Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

STT52-01 Room:102B Time:May 27 09:00-09:15

A feasibility study for geomagnetic measurements using the High Altitude LOng range aircraft (HALO)

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In June 2012 the High Altitude LOng range aircraft (HALO), originally acquired for atmospheric studies by the German Ministry for Research and Education, was used for a geophysical study. On board the aircraft were gravity, GNSSS reflectometry and geomagnetic instruments. The geomagnetic instrumentation consisted of two identical acquisition chains, each containing an Overhauser and a fluxgate magnetometer. They were mounted below each wing in under-wing canisters. For the first time, we were able to collect geomagnetic measurements with such a high and fast flying vehicle, covering a very large area in a short time period. The study was conducted during four flight days over the Italian peninsula. Due to the mounting of the instruments very close to the aircraft body, the measurements are strongly contaminated by the aircraft signal. Furthermore, the sensitivity of some of the scientific instruments on board HALO prevented large variations of the plane's pitch and roll angles during the calibration flight and thus a proper calibration of the vector magnetometers and the full determination of the aircraft signal. Nevertheless, we were able to obtain the long-wavelength part of the geomagnetic field in the study area and showed that geomagnetic measurements with HALO are possible and promising.

Keywords: aeromagnetics, geomagnetism

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FALCON AGG survey using Helicopter for geothermal exploration

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Airborne gravity surveys are applied to mineral and hydrocarbon exploration in Australia, Canada and other countries. JOG-MEC explored the geothermal potential of Kuju and Kirishima areas in Kyushu Island using FALCON^{TM} AGG (Airborne Gravity Gradiometry).

There are two airborne gravity methods of measuring gravity and gravity gradient. FALCON was developed from the basic AGG technique used by the US Navy and is operated at present by CGG Aviation. Gravity gradient maps show more detailed geological structures than gravity maps. HeliFALCON is the only heliborne gravity gradiometry system.

In the FALCON system, horizontal gravity gradients are measured using two sets of four accelerometers on a rotating disk mounted in an aircraft. Simultaneously, measurement location and topography is surveyed using GPS and a Laser scanner mounted on the aircraft. After tie line, terrain and micro-leveling corrections, differential curvature components G_{NE} and G_{UV} are calculated. Each gridded component is transformed to two-dimensional Fourier domain. In this domain, these components are integrated into components of the gravity gradient tensor and vertical gravity acceleration. Integrated components in spatial domain are estimated by using inverse Fourier transformation. Maps of the vertical gravity gradient component G_{DD} and the vertical gravity g_D are used to image geological structure. There is another method to estimate G_{DD} and g_D: Equivalent Source. In this method, an equivalent source is inverted from the measured G_{NE} and G_{UV} and then G_{DD} and g_D are estimated from it.

The Kuju and Kirishima areas, where geological and ground geophysical surveys around existing geothermal power plants have been applied were selected as the first stage of airborne geothermal exploration in order to validate the effectiveness of it. In both areas, data were acquired at line spacing of 250 m by drape flight under 120 m clearance to ground surface. The figure shows maps of G_{DD} and g_D in the infill area around Hatchobaru and Otake power plants in the Kuju area. Line spacing in the infill area is 125 m. NW-SE lineaments parallel to the dominant geological direction in this area and E-W lineaments crossing them are clearly delineated in the vertical gravity gradient map. In this project, the shape index representing gravity equipotential surfaces is estimated from the gravity gradient tensor. The shape index maps show geological boundaries more clearly than the vertical gravity gradient maps. Ground surface gravity had been surveyed with spacing beyond hundreds meters along roads and paths. The ground gravity data upwarded to the drape flight surface of HeliFALCON was compared with gD resulted from AGG. The maps of AGG's g_D are comprehensively the same as ground gravity maps, and delineate more detail than them.

The AGG investigates not only inaccessible areas with tough topography and dense vegetation, but also wide areas in detail and efficiently. Because ground gravity maps of wide areas are compiled with gravity datasets surveyed in different years, organizations and precisions, they have small differences among them. Because AGG's datasets in the same wide areas are surveyed with the same precision in one project result, they are more reliable than ground gravity datasets. On the other hand, ground gravity surveys in small areas can be surveyed more precisely, beyond the AGG survey limit. It is suggested that AGG is suitable for geothermal exploration because the datasets contain no long wave length components generated from deeper structures. AGG is expected to become widely used for not only geothermal exploration but also fault investigation and so on which gravity surveys have been applied.

Keywords: Airborne Gravity Gradiometry, geothermal exploration, Kuju area

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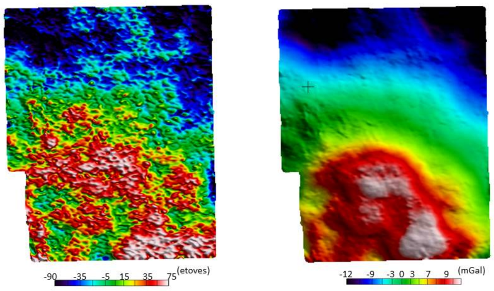

(b) Vertical Gravity Gradient (a) Gravity（g_D）

Fig. Outcome maps of HeliFalocon Airborne Gravity Gradiometry in Kuju infill area using Fourier transformation

STT52-03 Room:102B Time:May 27 09:30-09:45

Aeromagnetic 3D subsurface imaging of geothermal areas - A case of Akita-Yakeyama Volcano, northeast Japan

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Akita-Yakeyama Volcano is located at the northwestern edge of the Sengan Geothermal Area, northeast Japan, where many geothermal features such as fumaroles and hot springs are observed as well as many Quaternary volcanoes. In this area, geothermal explorations had been actively conducted since mid-1970s and four geothermal power plants are being operated now.

Magnetic analyses had been conducted in and around Akita-Yakeyama Volcano to reveal the regional and local subsurface structures of the area (Okuma, 1998; Okuma and Suto, 1987). A magnetic modeling, with known structural and magnetic parameters, had been conducted to reveal a detail subsurface structure of Akita-Yakeyama Volcano (Okuma, 1998). The magnetic model is composed of five polygons: three of them correspond to granitic intrusions below the northern flank, while rests of them correspond to the buried Old-Tamagawa Welded Tuffs below the southern flank. The northern polygons show the depth extent of the granitic intrusions or the local Curie isothermal depth. The southern polygons indicate a subsurface convex structure, implying the existence of a concealed old volcano associated with the Old-Tamagawa Welded Tuffs. These analyses were very useful to better estimate the subsurface structure related to the geothermal activity of the study area but it took much time to conduct the modelling.

Recently an aeromagnetic 3D subsurface imaging method has been developed (Nakatsuka and Okuma, 2014) and takes an important role in 3D visualization of subsurface structures especially in active volcanic regions (Okuma et al., 2009). Therefore we have applied the method to interpret the magnetic anomalies of Akita-Yakeyama Volcano. The resultant magnetization intensities were superimposed on the same cross-sections of the previous study. In the N-S cross-section crossing the summit of the volcano, magnetization highs are well imaged below the northern flank, corresponding to the granitic intrusions. Whereas, negative magnetizations lie below the southern flank and are associated with the reversely magnetized the Old-Tamagawa Welded Tuffs. In the E-W cross-section on the northern flank, magnetization highs are centered below the northwestern flank, suggesting higher subsurface temperatures than below the northeastern flank. Apparent negative magnetization intensities lie below Mt. Kurasawa south of Akita-Yakeyama Volcano and correspond to the wide distribution of the reversely magnetized Tamagawa Welded Tuffs (Suto, 1987).

Keywords: aeromagnetic survey, magnetic anomaly, geothermal area, Akita-Yakeyama Volcano, forward modelling, 3D imaging

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STT52-04 Room:102B Time:May 27 09:45-10:00

Case study of Volcano Survey using the Airborne Electromagnetic survey

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The distribution of the active volcanos as much as 110 are confirmed by Japan at present. The part of the volcanic collapsed at Mt. Ontake (1984) and Mt. Kurikoma (2008) in recent years, and large-scale sediment related disasters occurred. Then, serious damages occurred Mt. Aso (2012) and Izu-oshima (2013) by debris flow which were caused by the simultaneous multiple surface failure. On the other hand, risk management of low probability and high consequence disasters are the problems after the Great East Japan Earthquake, and understanding of the slopes tending to cause landslide is required in each volcano. Hence, the Ministry of Land, Infrastructure and Transport, has conducted volcano survey using the airborne electromagnetic survey from fiscal year 2013 at 15 volcanos out of 29 volcanos (Emergency Hazard Mitigation Measures Plan against Sediment Related Disaster Induced by Volcanic Eruption decision target volcano) where volcanic activity is active, and the social influence is serious.

In this study, we collected the results of volcano survey and extracted the slopes tending to cause landslide based on the topography, geological information and the structure of specific electrical resistance. Additionally, the sediment volume by landslides had been estimated.

A case will be introduced by this presentation, which are Mt. Hokkaido Komagatake, Mt. Azuma, Mt. Asama and Mt. Ontake.

Keywords: Airborne Electromagnetic survey, Volcano Survey, specific electrical resistance, topography, geology, active volcano

STT52-05 Room:102B Time:May 27 10:00-10:15

Aeromagnetic survey at Shinmoedake volcano by using unmanned helicopter in 2014

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1. Introduction

Shinmoedake volcano is one of the most active volcano in Japan, and had some sub-Plinian eruptions at the beginning of 2011. Now the eruptions cease and any apparent activity cannot be seen, but seismic activity and geodetic change are still observed near Shinmoedake volcano. It is important to monitor the volcanic activity for a long term by using various geoscientific measurements.

We have conducted surveys continually at Shinmoedake volcano by using unmanned helicopter since May 2011, after the eruptions. And very recently, our forth aeromagnetic survey was performed on 21st Oct. 2014.

2. Aeromagnetic survey

The aeromagnetic survey was conducted by using the unmanned helicopter YAMAHA RMAX G1. The magnetometer sensor of the total intensity was installed 4 m apart down from the helicopter in order to avoid the effect of the helicopter magnetism itself. The helicopter flied in the area of 3 km by 4 km which is western part of the Shinmoedake. The measurement line intervals were almost kept as 100 m, and also the flight altitudes above the ground were kept as about 100 m. The total measurement length is about 63 km.

3. Result

Obtained data of the magnetic total intensity shows the geomagnetic anomaly as large as about 1000 nT, which is almost the same as the previous surveys in general. Comparison of the data with the first survey data of May 2011 shows the notable anomaly around the crater of Shinmoedake volcano. The anomaly shows the dipole-like pattern which are the positive anomaly in the south and the negative one in the north. It indicates the magnetization occurs in the crater and the cooling down of the lava accumulating in the crater at the 2011 eruptions was inferred. The average magnetization intensity of the lava is estimated about 4.0 A/m, which is larger than the previous results.

Changes of the average magnetization follow a square root of an elapsing time, and thus the cooling of lava may be gradually done by the thermal diffusion, and is still going so far.

Keywords: repeated aeromagnetic survey, unmanned helicopter, Shinmoedake

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Study on the prediction of the large shallow landslides areas using Airborne Electromagnetic Survey

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In recent years, the investigations of deep-seated catastrophic landslides and volcano using airborne electromagnetic survey have been carried out. And, the study on prediction of sediment disasters occurrence areas gradually progresses. On the other hand, recently, many shallow landslides disasters including Hiroshima in 2014, Izu-Oshima island in 2013 and Nachi river basin in 2011were occurred. If we can predict the collapse occurrence slopes by using airborne electromagnetic survey, we can easily decide the priority of the constructions of sabo dams and make the evacuation systems. In this study, we nominated Nachi river basin where large shallow landslides were occurred in 2011 for an example and examined the difference of the ratio resistance characteristics of collapse and non-collapse slopes from the result of the airborne electromagnetic survey.

First, we arranged the relationships between geological features and ratio resistance properties. Because Nachi river basin is parted in the area of Kumano Acidic Rocks (granite porphyry) and the area of Kumano Group (sandstone mudstone alternative rock), we considered whether these were distinguishable by the ratio resistivity distribution. Next, we put the collapse slopes on the map of the distributions of the ratio resistivity and examined the ratio resistance of the collapse slopes. Final, we paid our attention to the structure of the contour of the ratio resistance and the change rate of the ratio resistance. We examined the difference of them about collapse and non-collapse slopes of Nachi river basin.

Kumano Acidic Rocks (granite porphyry) had high ratio resistance and Kumano Group (sandstone mudstone alternative rock) had low ratio resistance. As a result, we can express geological borders very well by airborne electromagnetic survey. In addition, we understood that the most of the collapse slopes were distributed near the geological border. From this, it is thought that collapses were occurred by the difference in geological properties of the plumb direction. About the difference of the collapse and non-collapse slopes, we found that the collapse slopes have vertical contours of the ratio resistance against the slope directions. And we found that the areas of the big change rates of the ratio resistance are disappeared at the upper parts of the collapse slopes about the collapse slopes. On the other hand, about the non-collapse slopes, we found that the contours of the ratio resistance were parallel with the slope directions and the area of the big change rates of the ratio resistance are continued at the upper parts of the slopes. The ratio resistance structure shows the structure of geological features. Because the contours of the ratio resistance of the collapse slopes are vertical, the geological structures of the collapse slopes are vertical and it is thought that Kumano Acidic Rocks (granite porphyry) penetrates Kumano Group (sandstone mudstone alternative rock) vertically. In addition, when geological structure is vertical, infiltrated water is hard to flow to the slope lower part, and it is thought that water level under the ground is easy to rise and the slope is easy to be collapsed. It is thought that the big change rate areas of the ratio resistance expresses water level under the ground. Because the areas of the big change rates of the ratio resistance are disappeared in the collapse slopes, it is thought that drainage abilities were low. Above all, in the risk evaluation of the shallow landslides, it is thought that we can evaluate the water levels under the ground and the drainage abilities of the groundwater by using the airborne electromagnetic survey.

Keywords: airborne electromagnetic survey, shallow landslide