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Stable Chlorine Isotope Reservoirs in Chondrites

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STABLE CHLORINE ISOTOPE RESERVOIRS IN CHONDRITES. J. C. Bridges¹, D. A. Banks² and M. M. Grady¹, 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 ³⁷Cl/³⁵Cl fractionation exists between chondrite components.

Zag halite crystallized from an evaporating brine at << 100°C on the H-parent body [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 [1].

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

Results and discussion: Zag halite and the silicate extract have light Cl-isotopic values compared to bulk carbonaceous chondrites [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 [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 Cl-isotopes towards light values [5] but there is no sign of such extensive fluid activity in Zag [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 $\delta^{37}\text{Cl}$ values but adsorption of aerosols tends to increase $\delta^{37}\text{Cl}$ [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 [1,2].

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

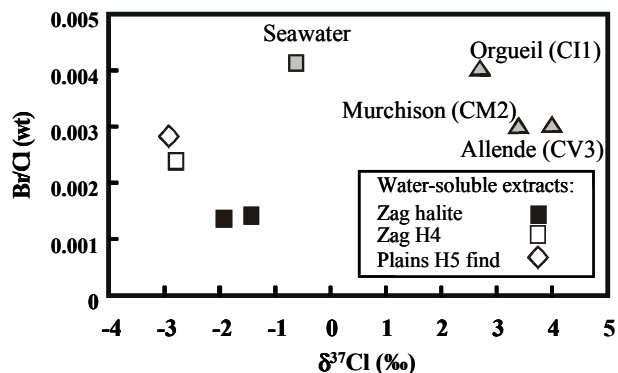


Fig. 1. Br/Cl (wt) vs. $\delta^{37}\text{Cl}$ (‰). Water soluble extracts (this study): Zag halite (2 samples from 1 grain); Zag (H4 matrix); Plains (H5 find). Terrestrial seawater [3]. Whole chondrite pyrolysis, Br/Cl ratios for 3 carbonaceous chondrites [4,8].

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