Imaging the source region of the 2004 mid-Niigata prefecture earthquake and the evolution of a seismogenic thrust-related fold

Aitaro Kato[1]; Eiji Kurashimo[1]; Naoshi Hirata[1]; Shin'ichi Sakai[2]; Satoru Nagai[1]; Takashi Iidaka[3]; Toshihiro Igarashi[1]; Yoshiko Yamanaka[3]; Satoko Murotani[4]; Tomonori Kawamura[5]; Takaya Iwasaki[6]; Toshihiko Kanazawa[7]

[1] ERI, Univ. Tokyo; [2] Earthquake Research Institute, Univ. of Tokyo; [3] ERI, Univ. of Tokyo; [4] ERI,Univ. of Tokyo; [5] ERI; [6] ERI, Tokyo Univ.; [7] ERI, Tokyo Univ

The velocity structure and accurate aftershock distributions of the 2004 mid-Niigata prefecture earthquake (Mw 6.6) are elucidated by inverting the arrival times from the aftershocks using double-difference tomography (Zhang and Thurber, 2003). Fifty six temporal seismic stations were immediately deployed in and around the source region after the occurrence of mainshock. Both P- and S-wave arrival times observed at the temporary and the surrounding permanent stations were picked manually. The initial hypocenter locations are determined assuming two different 1D velocity structures of the northwestern and southeastern sides of the source region. The boundary between these velocity structures roughly coincides with that of the Muikamachi fault and its northeastward extension. The two velocity structures were chosen based on a refraction study conducted approximately 20 km south of the source region (Takeda et al, 2005), the geological map, and the Bouguer gravity anomaly. The initial velocity structure for the tomography analysis is the same as for hypocenter determinations, and the Vp/Vs value is set as 1.73 in all the grids.

The seismic velocities in a hanging wall are lower than those in a footwall, and the velocity contrast extends to a depth of approximately 10 km. The aftershocks associated with the mainshock are distributed around the clear boundary between the low and high velocity structures. It is interpreted that the mainshock fault plane of the mid-Niigata prefecture earthquake was reactivated as a reverse fault since the crustal shortening initiated at 3.5 Ma. It is observed that the hypocenter of the mainshock coincides with the low Vp zone Further, it is interesting to note that that both the largest and eastward dipping aftershocks (Oct. 27) occurred in the slightly low Vp zones in the footwall of the high velocity body. Thus, crustal stretching or shortening along the Japan coastline has created complex structures such as low velocity zones, which can potentially control the seismic activities around the source region. The depth extent of the low velocity body in the hanging wall is more significant on the southern cross sections than on the northern ones, which is consistent with the geological and gravity studies.