Isotope geochemistry of submarine lavas from South Arch volcanic field, Hawaii

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The Hawaiian Arch is a broad swell in the Cretaceous sea floor surrounding the Hawaiian Islands. Numbers of Tertiary/Quaternary volcanoes, which located on the Hawaiian Arch, are discovered in 1986 during surveys using the USGS GLORIA sonar system. The origin of the arch lavas may be somewhat related to the structure of the arch itself. The total area of identified arch lavas exceeds that of the subaerialy exposed Hawaiian Islands. There has been a growing interest in the origin of these arch type volcanisms to understand Hawaiian hot spot magmatism.

The South Arch Volcanic Field is one area of the arch volcanism located 200km south of Hawaii Island. The South Arch volcanic field consists of flat sheet flows and pillows in a 35 by 50 km area. It is reported that South Arch lavas erupted at 1~10 ka according to the palagonite thickness on lava surfaces, demonstrating South Arch volcanism is similar in chemical compositions to North Arch lavas which located 500km far from the center of the plume beneath Kilauea (Lipman et al., 1989).

Glassy fresh pillow lavas were collected from the young lava flow field in South Arch volcanic field by ROV-KAIKO during JAMSTEC 2001 Hawaii Cruise. The present Sr and Pb isotope data of the South Arch glasses plot in the limited ranges; ^{87}Sr/^{86}Sr: 0.70331-0.70342 ^{206}Pb/^{204}Pb: 18.41-18.43, respectively. It is reported that two dredged glasses from the precursory South Arch have higher ^{206}Pb/^{204}Pb than peripheral North Arch lavas (Dixon et al., 2001). The Pb and Sr isotope data of fifteen North Arch lavas indicated that binary–like mixing occurred between a less-radiogenic and a more-radiogenic component during melting to produce magma (Kani et al., submitted). We present comparative study of isotope geochemical characteristics of the mantle source components involved in South Arch volcanism and North Arch volcanism and examine temporal special distribution of mantle components beneath Hawaiian hot spot region,

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NMR evidence for a new water dissolution mechanism in alkaline earth silicate melts

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The dissolution of water in magmas significantly affects their phase relations, and physical and thermodynamic properties. Most of the spectroscopic studies on Al-free silicate melts/glasses thus far have concluded that water is dissolved as molecular H_2O and silanols (SiOH). However, these studies have been limited mostly to SiO_2, and Na-, Ba-, and Sr silicate compositions. We now report new ^{1}H and ^{29}Si NMR evidence for another water dissolution mechanism in silicate melts in the $CaSiO_3$ (Wo) - $MgSiO_3$ (En) - SiO_2 (Qz) system, that can be regarded as rough analogs for mafic to ultramafic magmas.

A hydrous $Wo_{43.75}En_{43.75}Qz_{12.50}$ glass with 1.8 wt% H_2O was synthesized from anhydrous glass powder and deionized water at 2 kbar and 1450˚C. The ^{1}H 1-pulse and Hahn-echo MAS NMR spectra contain two partially resolved peaks at 1.4 and 4.6 ppm. The 4.6-ppm peak is broader and asymmetric with a shoulder near 14 ppm. Similar to those for hydrous Na-, Ba-, and Sr- silicate glasses, this peak can be ascribed to molecular H_2O and SiOH with a range of H-bonding strengths. The 1.4-ppm peak is close to those of MgOH and CaOH in crystalline hydrous silicates, and thus can be attributed to (Ca, Mg)OH. These ^{1}H NMR spectra are similar to those of another glass ($Wo_{48.6}En_{39.2}Qz_{12.2}$ from probe analysis) with 3.85 wt% added H_2O, synthesized at 1 GPa and 1500˚C (Xue et al., 2001). The ^{29}Si MAS NMR spectrum of the anhydrous $Wo_{43.75}En_{43.75}Qz_{12.50}$ glass contains a single asymmetric peak centered at –82.3 ppm with a FWHM of 19 ppm. That of the hydrous glass is almost identical, with only a slightly displacement to higher frequency.

Our study clearly indicates that a substantial part of the dissolved water is in the form of cationic hydroxyls ((Mg,Ca)OH), in addition to SiOH and molecular H_2O. The formation of cationic hydroxyls may be considered to result from the following reaction between water and non-bridging oxygens (NBO):

$$2SiO(Ca,Mg)\ (NBO) + H_2O = SiOSi\ (BO) + 2(Ca,Mg)OH$$

This reaction actually drives the silicate network to a more polymerized structure, and is thus expected to increase the melt viscosity, in contrast to the formation reaction for SiOH. Any models for the physical and thermodynamic properties of hydrous silicate melts must take this new water dissolution mechanism into account.

References

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