Primitive mantle source components with variable initial (U+Th)/He and U/Pb inferred from new data from Tristan da Cunha

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New He data of basaltic rocks from the Tristan da Cunha Island Group confirm that the mantle source of this plume has more radiogenic $^{3}He/^{4}He$ (5.4 Ra) than the MORB-source mantle. We combine this with new Pb isotope and trace element data to test models for the origin of the Tristan plume. We show that the Tristan plume's relatively high $^{207}Pb/^{206}Pb$ ratios are not due to the presence of a component derived from continental crust. Calculations also demonstrate that recycling of relatively undegassed oceanic crust does not contribute significant He, neither to the Tristan plume source nor OIB in general.

This leads us to propose a model whereby the variability of $^{3}He/^{4}He$ in OIB and much of the range of $^{207}Pb/^{206}Pb$ in OIB are fundamental features of 'primitive' mantle material processed in the first 100 Ma of Earth's history. Small variations in initial (U+Th)/He produced during accretion, core formation and subsequent degassing for ~ 100 Ma after solar system formation can produce the entire range of $^{3}He/^{4}He$ observed in OIB. We demonstrate that this is consistent with Ne isotopes in OIB. Furthermore slight variations in $^{238}U/^{204}Pb$ in the mantle prior to extraction of continental crust, possibly produced during core formation and as a result of volatile Pb loss can explain much of the range of $^{207}Pb/^{206}Pb$ observed in OIB.

This model challenges the view of a homogenous 'primitive mantle endmember' and instead proposes an ubiquitous contribution from undepleted, slightly heterogenous mantle to OIB. This source component dominates He and Ne isotope systematics of OIB and is discernible in Pb isotope systematics. Implications for the composition and nature of Bulk Silicate Earth and for the first terrestrial Pb isotope paradox are investigated.