

## Thematic Article

# Deformation mechanisms and fluid behavior in a shallow, brittle fault zone during coseismic and interseismic periods: Results from drill core penetrating the Nojima Fault, Japan

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**Abstract** This paper describes the results of petrographical and meso- to microstructural observations of brittle fault rocks in cores obtained by drilling through the Nojima Fault at a drilling depth of 389.52 m. The zonation of deformation and alteration in the central zone of the fault is clearly seen in cores of granite from the hanging wall, in the following order: (i) host rock, which is characterized by some intragranular microcracks and in situ alteration of mafic minerals and feldspars; (ii) weakly deformed and altered rocks, which are characterized by transgranular cracks and the dissolution of mafic minerals, and by the precipitation of zeolites and iron hydroxide materials; (iii) random fabric fault breccia, which is characterized by fragmentation, by anastomosing networks of transgranular cracks, and by the precipitation of zeolites and iron hydroxide materials; and (iv) fault gouge, which is characterized by the precipitation of smectite and localized cataclastic flow. This zonation implies that the fault has been weakened gradually by fluid-related fracturing over time. In the footwall, a gouge layer measuring only 15 mm thick is present just below the surface of the Nojima Fault. These observations are the basis for a model of fluid behavior along the Nojima Fault. The model invokes the percolation of meteoric fluids through cracks in the hanging wall fault zone during interseismic periods, resulting in chemical reactions in the fault gouge layer to form smectite. The low permeability clay-rich gouge layer sealed the footwall. The fault gouge was brecciated during coseismic or postseismic periods, breaking the seal and allowing fluids to readily flow into the footwall, thus causing a slight alteration. Chemical reactions between fluids and the fault breccia and gouge generated new fault gouge, which resealed the footwall, resulting in a low fluid condition in the footwall during interseismic periods.

**Key words:** Awaji Island, drilling, fault rock, fault zone, Hyogo-ken Nanbu earthquake, meteoric fluids, Nojima Fault, structural analysis, Tsushigawa granite.

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