Shear wave splitting in rocks containing fluid inclusions

Osamu Nishizawa[1], Kyuichi Kanagawa[2], Kentaro Yasunaga[3], Takashi Yoshino[4], Mamoru Takanashi[3]

[1] GSJ, [2] Dept. Earth Sci., Chiba Univ., [3] Grad. School Sci. & Tech., Chiba Univ., [4] Dep. of Civil and Environmental Eng., Toyo Univ.

Studies of shear-wave splitting are important to detect underground conditions. We measured shear-wave splitting in biotite schist having a strong anisotropy characterized by a bulge of qSV-wave phase velocity in 45 degrees from the foliation plane. The anisotropy is produced by preferred orientation of biotite. The bulge of the qSV-wave velocity and the shear-wave splitting becomes weak as crack density increases. The model calculation suggest that the shear-wave splitting becomes weak when oblate spheroidal cracks are aligned with their unique axis parallel to the unique axis of transverse isotropy. The results of the model calculateion also suggest that shear-wave splitting is strongly affected by bulk modulus of fluid in cracks.

Shear wave splitting is important for detecting changes of the earth's interior. If the shear wave splitting is affected by the bulk modulus of the fluid, it is useful for detecting the partial melt in the earth, oil or geothermal reservoir, or the changes of earthquake faults or magma environments. Recently, we made experiments of shear wave splitting in a strongly anisotropic rock and modeled the elastic anisotropy of the rock.

We used biotite schist from Hidaka metamorphic belt. We measured elastic wave velocity anisotropy with changing confining pressure for detecting the change of elastic wave velocity with changing crack density. When confining pressure increases, crack density of the rock sample decreases. The rock sample is assummed as a virtual transverse isotropy in the measured section. Shear wave splitting in the direction 45 degrees from the symmetry axis of transverse isotropy decreases with decreasing the confining pressure. The shear wave splitting in the rock is produced by a bulge of qSV wave in the direction 45 degrees from the symmetry axis. The experiment suggest that the bulge of qSV wave becomes small as crack density increases.

We modeled the anisotropy by assuming oblate spheroidal cracks having the unique axis parallel to the symmetry axis of the rock sample. The model calculation suggests that crack density and fluid bulk modulus affect the bulge of qSV wave. The shear wave splitting of the rock along 45 degrees from the axis is strongly affected by crack density and fluid bulk modulus. This phenomena will be important for detecting changes of underground having fluid filled cracks.