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

SGD22-P01 Room:Poster Time:May 1 18:15-19:30

Establishment of GSIGEO2011 (Japanese geoid model)

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Geospatial Information Authority of Japan (GSI) established Japanese geoid model ”GSIGEO2000”. The model has enabled a translation from ellipsoidal heights to orthometric heights in GNSS survey for triangulation points, which are positional reference for surveys in Japan. As a result, the model greatly has contributed to realize efficient control point survey. In order to expand utilization field of geoid model to height determination of third-order benchmarks by GNSS satellite positioning, GSI has established new Japanese geoid model ”GSIGEO2011” and reported here.

GSIGEO2011 has established as a hybrid geoid model of a gravity geoid model and observed geoid height data. New Japanese gravity geoid model, JGEOID2008 (Kuroishi, 2009), is adopted as the base model, and least square collocation method is adopted to fit the model to observed geoid height data obtained at over 750 GNSS-based control stations all over Japan. In order to utilize for height determination of third-order benchmarks, residuals between the model and input observed geoid heights are set to 2cm in standard deviation. JGEOID2008 is greatly improved at reduction of local systematic errors which are contained in older gravity geoid models. Therefore, short wavelength components in geoid are well described and fit to observed data, and as a result, the accuracy of the hybrid model is improved.

The 2011 off the Pacific coast of Tohoku Earthquake caused huge crustal deformation in an wide area around eastern Japan. GSI urgently conducted control point surveys for restoration and opened the result for eastern Japan. GSI also conducted geoid surveys for GNSS-based control points which is located in an area experienced huge crustal deformation, and the results have been utilized for the input geoid heights data of GSIGEO2011. Therefore, GSIGEO2011 is consistent with the revised survey results in eastern Japan.

GSI has published newly established GSIGEO2011 and tired to realize height determination of third-order benchmarks by GNSS survey referring GNSS-based control points which have orthometric heights. This challenge is expected to drive further improvement in efficiency of survey procedure in Japan.

Keywords: GSIGEO2011, Geoid model, survey results

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The Japan Gravity Standardization Net 2013 (JGSN2013)

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Geospatial Information Authority of Japan (GSI) have established new gravity standardization net, the Japan Gravity Standardization Net 2013 (JGSN2013), from the latest absolute and relative land gravity data which covers Japanese islands. GSI already established and published the Japan Gravity Standardization Net 1975 (JGSN75), which is consistent with the International Gravity Standardization Net 1971 (IGSN71). JGSN75 have been officially referred as Japanese gravity standard.

JGSN2013 have been established by combining gravity data obtained from primary-order absolute gravity survey and first-order relative gravity survey. In Tohoku area, at least one gravity survey was done for each gravity benchmark after the 2013 off the Pacific coast of Tohoku Earthquake. Therefore, the gravity survey data include gravity change caused by the earthquake.

JGSN2013, which is the second Japanese gravity standard net established by GSI, have achieved great improvement in accuracy and special coverage by adopting FG5 absolute gravity meter as an instrument, updating station coordinates to ITRF2008 and modifying tidal correction procedure to more consistent manner through all process. As a result, JGSN2013 have a capacity not only to contribute to monitoring of earth gravity filed, which is promoting by GGOS, but also to be registered to international absolute gravity database (AGrav), which is operated as a joint project by IAG IC-WG2.1 and IGFS. The establishment of JGSN2013 is reported in the paper.

Keywords: The Gravity Standardization Net, JGSN75, JGSN2013

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SGD22-P03 Room:Poster Time:May 1 18:15-19:30

Calibration of the superconducting gravimeter iGrav10 by parallel observation with the absolute gravimeter FG5 #217

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An iGrav superconducting gravimeter (SG) was re-installed in the Farnsworth field, TX for the purpose of studying the effects of CO2 injection at an enhanced oil recovery (EOR) site in December 2013. Usually the iGrav SG has an ultra-low drift of less than 0.5 microGal / month and a virtually constant scale factor. Empirically, the drift rate looks negligible using the TSoft program. However observed trend contains the drift-like component which is about 0.4 microGal / day. Strictly it is difficult to distinguish real gravity changes from time-varying instrumental drift. We made co-located measurements with the FG5 absolute gravimeter (AG) in middle of December 2013 and middle of January 2014. The gravity differences between the two periods was determined to be +1 +-2 microGal by the AG measurements, whereas -12 microGal by the SG measurements. The observed drift of the SG was much larger than the specified value, so that the SG was determined to be reset and is improved. Generally it takes at least six months to evaluate such low drift of less than 0.5 microGal / month using co-located measurements with AG. Another choice is parallel SG and SG measurements located in close proximity. We are planning such measurements at the Farnsworth site in 2014. This research is funded and supported by Ministry of Economy, Trade and Industry (METI).

Keywords: Superconducting gravimeter, iGrav, absolute gravimeter, FG5, parallel observation

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Densed gravity survey on the southeastern Kego fault system

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The Kego fault system is one of the active fault located in Fukuoka city, southwestern Japan. We have conducted densed gravity survey on the southeastern Kego fault systems. One of the purposes of the survey is to reveal the location and detailed shape of the active fault syatem. We have measured gravity value at 721 points using Scintrex CG-3+ and CG-5 gravimeter. The measurement point interval was arranged as about several tens to hundreds meters. The measured gravity values were processed with a series of correction (height, drift, tidal, the free-air, the Bouguer and terrain) in order to obtain a gravity anomaly map. We determined the Bouguer density of 2.47 g/cm^3 using an objective Bayesian approach (Murata, 1993).

According to the gravity anomaly map of the Fukuoka City area that consists of not only our gravity data but also the gravity data of other institutions, the gravitational basement, which has a high density and affects to the gravity anomaly, is thought as Paleozoic Sangun metamorphic rocks and Cretaceous plutonic rocks (Sawara Granite, etc.) (Karakida et al., 1994). And a clear low gravity anomaly extension that has a strike of NW-SE is detected and coincides with the location of Kego Fault confirmed by a trenching survey (Shimoyama et al., 2005).

We will report the result of a three-dimensional analysis using GRAV3D ver. 3.0 (Li and Oldenburg, 1998).

Keywords: Densed gravity survey, active fault, gravity anomaly

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Crustal thickness deduced from a three-dimensional gravity modeling with seismic survey results

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The Japan Coast Guard (JCG) has conducted multichannel seismic reflection and refraction surveys as part of the Continental Shelf Survey from 1983 through 2008 in the area from the northwest part of the Pacific plate to the Philippine Sea plate. On the other hand, it has also conducted marine gravity surveys in the same area and possesses enormous amount of gravity data. We calculate crustal density distribution by applying the three-dimensional gravity inversion method (Ishihara and Koda, 2007) using these data.

This method has performed in the following procedures: First, an initial density structure model constituting of seawater, sediment, crust and mantle is made by interpolation of seismic survey results with reference to a gravity distribution. Second, gravity anomalies are calculated using the initial model. Mantle Bouguer anomalies are calculated by subtracting a constant, which depends on the regional structure, from the differences between observed and calculated gravity anomalies. Finally, the Moho depths are obtained by inversion analysis to minimize the mantle Bouguer anomalies. We can estimate the crustal thickness distribution in this way.

It confirmed that the above method improves the initial model with the Moho depths due to velocity structure from refraction surveys, and that a more appropriate density structure model can be obtained.

In addition, it is necessary that whole structure depending on a sea area with the effects given by structure, such as a density and/or a thickness of sediment and/or lithosphere, should be considered if the effects of them are large. For example, in the case of the northwest part of Philippine plate, we found that the thickness of the lithosphere depending on its age strongly affects the result of the inversion. Therefore, we used the calculated gravity data after removal of variation for wave length than or equal to 400 km in order to remove effect given by the structure under crust.

We will report these revisions and the crustal thickness distribution in several sea areas. It is expected that gravity determination of the crustal thickness distribution in large sea area gives important clues on tectonic evolution of crust.

Keywords: gravity

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Estimation of the density structure beneath the Kanto Distinct, Japan, by 3-D gravity inversion

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We applied an improved gravity inversion technique by Bear et al. (1995) to rapidly invert Bouguer gravity data in Kanto District, Japan, for a 3-D density distribution as a source of the observed field. The technique estimates the density distribution within the source volume using a least-squares inverse solution that is obtained iteratively by singular value decomposition using orthogonal decomposition of matrices with sequential Householder transformations. The source volume is subdivided into a series of right rectangular prisms of specified size but of unknown density. This discretization allows the construction of a system of linear equations relating the observed gravity field to the unknown density distribution. Convergence of the solution to the system is tightly controlled by a damping parameter which may be varied at each iteration. Application to a gravity data set from Kanto District, Japan, has yielded a geologically reasonable result that agrees with published models derived from interpretation of gravity, magnetic, seismic, and drilling data.