Monitoring of elastic wave velocity on the cracked granite during shear deformation

*Tatsuro Kubo[1], Atsuko Namiki[2], Ikuo Katayama[1]

1. Department of Earth and Planetary Systems Science Hiroshima University, 2. Graduate School of Integrated Arts and Sciences, Hiroshima University

[Introduction] Changes in elastic wave velocity have a possibility to illuminate physical processes during earthquake rock failure. As elastic wave velocity was affected by propagation and closing of cracks, laboratory study for triaxial compression tests showed increasing elastic wave velocities due to dilation and compaction with increasing confining pressure (Scholz et al. 1973). Seismic observation also showed variations in elastic wave velocity. Li et al. (1998) found that fault-zone p- and s- wave velocities increased with time after 1992 Landers earthquake. To find systematic variations in elastic wave velocity may approach a prediction of failure mode in seismic cycle. In this study, we focus on the detecting of systematic variation in elastic wave under friction experiments, and monitor the change in elastic wave velocity during shear deformation.

[Experimental methods] We conducted monitoring of elastic wave velocity during friction experiments using by biaxial friction machine. Two sliding surface were made by two side blocks placed together to produce a double-direct shear configuration. Normal stress was applied via a hydraulic ram on the side blocks with 5, 10, 20 MPa, and then shear stress was applied by advancing central block downward at constant velocity. Samples we used as simulated host rock were Aji granite. These were thermally cracked with baking at 600 C for 4 hours, because the host rocks along fault zone were expected to have amount of cracks produced by seismogenic faulting movement. In observation of elastic wave velocity, we adopted pulse transmission method using electric transducer directly attached on sample with a direction normal to simulated slide surface sandwiched between these. Elastic wave velocity, amplitude and wave period from waveforms were recorded by oscilloscope.

[Results&Discussion] Observed elastic wave velocity passing through Aji granite samples have a tendency to increase with increasing normal stress due to closure of pre-existing cracks with an orthogonal plane to normal stress. Response in elastic wave velocity given by shear stress showed systematic change similar to that of normal stress, increasing elastic wave velocity with increasing shear stress. This change in elastic wave velocity can be mainly explained by closure of pre-existing cracks with an orthogonal plane to shear stress. The change cannot be observed in phases that shear stress reached at steady-state friction. We also observed change in amplitude during experiments from waveform recorded by oscilloscope. Amplitude increases with increasing normal and shear stress, however amplitude showed almost constant value in phases that shear stress reached at steady-state friction, similar to that of elastic wave velocity. Our results showed that changes in elastic wave velocity and amplitude have a systematical dependence on stress state. As a stress is expected to accumulate in inter-seismic phase in seismic cycle, monitoring a temporal variation in elastic wave velocity and amplitude along fault zone has a one of possibility to understand process of earthquake failure.

Keywords: elastic wave velocity, friction experiment, cracked granite, earthquake hazard assessment

