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Results of Previous Drilling on Cretaceous Oceanic Plateaus and Future Outlook

SANO, Takashi[1*] ; NAKANISHI, Masao[2]

[1]National Museum of Nature and Science, [2]Chiba University

Oceanic plateaus, reach volumes of several 10^6 to several 10^7 km^3, are characterized by anomalously high rates of mantle melting that represent the largest volcanic events in the Earth's history. There is currently a lively debate about the oceanic plateau volcanism: whether they are built by plume heads from the lower mantle, changes in plate stress, or even meteor impacts. One difficulty with their research is that several of oceanic plateaus (e.g., Kerguelen Plateau) were erupted on remnants of continents where assimilation of continental lithosphere can obscure the primary mantle signature of the lavas. In contrast, Cretaceous oceanic plateaus in the western Pacific (Ontong Java Plateau, Shatsky Rise, and so on) have no effect of the crustal assimilation, permitting its primary origin in mantle to be resolved. The time of productions of the western Pacific plateaus coincides with increases in climate warming, resulting oceanic anoxic event, and eustatic sea level change; and therefore, its origin receives attention from paleo-environment aspects, too. It is proposed that the western Pacific plateaus were formed by the upwelling of very large plume head of mantle material, superplume, that erupted beneath the Pacific basin (Larson, 1991, *Geology*, 19, 547-550). The present-day South Pacific superswell is probably the nearly exhausted remnant of the original upwelling. Moreover, the remnant of the superplume is likely detected by seismic data (e.g., Suetsugu *et al*., 2009, *Geochem Geophys Geosyst* 10, Q11014).

The plume head phenomenon occurs naturally in numerical and laboratory experiments, but there is currently no unequivocal geological evidence proving that a starting plume head in convecting mantle has operated with Earth. Thus several alternative explanations (described above) or more complex plume head models are proposed to explain origin of the oceanic plateaus.

To test the plume head model, petrological and geochemical data from igneous rocks are important. Although a small number of dredges have recovered basalts from the western Pacific plateaus, almost of all such samples were highly altered. The best way to obtain fresh samples is by drilling of holes. Thus, operations during Ocean Drilling Program (ODP) Leg 192 and Integrated Ocean Drilling Program (IODP) Expedition 324 drilled Ontong Java Plateau and Shatsky Rise, respectively, seeking evidence that would test the plume head hypothesis (Mahoney *et al*., 2001, *Init Rep ODP*, 192; Sager *et al*., 2010, *Proc IODP*, 324). Based on drilling of several holes in the oceanic plateaus, both expeditions have extended our knowledge of the compositions and origin of the plateaus magmas considerably. However, both expeditions uncovered complications that do not fit the simple model, so debate over plume head hypothesis continued.

One of the main reasons for the previous failure to test the plume head model is that the previous drilling holes in the oceanic plateaus were too thin; only <300 m basement lavas were recovered among the thick oceanic plateaus (>30 km). The information of such thin drilling holes is difficult to evaluate the plume head model that is proposed by numerical and laboratory experiments. The laboratory experiments of "thermo-chemical" plumes containing both thermal and chemical density anomalies are characterized by a strong time-dependence and could develop for mantle density anomalies lower than 2% (e.g., Kumagai *et al*., 2008, *Geophys Res Lett*, 35, L16301). Such thermal or chemical density anomalies would be detected by geological researches of long drilling cores (e.g., ~3000 m basement lavas which construct ~10% of total thickness of the oceanic plateaus). To date, such long cores were difficult to recover, but a riser drilling vessel Chikyu has made drilling >3000 m basement lavas technically feasible.

Keywords: oceanic plateau, large igneous province, plume, magma genesis