Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30112

Stable (O-Ca-Zn) isotope constraints on the origin of eclogite xenoliths from the Navajo Volcanic Field, Colorado Plateau (USA)

JOSHUA MUNRO, JAIME D. BARNES, JOHN C. LASSITER AND AARON M SATKOSKI

The University of Texas at Austin

Diatreme-hosted eclogite xenoliths from the Navajo Volcanic Field (NVF), Colorado Plateau, USA, are disputed to be fragments of subducted oceanic crust[1-3] or eclogite-facies mantle melts[3]. Previous work has shown that $\delta^{18}O$, $\delta^{44/40}Ca$ and $\delta^{66}Zn$ values can be tracers of recycled crustal material because sediment and altered oceanic crust (AOC) have isotope ranges distinct from mantle values (**Figure 1**, $\delta^{18}O \approx 5.5\pm0.2‰$, [4]; $\delta^{44/40}Ca \approx 0.95\pm0.05‰$, [5]; $\delta^{66}Zn \approx 0.28\pm0.05‰$, [6]). Additionally, eclogite xenoliths can be identified as basaltic or gabbroic eclogites based on Eu anomalies and $\delta^{18}O$ values[7], and $\delta^{44/40}Ca$ and $\delta^{66}Zn$ values can trace contributions from carbonate- and organic-derived fluids[5-7].

The $\delta^{18}O$, $\delta^{44/40}Ca$ and $\delta^{66}Zn$ composition of sixteen eclogites from Garnet Ridge diatreme, NVF, were measured. $\delta^{18}O$ values of garnet (6.6 to 9.8‰), clinopyroxene (6.6 to 9.7‰), and reconstructed whole-rock (6.4 to 9.6‰) are higher than average peridotite mantle. $\delta^{44/40}Ca$ values vary from 1.68 to 1.98‰ for garnet and 0.76 to 1.06‰ for clinopyroxene. Calculated whole-rock $\delta^{44/40}Ca$ values range from 0.87 to 1.38‰, extending to higher values than in fresh MORB (**Figure 1**). Whole-rock $\delta^{66}Zn$ compositions range from 0.13 to 0.62‰, both higher and lower than MORB.

Whole-rock NVF eclogites $\delta^{18}O$-$\delta^{44/40}Ca$-$\delta^{66}Zn$ values overlap with the AOC field (**Figure 1**). The eclogites have higher than mantle $\delta^{18}O$ values and small negative Eu anomalies, suggesting they derive from subducted upper oceanic crust basalts. Positively-correlated $\delta^{18}O$-$\delta^{44/40}Ca$ values suggest low-temperature seafloor alteration of oceanic crust. $\delta^{44/40}Ca$-$\delta^{66}Zn$ arrays may also indicate variable incorporation of organic material (low-$\delta^{66}Zn$) and marine carbonate (high-$\delta^{66}Zn$). Based on the O-Ca-Zn stable isotope compositions of the NVF eclogites, they are most likely derived from fragments of the Farallon Slab, although the role of older Proterozoic crust cannot be discounted. Future radiogenic isotopes will resolve this debate.

[1] Helmstaedt & Doig (1975) Physics and Chemistry of the Earth, 95–111.

[2] Usui *et al.* (2003) *Geology*, 589–592.

[3] Smith & Zientek (1979) *CMP* **69**.

[4] Eiler (2001) *RiMG* **43**, 319–364.

[5] Kang *et al.* (2019) *Chem Geol* **524**, 272–282.

[6] Huang *et al*. (2016) *JGeoRes: Solid Earth* **121**, 7086-7100.

[7] Smart *et al*. (2021) EPSL **556**, 116720.

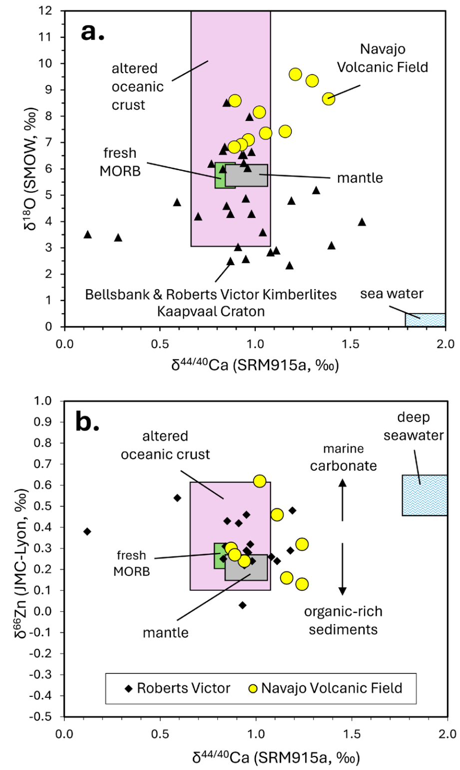

Figure 1. a. $\delta^{18}O$-$\delta^{44/40}Ca$ and **b.** $\delta^{44/40}Ca$-$\delta^{66}Zn$ data for NVF eclogites compared to eclogites from Kaapvaal Craton (Bellsbank, Smart *et al.*, 2021, EPSL 556; Roberts Victor, Chen *et al.*, 2020, GCA 290; Huang *et al.*, (2022) Geology 50), as well as the mantle (Amsellem *et al.,* 2019, GCA 258; Sun et al., 2023, GCA 346), fresh mid-ocean ridge basalts (MORB, Smart *et al.*, 2021, EPSL 556; Sun et al., 2023, GCA 346), altered oceanic crust and seawater (references in Smart *et al.*, 2021, EPSL 556; Huang *et al.*, (2022) Geology 50). Marine carbonates have $\delta^{66}Zn$ values generally above 0.3‰ and organic-rich sediments below 0.2‰ (Albarède, 2004, RiMG 55).