Tracing volatiles in Earth’s mantle using He-C-N isotopes in garnet-bearing diamondites

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The origin of diamond-forming carbon in the Earth is unclear [1-3]; sources include subducted organic sediment and primordial mantle carbon. For example, some diamonds contain eclogitic silicate + sulfide inclusions and have depleted δ13C (-10 to -30‰), enriched δ15N (+3 to +35‰) values, consistent with subducted crustal material [2-3]. However, some diamonds show mantle-like δ15N (<-5‰) and depleted δ13C values (-10 to -30‰) which have been cited as evidence of enstatite chondrite-like primordial C-N sources [1]. The helium isotope composition of mantle rocks are powerful tracers of Earth’s volatile history because primordial 3He is not recycled back into the mantle. However, there are few He isotope studies of diamond fluids. The 3He/4He of garnet-bearing diamondites from the Orapa mine (Botswana) range from 0.1 to 3 Ra [4-5], consistent with a recycled origin. However, our recent work has identified a suite of diamondites with 3He/4He = 0.06 to 8.2 Ra which correlates negatively with δ13C, suggesting that the subduction-related C is associated with mantle 3He/4He ratios.

To unravel this complexity we are combining He, C and N isotope analyses in polycrystalline diamond from garnet-bearing diamondites from the Orapa mine. These data will also be used to assess the extent to which carbon and nitrogen isotopes are decoupled during diamond-formation [3].