Zn and Fe isotopes : Sensitive tracers of partial melting and redox conditions

LUC S. DOUCET[1], NADINE MATTIELLI[1], DMITRI A. IONOV[2], DOMINIQUE WEIS[3], WENDY DEBOUGE[1] AND ALEXANDER V. GOLOVIN[4]

[1]Laboratoire G-Time, Université Libre de Bruxelles & FNRS, 1000 Brussels, Belgium; ldoucet@ulb.ac.be; nmattielli@ulb.ac.be; wdebouge@ulb.ac.be

[2]GM, Université de Montpellier & CNRS-UMR 5243, Montpellier, France; dmitri.ionov@gm.univ-montp2.fr

[3]PCIGR, EOAS, University of British Columbia, BC V6T1Z4 Vancouver, Canada; dweis@eos.ubc.ca

[4]IGM, Siberian Branch, Russian Acad. Sci. & Novosibirsk University, Novosibirsk 630090, Russia; avg@igm.nsc.ru

Mantle processes fractionate transition metal stable isotopes as documented by distinct Fe isotope compositions of peridotite xenoliths in comparison to basalts. Partial melting and oxidation state control transition metal isotopic compositons, although their respective roles remain to be quantified.

In contrast with Fe, Zn with an unique valence state is insensitive to mantle redox state and as such is a primary tool to investigate the effects of partial melting on transition metal isotope fractionation. We report Zn and Fe isotope compositions on 6 fertile (no or low-degree melting) and 7 refractory peridotite xenoliths (highly depleted) from Mongolia (Tariat, off-craton) and Siberia (Vitim, off-craton; Udachnaya, on-craton). The Zn and Fe isotope data, expressed as $\delta^{66}Zn_{JMC\text{-}Lyon}$ and $\delta^{56}Fe_{IRMM\text{-}14}$ are respectively obtained by high precision measurements on a Nu Plasma II and a Nu 1700 (HR) MC-ICP-MS on the same sample aliquot. The fertile peridotites have average $\delta^{66}Zn_{JMC\text{-}Lyon}$ values of +0.29±0.07‰(2SD) while refractory peridotites have average $\delta^{66}Zn_{JMC\text{-}Lyon}$ values of +0.16±0.07‰. $\delta^{66}Zn_{JMC\text{-}Lyon}$ are negatively correlated (R^2=0.8) with $Mg\#_{WR}$, Al_2O_3 and Zn contents indicating that partial melting may induce Zn isotope fractionation. In contrast, fertile and refractory peridotites show overlapping average $\delta^{56}Fe_{IRMM\text{-}14}$ of +0.00±0.11‰ and -0.06±0.11‰, respectively, though refractory peridotites appear slightly lighter than fertile peridotites. In addition, individual $\delta^{66}Zn$ and $\delta^{56}Fe$ values on all our samples define a weak negative correlation.

Our study suggests that processes such as variation in redox conditions, e.g. circulation of oxidizing fluids, prevail over partial melting in controling Fe isotopic signature in peridotite xenoliths, in contrast to Zn isotopic signature that is affected by partial melting conditions.