Inversion method in gravity field using Genetic Algorithms supported by geologic information and its practicality

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Introduction

We have developed Inversion method using Genetic Algorithms (GAs) for gravity field to analyze underground structure. Inversion method in these fields potentially has the problems of uniquity of result and geologic rightfulness. To solve these problems, Genetic algorithms and geologic data are used for analysis. Geologic data provide constrain data and enable quantity analysis. GAs based inversion has several advantages compare with existing method based on least square method as follow;

(1)'True' result can be obtained in high possibility because initial model is not needed and result is searched from various possibility.

(2) Reliability is increased by check of uniquity in addition to resolution check.

(3) Geologic data are easily included for analysis.

As a case study, under ground structure of Horie Lowland is analyzed, which is northern part of Matsuyama Plain in Shikoku Islands; Horie fault as NS trending fault is indicated (Ichihara et al., 2004).

Methodology

346 stations of gravity values including newly observed data are used for analysis.

'True'Bouguer anomaly is calculated because density distribution above sea level is clarified by borehole data (Ichihara et al., 2004) and surface geology. The borehole data also clarify underground structure under the Horie Lowland without basement surface shape, which consist of sediments (5 units) and basement rocks (granites). These wet densities are measured as follow: 2.12g/cm3 in coarse sediment, 1.93g/cm3 in fine sediment, 2.61 g/cm3 in granite and 2.43 g/cm3 in weathered granite. Under these constrain data, we solve 2D and 3D underground geology around Horie Lowland Note that solved value is only basement surface depth distribution. Multi-Island GA is used for inversion algorithm.

Result and Discussion

As a result of 2D and 3D analysis, synthetic test are completely succeeded and results of multiple analyses are converged into one shape. It indicates that unique and reliable geologic model obtained by GAs based method. In addition with it, these results match with basement depths by the boreholes within 20% of error. Thus, this availability of this technique is proved in actual geologic modeling. 2D analysis result demonstrates the basement shape that have rapid inclined belt of basement surface, which is corresponding with fault plane by borehole investigation (Ichihara et al., 2004). The analysis demonstrates 32 degree toward east of the 'dip of fault' compare with 45 degree toward east more than 32 degree toward east by borehole data. Therefore, fault character can be demonstrated by this analysis method. This inversion technique has possibility to solve more complicated geologic structure by using other geophysical information and geologic information such as basement depth: they are used for check of result in this study.

Reference

Ichihara, H., S. Sakakibara and I. Ohno, 2004, Underground structure under the Horie Lowland by gravity anomaly and drilling data, northern part of the Matsuyama Plain, Northwestern Shikoku, Japan. Jour. Geol. Soc. Japan, 110, 746-757.