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新潟地域における高分解能な地震波速度構造と地震活動との関係
Improved, high-resolution underground velocity structure in the Niigata region and its relation with seismicity

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Niigata area is part of a broader region, located in the central and north-eastern part of Japan, known for its high strain rates (Sagiya et al., 2000). To have a detailed understanding of the seismotectonic characteristics in the Niigata region, we have installed a dense temporary network of 300 seismic stations, which started functioning from 2008. In a previous tomography analysis (Enescu et al., 2011) we have revealed the undulated surface of the basement rock, hidden under a thick low-velocity layer of Neogene sediments and volcanic extrusions that form the Niigata basin. The earthquake locations, inverted together with the velocity structure, became systematically shallower, in agreement with results reported before (e.g., Kato et al., 2009).

In this study, we have used additional very deep earthquakes to better constrain the basement structure. The data consists of 1805 crustal events that have 151,780 P-wave and 169,696 S-wave arrivals, recorded at 434 temporary and permanent seismic stations. We have also manually picked deep earthquakes, with magnitudes larger than 3.5, which occurred within the subducting Pacific plate and have depths between 80 and 280 km. We have given ten times additional weight to the deeper events. The tomography inversion is conducted using the tomoDD software (Zhang and Thurber, 2003). The horizontal and vertical grid spacing were of 5 ˜ 10 km and 2 ˜ 10 km, respectively.

Due to the inclusion of deep earthquake picks, the velocity image of middle to lower crust was improved. The clearest feature of our velocity model is the undulated surface of the basement rock extending from SW to NE. Compared with the results we have reported previously, the undulated structure could be imaged further to the north-east, beneath the Niigata basin. The obtained results indicate that the majority of the earthquakes are located in regions where the P-wave velocity ranges from 5.5 to 6.5 km/sec. Most of the events occur on the flanks of the low-velocity region; in the basin area (of low-velocity) and the undulated basement underneath there is almost no seismicity. However, a few earthquakes do occur in the deeper region (at depths below 15 km). The earthquake activity from 2001 to present (Hi-net catalog) confirms these features. In particular, the aftershocks of the 2004, M6.8 and 2007, M6.8 Niigata earthquakes, as well as the more recent seismic activity following the M6.7 Nagano earthquake (April, 2011) are all located either on the flanks of the low-velocity region or slightly further apart. A high velocity body (i.e., P-wave velocity larger than about 6.5 km/s) is imaged below the central axis of the rift-like structure, similar with results reported by Kato et al. (2009). However, the high velocity body appears to be present only in the central part of our study region, in-between the aftershock distributions of the 2004 and 2007 Niigata aftershock sequences. Only a few earthquakes occur within the higher velocity region. The existence of the higher velocity body constrains the lower limit of the seismogenic region. The detailed mapping of the rift-like structure helps understanding where and why large earthquakes nucleate.