# Relationships between crustal stress fields and geological structures on pathways of upwelling deep-seated water at Kii Peninsula, southwest Japan

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The natural and hot springs with $^{3}He/^{4}He$ ratios higher than the atmospheric values are recognized to occur in nonvolcanic regions on the Kii Peninsula in the forearc regions of southwestern Japan arc (Sano & Wakita, 1985; Wakita et al., 1987; Matsumoto et al., 2003; Umeda et al., 2006, 2007), indicating that there are upwelling paths of the mantle-derived fluids in this region. A number of deep groundwater and natural spring water in this region are found to contain the slab-derived deep-seated fluid component, whose isotopic composition is similar to magmatic with the high Li/Cl ratio (>0.001 in wt. ratio) (Kazahaya et al., 2014). The upwelling of the deep-seated water provides significant information to understand the fluid movement in the crust and the water cycle in the subduction system (e.g. Hacker, 2008).
In this study, we present the upwelling of water and gas along the fractures and the relationships between orientations of the veins and the upwelling of the deep-seated water in the Shiotakibashi outcrop located to the north of Median Tectonic Line (MTL). And, we discuss the upwelling process of the deep-seated water at Kii Peninsula by using the relationships between crustal stress field and geological structures.
The Shiotakibashi outcrop along the Ishikawa river at the Kawachinagano city of Osaka prefecture is one of regions where the upwelling of the water and gas containing deep-seated water along the fractures can be observed (Tanaka et al., 2013). In the upwelling points at the outcrop, the patches of fractures that cut the Cretaceous granite belonging to the inner zone are filled by the calcite crystalized from the water. Furthermore, the water and gas are flowing so as to avoid the filled fractures. And, we can observe many mineral veins with several orientations in this outcrop. Mineral veins can provide evidences of the ancient fluid migration along the fractures.
In this study, we measured the strike, dip and width of the veins in a single outcrop of the Shiotakibashi outcrop (~100 veins). On the veins, the fractures that cut the cretaceous granite are filled by the calcite. The veins have thicknesses with a few mm to 2 cm. The most of the veins have NNE-SSW and ENE-WSW striking and dip with high angle while some veins have horizontal dip. The dilation tendency (Ferrill et al., 1999) for the filled fractures in the present stress inferred from the major active faults in the eastern part of the southwestern Japan including the Kii Peninsula (Tsutsumi et al., 2012) indicate that the fractures with upwelling of water and gas have high tendency on the pass ways of deep-seated water. Hence, the present tectonic stress may be feasible for upwelling of the deep-seated water along the fractures for a part of the fractures.
At the map scale, the Cretaceous-Paleogene accretionary complex, Shimanto Belt is exposed in the region located to the south of MTL in Kii Peninsula. The most of deformation structures of the Shimanto Belt have northward plunging thrusts. Based on the relationships between crustal stress field and attitudes of the geological structures, the dilation tendency is high on the geological structures. Hence, we suggest that the geological structures of the region under the present crustal stress are favorable pathways for deep-seated fluids.

Keywords: stress, fluid migration, fault, crust, deep low-frequency tremors, subduction zone

 