Spatial and temporal changes of $^{3}He/^{4}He$ ratios around a source region before and after an inland earthquake

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Static stress change caused by the megathrust slip of the 2011 M_w 9.0 Tohoku-Oki earthquake considerably affected the seismicity pattern in inland areas, resulting in the occurrence of numerous earthquakes along several active faults in Japan. On June 30, 2011, the M_j 5.4 central Nagano earthquake occurred at a shallow depth of 5 km, indicating the reactivation of the Gofukuji fault in Central Japan. This study was undertaken to elucidate spatial and temporal changes of $^{3}He/^{4}He$ ratios around a source region before and after an inland earthquake using both new and existing helium isotope data from hot spring and drinking water wells. Most gas samples near the seismic source region are characterized by increase in postseismic $^{3}He/^{4}He$ ratios. In contrast, the postseismic ratios decrease by up to about 30 % away from the seismic source region. Episodic faulting could release accumulated crustal (radiogenic) helium from host rocks, or enhance the transfer of mantle volatiles through permeable fault zones, such that subsequent fluid flow proximal to the source region could then explain the spatio-temporal variations in $^{3}He/^{4}He$ ratios.

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