Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.9344

Magellan Seamount Trail generated by superposition of Arago and Rarotonga hotspot volcanism: Insights from co-occurrence of HIMU and EM1 components in a single Pako guyot

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Oceanic intraplate volcanoes are generally accepted to originate from deep, relatively stationary mantle plumes. However, many seamount groups in the West Pacific Seamount Province (WPSP), form age-progressive but short-lived and discontinuous volcanic chains instead of long-lived, narrow, and clearly age-progressive chains of volcanoes [1], suggest that their origin cannot be accounted for solely by the mantle plume hypothesis [2]. The origin of the WPSP is enigmatic. Here we show a wide compositional spectrum of lavas from the Pako guyot within the Magellan Seamount Trail (MST), an age-progressive but short-lived volcanic chain in the WPSP. For the first time, both extreme high $\mu = {}^{238}U/{}^{204}Pb$ mantle (HIMU)- and enriched mantle 1 (EM1)-like mantle plume components occur in a single seamount in the Pacific Ocean (Fig. 1). The HIMU-like lavas are similar to the Arago (also known as "Young Rurutu" or "Atiu") hotspot composition [3, 4]. The EM1-like lavas display the largest Sr-Nd-Pb-Hf isotope variations that can be best explained by mixing between melts of FOZO (focal zone) and EM1-like mantle components (Fig. 1). The EM1-like lavas are compositionally similar to the Rarotonga hotspot composition (Fig. 1), suggesting that the MST is possibly an old trace of the Rarotonga hotspot which is most likely a long-lived hotspot generated above a deep mantle plume [5]. We propose that the Magellan Seamounts were likely derived from partial melting of a heterogeneous mantle plume containing HIMU, FOZO and EM1-like components (Fig. 2a). Alternatively, they could have been derived from the Arago and Rarotonga mantle plumes (Fig. 2b), each having its distinct compositional signature. The occurrence of HIMU- and EM1-like mantle plume components in a single volcano suggests that superposition of compositionally different hotspot volcanic trails in the South Pacific could have played an important role in the generation of the WPSP.

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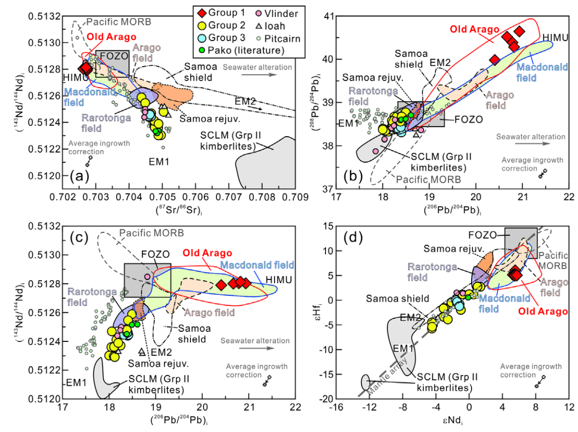

Fig. 1. The Sr, Nd, Pb, and Hf isotopic compositions of Pako guyot lavas from the Magellan Seamount Trail. Data sources: Macdonald, Rarotonga, Arago and Samoa hotpsot data and Samoa rejuvenated lavas are compiled by Jackson et al. (2020) and Wei et al. (2022), and from GEOROC database; Pacific MORB from http://www.earthchem.org/petdb; FOZO from Hauri et al. (1994); Pitcairn EM1 OIB and Group II kimberlites from GEOROC database.

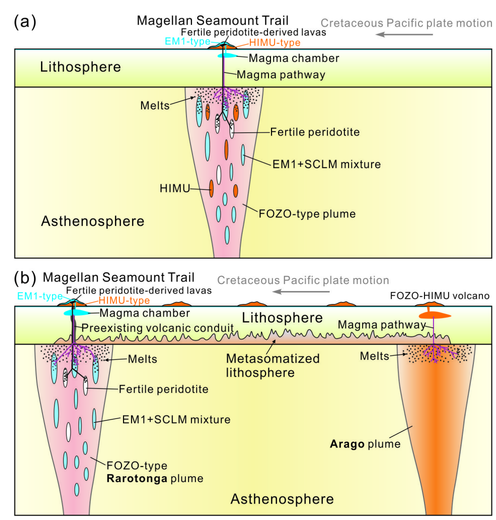

Fig. 2. Conceptual models for the generation of the Magellan Seamount Trail (MST). (a) The MST lavas were likely derived from partial melting of a single plume with a heterogeneous composition. (b) An alternative model showing that the MST lavas could have been formed during the passage of the lithosphere previously metasomatized by the old Arago plume material above the Rarotonga plume containing FOZO and an EM1-SCLM mixture with an additional fertile peridotite component.