Geophysical Research Abstracts
Vol. 13, EGU2011-2741, 2011
EGU General Assembly 2011

The evolution of the assumed state of stress on the Chelungpu Fault, Taiwan, post Chi-Chi earthquake, based on a set of hydraulic fracturing tests

Bezalel Haimson
University of Wisconsin, Materials Sci. and Engr., Madison, United States (bhaimson@wisc.edu)

A major goal of the Taiwan Chelungpu-fault Drilling Project (TCDP), following the 1999 catastrophic Chi-Chi earthquake, was the estimation of the in situ state of stress on the host fault after the event. Two scientific holes were drilled 40 m apart, each penetrating the fault, at 1111 m (hole A) and 1136 m (hole B) at a point some 100 km north of the Chi-Chi earthquake epicenter. In situ stress measurements were conducted by a commercial firm at four depths in hole B (at 1019, 1085, 1179, and 1279 m) using hydraulic fracturing (HF). The HF tests were, unfortunately, incomplete in that the resulting hydraulic fracture traces on the borehole wall were not monitored. Hung et al (Tectonophysics, 2009) were the first to interpret the HF results. Due to the lack of information, they made the common, and not always justified, assumption that the induced fractures were vertical, i.e. that the least principal stress was horizontal. Together with their interpretation of the shut-in pressure levels from the pressure-time test records, their assessment of the post Chi-Chi state of stress on the Chelungpu thrust fault was one favoring strike-slip movement, in which [U+F073]H > [U+F073]v > [U+F073]h.

Haimson et al (Tectonophysics, 2010) revisited the HF stress test records. They demonstrated that only two of the four tests yielded reliable "shut-in" pressures, from which the minimum principal stress (assumed horizontal, i.e. [U+F073]h) was determined. These two pressures, , at 1085 m and 1279 m depth, were very close to, albeit slightly smaller than, the gravity-based vertical principal stress. Their data analysis led to the conclusion that the state of stress on the Chelungpu fault was borderline between strike-slip and thrust faulting ([U+F073]H > [U+F073]v $\geq$ [U+F073]h).

Recently, a more critical study of the HF tests data was undertaken, which suggests a high probability that the induced hydraulic fractures at 1085 m and 1279 m depth were in fact horizontal, and not vertical as previously assumed. The shut-in pressures in these two tests were within a few percentage points of the estimated vertical stress at the respective depths, well within the margin of error of these estimates. Moreover, the pressure-time signatures in these two tests clearly resemble those experienced during horizontal fracturing. This implies that the minimum principal stress (represented by the recorded shut-in pressures) is vertical ([U+F073]v). The condition [U+F073]H > [U+F073]h > [U+F073]v is compatible with the thrust nature of the Chelungpu fault. However, all that can be said about the other two principal stresses at Chelungpu fault based on the HF tests is that [U+F073]h is equal to or larger than [U+F073]v by an unknown amount, and that the maximum horizontal stress [U+F073]H is the largest overall, but of unknown magnitude.