# Fractionation of Fe and O isotopes in the mantle: Implications for the origins of eclogites and the source regions of mantle plumes

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Oxygen isotopes are widely utilised as tracers of subducted and recycled oceanic crust in the convecting mantle and in the source regions of mantle plumes. This assumes that the $\delta^{18}O_{V\text{-}SMOW}$ values higher and lower than normal mantle (~5.2‰) reported for some ocean island basalts (OIB) and eclogites reflect the involvement of oceanic crust hydrothermally altered at low and high temperatures, respectively, in their genesis.

We have measured Fe and O isotopes in garnet and clinopyroxene mineral separates from 6 eclogite xenoliths from the Kaalvallei and Bellsbank kimberlites, South Africa. Iron isotope compositions ($\delta^{57/54}Fe_{IRMM\text{-}14}$) for garnet and clinopyroxene range from -0.64±0.08 (2 SD) to 0.61±0.08‰ and -0.21±0.08 to 0.57±0.06‰, respectively. Calculated bulk-rock $\delta^{57/54}Fe$ ranges from -0.58±0.12 to 0.28±0.1 ‰. Garnet and clinopyroxene $\delta^{18}O$ ranges from 3.8±0.2 (2SD) to 5.1±0.2‰ and 4.6±0.2 to 5.9±0.2‰, respectively. Calculated bulk rock $\delta^{18}O$ varies from 4.6±0.3 to 5.2±0.3‰. Mineral and bulk rock $\delta^{57/54}Fe$ values correlate positively with $\delta^{18}O$, implying that these isotopic signatures were produced by the same underlying mechanism.

One possibility is that the eclogites are derived from oceanic crust with a low $\delta^{18}O$ signature produced by high-temperature alteration, which also creates the $\delta^{57/54}Fe$-$\delta^{18}O$ trend. However, Fe isotopes only appear to be significantly fractionated during low temperature alteration when Fe is lost from the oceanic crust [1]. Iron isotopes are also unlikely to be fractionated by high temperature alteration as the Fe concentrations in these lithologies are unchanged from their precursors and the low Fe concentrations in hydrothermal fluids would limit isotopic exchange reactions.

It is therefore likely that the $\delta^{57/54}Fe$-$\delta^{18}O$ correlations are produced in the sub-continental lithospheric mantle (SCLM) by melting and metasomatic processes. Previous studies have shown that Fe isotopes can be fractionated in the mantle by processes such as partial melting [2]. If the measured variations in $\delta^{57/54}Fe$ and $\delta^{18}O$ can indeed be produced in the SCLM, the implication is that the low (<5.2‰) $\delta^{18}O$ values of some OIB and eclogites cannot necessarily be interpreted in terms of subducted oceanic crust components.

## References

[1] Rouxel *et al.*, (2003), *Chem Geol*, **202** 155-182.
[2] Williams *et al.*, (2005), *EPSL* **235** 435-452