Clay mineral analysis and chemical composition of the Hirabayashi NIED drill core

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The 1995 Hyogo-ken Nanbu earthquake occurred along the NE-SW-trending Rokko-Awaji fault system, and the Nojima Fault appeared on the surface on Awaji Island when the rupture occurred. The offset of the rupture was 1-2 m with more than 10 km length along the Nojima Fault. About one year after the earthquake, the National Research Institute for Earth Science and Disaster Prevention (NIED) drilled an 1838 m deep borehole (the Hirabayashi NIED borehole) penetrated the Nojima Fault and successfully recovered the drill core of about 800 m length (1001 m to 1838 m depths) containing fault rocks across the fault zones. The main type of rock mass intersected by the borehole granodiorite. Three fracture zones containing cataclastic fault rocks were recognized in recovered cores at approximate the depth of 1140 m, 1300 m and 1800m.

We detected some clay minerals such as smectite and kaolinite that are related to hydrothermal alternation in the fracture zones. And we detected plenty of H20+ and CO2, too. It means that fluid-rock interactions have occurred in the fracture zones. The interactions may be concerned with the fault activities. So we investigated properties the smectite to know details of the reaction. Concretely, we measured a d-space of the smectite (001) peaks by means of X-ray diffractmeter (XRD). To get clear XRD profiles of the clay minerals, we did particle size separation (under 5um) using by a centrifuge. And we use the Glass Slide (Oriented) method. To measure the d-space of the smectite, we analysed the samples in an air-dried (A.D.) condition. And to identify a sort of smectite, we did ethylene glycol solvation treatment to the samples. As a result, all sample's d-spaces were expanded to 17 angstrom. Therefore we can regard it as the same sort of smectite.

The d-spaces range from 12 angstrom to 15 angstrom according to an exchangeable cation in the interlayer of the smectite (For ex. Ca2+; 14 angstrom to 15 angstrom, Na+; 12 angstrom to 13 angstrom). And it is well-known that species so the exchangeable cations depend on surrounding liquid condition.

As a result, there are two types of d-space of smectite (001) peaks. One is 15 angstrom (around a depth of 1140m) and the other is 14 angstrom (around depths of 1300m and 1800m). It suggests that there will be a fluid barrier in the depth region from 1140 m to 1300 m, which separate upper circulation and lower circulation. Probably, the upper part is an open system and the lower part is a closed system. And rainwater has intruded into the upper fluid circulation.