Variations in the $^{3}He/^{4}He$ ratios of hot springs on the Noto Peninsula, Central Japan

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The Noto Peninsula, Central Japan, consists of Neogene volcaniclastic (so-called Green Tuff) and sedimentary rocks overlying pre-Neogene basements, such as Hida metamorphic rocks and Funatsu granite. Although no evidence of Quaternary volcanism is known, this peninsula has long been recognized to be unusual and atypical of non-volcanic regions, as indicated by high-temperature hot springs, such as Wakura (95 deg.C), Eiwa (60 deg.C), Yukawa (51 deg.C) [Kimbara, 1992] and high geothermal gradient values of more than 40 deg.C /km [Tanaka et al., 1999]. Most of hot springs is found in the vicinity of active faults and folding zone in the Noto Peninsula. The helium isotopes are of particular interest as they can provide unequivocal evidence for presence in the crust of mantle-derived materials and geochemical constraints on the heat source for the hydrothermal activity. Although abundant helium isotope data from fumarolic and hot spring gases in and around active volcanoes in Central Japan have been reported [e.g., Kusakabe et al., 2003; Ohwada et al., 2007], gas samples have not been measured previously on the Noto Peninsula, away from Quaternary volcanoes. In order to describe the geographical distribution of $^{3}He/^{4}He$ ratios in the Noto Peninsula, a total of 14 hot springs were collected. The observed $^{3}He/^{4}He$ ratios for all the hot springs, except for Monzen-Jinnobi and Yoshigaura, Tomisato, range from 0.03 to 1.2 Ra (Ra denotes the atmospheric $^{3}He/^{4}He$ ratio of $1.4x10^{-6}$), which are lower than the atmospheric value. This indicates that crustal helium is expect to be dominant in hot spring sample from the Noto Peninsula, resulting in an insignificant contribution of mantle helium, for example, due to newly ascending magma [Umeda et al., 2007] and/or aqueous fluid generated by dehydration of the subducting slab [Matsumoto et al., 2003]. Basement rocks in the Noto Peninsula are known to be associated with uranium-bearing granite pegmatite and free gases from hot springs contain an extremely large amount of He that reaches about 0.4 vol.%. These findings may imply that the hydrothermal activity in a non-volcanic region is attributed to the radioactive decay heat derived from basement rocks [Brugger et al., 2005] and/or the structural evolution of active fault and fold systems during the Pliocene and the Quaternary.

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