Characterization of fluids in the Nojima fault zone, SW Japan

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The active fault drilling at Nojima Hirabayashi after the 1995 Hyogoken-nanbu (Kobe) earthquake provides us a unique opportunity to investigate subsurface fault structure and in-situ properties of the fault. The GSJ borehole intersected the fault gouge of the Nojima fault at the depth interval of 623m to 625m. The borehole enters into the fault zone at 426m depth and the rocks are affected by the fault even at the bottom of the borehole. Characteristic alteration minerals in the fault zone are smectite, zeolites (laumontite, stilbite) and carbonate minerals (calcite, siderite, and dolomite). Carbonate minerals are important as sealing material in the shallow level of the Nojima fault.

The fault core was highly permeable due to fracturing. The borehole water was sampled in 1996. It was pumped up from the 630 to 650 m depth interval, just below the fault core. It is rich in calcium and bicarbonate ions and isotopic characteristics are similar to that of local meteoric water (Sato and Takahashi, 1999). We sampled the borehole water at the same depth in 1999 again. The chemical and isotopic characteristics were almost the same as those in 1996. These suggest that the water in the fault zone (about 630m depth) is mostly derived from meteoric water. However, it has been experienced relatively deep reservoir (80-90 degrees C) judging from geochemical thermometry. It is nearly in equilibrium with carbonate minerals, which is consistent with abundant carbonate minerals around the fault core.

Carbon and oxygen isotope ratios of carbonates from 41 samples at various depths were analyzed. The difference in carbon isotope ratio between footwall and hanging wall suggests that the Nojima fault has been acted as a barrier of the fluid. Seawater might be dominant in the footwall side and meteoric water might be dominant in the hangingwall. Fault core is characterized by relatively high meteoric water flux. This is consistent with the chemistry of borehole water.