U-Th-Pb cycling from ocean to mantle and the HIMU endmember source

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Of the isotopically distinctive mantle domains, the so-called HIMU source is the most extreme and its genesis continues to be debated. Here we report extreme U enrichment at unchanged Th concentrations in oceanic serpentinites, representing altered depleted peridotite. The U-enrichment from seawater has resulted in $^{206}Pb/^{204}Pb$ as high as 56, spectacular for samples drilled from a modern passive margin. By contrast, $^{208}Pb/^{204}Pb$ has remained unchanged. Similar but less extreme features are found in 1.9 billion years old altered oceanic crust (AOC).

These U/Th/Pb systematics are relevant to models of the HIMU source. Forward modelling demonstrates that convecting mantle, metasomatised by deep fluids derived from subducted AOC and serpentinites evolves to the HIMU Pb isotope signature, while satisfying experimental and empirical constraints on subduction zone element processing. Over time, the net U addition from subducted serpentinite to convecting mantle has become expressed as the second terrestrial Pb paradox. By contrast, the traditional genetic model – recycled oceanic crust residues as the HIMU source - can only satisfy uranogenic Pb isotope systematics but is irreconcilable with observed $^{208}Pb/^{204}Pb$.