MODELLING OF OXYGEN ISOTOPES AND MAJOR ELEMENT CHEMISTRY OF UREILITES

N. Rai[1,2], H. Downes[1,2] and C. L. Smith[2]. [1]Centre for Planetary Sciences, Birkbeck-UCL, University of London, Malet Street, London, WC1E 7HX, UK. [2] Natural History Museum, Cromwell Rd, London SW7 5BD, UK. E-mail: n.rai@ucl.ac.uk.

Introduction: Ureilite meteorites are ultramafic achondritic meteorites composed largely of olivine and pyroxenes, that are thought to have been derived as residues of partial melting within the mantle of a carbon-rich asteroid [1]. These meteorites display a wide range of oxygen isotope signatures that distinguishes ureilites from other planetary bodies such as the Earth, Moon and Mars. This possibly indicates that ureilites derived from a range of diverse materials present within the solar nebula. The oxygen isotope signatures of ureilites correlate very well with the bulk rock mg# and/or the Fo content of the constituent olivines.

Objective and methodology: The use of oxygen isotope signatures to constrain the building blocks of terrestrial planets has been a standard approach [2,3]. Here, we have undertaken modelling to constrain the possible building blocks of the ureilite parent body (UPB), based on combinations of Fe-rich and Fe-poor chondrules and carbonaceous and other chondritic meteorites that are considered to be the building blocks of all terrestrial planetary bodies. We ran simulations trying to find matches consisting of three and two member combinations from various chondritic meteorite types that could simultaneously satisfy the oxygen isotope characteristics ($\Delta^{17}O$, $\delta^{17}O$ and $\delta^{18}O$) of ureilites.

Results and discussion: Based on the oxygen isotope modeling, our results indicate that there are several possible three end-member solutions composed of different chondritic meteorites and in different proportions that could successfully match the oxygen isotope signatures of the UPB. We also found two-end member solutions composed of the Fe-rich and Fe-poor chondrules that could match the oxygen isotope signatures of the UPB. Given the well-known oxygen isotope similarity between the ureilites and the carbonaceous chondrites [4], it is not surprising to find numerous non-unique solutions.

In order to further refine our model and test the possibility of finding a unique solution, we ran additional simulations that could simultaneously match the elemental ratios (Mg/Si, Al/Si, Fe/Si, Fe/Al) along with the oxygen isotope signatures from UPB compositions. A two end-member solution composed of the Fe-rich and Fe-poor chondrules cannot satisfy the range of major element chemistry observed in ureilite meteorites. Our preliminary results indicate that including the elemental ratios has reduced the solution set to just two groups of solutions, with three end-members each consisting of the Fe-rich and Fe-poor chondrules in combination with either the CI chondrites or CM chondrites. Our modeling still leaves the issue of the non-traditional stable isotope compositions of ureilites unresolved [5].

References: [1] Mittlefehldt et al. (1998) *Mineralogical Society of America. Rev. Mineral.* 36. p. 195; [2] Lodders & Fegley (1997), *Icarus* 126, 373-394; [3] Sanloup et al. (1999) *Physics of the Earth and Planetary Interiors* 112, 43–54; [4] Clayton R. N. and Mayeda T. K. (1988) *Geochim. Cosmochim. Acta* 52, 1313–1318; [5] Warren P. H. (2011) *Geochimica et Cosmochimica Acta* 75 6912–6926