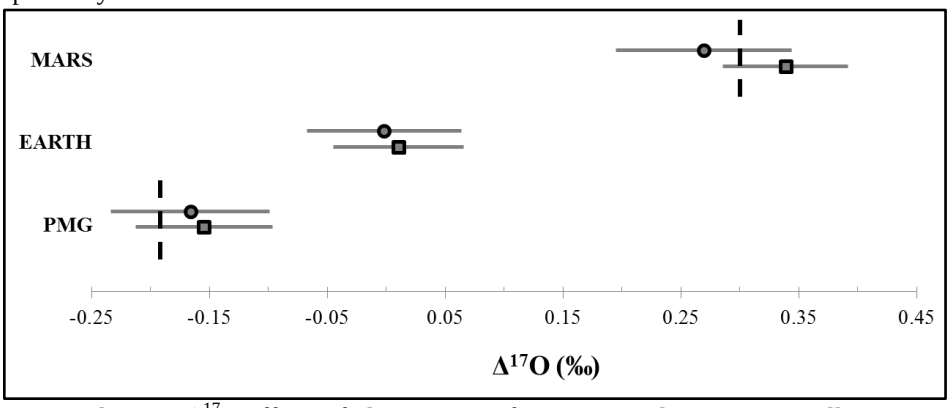

Figure 1: Measured *in situ* $\Delta^{17}O$ offsets of olivine grains from Mars and main group pallasites (PMG) relative to Earth (primary reference material). Multiple sessions are shown here with circles (S1) and squares (S2). Dashed lines correspond to literature vales for each respective planetary body: PGM: -0.19‰ [2], Mars: +0.30‰ [3-5].

Discussion: Here we demonstrate that our *in situ* triple oxygen isotope analysis of meteoritic samples using the SHRIMP SI ion microprobe can successfully resolve small $\Delta^{17}O$ offsets (i.e., order 0.20‰) and clearly distinguish populations from Mars, Earth (the terrestrial fractionation line, TFL) and the main group pallasites. Our high-precision measurements indicate that improvements in the electron gun configuration and charge mode analysis have led to better single analysis precision. Nevertheless, we are continuing developments on SHRIMP SI, working towards increasing our external reproducibility to be able to routinely measure triple oxygen isotope measurements where the resolution of $\Delta^{17}O$ is important to understanding the genetic processes occurring on the parent bodies. This includes, for example the offset of oxygen isotopes from the TFL to distinguish differentiated meteorites, such as main group pallasites and HEDs, and internal heterogeneity in breccias.

References. [1] Clayton R. N. 1993. Annual Review of Earth and Planetary Science. 21: 115–149. [2] Greenwood R.C. et al. 2015. Geochimica et Cosmochimica Acta 169: 115–136. [3] Franchi I. A. et al. 1999. Meteoritics and Planetary Science 34: 657–661. [4] Clayton R. N. and Mayeda T. K. 1996. Geochimica et Cosmochimica Acta 60: 1999–2017. [5] Clayton R. N. and Mayeda T. K. 1983. Earth and Planetary Science Letters 62: 1–6.