Physical properties of fault fracture zones by downhole physical loggings - Case study of Atotsugawa fault, central Japan

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Drilling is an effective method to investigate the structure and physical state in and around the active fault zone. In previous studies, we did integrate investigation on active faults in central Japan by drilling into the Nojima fault and Neodani fault. Those faults are estimated to be at different stage in the earthquake cycle, i.e., Nojima fault which appeared on the surface by the 1995 Great Kobe earthquake (M=7.2), the Neodani fault which appeared by the 1891 Nobi earth-quake (M=8.0). Each faults showed characteristic features of fracture zone structure according to their geological and geophysical situations. In a present study, we report core observations and downhole physical logging at the Atotsugawa fault, central Japan, that is considered to have activated at 1858 Hida earthquake (M=7.0). The Atotsugawa fault is characterized by active seismicity along the fault. But, at the same time, the shallow region in the central segment of the fault seems to have low seismicity.
A 350m depth borehole was drilled vertically beside the surface trace of the fault in the low seismicity segment. Logging data showed that the apparent resistance was about 100 - 600 ohm-m, density was about 2.0 - 2.5g/cm3, P wave velocity was approximately 3.0 - 4.0 km/sec, neutron porosity was 20 - 40 %. Results of physical logging show features of fault fracture zone that were the same as the fault fracture zones of other active faults that we have drilled previously. In addition, Caliper logging, which measures the diameter of borehole, showed enlargement of borehole (max. 2 times of initial borehole diameter) and indicate the strength of borehole wall was lowered extremely.
Recovered cores were overall heavily fractured and altered rocks. In the cores, we observed many shear planes holding fault gouge. The observations of cores and physical logging data indicate that the borehole passed in the fracture zone down to the bottom, and that the fracture zone has complicate internal structure including foliation not parallel to the fault trace.
With the results of Nojima and Neodani fault, physical logging data show physical properties are different among different lithologies, and that the host rock zone and fault fracture zone have much different physical properties. In addition, characteristics of physical properties of fracture zones are differet from each other fault. What factors affect the different physical properties are not yet clear. They may be associated with case histories in physical and chemical processes of each fault activity in the past. We need further comparative studies on different fault drilling results.

Keywords: physical logging, fault fracture zone, Atotsugawa fault

