Development of New Applications of Airborne Gravimetry–Gradiometry and Density Mapping of the Crust–

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In the airborne gravity measurement
1)It is possible to measure gravity precisely over a broad area during a short period.
2)It is possible to measure gravity from land to sea continuously.
3)By making use of GPS positionings it is possible to repeat gravity measurements along the exactly same tracks, or to fly a certain track with different height.

These characteristics of the airborne gravity measurement will provide some new methods of application of gravity.

1. Gravity measurement over a wide area in a short period.

In the Airborne gravity measurement the airplane flies at a speed of 45 to 120 knots and collect gravity values at an interval of 1 sec. This means that gravity is measured at every 22.5m to 60m. Since the measurement is made at a comparatively low altitude, the resolution of gravity value is much better than the satellite measurement. From the beginning of 1990s up to now a country wide or a continental wide airborne gravity measurements were conducted by the US or European groups. Such works finished within a two-to-three-year short period due to the high speed of measurement: The areas include Greenland, West Antarctica, Arctica, Taiwan and Mongolia. In Japan a similar work was done in the Suruga Bay with a very efficient result, although the scale of the area was much smaller.

2. A seamless measurement of gravity from land to sea.

Speaking of the Japanese case the gravity on land is measured by the Geographical Survey Institute, while that around the Japanese Islands is measured by the Maritime Safety Agency. No discussions have ever been made either on the methods or results of the measurements between the two organizations. Such an entire separation of the works have resulted in the existence of gravity void areas along the coastal lines with a width of 10 to 20 nautical miles. According to my research it has become evident that there is a
remarkable inconsistency between gravity values on land and offshore. This is an
important discovery about the gravity of Japan measured so far (EPS, April 2005).

3. Airborne gravity measurement by changing the altitude.

a) Mapping of crustal density derived from gravity values on two different height.

In a mountainous area a gravity measurement on land is quite different from the value measured on the airplane. The difference cannot be reconciled by only applying free-air reduction. Some part of the mountains exerts gravity attraction upward at the point on land, whereas it exerts gravity always downwards in the airplane. Taking advantage of this difference we can estimate density of the mountain by use of a least squares method.

b) Estimation or measurement of gravity gradients

It is getting popular, recently , to measure gravity gradient from the airplane by using a gravity gradiometer such as the Air-FTG gradiometer of Bell Geospace. But I think gravity gradient can be derived algebraically if you are provided by gravity data. The tensor gravity gradiometer was developed, originally, for the use on a satellite orbiting around the Earth, in order to measure the derivative of gravity. Since no gravity acts inside a satellite orbiting the Earth, we are obliged to measure the derivative of gravity with respect to space. I think , without the gradiometer, we can at least acquire the vertical derivative of gravity from gravity distribution itself or gravity data obtained by flying at two different altitudes.