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Petrogenesis of pillow basalts from Baolai in southwestern Taiwan

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The pillow basalts from Baolai in southwestern Taiwan have been inferred to bear Dupal signautres based on their Th/Ce ratio, linking the Baolai basalts to the South China Sea (SCS) seamounts that are characterized by Dupal Pb isotope signatures (Smith and Lewis, 2007). In this study, thirty-two Baolai basalt samples were analyzed for abundances of major and trace elements as well as Pb and Nd isotope ratios to verify their Dupal characters and to constrain their petrogenesis significance.
The Baolai basalts contain 4–10 % L.O.I.. Three stages of alteration are inferred from plots of L.O.I. abundance versus concentrations major oxides as well as mineral textures and compositions. The first alteration stage was characterized by albitization that converted Ca-rich plagioclase to albite. The second alteration stage was dominated by chloritization of olivine and augite, resulting in increases in L.O.I. abundance. The last alteration stage is represented by formation of secondary calcite in vesicles and cracks. These alteration processes reflect interaction with seawater and apparently did not affect the magmatic Pb isotope composition for the low Pb concentration in seawater.
Relative to the North Hemisphere Reference Line (NHRL), the Baolai pillow basalts have higher 208Pb/204Pb ratios at a given 206Pb/204Pb value, showing Dupal anomaly. For their relatively higher 208Pb/204Pb, 207Pb/204Pb, and 206Pb/204Pb ratios, the Baolai basalts are distinct from majority of the Cenozoic basalts in the Hainan-Leizhou peninsula, the Indochina peninsula, and the SCS seamounts, for which derivation from the Hainan mantle plume has been recently proposed (Wang et al., 2013). In contrast, the Baolai basalts and the Cenozoic basalts from eastern Guangdong at southeastern China have similar Pb and Nd isotope compositions, indicating derivation from similar mantle sources. However, the Baolai basalts have lower abundance ratios of Zr/Hf (40.3–45.6 versus 46.5–50.5), La/Yb (12.9–21.0 versus 26.0–33.5), and Dy/Yb (∼2.7 versus 2.97–3.62) with higher Lu/Hf (∼0.056 versus ∼0.045). Based on model calculations, the eastern Guangdong basalts represent mixtures containing large proportions (> 90%) of melt generated by < 2% melting from a source with residual garnet and small proportions (< 10%) of low degree melts (< 1%) from spinel lherzolite. The Baolai basalts are explained as involving higher proportions (10–20%) of melt from spinel lherzolite by higher degrees (2–3%) of partial melting. The unusually high Nb/La ratio of > 1.6 in the Baolai basalts is best explained as reflecting a component in the recycled dehydrated residues, indicating derivation from asthenospheric mantle source that involves subduction components. It is inferred that the subduction components are associated with the subduction of paleo-Pacific Ocean. If this is the case, a relatively high mantle circulation rate (i.e. 1 cm/yr; Wang et al., 2013) is required.

Smith and Lewis (2007), International Geology Review 49, 1–13.
Wang et al. (2013), Earth and Planetary Science Letters 377–378, 248–259.