La-P007 Room: Poster Time: June 8 17:30-19:30

Fault gouge analysis of the Nojima earthquake fault

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Fault gouges of the Nojima earthquake fault were analyzed in laboratory. The samples for analysis were taken at three outcrops in the northern fault and at one outcrop in the southern fault. The fault gouge in the 500m-boring core at the southern fault was also prepared for analysis. The gouge samples were analyzed by XRD, CPSA and SEM for the study of mineral assemblage, grain-size distribution and surface topography of quartz grains. The thin sections made from the gouge samples were observed under microscope for the study of grain-size distribution, roundness and fractal nature of quartz/feldspar grains. According to the analysis, each foliations in fault gouge samples is classified into one of four types which reflect the history and mechanism of the faulting.

Fault gouges of the Nojima earthquake fault were analyzed in laboratory. The samples for analysis were taken at four outcrops. The fault gouge in the 500m-boring core was also prepared for analysis. The gouge samples were analyzed by XRD, CPSA and SEM for the study of (1) mineral assemblage, (2) grain-size distribution and (3) surface topography of quartz grains. The thin sections made from the gouge samples were observed under microscope for the study of (4) grain-size distribution, (5) roundness and (6) fractal nature of quartz/feldspar grains. According to the analysis, each foliation in fault gouge samples is classified into one of four types which reflect the history and mechanism of the faulting.

Four types of fault gouges are described according to the result of analysis (1) - (6):

Type A: (1) Unconsolidated. Biotite and hornblende are not recognized, but kaolinite, montmorillonite, laumontite and calicite are recognized by XRD analysis. (2) Very gentle unimodal distribution between 1 and 50 microns. (3) Quartz grains show very fresh fracture surfaces, that is the sub-conchoidal type of the category I of four categories which indicate relative freshnesses of fracture surfaces of quartz. (4) The grain-size distribution follows the power-law even for grains of less than 10 microns in diameter. (5) The roundness is low, that is 0.1 to 0.4. (6) Fractal dimension is relatively high, that is 1.09 to 1.14.

Type B: (1) Similar to the type A. (2) Similar to the type A. (3) Quartz grains show fresh fracture surfaces, that is the orange-peel type of the category I. Fracture surfaces of the category II are also commonly observed in SEM. (4) The number of grains of less than 10 microns is smaller than the number presumed from the power-law of grain-size distribution. (5) The roundness is moderate, that is 0.3 to 0.7. (6) Fractal dimension is moderate, that is 1.03 to 1.06.

Type C: (1) Similar to the type A. (2) Similar to the type A. (3) Mainly categories II to IV. (4) Grains smaller than 10 to 20 microns are scarcely observed under microscope. (5) The roundness is high, that is 0.4 to 0.9. (6) Fractal dimension is low, that is 1.00 to 1.03.

Type D: (1) Consolidated. Clay minerals and zeolites are not recognized, but quartz, orthoclase and plagioclase are recognized by XRD analysis. (2) (Not analyzed because of consolidated sample). (3) (Not analyzed because of consolidated sample). (4) Similar to the type C. (5) Similar to the type C. (6) Similar to the type C.

The result of analysis is interpreted as follows:

Type A: The type-A fault gouges are found in those foliations just along the faulted surface of 1995 Hyogoken Nambu earthquake. (1) indicates a general feature of fault gouges. (2) is interpreted to be a result of repeated faulting along the foliations. (3) to (6) are indicative of the history of recent faultings.

Type B: (3) is indicative of much corrosion of fracture surfaces of quartz in comparison with the type A. Due to much corrosion, quartz/feldspar grains are more rounded as suggested by (5) and (6), and grains of less than 10 microns have been corroded to have disappeared as suggested by (4). Foliations of the types A and B occur even in the same fault gouge samples.

Type C: Corrosion is much advanced compared with the type B.

Type D: As for (4) to (6), the type D shows a similar feature to the type C, but mineral assemblages are those of the host rocks and the samples are consolidated. These features suggest that the type D is possibly a pseudotachylite caused by thermal fusion due to faulting.