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Development of active folding in the back-arc thrust belt, eastern part of the Niigata Basin, central Japan

Naoko Kato (1), Hiroshi Sato (1), Susumu Abe (2), Tatsuya Ishiyama (1), and Shin Koshiya (3)

(1) Earthquake Research Institute, University of Tokyo, Tokyo, Japan (naoko@eri.u-tokyo.ac.jp), (2) JGI Inc., Tokyo, Japan, (3) Iwate University, Morioka, Japan

The Niigata basin is located along the Japan Sea coast of the central Honshu and characterized by thick (max. 8 km) Neogene back-arc sediments and arc-parallel folds-and-thrusts. Thrust faults in the basement have been generated devastative M7-class earthquakes frequently. For precise estimation of strong ground motions, geometry of source faults is crucial. However, due to thick sediment cover, the relationship between active folding and seismogenic source fault is poorly understood. We performed deep and shallow high-resolution seismic reflection profiling across the eastern boundary fault of the Echigo plain at two seismic lines; 2008 Sanjo-Yahiko and 2010 Higashiyama-Mishima seismic lines. Both deep seismic surveys were revealed deep crustal architecture using air-guns and vibroseis trucks (Sato et al., 2010; 2011, EGU abstract). Shallow high-resolution seismic reflection data were acquired at the toe of the thrust-system along the deep seismic lines using Mini-vib (IVI T15000) and Enviro-vibe. By combining the deep and shallow seismic data, seismic sections portray the image of shallow to deep geometry of the fold-and-thrust system. Subsurface geology was interpreted based on seismic sections, velocity profiles, surface geology and borehole data.

The eastern boundary fault of the Echigo plain is imaged as an eastward dipping thrust in both seismic lines: Sanjo in north and Yukyuzan in south. Deeper extension of thrusts is clearly demonstrated down to 7 and 4 km by velocity profiles obtained by refraction tomography and narrow east-dipping reflectors. In both sections, the faults are blind thrusts with wedge-thrust. Style of deformation of hanging wall is different, reflecting the depth of detachment. In the Sanjo section, depth of detachment is 1 km and is marked by intense folding with shorter wavelength. The wavelength of folds in the hanging wall becomes shorter to the front of the thrust, suggesting the interaction between gravelly layers on the footwall and relatively weaker mudstone on the hanging wall. In the Yukyuzan section, the depth of detachment is 3.5 km and a broad anticlinorium is developed on the hanging wall. The important factor to control the style of deformation is a depth of detachment. In case of this basin, detachment is commonly accommodated in the Teradomari Formation, which is known as over-pressured mudstone (Imamura, 2000). Thus the distribution of the formation is essential. Secondary, the young fluvial sediments behave as a competent layer against hanging wall mudstone unit and controls style of folding on hanging wall blocks. Such information is important to estimate the geometry of source fault from the geologic structure based on surface and shallow subsurface geology.