Recovery of stress orientation around the Nojima Fault during postseismic period of ~20 years after the 1995 M_w 6.9 Kobe earthquake, Japan

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Knowledge of the horizontal stress orientation derived from analysis of borehole breakouts provides insights into the kinematic and seismic rupture processes of active fault zones during large earthquakes. The identification and analysis of borehole breakouts as a promising technique for in situ measurement of horizontal stress orientation and magnitude related to active faults, have received a great deal of attention during the past decades. Borehole breakouts are failures of the borehole wall due to concentration of in situ stresses, form in the direction perpendicular to the maximum principle horizontal compressive stress. Thus, by investigating localized changes in breakout direction, the horizontal orientations of maximum and minimum stresses at the time of drilling can be identified.
In this study, we have analyzed the current compressive stress using the observed azimuths of borehole breakouts in a ~1000-m-depth hole that was drilled throughout the Nojima Fault (NF) that triggered the 1995 M_w 6.9 Kobe earthquake. The ultrasonic borehole televiewer images used in this study were acquired from the scientific project “Drilling into Fault Damage Zone (DFDZ)” conducted in the period during 2015 and 2017 (Lin, 2017; Miyawaki et al., 2017). The main fault plane was found at a depth of ~532.3 m with a ~15 cm thick fault gouge zone and a damage zone of ~100 m wide developed in the both sides of the main fault plane.
Analysis shows that the maximum horizontal stress (S_{Hmax}) in the hanging wall at depths of shallower than ~500 m was oriented to N10˚E–70˚W, with average of N30˚W,sub-perpendicular to the general trend of the NF (~N45˚E, 80˚SE). In contrast, the maximum horizontal stress (S_{Hmax}) in the footwall at depths of deeper than ~650 m was rotated to N40˚E–80˚W, with average of N80˚E, sub-parallel to the regional tectonic stress direction. Our results reveal that the compressive stress which is the driving force of the fault rupturing in the deep seismogenic fault zone has been built up and that the fault zone has been healed during the postseismic period of ~20 years after the 1995 Kobe earthquake. This work was supported by a contract research project of DFDZ of the Secretariat of Nuclear Regulation Authority of Japan.

References

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