Stable Chlorine Isotope Reservoirs in Chondrites

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STABLE CHLORINE ISOTOPE RESERVOIRS IN CHONDrites. J. C. Bridges\textsuperscript{1}, D. A. Banks\textsuperscript{2} and M. M. Grady\textsuperscript{1}, 1Dept. of Mineralogy, Natural History Museum, London SW7 5BD, UK (j.bridges@nhm.ac.uk), 2Dept. of Earth Sciences, University of Leeds, Leeds LS2 9JT, UK.

**Introduction:** By analyzing the stable Cl-isotopes of halite from the Zag H-breccia and comparing the results with those from other chondritic materials we can provide new information about isotopes in the early Solar System. In particular Cl-isotope work may complement O-isotope studies. We show for the first time that substantial $^{37}\text{Cl}/^{35}\text{Cl}$ fractionation exists between chondrite components.

Zag halite crystallized from an evaporating brine at $< 100^\circ\text{C}$ on the H-parent body \cite{1,2}. The absence of clay alteration in olivine shows the rapid nature of this process which could have been started through melting of ice emplaced onto the planetesimal surface \cite{1}.

**Techniques:** Water soluble extracts were prepared from halite and H4 matrix from Zag (extract was primarily dissolved halite). Analysis of $^{37}\text{Cl}/^{35}\text{Cl}$ was carried out by TIMS. To further characterise brine compositions halogen values were determined by ion chromatography \cite{3}. Extracts were also analysed from the CM2 fall Murchison (Br/Cl ratio only) and H5 find Plains. $^{37}\text{Cl}$ is relative to SMOC.

**Results and discussion:** Zag halite and the silicate extract have light Cl-isotopic values compared to bulk carbonaceous chondrites \cite{4} (Fig. 1). The Br/Cl ratios of the halite samples are slightly less than that of Orgueil. Evaporation fractionates Cl-isotopes by $\leq 0.4\%$ relative to a parent brine \cite{5} suggesting that Zag isotope ratios are close in value to an initial reservoir. Pore fluid fractionation and crystallization of clays can also act to fractionate CI-isotopes towards light values \cite{5} but there is no sign of such extensive fluid activity in Zag \cite{1}.

The higher Br/Cl ratios of extracts from the Plains find suggest that terrestrial adsorption of halogens acts to increase Br/Cl ratios. This might also be expected to alter the $^{37}\text{Cl}$ values but adsorption of aerosols tends to increase $^{35}\text{Cl}$ \cite{6}, so the influence of terrestrial alteration is currently uncertain. However, the Zag halite was sampled pure so terrestrial contamination can be ruled out for it \cite{1,2}.

In the absence of any obvious mechanism to fractionate the CI-isotopes during fluid activity, the difference in $^{37}\text{Cl}$ between whole carbonaceous chondrites and our water soluble extracts suggests that there were at least 2 distinct reservoirs with $^{37}\text{Cl} \sim -1$ to $-2\%$ (ice/parent body brine) and $^{37}\text{Cl} \sim 2.5$ to $4\%$ (chondrite silicate solids). These reservoirs might be related to $^{16}\text{O}$-poor fluids and $^{16}\text{O}$-rich solids on parent bodies \cite{7}.

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**Fig. 1.** Br/Cl (wt) vs. $\delta^{37}\text{Cl}$ (‰). Water soluble extracts (this study): Zag halite (2 samples from 1 grain); Zag (H4 matrix); Plains (H5 find). Terrestrial seawater \cite{3}. Whole chondrite pyrolysis, Br/Cl ratios for 3 carbonaceous chondrites \cite{4,8}.