Initial findings of post-cruise research on IODP Expedition 352 hard-rock cores I: Petrology and geochronology

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IODP Expedition 352 drilled a nearly complete volcanic sequence in the Ogasawara/ Bonin fore-arc associated with subduction initiation in the western Pacific. Four sites were cored. The two deepest sites, U1440 and U1441, sampled fore-arc basalt (FAB), and the two shallower sites, U1439 and U1442, sampled a wide variety of boninites. Preliminary $^{40}Ar/^{39}Ar$ ages for FAB from Site U1440 stretch back to about 52 Ma, with several younger ages that we attribute to alteration. Major element data for FAB resemble those of highly depleted mid-ocean ridge basalts (MORB). Incompatible trace element concentrations are exceedingly depleted. Exceptions are variable enrichments in fluid-soluble elements such as Rb, K, and U in FAB whole rocks. However, these enrichments are absent or weakly expressed in FAB glasses, and thus are most likely the result of sea-floor alteration. FAB glass compositions are noteworthy in their unusually high Cl concentrations and H_2O/Ce compared with MORB glasses. Parental magmas for FAB thus appear to have been generated by melting of a highly depleted mantle source in the presence of fluids driven off the newly subducting plate. Rare andesite glasses in Hole U1440B appear to be the products of FAB differentiation involving assimilation of altered basaltic crust.

All lavas from Sites U1439 and U1442 are boninitic with considerable enrichments in fluid-soluble elements, presumably from the newly subducting Pacific plate. Preliminary $^{40}Ar/^{39}Ar$ ages of the boninites range from ~52-50 Ma from sites U1439 and U1442, respectively. The lowermost cores of Hole U1439C consist of fine-grained dolerites with rare chilled margins, suggesting they could represent the feeder system for the overlying lavas and tephras.[1] However, trace element concentrations in clinopyroxene phenocrysts from this basal section suggest that they represent a compositionally transitional unit between boninite and FAB. The sheet flows, pillow lavas, and hyaloclastites that make up the majority of cores from these sites are low-Si boninites. The oldest boninite age from Site U1439 indicates that boninites began erupting within the same time frame as FAB. This age is significantly older than the ages of boninites found on the nearby Ogasawara Ridge[2], which lengthens the duration of boninite magma generation in the nascent IBM system to at least 7 million years. High-Si boninites cap the stratigraphy at both sites. One high-Si boninite from Site U1442 was dated at ~50 Ma, indicating that volcanism persisted at our boninite sites for ~2 million years. Overall, REE concentrations in boninites generally decrease up-section, and change from LREE-depleted to LREE-enriched, reflecting an increase in subduction flux with time. Zr/Sm ratios increase up section, which we attribute to Zr mobility. Major element data imply melting depths shallowed over time. These data are consistent with initial production of basaltic crust during rapid sea-floor spreading immediately after subduction initiation at about 52 Ma with minimal involvement of fluids from the subducting Pacific plate. Within about 10^5 years, fluids from subducting Pacific lithosphere became involved in mantle melting to generate first low-, then high-Si boninites. The

persistence of boninitic volcanism at Sites U1439 and U1442 suggests that the dynamics of magma genesis transitioned from sea-floor spreading towards central-vent volcanism about the time boninites began erupting.

[1]Reagan et al. (2017) Intl. Geol. Rev., doi:10.1080/00206814.2016.1276482.
[2]Ishuzuka et al. (2006) Earth and Planet. Sci. Lett., doi:10.1016/j.epsl.2006.08.007.

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