High $^{3}He/^{4}He$ ratio anomalies in the source regions of recent large earthquakes

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A magnitude (Mj) 7.3 crustal earthquake occurred in the western Tottori prefecture, southwest Japan, on 6 October 2000. The estimated fault model resolved several individual faults segments, most of which are left-lateral strike-slip faults in the NW-SE direction. However, there was no indication of an active surface fault corresponding to the 2000 earthquake. In order to elucidate the geographic distribution of the $^{3}He/^{4}He$ ratios in and around the seismic source region, new helium isotope data for ground-water samples from drinking water wells were determined. The air-corrected $^{3}He/^{4}He$ ratios of water samples range from 0.36 to 4.6 R_A(cor) (R_A denotes the atmospheric $^{3}He/^{4}He$ ratio of $1.4x10^{-6}$). The maximum $^{3}He/^{4}He$ ratio is observed from well which is located nearest to the epicenter of the mainshock. In addition, there appears to be clear trend of decreasing $^{3}He/^{4}He$ ratios with distance away from the main trace of the estimated fault segments. The observations provide significant evidence that the source fault of the 2000 earthquake is associated with the leakage of the mantle volatiles within the crust to the Earth's surface. Geophysical findings indicate that this source fault extends vertically down to the lower crust deeper than the seismic upper crust. Geophysical findings indicate that this source fault extends vertically down to the lower crust deeper than the seismic upper crust. Therefore, ductile shear zones developed in the lower crust may play a key role in focusing migration of mantle fluids upward to the base of the seismogenic regime. We suggest the possibility that the helium isotope can be regarded as a tool for investigating concealed active faults with no surface expression, even as water samples collected from shallow wells.