Petrological Study of the Submarine Haleakala East Rift Zone, Hawaii

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Joint Japan-US Hawaii cruises in 2001, using a JAMSTEC vessel Kairei and a remotely operated unmanned submersible (ROV-Kaiko), we have observed three dives and took a total 71 samples for the first time on the submarine Hana Ridge. We have analyzed major and trace elements compositions from 55 and 12 bulk rocks, respectively. We also analyzed major element compositions for pillow glass rims and 31, 20, 21 inclusion and host olivines from euhedral, undeformed,and deformed phenocrystal, respectively. Total about 400 undivided of olivine phenocrysts were analyzed.

Submersible observation and samples show that the submarine Hana Ridge consists of pillow lavas, partly broken pillows and talus of rock fragments from small-scale landslides or debris flow. The volume of the debris lobe embraced by the branching arms of Hana Ridge tip appears to be too small to have been roduced by simple slope failure. Major and trace elements of bulk rock show no alkalic rock but typical Hawaii tholeiite composition as Kahoolawe shield lavas or similar to Kilauea shield lavas. These facts are not consisting with proviously proposed hypothesis for the origin of the Hana Ridge; 1) the arcuate tip was by landslide collapse, or 2) a Y-shaped old seamount was trapped by Hana Ridge. Our observation supports the third possibility 3) that this arcuate tip be an original volcanic structure which records at least three different growth stages.

No compositional different was recognized in melt inclusions from different type of olivines. Olivines from different type also have no compositional different and significantly different with compositions of olivines from Hawaiian mantle xenoliths. The compositions of the melt inclusions and olivines imply that all of those euhedral, undeformed, and deformed olivines are crystallized from host magmas.

We believe that the variation of major elements of samples from sumarine Hana Ridge is caused by crystallization, because 1) all oxides of major elements, except Fe2O3, increase with decreasing MgO content and little scatter; 2) characterized by linear arrays on Ni vs. MgO diagrams, indicating olivine fractionation and accumulation; 3) trace elements ratios such as K/Rb, Zr/Nb, Rb/U, Sm/Nd, Sr/Y, and Ca/Al are near constant and show no systematic relation to MgO, indicating that different magma mixing has not occurred; 4) Sm/Sr and Ti/Eu ratios are nearly constant, indicating mixing of primitive and evolved liquids has not occurred because that of ratios are sensitive indicators for plagioclase and Fe-Ti oxide crystallization; and 5) analyzed olivine data show that the CaO content of olivine cores are increasing with decreasing Mg# in higher than about 0.845 Mg# and decreasing with decreasing Mg# in lower than about 0.845 Mg#, indicating that olivines are crystallized from host magma. Beacause CaO content of olivine and melt are obey LnD* (equations see Libourel, 1999). Using most forsteritic olivine (Fo90.6), KD (Fe/Mg)(Ol-melt) and D(CaO* Ol-Melt) equations and combining with the trend of the bulk rock compositions, we estimated the primary magma compositions which contain MgO about 16.7% and about 8.4% CaO. Simulations of the trend of the bulk rock compositions at QFM buffer condition with Melts500 Program show that the condition of magma chamber which temperature range from higher than 1390 to lower than 1120'C, pressure is about 1kbar, and about 0.5% water contain in magma.

The Sm/Sr ratios of the submarine Hana Ridge lavas is nearly constant while Sm and Sr each show variation in aboundance. Beacause clinophyroxene has a D for Sr of 0.16, significantly higher than in garnet, and result in a D(Sm)/D(Sr) of nearly 3 (Hofman et al. 1984; Hauri et al. 1994). Clinophyroxene, then is the only phase that could control the Sm/Sr ratio and must be in the source residue of the submarine Hana Ridge lavas.