Noble gas isotopic compositions of late Cenozoic basalts and mantle-derived xenoliths from northern Kyushu, Japan

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Late Cenozoic alkaline basalts and associated rocks are widely distributed in back-arc region of southwest Japan arc. Since their geochemical characteristics are distinct from typical island-arc basalts, they are considered to be mantle plume origin. Noble gas isotopic compositions of OIBs are quite different from those of MORBs, thus noble gas isotopes are powerful tracers of plume activity. We will present noble gas data of basaltic rocks from Higashi-matsuura and Kita-matsuura peninsulas in northern Kyushu and of mantle-derived xenoliths from the Higashi-matsuura peninsula to discuss origin of the volcanism.

Noble gas analyses were carried out for olivine and pyroxene separates from alkaline basalts collected from Higashi-matsuura and from tholeiites from Kita-matsuura, respectively. Mantle-derived xenoliths contained in Higashi-matsuura alkaline basalts were collected from Takashima Island. Noble gases were extracted by in-vacuo crushing and stepwise heating methods.

3He/4He ratios of Higashi-matsuura basalts ranged from 6 to 7 Ra, which were slightly lower than the MORB-value (8+/-1Ra). Their 40Ar/36Ar ratios ranging from 300 to 800 were low with respect to mantle-derived materials. These data can be explained by addition of slab-derived argon to subcontinental lithospheric wedge mantle, which is enriched in incompatible elements and contain isotopically evolved helium compared to the MORB source mantle. Olivines in Kita-matsuura tholeiites showed low 3He/4He ratios of 2-4Ra. Since samples with primitive major element composition showed low 3He/4He ratios and the highest 40Ar/36Ar ratio among them is ca. 500 and lower than the Higashi-matsuura samples, the low 3He/4He ratios cannot be explained by assimilation of crustal materials with low 3He/4He and high 40Ar/36Ar. Tholeiitic melts of Kita-matsuura are considered to be generated at shallower depths than alkaline basaltic melts of Higashi-matsuura. Therefore, uppermost mantle beneath north Kyushu may have low 3He/4He ratio.

Whereas noble gas data of the basalts from Higashi-matsuura and Kita-matsuura showed isotopic signature of upper mantle beneath northern Kyushu, 3He/4He ratios of xenoliths from Takashima varied from 6.1 to 16.6Ra, indicating that plume-type helium was contained in some parts of the samples. On the basis of morphology of fluid inclusions, which would contain the low 3He/4He ratio, and of the fact that 3He/4He ratios of the Higashi-matsuura basalts erupted around Takashima are close to the low 3He/4He ratio, helium with the low 3He/4He ratios in xenoliths might be acquired from their host magma. Meanwhile, the high 3He/4He ratio indicates that plume-type helium had been trapped in uppermost mantle beneath northern Kyushu before eruption of the Higashi-matsuura basalts. No intra-plate volcanism is recognized in northern Kyushu before the alkaline basalt activity, which had started 11 million years ago. If the basaltic volcanism was related to plume activity, it is possible that plume-type helium was inherited from incipient melts carrying noble gases with plume signature, and when alkaline basalt magmas erupted in Higashi-matsuura were generated, 3He/4He ratio of the plume had decreased owing to dilution by MORB-like helium in surrounding mantle. Since noble gases analysis of alkaline basalts which erupted in the early stage will constrain this model, sampling and analyses of such samples are in contemplation.