Zinc, magnesium and oxygen isotope evidence for the origin of Roberts Victor mantle eclogites

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The origin of mantle ecclogites, brought to the Earth's surface by kimberlite eruption, is an on-going, hot debate. Two end-member models proposed for their origin include (1) metamorphosed altered oceanic crust subducted into the Earth mantle and crystallized products of deep-seated melts[1]. Here, we report the Zn isotopic compositions of mantle eclogites and mineral separates from the Roberts Victor kimberlite pipe, South Africa. The results, combined with previously-publised Mg and O isotopic data[2-3], can provide a new constraint on the origin of mantle eclogites.

The studied eclogites include Type IA, IB, IIA, and IIB. The reconstructed whole-rock δ^{66}Zn are from 0.03 to 0.43‰ for IA, 0.20 to 0.26‰ for IB, 0.38 to 0.53‰ for IIA, and ~0.23 ‰ for IIB eclogites. This and previous studies[2-3] reveal that the pristine Type II eclogites have lighter Mg and O but heavier Zn isotopic compositions relative to the normal mantle. These isotopic features are inconsitent with their origin as metamorphosed altered oceanic crust because altered oceanic crust with low δ^{18}O and high δ^{66}Zn have normal mantle-like δ^{26}Mg. We proposed that the Roberts Victor Type II eclogites originated as frozen lens of deap-seatd melts and experienced diffusive exchanges of Zn-Mg-O isotopes with wall-rock peridotites, which resulted in the above-mentioned isotopic signatures. The isotopic characteristics of the Type I eclogites reflect mixing between Type II eclgoites and metasomaitc carbonatitic-kimberlitic melts.

[1] Griffin and Suzanne, Episodes 3 (2017) 43-53; [2] Greau et al. Geochimica et Cosmochimica Acta 75 (2011) 6927-6954; [3] Huang et al. Chemical Geology 438 (2016) 73-83.