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

STT58-P01 Room:Poster Time:April 30 18:15-19:30

The 3D magnetic imaging using the L1 regularization and variable selection procedure.

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Recently some new method to obtain 3D subsurface structure from the gravity or geomagnetic data were proposed. Some of them have a goal to obtain a stable and most simple model which reproduce the observed data in high accuracy. This is because, in generally, most of the traditional way of inversion for the potential data provides distorted or unfocused mages of real gravitational or magnetic structures. In this study, we propose a new method introducing a L-1 penalized least square procedure and tried to obtain a simple, and therefor high- resolution model.

Lasso(Tibshirani,1995) is a linear regression and variable selection procedure based on the L1 penalized least square. L1 penalty has a effect of shrinkage the value of regression coefficients which has only weak contributions to be 0. So, the Lasso does both continuous shrinkage and automatic variable selection simultaneously. On the other hand, Lasso has some limitations and restrictions. One of them is, at most Lasso algorithm can select nonzero variables of same number of observed data. So, in the case of $p << n$ problem, i.e. in the case of number of unknown regression coefficients (p) is larger than the number of observations(n), this algorithm cannot be adopted or overly shrinkage model will be obtained.To overcome this limitation, Zou and Hastie (2005) proposed a new L-1 penalized method named Elastic Net.This method is a compromise of the L-1 and L-2 regularization method with two control parameters. Using this method, we can treat $p << n$ problems in the framework of L-1 penalized method.

In our presentation, we will show the results of applying this method to the synthesized and real magnetic data.

Keywords: potential, geomagnetism, magnetic structure, L-1 norm regularization

STT58-P02 Room:Poster Time:April 30 18:15-19:30

Magnetic structure of the north part of Deception Island based on the aeromagnetic survey by a small unmanned airplane

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Aerial magnetic survey was carried out in the part of the flight project of the autonomous unmanned aerial vehicles (UAV). The project was incorporated with National Institute of Polar Research (Japan), Korea Polar Research Institute, Chile Antarctic Institute, Bulgarian Antarctic research and Spanish Antarctic team. Magnetic anomaly data were aquired over the northern part of Deception Island (within South Shetland islands) in Bransfield Strait. It was the first time to succeed to get the geophysical data by a long-flight unmanned aerial vehicle (UAV) in the area of Antarctica as already reported by our team. Due to the severe weather the flight was canceled over the southern half of the Deception Island and its surrounding sae area.

The flight altitude is about 780m averaged. The main survey lines are directed east-west and the intervals of the lines are about 1000m. Longest length of the main survey line is about 18km. Probably due to the unstable atitude of the UAV body by strong wind, some east-west lines are shortcuted regardless of pre-programmed 18km length courses. The flight courses were overlapped on the survey lines along the latitude of 62 degree 53 minute and the longitude of -60 degree 28 minute. On these lines each direction of the flight is opposite. Some unnatural unduration was seen around overlapped lines. These kinds of unduration are occurred due to the difference of the observed magnetic field on each line. These differences have to be corrected, now we have the torerable data for estimate the structure of the Deception Island.

Outstanding high magnetic anomaly is recognized over the eastern peak of the island. Preparing topographic digital data of the Deception Island and bathymetric data on surrounding sea area, we estimated the distribution and the intensity of magnetization.

Keywords: Antarctica, Deception Island, Unmanned Aerial Vehicle, Magnetic Survey, South Shetland Islands

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Three dimensional inversion for the Grounded Electrical-Source Airborne Transient Electromagnetic (GREATEM) data

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Previous studies conducted by the Grounded Electrical-Source Airborne Transient Electromagnetic (GREATEM) have shown that, this system is a promising method for modelling 3D resistivity structures in coastal areas, in addition to inaccessible area such as volcano, mountainous area covered by deep forest. To expand the application of the GREATEM system in the future for studying hazardous wastes, sea water incursion,geothermal exploration and hydrocarbon exploration, a 3D-resistivity modelling that considers large lateral resistivity variations is required in case of large resistivity contrasts between land and sea in surveys of coastal areas where 1D resistivity model that assumes a horizontally layered structure might be inaccurate. In this abstract we present the preparation for developing a consistent three dimensional electromagnetic inversion algorithm to calculate the EM response over arbitrary 3D conductivity structure using GREATEM system. In forward modelling the second order partial differential equations for scalar and vector potential are discretized on a staggered-grid finite difference method (Fomenko and Mogi, 2002, Mogi et al., 2011). In the inversion method the 3D model discretized into a large number of rectangular cells of constant conductivity and the final solution is obtained by minimizing a global objective function composed of the model objective function and data misfit. To deal with a huge number of grids and wide range of frequencies in air borne datasets, a method for approximating sensitivities is introduced for the efficient 3-D inversion. Approximate sensitivities are derived by replacing adjoint secondary electric fields with those computed in the previous iteration. These sensitivities can reduce the computation time, without significant loss of accuracy when constructing a full sensitivity matrix for 3-D inversion, based on the Gauss?Newton method (Han, N.et al., 2008).

Firstly, we started testing the algorithm in the frequency domain electromagnetic response of synthetic model considering a 3D conductor embedded in uniform half space. In the second step we tested more complex synthetic model, considering vertical contact between two different high and low resistivity quarter-spaces and a conductor embedded in a high resistive quarter-space. Frequency-domain computation is executed at frequencies of five equal logarithm spacings in one decade in the frequency range of (10^5-10^{-2}) Hz. After the computation, we transformed into time domain using FFT and compared forward value with inverted value.The inverted results in case of the simple model, appear to highlight a conductive zone of potential interest within the resistive region. In addition, in case of two quarter spaces model, it was able to the reveal the clear resistivity contrast between the two quarters spaces and highlight a conductive zone within the high resistive quarter space. Both of the forward and inverted models have almost the same EM response which can confirm the accuracy of the inverted method. The next step for preparing this algorithm will be using the field data from previous GREATEM surveys to demonstrate this technique

Keywords: 3D EM inversion, GREATEM, Numerical approximations, Airborne Electromagnetic

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An Advanced Method of Data Analysis for Gravity Exploration System on a Mobile Vehicle

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A model of ground structure is very important to estimate earthquake ground motions. Gravity survey is one of exploration methods. We can estimate ground structure by using information of gravity anomaly which comes from heterogeneous density structure of the ground. Generally speaking, there are high correlation between density and velocity structure of the ground. Thus, the gravity survey is comparatively easier than other exploration method to estimate the ground structure, so that it is very suitable for the aspect of the seismic hazard projection.

For gravity survey, spring-type relative gravimeter is usually used. This type of gravimeter can provide accurate data, however, it is very expensive and difficult to handle. Furthermore, it takes much time to obtain adequate data. We, thus, began to develop a simple and inexpensive sensor which can measure gravity anomaly on a moving vehicle, such as air, land, and sea vehicles, that is, airplanes, motor vehicles, and ships. In a case where a gravimeter is used with a moving vehicle, we may survey the gravity over larger area in shorter time than using conventional survey techniques.

Generally, the gravity should be measured with resolution of 10 micro Gal at least for survey to estimate ground structure. However, the signal obtained from sensor is contaminated by various noise such as vibration of a moving vehicle etc. This means that a sensor with high resolution and large dynamic range is required. This is difficult to realize because resolution and dynamic range are conflicting requirement. To solve this problem, we have developed a sensor with a new feedback system, which has high resolution and large dynamic range.The performance of this sensor is examined in this study, and we also propose a technique of data processing based on the combination of second order blind identification (SOBI) and Hilbert Huang transform (HHT) technique.For this two different type of observations are carried out.

First, we set the sensor statically in a tunnel to confirm whether the sensor can respond to the gravitational effects caused by earth tides. From this observation, it is found that the sensor is affected by atmosphere. The effect is can be removed by applying second order blind identification (SOBI).

Second, the ship survey is carried out.Through a technique of data processing based,the observed data provide quite good agreement with theoretical gravity in phase and period of the signal.

Keywords: gravity survey, Hilbert-Huang Transform, Second Order Blind Identification