How deep are the aftershocks of the 2008 Iwate-Miyagi Nairiku sequence?

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Several large earthquakes, including the 2008 Iwate-Miyagi Nairiku earthquake (M_w6.9), occurred recently in the High Strain Rate Zone of Japan. In the framework of a large national project of observations and research in this region, we investigate the detailed earthquake distribution, fault and velocity structure in the area of the 2008 Iwate-Miyagi sequence.

The location of earthquakes is dependent, among other factors, on the (starting) velocity model used for the inversion and the availability of nearby seismic stations. In the case of the 2008 Iwate-Miyagi Nairiku sequence, the aftershock hypocenters determined by the Japan Meteorological Agency (JMA) were deeper than the later locations obtained from temporary, dense aftershock observations. Still, however, such studies suggest that the seismicity did not reach the surface and mostly located below about 5 km depth. This might be a true feature of seismicity or an artifact of an inappropriate velocity model used for the shallow part of the upper crust. We address this problem by locating earthquakes using different 1D velocity models and station configurations, and comparing the RMS residuals of each case. We use the NIED array data, as well the data from other seismic stations installed in the region, to analyze in detail the distribution of earthquakes and the velocity structure close to the mainshock fault. Preliminary results indicate that the aftershocks could be shallower, up to about 1 km depth or even reach the surface. The surface waves detected for some of the located events, together with their P-onset, suggest that these events are very shallow. Our relocated events define two quasi-perpendicular, intersecting faults dipping from NW to SE and NE to SW, respectively. The second fault corresponds probably to the mainshock and reaches the surface at a place where fault outcrops were reported.

We are also investigating the crustal structure in the area, focusing on the 2D structure along the linear array (perpendicular to the fault). We have already detected possible reflected/converted phases on seismograms of events recorded by the NIED array. Such phases could bring more information on the fault geometry and velocity discontinuities in the area. We will determine the focal mechanism solutions for the well-observed earthquakes to further investigate the complex faulting in the region.