Ion microprobe high precision measurements of oxygen and magnesium isotopic compositions in extraterrestrial materials

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Two key isotope systems in cosmochemistry are oxygen isotopes (non mass dependent oxygen isotope variations, i.e. $\Delta^{17}O$, are ubiquitous in meteorites, especially in the high temperature components of chondrites) and Mg isotopes (^{26}Mg radiogenic excesses, i.e. $\delta^{26}Mg^*$, are due to the *in situ* decay of short-lived ^{26}Al with a half life of 0.73 Myr). Because of the presence of Al/Mg variations and of mineralogical variations in chondrites at the micrometer scale, ion microprobe is the only technique which offers the appropriate spatial resolution to unravel the $\Delta^{17}O$ and $\delta^{26}Mg^*$ systematic.

Recent developments using multicollectors ims 1270 and ims 1280 HR2 large radius Cameca ion microprobes allow to reach a precision (2 sigma error) better than 0.01 ‰ for $\delta^{26}Mg^*$ and better than 0.04‰ for $\Delta^{17}O$, for sputtered volumes of 20μm diameter and less than 1μm depth (in Mg-rich silicates and oxides).

Such high precisions transform the "traditional" O and Mg isotopes into "new" isotopic systems in meteorites. In the case of ^{26}Al for instance, the homogeneity of the distribution of ^{26}Al (which is a prerequisite to its use as a precise chronometer) can be quantified for the first time by comparing chondrules to the solar system Mg isotopic growth curve [1]. ^{26}Al model ages can be calculated in chondrules or in Al-free phases from their Mg isotopic composition [2]. These model ages in Mg-rich olivines from type I chondrules can be compared to high precision $\Delta^{17}O$ values to identify the origin of the olivines and to test whether they could be fragments of the mantles of planetesimals which differentiated very early in the disk [3].

[1] Villeneuve J., Chaussidon M., Libourel G. (2009) *Science* **325**, 985-988. [2] Villeneuve J., Chaussidon M., Libourel G. (2011) *Earth Planet. Sci. Lett.* **301**, 107-116. [3] Libourel G., Chaussidon M. (2011) *Earth Planet. Sci. Lett.* **301**, 9-21.

Average Nd-Hf isotopic compositions and model age of the upper continental crust

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Establishing the average chemical and isotopic composition of the upper continental crust as well as its model age is difficult due to the diversity in compositions and ages of this major Earth reservoir. Estimates exist for major and trace elements as well as for some isotopic systems, but not for the Nd-Hf isotopic couple. In 1999, Vervoort *et al.* [1] defined the Nd-Hf "crustal array" and showed that Nd and Hf are correlated in crustal rocks of various ages and origins, but they could not define an average value.

Here we estimate the average composition of upper continental crust using two complementary types of sedimentary materials: (1) loess because they represent well-mixed materials from large areas of upper continental crust; (2) beach placers because they concentrate heavy and resistant minerals such as zircon and monazite. We determined the Hf and Nd isotopic compositions on samples from various locations in Western Europe, Tajikistan, China, Argentina, Africa, USA and Australia.

The loess have remarkably uniform Nd and Hf isotopic compositions and the average value plots on the "mantle array" within the field of crustal materials. Placers have more variable compositions linked to the age of the drained area. Indeed, samples from Europe, South Africa, Eastern Australia and USA have compositions comparable to the loess, but the Western Australian placers have significantly less radiogenic values due to the presence of Archean terranes in the source area.

Combining the constraints provided by the loess and the placers, we suggest that the following Nd and Hf characteristics: $\varepsilon_{Nd} = -10.3 \pm 1.2$ and $\varepsilon_{Hf} = -13.8 \pm 4.2$. The corresponding model age is 1.75 Ga, a value in the young side of other estimates.

[1] Vervoort *et al.* (1999) *EPSL* **168**, 79-99.