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Effect of tectonic environment on chemical composition of OIBs in the Pacific: implication for a deep mantle origin

Gen Shimoda[1*]

[1]Geological Survey of Japan, AIST

The Pacific Ocean is known to contain numerous ocean islands, seamounts and several oceanic plateaus and rises those may have formed during the large-scale magmatic event in the South Pacific. Proposed origins for this magmatism can be divided into two categories. One is mantle plume from the Earth's deep interior that is governed by mantle dynamics and the plume sometimes referred to as "superplume". The other is upper mantle process that is controlled by lithospheric dynamics, such as surface lithospheric fractures, melt focusing under broad upwellings condition and small-scale sublithospheric convection. In either case, documenting the large-scale magmatic event over both space and time may provide clues into understanding material recycling throughout the silicate Earth.

The South Pacific region is referred to as a "superswell" or the "South Pacific Isotopic and Thermal Anomaly" (SOPITA) due to its unusually shallow ocean floor, evidence of active intraplate volcanism, and the occurrence of isotopically anomalous magmas. These geophysical and geochemical features are usually attributed to a plume activity or lithospheric dynamics. Although it is unclear whether the process that is now operate in the South Pacific has been active since the Cretaceous, distinct isotopic signatures of the Cretaceous seamounts can be traced back to the magmas of SOPIAT. It might follow that single process has been active since the Cretaceous.

The notable geochemical character of this magmatism is quadratic correlation between elemental ratios (La/Yb, Sr/Y, Nb/Zr, Ta/Zr and Th/Ta) of the seamounts/island and "relative age" that can be an index of the thickness of lithosphere beneath hot spots. As the thickness of oceanic lithosphere is a function of square root of its age, these correlations suggest importance of tectonic environment to determine the chemical composition of the magmas. In addition, these correlations suggest the genetic relationship between oceanic plateaus and island/seamount chain because the elemental ratios of oceanic plateaus are on the trends. Other important geochemical feature is that the elemental ratios of mid-ocean ridge basalts (MORBs) from the East Pacific Rise (EPR) are not on these trends. This observation suggests that source material of the EPR MORBs is different from that of the seamounts and islands. Since the source material of EPR MORBs can have a representative composition of upper mantle beneath the South Pacific, this difference could imply the material flow from the deep mantle. Therefore melting of mantle plume from the lower mantle, which melting condition depends on thickness of lithosphere, can be a plausible origin of the magmatism in the South Pacific.

Keywords: Pacific, hot spots, ocean islands, Pb-Nd-Sr isotopes, superplume