Geophysical Research Abstracts,
Vol. 10, EGU2008-A-10374, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-10374
EGU General Assembly 2008


# Halite shearing experiments revisited; implications for diverse seismic fault motion

T. Shimamoto

Department of Earth and Planetary Systems Sciences, Graduate School of Science, Hiroshima University, Higashi-Hiroshima, 739-8526, Japan (shima007@hiroshima-u.ac.jp)

Halite is the only material that has been tested to produce complete transitions from brittle to fully plastic deformation (Shimamoto, 1986, 1989; Kawamoto and Shimamoto, 1997, 1998), solution/precipitation processes (a series of experiments lead by Spiers at Utrecht), from low to high velocity slip (Kim et al., 2007, AGU). This presentations will overview the rich behaviors of halite shear zones and summarise their implications for seismic fault motion.

Halite gouge in the brittle regime is characterized by velocity weakening (i.e., lower friction at a higher slip rate) and by stick-slip. This velocity-weakening behavior changes to velocity-strengthening behavior, and eventually to flow law with a decrease in velocity or with an increase in pressure and/or temperature. The lower bound of stick-slip generation nearly coincides with the change in velocity weakening to velocity strengthening. This is consistent with an often-made assumption for the lower bound of seismicity in the modeling of earthquake cycles; i.e., the lower bound of seismicity corresponds to the change in velocity dependency of steady state friction. But the overall change from velocity weakening to velocity strengthening is not simply a change in the sign of velocity dependence of the steady-state friction. Halite data clearly shows that plastic deformation begins to take place in about lower one-third of the seismogenic zone producing mylonitic deformation. Drilling in Kakkonda geothermal area in Japan revealed microseismicity at temperatures to almost 400 degrees Celsius. This is consistent with the formation of low-temperature mylonites in the seismogenic depths. Dry halite shear zone very close to the lower bound of seismicity exhibits very slow stick-slip; that is, the speed of fault motion is reduced by two to three orders of magnitudes than that at shallower conditions. Partial operation of plastic deformation may be a cause of low-frequency or ultra-low-frequency earthquakes recently found in subduction zones.

The velocity-weakening behavior changes to velocity-strengthening behavior with an increase in slip rate at around 0.01 to 0.1 mm/s, separating the low-velocity and intermediate-velocity regimes. This intermediate-velocity regime expands, the slope of velocity dependency increases, and the friction-velocity relationship changes to flow law with increasing depths. Shibazaki and Shimamoto (2007) produced slow slip in subduction zones by using the larger velocity dependency near the base of seismogenic zone, similar to those observed in subduction zones recently.

Finally, Kim et al. (2007, AGU) attempted high-velocity experiments on halite shear zones at slip rates to 2 m/s and showed that the velocity-strengthening in the intermediate velocity changes to dramatic velocity weakening at high velocities. They also demonstrated that frictional melting and formation of mylonitic deformation can take place in the brittle regimes at a low velocity. Frictional heating thus can cause plastic deformation in narrow zones within or close to the slipping zone during seismogenic fault motion and this may lead to a new interpretation to the genesis of coexisting pseudotachylite and mylonites in natural fault zones.

Establishment of constitutive laws describing those diverse behavior of halite shear zones is still a challenging task, but it will provide clues to understand the origin of diverse fault motion.