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Deep seismic profiling across the fore arc of central northern Honshu, Japan: Soma-Yonezawa seismic line

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The 2001 Tohoku earthquake (M9) produced large amount of crustal movements and stress changes. To evaluate the post seismic crustal activity, we have to construct a numerical model, which include lithospheric structures and receiver faults. For the sake of constructing a physical model, we performed deep seismic reflection profiling under collaboration with JAMSTEC. The seismic line starts from volcanic front and ends at the outer rise of the Japan trench. In this paper, we describe the only onshore upper crustal structure obtained by onshore survey. Along the seismic line, the Futaba fault and the western boundary fault of Fukushima basin are distinctive active faults.

The Futaba fault is located along the Pacific cast of southern part of Northern Honshu and continues at least 100 km. Based on tectonic morphological research, its central part show the active tectonic features. Due to the effect of M9 Tohoku Oki earthquake 2011, the evaluation of Coulomb stress changes on the fault surface is concerned for the assess of seismic hazards. To investigate the deep geometry of seismogenic source fault and basic crustal structure, we performed deep seismic reflection profiling along the 60-km-long seismic line across the Futaba fault. The seismic data were obtained using four vibroseis trucks and 2500 channel recorders. The seismic section portrays the half graben filled by1000-m-thick lower Miocene fluvial sediments, suggesting that the Futaba fault reactivated as a west dipping normal fault during the early Miocene associated with opening of the Sea of Japan. On the hanging wall of the Miocene normal fault, Mesozoic metamorphic rocks are cropping out forming a narrow range parallel to the fault. On the footwall of this range, footwall shortcut thrust is clearly identified by the deformation of Plio-Pleistocene sediments on the seismic section. The deeper extension of the Futaba fault can be traced down to 4.5 seconds (TWT) and sub-horizontal reflectors are developed around 6-7 seconds (TWT). The dip angle of the Futaba fault in the seismogenic zone is about 45 degrees. The footwall shortcut thrust was formed at the shallow high-angle part of the Futaba fault as a low-angle (30 degrees) reverse fault. The formation of half graben is limited along the northern part of this fault system. The footwall shortcut thrust was developed along a 40-km-long segment only accompanied with the Miocene half graben. The southern segment of the surface trace of the Futaba fault suggest a straight geometry may represent a change in dip angle.

The western boundary fault of Fukusghima basin (WBF) is marked as an eastern margin of the back-arc rift basin in early Miocene. Later, due to arc perpendicular compression, it reactivated as a reverse fault. For the deeper extension of this fault is recognized as west-dipping reflectors at moderate angle down to 3 sec (TWT).

Keywords: Futaba fault, seismogenic source fault, seismic reflection profiling, P-wave velocity structure, western boundary fault of Fukushima basin, northern Honshu