

DETERMINING THE EFFECTS OF AQUEOUS ALTERATION ON THE DISTRIBUTION OF OXYGEN ISOTOPES IN CARBONACEOUS CHONDRITES.

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Background: Carbonaceous chondrites (particularly the CI, CM and CR meteorites) have the most diverse range of high and low temperature mineral phases, and display the widest range of oxygen-isotopic compositions [1,2]. There are then inherent problems when trying to interpret early Solar System history. One is identifying the isotopic signature of oxygen from specific component compounds in a complex mixture of materials that existed in the solar nebular, and deconvoluting this from signatures developed during parent body processing, of which aqueous alteration is the most wide spread. Models to account for the variations in oxygen-isotopic compositions in carbonaceous chondrites e.g. [3,4] generally involve mixing of a solid anhydrous silicate component, with an isotopic composition enriched in ^{16}O , with liquid water depleted in ^{16}O along with mass-dependent isotopic fraction between various phases at low temperature [5]. Isotopic evolution of the fluids involved in these reactions would be expected to lead to significant isotopic heterogeneity within the components e.g. [4].

Research: We have employed a number of approaches to better determine the distribution of oxygen isotopic components within these complex meteorites. Much of our work has been involved with characterizing the products from artificial hydrothermal alteration of olivine. Olivine was reacted with neutral, acidic and alkaline solutions at 330°C and 50 bar pressure with the aim of producing phyllosilicates of serpentine composition (lizardite, chrysotile and antigorite); the products were characterised using Raman spectroscopy, SEM, XRD and thermal analysis. Stepped heating extraction to liberate water and structural (OH) $^-$ has also been undertaken [6]; this technique permits isotopic measurements of resolved components, the identification of which has been established by detailed study of the thermal release temperature of water (OH) $^-$ components and a range of terrestrial analogues. This method has been used to trace the location of different oxygen reservoirs as alteration proceeds in further artificial hydrothermal alteration reactions of olivine using isotopically labeled water. Stepped heating extraction of water and (OH) $^-$ have also been used to characterise the oxygen isotopic composition of liberated, indigenous, water (OH) $^-$ from a range of carbonaceous chondrites (CI, CM2, CR2).

Summary: The initial stepped heating experiments for carbonaceous chondrites revealed considerable variation in $\delta^{18}\text{O}$ [5]. Much of our new work has been aimed at determining the extent of isotopic fractionation associated with the formation of the common phyllosilicates found in meteorites, and identifying the specific minerals liberating (OH) $^-$ at each temperature. This will be used ultimately to better constrain the isotopic composition of the fluids involved in the alteration process on carbonaceous chondrite parent bodies.

References: [1] Clayton R. N. & Mayeda T. K. (1999) *GCA*, 63, 2089–2104. [2] Brearley A. J. & Jones R. H. (1998) *Planetary Materials*, 36, 3-01-3-370. [3] Clayton R. N. & Mayeda T. K. (1984) *EPSL*, 67, 151-161. [4] Young E. D. *et al.* (1999) *Science*, 286, 452-455. [5] Franchi. *et al* (2001) *Phil. Trans. R. Soc. Lond. A* 359, 2019–2035. [6] Baker. *et al.* (2002) *Analyt. Chem.* 74 1665-1673.