# Magma genesis and mantle sources in the Easter Hotspot–Easter Microplate system

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## Introduction

Large scale flow of material between upwelling mantle plumes and mid-ocean ridge spreading axes has been shown to occur throughout the ocean basins (Schilling, 1985). The volcanism associated with the Easter Hotspot–Easter Microplate spreading axes allows us to study the geochemical variation due to partial melting and source composition over a wide area. West of Easter Island young submarine volcanic fields and seamounts with ages of < 0.5 Ma occur in a 200 km wide region which marks the present-day position of the Easter Hotspot. The volcanic fields Ahu, Umu and Tupa lie closest to the spreading axis on about 2 Ma old crust while the two seamounts Moai and Pukao and Easter Island are located on about 3 Ma old crust (Naar and Hey, 1991).

## Methods

Major elements on glasses and whole rocks were analyzed by XRF and electron microprobe at the Mineralogical Institute in Kiel after the methods outlined in Haase and Devey (1994). Trace elements were measured on a PlasmaQuad PQ ICP-MS at the Geological Institute in Kiel (Garhe-Schönberg, 1993). On several samples from each location Sr, Nd, and Pb isotopes were analysed at the Max-Planck-Institut, Mainz.

## Melting and mantle dynamics

The most abundant lavas on the volcanic fields are enriched tholeiites with Cl chondrite-normalized Ce/Yb of 2–2.5 Two dredges also recovered incompatible element depleted tholeiites which we call the depleted Ahu and depleted Umu lavas. Most of the samples from the two seamounts and Easter Island (both subaerial and submarine) are alkali basalts with normalized Ce/Yb > 2.5. Lavas on crust older than about 2.5 Ma are alkaline while tholeiites have erupted on younger crust. The enriched tholeiites from the volcanic fields are different from MORB associated with the neighbouring spreading axis in having lower CaO and $SiO_2$, but higher $Na_2O$ and $FeO_T$ at 8 to 9 % MgO. These variations suggest different degrees and depths of partial melting. Because the MORB closest to the volcanic fields have similar incompatible element and isotopic compositions as the enriched tholeiites, we conclude that they share a common mantle source. The lower $FeO_T$ and higher $SiO_2$ of MORB are in accordance with cumulative melting models which predict such differences for melting at shallower depths (e.g. Klein and Langmuir 1987). Thus the enriched tholeiites formed by about the same degree of melting as neighbouring MORB, but at higher pressures. The lithosphere underneath the seamounts and Easter Island is considerably thicker than underneath the volcanic fields, which leads to melting at great depths producing alkali basalts.

From isotopic and incompatible element compositions we can show that four different mantle sources are present in the study area. Most prominent are the depleted MORB source of the upper mantle and an enriched source associated with the plume. The enriched plume source has $^{87}Sr/^{86}Sr$ of about 0.7032 and $^{206}Pb/^{207}Pb$ of about 19.7, and is observed undiluted in the most enriched alkali basalts near Easter Island. Therefore the enriched source is present underneath the Easter Hotspot as well as Sala y Gomez, 400 km to the east, as shown by Hanan and Schilling (1989). The plume material mixes to varying extents with MORB material. An isotopic zonation exists both along the spreading axis and normal to it. If we assume that the plume has an isotopic composition like the most enriched volcanics, the alkaline lavas from the seamounts and Easter Island consist > 60 % of plume material, while the enriched tholeiites are derived from 30 to 60 % mixing of plume with MORB.

150 km west of the volcame fields the lavas on a 100 km long segment of the Easter Microplate East Rift (26°S to 27°S) also contain a similarly high amount of plume material. A less strong plume influence can be seen on the East Rift between 24°30'S and 28°S. The plume influence possibly reaches as far east as 115°W on the West Rift of the Easter Microplate.

## Source compositions

Two other sources show their signatures in the depleted tholeiites from the volcanic fields. Despite their depleted chemistry the depleted Umu lavas have Sr and Pb isotopic compositions much higher than MORB but similar to the most enriched alkali basalts. In $^{143}Nd/^{144}Nd$ the depleted Umu samples are higher at a given $^{87}Sr/^{86}Sr$ than the alkaline lavas. They appear to reflect derivation from a plume source which was depleted by a previous melting event.

The depleted Ahu lavas have *REE* patterns which are either flat or show strongly depleted *LREE*. These tholeiites have Sr and Nd isotopic compositions like MORB but much higher Pb isotope ratios (e.g. $^{206}Pb/^{207}Pb$ ~ 19.3). This source may be explained either by mixing material having high U + Th/Pb similar to Tubuaii/Mangaia, with MORB material or by a source which is developing a radiogenic Pb isotope signature. EPR MORB from south of the Easter Microplate (29 to 35°S) also show variable Pb isotope ratios while Sr and Nd remain constant and appear to trend toward the depleted Ahu basalts. This suggests that the high U + Th/Pb source might be also present in the South Pacific MORD mantle.

## References

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