Enigmatic ground water enriched in isotopically light lithium

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Deep crustal fluids may involve with earthquake and volcanic activities. The geophysical survey such as seismic and electrical conductivity tomography can visualize distribution of crustal fluids, while they need abundant fluids for the detection. It is therefore expected that geochemical results provide us detailed information about origin of deep-seated fluids. However, admixture with surface water makes it difficult to draw precise conclusions regarding the origins of deep-seated fluids. Because of this, geochemical results of the deep-seated fluids had been limited. Lithium (Li) is relatively unaffected by surface water contamination because the Li contents of deep-seated fluids are much greater than the surface water content. These high Li concentrations result from dramatically elevated leaching of Li from solid phase into fluids at high temperatures, and the fact that subsequent re-uptake of the leached Li from the fluid by the solid phase (which occurs as the fluid cools) takes a considerable time. In addition, the two stable isotopes of Li are ^{6}Li and ^{7}Li, and their relative abundances are about 7.5% and 92.5%, respectively. Furthermore, the difference in the ^{7}Li/^{6}Li ratio between fluid and solid phases varies with the reaction temperature. As a result, the Li isotope ratio provide us information about origin of deep-seated fluids. Based on the Li isotopic results on ground water samples, we have researched the origin of deep-rooted fluids. One of major problems unsolved is that significantly low ^{7}Li/^{6}Li ratios are observed in several ground water samples. The Li isotope composition of fluid phase is currently heavier than that of solid phase. Therefore, the significantly low ^{7}Li/^{6}Li ratios of ground waters require the solid phase other than the crust or mantle. Nishio et al. (2010) reported that the significantly low ^{7}Li/^{6}Li ratios were observed in the southeast flank of Ontake volcano in central Japan. Since 1976, earthquake swarms have occurred beneath the southeast flank of Ontake volcano. Electrical conductivity surveys have shown that these earthquake swarms are associated with the upwelling of deep-seated fluid. Based on the Li and Sr isotopic results of ground water samples around Ontake volcano, Nishio et al. (2010) concluded that the fluid associated with the earthquake swarms beneath the southeast flank of Ontake volcano is not a simple volcanic fluid. However, it is still unknown the origin of significantly low ^{7}Li/^{6}Li ratios. Afterwards, such significantly low ^{7}Li/^{6}Li ratios were observed in ground water samples in the Kobe and Kochi area (unpublished data). Accordingly, I'll discuss about the origin of the significantly low ^{7}Li/^{6}Li ratios observed in several ground water samples.

Reference:
Nishio et al., 2010. Lithium and strontium isotopic systematics of waters around Ontake volcano, Japan: Implications for deep-seated fluids and earthquake swarms. Earth Planet. Sci. Lett. 297, 567-576.

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