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日本海背弧海盆玄武岩再検討
Sea floor basalts of the Japan Sea back-arc basin revisited: Upwelling and melting of hydrous mantle and slab sediment d

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Middle Miocene seafloor basalts recovered by ODP drilling from the Japan Sea floor (Cousens & Allan, 1992), were re-examined. Sr-Nd-Hf-Pb isotopic and incompatible trace element compositions reconfirmed two basalt types from enriched (E) and depleted (D) mantle sources. D-type basalt is unradiogenic in Sr and Pb, radiogenic in Nd and Hf, and has lower incompatible element abundances than in N-MORB. LREEs are strongly and HREEs are slightly depleted than in MREEs with positive spikes in Ba, Pb, and Sr. E-type basalt is radiogenic in Sr and Pb, unradiogenic in Nd-Hf, with LREE enriched and Nb-Ta depleted trace element compositions. E-type basalt has similar trace element compositions with those in the rear-arc Quaternary basalts in the adjacent NE-Japan arc overall; however, differ greatly in elevated Zr-Hf and in isotopic enrichment.

Forward model adiabatic melting calculations of hydrous metasomatized mantle were examined with varying parameters of (1) mantle potential temperature (Tp/C), (2) initial H2O content (H2O(i)/wt%), melting termination depth (Dmt/GPa), and terrigeneous sediment flux fraction (Fsed/wt%) mixed with the source peridotite. The calculation results suggest that conditions Fsed = 1.2 wt%, with H2O(i) = 0.01-0.12 wt%, Tp = 1200-1290 (C), final melting degree of F = 0.07 at depth of Dmt = 0.8-1.4 GPa explain the trace element abundances in E-type basalt. In contrast, D-type basalt can form at the conditions of Fsed = 0.0 wt%, H2O(i) = 0.00-0.08 wt%, Tp = 1340-1410 (C), F = 0.12-0.15 at depth of Dmt = 1.4-1.7 GPa. The melting conditions for D-type basalt are deeper and hotter than for primary N-MORB (H2O(i) = 0.01-0.10 wt%, Tp = 1230-1330 (C), Dmt = 0.7-1.4 GPa, F = 0.10-0.12) calculated by the same method consistent with the depleted nature in total REEs and HREEs with higher MgO in D-type basalt. E-type basalt has different source and can form at shallower depth and lower Tp and F suggesting heterogeneous source mantle in terms of the chemistry and the melting regime.

Mixing calculations using Nd-Hf-Pb isotopes between the depleted mantle and terrigeneous sediment suggest that the bulk sediment addition rather than sediment melt/fluid accounts for the source enrichment in E-type basalt. However, depletions in Rb, U, and K should have occurred perhaps by suduction modification before the bulk sediment is involved in the adiabatic melting regime beneath the back-arc basin. D-type basalt is from depleted mantle in DM-EM1 transition similar to those in the deep rear-arc OIBs in N-China. If elevated Ba, Pb, and Sr in D-type basalt is the inherent from the source mantle likewise in N-China, then their isotopic characteristics could be from ancient slab fluids stored in the mantle transition zone (e.g., Kuritani et al., 2011). The back-arc basin basalt in the Japan Sea would thus have formed by melting of both deep-sheeted hydrous mantle and subduction-modified slab sediment during ascent of the back-arc mantle while opening of the Japan Sea.

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