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Fluids in the brittle-plastic transition zone: Geochemical study on the Hatagawa fault zone, NE Japan

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Fluid chemistry is essential for evaluating the effect of water-rock interaction on the fault activity. However, the nature of fluid phase in the middle to lower crust, the important part for the inland earthquake generation, is poorly understood. We have been studying the Hatagawa fault zone, northeast Japan, as an ancient seismogenic zone from geological and geochemical aspects to clarify the physical and chemical processes in the seismogenic zone.

Various kinds of fault rocks of mostly Cretaceous granitoids origin are distributed and plastic deformation and brittle deformation are closely associated. Main cataclasite zone, which is considered core of the Hatagawa fault zone is extended continuously over 40 km in the direction of almost N-S with about 100m width. Mylonite zones with a sinistral sense of shear partially surrounds the cataclasite zone with a maximum width of 1 km. Small scale shear zones, of which width ranges from a few mm to a few m, are distributed in the surrounding granitoids. Deformation structure is well preserved in these small shear zones and pseudotachylyte bands sometimes occur (Kubo and Takagi, 1997). Shigematsu and Yamagishi (2002) categorized mylonite into two types based on microstructure. One was deformed under higher temperature (higher than 400 C) and the other was deformed under lower temperature (about 300 C). The cataclasite is formed at the temperature condition about 250 to 300C based on the alteration mineral assemblages. These temperature ranges cover the temperature of inland earthquake source region.

Epidote and chlorite are dominant alteration minerals in both low temperature mylonite and cataclasite, in contrast, calcite is characteristically occurred in fractured part. Decrease in oxygen isotope ratio and existence of epidote and chlorite even in weakly deformed granodiorite is evidence of water-rock interaction. The water/rock ratio is relatively small (not larger than one) and fluid chemistry is controlled by host rock chemistry in low temperature mylonite. Positive correlation between decrease in D18O and degree of deformation indicates the possibility of involvement of water in mylonitization. The occurrence of calcite in fractured part is explained by changes in water chemistry. Probably, CO_2 rich fluid was introduced at cataclastic deformation and increase in CO_2 partial pressure results in precipitation of calcite. The origin of CO_2 rich fluid is a future problem to solve.