

6.3.16

Zinc isotopic variations in chondrites (WR, CAI...): Early nebular processes or metamorphism?

J.M. LUCK¹, D. BEN OTHMAN¹ AND F. ALBARÈDE²

¹DL/cc60/USTL/34095 Montpellier (F) (jmluck@dstu.univ-montp2.fr; ben_oth@dstu.univ-montp2.fr)

²ENS Lyon (F) (albarede@ens-lyon.fr)

Zinc is a moderately volatile element (Tc: 650 K) which exhibits both chalcophilic (sulfide) and lithophilic (olivine, pyroxene, *spinel*) behaviour. Variations in its isotopic abundances (here reported as $\delta^{66}\text{Zn}$) may help discriminate condensation vs. evaporation processes. Isotopic variations (measured by MC-ICPMS; [1]) have been previously observed in carbonaceous and ordinary chondrites (like for Cu, another transition element [2]). Mass-dependent isotopic variations with identical slopes for both terrestrial and meteoritic samples indicate derivation of Zn from an initially homogeneous source. We report Zn isotope compositions on carbonaceous, and equilibrated (EOC) and unequilibrated (UOC) ordinary chondrites.

The slightly decreasing $\delta^{66}\text{Zn}$ trend from CI to CM to CV-CO and to UOC parallels that of Zn content, which suggests that depletion of Zn in planetary bodies was not created by heating CI-like material, but favors incomplete condensation models. The very low $\delta^{66}\text{Zn}$ values in refractory (HF-insoluble) materials and in a CAI from Allende indicate the presence in the early solar nebula (in addition to CI-like Zn), of isotopically light Zn presumably produced by previous evaporation of solid material.

Analyses on whole-rock type-3 and type-6 OCs, on sequential acid dissolutions and on separated materials from LL3.1 and H6 suggest the following:

1. the Zn isotope compositions of type-3 OCs are homogeneous;
2. for H and L samples Zn is isotopically heavier in EOC than in UOC whole-rocks, which indicates a preferential loss of light isotopes;
3. for H6, Zn from the matrix (sulfide ?) was remobilized and taken up by silicates [3] and spinel [4]. The corresponding increase in $\delta^{66}\text{Zn}$ upon transfer suggests an open-system behaviour during metamorphism at high temperature with Zn evaporative loss.

References

- [1] Maréchal C. *et al.* (1999) *Chem. Geol.* **156**, 251-273.
- [2] Luck, J.M. *et al.* (2003) *G.C.A.* **67**, 143-151.
- [3] Kloeck, M. *et al.* (1999) *62nd Met.Soc. Meet.*, #5163.
- [4] Grossman J.N. (1985) *GCA* **49**, 925-939.

6.3.21

Lithium and magnesium isotope analysis of inorganic constituents of the Murchison meteorite

M.A. SEPHTON¹, R.H. JAMES¹ AND P.A. BLAND²

¹Dept. of Earth Sciences, The Open University, Milton Keynes MK7 6AA, UK (M.A.Sephton@open.ac.uk; R.H.James@open.ac.uk)

²Dept. of Earth Science & Engineering, Imperial College, London SW7 2AZ, UK (P.A.Bland@imperial.ac.uk)

Establishing the origin of the various constituents of chondritic meteorites is essential for an accurate understanding of Solar System origin and evolution. The presence of carbonate and phyllosilicate constituents has commonly been attributed to alteration on the meteorite parent body by liquid water, but this has recently come into question as carbonates have been detected spectroscopically in the dust shells of evolved stars [1], and new models accommodate the formation of hydrated silicates in the Solar Nebula [2].

Li and Mg isotope studies of meteorites may help to diagnose aqueous activity on extraterrestrial bodies. Both elements are (i) mobile during aqueous alteration, and (ii) fractionated during incorporation into secondary minerals at low temperature [3, 4]. To this end, we have measured Li and Mg isotopes in different constituents of the Murchison meteorite that may have been involved in varying levels of aqueous alteration. Firstly, we examined the putative aqueously-generated carbonate and phyllosilicate-rich matrix; secondly, we analysed chondrules which are usually considered to be anhydrous objects produced in the nebula and relatively unaffected by aqueous processes.

The $\delta^7\text{Li}$ value of the whole rock is +4‰, but individual components have substantially different values. Carbonates are the most isotopically heavy constituent (+12.8‰), followed by the phyllosilicate-rich matrix (+6.0‰), and finally, the anhydrous chondrules are isotopically lightest (-1.9‰). These differences are most effectively explained in terms of increasing low-temperature hydrous alteration by a ⁷Li-rich fluid: chondrule < phyllosilicate-rich matrix < carbonate. The Mg isotope composition of individual components also differs; $\delta^{25}\text{Mg}$ and $\delta^{26}\text{Mg}$ values increase with increasing alteration. Together, these data suggest that a presolar or nebular origin for chondritic carbonates and phyllosilicates as bulk fractions is implausible.

References

- [1] Kemper F. *et al.* (2002) *Nature* **415**, 295-297.
- [2] Ciesla F.J., Lauretta D.S., Cohen B.A. and Hood L.L. (2003) *Science* **299**, 519-522.
- [3] Chan L.H., Edmond J.M., Thompson G. and Gillis K. (1992) *Earth Planet. Sci. Lett.* **108**, 151-160.
- [4] Galy A., Bar-Matthews M., Halicz L. and O'Nions R.K. (2002) *Earth Planet. Sci. Lett.* **201**, 105-115.