Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11225

Renewed Volcanism at the Hawaiian-Emperor Bend at ~31 Ma

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The significance of the Hawaiian-Emperor bend has been at the center of debates regarding mantle plume drift and plate motion direction and velocity changes since it was discovered. Yuryaku is the first seamount to occur after the Hawaiian-Emperor bend and is therefore a key volcano in defining Pacific plate motion and Hawaiian plume drift change at ~47 Ma.

Yuryaku exhibits a puzzling bimodality in ages. Basalts with shield-stage geochemical characteristics erupted ~47–48 Ma, consistent with models of linear age progression of the Hawaiian mantle plume[1-3]. However, some samples from the same dredge hauls are alkalic in composition and have $^{40}Ar/^{39}Ar$ ages that are 16–17 million years younger than when the Hawaiian plume was located at Yuryaku[2-3]. This unusually large gap is too long to correspond with rejuvenated volcanism, which occurs within one million years of the postshield volcanic stage.

This study presents the elemental and isotopic compositions of these bimodally aged rocks and interprets the data in the context of the regional tectonic framework and new high-resolution bathymetric maps. Some isotopic characteristics are consistent with a Hawaiian plume source with e_{Nd}Â»7–8, epsilon e_{Hf}Â»12, and $^{87}Sr/^{86}Sr$ Â» 0.70355–0.70358. In contrast, low chromium and nickel, and high aluminum and large ion lithophile element concentrations, as well as high $^{206}Pb/^{204}Pb$ (19.9–20.3) for a given $^{208}Pb/^{204}Pb$ (38.3–37.9) indicate low-degree melts that propagated through a cool edifice and potentially incorporated oceanic crust. Combined, this suggests renewed volcanism occurred far from the active plume at a time when the lithosphere underneath Yuryaku was ~93 Ma, the age when oceanic crust reaches a steady state between continued thickening and erosion from sub-lithospheric small-scale mantle convection. This process may produce upwelling and melting in mantle refertilized by the Hawaiian plume and beneath previously weakened lithosphere (e.g., Pau fracture zone). Conversely, these data could indicate a previously undocumented change in Pacific plate motion or velocity in the mid-Pacific at ~31–32 Ma.

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[2]O'Connor et al. 2013. Geochem Geophys Geosyst 14, 4564-4584.

[3]Jicha et al. 2018. Geol 46, 939–942.