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コーダ波減衰と地殻応力の関係性
Relationship between attenuation of coda wave and crustal stress

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It is important to monitor stress changes in the crust at seismogenic depth to understand seismic activities in advance. Stress field has been measured using the stress relief experiment for sampled core or in borehole, strain-meters buried in the subsurface, etc. In these techniques, stress field is either indirectly estimated using stress-strain relationship or directly obtained after releasing loaded stress to the underground medium after costly construction of tunnels or drilling. For the seismogenic depth, we could, however, hardly access using schemes that are available at present. Sano (2004) pointed out that the measurement of deep stress field is still a challenge with the present technologies.

Recently, Hiramatsu et al. (2000, 2010) discussed a change in coda-Q (denoted as Q_c, hereafter) of local earthquakes in the vicinity of the 1995 Southern Hyogo Prefecture earthquake before and after the main event. He also mentioned the relationship between Q_c and magnitude of the loaded stress to the crust. Aki (2004) proposed a Brittle-Ductile Hypothesis after a long-term observation of the seismicity around the San Andreas Fault that has led him to find a high correlation of the seismicity with Q_c. The recent results (Aki, 2004; Hiramatsu et al., 2000, 2010) indicate that the order of inhomogeneities may vary in the course of long-term earthquake generation cycle, i.e., before and after the failure of crustal material are created. We therefore hypothesize that the state of stress acting in the subsurface medium could be estimated in the course of routine seismic observation.

In this study, we employ a 2-D Finite Different Method to calculate seismic wave propagation through the lower and upper crust. We confirmed that the Q_c^{-1} (reciprocal of Q_c) would vary with the stress loaded to an elastic medium using the numerical simulation. The Q_c^{-1} roughly shows a proportional relationship with magnitude of the stress. Also we consider if there is a relationship between Q_c^{-1} calculated from field data and the strain obtained by geodetic GPS measurement, which is considered as a proxy of the crustal stress near surface. We revealed that Q_c^{-1} changes according with the stress change before and after a large earthquake from the observation around the Tohoku area in Japan.

Figure below shows variation in Q_c^{-1} [%] at each Hi-net station before and after the two major earthquakes. One is the Iwate-Miyagi Nairiku Earthquake (Jun. 6, 2008, Mw 7.2, 7.8 km depth) locating between the Region A and B and the other earthquake locates near the Region C (Jul. 24, 2008, Mw 6.8, 108 km depth). We take average of the Q_c^{-1} at each station respectively before and after earthquakes; May, 2006 - May, 2008 and Oct, 2008 - Jan 2010. Then, we calculate the difference between these two sets of the averaged Q_c^{-1}.

Keywords: Coda-Q, Attenuation, Scattering, Anisotropy, Crack