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Subsurface structures of Toyama basin estimated by Bouguer gravity anomaly

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Toyama basin is a sedimentary basin formed after the opening of the Sea of Japan in the Miocene; it has a negative Bouguer gravity anomaly because its sedimentary layer is very thick. It is known that the geological structures of this basin from the Neogene to the early Quaternary were formed essentially by tilting toward the south, and those in the late Quaternary were formed by vertical movements of a surface rectangular block having a NE-SW direction. Consequently, a compressive regional stress field having the principal stress axis in the NE-SW direction is expected in the late Quaternary.

Our ultimate aim is to restore the basic structure of the Toyama basin by numerical modeling and to quantitatively describe the formation processes of this basin and its source. However, we do not have a regional subsurface structure model of the basin. In this study, we attempted to estimate the regional subsurface structure model of the Toyama basin by using the Bouguer gravity anomaly. Here, we used the Bouguer gravity anomaly database of Komazawa (2004).

The Bouguer gravity anomalies around the Toyama basin have the following characteristics:

1) A gravity low reaching -80 mGal exists in the southeast part of the study area, which corresponds to the southern part of the Hida Mountains and Matsumoto basin.

2) Both the Tonami plain and the Toyama plain, which constitute the Toyama basin, are characterized by a gravity low, and the Noto Peninsula is characterized by a gravity high.

3) There are high gradient anomalies in the first-order horizontal derivative of the Bouguer gravity anomalies around the boundary of the Noto Peninsula and the Tonami plain. It seems that these correspond to existing active faults.

4) In addition, a high gradient anomaly of the first-order horizontal derivative of the Bouguer gravity anomalies appears around the boundary between Toyama and Niigata prefectures, and its magnitude reaches 9 mGal/km.

To obtain information on subsurface structures from the Bouguer gravity anomaly, we applied spectral analysis to the gravity anomaly in the study area; we found that the gravity anomalies in this area could be explained by a four-layers model. The average boundary depths for each layer were 10 km, 6 km and 3 km, and the wavelengths due to each layer were 16 km or more, 5-16 km and 2-5 km, respectively. From the characteristics of the long?wavelength gravity anomalies, we estimated the following characteristic subsurface structures:

i) The gravity low in the Hida Mountains is attributed to local isostasy, and the Matsumoto basin is not a deep basin; its structure does not reach the lower crust.

ii) The Itoigawa-Shizuoka tectonic line around Itoigawa, which is the northern end of this tectonic line, is not a large fault; its bottom does not reach the lower crust.

iii) The high gradient anomaly around the boundary between Toyama and Niigata prefectures is caused by a large fault, the bottom of which reaches the lower crust. We anticipated that some of the fundamental structures of Toyama basin might be formed by the activities of this large fault.

[Reference] Komazawa, M., 2004, Gravity grid database of Japan, gravity CD-ROM of Japan, ver. 2, digital geoscience map P-2, Geological Survey of Japan, AIST.