Origin of adakitic lavas in the Mariana Forearc

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Shinkai 6500 diving along the Mariana trench slope SE of Guam in 2006 recovered a suite of andesites with "adakitic" compositional traits. These andesites are vesicular and rich in phenocrysts of plagioclase, two pyroxenes, and hornblende. Most are volcanic although one sample is a gabbronorite. These samples crop out west of Shinkai 6500 collection sites for boninite and MORB-like samples, but significantly east of the Mariana forearc islands. Ages determined by 40Ar/39Ar methods range from 30-32Ma, which is nearly coincident with the initial rifting of the Kyushu-Palau Ridge to form the Parece Vela Basin. Like other adakitic lavas, our samples are characterized by Sr/Y>20 and Y<20 ppm. These samples also are characterized by steep concave upward REE patterns, which is consistent with fractionation of both amphibole and garnet during their genesis. Adakites elsewhere have been attributed to melting of young subducting basaltic crust (Defant & Drummond, 1990, Nature, v. 347) and it is possible that the Mariana LREE-andesites were generated in this way. Other possibilities for the origin of these magmas include crystal fractionation of a basaltic parental magma at the base of the arc crust or melting of deep gabbroic crust. Sr-Nd-Pb isotope values for these lavas suggest that they have a genetic kinship with nearby boninitic magmas, which would be most consistent with an origin by deep crustal melting. To further test this hypothesis by meeting time, we intend to analyze the andesites for 176Hf/177Hf. High Hf isotopic compositions with respect to Nd would lend further support to the crust melting hypothesis. Low Hf values would suggest a source for these magmas in the subducting Pacific crust (e.g. Pearce *et al*., 1999, J. Petrol., v. 40).

Origin of mantle endmembers and the role of depleted oceanic lithosphere

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The origin of mantle heterogeneities has been a subject of debate for nearly 40 years. The mass of oceanic lithosphere produced through geologic time, and subducted back into the mantle, is ~150% of the whole mantle mass (assuming the present-day production rate). Therefore, it is possible the entire mantle is compositionally variable, reflecting gradients between 0 to 25% melt removal, along with enriched crustal and sedimentary components.

The Very Enriched Mantle

Trace element and isotopic enrichment in OIBs was originally interpreted as evidence for the presence of continental crust recycled to the mantle through subduction. However, due to the inherent complexity of Earth's physical and chemical processes it is difficult to provide a unique solution to a given set of geochemical observations; this is largely because of the many parameters required in radiogenic isotope and trace element modeling, such as the composition of mixing components, degree of melting, mineral modes of the source, partition coefficients, and time of formation. The Samoan hot spot track is the type locality for the mantle component EM2; recent dredging has provided outrageously enriched lavas [1] with heavy oxygen isotope compositions which are extreme enough to show an undeniable signature of continental crust, confirming the original model for EM2.

The Very Depleted Mantle

Only by also understanding the compositional variation produced by melt extraction from the upper mantle can we fully understand geochemical signatures in modern mantle-derived materials. From pHMELTS modeling, it is clear that the upper 30 km of the oceanic lithosphere is nearly devoid of incompatible lithophile elements. This large and much depleted body of mantle could easily pick up any trace element pattern carried by melts, fluids or by mixing with other differentiated materials such as oceanic and continental crusts. The outcome of such mixing is that major element signatures appear "depleted" while trace element signatures could appear "enriched".

[1] Jackson *et al*. (2007) *Nature* **448**, 684-687.