Origin of spinel in CV chondrules

NICOLAS SCHNURIGER1, CAMILLE CARTIER2, JOHAN VILLENUEVE3, VALENTINA G. BATANOVA4, MAXENCE REGNAULT1 AND YVES MARROCCHI5

1CRPG, CNRS - Université de Lorraine
2Centre de Recherches Pétrographiques et Géochimiques
3Université de Lorraine, CNRS, CRPG
4Université Grenoble Alpes
5CRPG, CNRS-Université Lorraine

Presenting Author: nicolas.schnuriger@univ-lorraine.fr

In chondrites, spinel grains (MgAl2O4) are commonly observed in refractory inclusions (CAIs and AOAs), and in a lesser degree in chondrules. Several petrographic, chemical, and isotopic evidences suggest that chondrules could have formed from the melting of precursor materials similar to refractory inclusions [1, 2]. Considering the slow O diffusion rate in spinel [3] and its large stability field [4], chondrule spinels could thus be inherited from refractory inclusions. If spinels are refractory inclusions relicts, they would show 16O-rich compositions compared to the other phases. Conversely, spinel could result from the crystallization of a silicate melt during the chondrule-forming event, and would have oxygen isotopes values similar to the coexisting phases (e.g., olivine).

We report a petrographic, mineralogical and oxygen isotope survey of type I chondrules in two CV3 chondrites (Allende and NWA10235) to better understand the origin of spinels in chondrules. We observed that spinels in chondrules occur as small euhedral grains in a glassy mesostase, or are poikilitically enclosed in Mg-rich olivine grains, in contact with a pocket of silicate melt. In refractory inclusions, spinel occurs as euhedral grains in CAIs or in complex association with olivine in AOAs. All grains reported were nearly pure spinel sensu stricto. The O-isotopic compositions of all spinels studied here plot along the PCM line. CAIs and AOAs spinels have ∆17O ranging from -25.6 to -16.6 ‰ respectively. Chondrules spinels and the corresponding olivine grains have ∆17O ranging from -10.9 to -4.6 ‰ and from -6.4 to -1 ‰ respectively.

In most cases, olivine and spinel gains in the same chondrule (i) are in contact with glassy mesostase and (ii) have similar ∆17O. This suggests that these minerals are co-magmatic, i.e., they crystallized from a single silicate melt. Consequently, trace element distribution between spinels and olivines can be used for determining the temperature of chondrule formation.