Mantle-derived fluid migration along subduction plate boundary: Constraints from helium isotope analysis of shear veins in the subduction mélange

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Fluids released from dehydration reactions of a subducting slab have been considered to play an important role on fluid circulation and slow earthquakes in subduction zones. Mantle-derived helium was reported for surface spring waters above non-volcanic long-period deep tremors in Shikoku Island [1] and bottom seawater close to the Japan Trench after the Tohoku-Oki earthquake [2], indicating that the dehydrated fluid migrates from the mantle to the surfaces. However, it remains poorly understood how mantle-derived fluids migrate toward shallow depths. Fluid inclusions in mineral veins in subduction mé langes provide an opportunity to study the process of fluid migration, as they preserve the fluid that was present in the subduction plate boundary. In this study, we measured helium isotope ratio of fluid inclusions in shear veins distributed in the Makimine mélange in the Shimanto accretionary complex of southwest Japan, which was deformed at 10–15 km depth and 300–350 ℃. The measured $^{3}He/^{4}He$ ratio of fluid inclusions ranges 1.6–2.5 Ra (Ra is the atmospheric $^{3}He/^{4}He$ ratio of 1.4×10^{-6}). Assuming that the measured $^{3}He/^{4}He$ ratio results from the mixing of mantle helium ($^{3}He/^{4}He$ = 8 Ra) and crustal helium ($^{3}He/^{4}He$ = 0.02 Ra), 20–31 % of helium in vein-forming fluid was derived from mantle, showing the infiltration of mantle-derived fluid. Our results demonstrate that mantle-derived fluid migrates along the subduction plate boundary toward shallow depths of 10–15 km, which would constrain the origin of fluid in source regions of slow earthquakes.

[1] Doĝan et al. (2006) *Chem. Geol.* **233**, 235–248. [2] Sano et al. (2014) *Nat. Commun.* **5**, 3084.

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