Helium isotope variations along the Niigata-Kobe Tectonic Zone

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The seismic tomography study along the Niigata-Kobe Tectonic Zone (NKTZ; Sagiya et al., 2000) revealed segmentations of the seismic velocity structure and suggests the variable origin of the high-strain-rate along the NKTZ (Nakajima and Hasegawa, 2007). We compiled existing helium isotope data to inspect an implication of geographic distribution of helium isotope data to the geophysical structure of the NKTZ (Umeda et al., 2008; Sano et al., 2008; Umeda et al., 2009; Ninomiya et al., 2008).

Most hot springs in the southern part, fore-arc region of the SW Japan, have lower $^{3}He/^{4}He$ ratios than the atmospheric value, except for Arima hot spring (Matsumoto et al., 2003). The volcanic gases or hot spring gases observed near active volcanoes in the central NKTZ have high $^{3}He/^{4}He$ ratios. In the northern part, a non-volcanic region, the $^{3}He/^{4}He$ ratios are so high especially in the source region of the 2004 mid-Niigata prefecture earthquake and the 2007 Niigataken Chuetsu-oki earthquake. These $^{3}He/^{4}He$ ratios are similar to those related to the Quaternary volcanoes in the Northeast Japan Arc.

According to the seismic velocity structure, in the southern part the Philippine Sea slab dipping low angle directly contacts with the overriding crust and supplies the fluids into the lower crust (Nakajima and Hasegawa, 2007). The low $^{3}He/^{4}He$ ratios in the southern part are caused by the absence of a mantle wedge which is a possible source of the mantle helium. The ^{3}He emanation in the central NKTZ results from the effective transfer of mantle helium by mantle-derived magma in the crust. The low-velocity zone visible in the uppermost mantle beneath the northern part implies the fluids derived from the Pacific Plate slab (Nakajima and Hasegawa, 2007). These fluids will reduce the mechanical strength of the fault zone to trigger the earthquakes (e.g. Wang and Zhao, 2006; Umeda et al., 2008). The high $^{3}He/^{4}He$ ratios close to the source regions of the recent earthquakes suggest that active faults may play an important role in the effective transfer of mantle helium from the subcrustal lithosphere to the Earth's surface in non-volcanic regions.

References

Matsumoto et al. (2003) Earth Planet. Sci. Lett., 216, 221-230.
Nakajima, J. and Hasegawa, A. (2007) Earth Planets Space, 59, e5-e8.
Ninomiya et al. (2008) abstract, Japan Geoscience Union Meeting.
Sagiya et al. (2000) Pageoph, 157, 2303-2322.
Sano et al. (2008) Chemical Gology, doi:10.1016/j.chemgeo.2008.10.020.
Umeda et al. (2008) Geochem. Geophys. Geosyst., 9, Q12003, doi:10.1029/2008GC002272.
Umeda et al. (2009) J. Geophys. Res., 114, B01202, doi:10.1029/2008JB005812.
Wang, Z. and Zhao, D. (2006) Earth Planet. Sci. Lett., 244, 16-31.