

Chemical and noble gas isotopic compositions of the hot spring gases in the Kinki district

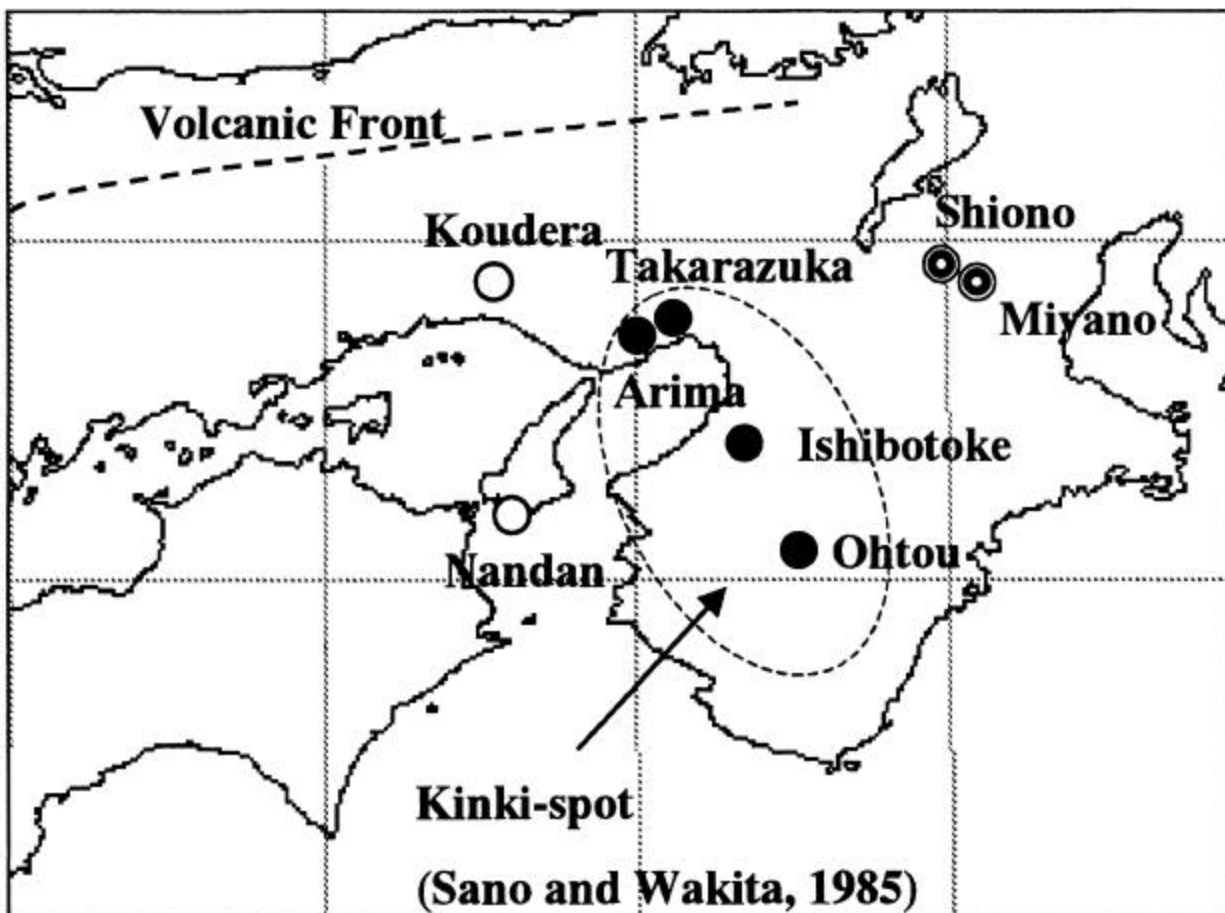
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Unlike the commonly observed distribution of $^3\text{He}/^4\text{He}$ ratio in island arcs (i.e., mantle-like $^3\text{He}/^4\text{He}$ ratios near the volcanic front and lower $^3\text{He}/^4\text{He}$ ratios in frontal arc regions), there is a region of high (mantle-like) $^3\text{He}/^4\text{He}$ ratios in the frontal arc region of the Kinki district (SW Japan). The region is referred as a "Kinki-spot", and its origin is not understood well. In order to elucidate the nature of the Kinki-spot, we have collected gas samples from eight hot and mineral springs, and analyzed them for abundances of major constituents and noble gas isotopic compositions.

Chemical and isotopic compositions of constituents of hot spring gas can be used for evaluating a variety of geotectonic environments. Because of the range of isotopic ratios of helium in the crust, mantle and air, helium can be a powerful tracer for such a purpose. In terms of helium isotopes sampled at the subduction zones, there is a general trend that $^3\text{He}/^4\text{He}$ ratios in gases collected in the forearc region are significantly lower than the air value of $1.4\text{E}-6$, whereas those found in the volcanic front to the backarc region commonly approach to the typical upper mantle ratio of about $1.0\text{E}-5$. However, it was reported that the helium isotope signatures observed in the Kinki district (SW Japan) do not follow such rule, and mark an area with elevated $^3\text{He}/^4\text{He}$ ratios on a scale of 100 km in the frontal arc region (so-called "Kinki-spot"; Sano and Wakita, 1985). In order to further elucidate the nature of the Kinki-spot, we analyzed the elemental and isotopic compositions of the gas samples from eight hot and mineral springs in the Kinki district.

As shown in Fig. 1, four samples (Arima, Takarazuka, Ishibotoke and Ohtou) are from the hot springs within the previously defined Kinki-spot, and are indeed showing relatively high $^3\text{He}/^4\text{He}$ ratios varying from 3.9 to 7.3 Ra (Ra: air value). These samples appeared to be CO_2 -rich, indicating an apparent association of mantle-derived helium and CO_2 . Samples from Koudera and Nandan are characterized by having lesser amounts of CO_2 with relatively low $^3\text{He}/^4\text{He}$ ratios which are close to the atmospheric value. These two hot springs are located western side of the Kinki-spot, providing an evidence for the western margin of the Kinki-spot. The $^3\text{He}/^4\text{He}$ ratios observed in the samples from Shiono and Miyano were also clearly higher than the air value. Such an occurrence of high $^3\text{He}/^4\text{He}$ ratios in localities about 50 km to the east of the margin of Kinki-spot may indicate that the Kinki-spot extends about 50 km to the east, or that there are several discrete emanation of mantle-derived helium distributed throughout the forearc region of the Kinki district.



- High $^3\text{He}/^4\text{He}$ ratio ($3.9\text{Ra}\sim 7.3\text{Ra}$)
- Low $^3\text{He}/^4\text{He}$ ratio ($\leq 1.1\text{Ra}$)
- ⊙ Relatively High $^3\text{He}/^4\text{He}$ ratio ($2.2\text{Ra}\sim 2.6\text{Ra}$)

Figure1. Sampling Sites