Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

AGE030-06 Room: 202 Time: May 26 10:15-10:30

Development of Characterization Technology for Fault Zone Hydrology

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Faults exist almost ubiquitously in Japan and in California, both of which are situated in a very active tectonic environment. Faults most often have major influence on the groundwater flow and transport in their surroundings. To this end, correct characterization of fault zone hydrology is crucial to the success of many environmental undertakings including nuclear waste isolation, geologic sequestration of CO2, groundwater remediation, as well as geothermal energy production. Nuclear Waste Management Organization of Japan and Lawrence Berkeley National Laboratory are collaborating at a dedicated filed site to further the understanding and to develop characterization technology of fault zone hydrology. Several deep trenches were cut and geophysical surveys were conducted across the Wildcat Fault on the Berkeley Hills in California. The Wildcat Fault is believed to be a strike-slip fault and a member of the Hayward Fault System with over 10km of displacement. So far, two boreholes of approximately 150m have been core-drilled; one the east side and another on the west side of the fault. After conducting hydrologic tests, the first two boreholes were instrumented with temperature and pressure sensors at multiple levels. Preliminary results from these two holes indicate that the geology is not what was expected based on the available literature. The lithology mainly consists of chert, shale and sandstone. The rocks are extensively sheared and fractured; gouges were observed at several depths and a cataclasite zone of over 4m thick was also observed. At this writing, the pressure and distributions have only been collected from the east side, which indicate downward hydraulic gradient and relatively large geothermal gradient. A third inclined borehole is planned to penetrate the main fault believed to lie in between the two holes. Using the first two holes as observation wells hydrologic cross-hole tests are planned in the third borehole. The main philosophy behind our approach for the hydrologic characterization of such a complex fractured system is to let the system take its own average and monitor a long term behavior instead of collecting a multitude of data at small length and time scales, or at a discrete fracture scale and to "up-scale," which is extremely tenuous.

Keywords: fault zone, hydrology, nuclear waste, pressure tests, mass transport