Recycling and melting of a dehydrated oceanic crust in the stagnant slab in back–arc mantle: Constraints from Cenozoic alkaline basalts in eastern China

Tetsuya Sakuyama[1], Wei Tian[2], Jun-Ichi Kimura[1], Yoshio Fukao[1], Yuka Hirahara[1], Toshiro Takahashi[1], Ryoko Senda[1], Qing Chang[1], Takashi Miyazaki[1], Masayuki Obayashi[1], Hiroshi Kawabata[1], Yoshiyuki Tatsumi[3]

[1]Japan Agency for Marine-Earth Science and Technology, Japan, [2]Peking University, China, [3]Kobe University, Japan

E-mail: sakuyama@jamstec.go.jp

Cold oceanic plates, which include igneous and sediment layers, start sinking along subduction zones. The layers dehydrate and melt as they undergo subduction, which feeds slab components to arc magmas. After the subduction, the remaining slab stagnates in the mantle transition zone (at depths of 400 – 660 km), where the minerals undergo pressure–induced transformation, and the resulting density turnover prevents further slab penetration. Recent experimental study predict that igneous layer of the stagnant slab could partially melt due to conductive heating from the ambient mantle, although relevant geochemical evidence of melting of the stagnant slab has not yet been found from igneous rocks above the stagnant slab. We present evidence that suggests that melts from the igneous layer in the stagnant Pacific slab have contributed to the source composition of basalts in eastern China.

Within the Late Cenozoic basalts of eastern China, primitive basalts with extremely Fe–rich (>13 wt%) and Si–poor (<43 wt%) features only occur in the area surrounded by 117 – 121 °E and 30 – 43 °N, which is ∼2000km to the west of the trench of the Pacific Plate. Multi trace element plots (normalized to the primitive mantle) of these basalts show that they commonly have convex–up patterns with depletions in Rb, Ba, Pb relative to other large ion lithophile elements and light rare earth elements, and to a lesser extent, depletions in Zr and Hf relative to middle rare earth elements. The peridotite xenoliths reported from eastern China commonly show positive Rb, Pb, and Sr anomalies, which is definitely not characteristic of the plausible source mantle of the basalts. Instead, these trace element features are similar to those of the OIBs with HIMU isotopic signatures, suggesting that their source material was modified by a subduction dehydration process. Source mantle of the basalts has, however, much less radiogenic Pb than the OIBs with HIMU isotopic signatures. Sr–Nd–Pb isotope compositions of the extreme basalts in China are similar to those of mid–oceanic–ridge basalt and have Nd–Hf isotope composition akin to the igneous layer in the Pacific slab. None of high–pressure melting experiments on peridotite have reproduced melt with the high FeO $*$ (>13 wt%) and low Al_2O_3 (<12 wt% at MgO ∼12 wt%), whereas partial melts with such major element characteristics can be generated by the melting of carbonated eclogite.

Taken together, these geochemical characteristics of these basalts help us to conclude that these basalts have received a significant contribution from dehydrated carbonate–bearing oceanic crust in the stagnant slab, without a long time–integrated ingrowth of Sr–Nd–Hf–Pb isotope systems, almost at the leading edge of the stagnant Pacific slab.