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Volatile studies through drilling of oceanic plateaus and hotspot seamounts

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Oceanic plateaus and hotspot seamounts are the manifestation of magmatism unrelated to plate boundary processes. Such oceanic volcanism is a key issue in mantle geochemistry as it is a probe of the source mantle in depth. Collecting submarine volcanic rocks is essential to geochemical and petrological studies because most part of volcanic bodies exist under water. Moreover, mantle volatiles can be only studied with submarine glasses quenched under high water pressure. A problem for studying submarine rocks would be that they are easily altered by hydrothermal and low-temperature fluids, but here I would show some examples in which noble gas compositions were successfully determined using fresh core samples from aged oceaic plateau and hotspot seamounts. This is probably the first study to determine noble gas compositions of oceanic plateau basalts.

Louisville seamount chain was formed by a long-lived hotspot in the southern Pacific. Moderately to highly altered rocks have been collected by previous dredge hauls. The IODP Expedition 330 drilled and cored seamounts at the age between 50 and 74 Ma. Although the cored rocks were variously altered, we occasionally found fresh basalts in which olivine phenocrysts were well preserved. Such olivines are good container of mantle volatiles including noble gases. The $^{3}He/^{4}He$ ratios of the studied olivines range from a value similar to those of MORB (~8 Ra) to slightly elevated ratios up to 10.6 Ra (Hanyu, 2014). Moreover, some olivines exhibit a primordial Ne isotopic signature that can be discriminated from MORB Ne ratios. These noble gas compositions document a deep origin of the Louisville mantle plume from less-depleted mantle.

Shatsky Rise in the northern Pacific is an oceanic plateau constructed by intense volcanism around 140 Ma. This plateau was recently revisited by IODP Expedition 324, in which amazingly fresh glasses were cored in two of the drill holes at such aged oceanic plateau. Well-preserved quenched glasses on pillow basalts and massive flows allowed us to determine reliable major and trace elements (Sano et al., 2012), volatile compositions (Shimizu et al., 2013), and noble gases (Hanyu et al., in press). Fortunately, the effect of radiogenic ingrowth was minimal for He isotopes because of high He abundance and low U and Th concentrations in tholeiitic basalts. Glasses from a drill core at Ori Massif show a narrow range in $^{3}He/^{4}He$ between 5.5 and 5.9 Ra, which is lower than the MORB value. Such low and uniform $^{3}He/^{4}He$ is assigned as a feature for their mantle source, suggesting the involvement of recycled slab material in the source of Shatsky Rise.

Our understanding of the time of volcanism, crustal structure, magma sources, and melting processes could be deepened through drilling of oceanic plateaus and hotspot seamounts. Emission of volatiles from oceanic plateaus might have caused drastic change of Earth's surface environment, such as mass extinction, a hypothesis of which must be proved by ocean drilling. Ontong Java Plateau could be one of potential targets of future drilling, as its crustal structure is partly getting uncovered by on-going geophysical surveys.

Keywords: oceanic plateaus, hotspots, ocean drilling, volatiles, mantle recycling