HIBONITE BEARING REFRACTORY INCLUSIONS AND EARLY SOLAR SYSTEM EVOLUTION.

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Introduction: Among the family of exceptional objects that are Calcium-Aluminium-rich Inclusions (CAIs), the corundum and hibonite bearing members of this group are of special interest. Corundum and hibonite are the two first phases predicted to condensate form a gas of Solar composition (e.g. [1, 2]) and can be used to study conditions in the earliest times of the Solar System. The presence of oxygen in the solid, liquid and gaseous phases makes stable O isotopes a very powerful tool to study these conditions.

Many corundum and hibonite bearing inclusions have been found and studied in CM chondrites (e.g. [3, 4]) and some have been found more recently in some of the least altered CO meteorites (e.g. [5, 6]). These inclusions display different isotopic signatures, notably regarding Mg isotopes and the presence or absence of ^{26}Al at the time of their formation (e.g. [4]).

An exceptionally ^{16}O-rich inclusion has been identified in the Allan Hills A77307 CO meteorite. Core corundum, hibonite and spinel in this inclusion are very ^{16}O-rich ($\Delta^{17}O_{Core}$ = -32.6 ± 3.2 (2σ) ‰) while the surrounding diopside rim displays a ^{16}O signature closer to those typically encountered in most CAIs ($\Delta^{17}O_{Rim}$ = -24.8 ± 0.5 (2σ) ‰) [5], suggesting an evolution of the O isotopic composition of the surrounding environment or a transit of this inclusion to another reservoir between the formation of the core and the rim. This CAI also displays a lack of live ^{26}Al in its core minerals, suggesting that it formed prior to most other refractory inclusions that display the canonical $^{26}Al/^{27}Al$ ratio of $\sim 5 \times 10^{-5}$.

This project's aim is to search for more corundum and hibonite bearing inclusions and to compare the O isotopic compositions in such CAIs from CM and CO meteorites in an effort to determine whether the parent body processes that took place on the CM (e.g. [7]) parent body affected these inclusions and how.

Methods: In-situ analyses of O and Al-Mg isotopes in CAI forming minerals were done by NanoSIMS. O isotopic data were acquired using a Cs^+ beam rastered over an area of 3 × 3 µm. The mass resolving power (MRP, Cameca definition) was set to ~10000 to resolve the ^{16}OH interference with ^{17}O. ^{16}O was measured on a Faraday cup (FC) with ^{17}O and ^{18}O measured on electron multipliers (EMs).

In a second step we plan to do Mg isotope analyses on the same samples by NanoSIMS.

Results and Discussions: The O isotopic compositions of minerals from hibonite bearing inclusions from the Murchison meteorite, with the exception of spinel in two inclusions, display remarkable homogeneity (Δ^{17}O = -23.5 ± 3.2 (2σ) ‰), which is coherent with the results presented for instance in [6] and very similar to the value found in most CAIs. The mineralogy of these inclusions correspond to SHIB (Spinel-HIBonite spherules) morphologies, unlike the inclusion presented in [5], that is closer to a PLAC (PLAty Crystal fragment) inclusion. Many SHIB inclusions incorporated live ^{26}Al at the time of their formation which suggests that they formed after some PLAC inclusions that show no ^{26}Mg* excess, indicative of the absence of this short lived radionuclide during the formation of some of these PLAC crystals. Thus, it is suggested that the studied CAIs formed after the injection of ^{26}Al in the same O reservoir in which most CAIs formed. This hypothesis will be verified by Mg isotope measurements. Spinel with ^{16}O-depleted compositions is hypothesized to have had original compositions similar those measured in the studied minerals but to have experienced alteration on the parent body, causing O isotopic exchange with ^{16}O-poor fluid on the CM parent body.

References:

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