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Cenozoic off-arc volcanisms and mantle dynamics in eastern margin of Eurasian continent

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The Cenozoic off-arc volcanism in eastern and northeastern China is characterized by eruption of basalts with high alkalinity. They occurred mainly in northeastern China but are distributed sporadically and widely in space and time in whole these areas. In Paleogene, before opening of the Japan Sea, chemical compositions of basaltic volcanism in eastern China are mainly tholeitic, whereas they are still richer in alkaline than Quaternary subduction volcanism in northeastern Japan. Since Japan Sea started opening in Neogene, Chinese basalts have shifted to transitional between tholeitic to alkalic, and ended up with dominance of strongly alkalic basalts in Quaternary. Here, geochemical characteristics and their spatial distribution of late Cenozoic ($<$ 15 Ma) primitive alkaline basalts in eastern and northeastern China as well as the results of geophysical investigations will be reviewed, and the recent models to explain their origin will be discussed.

Although large geochemical variation can be observed even in young ($<$ 15Ma) alkaline basalts, here we propose two important end-members of alkaline basalts in eastern and northeastern China in terms of major and trace elements and isotope compositions. Low-FeO alkaline basalts are depleted in FeO$*$ ($<$ 10 wt%) and TiO_2 ($<$1.5 wt%), enriched in SiO_2 ($>$48 wt%), Al_2O_3 ($>$14 wt%) for MgO ˜ 10 wt%, and enriched in fluid-mobile trace elements, such as Rb, Ba, K, and Pb. They show enriched Sr-Nd isotopic compositions and are enriched in radiogenic Pb. Changbaishan and Wudalianchi volcano erupted the most extreme low-FeO alkaline basalts, whereas low-FeO basalts are widely and sporadically distributed in eastern and northeastern China. Low seismic velocity zone that continues to the mantle transition zone has been observed especially in the upper mantle beneath Changbaishan volcano. The mantle transition zone beneath northeastern China has higher electrical conductivity than those of other tectonic settings. Taken together, these spatial correlations between low-FeO basalt geochemistry and geophysical structure of the upper mantle have been interpreted as an existence of hydrous mantle upwelling strongly affected by fluid released from sediments on a stagnant Pacific slab.

To the contrary, high-FeO alkaline basalts are extremely enriched in FeO$*$ ($>$ 13 wt%) and TiO_2 ($>$2.5 wt%), depleted in SiO_2 ($<$45 wt%), Al_2O_3 ($<$13 wt%) for MgO ˜ 10 wt%, and depleted in fluid-mobile trace elements. Their trace element compositions are similar to those of the ocean island basalts (OIBs) with HIMU isotopic signatures to which dehydrated subducted oceanic crust has been expected to contribute. High-FeO basalts in eastern China, however, show depleted Sr-Nd isotopic compositions and are depleted in radiogenic Pb, which is much less in radiogenic Pb than the HIMU OIBs. The most extreme high-FeO basalts have been observed in Shandong area, and distribution of high-FeO basalts is limited in middle to eastern China at approximately 119^oE between 30 and 40^oN, which is almost parallel to a trench where Pacific Plate is subducting. None of high-pressure melting experiments on peridotite have reproduced melt with the high FeO$*$ and low Al_2O_3, whereas partial melts with such major element compositions can be generated by contribution of carbonated eclogite. These geochemical characteristics suggest 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 isotope systems.

The origin of off-arc volcanism in eastern and northeastern China has been attributed to the upper mantle convection independent of the stagnant slab, contribution of sub-continental lithospheric mantle, or influence from the underlying Pacific stagnant slab. Recent integrated and improved geophysical, geochemical, and petrological studies are consistent with the third model.

Keywords: Cenozoic within-plate alkaline basalt, eastern margin of Eurasian Plate, stagnant Pacific slab, subducted sediment, dehydrated oceanic crust