Elastic wave velocities of rocks around Atotsugawa fault, Japan

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Atotsugawa fault is at the boundary of Toyama and Gifu Prefecture. The activity in the central part is contrasting from the eastern and western parts. The seismicity is quite calm in the shallow depths, and the seismogenic zone extends to 15 km. On the contrary, in the eastern and western parts, the seismicity is quite high and confined within the depth of 5 km.

Negishi and Matsubara (2003) obtained the seismic velocity structure beneath Chubu District. In order to estimate materials and physical conditions in the crust, it is essential to understand physical properties of rocks in this region. We have measured elastic wave velocities of rocks around Atotsugawa fault.

Rock samples were selected based on the geological map to cover this area: Hida granites (diorite, fine granite, and coarse granite) and Tedori group (sandstone) were sampled from the eastern part. Hida metamorphic rocks (Sandiness gneiss, fine gneiss, and coarse gneiss) from central and western parts, Nohi rhyolite from south of the fault. Elastic wave velocities were measured by the pulse transmission method (the resonant frequency: 2 MHz). Samples were loaded in a pressure vessel, and the confining pressure was applied up to 180 MPa.

Elastic wave velocities increased rapidly with increasing confining pressure below 60 MPa, while a slight increase was observed from 60 to 180 MPa. Averaged compressional wave velocities at 180 MPa are 5.94-6.07 km/s, and the shear wave velocities are 3.46-3.48 km/s in granites (diorite, fine granite). Metamorphic rocks (Sandiness gneiss, fine gneiss, and coarse gneiss) have higher velocities (Vp = 6.28-6.56 km/s), while the rhyolite has lower velocity (Vp = 5.69 km/s, Vs = 3.25 km/s). The sandstone shows the lowest compressional wave velocity (5.59 km/s), while its shear wave velocity (3.45 km/s) is similar to granites. The coarse granite shows the lowest shear wave velocity (3.17-3.18 km/s), while its compressional wave velocity (6.17-6.18 km/s) is similar to granites.

We estimated crustal materials in this area from the seismic velocity structure (Matsubara and Negishi, 2003). Velocities measured at 80 MPa were compared with the structure at 2.5 km depth. Measured velocities were extrapolated to confining pressure of 300 MPa, and these velocities were compared with the structure at 10 km depth. In the shallow part of the crust, metamorphic rocks may exist around the fault, and the rhyolite in the low velocity region in the south of the fault. In the middle crust, granites may exist around the fault and in the south. In the north of the fault, the observed seismic velocity is much higher than the velocity of granites, and much lower than the velocity of metamorphic rocks. Metamorphic rocks with fluid-filled cracks can explain the velocity in the north. If cracks are fully saturated, crack density parameter of these rocks is estimated 0.3 (If we assume that aspect ratio is 1e-3, porosity is about 0.1%).