Bathymetric, Sub-surface, and Gravity Survey off the Sada-misaki Peninsula

*Toshiya Fujiwara[1], Toshiya Kanamatsu[1], Takafumi Kasaya[1]

1. Research and Development Center for Earthquake and Tsunami, Japan Agency for Marine-Earth Science and Technology

We conducted a bathymetric, sub-surface, and gravity survey off the Sada-misaki Peninsula in the Seto Inland Sea aboard the R/V Shinsei-maru KS-16-E01 cruise (June 27: Yokosuka - July 2, 2016: Yokosuka). The objective of the survey is detailed mapping and collection of basic information about the Median Tectonic Line (MTL) active fault zone. The western end of the active fault zone is inferred to be located in the Seto Inland Sea.

The survey area is situated ~1 km from the coastline of the tip of the peninsula, and is extended ~8 km in the north-south direction, ~11 km in the east-west direction. Main survey lines were directed in the northwest-southeast. The line interval was ~280 m. The sub-surface survey was conducted every five lines, thus the line spacing was ~1400 m. The survey ship speed was ~8 knots for the bathymetric survey and ~4.5 knots for the sub-surface survey.

The bathymetric data were collected using a SeaBat 7125SV2 (200 or 400 kHz) multibeam echo sounder. During the cruise, nine XBT measurements were made to replace the water column sound velocity continuously. Tide level correction was applied using the data at the Matsuyama tidal station. As the result, detailed bathymetry was obtained. The sub-surface data were collected using a sub-bottom profiler Kongsberg TOPAS PS18 (Primary 15-21 kHz, Secondary 0.5-6.0 kHz). Shipboard gravity measurement was carried out using a Micro-g LaCoste Air-Sea Gravity Meter System II (S-177). Shipboard gravity data were tied to absolute gravity values at calibration stations in JAMSTEC Yokosuka before and after the cruise. No drift correction was applied because no drift was observed. Free-air gravity anomaly was calculated by subtracting the gravity formula of the Geodetic Reference System 1980. Crossover errors yield an RMS standard deviation of 1.79 mGal. Bouguer gravity anomaly was calculated by subtracting the predicted gravity effects of seafloor bathymetry obtained in this cruise. Assumed crustal density is 2.67 g/cc (2670 kg/m^3).

Water depth ranges from 60 to 120 m in the survey area. In the eastern side of the survey area, the bathymetry is characterized by sand wave and mega-ripple structures. A wavelength of the sand waves is ~200 m and a wave height is ~20 m, and the mega-ripples have a wavelength of ~40 m and a wave height of ~3 m. These structures are thought to be formed and maintained by strong tidal currents. In the eastern side of the survey area, the seafloor is rather smooth without the sand wave growth. Uneven topography is probably reflected by the MTL active fault zone previously reported (Geological Survey of Japan active fault database). A depression is considered to be formed by lateral fault movements. Our survey was conducted soon after the 2016 Kumamoto earthquake, but no topography like sharp scarps (surface faults) suggesting recent fault activities was found (Kanamatsu et al., 2017).

In the eastern side of the survey area, sub-bottom profiles were obscure. The sand sedimentary layer might have hampered the acoustic wave penetration. In the western side of the survey area, acoustic wave reflections interpreted as a boundary between Quaternary and Pleistocene were identified (e.g. Nanayama et al., 2002).

Our gravity anomaly is consistent with previous gravity studies (Koizumi et al., 1994; Ohno et al., 1994; Geological Survey of Japan, 2000; Nawa et al., 2008). The MTL is associated with a steep gradient zone of gravity anomaly. There is positive anomaly along the shoreline in the southeastern side, and the gravity anomaly decreases across the tectonic line to negative gravity anomaly in the northwestern side. Even in our high-resolution survey, the gravity anomaly shows quite a two-dimensional pattern. Even in the high-resolution gravity survey with slower speed of 4.5 knots, shorter-wavelength (less than several hundred meters) gravity anomaly was not observed. It suggests small or no spatial variation of density anomaly in the shallow layer. The longer-wavelength gravity anomaly reflects a deeper basement structure. Our survey could refine the gravity anomaly shape more accurately. Compared with the previous study’ s profiles, our gravity profiles normal to the MTL look slightly convex downward. The crustal structure off the Sada-misaki Peninsula is interpreted that the Ryoke metamorphic rock belt bordered with the Sanbagawa metamorphic rock belt slid down by listric faults, formed a half-graben, and a sedimentary layer filled the graben (e.g. Yusa et al., 1992). Our gravity profile convex downward supports the half-graben structure formed by the listric curving fault.

Keywords: Sada-misaki Peninsula, Median Tectonic Line, Sand Wave, Bathymetry, Sub-bottom Profiling, Gravity Anomaly

