

Deep seismic reflection profiling across the northern Fossa Magna, central Japan

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The northern Fossa Magna (NFM) is a back-arc rift basin produced in the final stages of the opening of the Sea of Japan. It divides the major structure of Japan into two regions, NE and SW Japan. The Itoigawa-Shizuoka Tectonic Line (ISTL) bounds the western part of the northern Fossa Magna and forms an active fault system that displays one of the largest slip rates in the Japanese islands. The eastern rim is bounded by the Shinanogawa fault system, which produced the Zenkoji earthquake of 1847 (M7.4). We carried out deep seismic reflection and refraction/wide-angle reflection profiling across the northern part of NFM in order to delineate structures in the crust, and the deep geometry of the active fault systems. The seismic data were acquired using four vibroseis trucks, explosives (4 locations, 100 kg). We further applied refraction tomography analysis to distinguish between previously undifferentiated syn-rift volcanics and pre-rift Mesozoic rock based on P-wave velocity. The 60-km-long velocity profile suggests 5-km-thick Miocene basin fill beneath in the NFM basin. The thick argillaceous basin fill was strongly deformed by compression since the Pliocene. The shortening deformation is marked by fault-related folds and detachment folds. The middle Miocene over pressured mudstone forms detachments within a basin fill. Geologic reconstruction based on the seismic section suggests that the NFM basin was formed by east dipping normal fault systems. Western edge of the NFM basin is formed by the ISTL and Otari-Nakayama fault. The vertical offset of the Otari-Nakayama fault is several times larger than that of ISTL. Thus, the Otari-Nakayama fault and its northeastern extension, played an important role for the formation of NFM basin. Due to reactivation of normal faults as reverse faults, Miocene major normal faults forms seismogenic source fault. The Shinanogawa fault system, which bounds the eastern rim of NFM basin, is estimated to form a wedge thrust with deep-sited eastward-dipping fault. The distribution of strong seismic intensity area accords well to such wedge thrust geometry.

Keywords: fold-and-thrust belt, source fault, Northern Fossa magna, deep seismic profiling, active fault, 1847 Zenkoji earthquake