Measurement of shear-wave polarization anisotropy in water-saturated Aji granite during shear experiment

*Jinki Tanaka[1], Ikuo Katayama[1]

1. Hiroshima University

The stress drop at the time of the earthquake not only releases the stress applied to the fault plane but also causes the rotation of the principal stress axis applied to the fault plane. In fact, the change in the direction of the principal stress axis after the earthquake is reported by the mechanism solution of aftershocks and the seismic wave anisotropy(e.g. Tadokoro and Ando 2002; Boness and Zoback 2006). It is thought that this is because the closing (opening) direction of the cracks around the fault plane correspond to the stress axis. Also it is considered that fluid exists in voids such as grain boundaries and cracks in the underground rock. Therefore, in this study, the elastic wave was transmitted during the shear experiment of water-saturated rock and the relation between the shear stress and the principal stress axis and elastic wave velocity was measured in the laboratory. Since the shear-wave polarization anisotropy has a characteristic which is sensitive to the direction of the crack, measurement of different vibration components of S wave is performed in addition to measurement of P wave velocity.

For the experiment, we investigated the change in elastic wave velocity according to shear deformation using a High-T biaxial frictional testing machine in Hiroshima University. For the experimental samples, Aji granite which generated thermal cracks inside by heating to 600 degrees Celsius was used. In the shear test, it was carried out by loading the central rock block at a constant speed while keeping the vertical stress constant. The shear sliding velocity was about 0.9 μm/s and the vertical stress was 5 MPa. For measurement of elastic waves, probes with a resonance frequency of 1 MHz (manufactured by Olympus Corporation) were used, and S wave and P wave were measured by pulse transmission method. The propagation direction of elastic wave is parallel to the shear plane and perpendicular to the shear direction, and for the S wave, we measured two components, wave (SH) oscillating in the plane orthogonal to the shear direction and wave (SV) oscillating parallel to the shear plane.

From the experimental results, with the increase of the shear stress, it is expected that the velocity of SH wave rises earlier and the SV wave rises late. It is also expected that there is a phenomenon in which the initial motion of the SV wave jump suddenly as the shear stress increased. This means that when the shear stress is low and the maximum principal stress axis in the sample is close to the direction of the normal stress, the shear direction cracks are frequently closed and the SH wave velocity increases and the shear stress increases, when the inclination of the maximum principal stress axis becomes steeper with respect to the normal stress, it is considered that the direction of the crack which closes is correspondingly inclined. In this way, since the SH wave and SV wave behave differently due to the increase of the shear stress and the corresponding change of the principal stress axis angle, by utilizing this property, a good index for monitoring the stress state around the fault.

Keywords: Earthquake prediction, Shear-wave polarization anisotropy, Thermal crack

