

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 FALCONTM 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 g_D 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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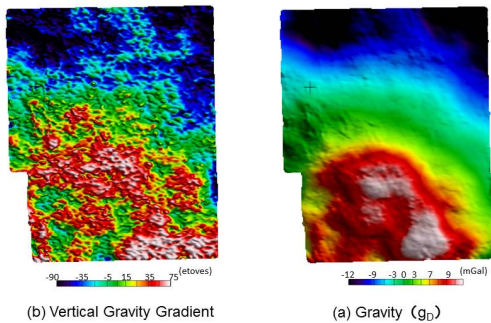


Fig. Outcome maps of Helifalcocon Airborne Gravity Gradiometry in Kuju infill area using Fourier transformation