ASSOCIATION INTERNATIONALE DE GÉODÉSIE

BUREAU GRAVIMÉTRIQUE INTERNATIONAL

BULLETIN D'INFORMATION

N° 79

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18, Avenue Edouard Belin
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INFORMATIONS for CONTRIBUTORS

Contributors should follow as closely as possible the rules below :

Manuscripts should be typed (single spaced), on one side of plain paper 21 cm x 29,7 cm with a 2 cm margin on the left and right hand sides as well as on the bottom, and with a 3 cm margin at the top (as indicated by the frame drawn on this page).

NOTA : *The publisher welcomes the manuscripts which have been prepared using WORD 5.1 for Macintosh and also accepts ASCII files on diskettes 3"5.*

Title of paper. Titles should be carefully worded to include only key words.

Abstract. The abstract of a paper should be informative rather than descriptive. It is not a table of contents. The abstract should be suitable for separate publication and should include all words useful for indexing. Its length should be limited to one typescript page.

Footnotes. Because footnotes are distracting, they should be avoided as much as possible.

Mathematics. For papers with complicated notation, a list of symbols and their definitions should be provided as an appendix. Symbols that must be handwritten should be identified by notes in the margin. Ample space (1.9 cm above and below) should be allowed around equations so that type can be marked for the printer. Where an accent or underscore has been used to designate a special type face (e.g., boldface for vectors, script for transforms, sans serif for tensors), the type should be specified by a note in a margin. Bars cannot be set over superscripts or extended over more than one character. Therefore angle brackets are preferable to accents over characters. Care should be taken to distinguish between the letter O and zero, the letter l and the number one, kappa and k, mu and the letter u, nu and v, eta and n, also subscripts and superscripts should be clearly noted and easily distinguished. Unusual symbols should be avoided.

Acknowledgements. Only significant contributions by professional colleagues, financial support, or institutional sponsorship should be included in acknowledgements.

References. A complete and accurate list of references is of major importance in review papers. All listed references should be cited in text. A complete reference to a periodical gives author (s), title of article, name of journal, volume number, initial and final page numbers (or statement "in press"), and year published. A reference to an article in a book, pages cited, publisher's location, and year published. When a paper presented at a meeting is referenced, the location, dates, and sponsor of the meeting should be given. References to foreign works should indicate whether the original or a translation is cited. Unpublished communications can be referred to in text but should not be listed. Page numbers should be included in reference citations following direct quotations in text. If the same information have been published in more than one place, give the most accessible reference ; e.g. a textbook is preferable to a journal, a journal is preferable to a technical report.

Table. Tables are numbered serially with Arabic numerals, in the order of their citation in text. Each table should have a title, and each column, including the first, should have a heading. Column headings should be arranged to that their relation to the data is clear.

Footnotes for the tables should appear below the final double rule and should be indicated by a, b, c, etc. Each table should be arranged to that their relation to the data is clear.

Illustrations. Original drawings of sharply focused glossy prints should be supplied, with two clear Xerox copies of each for the reviewers. Maximum size for figure copy is (25.4 x 40.6 cm). After reduction to printed page size, the smallest lettering or symbol on a figure should not be less than 0.1 cm high ; the largest should not exceed 0.3 cm. All figures should be cited in text and numbered in the order of citation. Figure legends should be submitted together on one or more sheets, not separately with the figures.

Mailing. Typescripts should be packaged in stout padded or stiff containers ; figure copy should be protected with stiff cardboard.

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http//www.obs-mip.fr/uggi/bgi.html

BUREAU GRAVIMÉTRIQUE
INTERNATIONAL

Toulouse

BULLETIN D'INFORMATION

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PART I

INTERNAL MATTERS

GENERAL INFORMATION

1. HOW TO OBTAIN THE BULLETIN
2. HOW TO REQUEST DATA
3. USUAL SERVICES B.G.I. CAN PROVIDE
4. PROVIDING DATA TO B.G.I.

1. HOW TO OBTAIN THE BULLETIN

The Bulletin d'Information of the Bureau Gravimétrique International is issued twice a year, generally at the end of June and end of December.

The Bulletin contains general information on the community, on the Bureau itself. It informs about the data available, about new data sets...

It also contains contributing papers in the field of gravimetry, which are of technical character. More scientifically oriented contributions should better be submitted to appropriate existing journals.

Communications presented at general meeting, workshops, symposia, dealing with gravimetry (e.g. IGC, S.S.G.'s,...) are published in the Bulletin when appropriate - at least by abstract.

Once every four years, an issue contains the National Reports as presented at the International Gravity Commission meeting. Special issues may also appear (once every two years) which contain the full catalogue of the holdings.

About three hundred individuals and institutions presently receive the Bulletin.

You may :

- either request a given bulletin, by its number (77 have been issued as of December 31, 1995 but numbers 2,16, 18,19 are out of print).

- or subscribe for regularly receiving the two bulletins per year (the special issues. are obtained at additional cost).

Requests should be sent to:

Mrs. Nicole LESTIEU
CNES/BGI
18, Avenue Edouard Belin
31055 TOULOUSE CEDEX - FRANCE

Bulletins are sent on an exchange basis (free of charge) to individuals, institutions which currently provide informations, data to the Bureau. For other cases, the price of each issue is 75 FF.

2. HOW TO REQUEST DATA

2.1. Stations descriptions Diagrams for Reference, Base Stations (including IGSN 71's)

Request them by number, area, country, city name or any combination of these.

When we have no diagram for a given request, but have the knowledge that it exists in another center, we shall in most cases forward the request to this center or/and tell the inquiring person to contact the center.

Do not wait until the last moment (e.g. when you depart for a cruise) for asking us the information you need: station diagrams can only reach you by mail, in many cases.

2.2. G-Value at Base Stations

Treated as above.

2.3. Mean Anomalies, Mean Geoid Heights, Mean Values of Topography

The geographic area must be specified (polygon). According to the data set required, the request may be forwarded in some cases to the agency which computed the set.

2.4. Gravity Maps

Request them by number (from the catalogue), area, country, type (free-air, Bouguer...), scale, author, or any combination of these.

Whenever available in stock, copies will be sent without extra charges (with respect to usual cost - see § 3.3.2.). If not, two procedures can be used:

- we can make (poor quality) black and white (or ozalide-type) copies at low cost,

- color copies can be made (at high cost) if the user wishes so (after we obtain the authorization of the editor).

The cost will depend on the map, type of work, size, etc... In both cases, the user will also be asked to send his request to the editor of the map before we proceed to copying.

2.5. Gravity Measurements

2.5.1. CD-Roms

The non confidential data, which have been validated by various procedures are available on two CD-ROMs. The price of these is :

- *800 (Eight hundred) French francs for individual scientists, universities and research laboratories or groups working in geodesy or geophysics.*
- *3000 (Three thousand) French francs for all other users.*

Most essential quantities are given, in a compressed format. The package includes a user's guide and software to retrieve data according to the area, the source code, the country.

2.5.2. Data stored in the general data base

BGI is now using the ORACLE Data Base Management System. One implication is that data are stored in only one format (though different for land and marine data), and that archive files do not exist anymore.

There are two distinct formats for land or sea gravity data, respectively EOL and EOS.

EOL
LAND DATA FORMAT
RECORD DESCRIPTION
126 characters

Col. 0 1-8 B.G.I. source number (8 char.)

1 9-16 Latitude (unit : 0.00001 degree) (8 char.)

2 17-25 Longitude (unit : 0.00001 degree) (9 char.)

3 26-27 Accuracy of position (2 char.)

The site of the gravity measurements is defined in a circle of radius R

0 = no information
1 - R <= 5 Meters
2 = 5 < R <= 20 M (approximately 0'01)
3 = 20 < R <= 100 M
4 = 100 < R <= 200 M (approximately 0'1)
5 = 200 < R <= 500 M
6 = 500 < R <= 1000 M
7 = 1000 < R <= 2000 M (approximately 1')
8 = 2000 < R <= 5000 M
9 = 5000 M < R
10...

4 28-29 System of positioning (2 char.)

0 = no information
1 = topographical map
2 = trigonometric positioning
3 = satellite

5 30 Type of observation (1 char.)

1 = current observation of detail or other observations of a 3rd or 4th order network
2 = observation of a 2nd order national network
3 = observation of a 1st order national network
4 = observation being part of a nation calibration line
5 = coastal ordinary observation (Harbour, Bay, Sea-side...)
6 = harbour base station

6 31-38 Elevation of the station (unit : centimeter) (8 char.)

7 39-40 Elevation type (2 char.)

1 = Land
2 = Subsurface
3 = Lake surface (above sea level)
4 = Lake bottom (above sea level)
5 = Lake bottom (below sea level)
6 = Lake surface (above sea level with lake bottom below sea level)
7 = Lake surface (below sea level)
8 = Lake bottom (surface below sea level)
9 = Ice cap (bottom below sea level)
10 = Ice cap (bottom above sea level)
11 = Ice cap (no information about ice thickness)

8 41-42 Accuracy of elevation (2 char.)

0 = no information
1 = E <= 0.02 M
2 = .02 < E <= 0.1 M
3 = .1 < E <= 1
4 = 1 < E <= 2
5 = 2 < E <= 5
6 = 5 < E <= 10
7 = 10 < E <= 20
8 = 20 < E <= 50
9 = 50 < E <= 100
10 = E superior to 100 M

9 43-44 Determination of the elevation (2 char.)

0 = no information
1 = geometrical levelling (bench mark)
2 = barometrical levelling
3 = trigonometric levelling
4 = data obtained from topographical map
5 = data directly appreciated from the mean sea level
6 = data measured by the depression of the horizon
7 = satellite

10 45-52 Supplemental elevation (unit : centimeter) (8 char.)

11 53-61 **Observed gravity** (unit : microgal) (9 char.)

12 62-67 **Free air anomaly** (0.01 mgal) (6 char.)

13 68-73 **Bouguer anomaly** (0.01 mgal) (6 char.)

Simple Bouguer anomaly with a mean density of 2.67. No terrain correction

14 74-76 Estimation standard deviation free-air anomaly (0.1 mgal) (3 char.)

15 77-79 Estimation standard deviation bouguer anomaly (0.1 mgal) (3 char.)

16 80-85 **Terrain correction** (0.01 mgal) (6 char.)

computed according to the next mentioned radius & density

17 86-87 Information about terrain correction (2 char.)

- 0 = no topographic correction
- 1 = tc computed for a radius of 5 km (zone H)
- 2 = tc computed for a radius of 30 km (zone L)
- 3 = tc computed for a radius of 100 km (zone N)
- 4 = tc computed for a radius of 167 km (zone 02)
- 11 = tc computed from 1 km to 167 km
- 12 = tc computed from 2.3 km to 167 km
- 13 = tc computed from 5.2 km to 167 km
- 14 =tc (unknown radius)
- 15 = tc computed to zone M (58.8 km)
- 16 = tc computed to zone G (3.5 km)
- 17 = tc computed to zone K (18.8 km)
- 25 = tc computed to 48.6 km on a curved Earth
- 26 = tc computed to 64. km on a curved Earth

18 88-91 Density used for terrain correction (4 char.)

19 92-93 Accuracy of gravity (2 char.)

- 0 = no information
- 1 = E <= 0.01 mgal
- 2 = .01 < E <= 0.05 mgal
- 3 = .05 < E <= 0.1 mgal
- 4 = 0.1 < E <= 0.5 mgal
- 5 = 0.5 < E <= 1. mgal
- 6 = 1. < E <= 3. mgal
- 7 = 3. < E <= 5. mgal
- 8 = 5. < E <= 10 mgal
- 9 = 10. < E <= 15. mgal
- 10 = 15. < E <= 20. mgal
- 11 = 20. < E mgal

20 94-99 Correction of observed gravity (unit : microgal) (6 char.)

21 100-105 **Reference station** (6 char.)

This station is the base station (BGI number) to which the concerned station is referred

22 106-108 Apparatus used for the measurement of G (3 char.)

0.. no information
1.. pendulum apparatus before 1960
2.. latest pendulum apparatus (after 1960)
3.. gravimeters for ground measurements in which the variations of G are equilibrated of detected using the following methods :
30 = torsion balance (Thyssen...)
31 = elastic rod
32 = bifilar system
34 = Boliden (Sweden)
4.. Metal spring gravimeters for ground measurements
41 = Frost
42 = Askania (GS-4-9-11-12), Graf
43 = Gulf, Hoyt (helical spring)
44 = North American
45 = Western
47 = Lacoste-Romberg
48 = Lacoste-Romberg, Model D (microgravimeter)
5.. Quartz spring gravimeter for ground measurements
51 = Norgaard
52 = GAE-3
53 = Worden ordinary
54 = Worden (additional thermostat
55 = Worden worldwide
56 = Cak
57 = Canadian gravity meter, sharpe
58 = GAG-2
59 = SCINTREX CG2
6.. Gravimeters for under water measurements (at the bottom of the sea or of a lake)
60 = Gulf
62 = Western
63 = North American
64 = Lacoste-Romberg

23 109-111 **Country code** (BGI) (3 char.)

24 112 **Confidentiality** (1 char.)

0 = without restriction
.....1 = with authorization
2 = classified

25 113 **Validity** (1 char.)

0 = no validation
1 = good
2 = doubtful
3 = lapsed

26 114-120 Numbering of the station (original) (7 char.)

27 121-126 Sequence number (6 char.)

EOS
SEA DATA FORMAT
RECORD DESCRIPTION
146 characters

Col. 1-8 **B.G.I.** source number (8 char.)

9-16 **Latitude** (unit : 0.00001 degree) (8 char.)

17-25 **Longitude** (unit : 0.00001 degree) (9 char.)

26-27 Accuracy of position (2 char.)

The site of the gravity measurements is defined in a circle of radius R
- 0 = no information
- 1 - R <= 5 Meters
- 2 = 5 < R <= 20 M (approximately 0'01)
- 3 = 20 < R <= 100 M
- 4 = 100 < R <= 200 M (approximately 0'1)
- 5 = 200 < R <= 500 M
- 6 = 500 < R <= 1000 M
- 7 = 1000 < R <= 2000 M (approximately 1')
- 8 = 2000 < R <= 5000 M
- 9 = 5000 M < R
- 10...

28-29 System of positioning (2 char.)
- 0 = no information
- 1 = Decca
- 2 = visual observation
- 3 = radar
- 4 = loran A
- 5 = loran C
- 6 = omega or VLF
- 7 = satellite
- 8 = solar/stellar (with sextant)

30 Type of observation (1 char.)
- 1 = individual observation at sea
- 2 = mean observation at sea obtained from a continuous recording

31-38 **Elevation of the station** (unit : centimeter) (8 char.)

39-40 Elevation type (2 char.)
- 1 = ocean surface
- 2 = ocean submerged
- 3 = ocean bottom

41-42 Accuracy of elevation (2 char.)
- 0 = no information
- 1 = E <= 0.02 Meter
- 2 = .02 < E <= 0.1 M
- 3 = .1 < E <= 1
- 4 = 1 < E <= 2
- 5 = 2 < E <= 5
- 6 = 5 < E <= 10
- 7 = 10 < E <= 20
- 8 = 20 < E <= 50
- 9 = 50 < E <= 100
- 10 = E superior to 100 Meters

43-44 Determination of the elevation (2 char.)
- 0 = no information
- 1 = depth obtained with a cable (meters)
- 2 = manometer depth
- 3 = corrected acoustic depth (corrected from Mathew's tables, 1939)
- 4 = acoustic depth without correction obtained with sound speed 1500 M/sec. (or 820 fathom/sec)
- 5 = acoustic depth obtained with sound speed 1463 M/sec (800 fathom/sec)
- 6 = depth interpolated on a magnetic record
- 7 = depth interpolated on a chart

45-52 Supplemental elevation (8 char.)

53-61 **Observed gravity** (unit : microgal) (9 char.)

62-67 **Free air anomaly** (0.01 mgal) (6 char.)

68-73 **Bouguer anomaly** (0.01 mgal) (6 char.)

Simple Bouguer anomaly with a mean density of 2.67. No terrain correction

74-76	Estimation standard deviation free-air anomaly (0.1 mgal)	(3 char.)
77-79	Estimation standard deviation bouguer anomaly (0.1 mgal)	(3 char.)
80-85	**Terrain correction** (0.01 mgal)	(6 char.)
	computed according to the next mentioned radius & density	
86-87	Information about terrain correction	(2 char.)
	0 = no topographic correction	
	1 = tc computed for a radius of 5 km (zone H)	
	2 = tc computed for a radius of 30 km (zone L)	
	3 = tc computed for a radius of 100 km (zone N)	
	4 = tc computed for a radius of 167 km (zone 02)	
	11 = tc computed from 1 km to 167 km	
	12 = tc computed from 2.3 km to 167 km	
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	14 =tc (unknown radius)	
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	16 = tc computed to zone G (3.5 km)	
	17 = tc computed to zone K (18.8 km)	
	25 = tc computed to 48.6 km on a curved Earth	
	26 = tc computed to 64. km on a curved Earth	
88-91	Density used for terrain correction	(4 char.)
92-93	Mathew's zone	(2 char.)
	when the depth is not corrected depth, this information is necessary. For example : zone 50 for the Eastern Mediterranean Sea	
94-95	Accuracy of gravity	(2 char.)
	0 = no information	
	1 = E <= 0.01 mgal	
	2 = .01 < E <= 0.05 mgal	
	3 = .05 < E <= 0.1 mgal	
	4 = 0.1 < E <= 0.5 mgal	
	5 = 0.5 < E <= 1. mgal	
	6 = 1. < E <= 3. mgal	
	7 = 3. < E <= 5. mgal	
	8 = 5. < E <= 10. mgal	
	9 = 10. < E <= 15. mgal	
	10 = 15 < E <= 20. mgal	
	11 = 20. < E mgal	
96-101	Correction of observed gravity (unit : microgal)	(6 char.)
102-110	Date of observation	(9 char.)
	in Julian day - 2 400 000 (unit : 1/10 000 of day)	
111-113	Velocity of the ship (0.1 knot)	(3 char.)
114-118	Eötvös correction (0.1 mgal)	(5 char.)
119-121	**Country code** (BGI)	(3 char.)
122	**Confidentiality**	(1 char.)
	0 = without restriction	
	1 = with authorization	
	2 = classified	
123	**Validity**	(1 char.)
	0 = no validation	
	1 = good	
	2 = doubtful	
	3 = lapsed	
124-130	Numbering of the station (original)	(7 char.)
131-136	**Sequence number**	(6 char.)
137-139	**Leg number**	(3 char.)
140-145	**Reference station**	(6 char.)

Whenever given, the theoretical gravity (γ_o), free-air anomaly (FA), Bouguer anomaly (BO) are computed in the 1967 geodetic reference system.

The approximation of the closed form of the 1967 gravity formula is used for theoretical gravity at sea level :

$$\gamma_o = 978031.85 \times [1 + 0.005278895 * \sin^2 (\phi) + 0.000023462 * \sin^4 (\phi)] \text{, mgals}$$

where ϕ is the geographic latitude.

The formulas used in computing FA and BO are summarized below.

Formulas used in computing free-air and Bouguer anomalies

Symbols used :

g	*: observed value of gravity*
γ	*: theoretical value of gravity (on the ellipsoid)*
Γ	*: vertical gradient of gravity (approximated by 0.3086 mgal/meter)*
H	*: elevation of the physical surface of the land, lake or glacier ($H = o$ at sea surface), positive upward*
D_1	*: depth of water, or ice, positive downward*
D_2	*: depth of a gravimeter measuring in a mine, in a lake, or in an ocean, counted from the surface , positive downward*
G	*: gravitational constant ($667.2\ 10^{-13}\ m^3\ kg^{-1}\ s^{-2}$) $\Rightarrow k = 2\ \pi G$*
ρ_c	*: mean density of the Earth's crust (taken as 2670 kg m^{-3})*
ρ_w^f	*: density of fresh water (1000 kg m^{-3})*
ρ_w^s	*: density of salted water (1027 kg m^{-3})*
ρ_i	*: density of ice (917 kg m^{-3})*
FA	*: free-air anomaly*
BO	*: Bouguer anomaly*

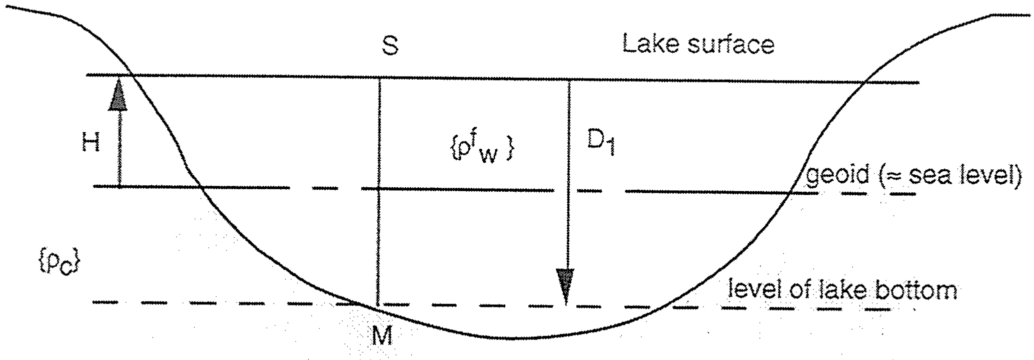
Formulas :

* *FA : The principle is to compare the gravity of the Earth at its surface with the normal gravity, which first requires in some cases to derive the surface value from the measured value. Then, and until now, FA is the difference between this Earth's gravity value reduced to the geoid and the normal gravity γ_o computed on the reference ellipsoid (classical concept). The more modern concept *, in which the gravity anomaly is the difference between the gravity at the surface point and the normal (ellipsoidal) gravity on the telluroid corresponding point may be adopted in the future depending on other major changes in the BGI data base and data management system.*

* *BO : The basic principle is to remove from the surface gravity the gravitational attraction of one (or several) infinite plate (s) with density depending on where the plate is with respect to the geoid. The conventional computation of BO assumes that parts below the geoid are to be filled with crustal material of density ρ_c and that the parts above the geoid have the density of the existing material (which is removed).*

* cf. "On the definition and numerical computation of free air gravity anomalies", by H.G. Wenzel. Bulletin d'Information, BGI, n° 64, pp. 23-40, June 1989.

For example, if a measurement g_M is taken at the bottom of a lake, with the bottom being below sea level, we have :



$$g_S = g_M + 2k\ \rho^f_w D_1 - \Gamma D_1$$
$$\Rightarrow FA = g_S + \Gamma H - \gamma_0$$

Removing the (actual or virtual) topographic masses as said above, we find :

$$\delta g_s = g_s - k\,\rho^f_w\ D_1 + k\,\rho_c(D_1 - H)$$
$$= g_s - k\,\rho^f_w\left[H + (D_1 - H)\right] + k\,\rho_c\,(D_1 - H)$$
$$= g_s - k\,\rho^f_w\ H + k\,(\rho_c - \rho^f_w)(D_1 - H)$$

$$\Rightarrow \quad BO = \delta g_s + \Gamma\ H - \gamma_o$$

The table below covers most frequent cases. It is an update of the list of formulas published before.

It may be noted that, although some formulas look different, they give the same results. For instance BO (C) and BO (D) are identical since :

$$-k\,\rho_i H + k(\rho_c - \rho_i)(D_1 - H) \equiv -k\,\rho_i(H - D_1 + D_1) - k(\rho_c - \rho_i)(H - D_1)$$
$$\equiv -k\,\rho_i\ D_1 - k\,\rho_c(H - D_1)$$

Similarly, BO (6), BO (7) and BO (8) are identical.

Elev. Type	Situation	Formulas
1	Land Observation-surface	$FA = g + \Gamma H - \gamma_0$
		$BO = FA - k\rho_c H$
2	Land Observation-subsurface	$FA = g + 2k\rho_c D_2 + \Gamma(H - D_2) - \gamma_0$
		$BO = FA - k\rho_c H$
3	Ocean Surface	$FA = g - \gamma_0$
		$BO = FA + k(\rho_c - \rho_w^s) D_1$
4	Ocean submerged	$FA = g + (2k\rho_w^s - \Gamma) D_2 - \gamma_0$
		$BO = FA + k(\rho_c - \rho_w^s) D_1$
5	Ocean bottom	$FA = g + (2k\rho_w^s - \Gamma) D_1 - \gamma_0$
		$BO = FA + k(\rho_c - \rho_w^s) D_1$
6	Lake surface above sea level	$FA = g + \Gamma H - \gamma_0$
	with bottom above sea level	$BO = FA - k\rho_w^f D_1 - k\rho_c(H - D_1)$
7	Lake bottom, above sea level	$FA = g + 2k\rho_w^f D_1 + \Gamma(H - D_1) - \gamma_0$
		$BO = FA - k\rho_w^f D_1 - k\rho_c(H - D_1)$
8	Lake bottom, below sea level	$FA = g + 2k\rho_w^f D_1 + \Gamma(H - D_1) - \gamma_0$
		$BO = FA - k\rho_w^f H + k(\rho_c - \rho_w^f)(D_1 - H)$
9	Lake surface above sea level	$FA = g + \Gamma H - \gamma_0$
	with bottom below sea level	$BO = FA - k\rho_w^f H + k(\rho_c - \rho_w^f)(D_1 - H)$
A	Lake surface, below sea level (here $H < 0$)	$FA = g + \Gamma H - \gamma_0$
		$BO = FA - k\rho_c H + k(\rho_c - \rho_w^f) D_1$
B	Lake bottom, with surface below sea level ($H < 0$)	$FA = g + (2k\rho_w^f - \Gamma) D_1 + \Gamma H - \gamma_0$
		$BO = FA - k\rho_c H + k(\rho_c - \rho_w^f) D_1$
C	Ice cap surface, with bottom below sea level	$FA = g + \Gamma H - \gamma_0$
		$BO = FA - k\rho_i H + k(\rho_c - \rho_i)(D_1 - H)$
D	Ice cap surface, with bottom above sea level	$FA = g + \Gamma H - \gamma_0$
		$BO = FA - k\rho_i D_1 - k\rho_c(H - D_1)$

All requests for data must be sent to :

Mr. Gilles BALMA
Bureau Gravimétrique International
18, Avenue E. Belin - 31055 Toulouse Cedex - France

In case of a request made by telephone, it should be followed by a confirmation letter, or telex.
Except in particular case (massive data retrieval, holidays...) requests are satisfied within one month following the reception of the written confirmation, or information are given concerning the problems encountered.

If not specified, the data will be written, formatted (EBCDIC) on labeled 9-track tape (s) with a fixed block size, for large amounts of data, or on diskette in the case of small files. The exact physical format will be indicated in each case.

3. USUAL SERVICES BGI CAN PROVIDE

The list below is not restrictive and other services (massive retrieval, special evaluation and products...) may be provided upon request.

The costs of the services listed below are a revision of the charging policy established in 1981 (and revised in 1989) in view of the categories of users : (1) contributors of measurements and scientists, (2) other individuals and private companies.

The prices given below are in French Francs. They have been effective on January 1, 1992 and may be revised periodically.

3.1. Charging Policy for Data Contributors and Scientists

For these users and until further notice, - and within the limitation of our in house budget, we shall only charge the incremental cost of the services provided. In all other cases, a different charging policy might be applied.

However, and at the discretion of the Director of B.G.I., some of the services listed below may be provided free of charge upon request, to major data contributors, individuals working in universities, especially students ...

3.1.1. Digital Data Retrieval

. on one of the following media :
** printout .... 2 F/100 lines*
** diskette....................... 25 F per diskette (minimum charge : 50 F-*
** magnetic tape .... 2 F per 100 records*
+ 100 F per tape - 1600 BPI
(if the tape is not to be returned)

. minimum charge : 100 F

. maximum number of points : 100 000 ; massive data retrieval (in one or several batches) will be processed and charged on a case by case basis.

3.1.2. Data Coverage Plots : in Black and White, with Detailed Indices

. 20°x20° blocks, as shown on the next pages (maps 1 and 2) : 400 F each set.

. For any specified area (rectangular configurations delimited by meridians and parallels) : 1 F per degree square : 100 F minimum charge (at any scale, within a maximum plot size of : 90 cm x 180 cm).

. For area inside polygon : same prices as above, counting the area of the minimum rectangle comprising the polygon.

3.1.3. Data Screening

(Selection of one point per specified unit area, in decimal degrees of latitude and longitude, i.e. selection of first data point encountered in each mesh area).

. 5 F/100 points to be screened.

. 100 F minimum charge.

3.1.4. Gridding

(Interpolation at regular intervals Δ in longitude and Δ' in latitude - in decimal degrees) :

. 10 F/($\Delta\Delta'$) per degree square

. minimum charge : 150 F

. maximum area : 40° x 40°

3.1.5. Contour Maps of Bouguer or Free-Air Anomalies

At a specified contour interval Δ (1, 2, 5,... mgal), on a given projection :
10 F/Δ per degree square, plus the cost of gridding (see 3.4) after agreement on grid stepsizes. (at any scale, within a maximum map size for : 90 cm x 180 cm).

. 250 F minimum charge

. maximum area : 40° x 40°

3.1.6. Computation of Mean Gravity Anomalies

(Free-air, Bouguer, isostatic) over Δ xΔ' area : 10F/ΔΔ' per degree square.

. minimum charge : 150 F

. maximum area : 40°x40°

3.2. Charging Policy for Other Individuals or Private Companies

3.2.1. Digital Data Retrieval

. 1 F per measurement for non commercial use (guaranteed by signed agreement), 5 F per measurement in other cases (direct or indirect commercial use - e.g. in case of use for gridding and/or maps to be sold or distributed by the buyer in any project with commercial application).

. minimum charge : 500 F

3.2.2. Data Coverage Plots, in Black and White, with Detailed Indices

. 2 F per degree square ; 100 F minimum charge. (maximum plot size = 90 cm x 180 cm)

. For area inside polygon : same price as above, counting the area of the smallest rectangle comprising ihe polygon.

3.2.3. Data Screening

. 1 F per screened point for non commercial use (guaranteed by signed agreement), 5 F per screened point in other cases (cf. 3.2.1.).

. 500 F minimum charge

3.2.4. Gridding

Same as 31.4.

3.2.5. Contour Maps of Bouguer or Free-Air Anomalies

Same as 3.1.5.

3.2.6. Computation of Mean Gravity Anomalies

Same as 3.1.6.

3.3. Gravity Maps

The pricing policy is the same for all categories of users

3.3.1. Catalogue of all Gravity Maps

Printout : 200 F
Tape 100 F (+ tape price, if not to be returned)

3.2.2. Maps

. Gravity anomaly maps (excluding those listed below) : 100 F each

. Special maps :

Mean Altitude Maps

FRANCE	(1: 600 000)	1948	6 sheets	65 FF the set
WESTERN EUROPE	(1:2 000 000)	1948	1 sheet	55 FF
NORTH AFRICA	(1:2 000 000)	1950	2 sheets	60 FF the set
MADAGASCAR	(1:1 000 000)	1955	3 sheets	55 FF the set
MADAGASCAR	(1:2 000 000)	1956	1 sheet	60 FF

Maps of Gravity Anomalies

NORTHERN FRANCE	Isostatic anomalies	(1:1 000 000)	1954	55 FF
SOUTHERN FRANCE	Isostatic anomalies Airy 50	(1:1 000 000)	1954	55 FF
EUROPE-NORTH AFRICA	Mean Free air anomalies	(1:1 000 000)	1973	90 FF

World Maps of Anomalies (with text)

PARIS-AMSTERDAM	Bouguer anomalies	(1:1 000 000)	1959-60	65 FF
BERLIN-VIENNA	Bouguer anomalies	(1:1 000 000)	1962-63	55 FF
BUDAPEST-OSLO	Bouguer anomalies	(1:1 000 000)	1964-65	65 FF
LAGHOUAT-RABAT	Bouguer anomalies	(1:1 000 000)	1970	65 FF
EUROPE-AFRICA	Bouguer Anomalies	(1:10 000 000)	1975	180 FF with text 120 FF without text
EUROPE-AFRICA	Bouguer anomalies-Airy 30	(1:10 000 000)	1962	65 FF

Charts of Recent Sea Gravity Tracks and Surveys (1:36 000 000)

CRUISES prior to	1970	65 FF
CRUISES	1970-1975	65 FF
CRUISES	1975-1977	65 FF

Miscellaneous

CATALOGUE OF ALL GRAVITY MAPS

listing	200 FF
tape	300 FF

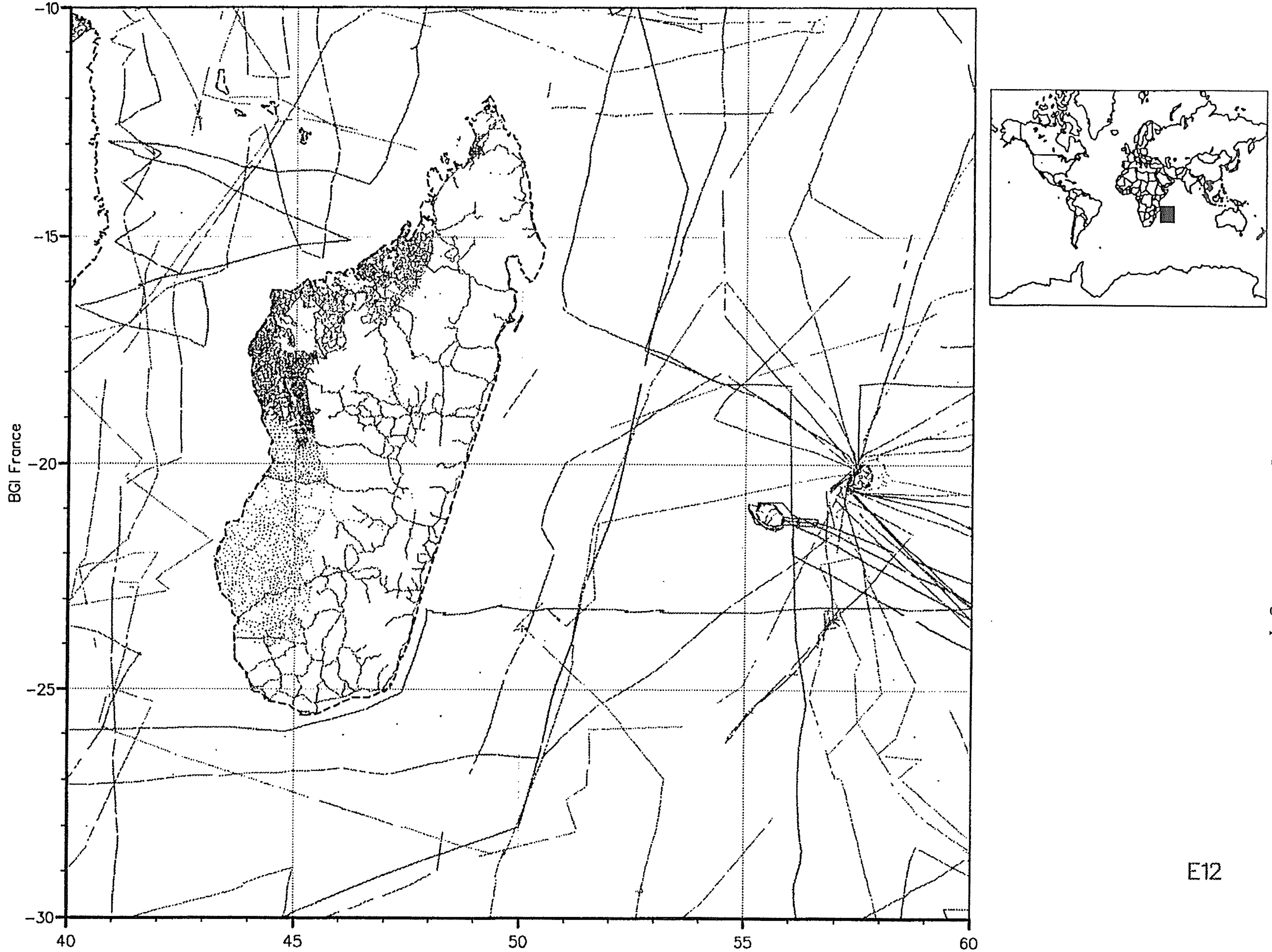
THE UNIFICATION OF THE GRAVITY NETS OF AFRICA

(Vol. 1 and 2) *1979* *150 FF*

. Black and white copy of maps : 150 F per copy

. Colour copy : price according to specifications of request.

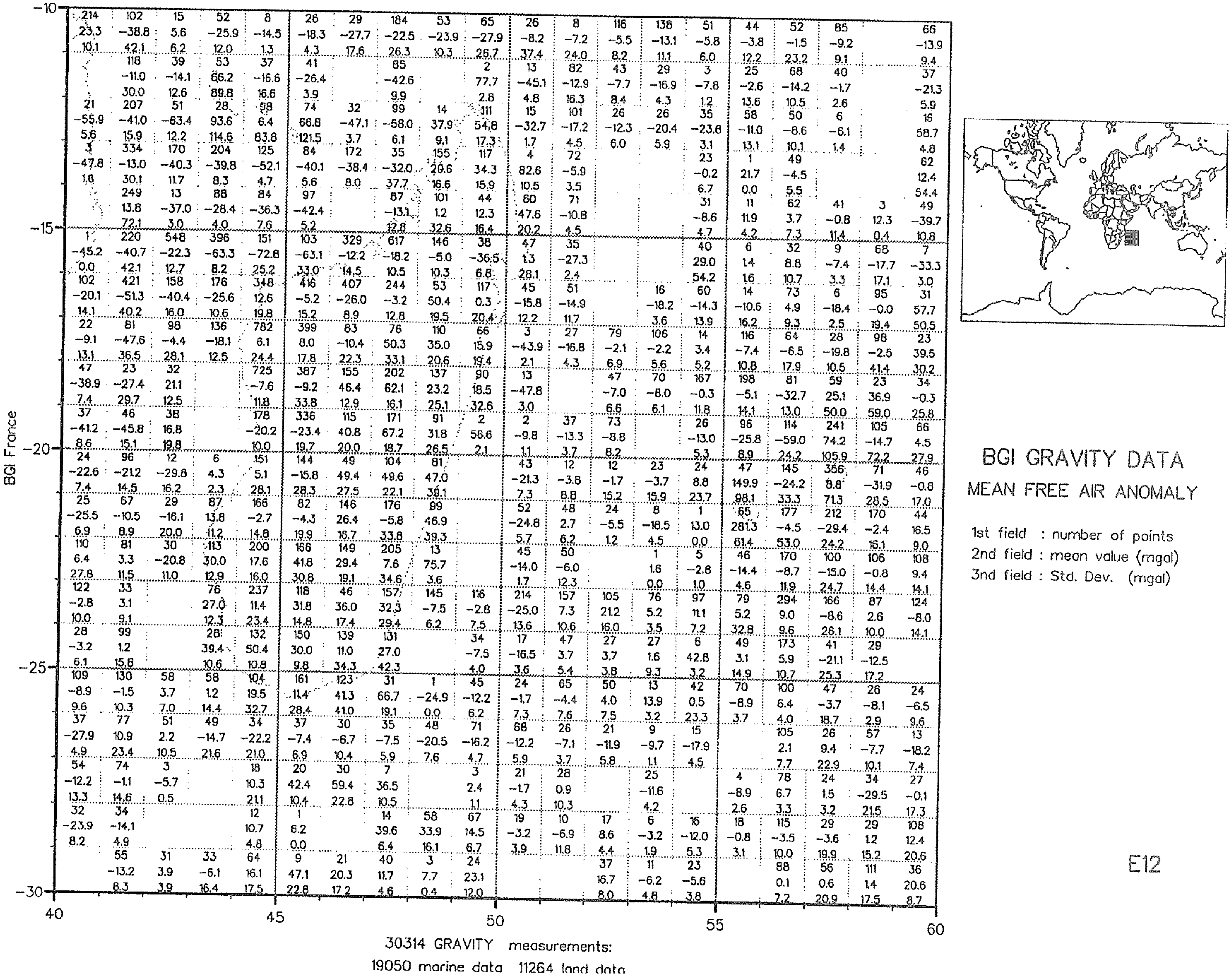
Mailing charges will be added for air-mail parcels when "Air-Mail" is requested)



51732 GRAVITY measurements:
40389 marine data 11343 land data

Map 1. Example of data coverage plot

E12



Map 2. Example of detailed index (Data coverage corresponding to Map 1)

4. PROVIDING DATA TO B.G.I.

4.1. Essential Quantities and Information for Gravity Data Submission

1. Position of the site :

- *latitude, longitude (to the best possible accuracy),*
- *elevation or depth :*
  . for land data : elevation of the site (on the physical surface of the Earth) *
  . for water stations : water depth.

2. Measured (observed) gravity, corrected to eliminate the periodic gravitational effects of the Sun and Moon, and the instrument drift **

3. Reference (base) station (s) used. For each reference station (a site occupied in the survey where a previously determined gravity value is available and used to help establish datum and scale for the survey), give name, reference station number (if known), brief description of location of site, and the reference gravity value used for that station. Give the datum of the reference value ; example : IGSN 71.

4.2. Optional Information

The information listed below would be useful, if available. However, none of this information is mandatory.

. Instrumental accuracy :

- *identify gravimeter (s) used in the survey. Give manufacturer, model, and serial number, calibration factor (s) used, and method of determining the calibration factor (s).*

- *give estimate of the accuracy of measured (observed) gravity. Explain how accuracy value was determined.*

. Positioning accuracy :

- *identify method used to determine the position of each gravity measurement site.*

- *estimate accuracy of gravity station positions. Explain how estimate was obtained.*

- *identify the method used to determine the elevation of each gravity measurement site.*

- *estimate accuracy of elevation. Explain how estimate was obtained. Provide supplementary information, for elevation with respect to the Earth's surface or for water depth, when appropriate.*

. Miscellaneous information :

- *general description of the survey.*
  date of survey : organization and/or party conducting survey.
- *if appropriate : name of ship, identification of cruise.*
- *if possible, Eötvös correction for marine data.*

. Terrain correction

Please provide brief description of method used, specify : radius of area included in computation, rock density factor used and whether or not Bullard's term (curvature correction) has been applied.

---

* Give supplementary elevation data for measurements made on towers, on upper floor of buildings, inside of mines or tunnels, atop glacial ice. When applicable, specify whether gravity value applied to actual measurement site or it has been reduced to the Earth's physical surface (surface topography or water surface)
Also give depth of actual measurement site below the water surface for underwater measurements.
** For marine gravity stations, gravity value should be corrected to eliminate effects of ship motion, or this effect should be provided and clearly explained.

. Isostatic gravity

Please specify type of isostatic anomaly computed.
Example : Airy-Heiskanen, T = 30 km.

. Description of geological setting of each site

4.3. Formats

Actually, any format is acceptable as soon as the essential quantities listed in 4.1. are present, and provided that the contributor gives satisfactory explanations in order to interpret his data properly.

The contributor may use the EOL and/or EOS formats as described above, or if he wishes so, the BGI Official Data Exchange Format established by BRGM in 1976 : "Progress Report for the Creation of a Worldwide Gravimetric Data Bank", published in BGI Bull. Info, n° 39, and recalled in Bulletin n° 50 (pages 112-113).

If magnetifc tapes are used, contributors are kindly asked to use 1600 bpi, unlabelled tapes (if possible), with no password, and formatted records of possibly fixed length and a fixed blocksize, too. Tapes are returned whenever specified, as soon as they are copied

PART II

Minutes of BGI Directing Board

Minutes of the meeting of the Directing Board of the Bureau Gravimetrique International held on 8th July 1995 at the Boulder IUGG assembly.

Present: Marson (Chair), Balmino, Boedecker, Courtier, Faller, Forsberg, Groten, Mäkinen, Poitevin, Sanso, Sünkel, Wenzel.

1. Report of the Director of the BGI (Balmino).

Balmino presented the Bureau Gravimetrique International activity report for June 1991 - June 1995 (report distributed).

A notable number of point gravity measurements from Africa have been added. The BGI holdings now total 12,702,874 point measurements, consisting of 10,534,635 validated marine measurements and 2,168,239 land measurements.

Software is now in place providing fast routine validation of marine data.

A CD-ROM of non-confidential gravity data and retrieval software is now available for UNIX systems. The pricing policy is fixed with a low price for scientists and individuals and a higher price for companies and institutions. The PC version should be available later this year.

The last point of the report shows the number of requests for only part of 1995. The number of requests is expected to continue to increase as in previous years. It was noted that the distribution of the CD-ROM may have an impact on the number of future direct requests for data.

The Board discussed the relationship and interaction of the BGI and IGeS. The discussion will be continued when the IGeS receives a formal structure.

2. Report of the President of the IGC (Marson).

Marson has been reelected as President of Commission III for a second and last term of four years. Due to the renewed structure of the Commission the Directing Board members will be:

Voting members :	I. Marson	(Italy)	IGC President
	G. Boedecker	(Germany)	IGC Vice-Prdt + WG2 Chairman
	J. Mäkinen	(Finland)	IGC Vice-President
	G. Balmino	(France)	BGI Director
	R. Forsberg	(Denmark)	Section III President
	J.E. Faller	(USA)	Elected
	E. Groten	(Germany)	Elected
	P.P. Medvedev	(Russia)	Elected
	S. Takemoto	(Japan)	Elected
Non voting members :	L. Robertsson	(France)	WG6 Chairman
	B. Richter	(Germany)	WG7 Chairman
	M. Becker	(Germany)	WG8 Chairman
	N. Courtier	(Canada)	Secretary
	E. Klingele	(Switzerland)	Secretary
Ex-Officio members :	F. Sanso	(Italy)	IGeS Director
	H. Sünkel	(Austria)	IGeC President
	P. Paquet	(Belgium)	FAGS Representative

Action: Marson - Contact candidates for the position on the Board open for a representative from Japan.

Action: Balmino - The updated list of members of Directing Board should be communicated to FAGS.

The project to establish absolute datums in central Europe is going smoothly. Absolute measurements are being made and the problem of lack of absolute datums should be solved in a short time.

Sünkel and Marson have received a proposal from Segawa for a mid-term symposium in September 1996, to be held in Japan, between the IGC/IGeC meetings in 1994 and 1998. The schedule for IAG and IGC/IGeC meetings was reviewed and two options were proposed:

1) Full meeting in Japan in 1998.

2) Regional meeting in Japan in 1996, Full meeting in Europe in 1998.

Action: Marson to consult with Segawa.

The next absolute gravity intercomparison should be held in Sèvres in June 1997. This will bring the intercomparisons back into the original four year cycle and will address, in a timely fashion, the systematic error recently discovered by Niebauer and Sasagawa which is associated with the comparator chip of the JILA and some FG5 absolute gravimeters.

The subcommissions will be reactivated with precise tasks. The first of these will be to establish absolute gravity datum sites in Africa followed by network densification. The work will probably have to be a series of small bilateral projects between individual African countries and the country providing the instrumentation. Some funding may be available.

Action: Marson to contact candidates for the posts of President and Vice-President of the African Subcommission.

3. Report of the Working Group chairmen

The lifetime, roles, and lack of rules or terms of reference for the working groups were discussed. The working groups could be more focused on specific problems and have a clearly defined lifetime.

Action: Marson and Wenzel to talk to other commission presidents to establish a common platform for working groups.

Working Group 2 (WG2): World Gravity Standards (Boedecker).

Boedecker tabled a summary report.

The proposal that "BGI take over the data collection, absolute gravity data and contact information" was agreed upon. WG2 will continue to promote the need for absolute measurements.

Action: Boedecker to rephrase the terms of reference for WG2 for inclusion in the handbook.

There is a lack of measurements at IAGBN-A stations in Africa, India and Siberia.

Working Group 5 (WG5): Monitoring of Non-Tidal Gravity Variations (Poitevin).

The second workshop on "Non-Tidal Gravity Changes, Intercomparison between Absolute and Superconducting Gravimeters" was held in Walferdange September 1994. One thousand copies of the proceedings published by the European Centre for Geodynamics and Seismology have been widely distributed.

The Board thanked Poitevin for organizing an outstanding meeting and the high quality of the proceedings. This working group, having achieved its objectives, was closed.

Working Group 6 (WG6): Intercomparison of Absolute Gravimeters (Marson).

An international intercomparison was held in Sèvres in 1994. The results which show that there may be two families of instruments may be explained by the recently discovered systematic error of 10-20 microgals in many of the JILA and FG5 absolute gravimeters.

The proposal that "the next intercomparison of absolute gravimeters be held in Sèvres in June 1997" was agreed upon.

Action: Marson to contact Robertson (BIPM) to see if he would be willing to become the chairman for this working group.

New Working Group (WG7): Global Gravity Monitoring Network.

Following the agreement between the International Gravity Commission and the Earth Tides Commission a common working group will be established with one chairman reporting to both Commissions. The group will have separate numbers in the two commissions. The working group will be chaired by Richter, IFAG.

New Working Group (WG8): Relative Gravity Network for 1997 Absolute Gravimeter Intercomparison (Becker).

The proposal that a new working group to "Provide a relative gravity network for the 1997 International Absolute Gravimeter Intercomparison" be formed was agreed upon.

4. Future Activities.

Aspects of future activities had been discussed in items 1 - 3.

A questionnaire to assess the needs of the gravity community has been distributed to a number of agencies and institutions. The results will be reported at the 1997 IAG meeting.

5. International Geoid Activities - Global and Regional.

Sünkel reported on the activities of the International Geoid Commission and its operating arm; the International Geoid Service.

6. Miscellaneous

None

Minutes of the meeting of the Directing Board of the Bureau Gravimetrique International held on 2nd October 1996 at the GraGeoMar96 Symposium, Tokyo (Japan)

Present : I. Marson (IGC President), J. Mäkinen (IGC Vice-President), G. Balmino (BGI Director), R. Forsberg (Section III President), B. Richter (Chairman WG07), J. Faller, E. Groten, H.G. Wenzel (delegated as FAGS representative), E. Klingelé (Secretary).

Agenda of the meeting :

1. - BGI activity report
2.- Directing Board members
3.- WG activities
4.- IGC activities and next meeting
5.- Miscellaneous

I.- BGI Activities Report

Dr. Balmino reports about the activities of the BGI by commenting a distributed paper. A discussion follows about access to the data base of the BGI. Dr. Balmino explains the concept developed at the BGI. He also explains that the data base is located on one main computer of the « Centre National d'Etudes Spatiales » in Toulouse, and that for reasons of confidentiality and security, the access will be possible only after the data base has been separated from the main frame or an ad'hoc security procedure has been found.

A home page about IUGG is in preparation and the BGI will prepare a rubric concerning its activities and in what manner the gravimetric data can be retrieved.

The BGI has a project to collect and merge all the available absolute g values and airborne data into its data base. For the later the BGI will start with the Swiss data which will serve to define the format to be used for further collection.

Dr. Forsberg says that he will try to obtain the release of the Greenland data but that he will have to discuss this with the NIMA, previously DMA (Defense Mapping Agency) first.

Dr. Balmino informs the Directing Board that his mandate as Director of BGI will expire at the end of 1999. Therefore the Directing Board will face the problem of redefining the role of the BGI for the future and of the preparation of a « call for proposal » for running the BGI and for a new Director. The candidatures will be submitted to a review process and then presented at the IAG for decision. The critical point is that the country providing a head-office will also have to provide the financial means and manpower for running the office. This aspect has to be made clear in the call for proposal.

The Directing Board decides to nominate a small committee of five members for analysing the future of BGI, for preparing the call for proposals and to set a time schedule. This committee will consist of

Dr. G. Balmino
Dr. R. Forsberg
Prof. I. Marson
Prof. S. Takemoto
Dr. J. Faller

II.- Directing Board Members

New members should be elected at the IGC General Assembly in 1998. The new board should be accepted by the IUGG council in 1999.

A new President, a new Vice-President and a new Secretary of the IGC should also be elected in 1999.

Prof. Wenzel points out that the elections shall take place in 1998 and the new committee should start acting in 1999, just after the IUGG General Assembly.

III.- WG Activities

WG02 : Chairman : Dr. G. Boedecker

Prof. Marson reports in the name of G. Boedecker about the activities of the WG02. Prof. Wenzel and Dr. Forsberg suggest that the collection of reference points at sea coasts should be continued by the BGI.

WG06 : Chairman : Dr. L. Robertsson

Prof. Marson explains that the working group terminated its activities under his chairmanship after the meeting held in Trieste in June 1996, about the inter comparison campaign of absolutes instruments. Dr. Robertson will organise the fifth inter comparison in the late autumn of 1997.

WG07 : Chairman : Dr. B. Richter

Dr. Richter informs the Directing Board that the first working group meeting will take place the following day.

WG08 : was not represented

IV.- IGC Activities and Next Meeting

Prof. Marson informs about the progress of the project endorsed by IGC and NIMA (ex DMA) to perform absolute gravimetry in Central Europe, and which is almost completed. Absolute sites have been established in Lithuania, Latvia, Estonia, Poland, Hungary, Slovenja and Croatia.

IGC is sponsoring the workshop on gravimetry which will be held in Cairo (Egypt) at the end of November - beginning of December, 1996. Members of the IGC executive board will actively participate in the workshop which is aimed at training young scientists of Africa, to plan, measure and analyse gravity networks.

V.- Miscellaneous

None.

Meeting ended at 13:05 (local time)

The Secretary of the BGI Directing Board
Prof. E. Klingelé

PART III

CONTRIBUTING PAPERS

MEAN 1° x 1° VALUES OF POTENTIAL FUNCTIONALS OVER CHINA

G. Balmino
Bureau Gravimétrique International, Toulouse (France)
J.Y. Chen
National Bureau of Surveying and Mapping,, Beijing (China)
N. Valès
Groupe de Recherches de Géodésie Spatiale and Bureau Gravimétrique International, Toulouse (France)

Abstract. Three sets of 1° x 1° averaged values of potential functions over main land China : free air anomalies, Bouguer anomalies and geoid heights, useful to geodesists and geophysicists, have been released by the National Bureau of Surveying and Mapping and placed at the Bureau Gravimétrique International for wide distribution to the community of geoscientists.

Introduction and Background

Essential gravitational potential data over China had been limited for a long time to very few point gravity measurements made in the 1930's and 40's by R.F. Lejay and his collaborators (fig. 1). Needless to say that such scarce data over a territory of this size were of no use to geoscientists.

Similarly no international gravity reference station had been installed; the IGSN71 station in Hong-Kong was the only one usable in this part of the Asian continent. On the other hand, long wavelength geopotential models derived from satellite data were the only sources of reliable, though not detailed information over China. The situation was similar in some other large countries, as a matter of fact, sometimes as the result of classification exerted at that time, or because of difficulties of making measurements for instance over regions with high mountains, large glaciers, etc... Predicted mean values based on topo-isostatic models were sometimes used although they later proved to be inadequate in many cases.

In the 1980's, the State Seismological Bureau (SSB) undertook a Lithospheric Map Project over China in the framework of the International Commission for the Lithosphere (a joint commission of IUGG[1] and IUGS[2]). This involved over 200 scientists from seven different Institutes of the SSB, of the Provincial Seismological Bureaus and also from the Wuhan Geological College, the Aerogeophysical Team of the Ministry of Geology and Mineral Resources. The outcome was the production of an atlas with a comprehensive set of 68 maps on the scale of 1:14 000 000 and of 1:4 000 000, of China and adjacent seas (Ma Xingyuan, 1989). Among these maps was a map of free-air gravity anomalies at the scale of 1:14 000 000, shown with contour lines every 20 mgals. It was based on previous maps at 1:1 000 000 scale established by the National Bureau of Surveying and Mapping (NBSM) and on anomalies transformed from the 1:3 000 000 scale Bouguer Anomaly Map produced by the Oceanic Research Institute of Southern Sea, Chinese Academy of Science. The 1° x 1° mean values were obtained by averaging up to 24 values screened at the resolution of 15' x 10'. Fundamental stations on which the map is referenced were in the Potsdam System and the heights were in the Yellow Sea System. The anomalies were given with respect to the Helmert normal formula (see below). Although the resolution of this map was strongly limited due to the contour line inverval, it represented a big step forward in the gravity field knowledge over China. Fig. 2 shows this free-air field obtained after digitization of the map and re-gridding with a 0.5° stepsize in latitude and longitude.

In 1995, the NBSM in Beijing placed three files of averaged 1° x 1° values of potential functionals at the BGI in Toulouse, which open new possibilities in works of qualitative or quantitative character.

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[1] IUGG : International Union of Geodesy and Geophysics
[2] IUGS : International Union of Geological Sciences

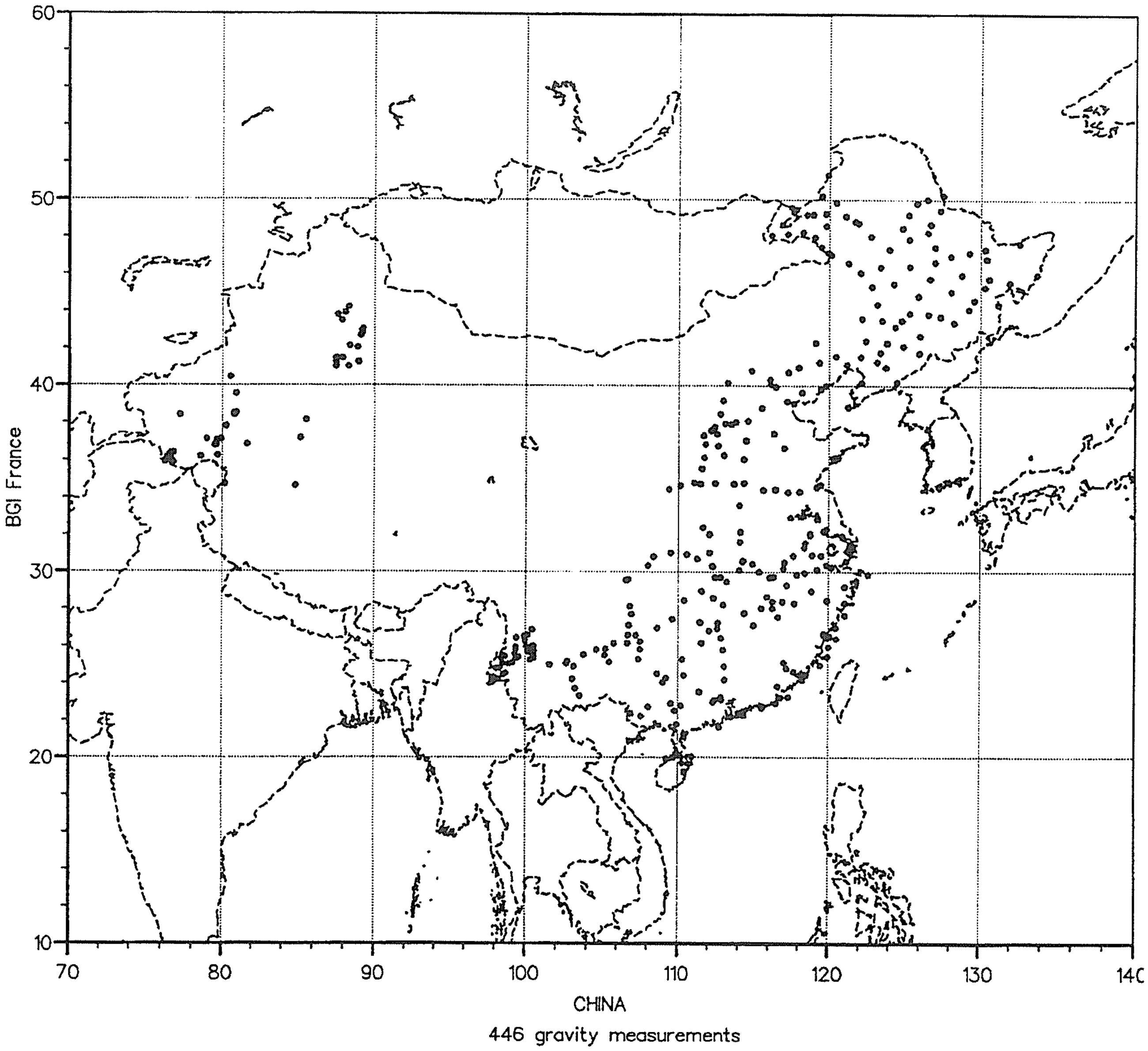
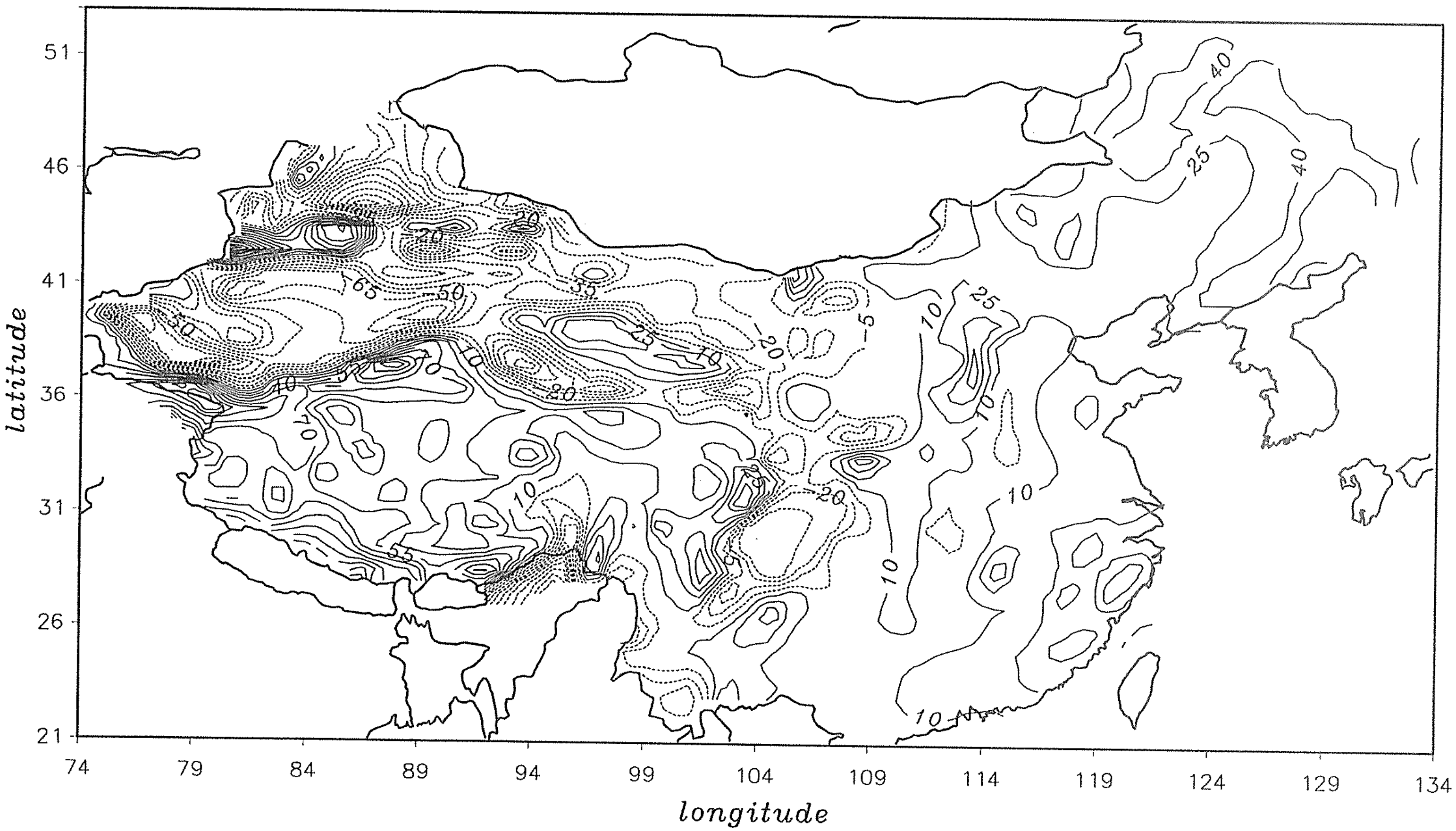


Fig. 1. Point gravity measurements in the BGI data base (as of Dec. 17, 1996)

Fig.2 : Free-air anomalies 30'*30' , ICL Atlas



The NBSM files

The grids provided to BGI consist of mean values of :

. Free-air gravity anomalies
. Bouguer anomalies
. Geoid heights

The last two sets were entirely computed at NBSM. Each value was referenced to the N-W corner latitude and longitude. The gravity anomalies had been corrected for the Potsdam bias (- 13 mgals)[3] and were referenced to the Helmert formula (because its parameters are very close to the Krasovsky ellipsoid adopted in China). According to it, the normal gravity at the ellipsoid surface is :

$$\gamma_o \text{ (mgal)} = 978030 \text{ (}1 + 0.005302 \sin^2 \varphi - 0.000007 \sin^2 2\varphi$$

All values were then transformed into the GRS67 system, to be in accordance with all data stored in the BGI data base. Figures 3, 4 and 5 are contoured maps of the three grids.

The precision of the mean gravity anomalies is about 5 to 7 mgals in the low elevation terrains (approximately east of the meridian λ = 108°E) and can be significantly worse over mountainous areas where it can reach 15 to 20 mgals due to poorer point measurement coverage. The comparison of these new gravity anomalies with a set of 1° x 1° anomalies derived from figure 2 and after conversion into GRS67, exhibits an r.m.s. of 21 mgals, a large part of it being probably due to the relatively poor resolution and contour interval of the ICL atlas map.

First Utilization of the New Free-Air Grid

The NBSM set of free-air gravity anomalies has been used in the latest global geopotential solution GRIM4-C4 (Schwintzer et al., 1996) which is a combined model based on satellite measurements, mean surface gravity and satellite altimetry derived geoid heights and gravity data. This model is truncated at degree and order 72, which is sufficient for general utilization, especially as concern precise satellite orbits of usual geodetic satellites with applications in satellite altimetry, earth kinematics monitoring, etc... Figure 6 shows the long wavelength gravity field represented by this model over China.

In the framework of the continuing cooperation between the GeoForschungsZentrum (Germany) and the Groupe de Recherches de Géodésie Spatiale (France), which are computing the GRIM series solutions, future work will expand the resolution of such general models to higher frequencies and will therefore fully benefit from the one degree resolution of this new data set, which can be used in principle for models of degree and order up to 180.

---

[3] There are two gravimetric reference systems in China : CGBN57 (China Gravity Base Net 1957), based on the Potsdam system and introduced in China by ties to three fundamental stations on the ex-USSR ; and CGBN85 based on 6 absolute measurements made by Prof. Marson and his group in 1981 and on 5 links to international reference stations (Xu et al., 1986). Actually the bias between the two systems (g_{85} - g_{57}) is close to - 14 mgals in the North and close to - 13 mgals in the South of China, and can be approximated by a linear correction.

*Fig.3 : Free-air anomalies 1deg.*1deg. , NBSM file*

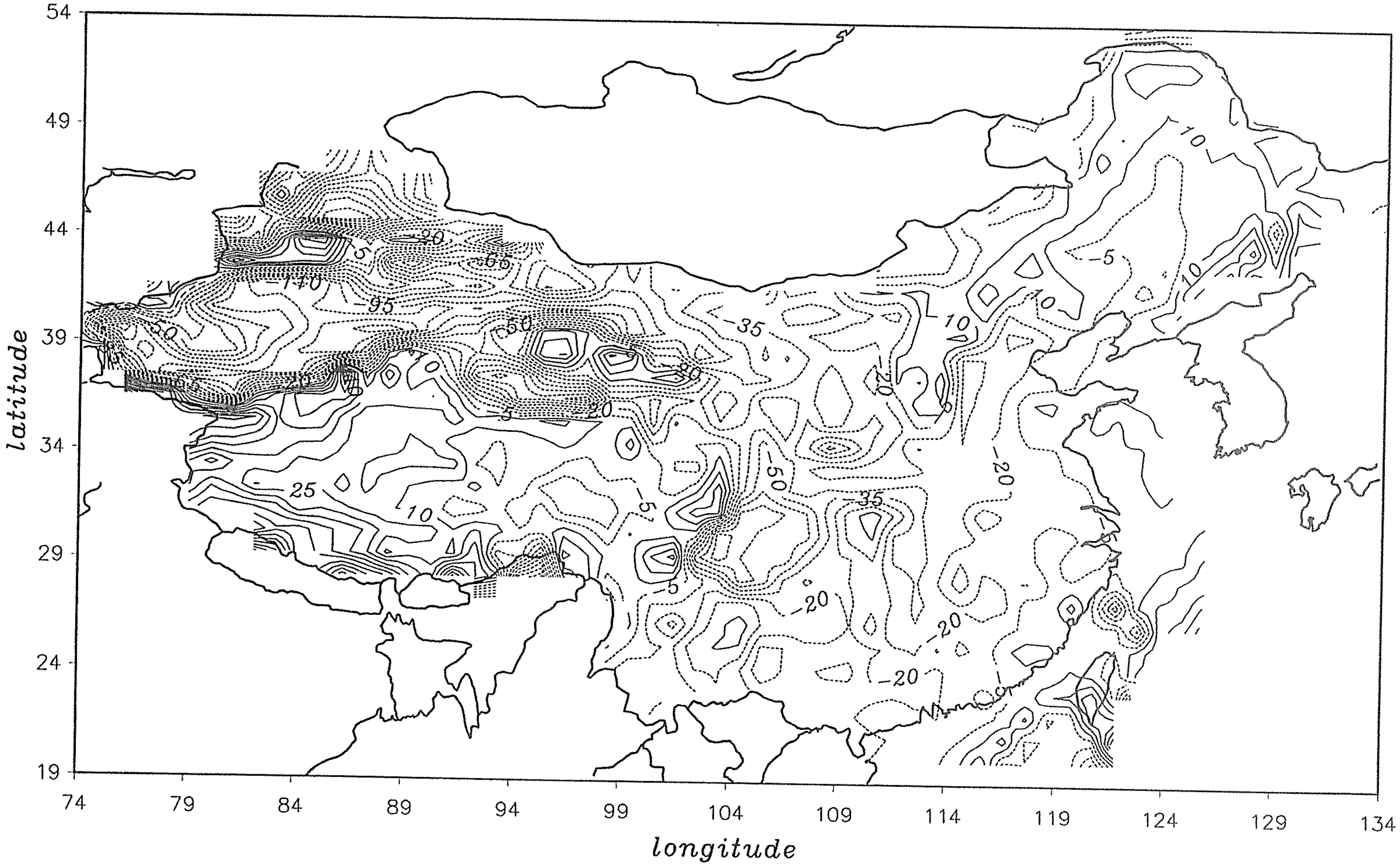


*Fig.4 : Bouguer anomalies 1deg.*1deg. , NBSM file*

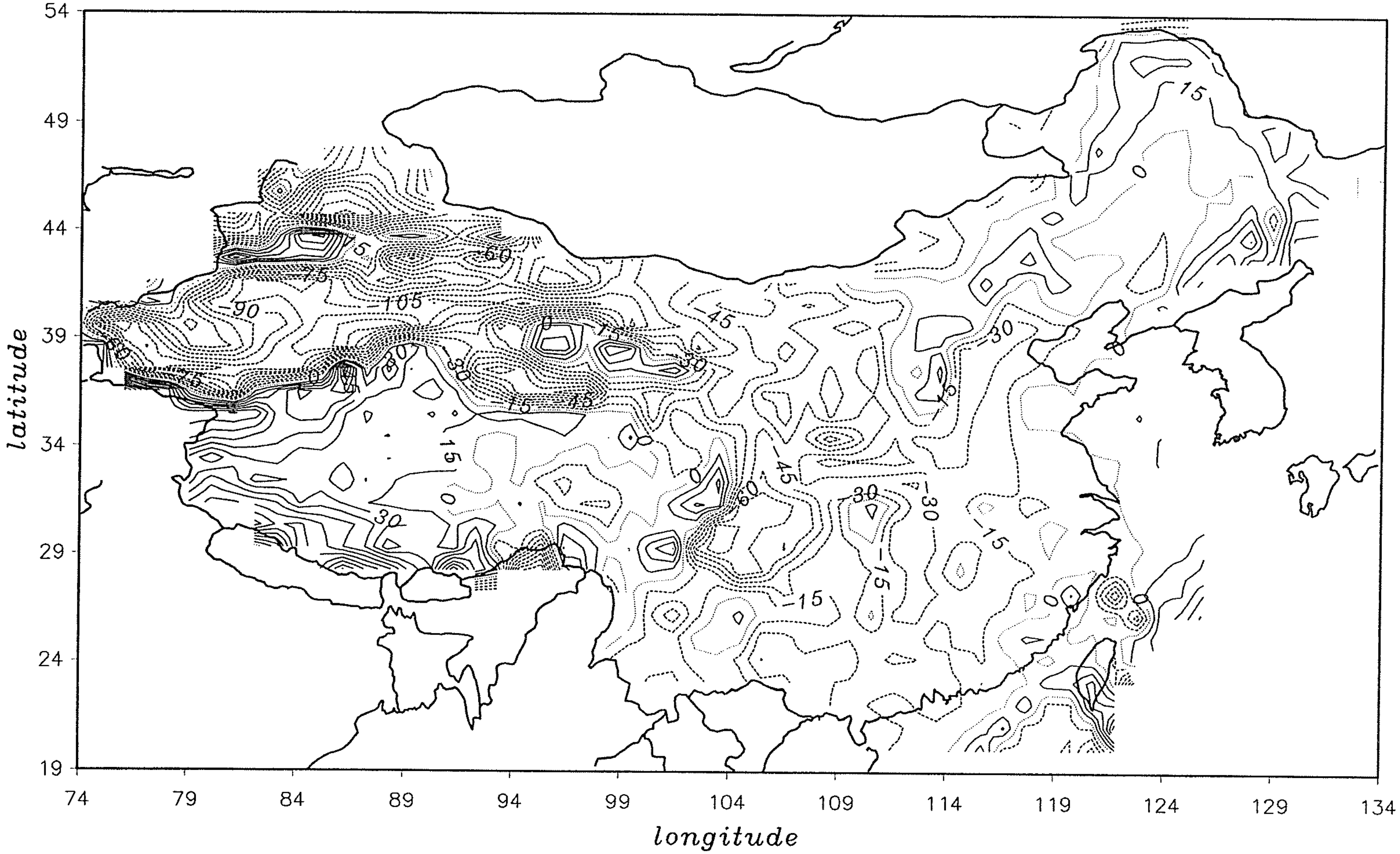


*Fig.5 : Geoid heights 1deg.*1deg. , NBSM file*

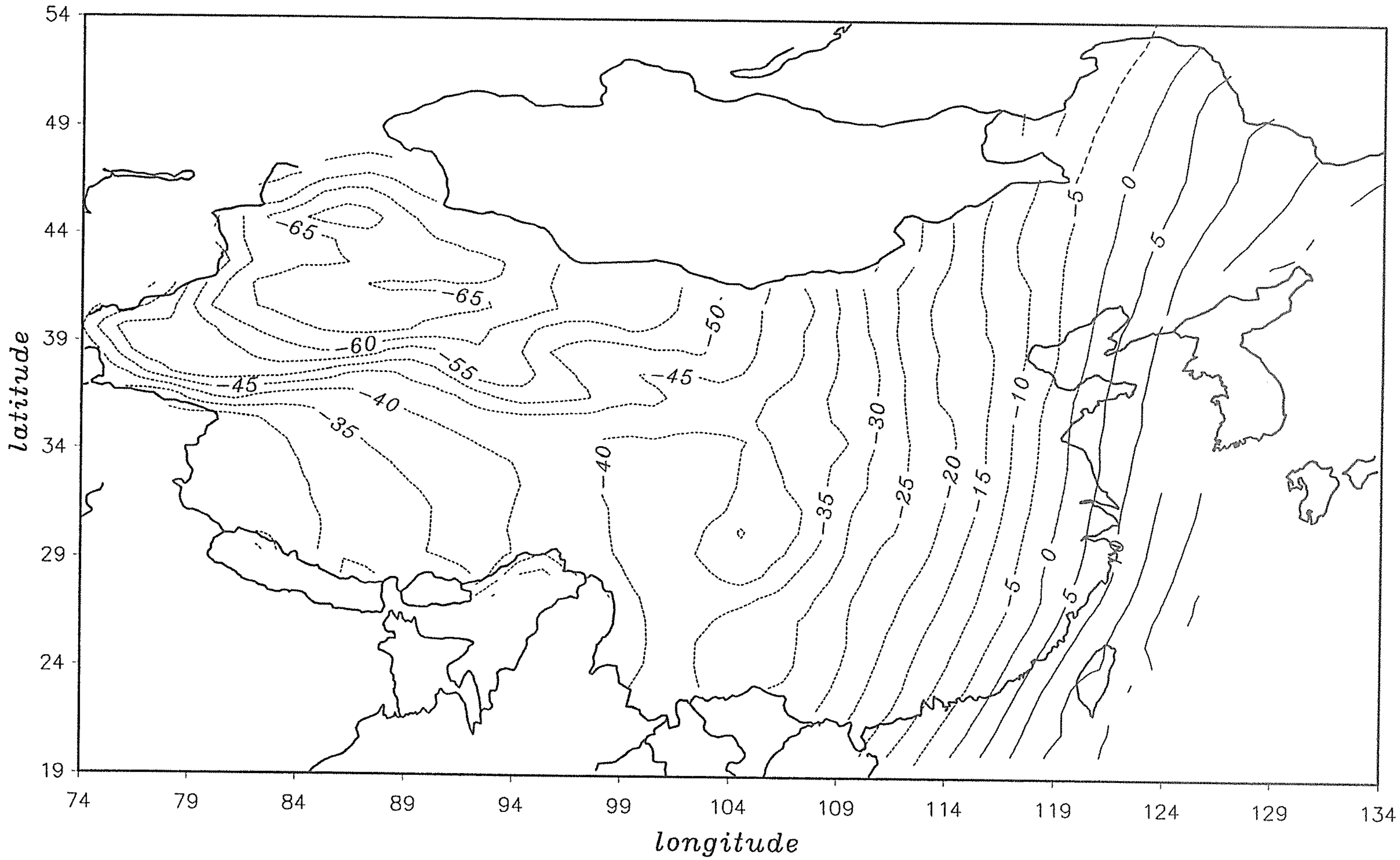
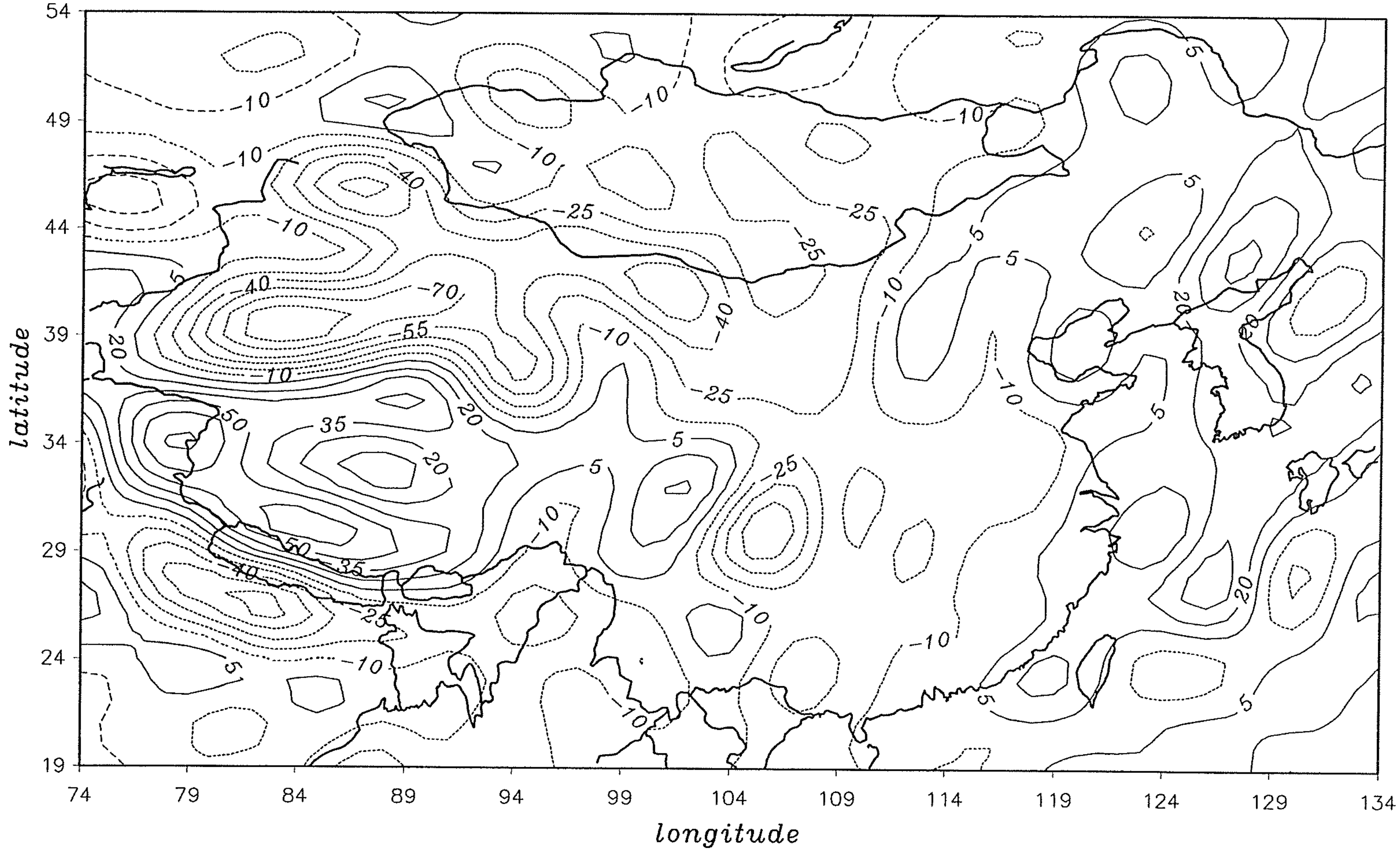


*Fig.6 : Free-air anomalies 1deg.*1deg. , GRIM4-C4 model*



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