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Deep seismic profiling across the Niigata basin and Sado island, central Japan: 2009 Aizu-Sanjo seismic survey

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In the fold-and-thrust belt along the along the Japan Sea coast of northern Honshu, devastative earthquakes, such as 1964 Niigata (M7.5), 2004 Chuetsu(M6.8) and 2007 Chuetsu-Oki(M6.8) earthquakes, occurred by reverse faulting. To investigate seismogenic source fault is important for better estimation of strong ground motions and mechanisms of earthquake occurrence. However, due to thick Neogene sediments, relationship between active faults/folds at near the surface and deep sited seismogenic source faults is poorly understood. Multi-disciplinal research project to understand the structure and crustal deformation processes along this zone of high-strain rate started in 2008 as a five years project.
In 2009, we conducted the deep seismic profiling to reveal the geometry of active-seismogenic fault systems across the western part of the Echigo Mts., Niigata basin and Sado island. The length of seismic line is 135 km. In the seismic survey, four vibroseis trucks, air guns (3,020 cu in.), and 100 kg explosives (4 sites) were used as seismic sources. At the Sado strait, two-ships seismic reflection survey was carried out; a ship towing 2-km-long streamer cable and small air-gun (480 cu. In.) and the other ship with 3,020 cu.in.). By changing their offset distance, we produced shot-gathers more than 10 km receiver spread. At the eastern part of Sado strait, a 6-km -long bay cable was deployed and onshore-offshore seismic signals were recorded by this cable. Along a 135-km-long seismic line, about 698 vibroseise shots, 285 air-gun shots, 16 high energy shots up to 100 stationary sweeps at each shot point by vibroseis trucks and air-guns, and 4 explosive shots were recorded by commonly 50 m spacing receivers, including ocean bottom cable, a cable-linked recorder and off-line recorders. We used 2417 channels. The seismic data were acquired in September 2009. Common Mid-point reflection analysis, low-fold stacking of high-energy shot records and diving wave tomography were carried out. Diving wave tomography revealed the P-wave velocity structure beneath the Niigata sedimentary basin down to 10 km. In the Niigata sedimentary basin, deep geometry of active faults, such as the Tsukioka fault, the fault of eastern flank of Niitsu anticline and the western boundary fault of the Nagaoka plain, are clearly demonstrated. These are west-dipping reverse faults at moderate angle and were formed as normal faults associated with the opening of Sea of Japan. These are active faults and their onset timing of reverse faulting is identified by growth strata and well data. The fault systems of Sado island are also marked by west-dipping Miocene normal fault. However, the east-dipping thrust was newly formed at the edge of Miocene normal fault. Basin development and fault evolution along the seismic line will be presented.