Noble gas study of on- and off-axis alkali volcanism at the Hawaiian hotspot

T. HANYU[1], D. A. CLAGUE[2], I. KANEOKA[3], T. J. DUNAI[4] AND G. R. DAVIES[4]

[1]Institute for Frontier Research on Earth Evolution, Japan Marine Science and Technology Center (hanyut@jamstec.go.jp)
[2]Monterey Bay Aquarium Research Institute
[3]Earthquake Research Institute, University of Tokyo
[4]Faculty of Earth and Life Sciences, Vrije Universiteit

Noble gas isotopes of off-axis volcanic rocks of the Hawaiian hotspot chain are presented. Recent underwater surveys reveal abundant abyssal alkali volcanism around the Hawaiian islands. The major and trace elemental composition of the rocks are similar to those from pre-shield and rejuvenated series. Noble gas isotopes are sensitive tracers of flux from a mantle plume, and so should provide constraints for the origin of such abbysal alkali volcanism.

Samples are from Oahu-Kauai Channel, north of Molokai, northwest of Niihau, North Arch, South Arch and southwest of Oahu. They were collected by dredging or using submersibles operated by JAMSTEC and MBARI. Quenched glass on pillow basalts and sheet flow fragments was hand-picked for noble gas analysis.

Oahu-Kauai Channel, north of Molokai and northwest of Niihau are small lava fields located downstream from the center of the hotspot. $^{3}He/^{4}He$ ratios mostly plot close to MORB about 8 Ra (Ra; atmospheric ratio). North Arch is also located downstream on the Hawaiian Arch north of the islands. $^{3}He/^{4}He$ ratios of North Arch are also similar to those of MORBs. Furthermore the neon isotope ratios plot on a MORB array in the $^{21}Ne/^{22}Ne$-$^{20}Ne/^{22}Ne$ diagram. The noble gas isotopic evidence demonstrates that the magmas erupted at these sites had minimum contribution from a mantle plume.

In contrast, the South Arch, located upstream of the hotspot on the Hawaiian Arch, has $^{3}He/^{4}He$ ratios for two different lava flows between 17 and 21 Ra, demonstrating a strong plume influence. $^{4}He/^{40}Ar^{*}$ ratios ($^{40}Ar^{*}$ is ^{40}Ar of non-atmospheric origin) of South Arch, as well as Loihi, are typically greater than mantle production ratio, which is set by uniform U/K ratios in the mantle, indicating He enrichment in the magma source compared to Ar.

Differences in noble gas isotopic characteristics between alkali volcanism downstream and upstream of the hotspot imply that upstream volcanism contains incipient melts from an upwelling mantle plume, having greater He/Ar and primitive $^{3}He/^{4}He$. Geophysical observations suggest confined melting region in a mantle plume. We therefore propose that downstream magmatism is a consequence of plume derived metasomatic melt enrichment by melts depleted in noble gases by prior melt extraction.

Fluctuation of alkenone temperature in the Okhotsk Sea over the last 20ka

N. HARADA[1], N. AHAGON[1], M. UCHIDA M[1], T. SAKAMOTO[2] AND M. IKEHARA[3]

[1]Mutsu Inst. for Oceanogr., Japan Marine Science and Technology Center, 690 Kitasekine, Sekine Mutsu, Japan haradan@jamstec.go.jp ahagon@jamstec.go.jp uchidama@jamstec.go.jp
[2]Institute for Frontier Research on Earth Evolution, Japan Marine Science and Technology Center, 2-15 Natsushima-cho, Yokosuka, Japan (tats-ron@jamstec.go.jp)
[3]Kochi Univ., Nangoku, Kochi, Japan (ikehara@cc.kochi-u.ac.jp)

The sediment was collected at the Kuril Basin (PC-04, 49N, 153E, water depth 1,821m) in the Okhotsk Sea and the southeastern site in the Pacific side of the Kulzenshutana Strait (PC-01, 46N, 152E, water depth 2,800m), during the MR00-K03 cruise from May 9 to June 10 in 2,000, as an investigation of a JAMSTEC project on "Biogeochemical Change of the Past Northern North Pacific and its Adjacent Seas." The main objective was to understand the past environmental change such as sea surface temperature, productivity and deep water circulation in the northwestern North Pacific and the Okhotsk Sea throughout the late Quaternary period (ca 150,000 yr). Additionally, we used a sediment core collected at Off Shari in the Okhotsk Sea (MD01-2412, 44.3N, 145E, water depth 1,225m) as an investigation of IMAGES.

We show alkenone flux and alkenone temperature by using $U^{K'}_{37}=0.034T(C) + 0.039$ (Prahl et al., 1988) were reconstructed for PC-01, PC-04 and MD01-2412 over the past 20kyrBP.

Alkenone was first detected at 17500yrBP for PC-01 and at 16,000yrBP for PC-04 and its concentration rapidly increased within 200-300yr after the first occurrence. Alkenone producer is difficult to survive where sea ice covers. Therefore, it seems that an area of the Kuril Basin and the southeastern site in the Pacific side of the Kulzenshutana Strait was covered by perennial ice until 16,000yrBP and 17,500yrBP, respectively, and the perennial ice melted within only several hundreds year after the LGM.

Reference

Prahl F. G., et al. (1988) Further evaluation of long-chain alkenones as indicators of paleoceanographic conditions. *Geochim. Cosmochim. Acta* **52**, 2303-2310.