A near-primitive mantle source for the Ontong Java Plateau (OJP)? Insights from Nd-Sr-Pb-Hf isotope study of ODP Leg 192 lavas

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The OJP is the largest of the world's large igneous provinces, with a volume estimated at 5 x 10^7 km^3 (e.g., Coffin & Eldholm, 1994). New Pb, Sr, Nd, and Hf isotope data for basalts sampled across the OJP during ODP Leg 192 (Sept.-Nov. 2000) are remarkably uniform (e.g., εNd[120 Ma] = +5.8 to +6.5) and cluster within the small range of compositions reported previously for plateau lavas from earlier drill sites and outcrops in the eastern Solomon Islands, as well as lavas filling the Nauru and East Mariana basins. The Leg 192 isotopic data all fall within the field of the dominant Kwaimbaita-type OJP basalts. In the context of a plume-head model, this basalt type's mantle source has been inferred to represent material from the plume-source region (e.g., Tejada et al., 2002). Our isotopic modeling suggests that the Kwaimbaita-type mantle source could correspond to originally primitive mantle that experienced a small (~1%) amount of partial melting ~3 Ga or earlier and underwent closed-system isotopic evolution thereafter until it was tapped by plateau magmatism around 120 Ma. These results are consistent with current models of a compositionally distinct lower mantle and a plume-head origin for the plateau. However, the greater-than-expected eruptive depths of OJP lavas and the apparent absence of a plume-tail track call for a reconsideration of other plateau-forming mechanisms. One possibility we have considered is that oceanic plateaus are products of pressure-relief melting caused by meteorite impact (Rogers, 1982). However, for the OJP this mechanism is not supported by the OIB-like isotopic compositions and the absence of any indication of involvement of MORB-type mantle in the lavas, despite the now plateau-wide sampling of OJP basement.

References:

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In-situ ion microprobe U-Pb dating of volcanic/impact spherules from Apollo17 lunar sample

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Tiny spherules (~100 µm sized) observed among lunar soils are considered to have two different origins. Parts of them are formed by impacts caused by planetary materials such as meteorites/micrometeoroids falling onto the Moon, while others are formed by volcanic activity of Moon itself. On account of lack of volcanic/tectonic activity at the present Moon surface, in-situ analyses of individual spherules could provide a new insight into the impact/igneous history of Moon from c.a. 4.5 Ga to the present.

We have been working on in-situ analyses of individual glass spherules from Apollo17 lunar samples, using a EPMA and the Sensitive High Resolution Ion MicroProbe (SHRIMP) installed at Hiroshima University, JAPAN. At this point, we picked up about 30 spherules from regolith breccia 79035 and lunar soil 71501, whose masses are about 300mg provided by NASA as a Request No. 2423. Based on the textures of backscattered-electron images of polished midsections of glass spherules and chemical composition of major elements determined by EPMA, 10 volcanic spherules and 17 impact spherules are identified. For these sample, all volcanic spherules show devitreous textures, and impact spherules shows vitreous or agglutinate textures. These results might support the scenario that the cooling of volcanic glass is not so rapid as that of impact glass in free flight, possibly due to the hot vapor (Arndt et al. 1984).

Based on SHRIMP analyses of several different spots in each spherule, a total U-Pb isochron age for respective spherule was determined. The formation ages of impact glass spherules (7 spherules from 79035 and 4 spherules from 71501) widely spread from 0.5 Ga to 4.5 Ga. On the other hand, the formation ages of volcanic spherules (4 spherules from 79035 and 6 spherules from 71501) concentrate around 3.6 Ga. Averaged age of 3.6 +/- 0.2 Ga is consistent with the orange glass formation of 3.66 +/- 0.03 Ga (Alexander et al. 1980) and 3.60 +/- 0.04 Ga (Huneke 1978).