O ISOTOPIC CONSTRAINTS ON THE ORIGIN OF MG-RICH OLIVINES FROM ALLENDE CHONDRULES: PLANETARY OR NOT ?

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Introduction: If chondrites parent bodies accreted late, ≈ 4-5 Myr after the condensation/crystallization of type B CAIs (when $^{26}Al/^{27}Al=5.2x10^{-5}$) as imposed by chondrule ages, there are several evidences that planetesimal accretion (up to sizes of ≈1000 km) started very early, perhaps nearly at the same time than CAIs formed [1]. Developments of high precision Mg isotopic analysis by multi-collector ion microprobe allow to determine both the slopes ($^{26}Al/^{27}Al$) and the initial ($\delta^{26}Mg_0$) of ^{26}Al isochrons in chondrules and CAIs. This can be used to test the homogeneous distribution of ^{26}Al and Mg isotopes in the accretion disk at the time of formation of CAIs [2] and to try to calculate model ^{26}Al ages (under the assumption of an homogeneous distribution) for chondrule precursors [2] or for minerals devoid of Al such as Mg-rich olivines in chondrules [3]. This suggests that some of the chondrule precursors and Mg-rich olivines were formed very early, within 1 Myr or less than CAIs [2, 3]. One possibility would be that these Mg-rich olivines are precursors of type I chondrules and could be the fragments of the mantle of pre-existing disrupted planetesimals [4]. In the present study we explore what constraints could be derived on the origin of Mg-rich olivines in Allende (either in type I chondrules or isolated in the matrix) from high precision measurements of their O isotopic compositions and from their major and trace elements concentrations.

Experimental: The O isotopic compositions were measured with the CRPG-CNRS (Nancy) ims 1270 and ims 1280HR2 multi-collector ion microprobes. In each olivines numerous (from 10 to 25) spots were made in order to reach an analytical precision on the level of ± 0.01-0.02 ‰ (2 sigma) on ^{17}O excesses relative to mass fractionation (i.e. $\Delta^{17}O$).

Results and discussion : Mg-rich olivines in type I chondrules from Allende cluster around a few modes (less than 10) of $\Delta^{17}O$ values ranging from -7.5 to 0‰. They do not show a continuum of $\Delta^{17}O$ values contrary to bulk $\Delta^{17}O$ values for Allende type I chondrules [5]. Bulk $\Delta^{17}O$ values are likely the result of variable isotopic exchange with the nebular gas during chondrule melting. In most cases Mg-rich olivines appear relict (predating chondrule melting) from their $\Delta^{17}O$ values. The most populated mode for Mg-rich olivines is at $\Delta^{17}O$ =-5.56±0.09 ‰. Within a given mode of $\Delta^{17}O$ values, a large range of mass fractionation (up to ≈ 6‰ for $\delta^{18}O$ values) is observed. This is consistent with previous (but less precise) measurements [4]. Correlations between $\Delta^{17}O$, $\delta^{18}O$, major and trace element concentrations, allow to better constrain the origin of the olivines and to test the possibility that they originate from a restricted number of planetesimals which differentiated very early in the disk.

References: [1] Dauphas N. and Chaussidon M. 2011, *Ann. Rev. Earth. Plan. Sci.* 39, 351-386. [2] Villeneuve J. et al. 2009, *Science* 325, 985-988, [3] Villeneuve J. et al. 2011, *Earth Planet. Sci Lett.* 301, 107-116, [4] Libourel G. and Chaussidon M. 2011, *Earth Planet. Sci Lett.* 301, 9-21. [5] Clayton R.N. et al. 1983 in "Chondrules and their Origins" LPI 37-43.