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Fault planes distribution and velocity structure in the western Nagano Prefecture, central Japan, using dense array data

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The 1984 Western Nagano Prefecture Earthquake (Mj 6.8) occurred about 10 km southeast of Mt. Ontake, an active volcano in the central Japan, on September 14, 1984, and caused huge damages including landslides. Ooida et al. [1989] pointed out that there was a high seismic activity in the hypocentral region of this earthquake even before the mainshock (at least from May, 1978, when Mt. Ontake erupted). This activity is still high even now, and the events with the magnitude larger than 4.0 occurred about every two years. We can see not only the seismic activity distributed along the mainshock fault plane, but also the swarm-like one in the eastern part of the source region.

In this study, we conducted the three-dimensional travel time tomography in and around the source region in order to investigate the generation process of the mainshock and the swarm activity near the source. As much as about 220,000 travel time data from dense network [Iio et al., 1999] with good quality (1 ms error) were compiled and we obtained the hypocentral distributions and the three-dimensional P wave velocity structure with high accuracy and resolution. We used pseudo bending [Um and Thurber, 1987] and LSQR method [Paige and Saunders, 1982] for ray tracing and matrix inversion, respectively.

Hypocenters and velocity structures were estimated with good accuracy at depths of 1-6 km, and we detected at least five fault planes of small earthquakes. We found the hypocenter distribution corresponding to the mainshock fault plane, sandwiched by the high velocity regions on both horizontal sides. In the northeastern side of the mainshock fault, where there is a swarm activity, we detected other several alignments of hypocenters, most of which may be located at the boundaries of geological strata. Low velocity regions were found at the bottoms of the alignments of the mainshock and the swarm. These low velocity regions may be due to the fluids from below the seismogenic zone from the comparison with the magnetic[Kasaya et al., 2002], hot spring [Takahata et al., 2003], and leveling surveys [Kimata et al., 2004]. These fluids may intrude into the cracks in the rocks or geological boundaries from the lower side of the hypocenter alignments and increase the pore pressure to generate these swarm activities.