Petrology of basalts from Loihi submarine volcano, Hawaii

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During the summer of 1998, we conducted two KAIKO dives at Loihi Seamount in order to explore the geology of the deeper, basal parts of Loihi Volcano. These dives were conducted on the south rift zone at a water depth of ca. 4000 meters and on the southern basal flank at a water depth of ca. 4900 meters. During the dives, we collected rock samples at 14 localities. These rocks are mostly olivine phyric to picritic basalt with glassy selvage generally less than a few millimeters in thickness. It is most remarkable that some of these specimens are extremely vesicular, having as much as 30 vol.% vesicles. Bulk rock compositions indicate that the collected samples range from 43.9 to 47.1 wt% in SiO2 contents, from 11.9 to 23.9 wt% in MgO, and from 1.58 to 2.58 wt% in total alkalis.

Loihi Seamount, located 34 kilometers south of the Island of Hawaii, is the most southern volcano of the Kahoolawe-Hualalai-Mauna Loa volcanic line and is the most recent volcano produced by the Hawaiian hotspot. Among the currently active Hawaiian volcanoes, Loihi is unique in that it still remains underseas and represents the preshield stage in the evolution of Hawaiian shield volcanoes. Thus, Loihi provides a unique opportunity to explore the preshield stage magmatic processes of the Hawaiian volcanoes. Loihi Seamount shows overall topography with an elongated appearance, stretching approximately north-south over 35 kilometers, and its rift zone runs parallel to this north-south elongation. The summit is located at a water depth of 960 meters, and its basal apron extends to the sea floor as deep as over 5000 meters water depth.

So far extensive submersible studies have been conducted over the summit of Loihi; however, in contrast to the shallower portions of Loihi Volcano, its deeper parts are less explored and very few submersible dives were made over the water depth of 2000 meters. As a result, well-located samples from the deeper portions of Loihi are scarce. During the summer of 1998, we conducted four KAIKO dives at Loihi site in order to explore the geology and hydrothermal activity of the deeper, basal parts of Loihi Volcano. Two KAIKO dives (#94 and #96) were successfully conducted on the south rift zone at a water depth of ca. 4000 meters and on the southern basal flank at a water depth of ca. 4900 meters, respectively. During these dives, we found that fairly young lava flows with various lava morphologies occur in these dive areas. The lava morphologies provide us with valuable information to define flow directions; in the ridge crest zone observed during dive #94, we could trace the eruption center from which magma was possibly supplied. Besides pillow lavas, lava tubes, and lobate pillows commonly observed underseas, we encountered lava flows that are more like subareal, shelly pahoehoe. Also, collapsed pits and hollow lava flows are ubiquitously present. The local topography is dominantly due to volcanic constructions, but we came across the deep depressions with possible tectonic origin during dive #96. It is also worthwhile to note that we observed several open fissures with several tens of centimeters to over one meter wide at the #94 dive site; these fissures run nearly parallel to each other and trend north-south. This north-south trend is slightly oblique to the trend of the ridge crest and the overall, general trend of the South Rift.

During these two dives, we successfully collected rock samples at 14 localities. These rocks are mostly olivine phyric to picritic basalt with glassy selvage generally less than a few millimeters in thickness. It is most remarkable that some of these specimens are extremely vesicular, having as much as 30 vol.% vesicles in visual estimates. Bulk rock compositions indicate that the collected samples range from 43.9 to 47.1 wt% in SiO2 contents, from 11.9 to 23.9 wt% in MgO, and from 1.58 to 2.58 wt% in total alkalis.

We also conducted a petrologic study on dredge samples obtained from Loihi Seamount during the Hakuho-maru KH84-1 cruise. This study indicates that a wide range of basalt types including tholeiite, alkali basalt, and basanite occur on the shallower parts of this immature volcano (<3000m water depth). This wide spectrum in major element variations is accompanied by large variations in trace element contents as well as Sr and Nd isotope ratios. Apparently, shallow level fractional crystallization or different degree of partial melting of a homogeneous source does not genetically relate these basalt types to each other. In order to understand magmatic evolution at Loihi Volcano, we attempt to relate these basalt types to the picritic basalt in terms of major and trace element chemistry, and to define, if any, magmatic lineage.