Temporal variation in shear wave anisotropy detected with ACROSS

Ryoya Ikuta[1]; Koshun Yamaoka[2]

[1] Environment,Nagoya Univ.; [2] RC. Seis. & Volc., Nagoya University

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Temporal variation in the shear wave anisotropy was detected in a monitoring experiment using an accurately controlled routinely operated signal system (ACROSS). We made an experiment lasting for 15 month, from January 2000 to April 2001 at a site near the Nojima fault, which ruptured during the 1995 Kobe earthquake (Mw7.2) {Yamaoka et al. 2001; Ikuta et al. 2002}.

Two vibration sources that generate 2 x 10^5 N with centrifugal force are firmly fixed on the ground. The emitted elastic waves are received with seismometers deployed in the bottom of 800m- and 1700m-deep boreholes near the ACROSS sources. We extracted small temporal changes in the travel-time for P- and S-wave calculating cross-spectral density among the records at each calendar time.

During the experiment, sudden delays of S waves travel-time were observed at the time when the 2000 Western-Tottori earthquake (Mw6.6) and the 2001 Geiyo earthquake (Mw6.4) occurred. Their epicenters were 165 km and 215 km away from the site, respectively.

The travel-times for the S waves showed the abrupt delay and gradual subsequent recovery between the surface and the bottom of 800m-deep borehole associating with each earthquake, though P waves scarcely changed. The delay in travel-time suggests increase of cracks in the media. The sudden increase of Vp/Vs suggests that the cracks should be opened by pore pressure increase. The delay of S was about 0.4% and 0.1% for the Western-Tottori earthquake and the Geiyo earthquake, respectively. Both the delays were polarized in the direction perpendicular to the Nojima fault. This polarization indicates preferred orientation of the cracks, density of which temporally increased, in the direction parallel to the Nojima fault. We checked if the static anisotropy exists by examining the splitting of S wave using ACROSS. The S wave was revealed to be splitting into two orthogonal directions, the leading one was parallel to the fault and the lagging one was perpendicular to it. This suggests that cracks which orientate to the fault strike had been dominant. One explanation is that increasing pore pressure caused by earthquake shaking expanded the dominant cracks, which orientated into parallel to the fault.