1. GRAVITY ANOMALIES
   BOUGUER ANOMALIES
   FREE AIR ANOMALIES
2. GEOMAGNETISM
   TOTAL INTENSITY
   HORIZONTAL INTENSITY
   DECLINATION
   INCLINATION

1. Gravity Anomalies
Bouguer Anomalies. Free Air Anomalies.

Gravity is the force which pulls and holds objects on the earth's surface. It is a resultant force formed by the interaction of universal gravitation operating between an object and the whole earth, and the centrifugal force generated by terrestrial rotation.

Gravity varies from place to place on the earth due to the inequality of internal terrestrial structures, differences in latitude and altitude at each point measured, and also because the earth is not completely spherical. The difference between the corrected value obtained from the observed gravity value and the value of normal gravity derived by calculation is called a gravity anomaly. The internal structure of the earth can be estimated from gravity anomalies.

Considering the regional state of gravity anomalies, free air anomalies show that the belts of negative gravity anomaly appear noticeably on the side of ocean trenches and adjacent land, while positive gravity anomalies largely appear near high mountains corresponding to land contours. Bouguer Anomalies indicate that the belts of negative gravity anomaly appear most noticeably in the mountains of the Tyūbu area.

[**Salient Points of the Legend and Map Compilation**]

Free Air Anomalies: the difference between the value obtained after carrying out free air reduction on the actually measured value of gravitation, and the value for normal gravity. Free air reduction is carried out to determine the gravitation value on the sea's surface, assuming that no object lies between it and the point of measurement. It is known from calculations that gravity decreases 0.3086mgal per 1m of altitude. As the marine gravity measurement is taken on the surface of the sea, the difference between the actual value measured and normal gravity is the free air anomaly.

Measurements were taken between 1952–1969 in the case of land measurement, and 1962–1988 in the case of marine measurement.

Bouguer Anomalies: strictly speaking, this refers to the difference between normal gravity and the value resulting after free air reduction, Bouguer correction and topographic correction have been carried out on the actually measured value of gravity; on this map, however, topographic correction was omitted. Bouguer correction is carried out to remove the influence of objects existing between the measuring point and the sea surface. The calculation is carried out assuming the density of objects on the sea surface is 2.67g/cm³. It is considered that Bouguer Anomalies simply reflect the distribution of density inside the earth.

Measurements were carried out between 1952–1969.

All units are mgal (10^{-3}cm/S^2)

2. Geomagnetism
Total Intensity. Horizontal Intensity. Declination. Inclination.

If a magnetic needle is suspended so that it can rotate freely at a given point on the earth's surface, it will point in one direction. This means the magnetic field (geomagnetic field) is formed near the surface of the earth.

The force of the geomagnetic field is called total intensity; the horizontal component is called horizontal intensity and the vertical component is called vertical intensity. The angle formed by the direction of the geomagnetic field and the horizontal plane is called inclination, and the angle formed by the direction of horizontal component and the meridian is called declination. In order to determine the geomagnetic field, which is a vectorial quantity, three independent components are necessary, generally, horizontal component declination and inclination.

Declination shows the difference between north (magnetic north), indicated by the magnetic needle, and the true north. Those who survey or navigate at sea must know the value of declination before measuring the azimuth by compass. The compass used most commonly is made with the magnetic needle horizontal and inclination cannot be determined with it. Around Japan, the declination is westward and the inclination deviates northward.

As the geomagnetic field is continuously changing, it is necessary to conduct an epoch reduction of the values measured at different times for an analysis of the geographical distribution of factors of magnetism. This adjustment is carried out using records from the Magnetic Observatory, Japan Meteorological Agency, and the Kanōzan Geodetic Observatory, Geographical Survey Institute, where continuous observation is conducted.

Both regional anomalies whose wave length amounts to several thousand kilometers and local anomalies on a smaller scale are seen in the geomagnetic field. The local anomalies are caused by underground structure and the nature of rocks. The local anomalies are commonly seen in volcanic areas and around iron ore deposits. Magnetic prospecting is a method of prospecting which utilizes this characteristic.

[**Salient Points of the Legend and Map Compilation**]

The Geographical Survey Institute has been regularly conducting magnetic surveys, setting up approximately one hundred first order magnetic points and eight hundred second order magnetic points all over Japan. A variety of observations are conducted by the Japan Meteorological Agency, the Maritime Safety Agency and universities.

The black isopleth on this map was drawn based on all available data, including measurements from the first and second order magnetic points, excepting isolated points of magnetic anomalies.

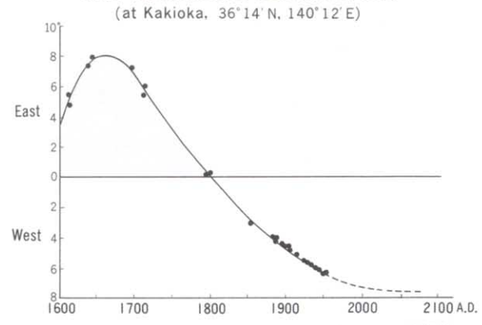
As the magnetic anomalies seen in Izu-Hantō and Izu-Sitito are extremely large, a section or the whole isopleth was omitted.

The red isopleth was determined largely from calculations carried out on the survey results from the first order magnetic points and shows the average distribution of each component.

[**Sources**]

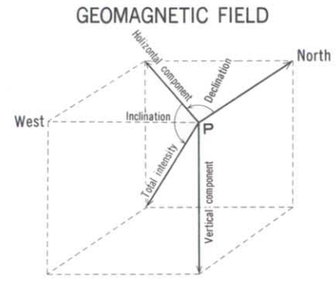
1. Geographical Survey Institute, 1:2,000,000 Free Air Anomalies in Japan, and Bouguer Anomalies in Japan, 1970
2. Hydrographic Department of Japan, Free Air Gravity Anomaly at Sea, 1989
3. Tomoda, Y. and Fujimoto, H., Maps of Gravity Anomalies and Bottom Topography in the Western Pacific, Bulletin of the Ocean Research Institute, University of Tōkyō, No.14 1982
4. Geographical Survey Institute, 1:4,000,000 Scale Magnetism Chart, 1980
5. Imamiti, S., Secular Variation of the Magnetic Declination in Japan, Memoirs of the Kakioka Magnetic Ovservatory, Vol.7, No.2, 1956

SECULAR VARIATION OF THE MAGNETIC DECLINATION
(at Kakioka, 36°14′N, 140°12′E)

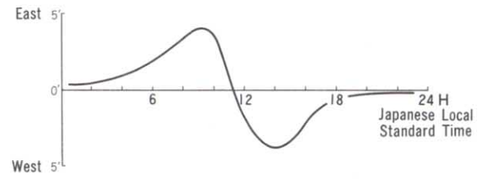


(IMAMITI, 1956)

COMPOSITION OF GEOMAGNETIC FIELD

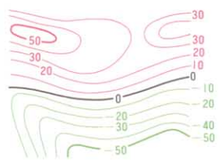


AN EXAMPLE OF THE DAILY VARIATION OF DECLINATION



8.1

BOUGUER ANOMALIES



Positive anomaly

Negative anomaly

10 Milligal interval

1 : 4,000,000

0 50 100 150 200km

SEA OF OKHOTSK

JAPAN SEA

NORTH PACIFIC OCEAN

Etorohu Tō

Rebun Tō

Risiri Tō

Kunasiri Tō

Sikotan Tō

HABOMAI SYOTŌ

Asahikawa

Kusiro

Sapporo

Okusiri Tō

Hakodate

Aomori

Morioka

Akita

SADO

Niigata

Hukusima

Utunomiya

Mito

Maebasi

Nagano

Toyama

Kanazawa

Urawa

Tōkyō

Tiba

Kawasaki

Yokohama

Kōhu

Hukui

Giĥu

Sizuoka

Nagoya

Tu

Ōtu

Kyōto

Kōbe

Ōsaka

Nara

Wakayama

Awaji Sima

Okayama

Hirosima

Tottori

Matue

Takamatu

Tokusima

Yamaguti

Matuyama

Kita-Kyūsyū

Kōti

Hukuoka

Ōita

Saga

Nagasaki

Kumamoto

Miyazaki

Kagosima

Take Sima

OKI

GOTŌ RETTŌ

KOSIKIZIMA RETTŌ

ŌSUMI SYOTŌ

Tanega Sima

Yaku Sima

TOKARA RETTŌ

Ō Sima

Miyake Zima

IZU SYOTŌ

Hatizyō Zima

Aoga Sima

AMAMI SYOTŌ

Tokuno Sima

Okinoerabu Zima

OKINAWA SYOTŌ

Okinawa Zima

Kume Zima

Naha

RYUKYU SYOTŌ

SENKAKU SYOTŌ

SAKISIMA SYOTŌ

Miyako Zima

Iriomote Zima

Yonakuni Zima

Ishigaki Zima

DAITŌ SYOTŌ

Kita-Daitō Zima

Minami-Daitō Zima

KAZAN RETTŌ

Iō Zima

OGASAWARA GUNTŌ

Titi Zima

Haha Zima

8.2

TOTAL INTENSITY

(1980.0)

46000 — 50000

45700 — 49000

Lines of equal total intensity — general distribution

Represented in gamma (1 gamma = 10^{-5} gauss)

A value reduced to the beginning of 1980 was used

1:8,000,000

0 100 200 300 400km

HORIZONTAL INTENSITY

(1980.0)

26000 — 26000

26300 — 27000

Lines of equal horizontal intensity — general distribution

Represented in gamma (1 gamma = 10^{-5} gauss)

A value reduced to the beginning of 1980 was used

1:8,000,000

0 100 200 300 400km

ISOGONIC LINES

(1980.0)

8° — 8°

8°30′ — 7°

Isogonic lines (Westward) — general distribution

A value reduced to the beginning of 1980 was used

1:8,000,000

0 100 200 300 400km

ISOCLINIC LINES

(1980.0)

57° — 52°

56°30′ — 50°

Isoclinic lines (Northward) — general distribution

A value reduced to the beginning of 1980 was used

1:8,000,000

0 100 200 300 400km