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Old zircons in Hawaiian xenoliths constrain mantle chemistry, evolution and convection models.

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Summary

Two garnet pyroxenite xenoliths from the Salt Lake Crater basanite ($\leq$ 0.6 Ma), Oahu, Hawaii (island $\leq$ 5 Ma old), yielded 7 zircons with ~14 Ma rims and interiors recording 45, 70 and 101 Ma ages (Laser Ablation Inductively Coupled Plasma Mass Spectrometry; LAICPMS). SelFrag disaggregation with fastidious sanitizing between samples (Queen's), scrupulous inter-sample cleaning of glassware and the magnetic separator (Toronto), year-plus records showing no processing of equivalent-age samples (both labs), and equivalent rim ages, make it unlikely the zircons are contaminants. These are the first mantle zircons recovered from Oceanic Island Basalt (OIB) xenoliths, and oldest mantle ages from a mid-plate ocean basin. The zircons produced 900 to 1300 Ma T_{DM} Hf model ages (solution multicollector ICPMS) and $^{207}Pb/^{206}Pb$ model ages up to ~ 2000 Ma from Thermal Ionization Mass Spectrometry. Old zircon interiors, and Proterozoic Hf and Pb model ages indicate formation in subcontinental lithospheric mantle (SLM) far from Oahu. The xenoliths represent the types of materials that may generate the isotopic OIB "mantle component" signatures. Literature mixing models suggest convective mantle homogenization on time-scales <1 Ga but the radiogenic isotope compositions of mantle component OIB imply longer-term isolation to generate/preserve isotopic signatures. Storage and isotopic incubation of subducted materials at the core-mantle boundary, with rise to the asthenosphere in plumes, might yield the OIB component signatures in basalts. However, diffusion experiments indicate that zircons would not preserve old dates at high, lower mantle temperatures. The pyroxenites/zircons may represent SLM delaminated during NE subduction at Papa New Guinea ~10 Ma ago. This requires rapid, 0.75m/yr asthenospheric transport to Oahu in SLM blocks thick enough to prevent interior heating and resetting of the zircon isotopic clocks. Alternatively, they may be SLM stranded in the convecting mantle during Phanerozoic disaggregation of Pangea. No matter how they ended up below Oahu, they provide further support for a Grand Unifying Hypothesis suggesting that the OIB mantle components reflect subduction-related SLM "recently" returned to the convecting upper oceanic mantle.