GRAVITY SURVAY AT SEA

This is a continuation of the report of gravity surveys at sea by the Hydrographic and Oceanographic Department. The results of three cruises , Northeast offing of Izu-Oshima, Offing of Wakasa Wan and Kikai-Caldera surveyed in 2006-2008 are presented in this report.

Key words: marine gravity survey

1. Surveys

The Hydrographic and Oceanographic Department (JHOD) has carried out gravity surveys at sea by using the sea surface gravity meters, KSS-30 or KSS-31(Bodenseewerk), on board the survey vessels, the Meiyo, and the Shoyo. The gravity meters are composed of the sensor, stabilized platform and data handling subsystems.

KSS-30 and KSS-31 measures the gravity by means of the zero method using the balance between gravity and electro-magnetic forces. The change of electric current, which balances the gravity change, is filtered in time domain and then converted into frequency variation. A brief explanation of the gravity meter is described in No. 19 of this publication series (Ueda, et al., 1985). ;

2. Reduction

The KSS-30 and KSS-31 gravity meter is calibrated in advance of each cruise using a LaCoste & Romberg gravity meter. A gravity value of 979,778.272 mGal (JGSN75) at the gravity station of the Hydrographic Department (JHD-G_0) is adopted as the reference value for calibrations. The gravity value at pier for the Meiyo is reduced to 979,770.36 mGal and the Shoyo reduced to 979,767.66 mGal on the base of the value at JHD-G_0. The corrections of Eotvos and drift effect are applied to measure gravity values.

(a) Free-air gravity anomaly, Δg_0, is calculated by the following equation,

$$\Delta g_0 = g_0 + 0.87 - \gamma \quad \text{(mGal)},$$

where g_0 is the corrected gravity value, 0.87 (mGal) is an atmospheric correction at sea level and γ is the normal gravity value based on the Geodetic Reference System 1980 given by the formula:

$$\gamma = 978.03267715[\ 1 + 0.005279041\sin^2\phi + 0.0000232718\sin^4\phi + 0.0000001262\sin^6\phi + 0.0000000007\sin^8\phi\ ] \quad \text{(Gal)}$$

where ϕ is the latitude of the reference point.

(b) Bouguer gravity anomaly, Δg_1 is calculated by the following equation,

$$\Delta B = 2\pi G(\rho_c - \rho_w) \times d \quad \text{(mGal)} + \rho_c T_c - \rho_w T_w,$$

where d is depth in meter, T_c is terrain correction value for the earth's crust, T_w terrain correction value for the sea water, $G = 6.673 \times 10^{-8}$ (cm^3 /g.sec^2), $\rho_c = 2.67$(g/ cm^3) and $\rho_w = 1.03$ (g/ cm^3) whence the Bouguer anomaly is calculated by

$$\Delta g_1 = \Delta g_0 + \Delta B\ .$$

The reduction and compilation of four cruises in Table 2 have been completed, and the details of those surveys are shown in this table.

3. Results of gravity survey

Free-air gravity anomaly maps and Bouguer gravity anomaly maps are shown in Figure 1 to 5. The free-air gravity anomaly and associated data have been compiled on digital media with relevant information and are available on request.

The data format and other information concerning the gravity data file of JHDGF should be referred to Ganeko and Koyama(1981).

This report was written by S.Kato and K.Koyama, Geodesy and Geophysics Office.

References

Ganeko, Y., Koyama, K. 1981: *Report of Hydrographic Researches,* No. 16, p. 103.
Ueda, Y., Harada, Y., Hiraiwa, T. 1985: *Data report of Hydrogr.Obs,Series of astronomy and Geophi.,* No. 19, p. 99.
Ueda, Y., Harada, Y., Hiraiwa, T., Horii, R. 1986: *ibid.,* No. 20, p. 90.

The results of gravity surveys at the sea surface for the preceding years are found in the back numbers of this publication series listed in Table 1.

Table 1. The list of back numbers of this publication series

Cruise index	Data Report of Hydrographic Observation, Series of Astronomy and Geodesy
65TEST	Tokuhiro, A., 1966, No.1, p.43. Tokuhiro, A., 1967, No.2, p.29. Sugimoto, K., Yanagi, T., 1968, No.3, p.22.
68TK	Takemura, T., Yanagi, T., Ganeko, Y., 1969, No.4, p.13.
68AK	Takemura, T., Yanagi, T., Ganeko, Y., 1970, No.5, p.33.
68NI	Takemura, T., Yanagi, T., Ganeko, Y., 1971, No.6, p.19.
70IR	Takemura, T., Yanagi, T., Tomioka, Y., 1972, No.7, p.23.
70SN	Takemura, T., Yanagi, T., Nisiya, S., 1974, No.8, p.29.
71SN	Takemura, T., Yanagi, T., Tomioka, Y., 1975, No.9, p.42.
72HU	Yanagi, T., Tomioka, Y., Katsuno, K., 1976, No.10, p.49.
72KU,72HI,72HD, 73HK,73KG,73MI	Yanagi, T., Tomioka, Y., Katsuno, K., 1977, No.11, p.76.
73KO,74NG,74TR 74KG,76IK	Yanagi, T., Kubo, K., 1978, No.12, p.55.
75OK,75YM	Yanagi, T., Matumoto, K., Nisisita, A., 1979, No.13, p.48.
75BO,75SI,76OK,76MK	Ganeko, Y., Yanagi, T., Nisisita, A., 1980, No.14, p.59.
76IK,77JO,78JO	Ganeko, Y., Harada, Y., Komatu, Y., 1981, No.15, p.44.
80KT,80IS-A,80IS-B	Ganeko, Y., Harada, Y., Komatu, Y., 1982, No.16, p.64.
81IO,81YK	Ganeko, Y., Harada, Y., Koyama, K., Futinoue, S., 1983, No.17, p.88.
82SN,82AM	Ganeko, Y., Harada, Y., Koyama, K., Hiraiwa, T., 1984, No.18, p.85.
83SN,83NT,83HN	Ueda, Y., Harada, Y., Hiraiwa, T., 1985, No.19, p.99.
84HN,85TH,85IS	Ueda, Y., Harada, Y., Horii, R., Hiraiwa, T., 1986, No.20, p.90.
84ST,85BM,85TB	Ueda, Y., Asao, T., Hiraiwa, T., 1987, No.21, p.122.
84SM,85SB,85BT,86IZ	Ueda, Y., Nakagawa, H., Onodera, K., Nagaya, Y., 1988, No.22, p.36.
85TR,86TR,86BK	Yanagi, T., Onodera, K., Ito, H., Kato, T., 1989, No.23, p.34.
87HT,87TT,88SN	Yanagi, T., Mihara, S., Yamano, H., 1990, No.24, p.63.
88WP,88ST	Yanagi, T., Mihara, S., Yamano, H., 1991, No.25, p.40.
90ST	Ono, F., Mihara, S., Okumura, M., 1992, No.26, p.44.

Cruise index	Data Report of Hydrographic Observation, Series of Astronomy and Geodesy
91BEPPU,91UN-T ,91UN-S,91MI	Ono, F., Mihara, S., Kato, T., Usijima, M., 1993, No.27, p.44.
91ZN,91BO,92NI	Ono, F., Kato, T., Usijima, M., 1994, No.28, p.52.
91MF,92EN,92IZ,93KO,93HY,93TO,94EN 94IR	Kato, T., Usijima, M., Tugawa, T., 1995, No29, p.64.
94NI,94AY	Okumura, M., Toyama, S., 1997, No31, p.70.
94ENB,95IS,95AM,96TS	Okumura, M., Toyama, S., 1998, No32.
98KI,98MI,98IZ	Suzuki,A.,Sakamoto,H., 1999, No33.
99FU,99NI	Suzuki,A.,Sakamoto,H., 2000, No34.
98MY,99MY,98IZ,99FU,00MI	Kato, T.,Suzuki,A.,2001, No35.
96SR,96RO,97TM,00BU	Kato, T.,2002, No36.
95ISE,98NI,99NI,01NI,01HI,02NI	Kato, T.,2003, No37.
02-03KIF, 03KIT,00-01-03SI,04WAK	Onodera, K.,Koyama,K.,Kon,T., 2004, No38

Table 2. Detailed information on the compiled sea gravity surveys

Cruise index	**OS06**	**WA07**	**KC06** **KC07** **KC08**	
Area	Northeast offing of Izu-Oshima	Offing of Wakasa Wan	Kikai Caldera	
Period	Jul, 2006	May-Jun, 2007	Jan-Feb, 2006 Aug, 2007 May-Jun, 2008	
Vessel	Meiyo	Meiyo	Meiyo	
Gravimeter	KSS-30	KSS-30	KSS-30	
Positioning	Integrated Navigation System	Integrated Navigation System	Integrated Navigation System	
Survey speed	9～10 knot	10～11 knot	10 knot	
Survey line spacing	0.5 N.M. NW-SE	2 N.M. W-E	0.5 N.M. W-E	
Observation interval	5sec	5sec	5sec	
Drift	+0.2mGal/month	+0.1mGal/month	+0.2mGal/month +0.1mGal/month +1.2mGal/month	
Mean of cross difference	±0.7mGal	±0.5mGal	±0.5mGal	
Free air Anomaly map	Figure 1	Figure 3	Figure 4	
Bouguer Anomaly map	Figure 2		Figure 5	
Scale of original chart	1:125,000	1:500,000	1:150,000	
Map projection	TM	TM	TM	

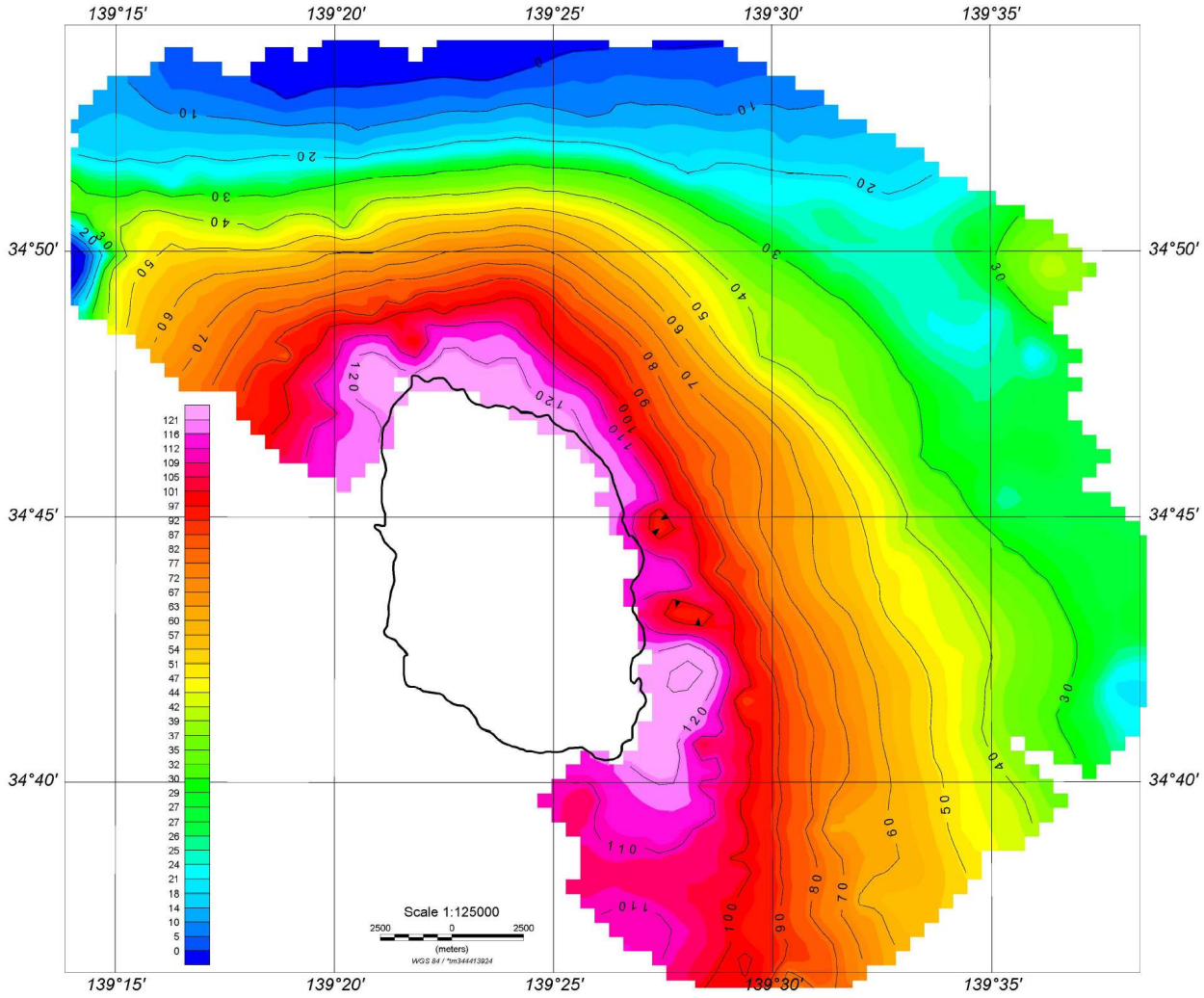

Fig.1 Free-air gravity anomaly map in Northeast offing of Izu-Oshima.

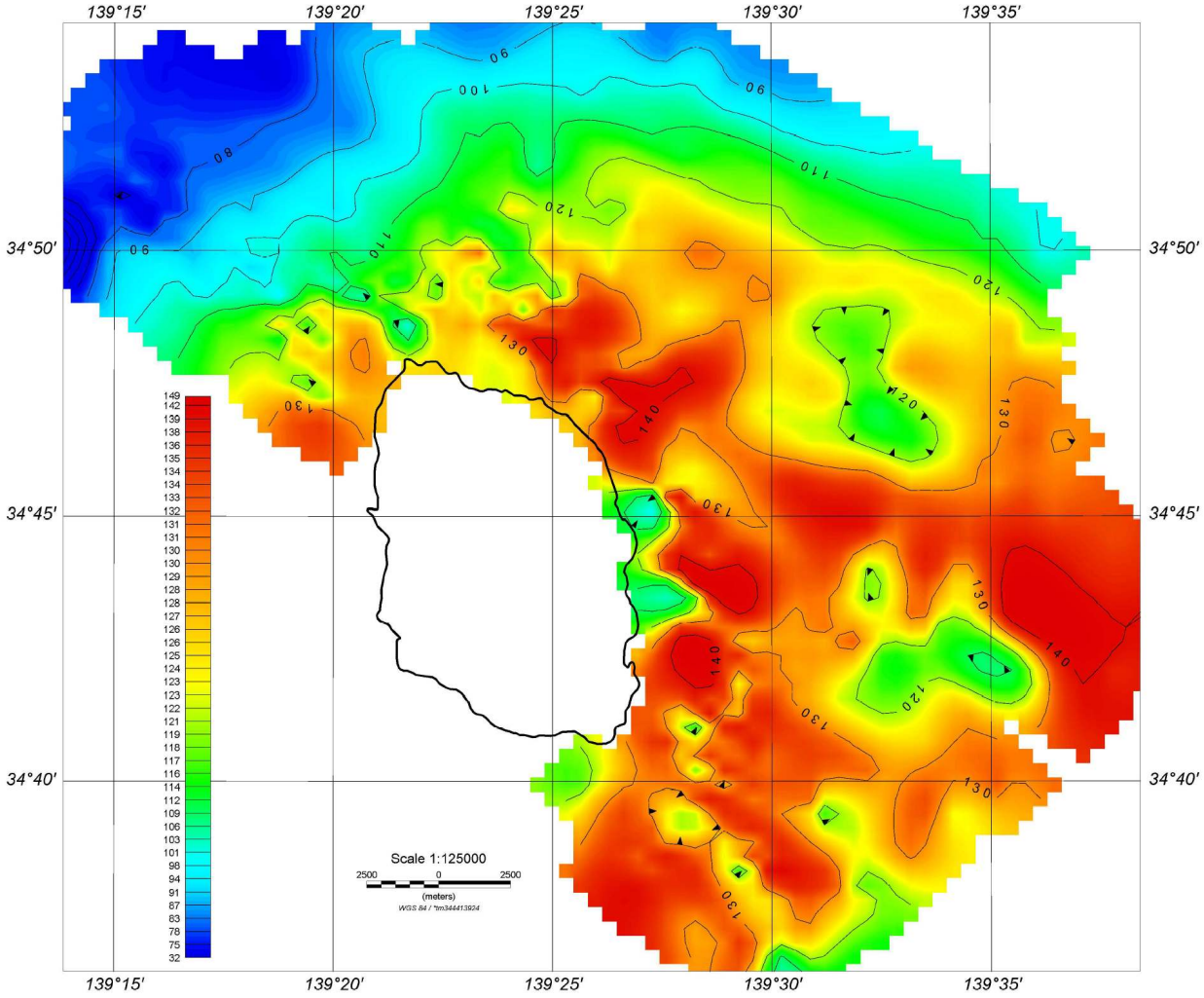

Fig.2 Bouguer gravity anomaly map in Northeast offing of Izu-Oshima.

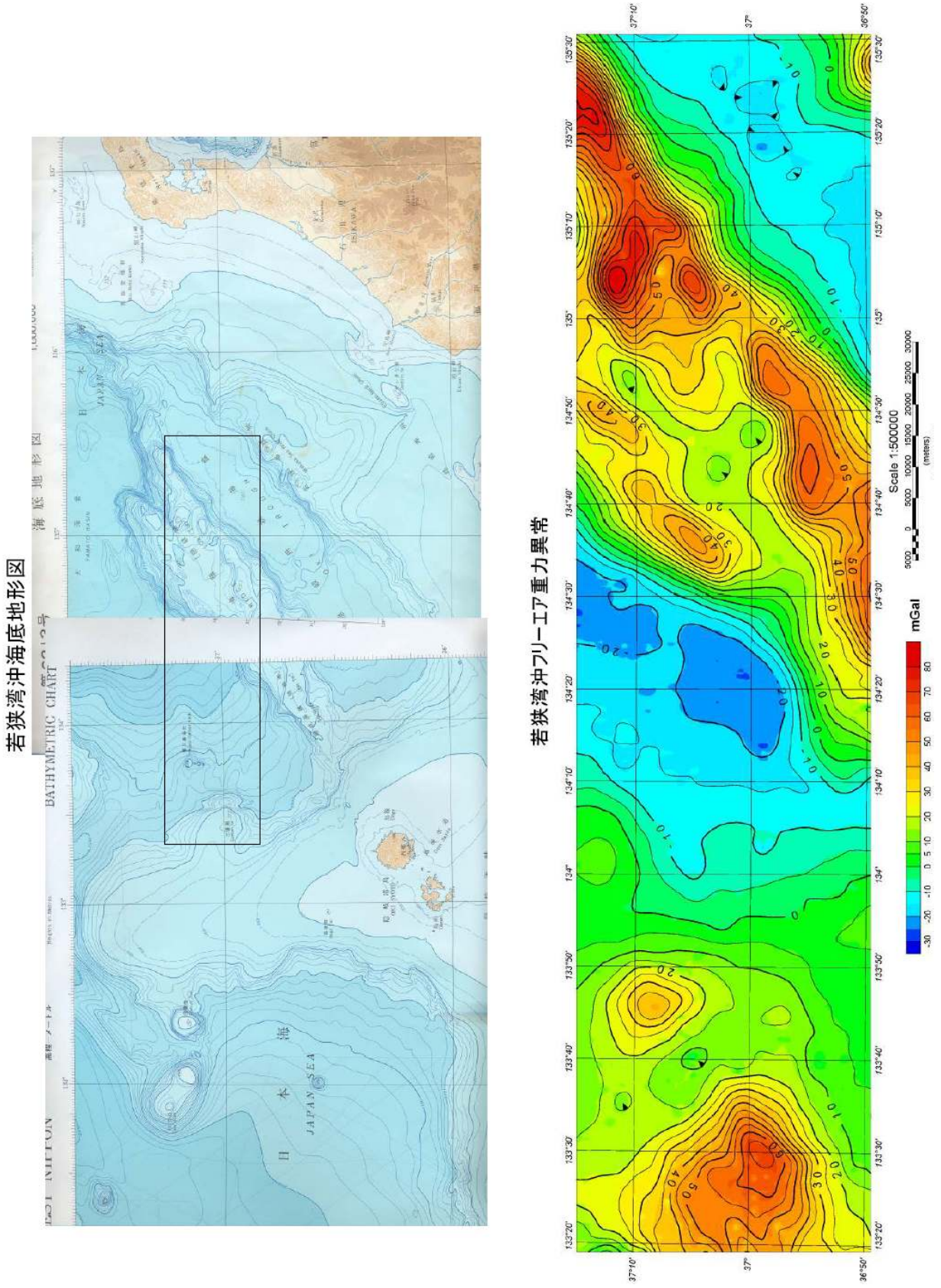

Fig.3 Free-air gravity anomaly map offing of Wakasa Wan.

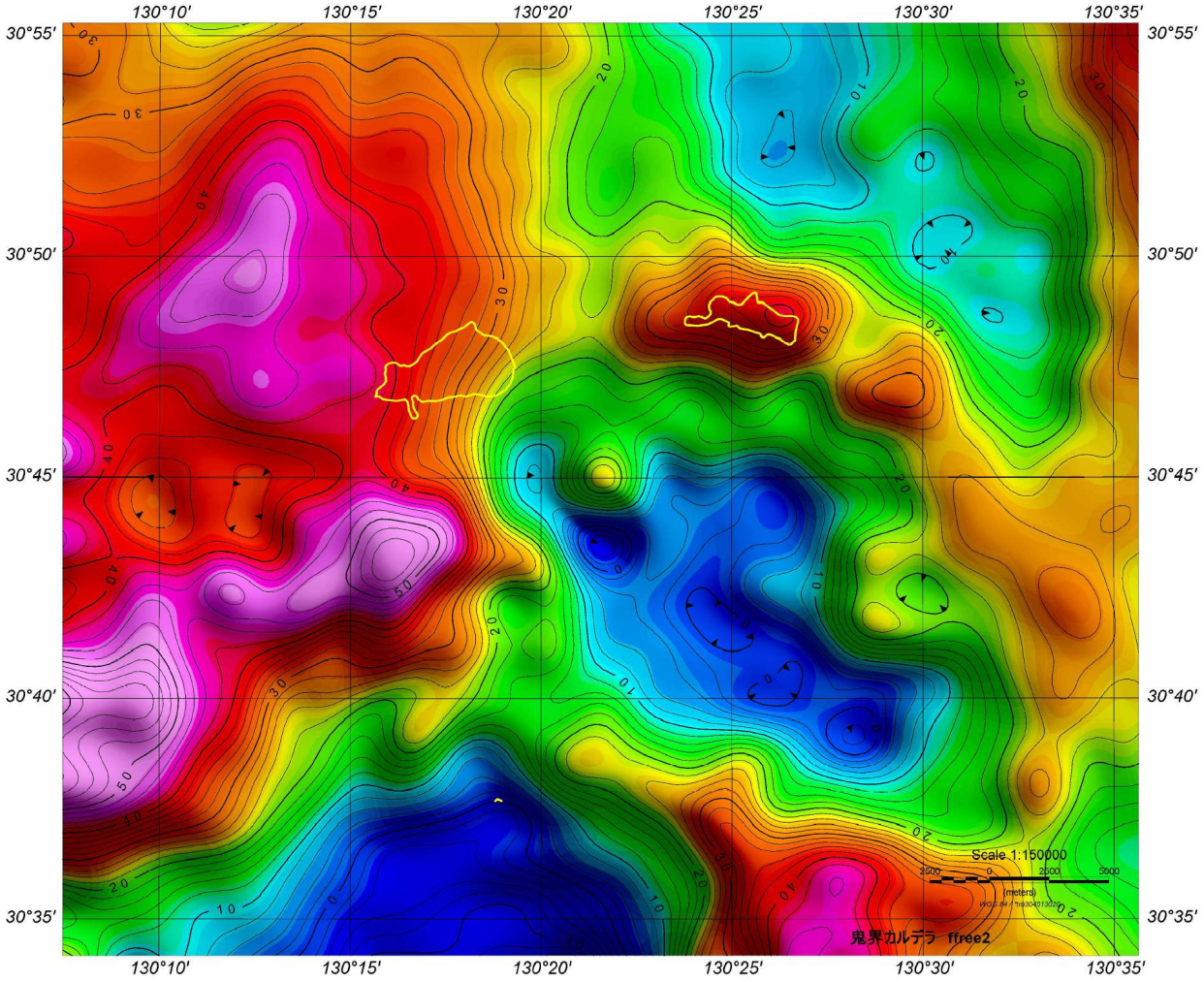

Fig.4 Free-air gravity anomaly map in Kikai Caldera.

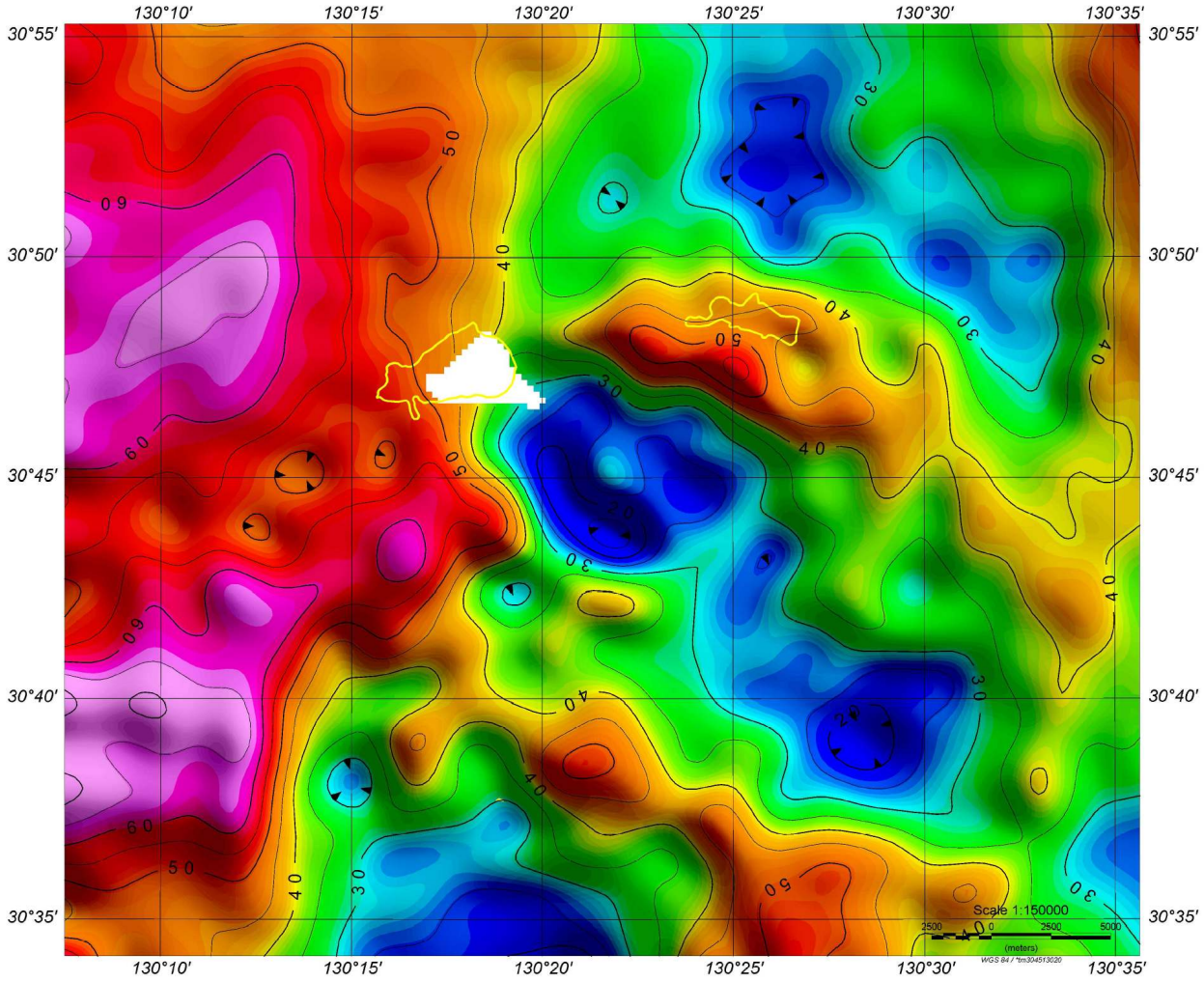

Fig.5 Bouguer gravity anomaly map in Kikai Caldera.