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Noble Gas and Other Isotope Characteristics Relating to the Subduction Processes Around the Japanese Islands

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Japanese Islands are classified as one of the typical areas where subduction processes are operating. Hence, isotopic signatures of volcanic materials and mantle xenoliths from the area would give us significant information on the subducted processes.

Quaternary volcanic rocks and mantle xenoliths from the Japanese Islands show the $^{3}He/^{4}He$ value of less than about 8Ra, but higher than the atmospheric value, while the ^{40}Ar/36Ar is relatively low and characterised with values of 300-700 in most cases (e.g., Nagao and Takahashi, 1993; Hanyu and Kaneoka, 1997). Ne and Xe isotopes show no difference from the atmospheric compositions. The amounts of noble gases in mantle xenoliths are relatively low compared with those from plume areas such as Hawaiian Islands. Although systematic differences in the $^{143}Nd/^{144}Nd$ vs. $^{87}Sr/^{86}Sr$ diagram are observed for Quaternary volcanic rocks between the Northeast and the Southwest Japan, no such difference has been observed in noble gas isotopic ratios (e.g., Kaneoka, 1986). Such systematics might be attributed to some processes through which the noble gas isotopic compositions were homogenised. The incorporation of water during subduction process might play a significant role to operate it. Since the $^{3}He/^{4}He$ is slightly lower than the MORB value(about 8Ra) in general case, some radiogenic components should also be incorporated from subducted materials such as oceanic sediments and/or altered basalts.

The $^{10}Be/^{9}Be$ for Quaternary volcanic rocks in the Northeast Japan recently obtained in our group have shown the occurrence of systematically higher values than MORB or OIB, suggesting the incorporation of oceanic sediments in producing arc magmas (Shimaoka and Kaneoka, 2000). Such trend is observed in volcanic rocks of both the volcanic front and the Japan Sea side off the volcanic front. This implies tat the oceanic sediments might be incorporated even in the magma sources of volcanoes which are located at a place off the volcanic front. The variations of Sr and Nd isotopes seem to correlate for volcanic rocks in the Japanese Islands. Although Sr is easily dissolved in (sea) water, Nd and be are not well dissolved in it as long as reported data are concerned. If such situation is taken into account, it is not guaranteed that these elements moved together with Sr in (sea) water. Hence, we cannot deny a possibility that some silicate melts might have existed at some places almost close to the surface of the subducting slab, though its abundance might be so low as to be not detected directly by seismic tomography.

We have also observed extremely low $^{3}He/^{4}He$ ratios in mantle xenoliths from eastern Siberia, whose peripheres might have been connected to the Japanese Islands before the opening of the Japan Seqa about 20-25 Ma (Yamamoto et al., 2000). The $^{3}He/^{4}He$ is lower than the atmospheric value for some samples. Since such He was extracted by crushing of olivine separates, it is conjectured that such He has been incorporated into olivines in the mantle with some fluids probably derived from the subducted slabs. Since the $^{3}He/^{4}He$ is not homogenised with that of the surrounding mantle materials (probably similar to the MORB value), the subducted slab would have the thickness of more than a few km at least (Hanyu and Kaneoka, 1998) and fluids might have been incorporated by some processes into xenoliths in the mantle. Such signatures would be only observed in an area where a subducted slab might have not yet been homogenised with the surrounding mantle materials.

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