

The Oxygen Isotopic Composition of Water Extracted from Carbonaceous Chondrites. L. Baker, I. A. Franchi, I. P. Wright and C. T. Pillinger. Planetary and Space Sciences Research Institute, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK. (I.Baker@open.ac.uk).

Introduction: Some hypotheses regarding the origin and movement of water in the Solar System as a whole are based upon models which utilise the D/H ratio of terrestrial and extra-terrestrial materials [e.g. 1,2]. However, these have provided little insight into the subsequent interaction that has taken place between water reservoirs and the solid portions of primitive Solar System material, e.g. meteorite parent bodies. Understanding the evolution of oxygen isotopic reservoirs on meteorite parent bodies has the potential to provide greater insight into the sources and effects of Solar System water. Such insight has thus far been hampered by the inherent difficulty of measuring the oxygen isotopic compositions of the necessarily small quantities of water present in meteoritic samples. Despite this, numerous attempts at modeling parent body evolution using measured silicate and carbonate compositions [3-5] have allowed first order estimates of the oxygen isotopic composition of pre-cursor water. Nevertheless the requirement for direct measurements of oxygen isotopes in water is undiminished. Using a recently developed stepped pyrolysis/fluorination system [6] we have measured the oxygen isotopic composition of water extracted from a range of whole-rock samples of CI and CM chondrites. The results of the analyses herein allow discrimination between contaminant water of terrestrial origin, evolved at low temperature steps, with that of indigenous water released subsequently and provides new insight into the sources and interaction of water in meteorite parent bodies.

Analytical Technique: Measurements of $\delta^{17}\text{O}$ and $\delta^{18}\text{O}$ were made on water released by pyrolysis of crushed, bulk meteorite samples of 1-4 mg. This water was swept by a flow of purified helium directly onto an in-line fluorinating agent (CoF_3), releasing oxygen for analysis using a continuous-flow, isotope ratio mass spectrometer (Delta C, Finnigan Mat). For details see [6]. The 1σ precision of the data, as determined by repeat analysis of standard waters and an internal solid standard, are $\pm 0.30\text{‰}$ ($\delta^{18}\text{O}$) and $\pm 0.14\text{‰}$ ($\Delta^{17}\text{O}$, where $\Delta^{17}\text{O} = \delta^{17}\text{O} - 0.52\delta^{18}\text{O}$).

Results: Water yields from all samples were between 3.5 and 15 wt%. In all cases water released at low temperatures had oxygen isotopic compositions characteristic of a terrestrial origin, with $\Delta^{17}\text{O}$ values close to 0‰. At temperatures above 350°C $\Delta^{17}\text{O}$ values indicated that the released water had an extraterrestrial origin. The peak release temperature of this indigenous component occurs at a higher temperature in the CIs than in the CMs. $\delta^{18}\text{O}$ values in water from CM samples displayed a relatively simple release pattern whilst those from CI samples produced a more complex pat-

tern, indicative of multiple reservoirs. $\Delta^{17}\text{O}$ values from CI samples (after removal of terrestrial water) were positive ($\sim +0.6\text{‰}$), possessing values close to those measured in bulk samples and matrix. $\Delta^{17}\text{O}$ values from CM samples were, like the CM matrix and silicate, negative (-0.6 to -1.3‰). Water from the Tagish Lake meteorite shows similarities to both groups but does not comfortably fit into either. It has a relatively low water content and displays a simple $\delta^{18}\text{O}$ pattern over a wide range of values. Its $\Delta^{17}\text{O}$ values are much more positive than whole rock and other solid components.

Discussion. The geochemical effects of extraterrestrial water are exhibited particularly clearly in the highly altered matrix material found in carbonaceous chondrites [3]. Phases such as carbonates and phyllosilicates retain a record of the isotopic composition of the fluids within which they formed. Comparison of isotopic data from water originating from phyllosilicates with oxygen isotopic data from carbonate phases [7] suggests that for each of the CI and CM samples the two groups of minerals lie close to a single mass fractionation line. Unless deposition of carbonate and formation of phyllosilicates occurred simultaneously this is more compatible with a closed system than one involving fluid flow in which the isotopic composition of the liquid continually changes with time. In the CM meteorite Cold Bokkeveld this line displays a larger negative $\Delta^{17}\text{O}$ value than either Murchison or Murray indicating either a greater level of equilibration between fluid and anhydrous silicate (consistent with the mineral alteration index of [8]) or a slightly lower water/rock ratio during reaction. This assumes that silicates initially had large negative $\Delta^{17}\text{O}$ values ($\sim -5.2\text{‰}$) [3] and water possessed large positive $\Delta^{17}\text{O}$ values ($> +2\text{‰}$). Carbonates and water from Tagish lake do not show a consistent $\Delta^{17}\text{O}$ value, implying a lack of equilibrium and possibly fluid flow during alteration.

References: [1] Drouart et al. (1999) *Icarus* 140, 129-155. [2] Robert et al. (2000) *Space Sci. Rev.* 92 201-224. [3] Clayton and Mayeda (1984) *EPSL*. 67, 151-161. [4] Rowe M.W. et al. (1994). *GCA*. 58, 5341-5347. [5] Young E.D. et al. (1999). *Science*. 286. 1331-1335. [6] Baker L. et al. (1998). *LPSC XXIX*. [7] Benedix et al. (2000) *LPSC XXXI*. [8] Browning et al. (1996) *GCA* 60, 2621-2633.