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Using Triple Oxygen Isotopes to Distinguish Mantle Metasomatism in Eclogite Xenoliths

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Large oxygen isotope variation in eclogite xenoliths has been one of few strong chemical indicators of their origin as ancient altered oceanic crust. Here we present triple oxygen isotope measurements of mantle eclogite from Roberts Victor and Orapa kimberlite pipes relative to modern altered oceanic crust. Roberts Victor reconstructed bulk rock $\delta'^{18}O$ values range from 1.6 to 7.4‰ and $\delta'^{17}O$ from -0.066 to -0.042‰ vs. SMOW, λ=0.528. Orapa reconstructed bulk rock $\delta'^{18}O$ values range from 4.6 to 9.4‰ and $\delta'^{17}O$ from -0.075 to -0.044‰ vs. SMOW, λ=0.528. IODP Hess Deep and DSDP hole 504B high and low temperature altered oceanic crust $\delta'^{18}O$ range from 1.94 to 9.24‰ and $\delta'^{17}O$ from -0.043 to 0.067‰ vs. SMOW, λ=0.528 (McGunnigle, In Submission). McCandless and Gurney (1989, GROUP) originally classified eclogite xenoliths based on samples from South Africa by enriched K_2O in clinopyroxene and Na_2O in garnet as Group I and depleted as Group II. At Orapa, Group I samples are mostly diamondiferous, with samples measured in this work containing $\delta^{13}C$ values from -12 to -22‰ (Deines, 1991, GCA), consistent with subduction of surface derived organic matter. On the other hand, Group II samples are diamond-barren, exhibit elevated Cr_2O_3, and LREE enrichment in clinopyroxene, which has been inherited through the process of mantle metasomatism (Aulbach, 2017, GCA). Our Orapa data shows that Group I samples overlap with altered oceanic crust, and we suggest that these eclogites have retained their surface oxygen isotope composition throughout subduction and their billion-year mantle residence. Relative to the ~5‰ variation in Group I samples, Group II show $\delta'^{18}O$ variation in garnet and clinopyroxene of 2‰ and 1‰, respectively. The more closely confined $\delta'^{18}O$ values of Group II samples is attributed to metasomatic interaction resulting in the overprinting of the original protolith composition, showing greater equilibration in clinopyroxene than garnet.