Initial findings of post-cruise research on IODP Expedition 352 cores II: Radiogenic isotopes

Hongyan Li[2], Julie Prytulak[3], Rex Taylor[4], Wendy R. Nelson[5], Julian A. Pearce[6], *Mark K Reagan[1]

1. University of Iowa, 2. Chinese Academy of Sciences, Guangzhou, 3. Imperial College London, 4. University of Southampton, 5. Towson University, 6. Cardiff University

The isotopic compositions of volcanic rocks recovered during IODP Expedition 352 vary significantly over time reflecting changes in magma sources as the nascent arc system developed. Fore-arc basalts (FAB) drilled at the two deepest sites, U1440 and U1441, were generated during near trench seafloor spreading after subduction initiation. These lavas have Nd and Hf isotopic ratios in the range of depleted mid-ocean ridge and back-arc basin basalts from the Indian and Philippine Sea plates. The FAB sample with the most depleted incompatible trace element composition has the highest Nd and Hf isotope ratios, indicating that the mantle may have been variably depleted in incompatible trace elements long before it was involved in melting to produce FAB. Pb isotopes in most FAB also are similar to those of Indian Ocean mid-ocean ridge basalts. However, some have Pb isotopic compositions trending towards values of the Pacific basaltic crust, which we attribute to alteration by fluids from the subducted Pacific plate. Os isotopes are radiogenic compared to primitive mantle, similar to Indian Ocean MORB. Sites U1439 and U1442 drilled a diverse sequence of boninites upslope from the FAB sites. Nd, Hf, and Pb isotopic ratios for low-Si boninites (LSB), which make up the lower 4/5 of the cores at these sites, plot between FAB and subducting Pacific basaltic crust. High-Si boninites (HSB) atop these sites have a narrow range of Hf isotopic compositions similar to those of the lowest values for LSB, but trend towards lower Nd isotope values. Pb isotopes for these lavas plot between those of Pacific basaltic crust and subducting sediments. Both LSB and HSB record a range of Os isotopes from depleted to mildly radiogenic values. The Nd-Hf-Pb isotopic compositions of LSB can be explained by flux melting of a strongly depleted mantle source involving a subduction component largely derived from basaltic crust. The younger HSB are generated by extreme degrees of melting of harzburgitic mantle, with incompatible trace elements and Nd, Hf, and Pb isotopes modified by fluids and melts derived from subducted basalt and sediment. Eruption of boninites began about the same time as volcanism transitioned from rapid sea-floor spreading to focused edifice building.[1] The enrichment of elements from the subducting slab in all boninites including both relatively low-temperature fluid soluble elements such as Pb, and relatively high-temperature melt-soluble elements such as Hf, is consistent with the boninite genesis in the nascent Izu-Bonin-Mariana subduction system beginning at the time of first slab melting or first formation and subsequent melting of melange diapirs.[2]

[1]Reagan et al. (2017) Intl. Geol. Rev., doi:10.1080/00206814.2016.1276482.
[2]Marschall and Schumacher (2012) Nature Geosci., doi: 10.1038/NGEO1634.

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