Oxygen isotopes of an early Archaean layered ultramafic body, west Greenland

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Minerals separated from an early Archaean (>3.81 Ga) layered body in the Ujaragssuit nunât area, south of Isua, west Greenland, have been analysed for $\delta^{18}O$ by CO_2 laser fluorination IRMS at RHUL. The intrusion has been subjected to high-grade metamorphism, but for the most part the primary mineralogy remains intact.

The lower cycles are dominated by dunites with banded and massive chromitites and secondary phlogopite. $\delta^{18}O$ values range from 0.15 to 2.53‰ for chrome-spinel, 4.49 to 4.93‰ for olivine and 5.63 to 5.70‰ for phlogopite. Higher in the sequence the dunites contain some orthopyroxene and secondary amphibole. Here the $\delta^{18}O$ values range from –0.20 to 2.40‰ for chrome-spinel, 4.49 to 4.77‰ for olivine, 5.70 to 5.81‰ for orthopyroxene and 5.41 to 5.59‰ for amphibole. The upper cycles contain amphibole harzburgite layers which have zones almost anorthositic in composition. Patches of amphibole from these zones have $\delta^{18}O$ around 4.95‰ and plagioclase around 6.2‰. Secondary biotite and ruby corundum have values of 4.3‰.

Oxygen isotope temperatures for mineral pairs vary from 450-860°C. Some mineral pairs do give more restricted ranges. Olivine-orthopyroxene pairs give a range of 800-860°C and may be close to primary crystallisation equilibration temperatures. A sub-solidus re-equilibration event is recorded between 680 and 750°C. In this event some zones of olivine were depleted in $\delta^{18}O$ from 4.75‰ to 4.5‰, and this was associated with lowering of chromite values and most probably the formation of secondary phlogopite in the lower cycles. The massive chromitite and some of the banded chromitites are least affected by these changes. The greatest lowering of $\delta^{18}O$ is evident where the chromite formed as dispersed crystals in dunite and preliminary findings suggest that these changes are also related to changes in chromite chemistry associated with exchange with olivine.

A second unlayered dunite body in this region has olivine at 5.25 to 5.3‰, more typical of high temperature magmas. This probably represents a different type of magmatic system, but also indicates that olivine $\delta^{18}O$ was not lowered during regional metamorphic events.

The isotopic values for nearly all phases throughout the layered body are consistent with a cooling magmatic system, channelled hydration with residual melt/fluids and re-equilibration during metamorphism.

What Do Cu-Zn Isotopes Tell Us On Meteorites ?

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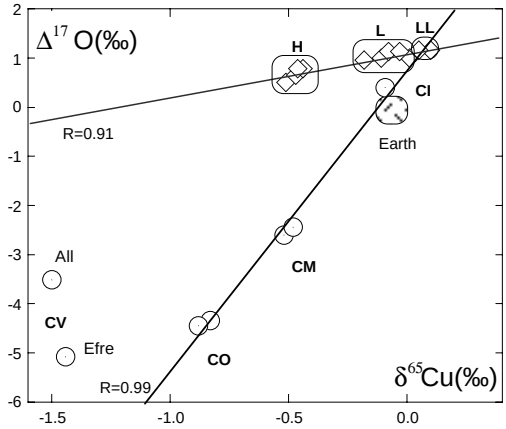
Like terrestrial samples (Maréchal et al., 1999), meteorites exhibit Cu and Zn isotopic variations : they are of the order of the permil or more per mass unit.

Cu isotopes in Carbonaceous Chondrites are very homogeneous within each group, and vary regularly from CV to CO, CM and CI, Cu being heaviest in the latter. The remarkable relationships between Cu isotopes and Ca/Mn on one hand, $\Delta^{17}O$ on the other may be explained as the result of mixing between two isotopically distinct Cu reservoirs, one of them possibly related to short-lived ^{63}Ni excesses. Cu isotopes in Ordinary Chondrites (WR) are less variable but are consistent with a mixing process, and show distinct mean signatures between H, L and LL, whatever their petrologic



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Zn isotopes from Meteorites define lines in multi-isotope diagrams which agree with mass-fractionation processes, i.e. no isotope anomaly. Zn in Carbonaceous Chondrites varies opposite to Cu, and the CO-CM-CI trend, although present, shows more scatter than Cu. UOC show highly variable values, while EOC seem more clustered.

The large Zn isotopic variation in IAB-IIICD irons (4‰), negatively correlated with Cu, seems to call for several processes (e.g. alteration and/or impact melting and mixing).

Both elements are isotopically fractionated between magnetic and non-magnetic fractions.

Maréchal C. N., Telouk P., and Albarède F. (1999). *Chem. Geol.* **156**, 251-273.