[EE] Evening Poster | S (Solid Earth Sciences) | S-CG Complex & General

[S-CG53]Science of slow earthquakes: Toward unified understandings of whole earthquake process

convener:Satoshi Ide(Department of Earth an Planetary Science, University of Tokyo), Hitoshi Hirose(Research Center for Urban Safety and Security, Kobe University), Kohtaro Ujiie(筑波大学生命環境系, 共同), Takahiro Hatano(Earthquake Research Institute, University of Tokyo)

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Accumulating observational studies on various types of slow deformation events, such as tectonic tremors, very low frequency events, and slow slip events, portrays some universal characteristics in generally complex behavior, including interaction among events and influence by various outer loadings. Some of these phenomena seem to have causal relation with the occurrence of very large earthquakes. A unified understanding of these slow and fast earthquake processes requires an approach integrating geophysics, seismology, geodesy, geology, and non-equilibrium statistical physics. We welcome presentations based on, but not limited to, geophysical observation, data analysis, analytical theory, numerical simulation, field study, and laboratory experiments.

[SCG53-P21]Stress and Acoustic Emission measurements in granular stick-slip

*Hidekazu Fukumizu[1], Ikuro Sumita[2] (1.Earth and Environmental Science Course, Division of Natural System, Graduate school of Natural Science and Technology, Kanazawa University, 2.Kanazawa University)

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Slow slip and tremor are observed to occur simultaneously (e.g., Rogers and Dragert, Science, 2003). Such observation can be modelled using granular stick-slip experiments which shows that the timing of slips and acoustic emission (AE) are well correlated (e.g., Johnson et al., GRL, 2013, Jiang et al. GRL, 2017). AE waveforms are complex (e.g., Michlmayr &Or, Gran. Matt., 2014), and we do not fully understand the details of the temporal change of AE during the slip. Here we report the results of granular stick-slip experiments which focuses on the relation between the shear stress and AE, and their dependence on the shear rate, particle size and pore fluid.

We shear glass beads using a rotating viscometer (Higashi and Sumita, JGR, 2009), and measure the shear stress and AE, using torsion spring and accelerometers, respectively. Mean shear stress decreases with shear rate, and also when particle size is smaller or when the granular matter is water-immersed. AE acceleration amplitude increases with shear rate and particle size, and decreases for a water-immersed case. AE velocity – time series data, obtained by integrating acceleration, indicates that there are two characteristic frequency (f) components ; a high f (of the order of 100 Hz) and a low f (of the order of 10Hz) components, and that the former tends to end earlier than the latter. Using the bandpass filtered data, we calculate the energy median time for the high f and low f components, and showed that for most cases, h-f component precedes the low-f component. We also confirmed a positive correlation between the AE power and the work per unit time needed for shearing.

We hypothesize that the high-f component corresponds to the particle readjustment time. We extend the“Singing sand” model (Bagnold, 1966) and find that it explains the high-f of the order of 100. In order to evaluate the effect of fluid viscosity, we calculated the Stokes number (St) for the situation in our experiments. We find that St = 41 for the water-immersed case, indicating that inertia dominates over

viscosity for particle size motions. This explains why fluid viscosity had small effect on AE in our experiments.
The broad-band waveform analyses which we conducted using our experimental data suggest that such analyses may be useful to investigate the details of the relation between slow earthquakes and tremor.