Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SCG68-09 Room:502 Time:April 30 11:15-11:30

Geologic structure in and around the Beppu Bay estimated by gravity analysis

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Seismic profiling in the Beppu Bay and the Bungo Straight performed by Kyoto University and JGI inc. from 1988 to 1990 (Yusa et al., 1992) raised new progresses of studies on the geologic structure of the Median Tectonic Line (MTL) in Kyushu and the development of the Beppu Bay Sedimentary Basin (BSB) accompanying it (Yamakita et al., 1995; Ito et al., 1996). The P-wave velocity assumed by Yusa et al. (1992) for the rocks in Ryoke Belt, however, was too low for granitic and metamorphic rocks constituting this Belt, and it is likely that the dip of the MTL beneath it was underestimated. Besides, the structure of the basin in the innermost part of the Beppu Bay has remained uncertain because this part is located in the terminal part of the seismic lines. On the other hand, there are plenty of gravity data in and around the Beppu Bay (Yusa et al., 1992; GSJ, 2000; Gravity Research Group in Southwest Japan, 2001). It can be expected that these gravity data clarify the structure of BSB, combined with correct seismic profiles. Fortunately, a profile reprocessed with re-estimated P-wave velocity along the Bungo straight (J-line) was presented last year (Abe et al., 2013). Using this reprocessed profile and gravity data, we tried to determine the subsurface structure along the G-line of Yusa et al. (1992), trending N70E, 35 km long, from on-land area, across the Asamigawa fault (AF) and the Beppu Bay Central Fault (BCF), to the mouth of the Beppu Bay (Fig. A), occupied by Sanbagawa metamorophic rocks (Sm, ρ=3.0g/cm^3), Ryoke granitic and metamorphic rocks (Rk, ρ=2.8g/cm^3), lower (Bl, ρ=2.6g/cm^3) and upper (Bu, ρ=2.4g/cm^3) sediments of BSB. Assuming only the depth and form of the MTL estimated from the reprocessed profile of J-line and geologic constraints, and the position of the AF on the surface, we determine other subsurface structures to fit with the gravity data through traial and error (Fig. B). In this profile, the upper surface of the Ryoke basement almost coincides with that in the Yusa et al. (1992)'s profile. This fact suggests high reliability of this profile. We concluded the structure of BSB from this and Yusa et al.(1992)' s profiles as follows.

1. The innermost part of the BSB was formed by two listric normal fault systems, NE-dipping Asamigawa Fault System (AFS) and SW-dipping Beppu Bay Central Fault System (BCFS). Both systems formed roll-over structure in the sediments of BSB.

2. The AFS consists of three faults (I, II, III), which converge to the MTL. It is uncertain whether the fault AFS-II reaches the uppermost part of the sediments. The total amount of the vertical displacement of ASF may be up to 3000m, although it depends on the thickness of sediment in the SW-side on AF and the amount of erosion of Ryoke basement

3. Two faults BCFS-I and BCFS-II vertically displaced the bottom of the Bu in 250m and 150m respectively and reach the uppermost part of it, although it is difficult to recognize in this figure because of its highly reduced scale. Both, however, did not displace the bottom of the Bl (= the upper surface of the Ryoke basement).

4. BSB is inferred to be formed and developed by eastward movements of the hanging wall (Ryoke basement), strike-slip on the MTL and downward on the AF. The BCFS was secondarily formed in eastward moving sediments.

These results are almost concordant with the model of a strike-slip basin proposed by Yamakita and Ito (1999), which assume a not vertical but moderately dipping strike-slip fault with a releasing bend. This model ignored the effects of secondary listric normal faults in sediments, dipping toward the main oblique normal fault forming the oblique ramp, but they contributed to the development of BSB to some extent. Their effects, however, are rather small as indicated by the fact that they did not displace the basement.

Keywords: Gravity analysis, Beppu Bay, MTL, Asamigawa Fault, Beppu Bay Central Fault

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