Origin of oxygen isotopic variations in meteoritic chondrules

MARC CHAUSSIDON[1] & YVES MARROCCHI[1]

[1]IPG-CNRS-USPC, Paris, France, chaussidon@ipgp.fr
[2]CRPG-CNRS, Nancy, France, yvesm@crpg.cnrs-nancy.fr

Large non mass-dependent oxygen isotopic variations are known to be present within meteoritic chondrules [1]. These variations are understood as reflecting the presence in the accretion disk of several reservoirs having various ^{16}O contents. However, there is no general model based on simple physico-chemical processes operating during the formation of chondrules which would be able to explain the different characteristics of the oxygen isotopic variations, namely the range of isotopic variations ($\delta^{18}O$ and $\Delta^{17}O$) and the slopes of the correlation lines between $\delta^{17}O$ and $\delta^{18}O$ in the 3 oxygen isotopes diagram.

We will show that the systematics of the oxygen isotopic variations observed in Mg-rich porphyritic chondrules result from gas-melt exchanges taking place at high-temperatures between precursor silicate dust and a nebular gas enriched in SiO (and other elements) by the partial melting and evaporation of this precursor dust [2]. This models reproduces (i) the range of bulk oxygen isotopic composition observed for Mg-rich porphyritic chondrules (≈15‰ range in $\delta^{18}O$), (ii) the existence of various levels of isotopic disequilibrium between olivine, glass and pyroxene (from 0 to ≈5‰ for $\delta^{18}O$) which results from different dust enrichments in the chondrule forming region and (iii) the details of the variations observed for the slope of the $\delta^{17}O$ versus $\delta^{18}O$ lines that is in between the YR (slope 1) and the CCAM (slope 0.94) lines.

Two astrophysical settings, commonly proposed as viable chondrule forming regions, are compatible with the present model: either shock waves which would cause partial evaporation of dust concentrations in the accretion disk or impact plumes generated during impact between planetesimals. These two settings are not mutually exclusive.

[1] Clayton R.N., Onuma N., Grossman L., Mayeda T.K. (1983) in King, E.A. (Ed.) Chondrules and Their Origins. Lunar and Planetary Institute, Houston, pp 37–43. [2] Marrocchi Y. & Chaussidon M. (2015) *Earth Planet. Sci. Lett.* **430**, 308-315.