Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)


SCG60-P07 Room:Convention Hall Time:May 25 18:15-19:30

# Dehydration effect on frictional instability: Experimental study using gypsum hemihydrate

SASAKI, Yuto[1*] ; MUTO, Jun[2] ; NAGAHAMA, Hiroyuki[2]

[1]Div. GeoEnviron. Sci., Tohoku Univ., [2]Dept. Earth Sci., Tohoku Univ., [3]Now at: Dept. E. P. Sci., Univ. Tokyo

Subduction zone seismicity can be controlled by water. For example, dehydration embrittlement of subducting slab is thought to generate intermediate depth earthquakes and their epicenters concentrate in "the upper plane earthquakes belt." The lower boundary of "the upper plane earthquakes belt" is possibly related to the stability of anhydrous phase after dehydration [1, 2]. Besides, the presence of serpentinized mantle wedge or excess pore pressure derived from hydrous slab may explain the distribution of asperities possibly inducing plate boundary earthquakes [2, 3]. In this way, hydrous minerals in subducting slab physicochemically transport water into deeper part of the Earth at subduction zone; the water probably has relationship with seismicity. Nevertheless, it has not concretely resolved yet how water has elementary microscopic effects on the macroscopic seismicity.

Many hydrated minerals such as serpentinites [4] exhibit mechanical instability such as dehydration weakening. Especially for gypsum, previous researches clarified that the condition of brittle-ductile transition and dehydration reaction can be achieved easily in laboratory [5, 6], so that gypsum is thought to be a good rheological analogue for hydrous slab. Thus, in this research, we investigate a following problem on the hypothesis that hydrous mineral dehydration microprocess affects frictional characteristics and rheology. The problem is how dehydration of hydrous minerals controls frictional properties and rheology of seismogenic zone by friction experiments of simulated gypsum gouges.

In this study, simulated gouge sample of gypsum hemihydrate, bassanite, between precut gabbro pistons was deformed in gas-medium apparatus at confining pressures of 10 − 200 MPa and temperatures up to 180 ℃. From the results at room temperature, the magnitude of stress drops proportion to confining pressure explains the depth distribution of seismicity in subduction zones. At 200 MPa, 70 ℃ corresponding to non-dehydration condition, samples exhibited stick-slip behavior and the strength of the samples became larger. On the other hand, at 200 MPa, 110 ℃ and higher, likely corresponding to condition for stable anhydrite phase, stick-slip behavior was found to be diminished with the reduction in mechanical strengths with strain. Microstructural observations clarified opening shear planes ($R_1$) oblique to shear direction in non-dehydrated samples, while the number of shear planes decreased and another sets of shear planes parallel (Y) or orthogonal (X) to the direction against shearing were formed in dehydrated samples. Cleavages were turned parallel to shearing by shape preferred orientation of the gouge particles and most of deformation was covered along them as mechanically weaker planes. The generation of excess pore pressure generated by dehydration of hydrous minerals, low permeability of the surroundings and connection of internal shear planes or cleavages may have significantly reduced the strength of rock. Because the phase after dehydration, anhydrite, is known to show higher frictional strength than the hemihydrate, bassanite [7], existence of excess pore pressure rather than the change in frictional properties may induce weakening during or after the dehydration. Hence, this implies that the dehydration weakening process is possibly related to formation of aseismic or stable sliding zones.

References: [1] Kita *et al.* (2006) *GRL*, **33**, L24310. [2] Hasegawa *et al.* (2012) *Jour. Tokyo Geogr. Soc.*, **121**, 128. [3] Fagereng and Ellis (2009) *EPSL*, **278**, 120. [4] Raleigh and Paterson (1965) *JGR*, **70**, 3965. [5] Brantut *et al.* (2011) *JGR*, **116**, B01404. [6] Heard and Rubey (1966) *GSAB*, **77**, 741. [7] Shimamoto and Logan (1981) *JGR*, **86**, 2902.

Keywords: dehydration weakening, phase transition, hydrous mineral, gypsum