Geographical distribution of $^{3}He/^{4}He$ ratios in the Chugoku district, Southwestern Japan

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We have collected 34 hot spring and mineral spring gases and waters in the Chugoku and Kansai districts, southwestern Japan and measured the $^{3}He/^{4}He$ and $^{4}He/^{20}Ne$ ratios by using a noble gas mass spectrometer after purifications. Observed $^{3}He/^{4}He$ and $^{4}He/^{20}Ne$ ratios range from 0.054 R_{atm} to 5.04 R_{atm} (where R_{atm} is the atmospheric $^{3}He/^{4}He$ ratio of $1.39x10^{-6}$) and from 0.25 to 36.8, respectively. They are well explained by a mixing of three components, mantle-derived, radiogenic, and atmospheric helium dissolved in spring water. The $^{3}He/^{4}He$ ratios corrected for air contamination are low in the frontal arc and high in the volcanic arc regions, which are consistent with data of subduction zones in literatures. The geographical contrast may provide a constraint on the position of volcanic front in the Chugoku district where it was not well defined by previous works. Taking into account the magma aging effect, we can not explain the high $^{3}He/^{4}He$ ratios of volcanic arc region by the slab melting of the subducting Philippine Sea plate. The other source with pristine mantle material may be required. More precisely, the highest and average $^{3}He/^{4}He$ ratios of 5.88 R_{atm} and 3.8±1.6 R_{atm}, respectively, in the narrow regions near the volcanic front of the Chugoku district are lower than those in Kyushu and Kinki Spot in southwestern Japan. Instead they are close to those in northeastern Japan. This suggests that the magma source of the former may be related to the subduction of the Pacific plate, in addition to a slight component of melting of the Philippine Sea slab.