Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

STT55-01 Room:203 Time:May 22 09:15-09:30

Volcanic plume measurement with UAV

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Volatiles in magmas are the driving force of volcanic eruptions and quantification of volcanic gas flux and composition is important for the volcano monitoring. Recently we developed a portable gas sensor system (Multi-GAS) to quantify the volcanic gas composition by measuring volcanic plumes and quantified volcanic gas compositions of actively degassing volcanoes such as Miyakejima, Asama and Aso. As the Multi-GAS measures variation of volcanic gas component concentrations in the pumped air (volcanic plume), we need to bring the apparatus into the volcanic plume. Commonly the observer brings the apparatus to the summit crater by himself but such measurements are not possible under conditions of high risk of volcanic eruption or difficulty to approach the summit due to topography etc. In order to overcome these difficulties, volcanic plume measurements were performed by using manned and unmanned aerial vehicles. The volcanic plume measurements by manned aerial vehicles, however, are also not possible under high risk of eruption. The strict regulation against the modification of the aircraft, such as installing the sampling pipes, also causes the difficulty due to the high cost. In order to avoid these difficulties, we are trying to apply the UAVs for the volcanic plume measurements.

The Multi-GAS consists of IR-CO2 and H2O gas analyzer, SO2-H2O chemical sensor and H2 semiconductor sensor and the total weight ranges 3?6 kg including batteries. The necessary conditions of the UAV for the volcanic plumes measurements with the Multi-GAS are the payloads larger than 3 kg, maximum altitude larger than the plume height and installation of the sampling pile without contamination of the exhaust gases. Since the exhaust gases contain high concentrations of H2, SO2 and CO2, its contamination should be avoided. Up to now, three different types of UAVs were applied for the measurements; Kite-plane (Sky Remote) at Miyakejima operated by JMA, Unmanned airplane (Air Photo Service) at Shinomoedake, Kirishima volcano, and Unmanned helicopter (Yamaha) at Sakurajima volcano operated by ERI, Tokyo University. In all cases, we could estimated volcanic gas compositions, such as CO2/SO2 ratios, but also found out that it is necessary to improve the techniques to avoid the contamination of the exhaust gases and to approach more concentrated part of the plume. It was also revealed that the aerial measurements have an important advantage of the stable background. The error of the volcanic gas composition estimates are largely due to the large fluctuation of the atmospheric H2O and CO2 concentrations near the ground. The stable atmospheric background obtained by the UAV measurements enables accurate estimate of the volcanic gas compositions. One of the most successful measurements was performed on May 18, 2011 at Shinomoedake, Kirishima volcano during repeating Vulcanian eruption stage. The major component composition was obtained as H2O=97, CO2=1.5, SO2=0.2, H2S=0.24, H2=0.006 mol%; the high CO2 contents suggests relatively deep source of the magma degassing and the apparent equilibrium temperature obtained as 400C indicates that the gas was cooled during ascent to the surface. The volcanic plume measurement with UAV will become an important tool for the volcano monitoring that provides important information to understand eruption processes. The measurement of the plume produced by large explosive eruptions, however, is not possible yet even with the UAVs because of the high concentration of volcanic ashes. As accumulation of bubbles is considered as the cause large explosive eruptions, the volcanic gas compositions are the key to understand these processes and further development is required to enable such measurements.

Keywords: Volcanic plume, Volcanic gas, UAV, Multi-GAS, Volcano monitoring

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STT55-02 Room:203 Time:May 22 09:30-09:45

A Development of Airborne Survey of Gravity and Magnetics on an Unmanned Helicopter and Its Data Processing

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It is important for the regional earthquake disaster prevention to make a model of ground structure and clarify the non-fairing nature of the ground in detail. For this purpose, gravity and magnetic surveys can be used to estimate the deep and vast velocity and density structures of the ground because of quick observations.

Nowadays, since these implements such as gyroscopes, accelerometers, computers and GPS measurement system are dramatically improved, observation system becomes much smaller and higher-performance. We now aspire to make observation system simple, which sensors installed directly on the career, then correct the observed data by post processing from the accurate posture data. Furthermore, the new accelerometer sensor “D-servo,” which has enough dynamic range for the carrier disturbance and resolution for detection of gravity anomaly had been developed as shown in Yokoi et al.(2012).

To discuss the sensitivity and practicability of the exploration system, airborne survey has been carried out. We set the observation system on an autonomous-cruise-type uninhabited helicopter and navigate it over a huge concrete gravity dam, which makes large gradient in gravity, with some magnetic body as flood spillway. By means of GPS data of each cruise, theoretical gravity is calculated from terrain model made of 50m-mesh rectangular parallelepiped which height is altitude. Effects of stored water and dam itself are also considered.

As results from the observation, it is observed that sensitivity of the magnetic survey was quite well, though, inclination correction seems to be required for the gravity survey. For the accurate correction, we should consider some suitable way of the calibration of sensors. Improved method for gravity analysis is also proposed and the result has quite good agreement with theoretical gravity in phase and period of the signal. An mesurement and algorithm might be required to determine the accurate inclined angles for the correction as future development.

Acknowledgments: A part of this study is supported by JSPS KAKENHI (21671003).

Keywords: gravity survey, magnetic survey, airborne survey, unmanned helicopter, Hilbert-Huang transform (HHT)

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STT55-03 Room:203 Time:May 22 09:45-10:00

Aeromagnetic survey by a small unmanned airplane over northern part of Deception Island

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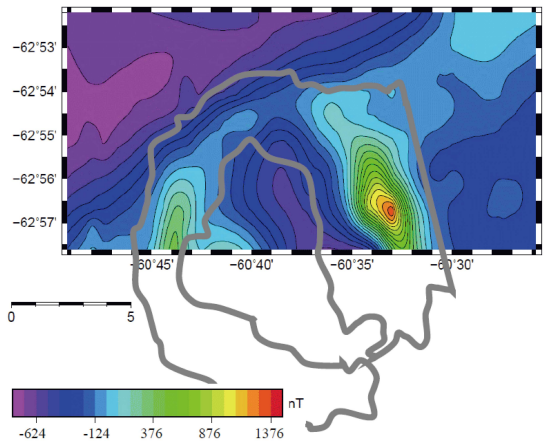
Part of the Scientific program incorporated with researchers in (Japanese) National Institute of Polar Research (NIPR), Korea Polar Research Institute, Chile Antarctic Institute, Bulgarian Antarctic research and Spanish Antarctic team, magnetic anomaly data were aquired over the Deception Island in Bransfield Strait. It was probably the first time to succeed to get the geophysical data by a long-flight unmanned aerial vehicle (UAV) in the area of Antarctica. Due to the severe weather the flight was only over the northern half of the Deception Island and its surrounding sae area.

Fig. 1 shows obtained magnetic anomaly, flight lines and coastline. 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 62deg53min and the longitude of -60deg28min. On these lines each direction of the flight is opposite. Some unnatural unduration can be seen around overrapped 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.

Standing high magnetic anomaly is recognized over the eastern peak of the island. Although we don't have precise topographic data of the Deception Island and bathymetric data on surrounding sea area, we will try to estimate of the distribution and the length of magnetization.

Keywords: Deception Island, aeromagnetic survey, unmanned aerial vehicle, fluxgate magnetometer



Japan Geoscience Union Meeting 2013
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STT55-04 Room:203 Time:May 22 10:00-10:15

Repeated aeromagnetic survey of Shinmoe-dake, Kirishima volcano, Japan, after the 2011 eruption using unmanned autonomo

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We conducted the highly resolved aeromagnetic surveys around Shinmoe-dake, Kirishima volcano twice by using the unmanned autonomous helicopter, when it was after the magmatic sub-plinian eruptions.

First survey was carried out in the end of May covering 3 by 3 km area of western Shinmoe-dake. The flight altitude is as low as about 100 m above the ground and spacing of flight lines are as close as almost 100 m. Total flight distance is about 85 km. The cesium optically-pumping magnetometer was installed by hanging below the helicopter to measure the geomagnetic total intensity. Due to this survey, we detected a large geomagnetic total intensity anomaly as 1000 nT. Using these data, the horizontal map of magnetization intensity was obtained beneath the survey area. We found the followings;

1) The average value of the magnetization is as low as 1.5 A/m;

2) Northwestern Shinmoe-dake has lower magnetization than average;

3) Strong magnetization appears the area corresponding the lava at the foot of Karakuni-dake.

Second survey was carried out about 5 months later than the first survey, in the end of October to the beginning of November, in order to detect temporal change of geomagnetic total intensity. By comparing both data, we could detected a dipole-like change as large as about $\pm$ 100nT around the crater of Shinmoe-dake. This change can explain by magnetization enhancement with 2.3 x 10^7 Am^2 in the crater. In the 2011 eruptions of Shinmoe-dake, a large pancake-like lava was found in crater with 1.5 x 10^7 m^3 (Nakada et al., submitted), and the cooling of this lava probably causes this magnetization enhancement.

Keywords: repeated aeromagnetic survey, unmanned autonomous helicopter, Shinmoedake

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Airborne surveillance using an unmanned autonomous helicopter at Tarumae volcano

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1. Introduction

Volcanic eruptions generally prohibit humans from approaching active craters. Meanwhile, it is important during an eruption to perform visual surveillance, geophysical measurements, material sampling in the vicinity of the craters. Besides scientific purposes, these are also useful in deciding emergency actions such as evacuation or recovery plans considering the ongoing volcanic activity and possible subsequences. We started airborne volcano surveillance using an unmanned helicopter on a trial basis in cooperation with the Hokkaido Regional Development Bureau since 2011. We performed the experiments at Mt.Tarumae (1,041m) in 2011 and 2012. As of 2012, the volcano was not erupting but showed persistent fumarolic activity around the summit lava dome. In this study, we report the results of the repeated aeromagnetic survey and an operation test of a material sampler.

2. Aeromagnetic surveys

We performed the first airborne magnetic survey in Sep. 2011. The vehicle flew on the programmed route in the autonomous flight mode with the aid of GPS navigation. The same route was intended to be flown in the second survey in Sep. 2012 aiming for detecting temporal changes. Although we partly failed to fly due to an unfavorable weather in the second survey, we recovered the data from important part across the lava dome. We compared the actual flight paths between the two surveys and found that the deviation was mostly within 10m. Meanwhile, the field gradient along the flight paths was generally within +/-1nT/m. Then we considered that +/-10nT was an error range in a direct comparison of the magnetic field between the nearest points from the separate datasets. Through this procedure, we obtained a systematic pattern of temporal changes with a p-p amplitude of approximately 30nT. The spatial pattern implying the cooling remagnetization beneath the dome was consistent with the recent result from the repeated magnetic surveys on the ground by Hokkaido University and Sapporo District Meteorological Observatory, JMA. However, the observed amplitude was almost five times larger than the estimation from the ground-based remagnetization rate. Further careful investigations are necessary to identify the cause of this difference.

3. Material sampling

In the experiment in 2012, we also performed an operation test of a material sampling attachment in the vicinity of the base station. The gadget is reeled down from a winch on the fuselage. At a touchdown, the lock is released and the grab-bucket is shut. Because this system is originally designed for sampling solid pieces or muddy materials, we attached some double-stick tapes on the grab-bucket to collect ash grains, too. In our experiment, several pieces of pumice and lithic with a diameter of some centimeters were picked up as well as ash particles of some grams. Although we found some issues to improve such as the triggering sensitivity at a touchdown, the first test was generally satisfactory. When applied to a future eruption, the amount collected will be sufficient for analyzing the contribution of a fresh magma at an initial eruption stage.

4. Summary and conclusions

Through our two-year experiments, the unmanned helicopter was proved to be practically useful for volcano surveillance at Mt.Tarumae. In particular, autonomous flight proved a performance of positioning control within an accuracy of approximately 10m. This is an advantage in detecting volcano-magnetic changes from a direct comparison procedure. In application of this vehicle to a future volcanic unrest, it is practically important to find beforehand some candidate sites for a base station from which we control the helicopter, and to perform some preliminary operations to overview an undisturbed condition when a volcano is calm.

Acknowledgments: We express sincere thanks to Muroran and Sapporo Development and Construction Departments of the HRDB for the cooperation in the field experiments using their unmanned helicopter.

Keywords: Tarumae volcano, unmanned helicopter, airborne surveillance, geomagnetic field, temporal change, material sampling

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Case study of geotechnical estimation by GREATEM and a helicopter-borne magnetic survey over a tunnel construction site

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1. Introduction

Helicopter-borne geophysical explorations, such as a grounded electrical source airborne transient electromagnetic (GREATEM) method and a helicopter-borne magnetic survey (HMS), have recently become more common in surveys in geological investigation and monitoring of active volcano. These methods enable the rapidly and broadly measuring the characteristic values of the underground, and these methods allow the gathering of three-dimensional geological information. In this study, we used GREATEM and HMS to delineate the geological structures of long tunnel construction site planned in the northern side of Hokkaido pref., Japan and report the feasibility and effectiveness of these surveys to provide geotechnical information for tunnel construction.

2. Outline and Method

In this study, we conducted our surveys on a planned mountainous tunnel with a total length of 2.7 km long and maximum overburden is 380 m. Geological features of tunnel site is the Cretaceous sedimentary rocks extending north to south and is penetrated by serpentinite. The serpentinite is mostly distributed in the central part of the tunnel route, and sedimentary rocks are distributed in the eastern and western sides, respectively. Excavating through the serpentinite zone would raise various geotechnical issues, such as squeezing; therefore, it is very important that the distribution of serpentinite be detected. We describe the results of GREATEM and HMS, and compare them with those of geological ground surveys, two-dimensional electric resistivity prospecting (2DERP), controlled source magneto-telluric method (CSMT), magnetic survey at ground surface, borings, electrical logging (EL) and measured electrical resistivity (ER) of bore core samples performed in the same area by tunnel constructor.

3. Results

As the results of GREATEM, relatively high ER zones were mainly seen from the surface layer to a depth of 100 m and relatively low ER zones were distributed on tunnel elevation line. These tendencies are similar to results of 2DERP, CSMT and EL. As the results of ER by bore core samples, serpentinites, the massive type showed the highest resistivity value, followed by foliated and clayey types and sedimentary rocks in this order. Although relatively low ER zones were seen in the deeper section, high and low ER mixed layer zones and steep gradient part of ER zones, as the ER contrast zones, are present in the deeper section along the tunnel elevation line. These are estimated that low ER zones consist of a clayey layer or/and weak foliated serpentinite and sedimentary rocks. The massive serpentinites are probably distributed in relatively high ER zones. The geological conditions change at depths where correspond to existence of ER contrast zones were found in the GREATEM survey. When excavating a tunnel in these zones, one must pay attention to faults, fracture zones, unsymmetrical pressure zones due to geological condition changes, flowing groundwater, and similar factors.

As the result of HMS, magnetization map based on magnetic intensity (MI), applied upward continuing to 900 m above sea level, were delineated shown as low magnetization bodies (MB) on both sides of the tunnel site and high MB on its central part. The highly MB zones are almost identical to the distribution of serpentinites revealed in the geological map and the other geological investigation results. However, the MI distribution is not homogeneous in the direction of the geological structure underground. Therefore, it is only difficult to estimate the geological properties of underground based on MI.

The resistivity structure of deep sections determined by combination of GREATEM and HMS surveys are effective for the acquisition of basic data to predict potential geotechnical issues when excavating a tunnel. We will verify these results by comparison with clarified geological conditions after tunnel was excavated.

Keywords: GREATEM, HMS, Helicopter, Tunnel, Geological investigation

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Helicopter-borne EM survey over coastal areas inundated by the tsunami of March 11, 2011, in northeast Japan

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The Geological Survey of Japan, AIST conducted a helicopter-borne EM survey over inundated areas by the tsunami on March 11, 2011 in northeast Japan 15 months after the 2011 off the Pacific coast of Tohoku Earthquake. The purpose of the survey is to map the electrical resistivity of the ground intruded by seawater during the tsunami for its reutilization as farming lands and water assessment of the area.

The survey was flown in June 2012 at an altitude of 60 m above ground with a speed of 50 km/h along survey and traverse lines spaced 100 m and 1,000 m apart, respectively. The airborne EM system (Fuguro Airborne Surveys' RESOLVE system) was installed in a bird and towed 30 m below the helicopter. This is a frequency-domain system operated at five frequencies (340, 1,500, 6,900, 31,000, 140,000 Hz) in a horizontal coplanar configuration and at a frequency (3,300 Hz) in a vertical coaxial configuration.

The survey area is located at the border of Miyagi and Fukushima Prefectures along the Pacific coast in the southern part of the Sendai Plain and is divided into two sub-areas: Watari-Yamamoto-Shinchi area (area A) and Matsukawaura area (area B). The area A is known for its production of high-quality strawberries on beach ridges and much fresh groundwater has been used for irrigation of strawberries and warming of strawberry greenhouses by water curtain. However, the salinity of groundwater from shallow irrigation wells in this area increased dramatically after the tsunami (Mori et al., 2012). Since it still remains at high level, there is an urgent need to find new water resources. Whereas, the area B is characterized by a beautiful lagoon called the Matsukawaura which is preserved as one of prefectural parks of Fukushima Prefecture. Rice fields occupy the areas west of the Matsukawaura and most of them were covered by seawater during the attack of the tsunami. Desalinization of the rice fields is being conducted intensively to resume rice farming in these fields.

The observed electromagnetic data were processed and apparent resistivity maps were created for each frequencies. As for the apparent resistivity map at a frequency of 140,000Hz, very low resistivities less than 4 ohm-m are dominant over lagoons and river mouths along the coastline, indicating the existence of salt water wedge. Relatively low resistivities (8 - 22 ohm-m) range from close to the coastline up to 4km inland and are edged to the west by high resistivities (64 - 128 ohm-m), corresponding to the maximum inundated area as derived from aerial photos by the Geospatial Information Authority of Japan (2011). These low resistivities might be associated with the effect of seawater intrusions. As the frequency becomes lower, low resistivities areas ($<$ 8 ohm-m) extend to inland, indicating the existence of deep salt water wedges and/or fossil salt water. To verify the results by airborne surveys and confirm the groundwater environment, further studies will be done with shallow drillings as well as with time-domain EM and high-density electrical surveys on ground.

Keywords: airborne EM survey, resistivity, the 2011 Off the Pacific Coast of Tohoku Earthquake, tsunami, groundwater environment, salt damage

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Three-dimensional electromagnetic modeling of topographic effects on electromagnetic field induction by GREATEM surveys

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A grounded electrical source airborne transient electromagnetics (GREATEM) survey was performed at Kujukuri beach in central Japan, where an alluvial plain is dominated by sedimentary rocks and shallow water. A reliable resistivity structure was obtained at a depth range of 300?350 m both on land and offshore, in areas where low-resistivity structures are dominant (Ito et al., 2011). Another GREATEM survey was performed at northwestern Awaji Island, where granitic rocks crop out onshore. Underground resistivity structures at depths of 1 km onshore and 500 m offshore were revealed by this survey. The absolute resistivity found onshore was much lower than existing results. To circumvent this problem and understand the reason for the inaccurate results, we used a three-dimensional (3D) electromagnetic (EM) modeling scheme based on the staggered-grid finite-difference (FD) method (Fomenko and Mogi, 2002) to study the effects of oceanic saltwater (or the sea effect) on EM field induction when conducting GREATEM surveys at coastal areas with topographic features. Topography in our model was represented as an anomaly (1E-8 S/m) in the air layer. We selected a 3D-topographic model consisting of a topographic feature (1E-2 S/m) placed on top of a uniform half-space earth medium (1E-3 S/m). The resistivity contrast was 1E+6 times between the air and the topography. In the topographic area we used X: 50 x Y: 50 x Z: 25 m cells. Outside the topographic area, irregular cells were used. The total number of nodes was 52 x 38 x 32 = 63232 cells. The computation was done for four topographic slope angles (90, 45, 26.5 and 14 Degree). A horizontal electric dipole source was directed along the y-axis situated at the origin (x = -1500)

The most significant effect of topography on EM field induction occurs at low flight altitudes and gradually decreases with increasing the flight altitude. The topographic effect of steep slope angles (e.g., 90 and 45 Degree) is higher than for gentler slopes (e.g., 26.5 and 14 Degree). Furthermore, the area of the topographic feature closer to the dipole source has a larger effect on EM field induction for several meters.

Keywords: Airborne EM,, coast effect, Topography effect, 3D resistivity modeling, GREATEM surveys

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Precise formula for horizontal acceleration correction and method for its effective use

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We provide a precise formula for horizontal acceleration correction and discuss a method for its effective use in airborne gravity measurements using the SEGAWA airborne (helicopter-borne) gravimeter.

In order to determine a gravity anomaly from the observed acceleration data using a gravimeter, it is necessary to perform vertical acceleration correction, Eotvos correction, normal gravity correction, free-air reduction, and horizontal acceleration correction. These corrections (with the exception of the vertical acceleration correction and horizontal acceleration correction) each have precise individual formulas. The precise formula for the horizontal acceleration correction has not yet been presented because it is considered to be an optional correction. In fact, horizontal acceleration correction is unnecessary if the gravimeter sensor remains vertical at all times.

In previous horizontal acceleration corrections, the equations that give the component acceleration vectors acting on the gravimeter with a platform off-level angle and that give the off-level angle of the platform were linearized. Of course, the linearization of the equations is a valid technique for simplifying calculations and for finding the essence of the problem. In the present horizontal acceleration correction, the linearized equations are normally used because the off-level angle is generally kept very small using a gyroscope. However, this equation cannot deal effectively with sudden large acceleration changes caused by turning which changes the measurement profile.

In this study, we first provide the precise formula mentioned above for horizontal acceleration correction without linearization and evaluate the effects of the nonlinear terms in a new solution. In addition, we suggest a method for estimating the true values of the gravity and the off-level angle by successive iteration because our equation requires the true values to estimate the correction amount by deriving the true gravity value and the off-level angle.

Keywords: Aieborne gravity measurement, Horizontal acceleration correction, Precise formula for horizontal acceleration correction

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Denoise of Severely Contaminated Gravity Anomaly Data Using Statistical Independence of Source and Perturbation Signals

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1.Introduction

Gravity anomaly, which is caused by the spatial distribution of stiff (heavy) layer, is used for the estimation of ground structure. For the improvement of usability and applicability, Morikawa et al.[1] has been working on the development of compact gravity observation system using force-balance (FB) accelerometer. It has a difficulty that the observed data is severely contaminated by various kinds of disturbances such as tilting motion of the carrier vessel. This report presents a scheme to extract the gravity anomaly signal from the noise-contaminated observed data, by exploiting the statistical independent property of gravity anomaly data and other perturbation signals. Although the final objective is to measure the gravity anomaly by using the air plane or some other aviation carrier, as a basic study of the research, this paper works on the results obtained by the ship in the Toyama Bay.

2.Methodology

As a scheme of considering independence of signals of source and other signals, blind source separation (BSS) techniques are used. Second Order Blind Identification method (SOBI)[2] separates signals from different sources by exploiting the statistical property of data. It separates the target source by assuming that source and unwanted data are un-correlated at various time-lags. Similar scheme is also implemented with the Independent Component Analysis (ICA), which separates the sources by maximizing the independence of linearly transformed observed signals. The method is referred to as ThinICA[3].

3.Data Observation

The presented schemes are applied to the data obtained by the field survey which was conducted at The Toyama Bay area, Japan. The carrier vessel was a middle size ship of 55 long. As the reference for comparison, we use the data generated based on the reliable data measured by AIST (National Organization of Advanced Industrial Science and Technology) by considering the Eotvos effect due to the location of the carrier and the free air anomaly, etc.

4. Results

It was found that application of low pass filtering (LPF) is efficient as a pre-process of observed data. Both SOBI and ICA worked well after the data is processed by low pass filter (LPF). As for the applicability of devices, combination of VSE data and vertical component of accelerometer Titan (Taurus-Z) were found to be suitable for our data set. It was also discussed that the motion of the carrier vessel influences the performance of noise removing algorithm. Under certain conditions, the proposed method was not able to salvage the gravity anomaly data from the observed data with the accuracy sufficient for the purpose of identification of gravity anomaly distribution. It was difficult, for example, to salvage the gravity data from the data obtained during the ship is stopped. Comparison of the LPFed observed data and the data extracted by the presented method using SOBI and ThinICA show that they are at acceptable level for the purpose of subsurface modeling. It would require, however, improvement for the application for the data obtained by the aviation carrier devices such as unmanned helicopter.

5. Conclusion

The noise removal method for the highly contaminated data to salvage the target data is discussed. The method is applied to the observed data from Toyama. It requires the condition for the mobility of carrier vessel. For the purpose of data obtained using the aviation device, considerable improvement of performance is required.

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Keywords: Gravity Anomaly, Independent Component Analysis

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Regularization of the aeromagnetic data using eigen-function expansion in Cartesian coordinate system

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The dominant upward- and downward-continuation technique used in the potential-field is the fast Fourier transform (FFT) technique. However, this technique is, in principle, only applicable to the regularized data obtained on a flat plane. So, for the data on irregular grid on an uneven surface, the inversion technique based on the equivalent sources is commonly used.

For the equivalent sources, dipole source is often used. In this case, the computational cost of inversion becomes large because the observation equation is represented by a dense matrix.

In this study, we design a continuation operator used for the direct continuation of the geomagnetic field data on irregular and uneven surface and developed an algorithm for calculating upward- or downward-continuation using the eigen function expansion based on the basic solutions of the Laplace equation defined on the Cartesian-coordinates. We apply the eigen function expansion to each rows of the coefficient matrix of the observation equation and subsequently threshold the matrix to generate a sparse representation in the wave number domain.

Keywords: aeromagnetic observation, upward continuation, downward continuation, regularization

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STT55-P06 Room:Convention Hall Time:May 22 18:15-19:30

Analysis of the magnetization intensity in Mt. Unzen using an air-borne magnetic survey data

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[1]OYO Corpration

We carried out airborne geophysical and LiDAR survey around the lava dome of Mt. Unzen, under a contract with Kyushu distinct Maintenance-and-Repair Offfice, Ministry of Land, Infrastructure and Transport.

Aeromagnetic and electromagnetic data was colleted during airborne geophysical surveys. The former was analysed by means of three-dimensional inversion techniques, and subsurface magnetic sutructure (magnetic-intensity distribution) to the depth of 1000m was derived. In addition, comapring with aeromagnetic data obtained at 1999 by the Shimabara Development and Protection Bureau, Nagasaki Prefecture, clearly showed the temporal change in the pattern of magnetic anomalies, which was also analysed by time-lapse inversion technique.

In this study, we reported the results of the above survey and analysis, with special attention to three-dimensional magnetic strsucture and its temporal change for about a decade.

Keywords: Airborne magnetic survey, Airborne geophysics, Three-dimensional inversion, Mt. Unzen, Lava dome, slope failure

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The airborne electromagnetic survey to the slope with high risk of deep catastrophic landslide in the Himekawa basin

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Including the collapse of Hiedayama, Himekawa basin has caused a number of deep catastrophic landslides in the past, and many landslides and large-scale collapse scars are distributed. Investigated based on the manual ”Extraction method of Mountain Stream trending to cause deep catastrophic landslide”, in the Ministry of Land, Infrastructure, Transport and Tourism, we announced the results of the evaluation level mountain stream. Relatively high risk streams are extracted in the Himekawa basin.

The technique evaluated from stereoscopic examination of aerial photographs or digital elevation models, and the evaluation technique using LiDAR data and etc. are studied to extraction of the slope with risk of deep catastrophic landslide. In order to acquire subsurface structure broadly and to acquire the information on the depth direction of deep collapse, the evaluation technique which used the airborne electromagnetic survey is effective.

In this research, airborne electromagnetic survey was performed as a target in the Urakawa up-stream basin and Otokorogawa middle-stream basin especially with high risk of deep catastrophic landslide among Himekawa valleys. We have carried out an understanding of three-dimensional resistivity distribution. Then, the drilling survey and borehole test were done to a certain specific slope, and it verified about the extraction technique of layer thickness with risk of depths collapse by comparing with the specific resistance distribution map by an airborne electromagnetic survey result.

Keywords: deep catastrophic landslide, airborne electromagnetic survey, resistibility, microtopography, saturation