Constraints from Sr-Nd-Hf-Pb-Os isotopes for enriched and depleted Hawaiian plume components in the oldest Emperor Seamounts

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Depleted and enriched geochemical compositions have been found at the oldest (~85-70 Ma) end of the Hawaiian-Emperor hotspot chain. The origin of these components is controversial. During two R/V SONNE 201 cruise legs, fresh lavas were recovered from the NW Emperor seamounts (Suizei, Tenji and Meiji). Major and trace element and Sr-Nd-Hf-Pb-Os isotope investigations provide new insights into the origin and evolution of the Hawaiian plume volcanism in the Late Cretaceous. The recovered samples range from enriched tholeiites and alklai basalts (e.g., La/Yb = 1.5-6.5) to depleted tholeiites (La/Yb = 0.7-1.2). Initial Pb and Nd isotope ratios form a tight inverse linear array, consistent with mixing of 1) an enrihced Kea-type component found in present day Hawaiian tholeiites (Abouchami et al., 2005, Nature 434: 851-856) and 2) a depleted component with less radiogenic Nd than Pacific MORB at a given Pb isotopic composition. Initial Pb and Os isotope ratios correlate inversely whereas Nd and Os isotope ratios correlate positively. The depleted component has radiogenic (superchondritic) Os and thus cannot be derived from a MORB source. Therefore, we believe that the Suizei depleted endmember was a component in the Hawaiian plume, possibly derived from recycled metasomatized oceanic lithospheric mantle (Regelous et al. 2003, J. Petrol. 44: 113-140; Huang et al. 2005, G-cubed 6: 1-52; Portnyagin et al., 2009, EPSL 287: 194-204) or ancient non-chondritic primitive mantle (Jackson et al., 2010, Nature 466: 853-856; Jackson and Carlson, 2011, Nature 476: 316-319). The enriched component, with similar Sr-Nd-Pb isotope ratios to the Hawaiian Kea component, however, has subchondritic Os isotope ratios, suggesting recycled ancient subcontinental lithospheric mantle in the source. The subchondritic Os contrasts with slightly superchondritic ratios found in lavas from Mauna Kea, posing the question as to whether the Kea component was really present in the early Hawaiian plume or if the differences in Os isotopic composition simply reflect temporal heterogeneity in the plume source.