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BUREAU GRAVIMETRIQUE INTERNATIONAL

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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.

Address :

BUREAU GRAVIMETRIQUE INTERNATIONAL
18, Avenue Edouard Belin
31055 TOULOUSE CEDEX
FRANCE

Phone :

(33) 61 33 28 89
(33) 61 33 29 80

Fax :

(33) 61 25 30 98

E-mail :

balmino@pontos.cnes.fr

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INTERNAL MATTERS

GENERAL INFORMATION

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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 (75 have been issued as of December 31, 1994 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

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.			
	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 = topographical map	
		2 = trigonometric positioning	
		3 = satellite	
	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	
	31-38	Elevation of the station (unit : centimeter)	(8 char.)
	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)	
	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	
	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	
	45-52	Supplemental elevation (unit : centimeter)	(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	
	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	
88-91	Density used for terrain correction	(4 char.)
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	
94-99	Correction of observed gravity (unit : microgal)	(6 char.)
100-105	**Reference station**	(6 char.)
	This station is the base station (BGI number) to which the concerned station is referred	

106-108	Apparatus used for the measurement of G 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	(3 char.)
109-111	**Country code (BGI)**	(3 char.)
112	**Confidentiality** 0 = without restriction .....1 = with authorization 2 = classified	(1 char.)
113	**Validity** 0 = no validation 1 = good 2 = doubtful 3 = lapsed	(1 char.)
114-120	Numbering of the station (original)	(7 char.)
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) *computed according to the next mentioned radius & density*	(6 char.)
86-87	Information about terrain correction 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	(2 char.)
88-91	Density used for terrain correction	(4 char.)
92-93	Mathew's zone *when the depth is not corrected depth, this information is necessary. For example : zone 50 for the Eastern Mediterranean Sea*	(2 char.)
94-95	Accuracy of gravity 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	(2 char.)
96-101	Correction of observed gravity (unit : microgal)	(6 char.)
102-110	Date of observation *in Julian day - 2 400 000 (unit : 1/10 000 of day)*	(9 char.)
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** 0 = without restriction 1 = with authorization 2 = classified	(1 char.)
123	**Validity** 0 = no validation 1 = good 2 = doubtful 3 = lapsed	(1 char.)
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).*

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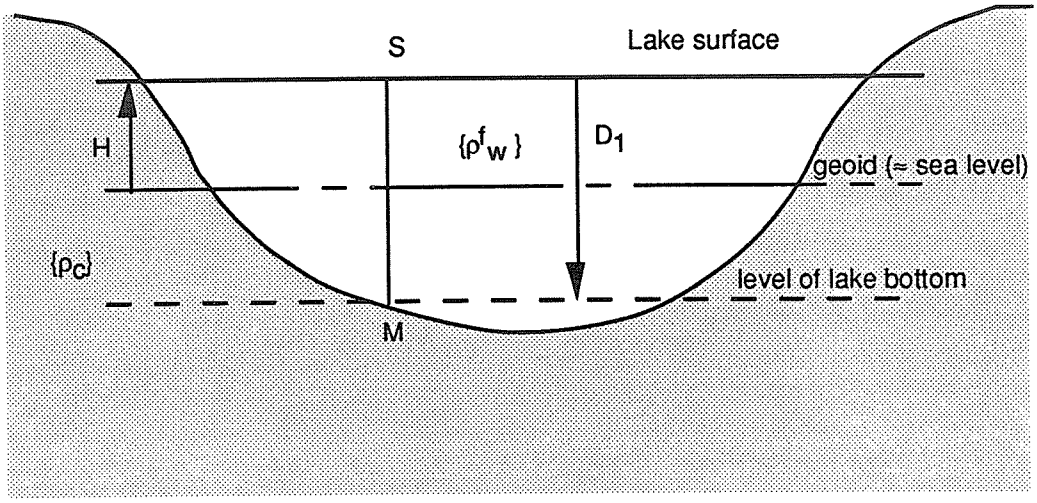
[*] cf. "On the definition and numerical computation of free air gravity anomalies", by H.G. Wenzel. Bulletin d'Information, BGI, n° 64, pp. 23-40, June 1989.

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



$g_S = g_M + 2\,k\,\rho_w^f D_1 - \Gamma D_1$
$\Rightarrow FA = g_S + \Gamma H - \gamma_o$

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

$$\begin{aligned}\delta g_s &= g_s - k\,\rho_w^f\,D_1 + k\,\rho_c(D_1 - H)\\ &= g_s - k\,\rho_w^f\,[H + (D_1 - H)] + k\,\rho_c\,(D_1 - H)\\ &= g_s - k\,\rho_w^f\,H + k\,(\rho_c - \rho_w^f)(D_1 - H)\end{aligned}$$

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

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 :

$$\begin{aligned}-k\,\rho_i H + k(\rho_c - \rho_i)(D_1 - H) &\equiv -k\,\rho_i(H - D_1 + D_1) - k(\rho_c - \rho_i)(H - D_1)\\ &\equiv -k\,\rho_i\,D_1 - k\,\rho_c(H - D_1)\end{aligned}$$

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

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

2.6 Satellite Altimetry Data

BGI has access to the Geos 3, Seasat and Geosat data bases which are managed by the Groupe de Recherches de Géodésie Spatiale (GRGS). These data are now in the public domain. ERS1 and TOPEX-POSEIDON data are not.

Since January 1, 1987, the following procedure has been applied :

(a) Requests for satellite altimetry derived geoid heights (N), that is : time (julian date), longitude, latitude, N, are processed by BGI. for small areas (smaller than 20° x 20°), and forwarded to GRGS for larger areas.

(b) Requests for the full altimeter measurements records are forwarded to GRGS, or NASA in the case of massive request.

In all cases, the geographical area (polygon) and beginning and end of epoch (if necessary) should be given.

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

. minimum charge : 150 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

. 250 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*

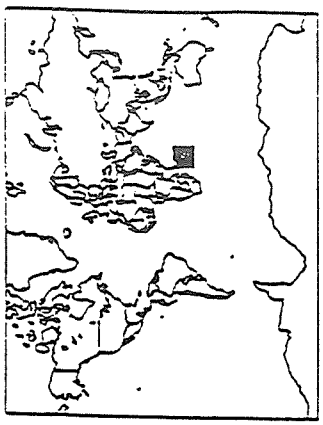
THE UNIFICATION OF THE GRAVITY NETS OF AFRICA

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

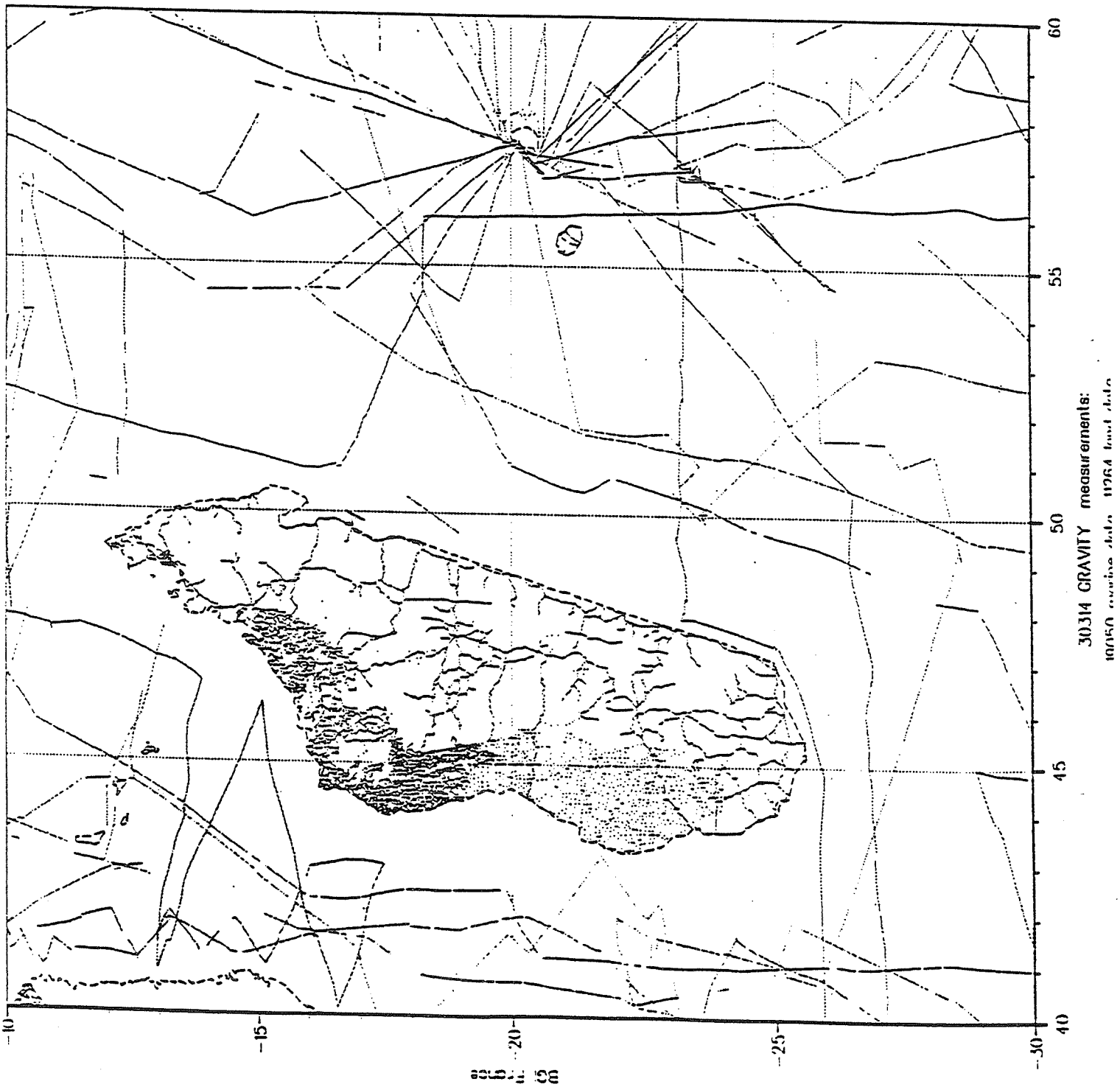
. Black and white copy of maps : 150 F per copy

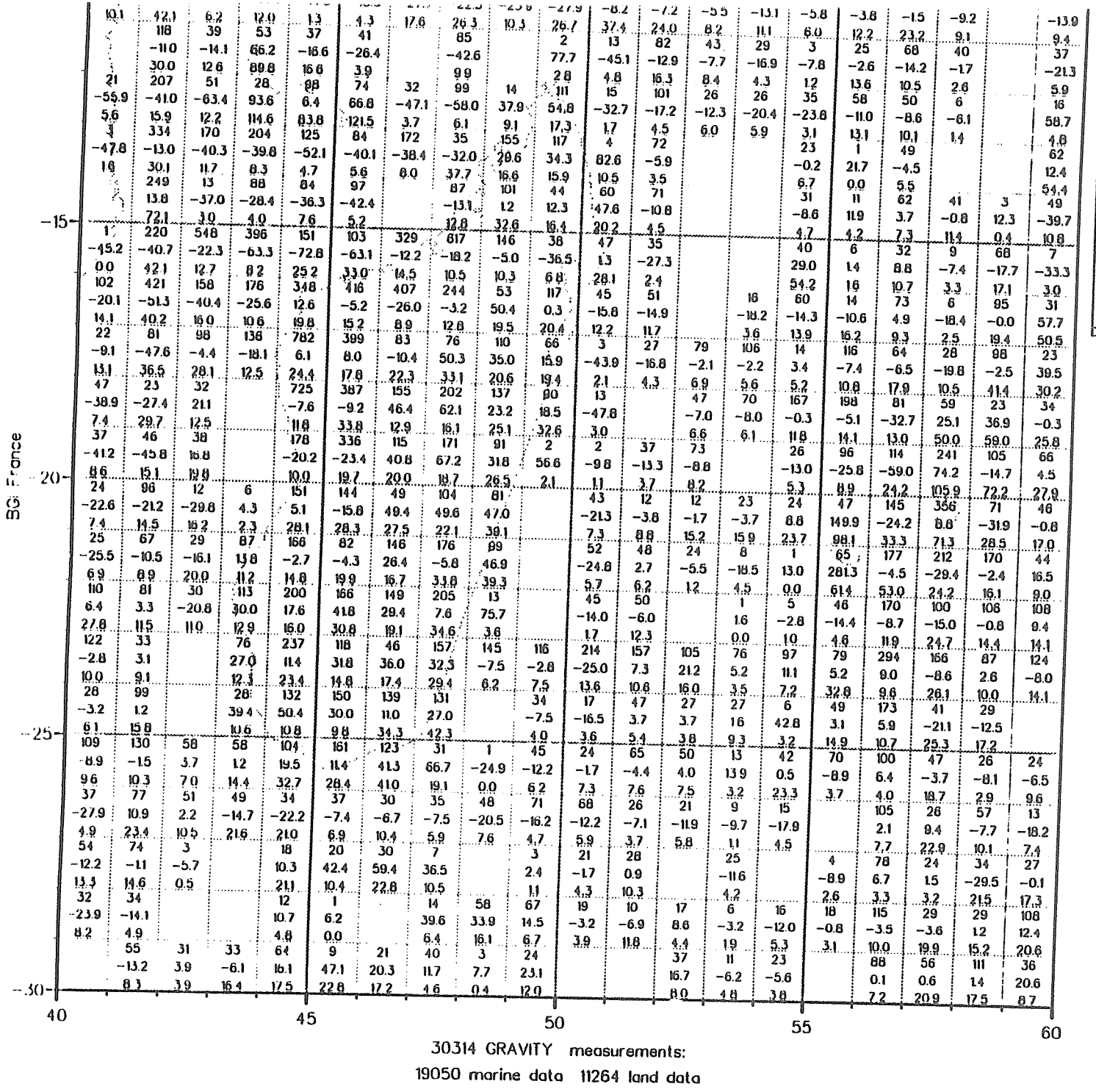
. Colour copy : price according to specifications of request.

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



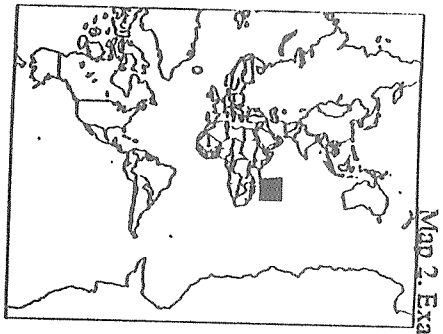
Map 1. Example of data coverage plot





30314 GRAVITY measurements:

19050 marine data 11264 land data



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

BGI GRAVITY DATA

MEAN FREE AIR ANOMALY

1st field : number of points

2nd field : mean value (mgal)

3nd field : Std. Dev. (mgal)

E12

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.

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* 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

QUADRENNIAL REPORT

BUREAU GRAVIMETRIQUE INTERNATIONAL
ACTIVITY REPORT
June 1991 - June 1995

1• INTRODUCTION

In geodesy, gravity values play a great part in the modeling of the Earth gravity field, which is of permanent use for the computation of precise satellite orbits. It is also an essential information for the determination of the geoid, and for the definition of the ocean mean surface used for the study of the global circulation. In geophysics, the interpretation of the gravity field anomalies allows to study density variations in the lithosphere or the mantle, with applications in oil and mineral prospecting.

The Bureau Gravimétrique International (BGI) is one of the offices of the Federation of Astronomical and Geophysical Services (FAGS) which operates under the auspices and in part thanks to the financial support of the International Council of Scientific Unions (ICSU) and the United Nations Educational Scientific and Cultural Organisation (UNESCO). Primarily interested in the activities of these services are the International Astronomical Union (IAU), the International Union of Radio-Sciences (IURS), and of course the International Union of Geodesy and Geophysics (IUGG). It may also be considered as an executive arm of the International Gravity Commission (IGC) within the International Association of Geodesy (IAG), one of the seven associations of which IUGG is composed.

The offices have been located in Toulouse (France) since 1980, in the premises of the Observatoire Midi-Pyrénées (OMP) where BGI is viewed as an important part of a pole of activities centered on geopotential modeling and interpretation. The other French supporting organisations are : the Centre National d'Etudes Spatiales (CNES), the Institut Géographique National (IGN), the Centre National de la Recherche Scientifique (CNRS) - via the Institut National des Sciences de l'Univers (INSU), and the Bureau de Recherches Géologiques et Minières (BRGM). There exists a covenant between these agencies to guarantee their support to BGI, which is re-discussed every four years.

BGI has a Directing Board composed of ten voting members (comprising the IGC president, vice-president, secretary, the section III chairman, the BGI director, plus elected members), and non voting members : the chairmen of the IGC-BGI working groups ; the secretary of the Board ; two ex-officio members (the Geoid Commission president and a FAGS representative).

2• OBJECTIVES AND TERMS OF REFERENCE

The main task of BGI is to collect, on a world-wide basis, all gravity measurements and pertinent information about the gravity field of the Earth, to compile them and store them in a computerized data base in order to redistribute them on request to a large variety of users for scientific purposes. The data consist of : gravimeter observations (mainly location - three co-ordinates, gravity value, corrections, anomalies ...), mean free-air gravity values, gravity maps, reference station descriptions, publications dealing with the Earth's gravity. BGI also has access through one of his host agencies to satellite altimetry derived geoid heights (presently from Geos 3, Seasat, Geosat, ERS1, Topex/Poseidon) ; spherical harmonic coefficients of current global geopotential models ; mean topographic heights. These data are sometimes used internally for data validation and geophysical analysis.

The data collection activities are conducted on a routine basis, and sometimes especially in the framework of large regional projects, in order to densify the world data coverage, and BGI has put emphasis on the validation of received measurements, so as to improve the quality of the delivered information.

3• SERVICE INFORMATION

3•1— Providing Data to BGI

All kinds of gravity data can be sent to BGI, with or without restrictions of redistribution to be specified by the contributors, sometimes in the form of a protocol of usage.

Essential quantities and information for gravity data submission are regularly indicated in the Bulletin d'Information (two issues per year).

3•2— Getting Data and Services from BGI

The most frequent service BGI has been providing is data retrieval over a limited area. Data are sent on tapes or diskettes or printouts, sometimes electronically. Data coverage plots may also be provided, usually over 20° x 20° areas. Massive data retrieval requests have been received and usually satisfied.

Other services include : data screening, provision of gravity base station information (on micro-fiches, sometimes rushed by fax), data evaluation and gridding, computation of mean values, contouring, supply of maps or information on existing maps (catalogue available in printed form and on tape).

3•3— The Publications

BGI issues a Bulletin d'Information twice a year (generally in June and December). It is sent to over 300 subscribers. 76 issues have been published so far. The Bulletin contains : general information in the field, news about the Bureau itself, recent additions to our holdings ; contributing papers in gravimetry ; communications at meetings dealing with gravimetry (e.g. IGC meeting).

Every four years, an issue contains the National Reports of Activities in Gravimetry (e.g. n°70,75).

Besides, the full catalogue of the holdings is issued every two years, that is in 1993 and 1995 over this period.

4• THE SERVICE ACTIVITIES

4•1— Data Base :

Since 1980, the data base management system used at BGI had been one developed in-house, specifically for gravity data and had been running on one of the CNES main frames. Along the years, after having suffered from computer changes and staff turn-over, also facing difficulties in upgrading the software (for instance to speed up the merging operations which had to be done more and more frequently with the increase of the data volume), B.G.I. decided to change its strategy in data base maintenance.

Instead of putting more efforts from BGI staff and following the availability of the ORACLE software on a main frame at CNES, it was decided in 1991 and after extensive satisfactory testing to discontinue the usage of the old software and to switch to ORACLE (level 6). A first version was operational in the fall of 1991. Attention was exerted to ensure no interruption in the services ; for this purpose, the two software with two different data bases have been run and used in parallel up to early 1992 until not a single failure appears with the new system. This is described by Toustou (1992). The level 7 version is being installed and tested while this report is written.

4•2— Data Collection

The data base content, as concerns actual measurements, undergone an extraordinary increase. It contained a little more than 4.0 million point values in 1991 (to be for instance compared with 800 000 measurements in 1979). There still remain several sets of land data to be added. This has been a very slow process due to the characteristics of the old CDC software, until the new system was perfectly working. Large data sets of marine data were received in 1992 from NGDC* in the context of the European Geoid Project and, in 1993, BGI acquired the totality of the NGDC data on CD-Rom. These were processed and merged in the course of 1994 and 1995. New catalogues, available on request, have just been produced (June 1995). In addition, new efforts were exerted in trying to get data from the ex-Eastern countries due to the important geopolitical changes. In most cases, gridded values of free-air gravity and topography were obtained such as in Poland (5' x 5'), Hungary (5' x 7.5'), Rumania (5' x 5').

The data base contains 12 702 874 point measurements (as of June 1, 1995), of which 10 534 635 were taken over the oceans, and 2 168 239 over land.

4•2—1. The land data : they have been carefully edited (with the DIVA/VERSET software) and especially those over Africa, South America, Europe, Australia and South East Asia. The main data sets merged during the four year period are given in table 1.

Table 1. Land data collected and merged recently

Source	Country	# of measurements
ORSTOM*	Burkina Faso	4 582
	Mali	13 424
	Mauritania	10 392
	Niger	19 573
	Senegal	3 118
	Tchad	16 665
DMA-IGN	Misc. (Africa)	8 287
BRGM**	France	50 208
Misc.	Algeria	2 765
	Austria	2 182
	Belgium	10 327
	Finland	29 274
	Iceland	663
	India	2 450
	Italy	490
	Luxembourg	96
	Malaysia	8 217
	Portugal	1 800
	RCA	5 900
	Senegal	1 141
	Zaïre	1 895

4•2—2. Marine data : as said above, a huge data set from NGDC (~ 11.10^6 measurements) was merged. Most data were not validated. A one man-year effort was necessary to clean the data (per cruise ; no inter-cruise adjustment was performed in general) using a specially developed interactive graphical software (SEAVALID). Table 2 gives a summary of these data.

* National Geophysical Data Center, Boulder, USA

* out of a total of 100 166 points

** screened data set (the total file has 355 436 measurements)

Table 2. Marine Data validated and integrated in 1993-94

Institute (or country)	Number of cruises	Number of measurements (in 10^3)
LAMONT Doh. Lab.	466	1 681
WOODSHOLE Oc. Inst.	90	460
N.O.A.A.	59	345
U.S.G.S.	115	1 650
OREGON St. Univ.	56	135
SOEST (HAWAII)	113	1 325
U.S. NAVY	56	420
SCRIPPS Inst.	33	500
FRANCE	123	1 780
NEW-ZEALAND	10	135
U.K.	33	353
JAPAN	90	401
Misc.	92	1 715
GRAND TOTALS	1 336	10 900

4•3— Data validation

A great deal of efforts have been spent at validating data for several years. Land data were validated using the DIVA/VERSET software firstly developed and run on a mainframe (CDC Cyber), then transported on a Sun-Sparc 2 workstation (using the SUNPHIGS library) for higher flexibility.

Efforts were also put in developing a similar software for the validation of marine data especially to solve for cross-over minimisation parameters. A program (SEAGRA) for performing this task, was received from H.G. Wenzell. It was installed, upgraded ; in particular, the decomposition of each cruise into legs was implemented in an automatic mode in late 1991. A complete tool in its first version was presented at a workshop organised by BGI on these topics (Oct. 1992). After upgrading it was used for editing and adjusting about one million points in the North-West Pacific area (Adjaout 1994).

A specific undertaking was to validate, cruise by cruise, the marine data newly acquired. A software, named SEAVALID, was developed for this purpose, which is an interactive graphic tool enabling the fast editing of data by simultaneously looking at the measurement, the Eötvös correction, the bathymetry and the ship navigation. This software has been used in preprocessing the data of table 2. No global inter-cruise validation has been yet performed (by looking at and minimizing the cross-over differences except over specific areas (see above). This work might be undertaken after all marine data have been internally validated. However, it now appears that it will be easier and faster to adjust most marine data on the free air gravity field derived from satellite altimetry data, the cross-over adjustments being limited to specific cases.

4•4— Preparation of a CD-ROM

Following the advices of the Directing Board in October 1992, the project of producing a CD-ROM with all BGI non confidential data was studied and undertaken. The main characteristics of such a product was defined. The principal concern was to secure an easy access to the data by type (land/sea), by source, by country, by geographic area. Software was developed and is to be provided with the data base. Organisational matters were discussed with the French Space Agency which facilities are used to press all the CDs (with regular updates). A first version with land data only and a poster paper presented an experimental product to the inter-commission assembly of IGeC and ICG in Sept. 1994 (Graz, Austria). Some selected users were asked to test the product.

Land and marine data are now put separately on two CD-ROMs (with separate software). The prices for commercial organisations and for scientific institutes are different. BGI will, for some time, continue the distribution of gravity data over specific areas on request (but up to the capacity of one high density diskette in compressed format).

4•5— Requests

The Bureau has received between 165 and 220 requests per year between 1991 and 1994 and processed 71 for the first four months in 1995. Fig. 1 clearly shows the increase of this service activity over the last thirteen years. It presently employs one person more than half-time.

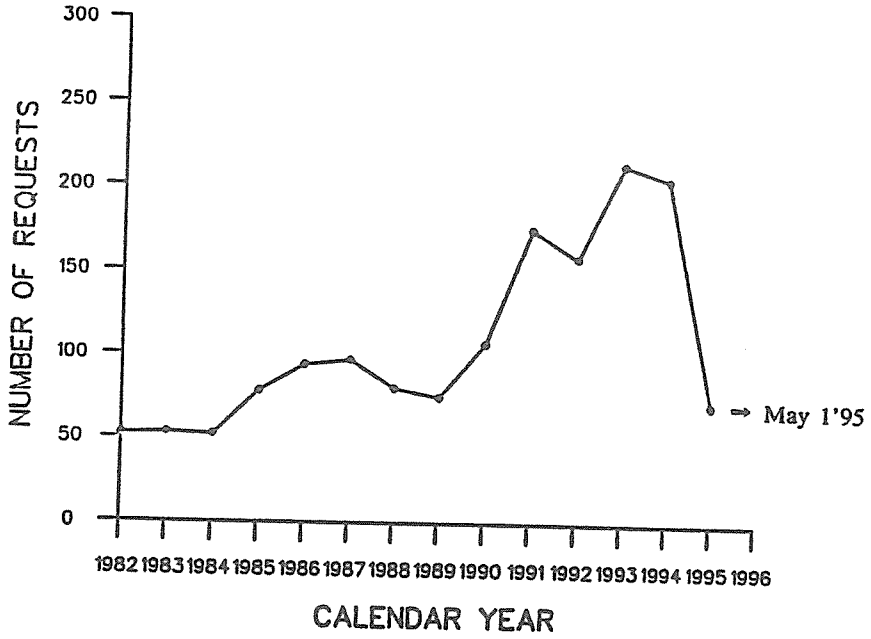

Fig. 1. Requests for data, processed by BGI since 1982

4•6— Bibliography

Compiling bibliographical references of all publications received at the Bureau and dealing with gravimetry or closely related subjects has been an historical task. The digitisation of these references started with the current material in 1980 when the office was moved from Paris to Toulouse.

The digitization of the old bibliography (prior to 1980) was undertaken in 1990. This was a huge work which was performed by the BGI secretary, with an additional temporary help. It was completed in 1991. Compilation continues and references (~ 8 000 as of June 1, 1995) regularly accumulate. A file is available on diskette.

4•7— Miscellaneous

— training of students : data validation procedures, computational methods (determination of gravity, geoid, etc ... from spherical harmonic models ; numerical works with the integral equations of physical geodesy), graphics.

— compilation of absolute measurements : still difficult notwithstanding the help of Working Group 2 (agencies do not answer to our request for data and facts). This point was debated by the Directing Board at each of its last meetings.

— status of IGSN 71* reference gravity stations : a situation was established in 1989, with the help of some sub-commissions of IGC. About 1200 stations (out of 1850) still existed at that time, the others having been destroyed (generally when reconstructing buildings ...). The other reference stations (e.g. the ACIC* file) are updated from time to time. Their description sketches are on microfiches and numerical values (code number, site co-ordinates, g-value, microfiche number) are in a computer file (like for the IGSN71 network) ; there are about 10 166 reference stations as of today (1 220 in IGSN71 *, 5 200 in ACIC, 320 in WHOI*, 800 in LAGSN77*, 2 626 in various national networks).

— BGI also archives gravity maps of various types and scales, from different origins. A map file and a catalogue (print-out and computer form) exist, which contain references of ~ 3000 maps. Software to extract information from the file exists. Nowadays, only a few new maps are added each year.

5• SPECIAL PROJECTS OR EVENTS

5•1— The release of 1°x1° gravity data by Russia

A catalog of 1°x1° averaged free-air gravity anomalies over the whole former Soviet Union (FSU) has been placed at BGI as an open file (named MGK93 catalog) by the International Scientific Environmental Center of the Russian Academy of Sciences. The transfer was made during the official visit to BGI of a delegation of four Russian scientists in June 1993. A protocol of usage of these data was established and a paper describing the file appeared in EOS (Makedonskii et al., 1994). A subsequent paper discussing the tectonic and lithospheric strength of northern Eurasia, and based on this data set, was published in 1995 (Kogan et al.).

5•2— The release of 1°x1° gravity data by China

The National Bureau of Surveying and Mapping (Beijing, China) released files of 1°x1° averaged free-air, Bouguer anomalies and geoid heights, to BGI in March 1995. These data are being evaluated (compared to actual global gravity field models) and will be reported in a subsequent issue of the Bulletin d'Information.

5•3— Use of satellite altimetry

Simultaneous use of GEOSAT, ERS1 and TOPEX POSEIDON altimetry derived geoid heights to compute mean gravity anomalies in the North Atlantic, North Sea, Arctic Ocean and in parts of the Pacific and Indian Oceans in the context of large regional projects (cf. below) : algorithms and software realizing this transformation through a remove-restore process and FFT have been developed and successfully applied (Olgiati et al., 1994). The quality of the recovered field makes this method suitable for global validation of the marine data at BGI in the future.

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* IGSN : International Gravity Standardization Net 1971, ACIC : Aeronautical Chart and Information Center
WHOI : Woods Hole Oceanographic Institution, LAGSN77 : Latin American Gravity Standardization Net 1977

5•4— Participation in regional gravity projects

BGI has been involved through the last four years in the West and East European Gravity Project (WEEGP), the South East Asia Gravity Project (SEAGP), and the North and Central Asia Gravity Project (NCAGP), undertaken by a group at the University of Leeds (UK) with private support. WEEGP is of special interest since it combines efforts specific to the project and those done by the Sub-Commission for the Geoid in Europe (sub-commission from ICG, within IAG).
BGI task has been : (i) to validate extensive sets of land data ; (ii) derive free-air gravity anomalies from satellite altimetry measurements. BGI uses the expertise gained in joint activities in this area with the Groupe de Recherches de Géodésie Spatiale (some of the developed software is being applied to the direct problem of the computation of a French gravimetric geoid in which IGN, one of the supporting organisations of BGI, is mostly interested). Of special interest have been the availability of two cycles of the ERS1-168 day repeat orbit data (dense coverage provided thanks to inter-track satellite spacing of ~ 8 km at equator), and of ERS1 altimetric data collected on sea ice over the Arctic Ocean.

5•5— Meetings

— BGI participated in the European Geoid Workshop in Prague (May 1992) with the presentation of a paper (« The Data Base Management System at BGI », D. Toustou).

— BGI organised and participated in the first WEEGP-SEAGP Progress Meeting (Toulouse, Oct. 12-16, 1992) and presented four papers :

. »Data Base Management System under ORACLE » (D. Toustou)
. »The Validation of Land Gravity Data » (M. Sarrailh)
. »The problem of Datum Shifts » (G. Balmino)
. »Satellite Data : from Altimetry Measurements to Gravity Anomalies » (G. Balmino)

— BGI organised a workshop on Marine Gravity Data Validation (Toulouse, Oct. 1992), with three technical papers by BGI staff, including a report on a test case distributed for comparison to participants (proceedings appeared in Bulletin d'Information n°71).

— BGI co-organised and participated in the final technical and scientific meetings of the West and East European Gravity Project (April 1994 in Leeds, UK) and also participated in a similar meeting marking the termination of the South East Asia Gravity Project (Aug. 1994, in Houston, USA). Papers and posters were presented by BGI staff members.

— BGI also took part in the preparation of the combined Gravity and Geoid Meeting held in Graz (Austria) in September 1994, where were presented several papers on the scientific works, the data base, regional projects, and satellite geopotential mission projects.

6• PUBLICATIONS

— Bulletin d'Information :

Dec. 1991	(n°69)
June 1992	(n°70)
Dec. 1992	(n°71)
June 1993	(n°72)
Dec. 1993	(n°73)
June 1994	(n°74)
Dec. 1994	(n°75)
June 1995	(n°76)

— BGI Holdings :

Data Base Coverage, July 1993
Statistics, Sept. 1993
Data Base Coverage, June 1995 (in Bulletin n°76)

— The Bureau Gravimétrique International : A ten year status report (G. Balmino)

published in : BGI Bulletin d'Information n°72 (June 1993).
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IUGG Chronicle n°217 (May/June/July 1993).

— The gravity data base of BGI, by Toustou D., First continental workshop on the geoid in Europe, Prague, Proceedings, pp. 41-57, May 92.

— Gravity field over the Former USSR from land based surveys : validation, geodetic and geophysical implications, by Makedonskii E.L., Balmino G., Galazin F.C., Kogan M.G., McNutt M.K. and J.D. Fairhead, EOS, Vol. 75, n°40, pp. 463-464, Oct. 94.

— A new gravity map, a new marine geoid around Japan and the detection of the Kuroshio Current, by Adjaout A. and M. Sarrailh, accepted in Manuscripta Geodaetica, Oct. 1994.

— Comparison of geopotential recovery capabilities of some future satellite missions, by Balmino G. and F. Perosanz, submitted for publication, October 12, 1994 « Gravity and Geoid », Springer Verlag.

— Gravity Anomalies from Satellite Altimetry : Comparison between computation via geoid heights and via deflections of the vertical, by Olgiati A., Balmino G., Sarrailh M. and C.M. Green, accepted in Manuscripta Geodaetica, Nov. 1994.

— Tectonic fabric and lithospheric strength of Northern Eurasia based on gravity data, by Kogan M.G., Fairhead J.D., Balmino G., and E.L. Makedonskii, Geophysical Res. Letters, Vol. 21, n°24, pp. 2653-2656, Dec. 94.

7• PROGRAM OF ACTIVITIES FOR THE NEXT FOUR YEARS

— Continue data collection, archiving and distribution : emphasis will be on those countries which have not, or seldom, contributed to the BGI data bank. First priority will be given to careful data evaluation, and especially to the validation of marine measurements with the help of satellite derived gravity anomalies. CD-ROM data basing will be pursued with regular updates, while direct access to (part of) the data base will be established (on W3) ;

— Continue the publication of the Bulletin d'Information and of the holdings ;

— Link with IGC in setting up the International Absolute Gravity Base Station Network (IAGBN), and assist in the inter comparisons of instruments ;

— Establish simple procedures for the collection and archiving of absolute measurements : the present problem is the lack of cooperation of the measuring groups, who do not transfer synthetic data to BGI despite repeated requests ;

— Link with the Commission for the Geoid in data preparation in view of geoid computations and evaluations to be performed by the International Geoid Service (IGeS) ; this includes the collection of DTM models and the establishment of a worldwide high resolution DTM data base.

A re-definition of the roles of BGI and IGeS will become necessary as the service activity part of the latter develops. It is conceivable that IGeS may wish to become a new member of FAGS, but FAGS has clearly expressed the desire that BGI and IGeS envisage a merging and restructuring (such as the one undertaken by BIH and IPMS when they gave birth to IERS).
A proposal will be prepared for discussion at the 22nd. General Assembly of IUGG (the mother Union of BGI) in 1999.

— Assist in promoting satellite techniques to improve our global knowledge of the Earth's gravity field : satellite-to-satellite tracking, satellite gradiometry, etc ...

ANNEX - THE BGI STAFF

The staff of the Bureau is composed of the following, as of June 1995 :

Position	Supporting Institute	Percentage of time spent in BGI activities (%)	Name
Director	CNES	30	G. Balmino
Secretary	CNRS	30	N. Rommens
Secretary	CNRS	20	M. Barriot
Engineer	CNES	100	M. Sarrailh
Engineer	CNES	20	B. Moynot
Analyst/Prog.	IGN	100	D. Toustou
Technician	IGN	100	G. Balma

Acronyms : CNES : Centre National d'Etudes Spatiales
CNRS : Centre National de la Recherche Scientifique
IGN : Institut Géographique National

There exists a covenant between these agencies to guarantee their support in manpower (and also logistics, travel budget, computer expenses, ...) and it must be made clear that the manpower part is critical. Not only is it at present the minimum which is required to run BGI, but the technicality and experience of some staff members has become so great that the Bureau would immediately collapse if they were to be replaced by less experienced people.

Since there is no redundancy at all in the skills and work shares of these staff members, it also means that the equilibrium of BGI is very unstable. In the context of a re-definition of the role of BGI and as people get older, this should not be overlooked in the future.

PART III

BGI HOLDINGS

BGI HOLDINGS

The content of the BGI data base is usually given in the form of updates to the previous status. Since a list of all sources had not been published for some time and since the catalogue has so far been distributed solely on request, we decided to publish the coverage plots of all our data, over lands and oceans, in this issue of the Bulletin, in order to advertise better this data base which to-day contains over 12 million measurements.

CD-ROMs

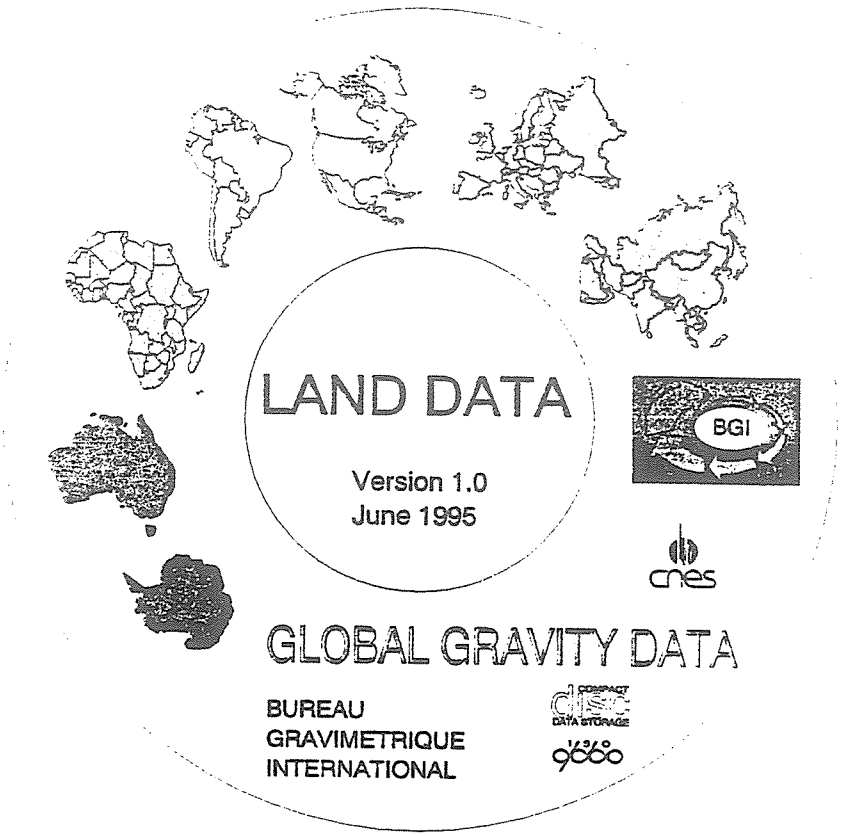
On the other hand, the non confidential data, which have been validated by various procedures as explained in the quadrennial report (1991-1995) are now available on two CD-ROMs.

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.

The package includes a users'guide and software to retrieve data according to the area, the source code, the country.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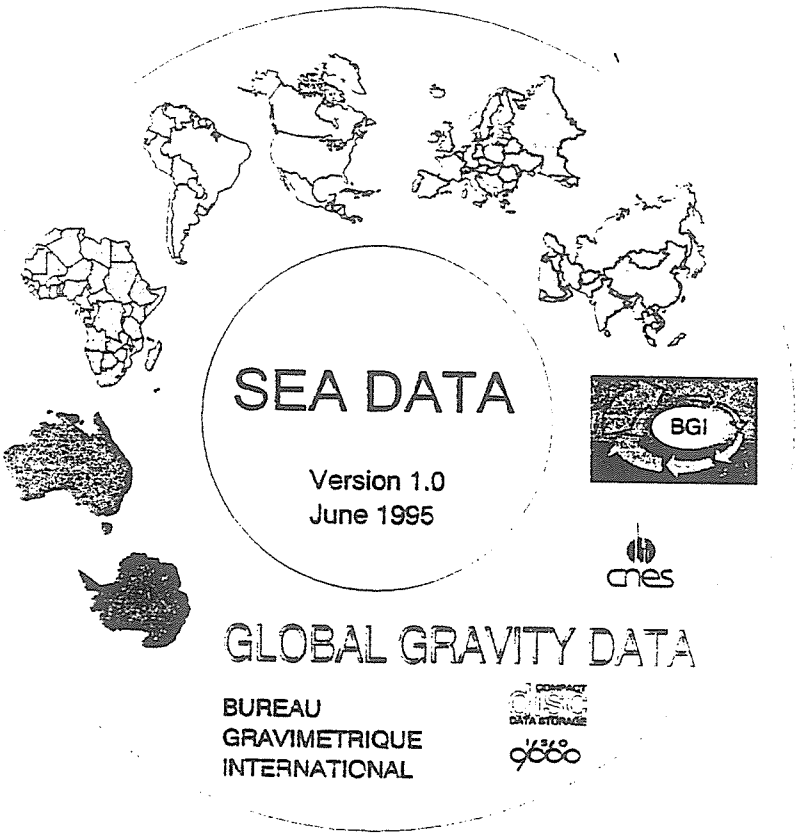
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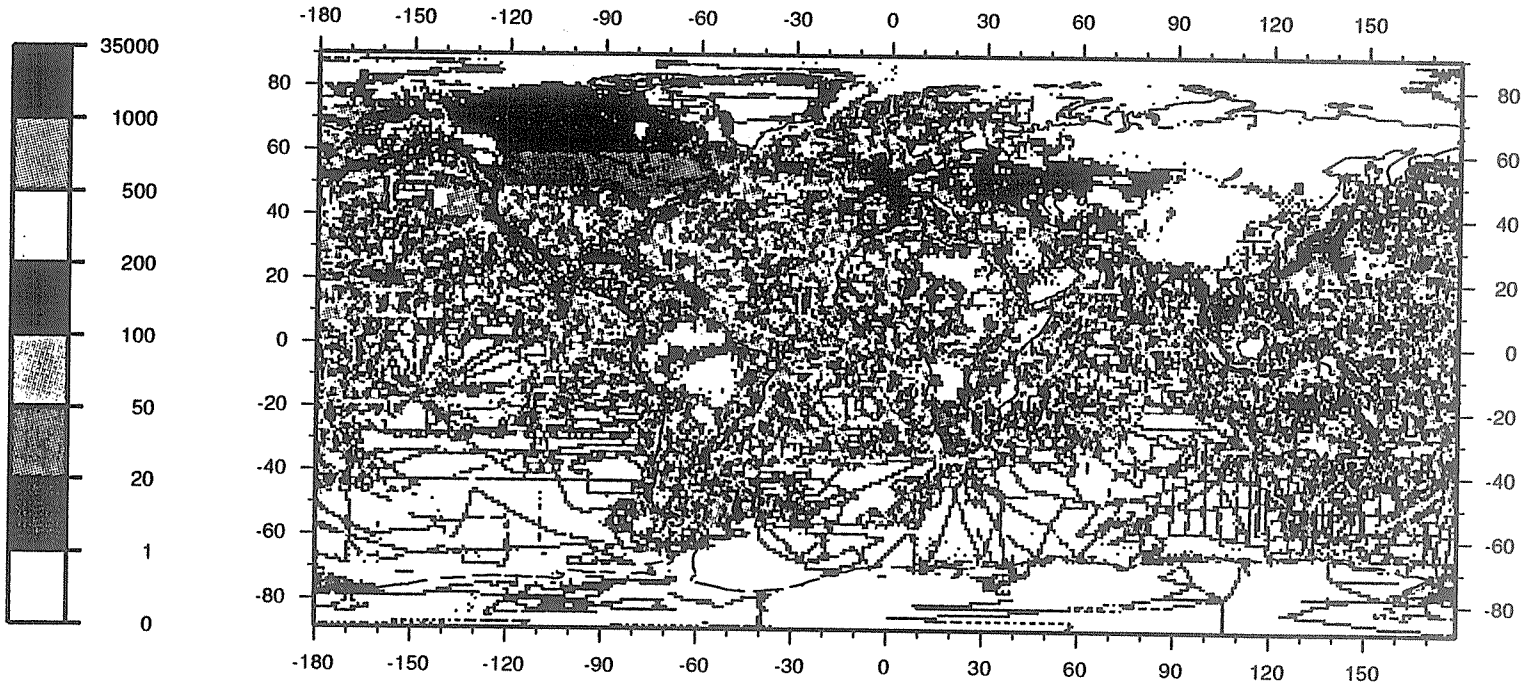
B.G.I. GRAVITY DATA BASE (density per square degree)



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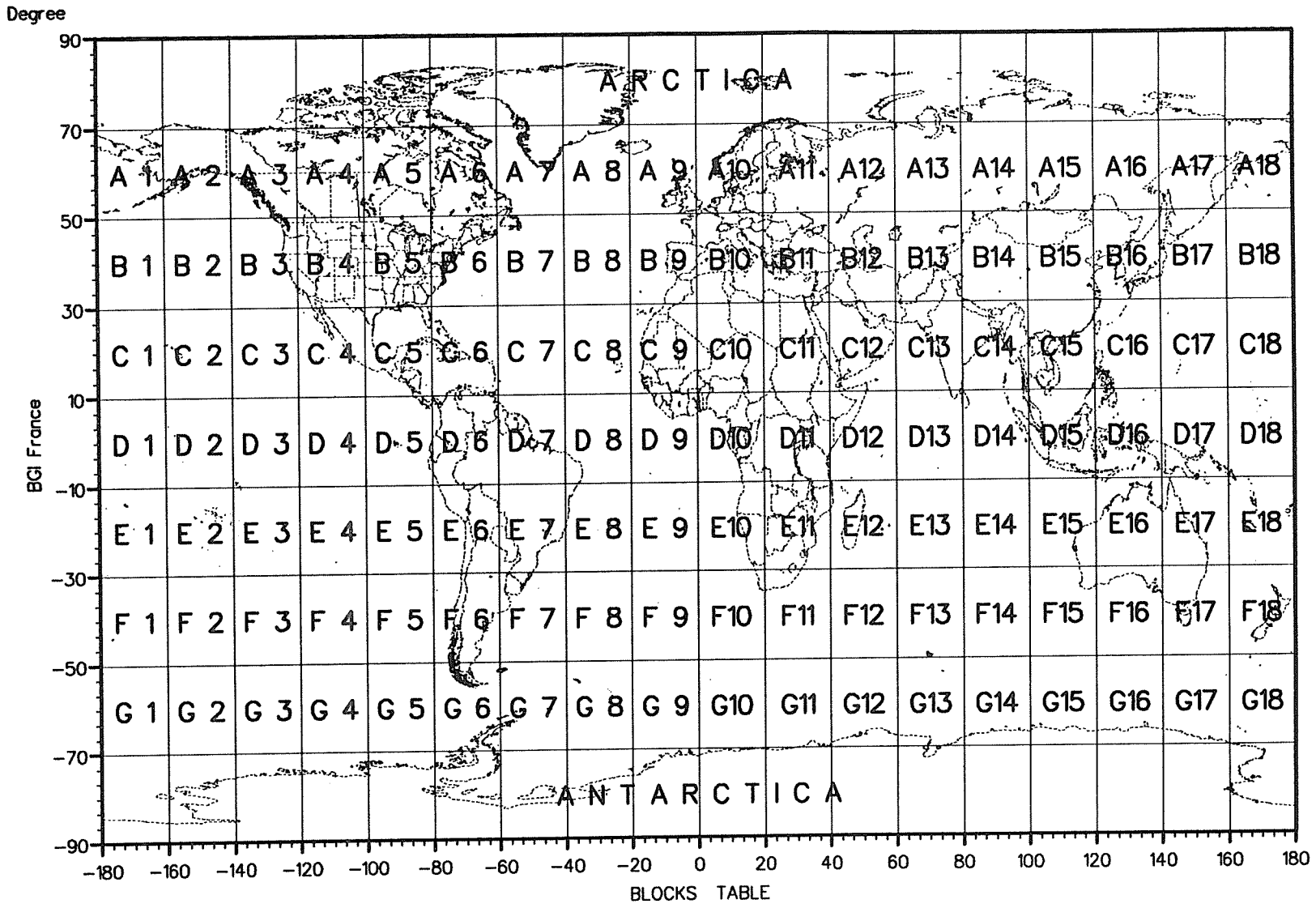
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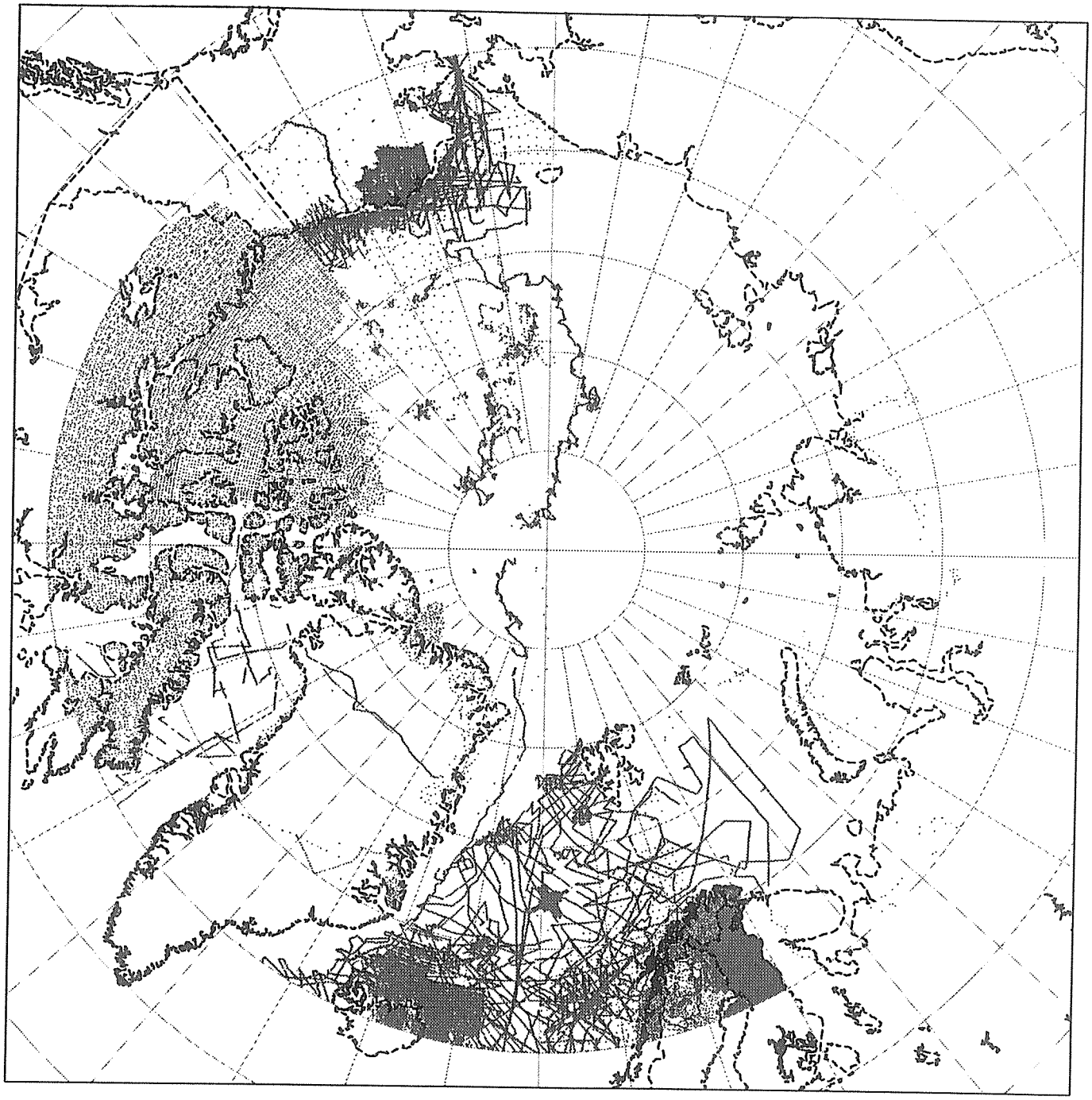

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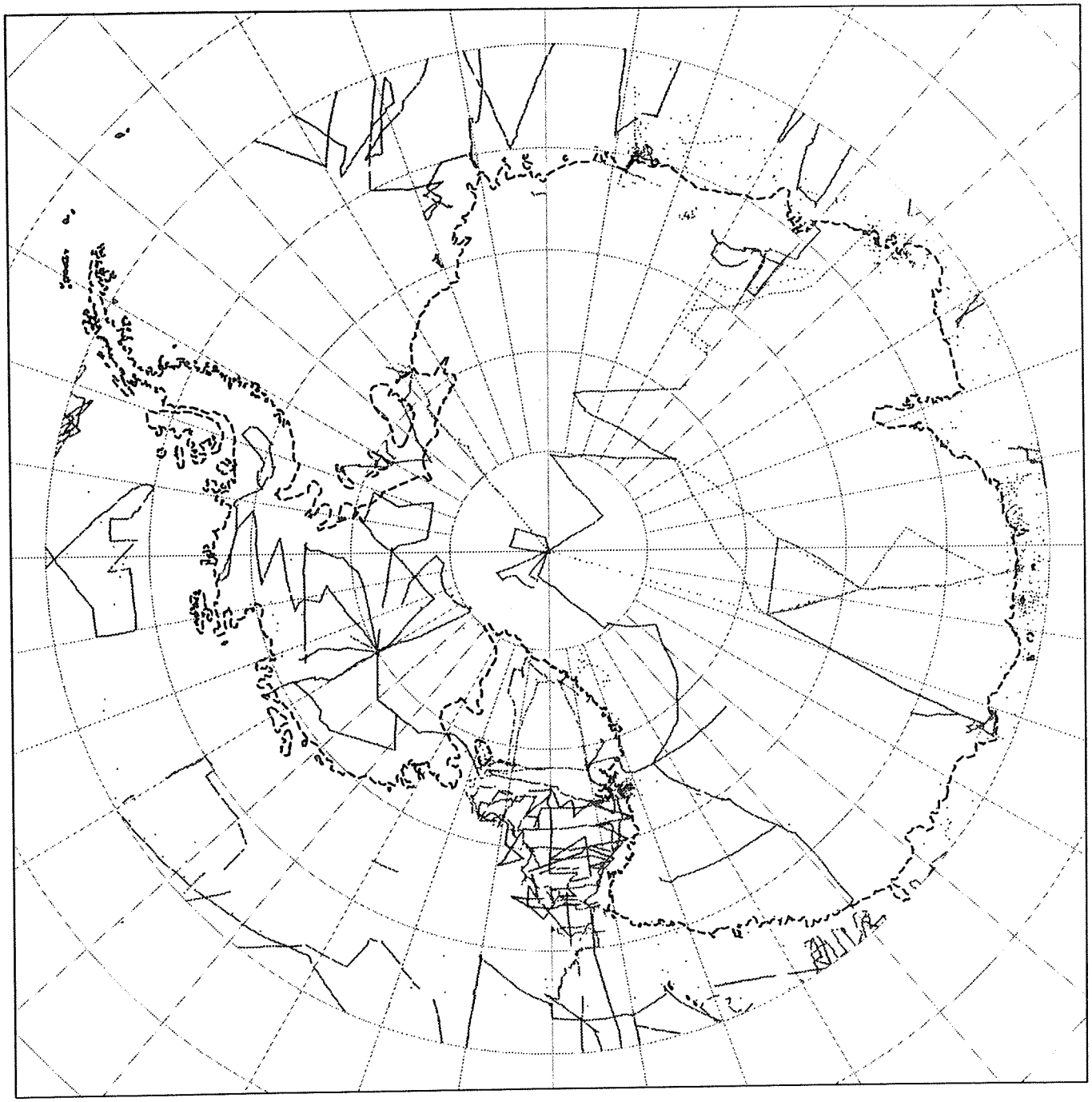

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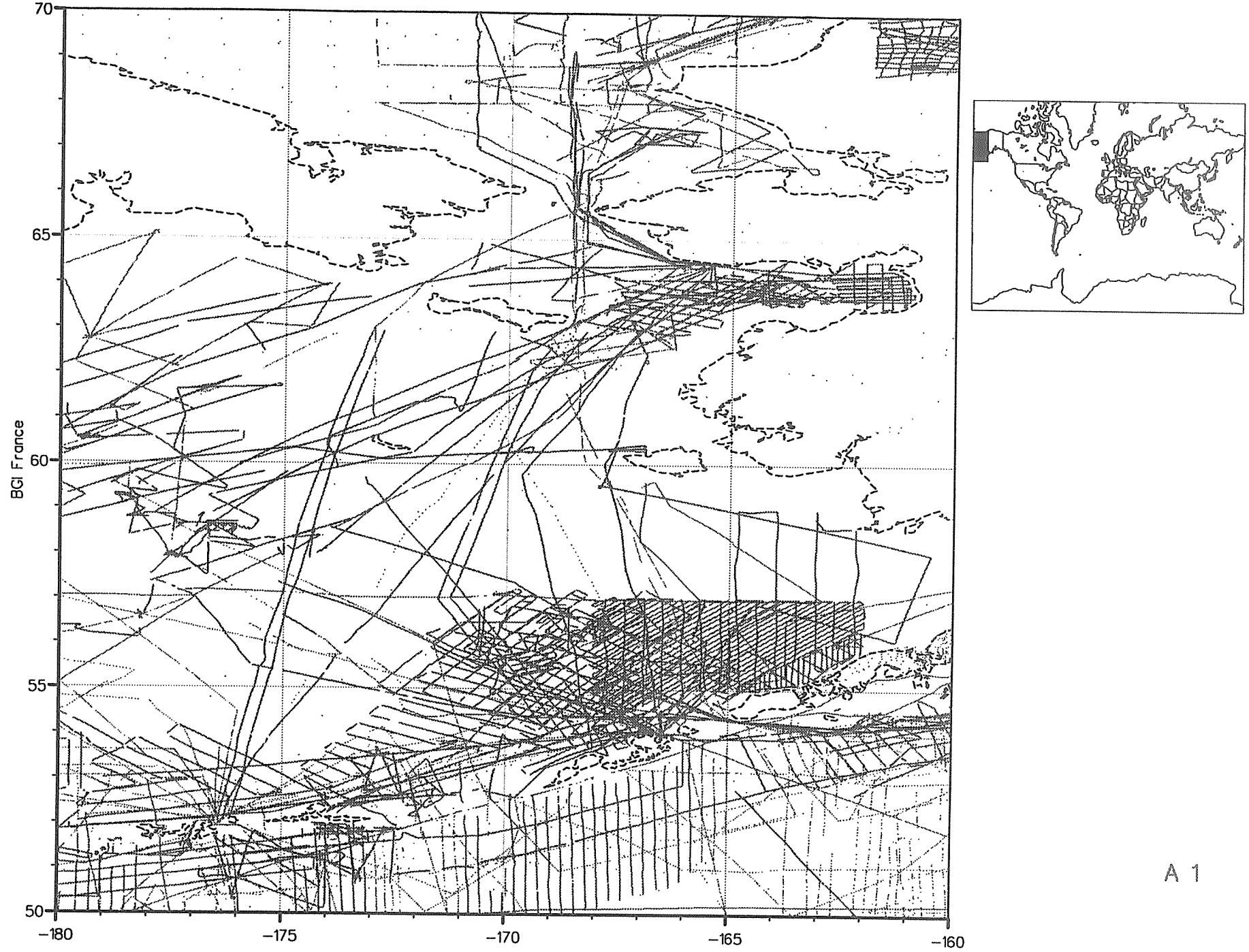
9371 on land

BGI France



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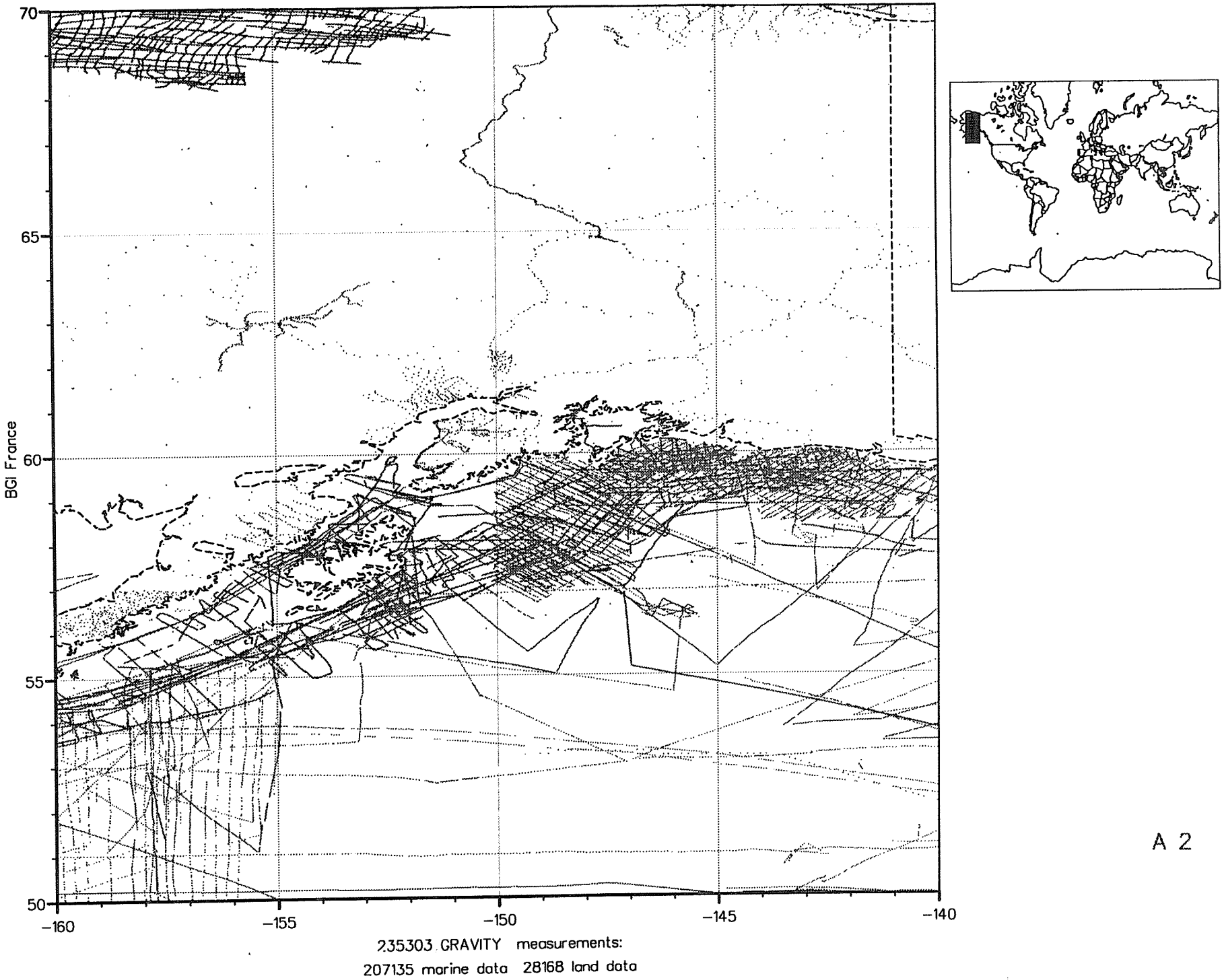
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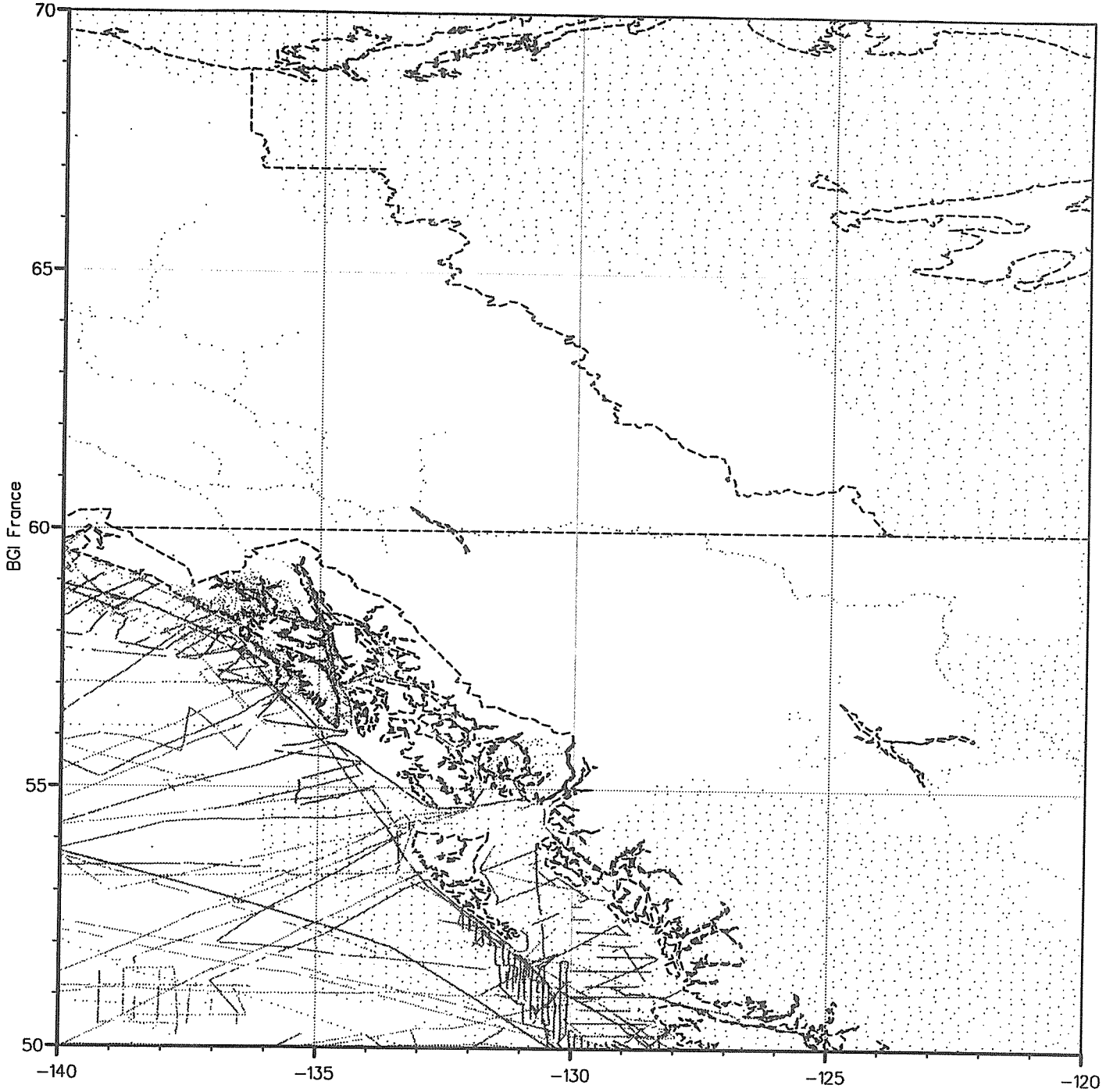
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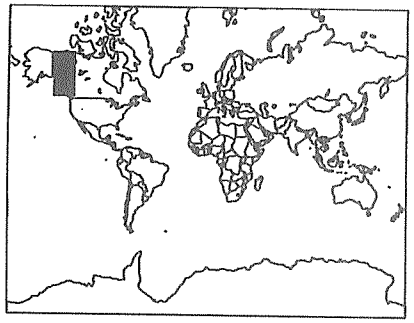

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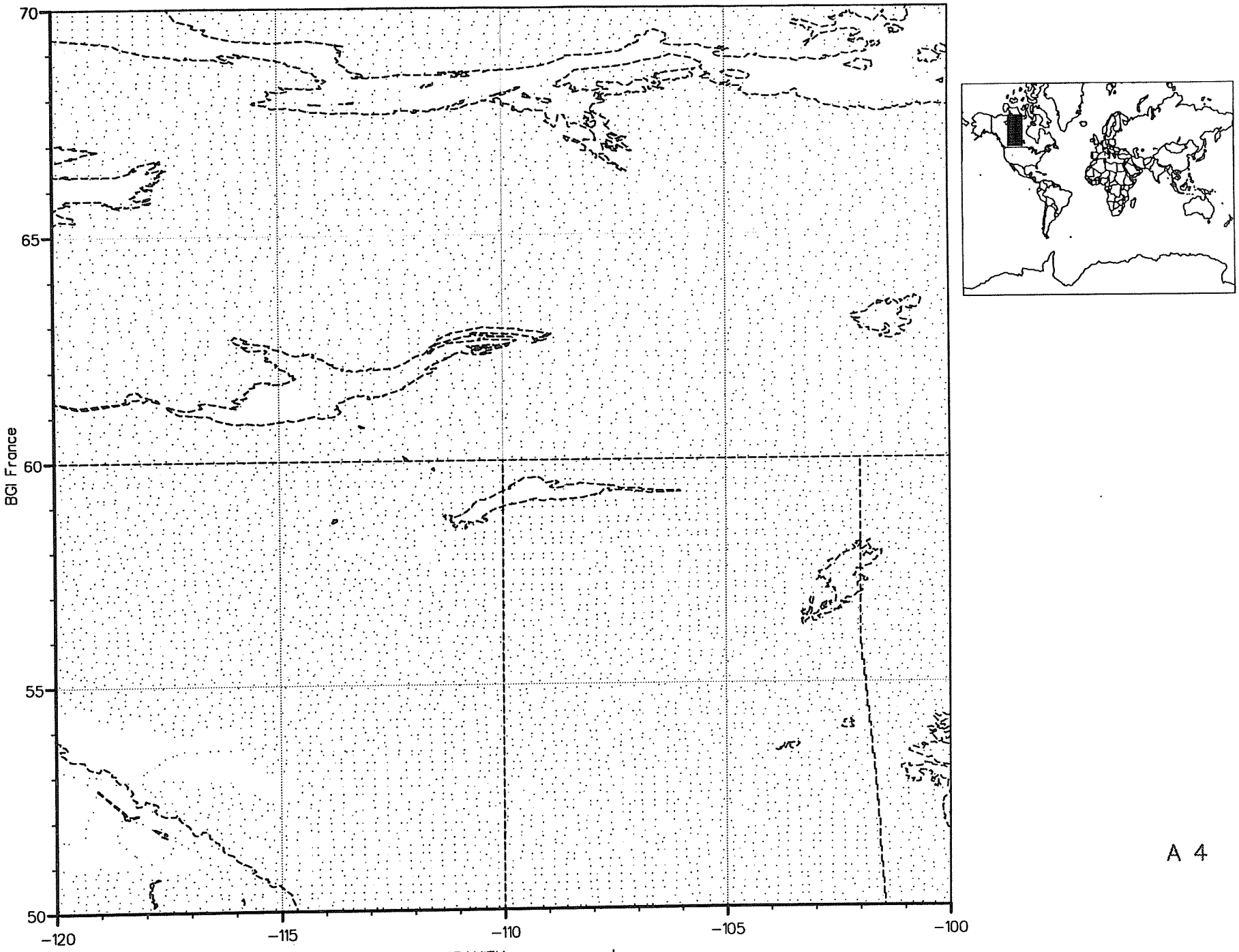
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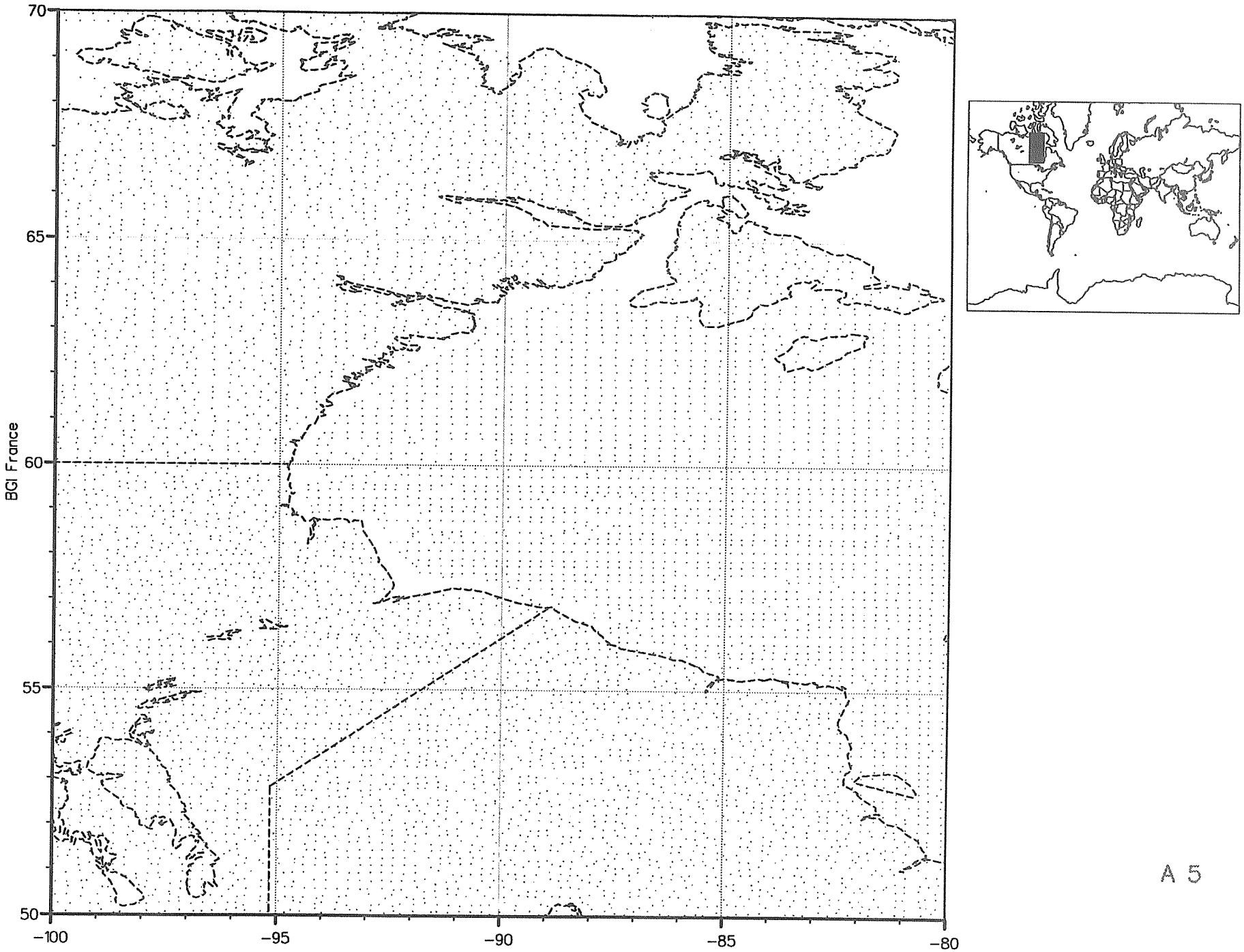

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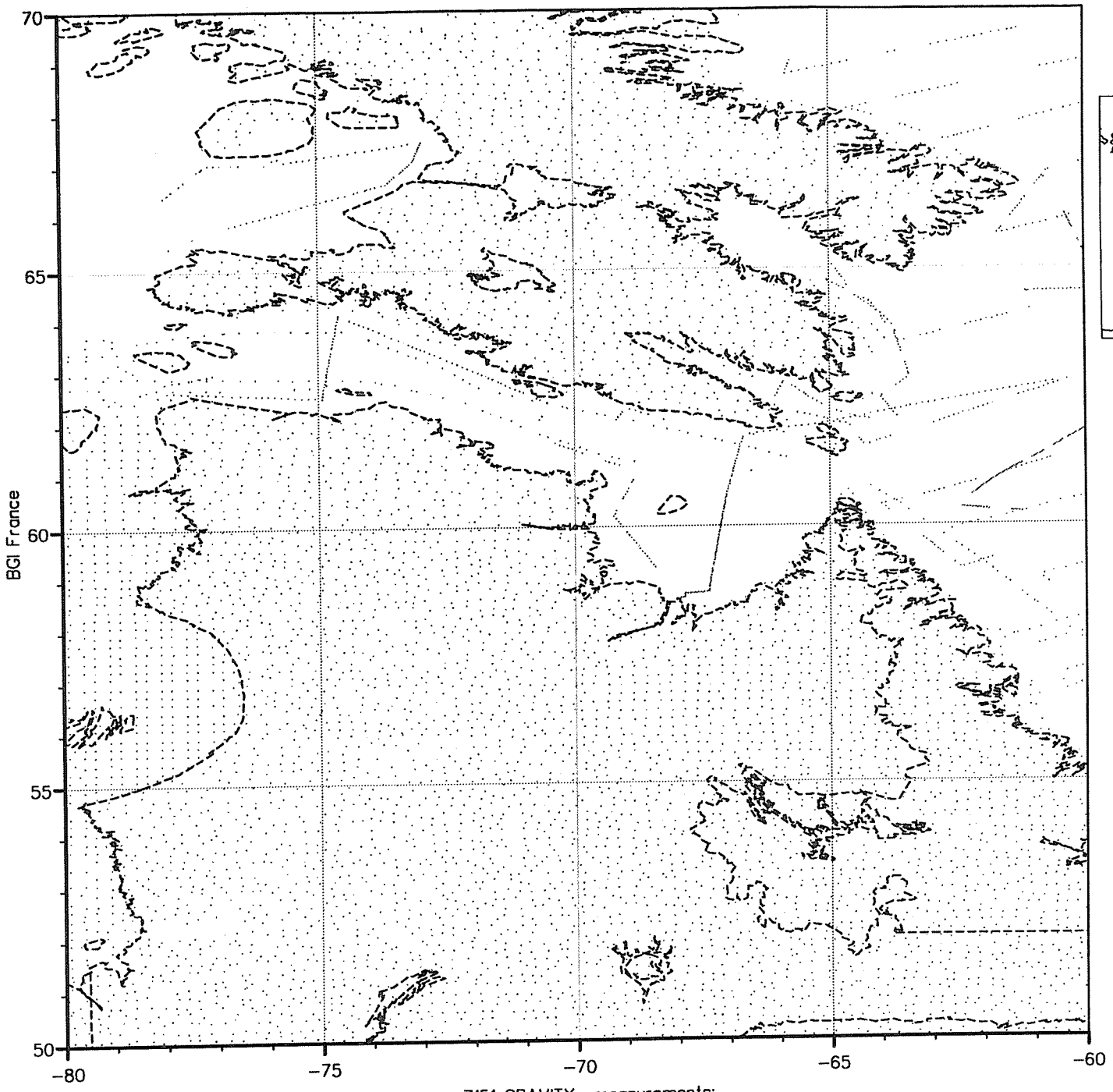
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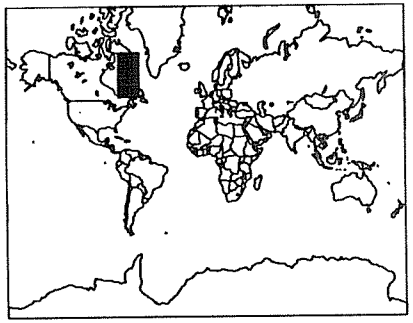

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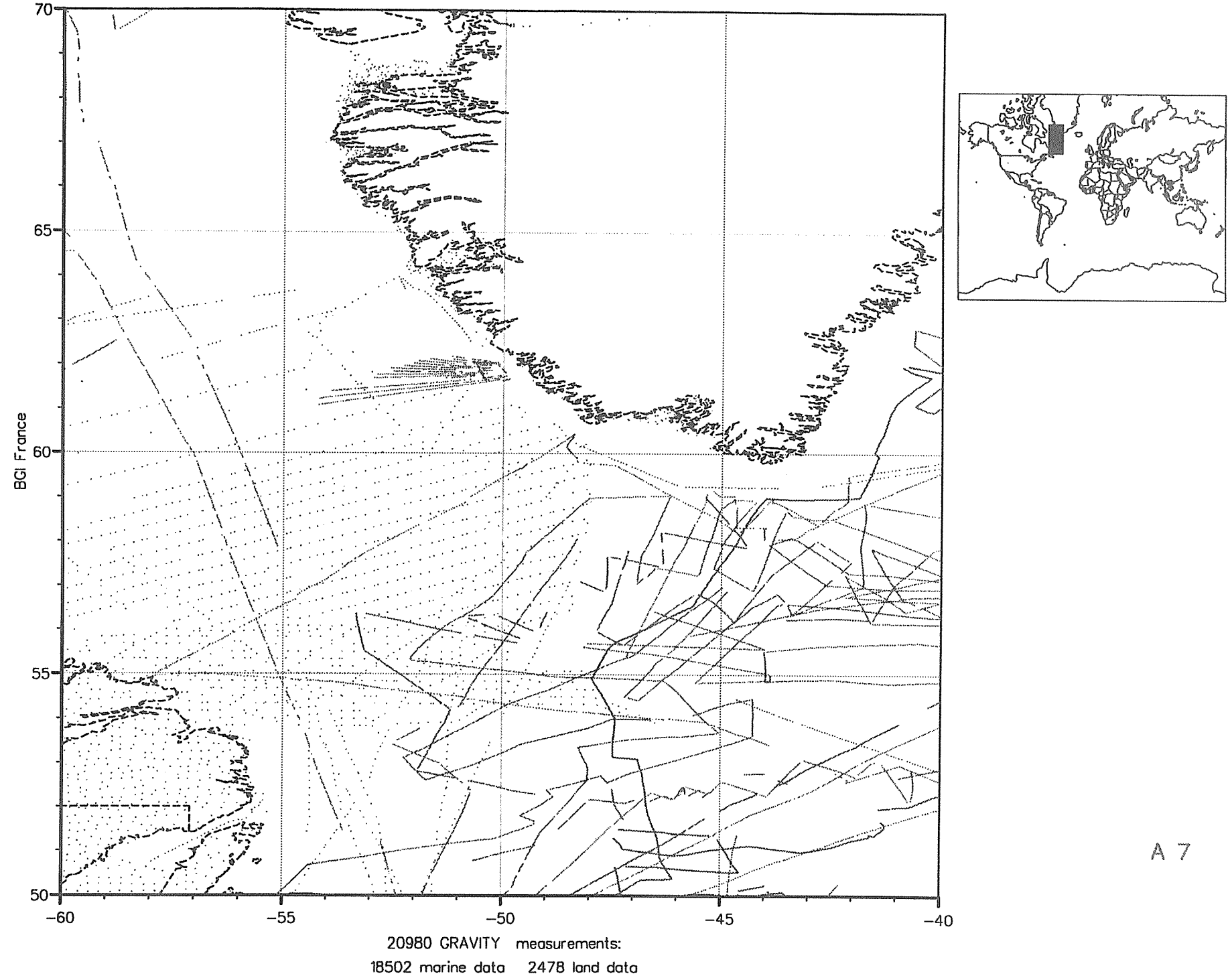
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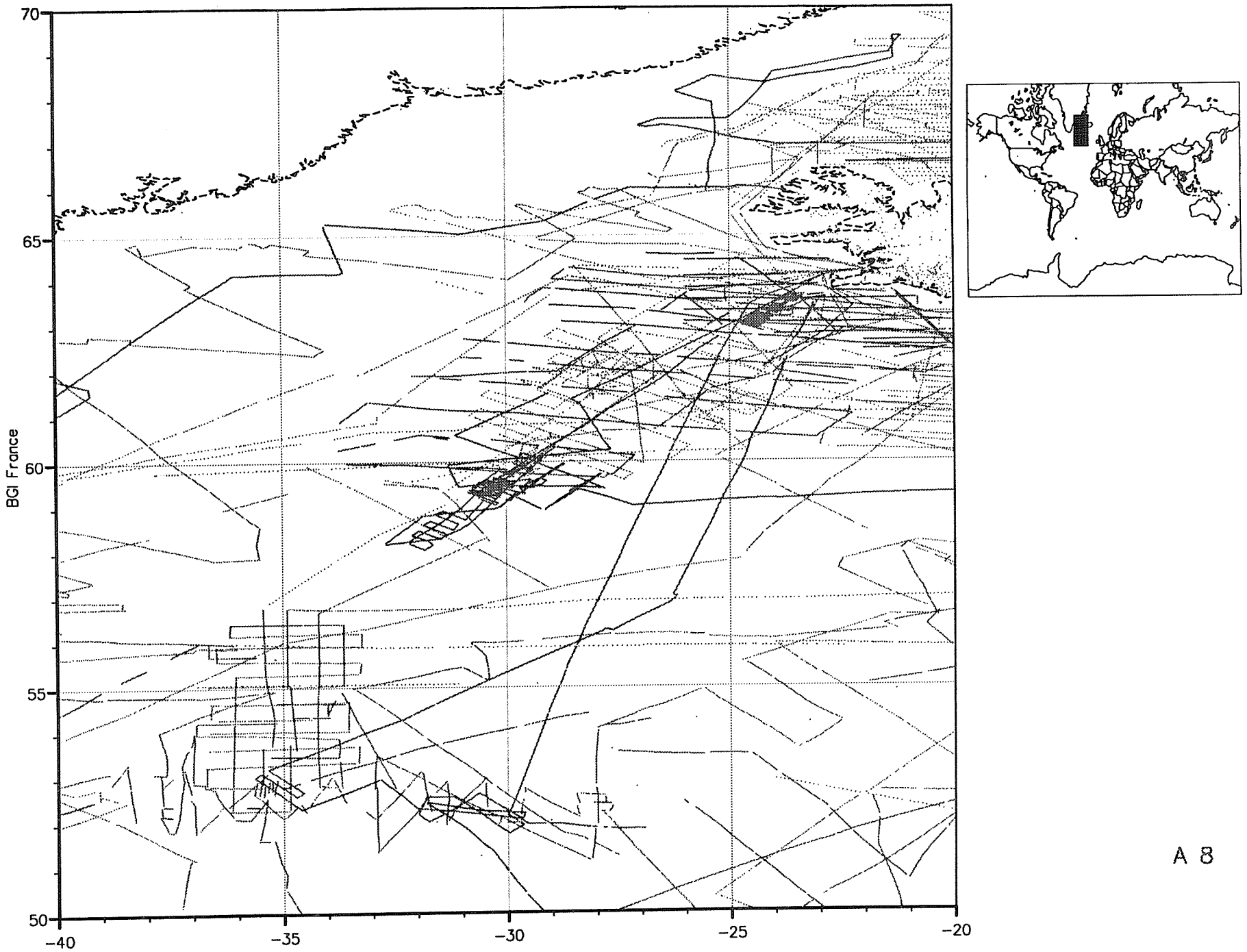
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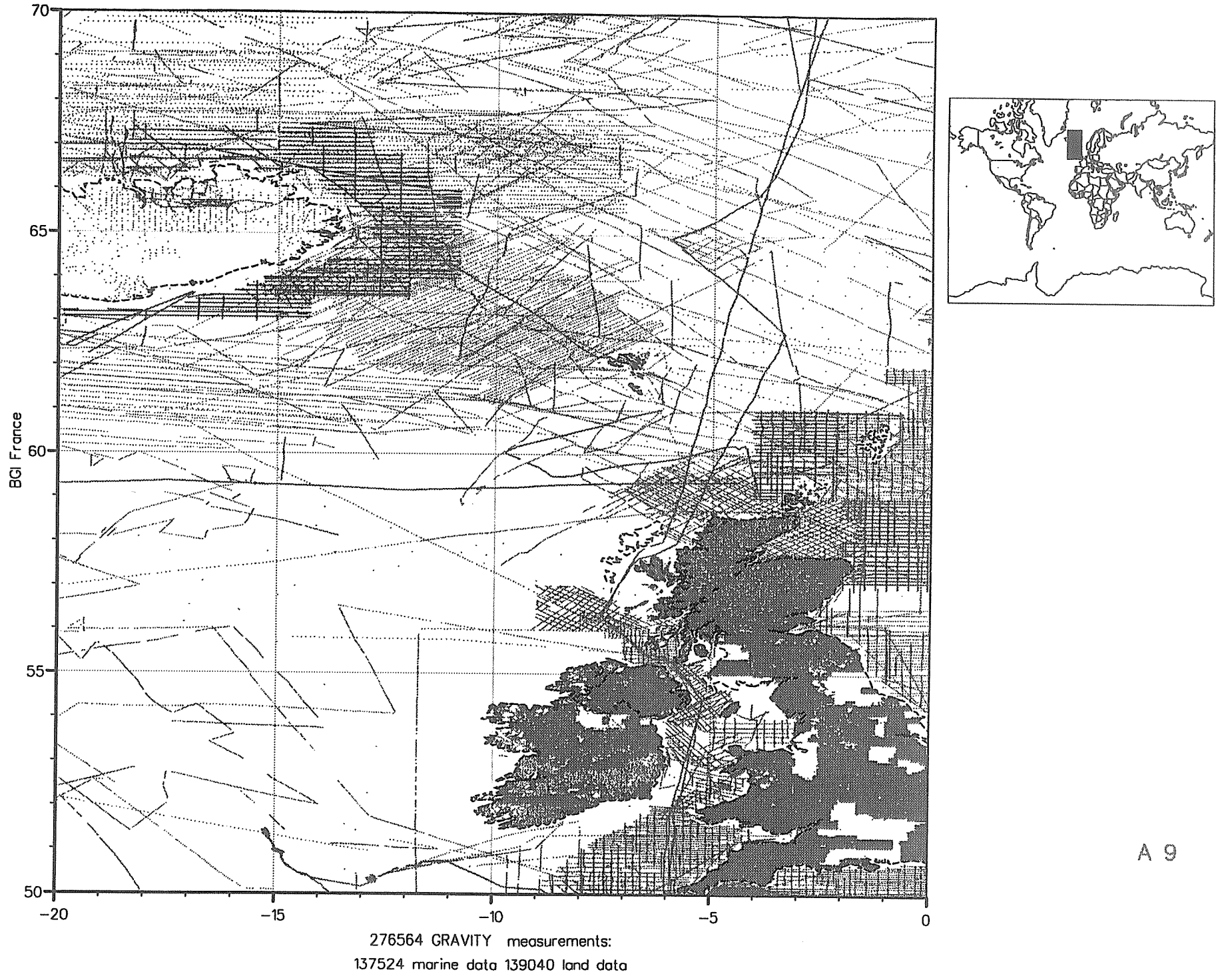
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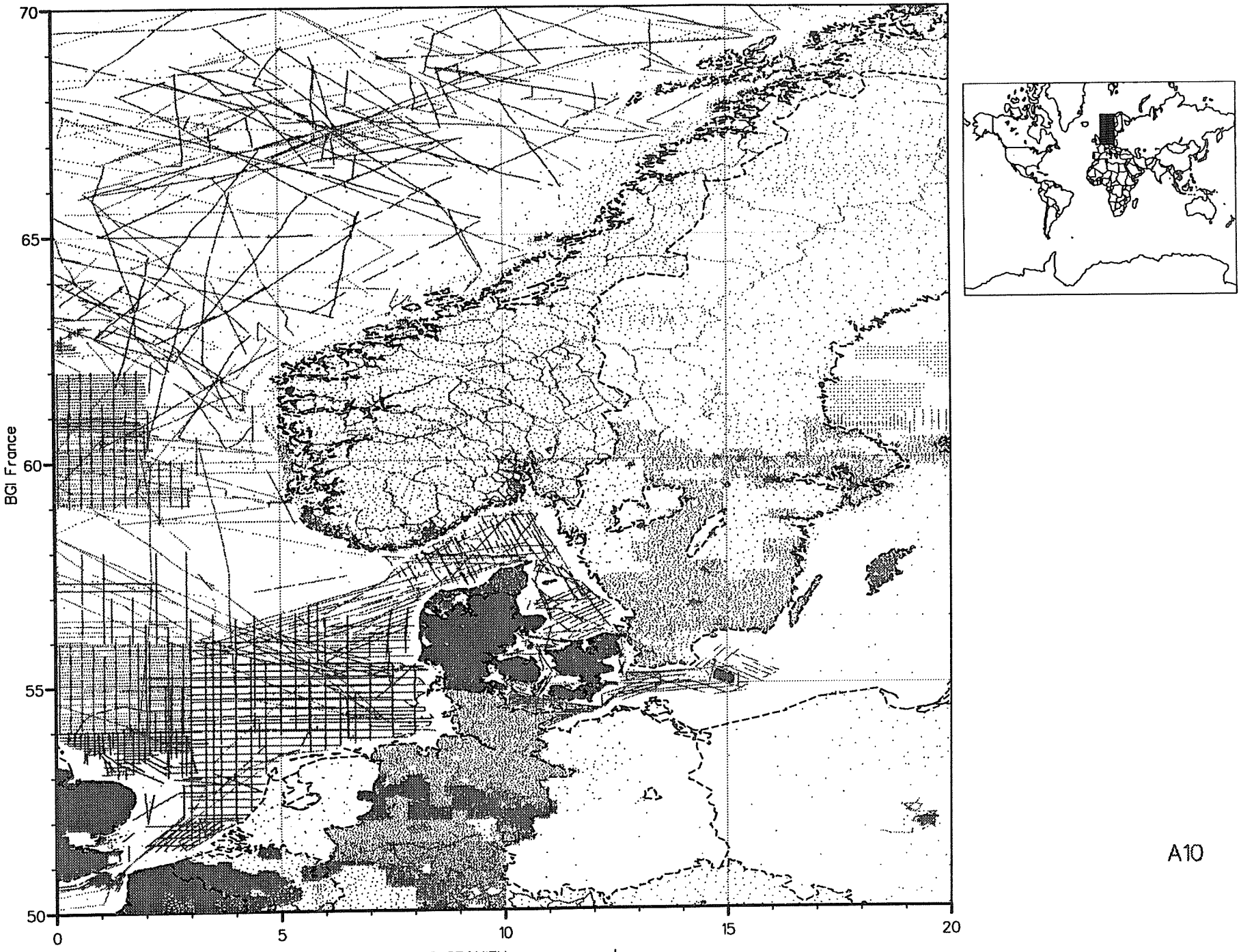
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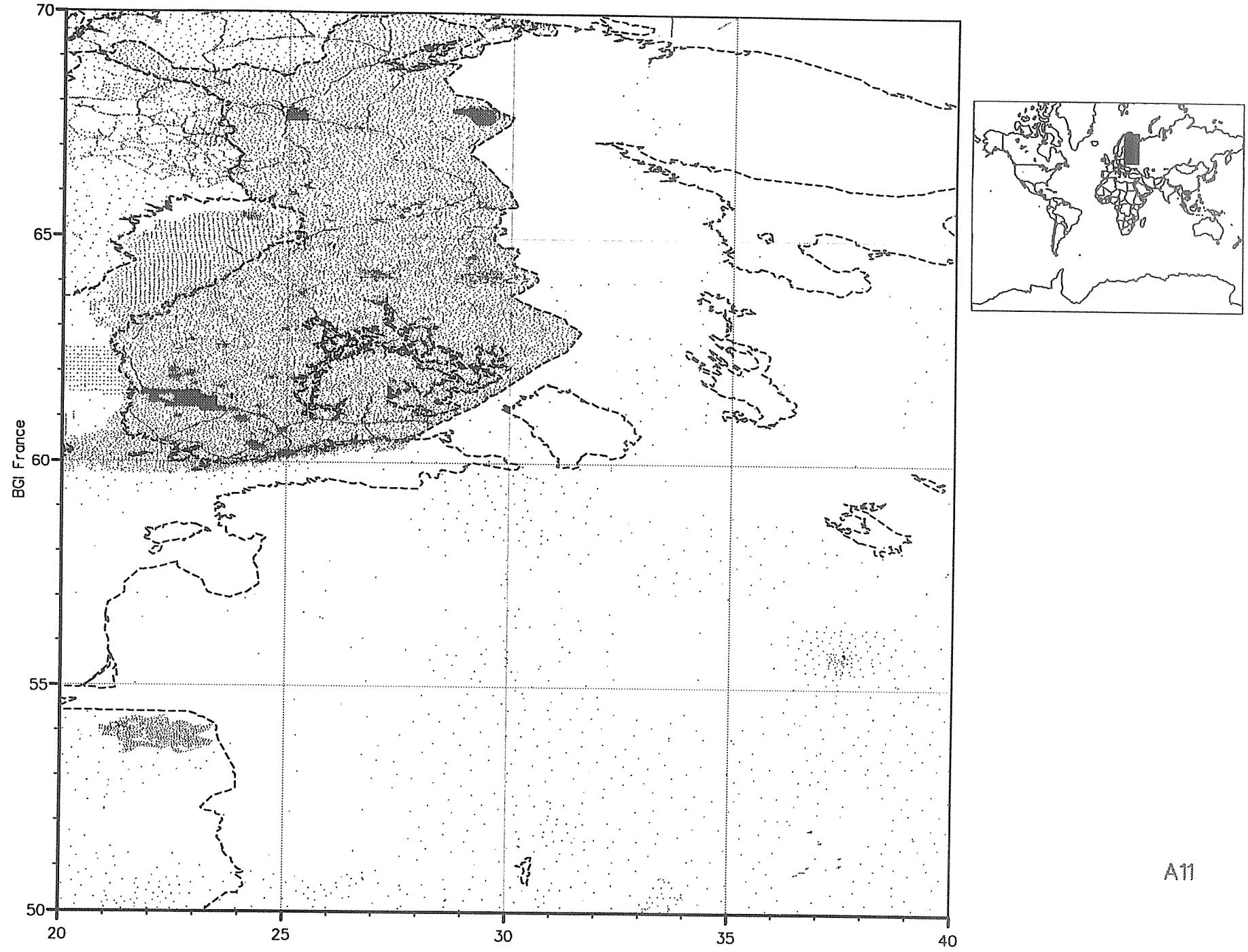
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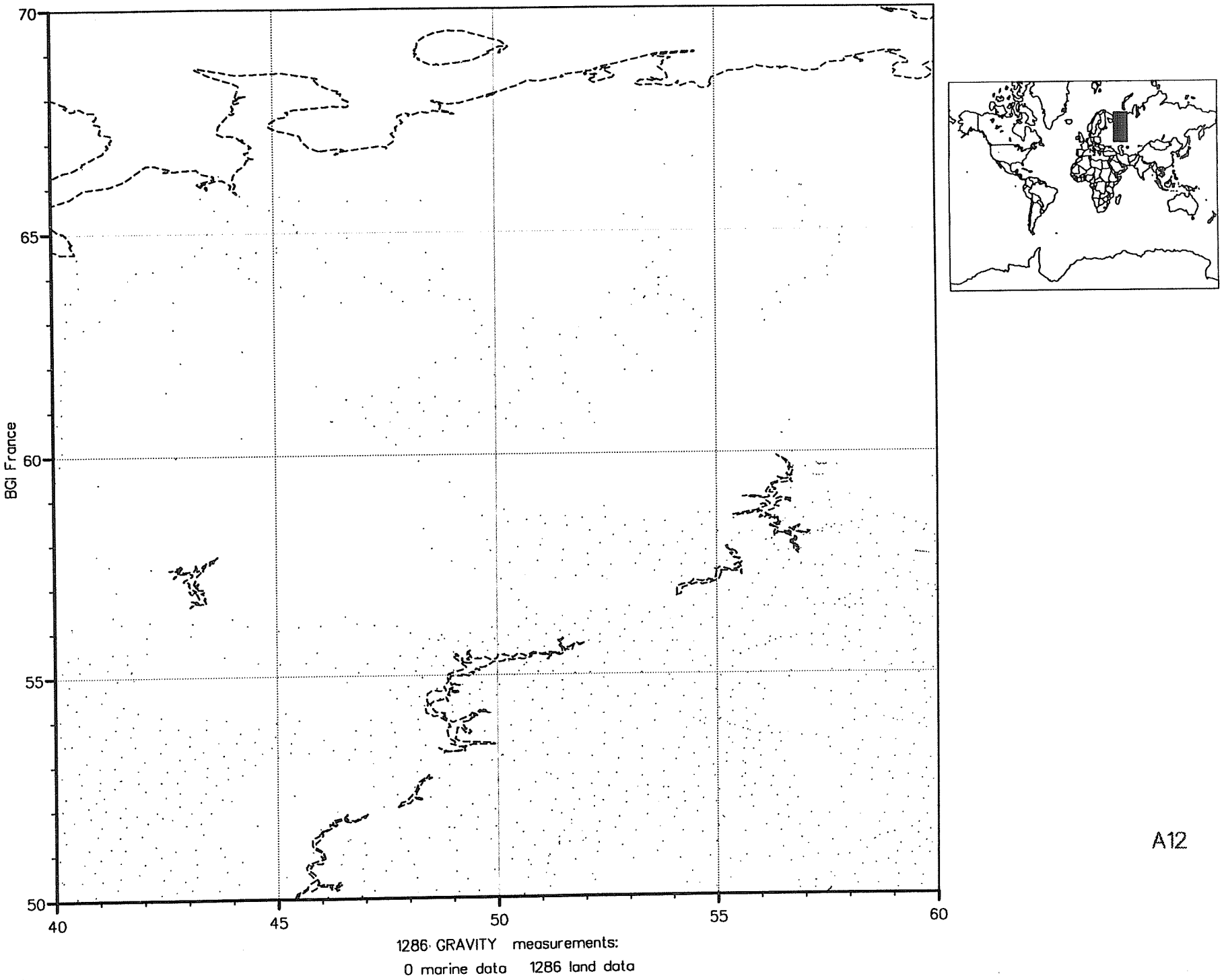
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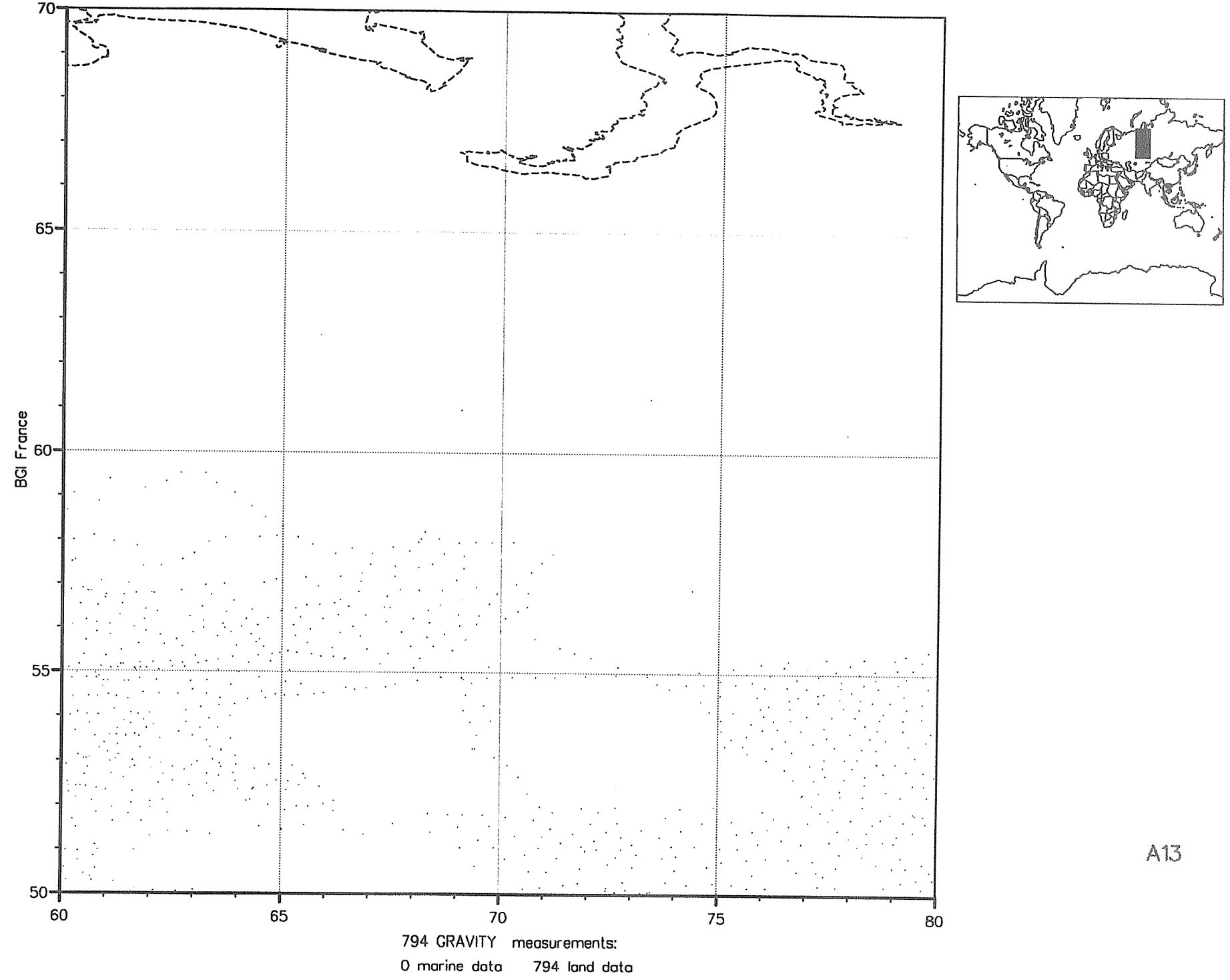
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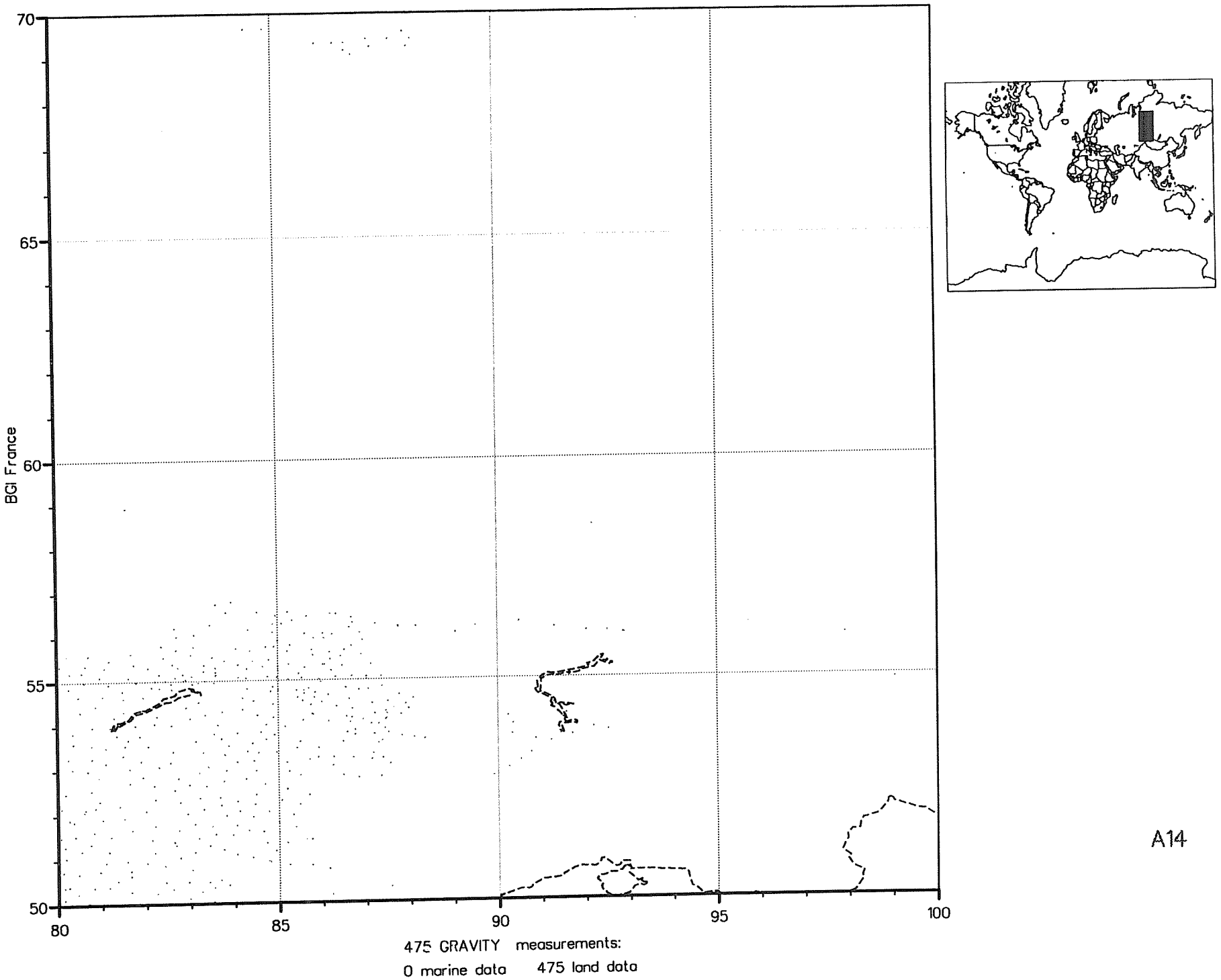
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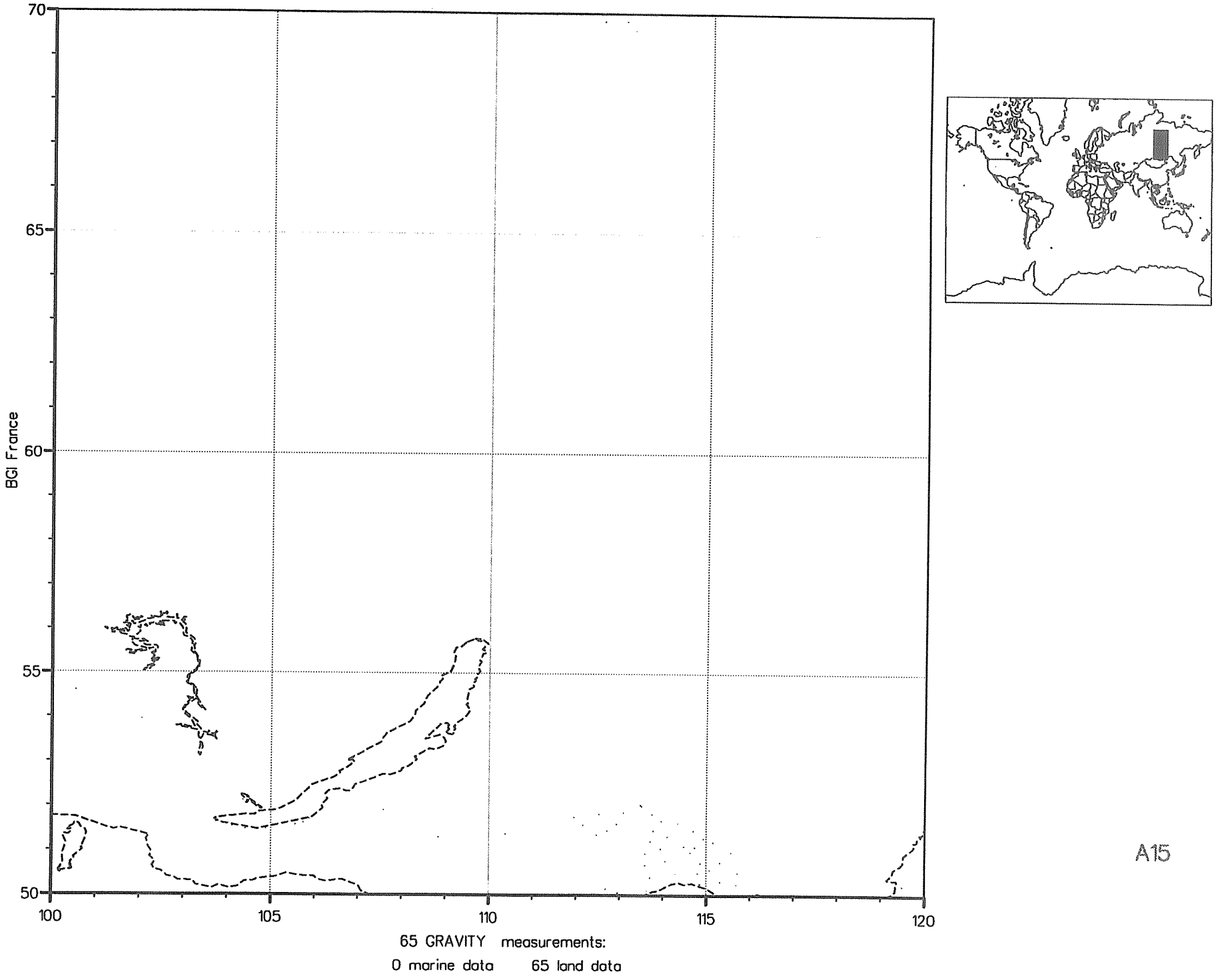
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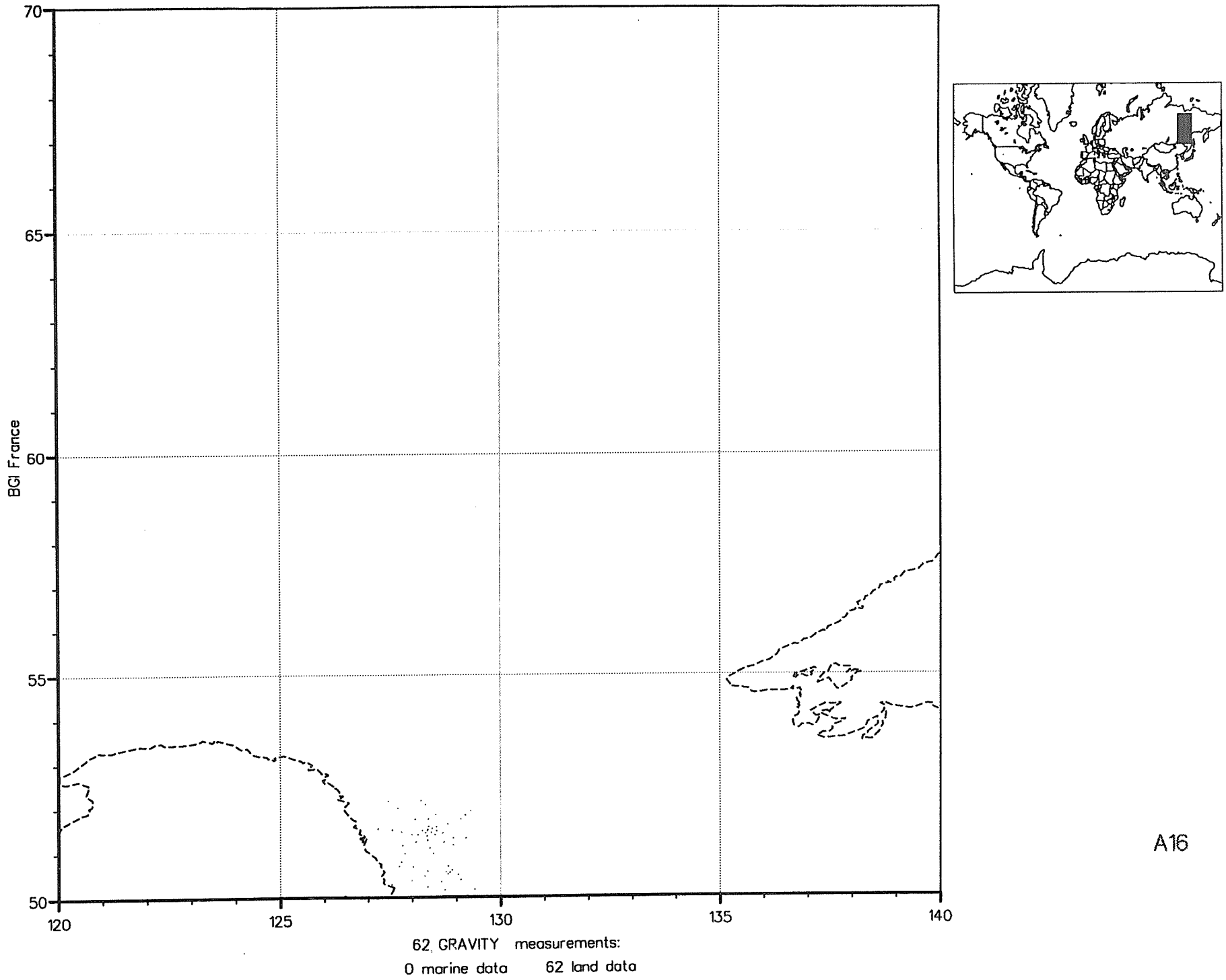
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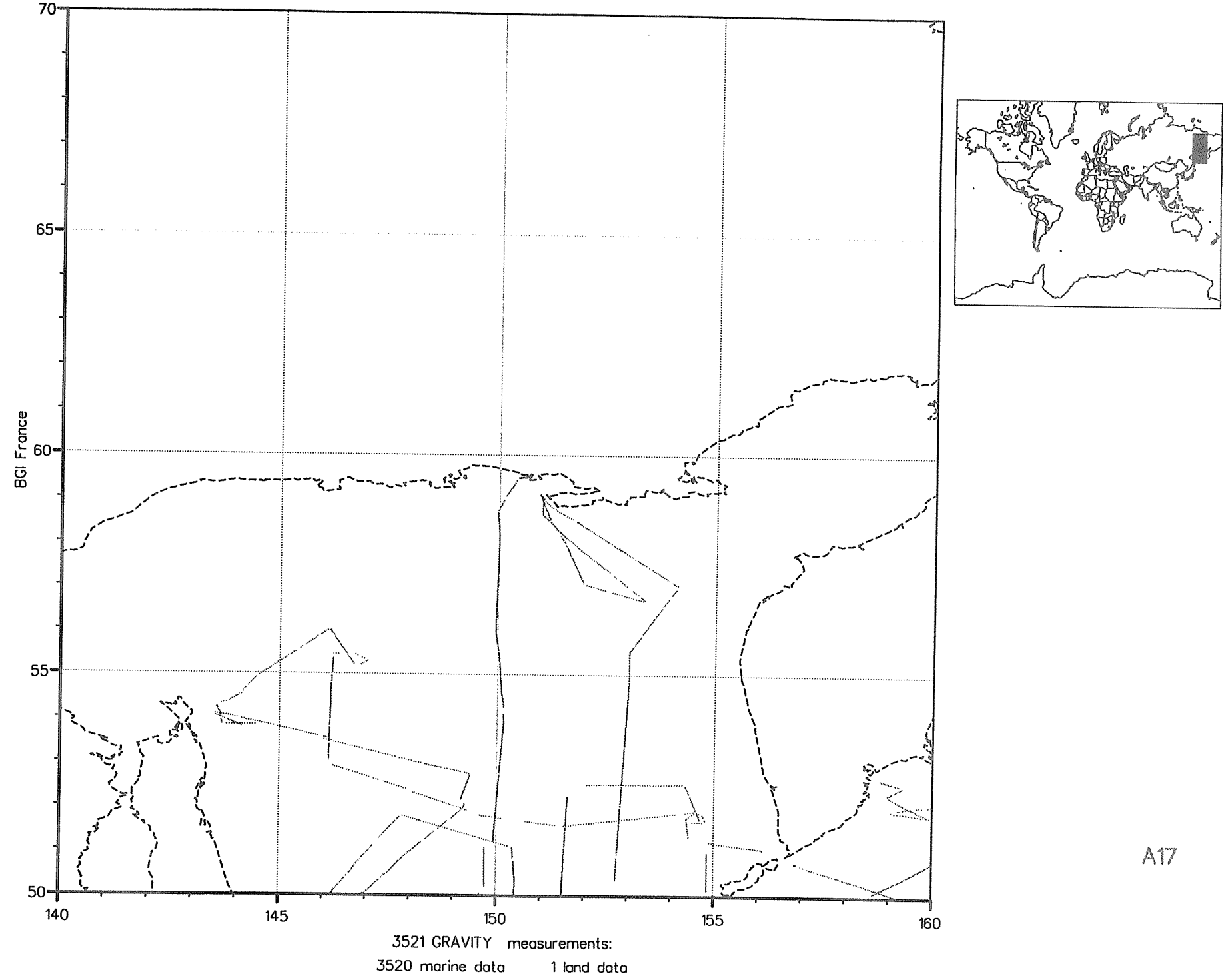
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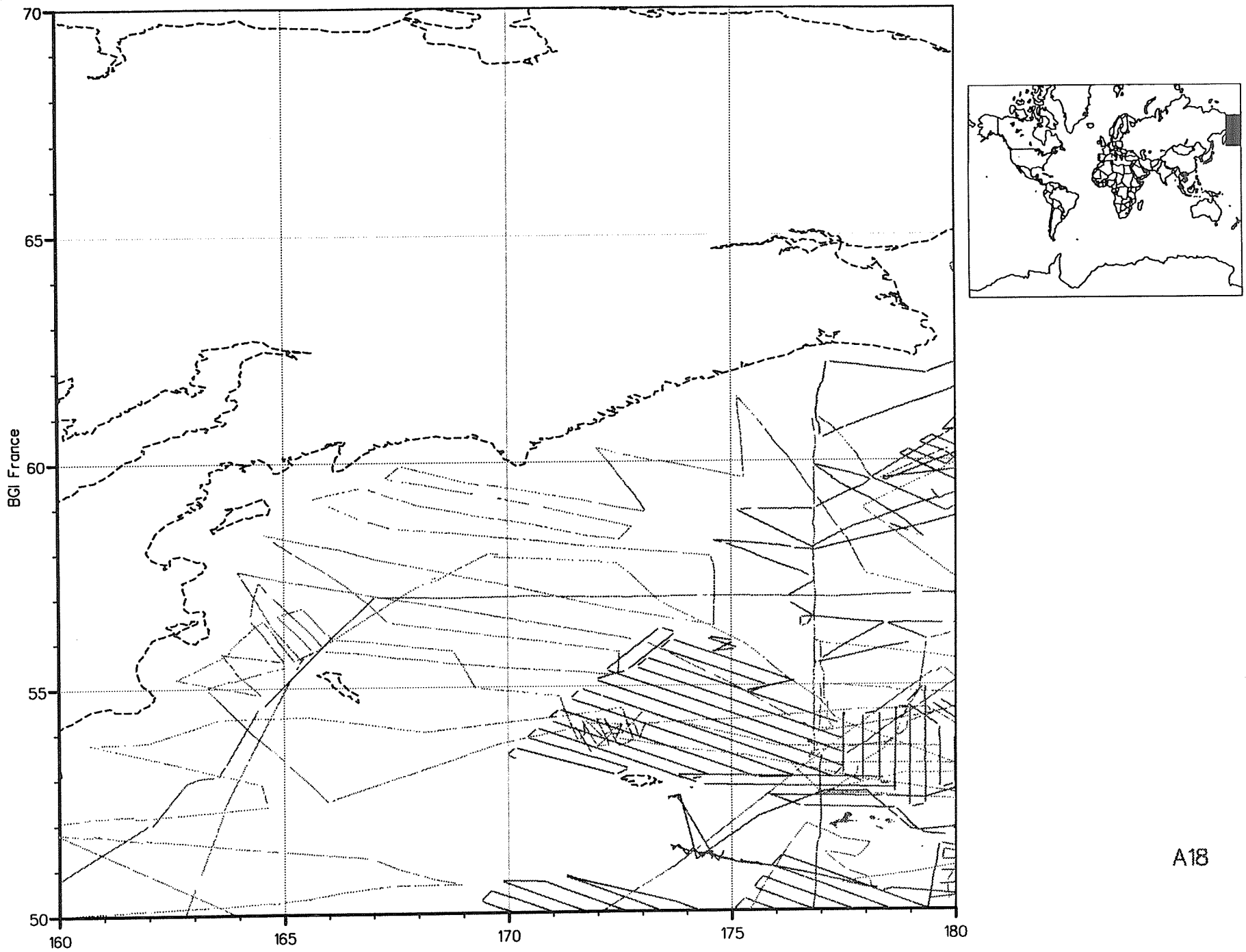
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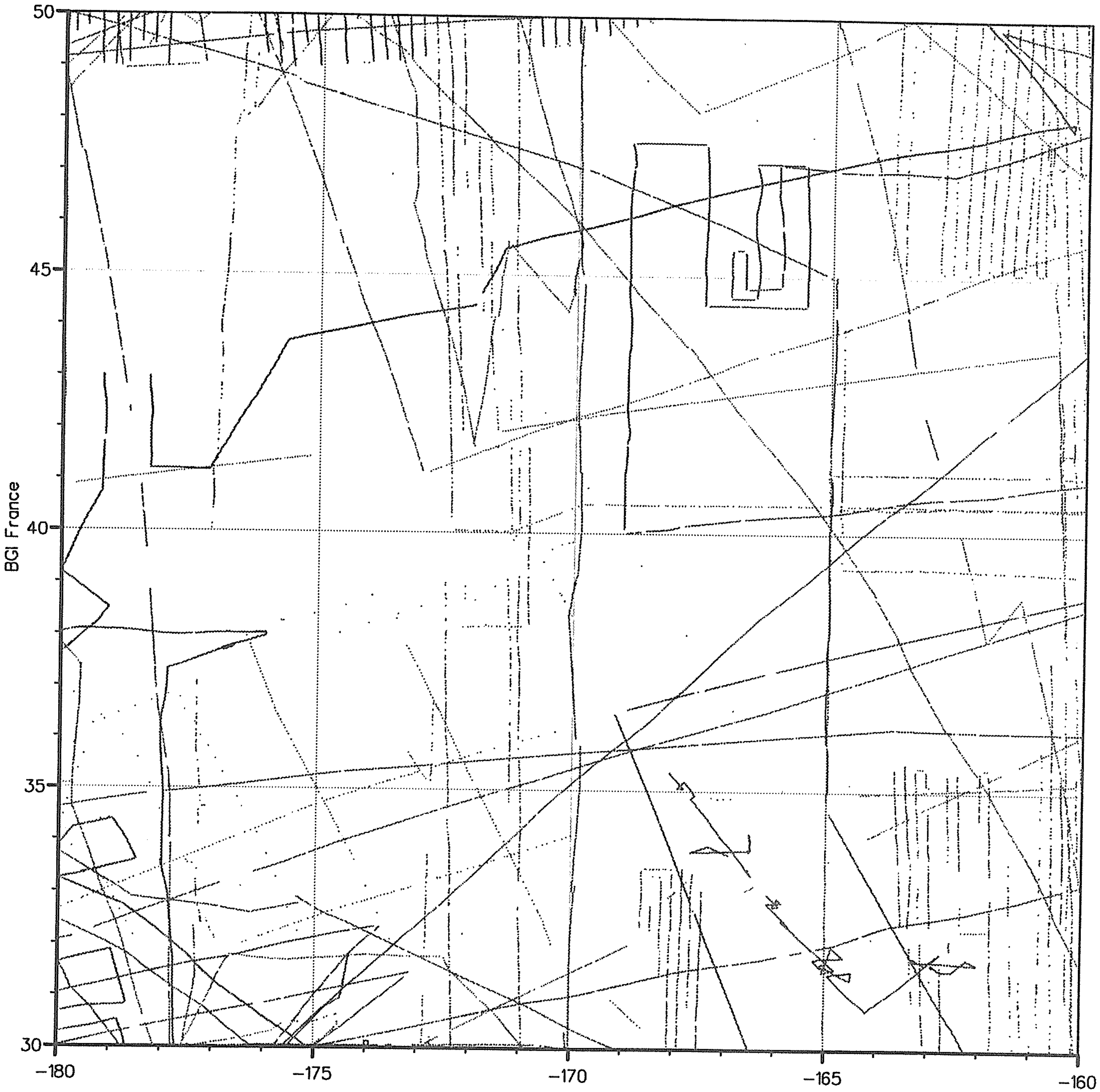

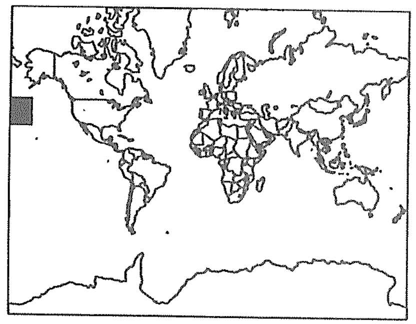

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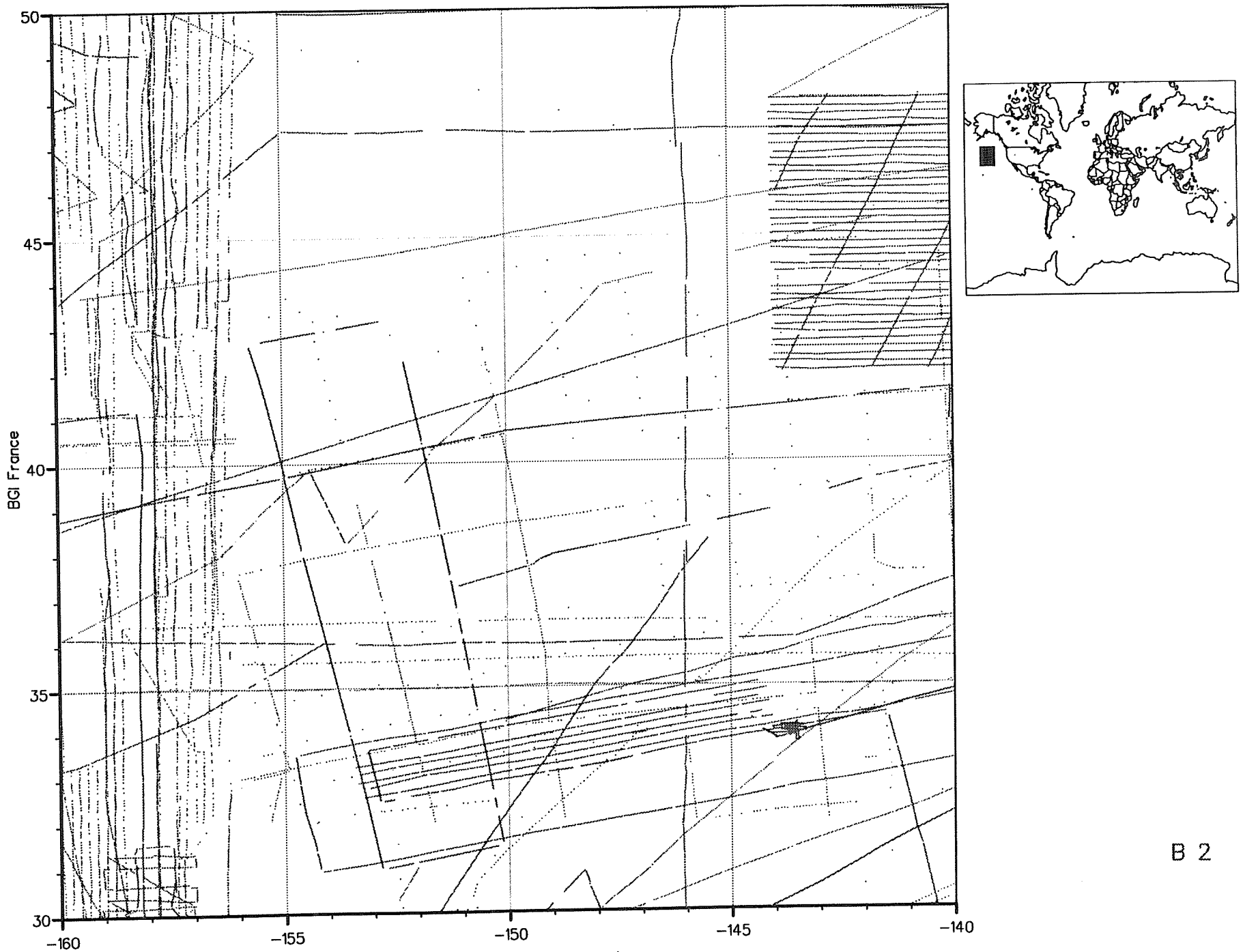
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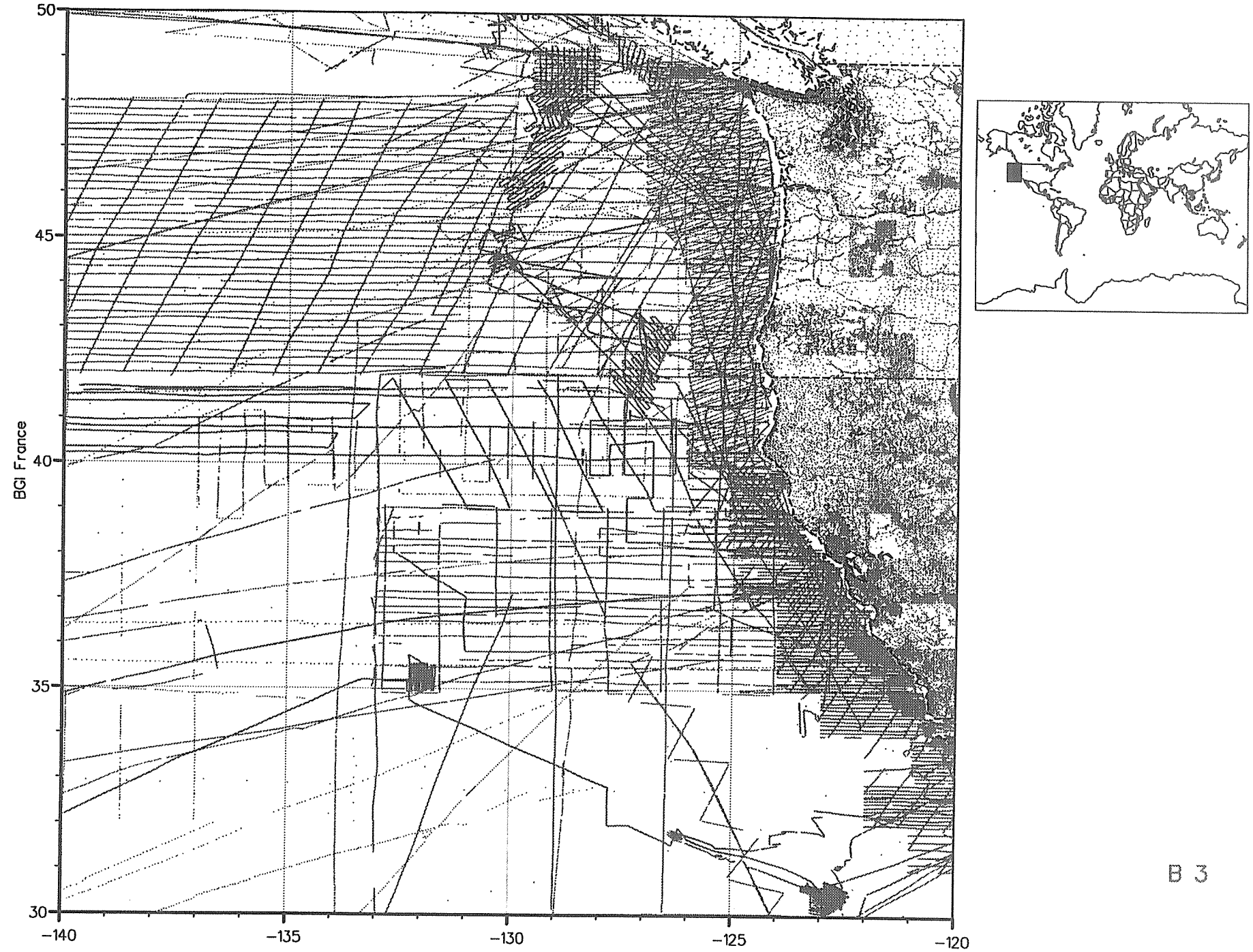
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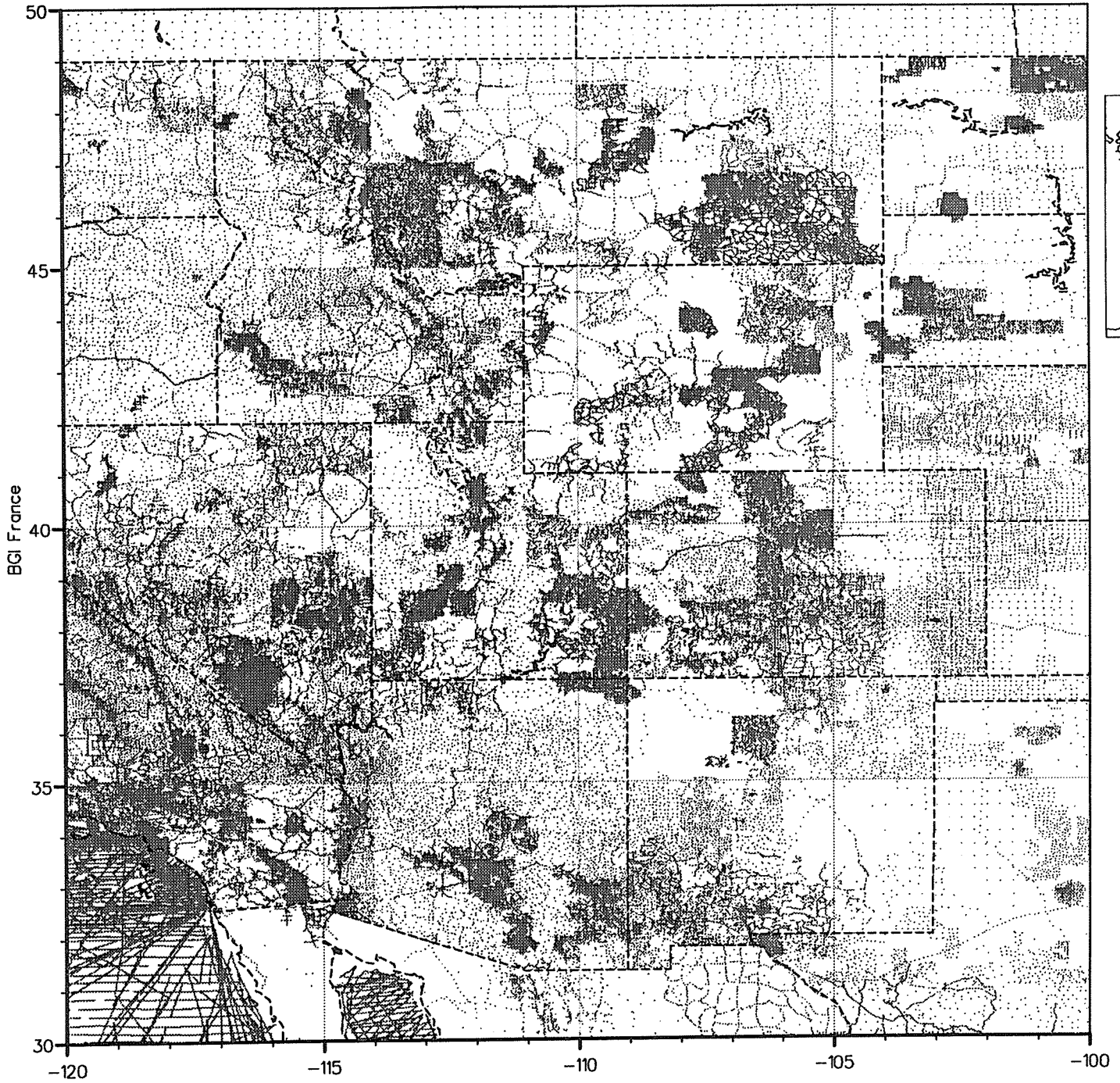
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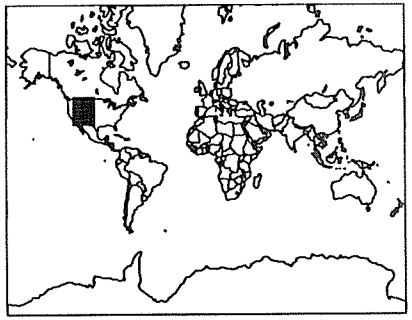

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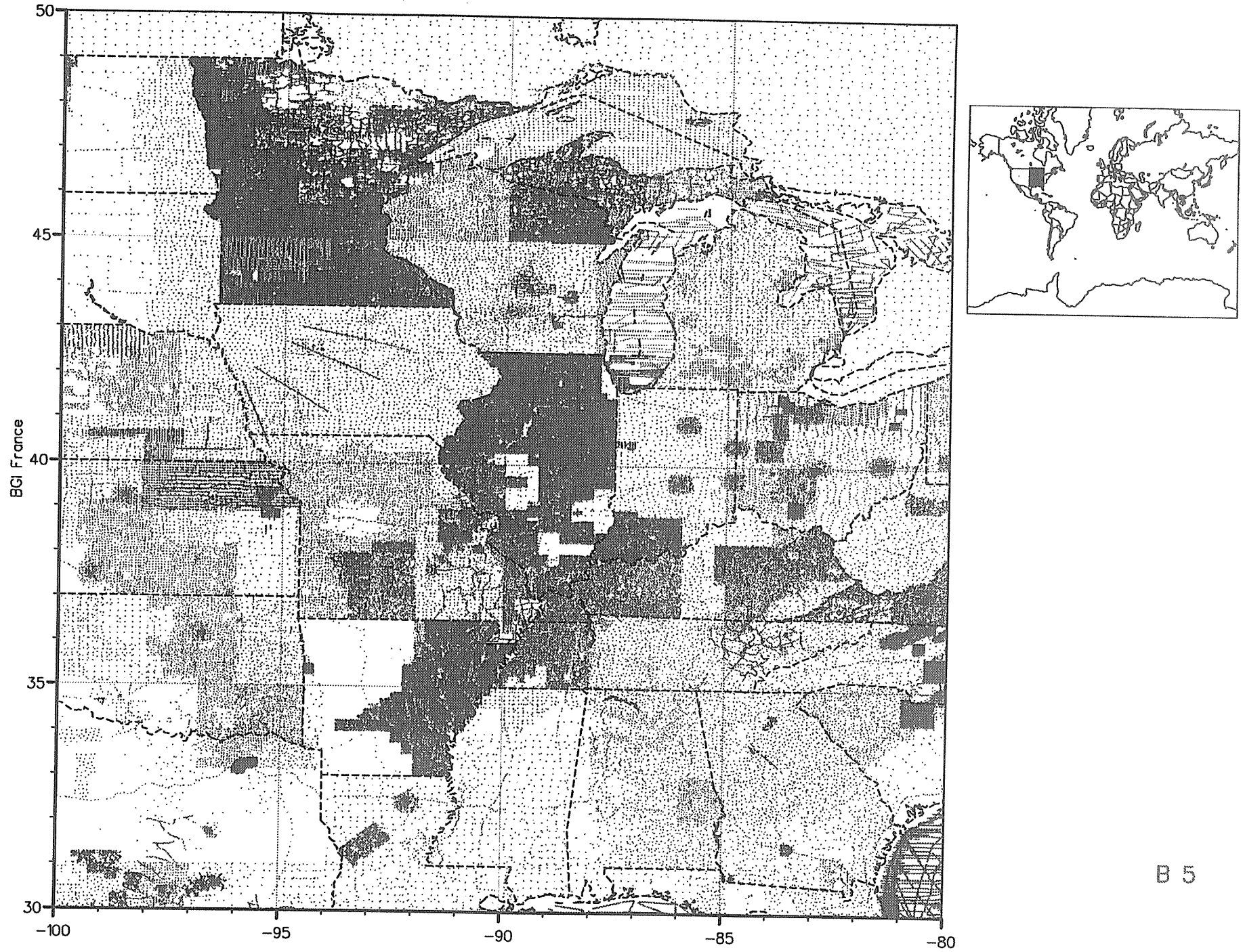
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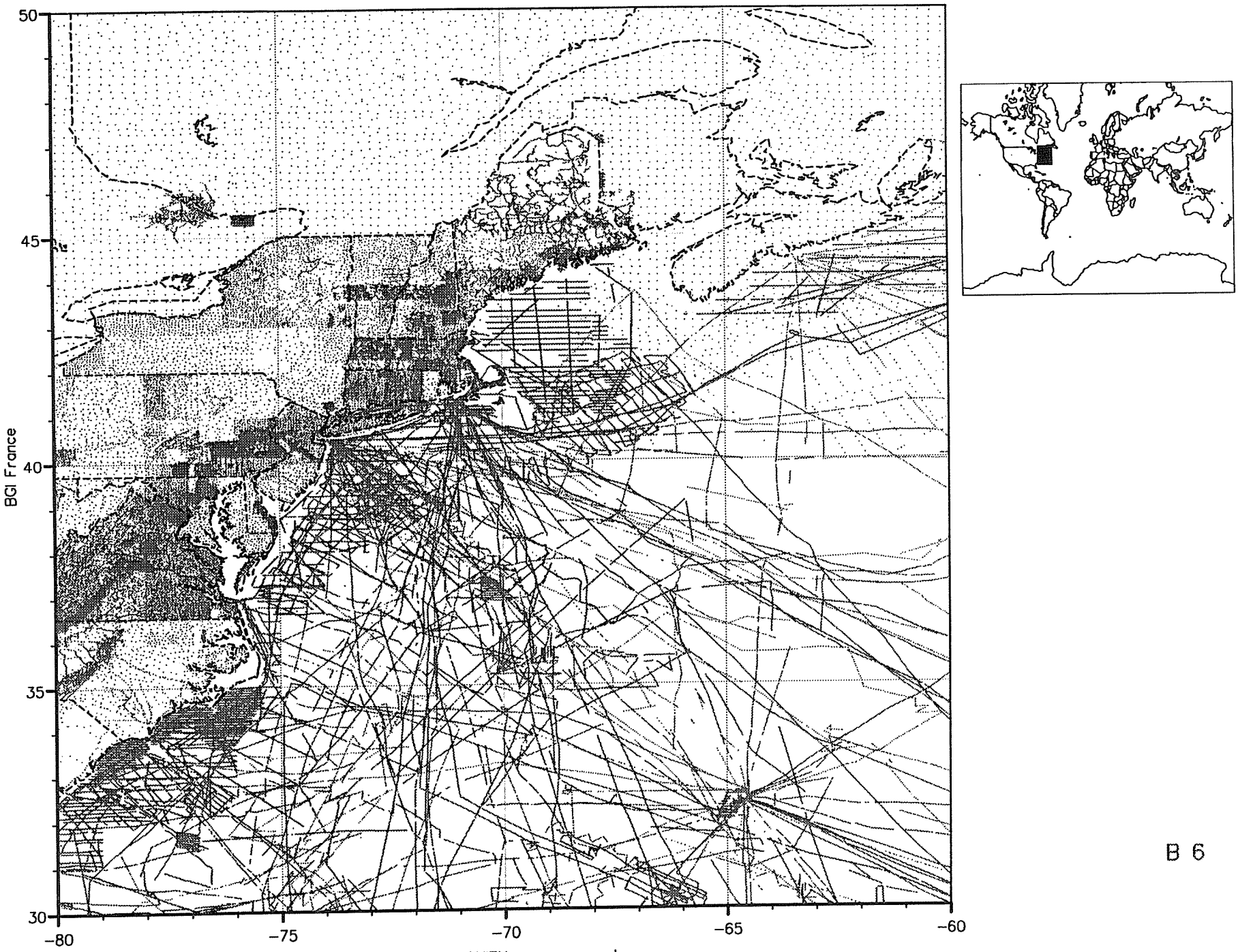
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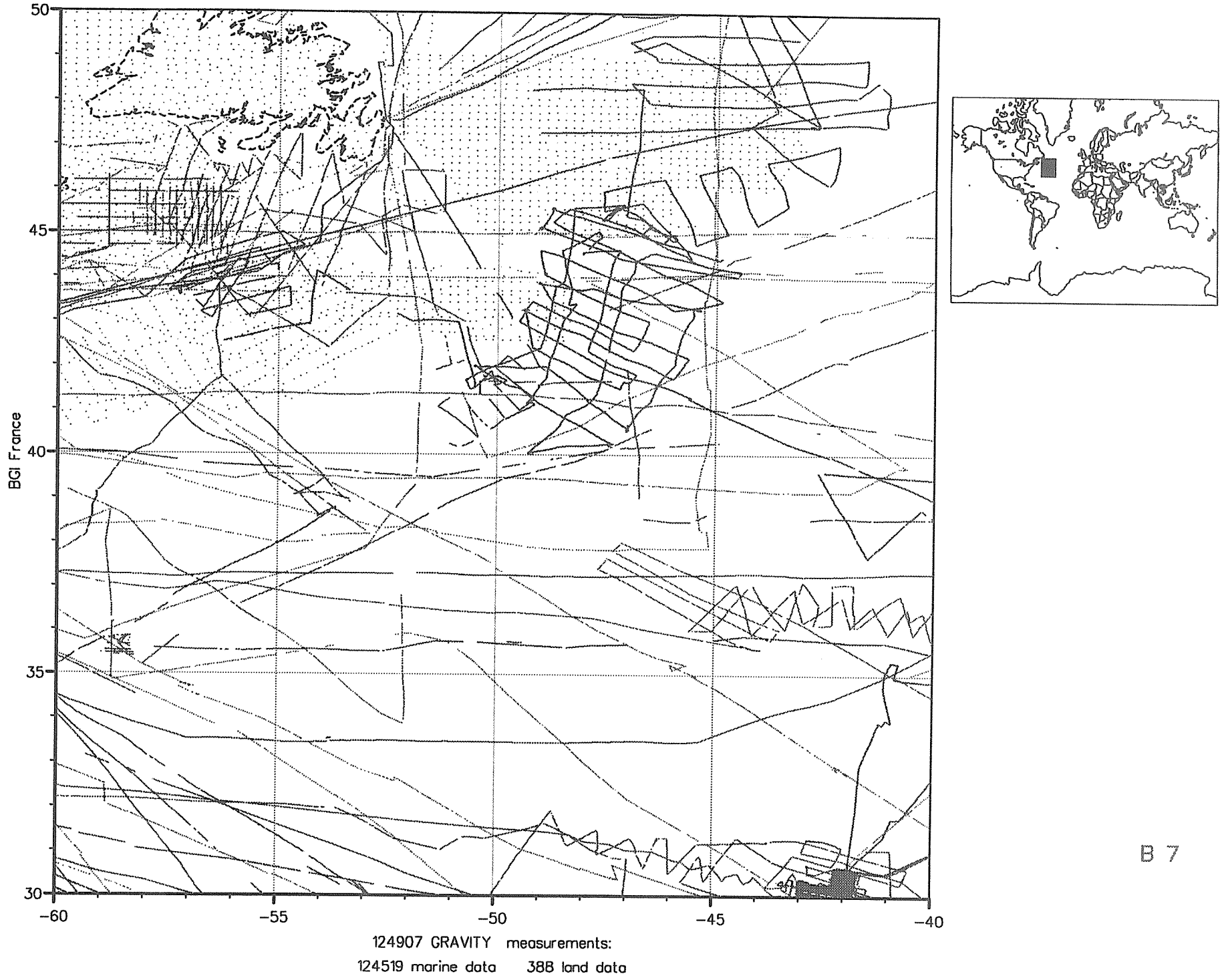
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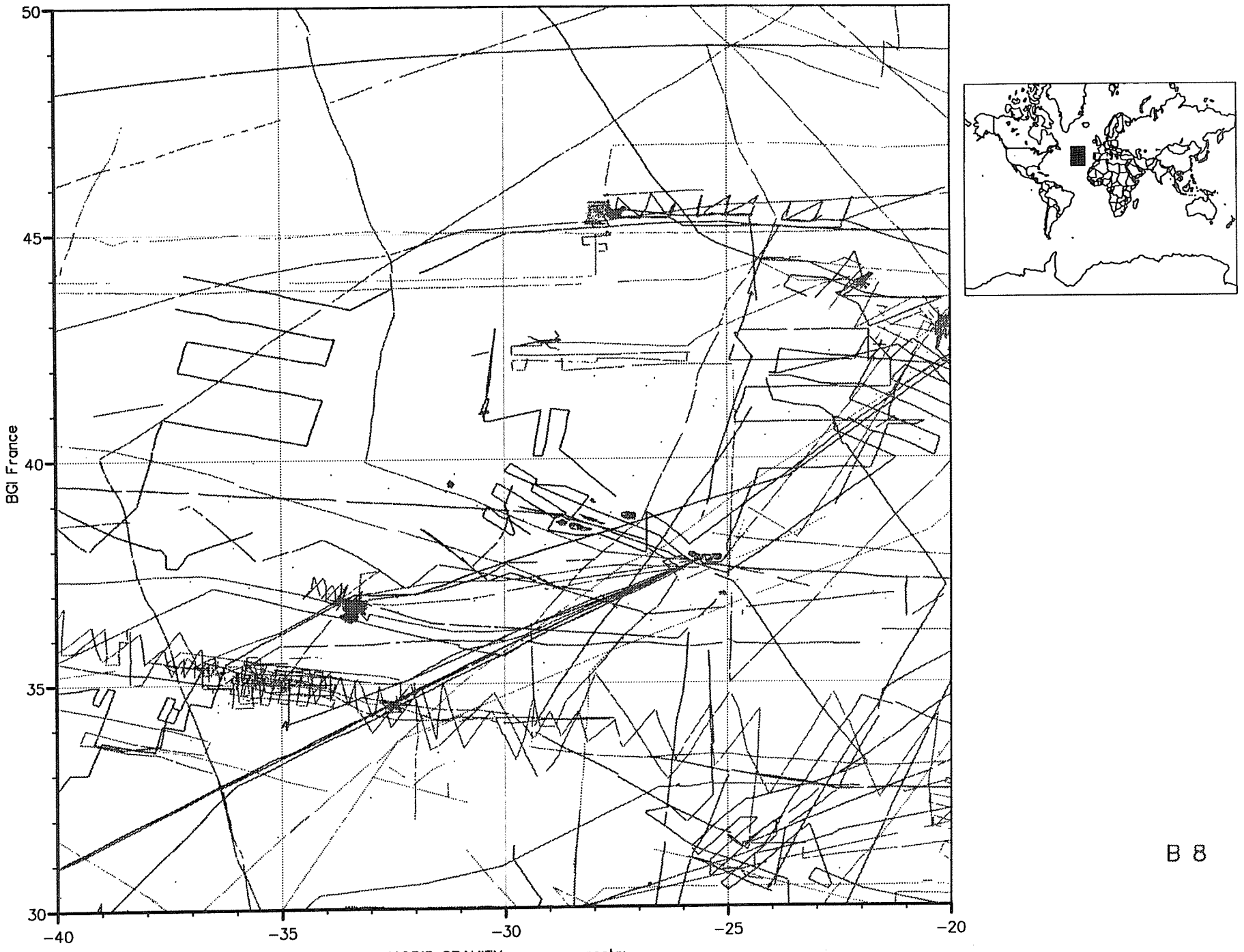
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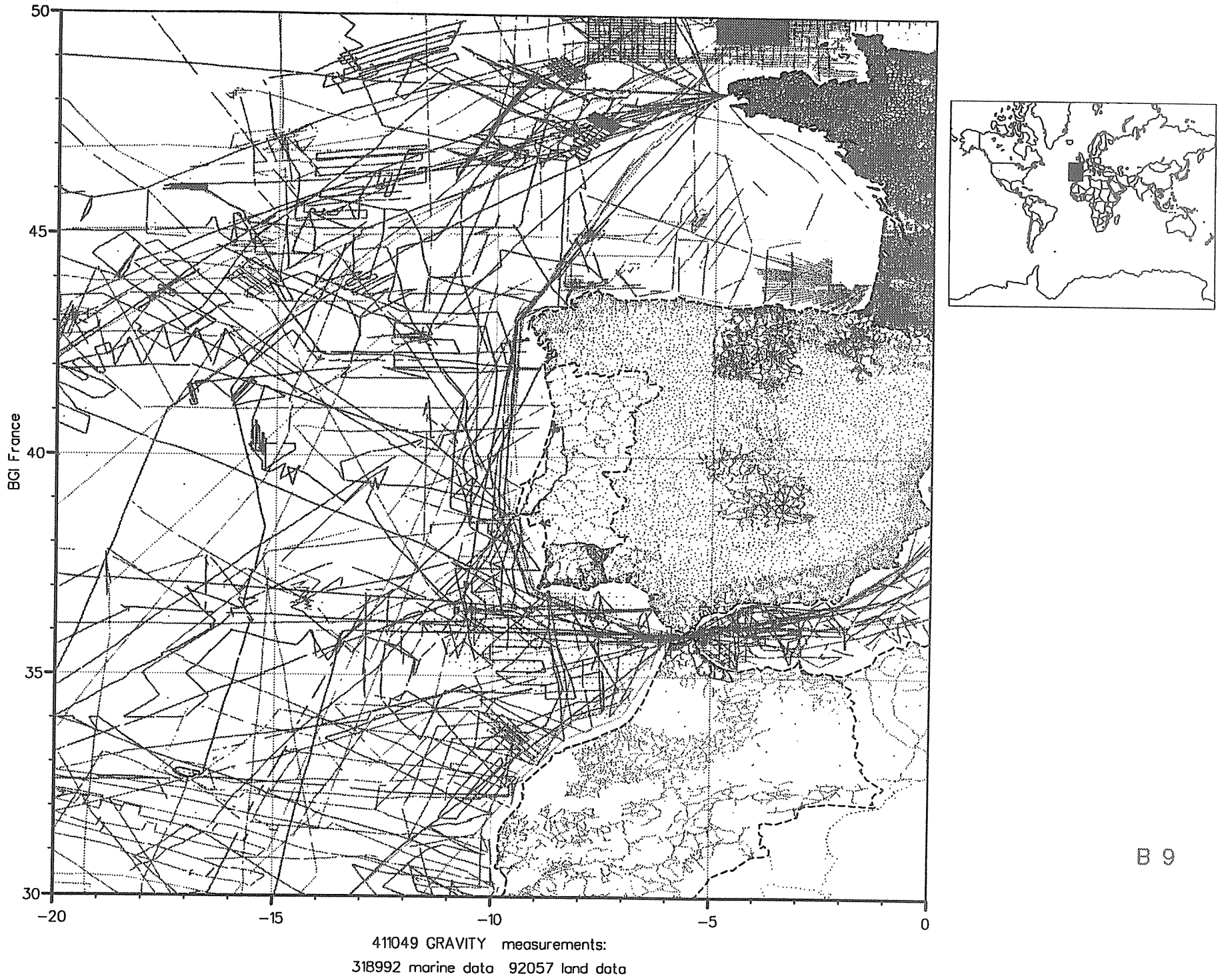
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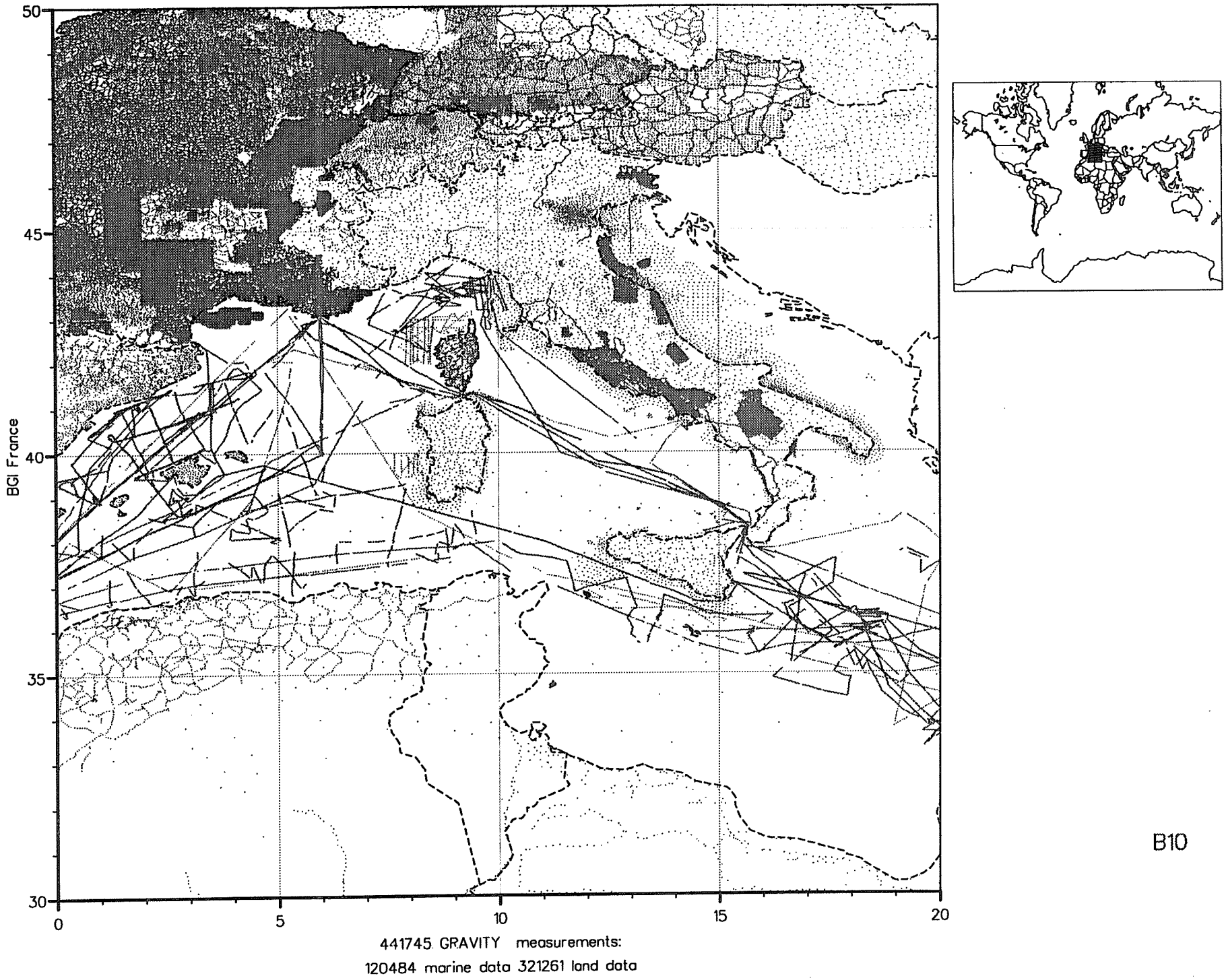
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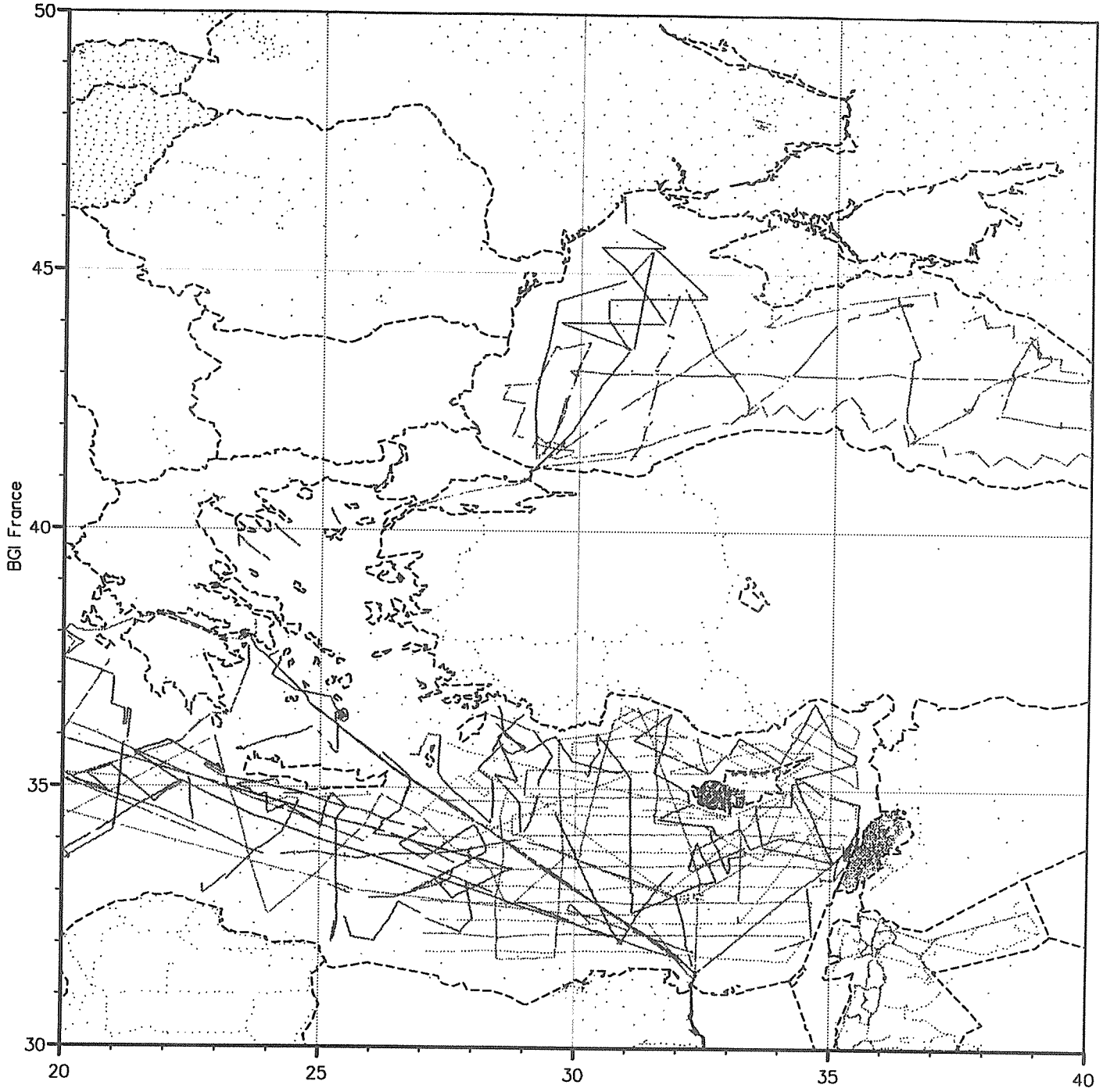

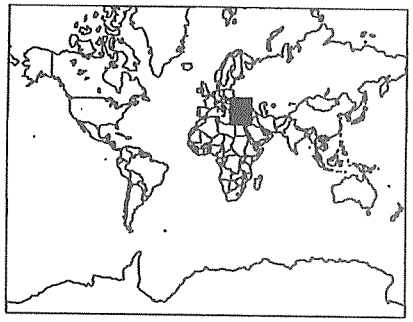

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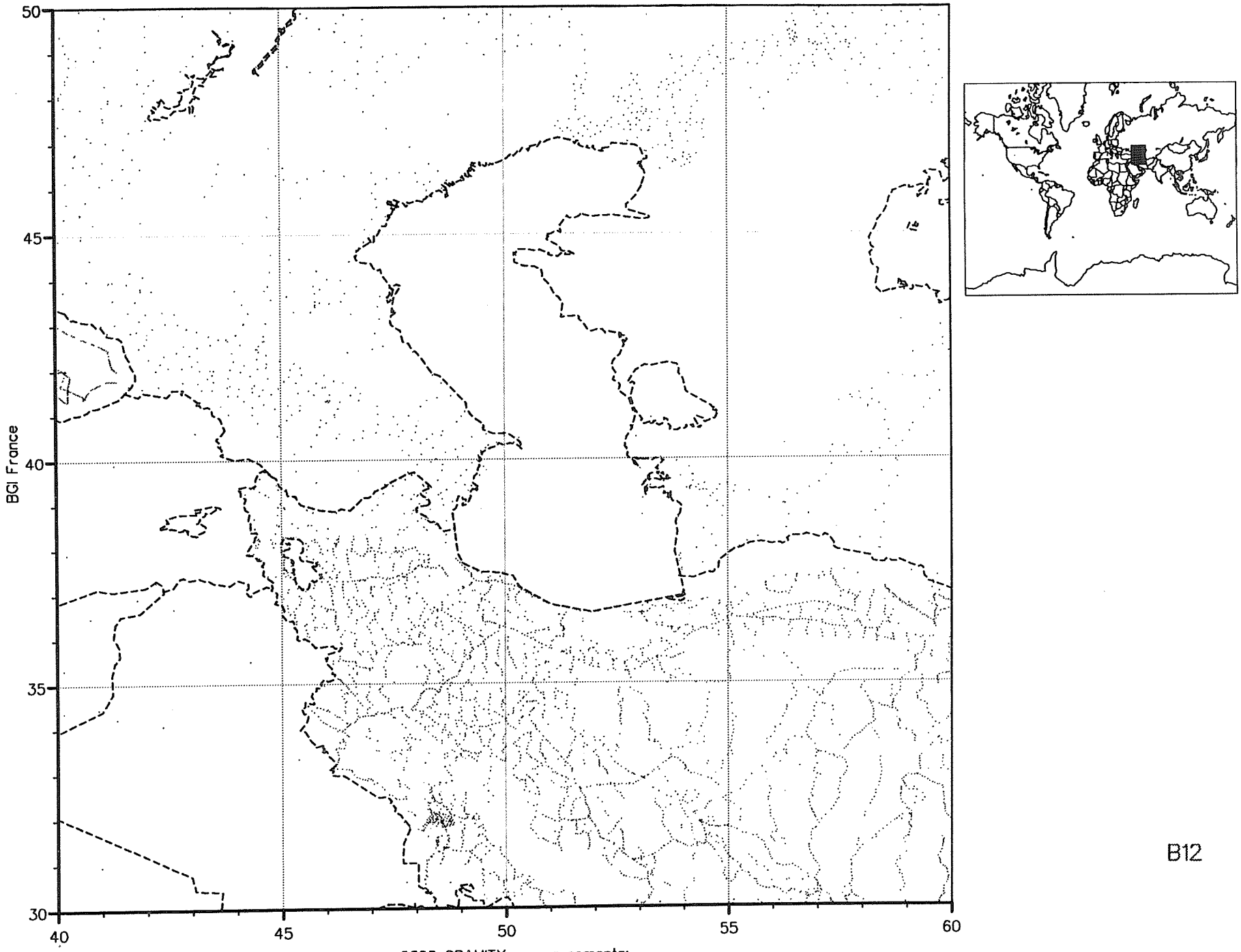
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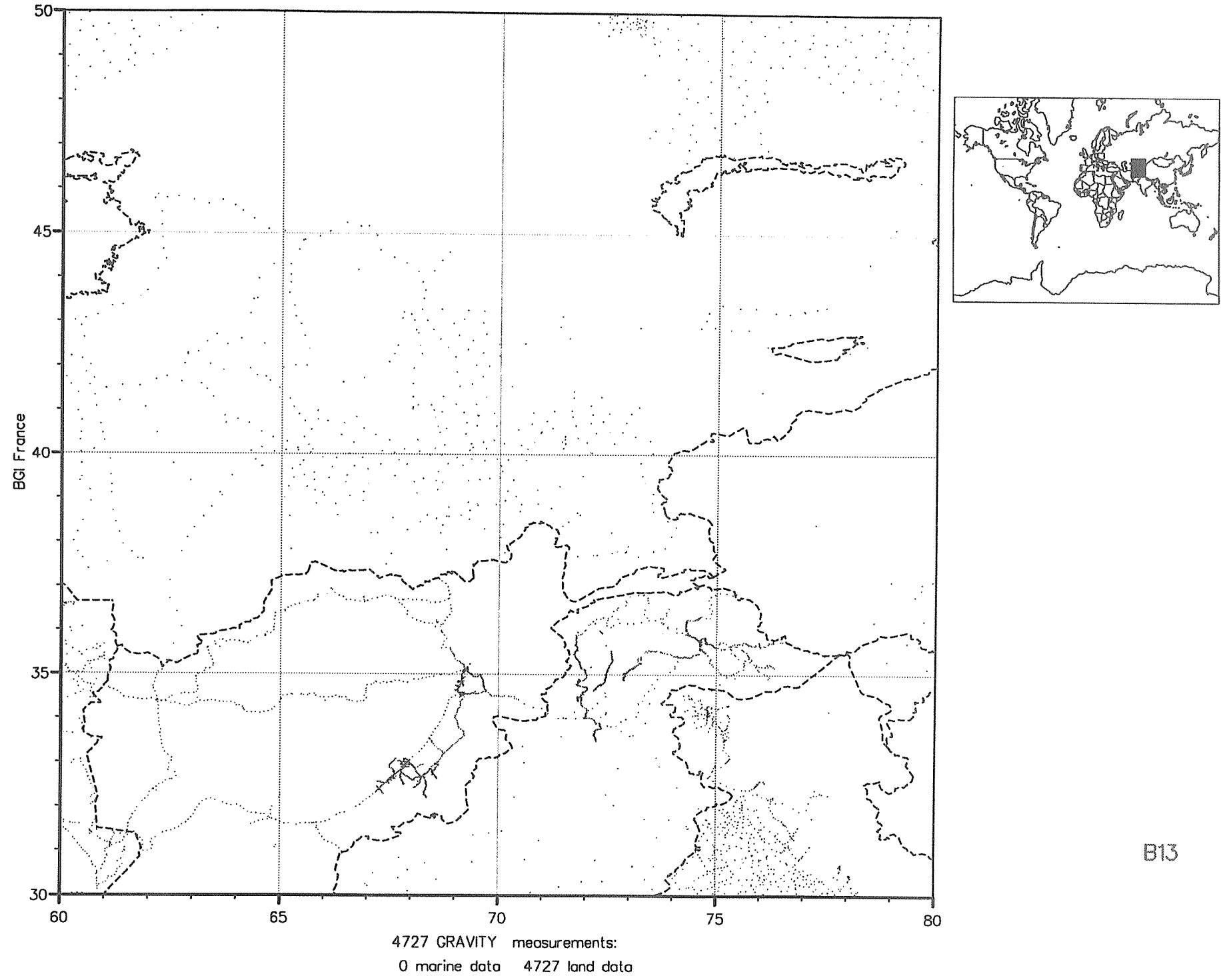
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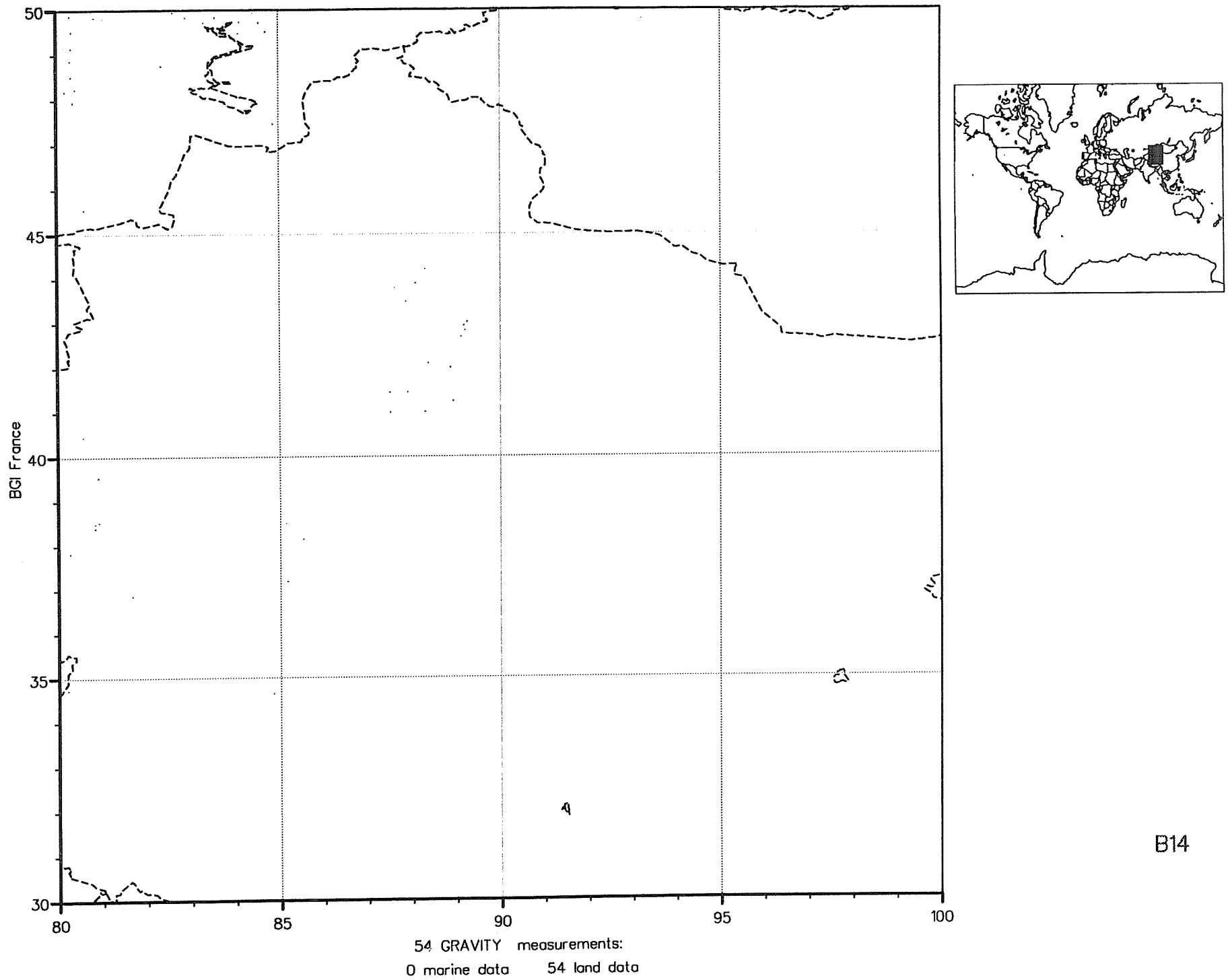
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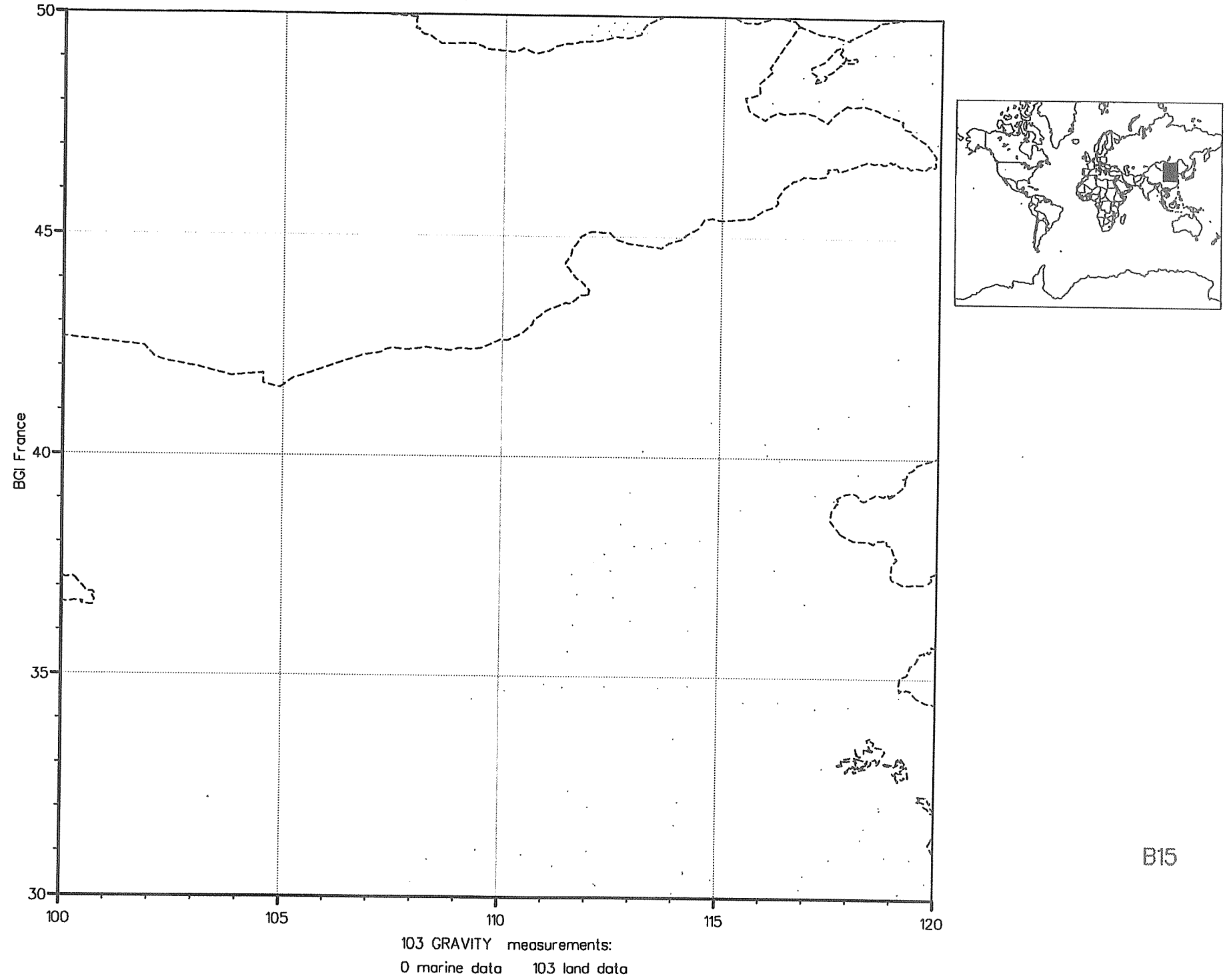
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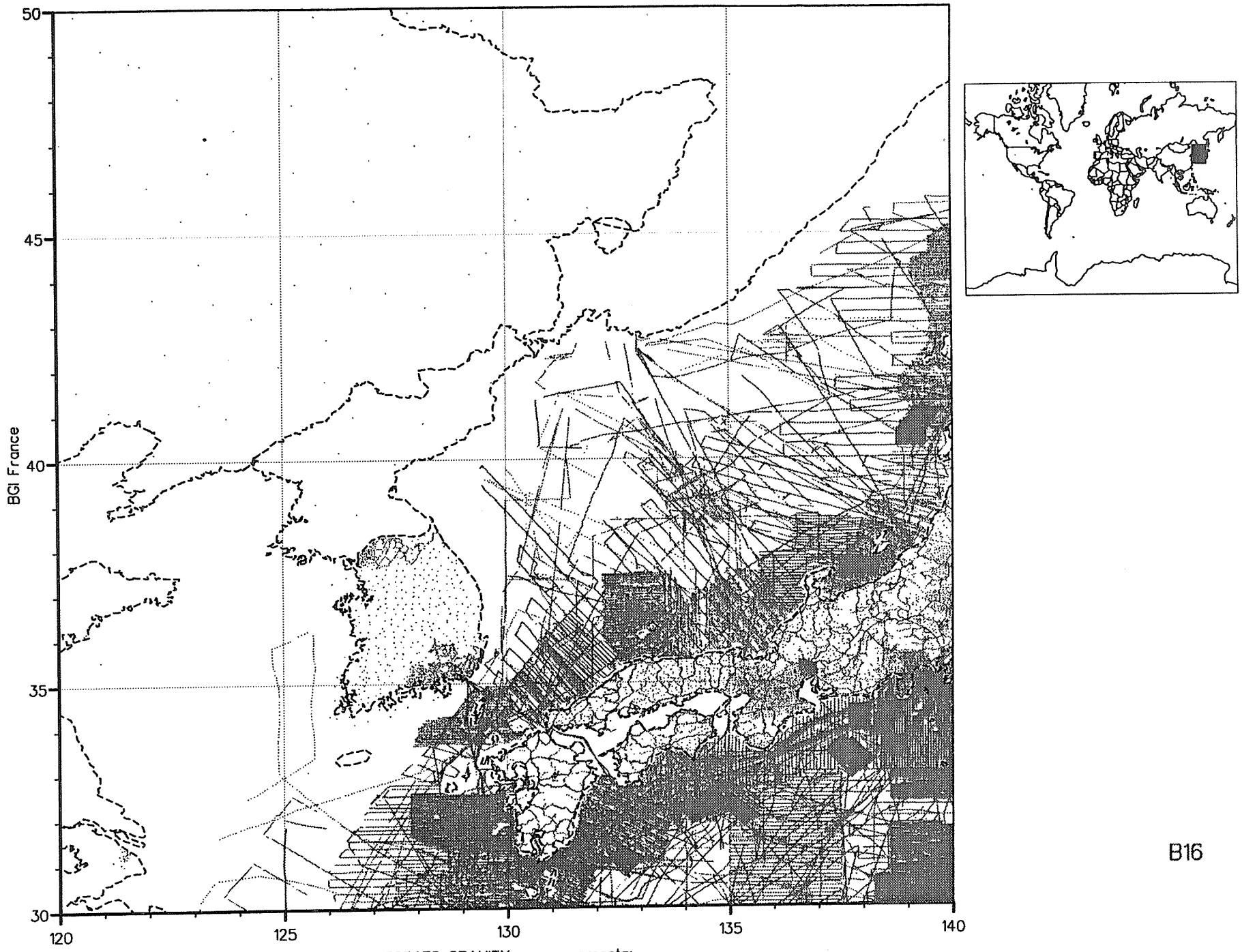
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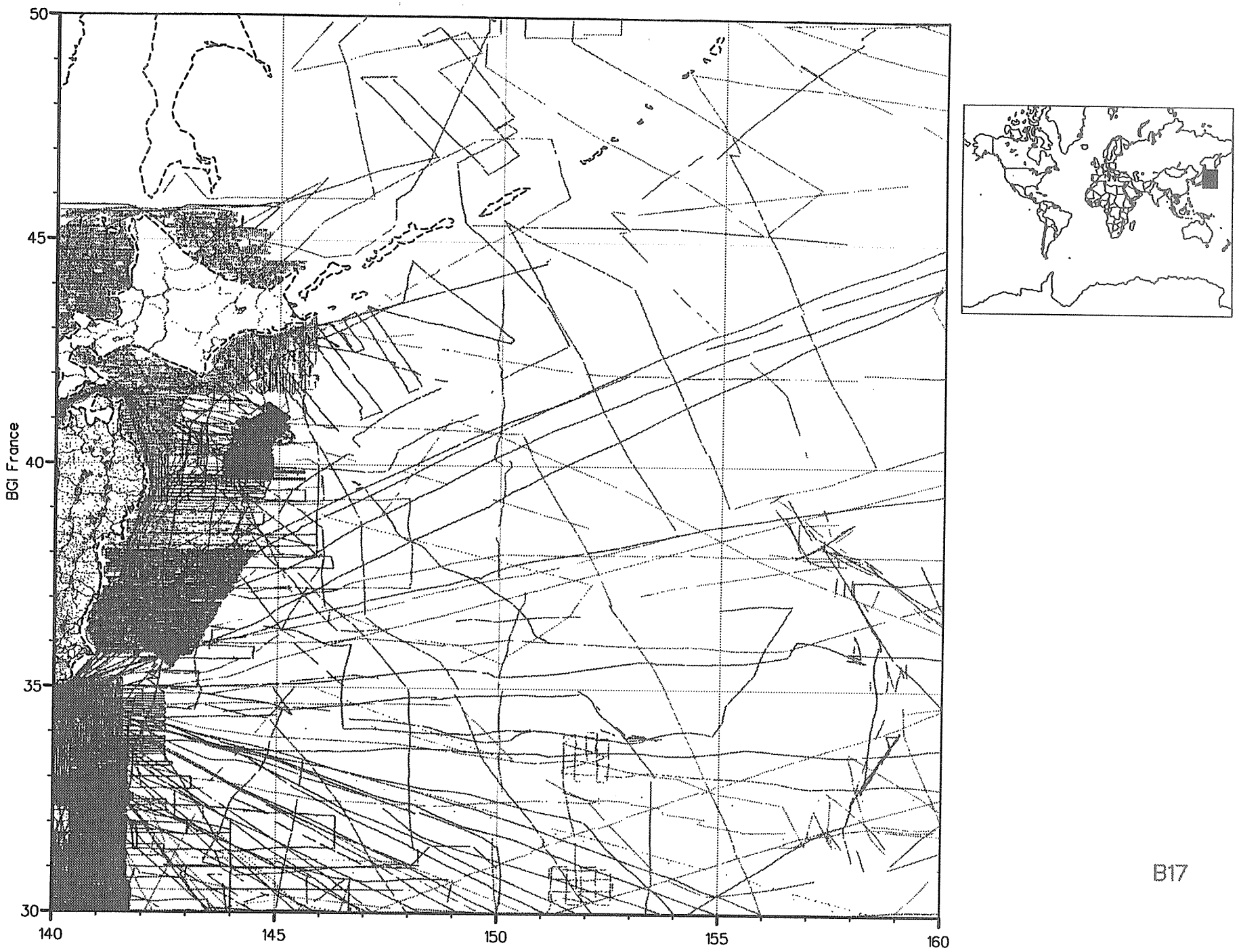
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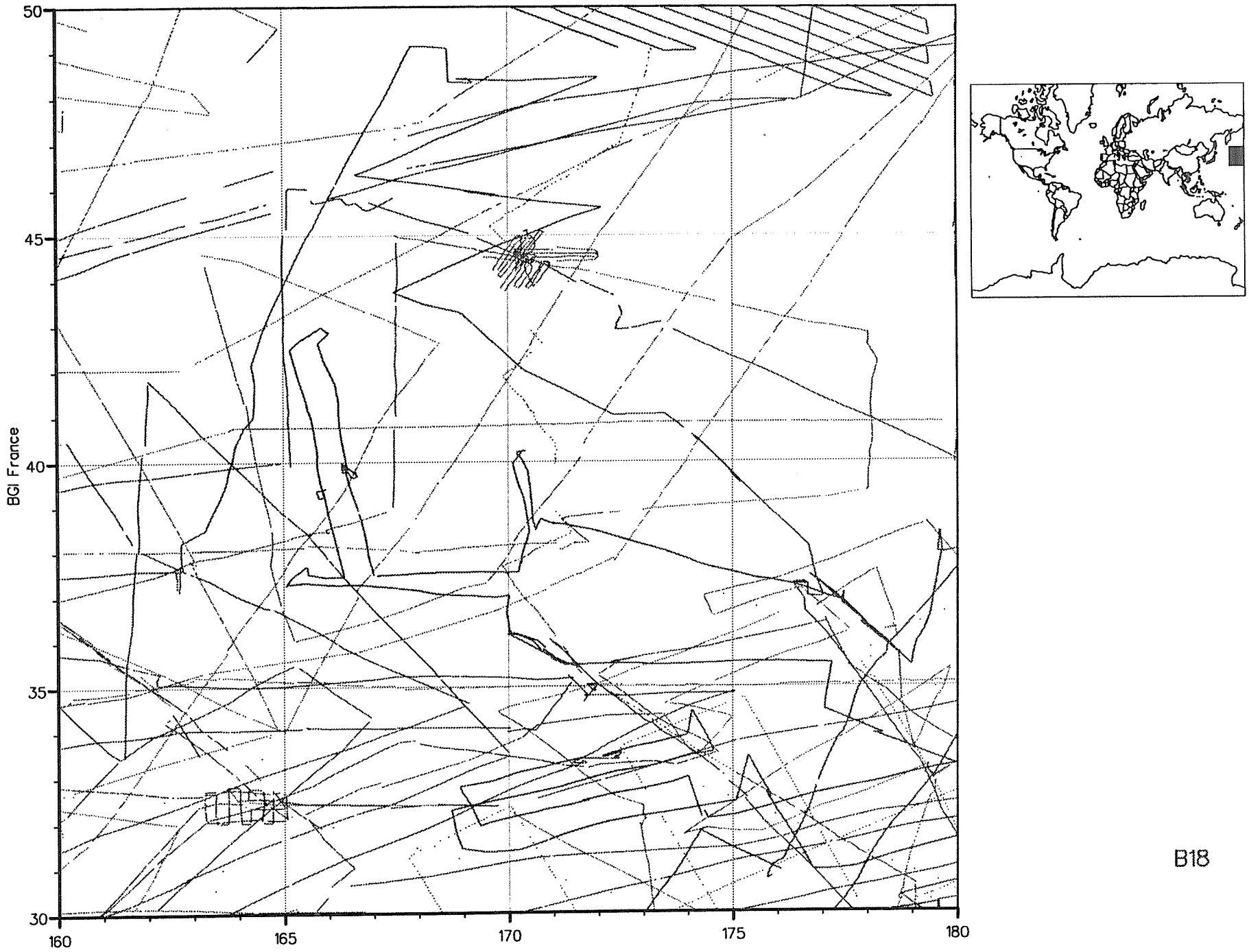
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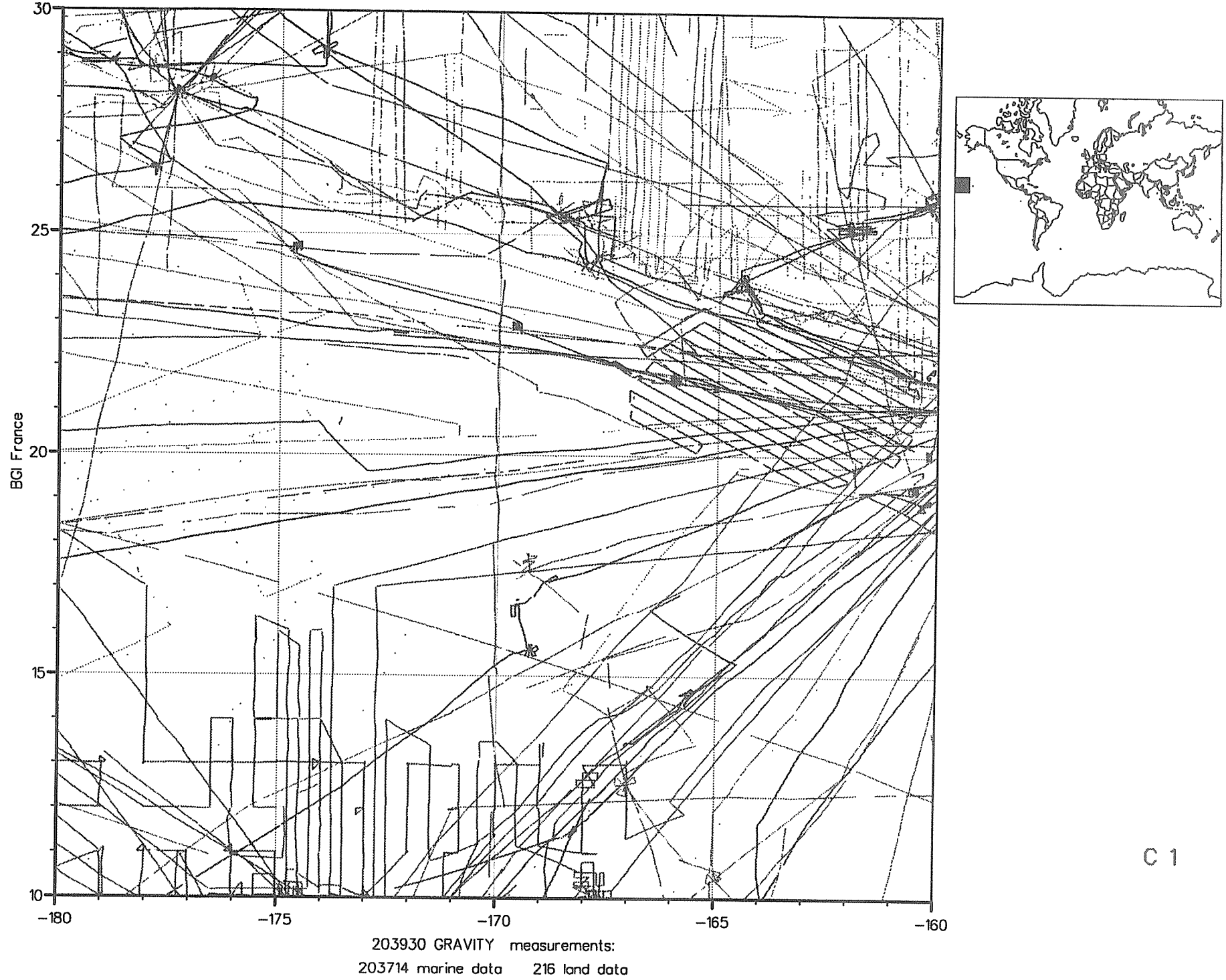
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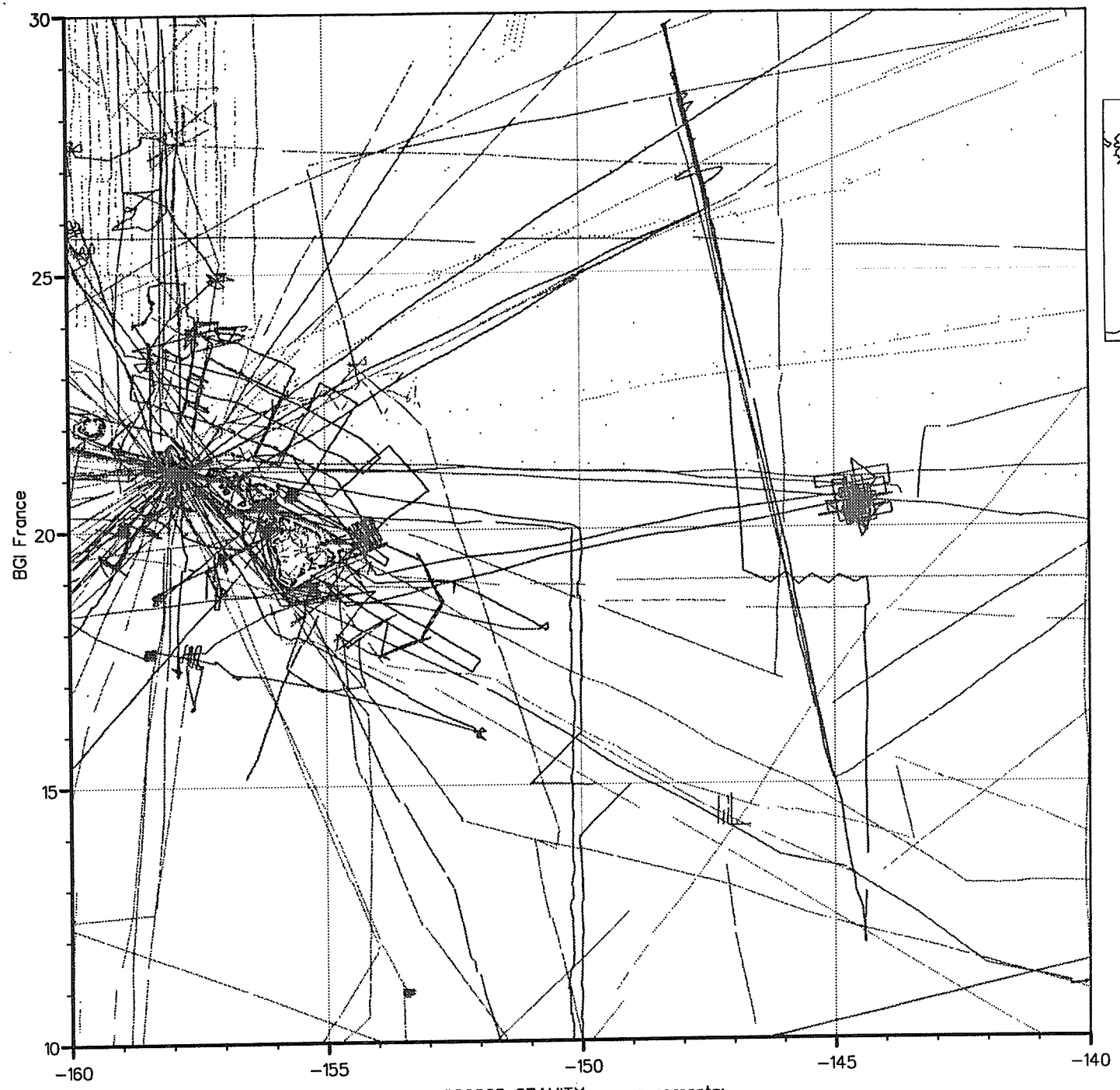
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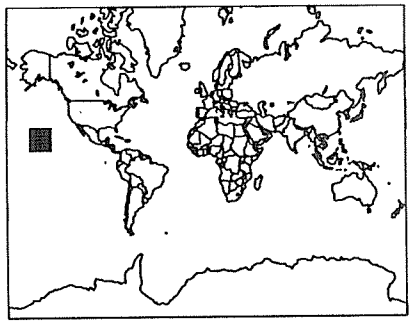

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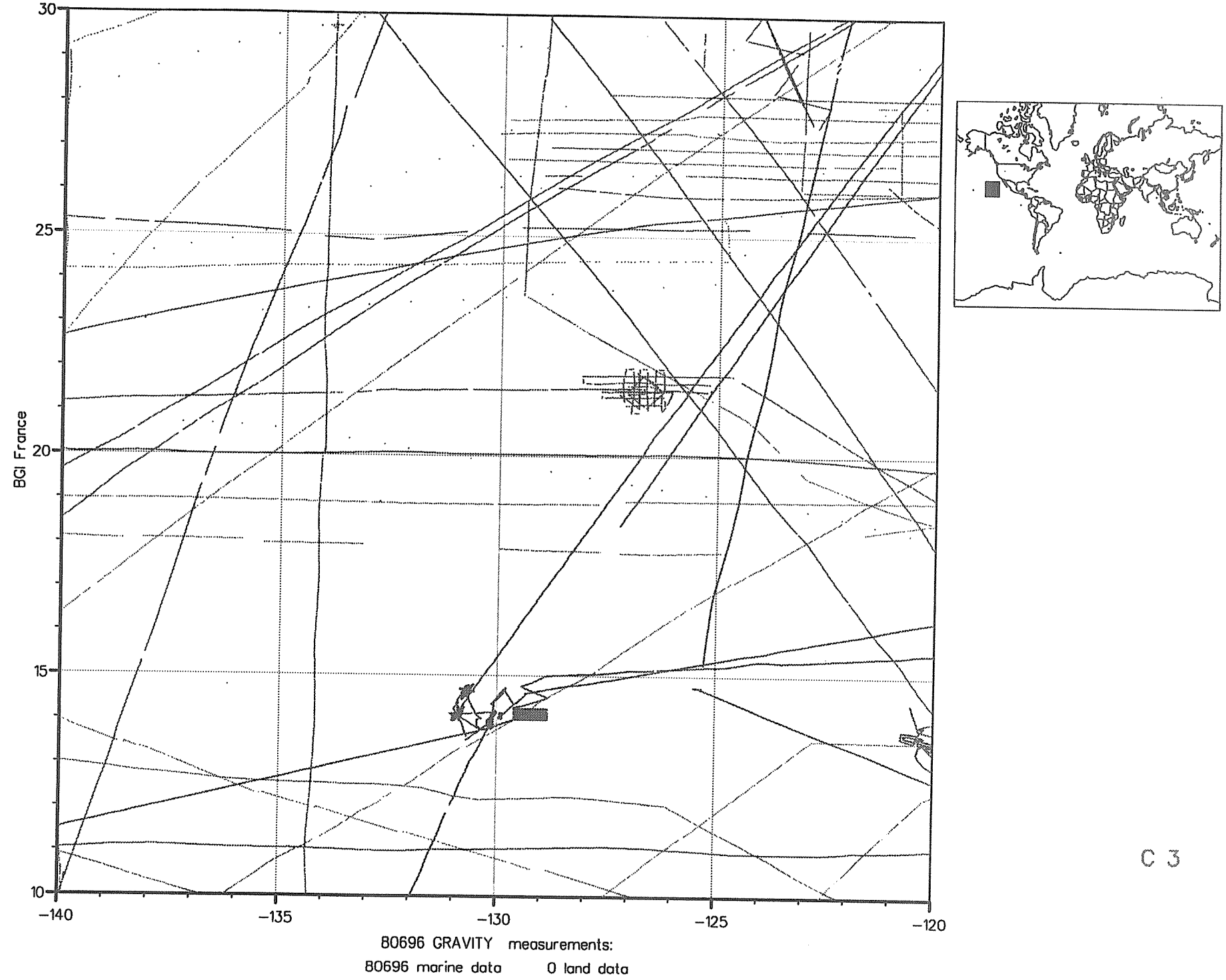
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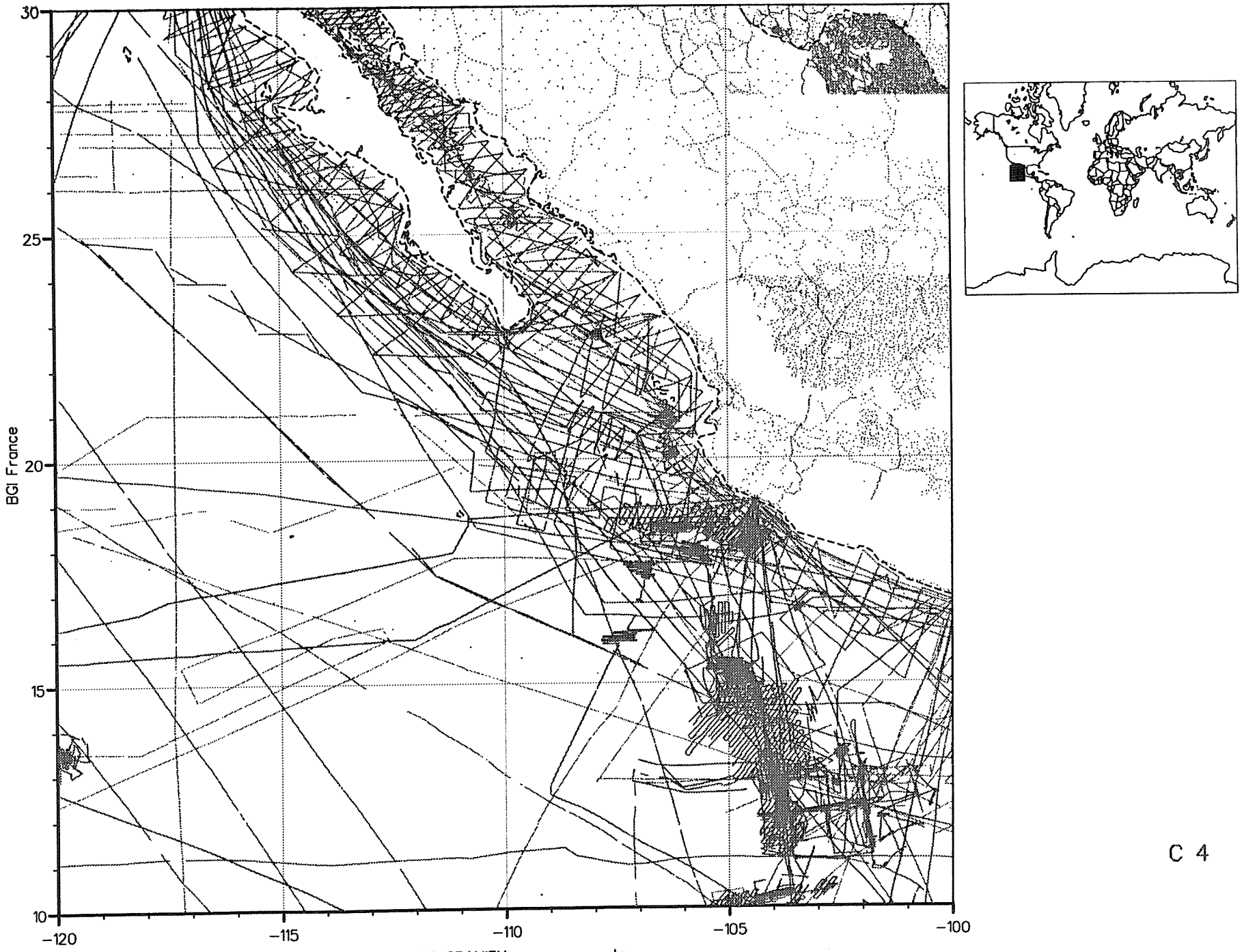
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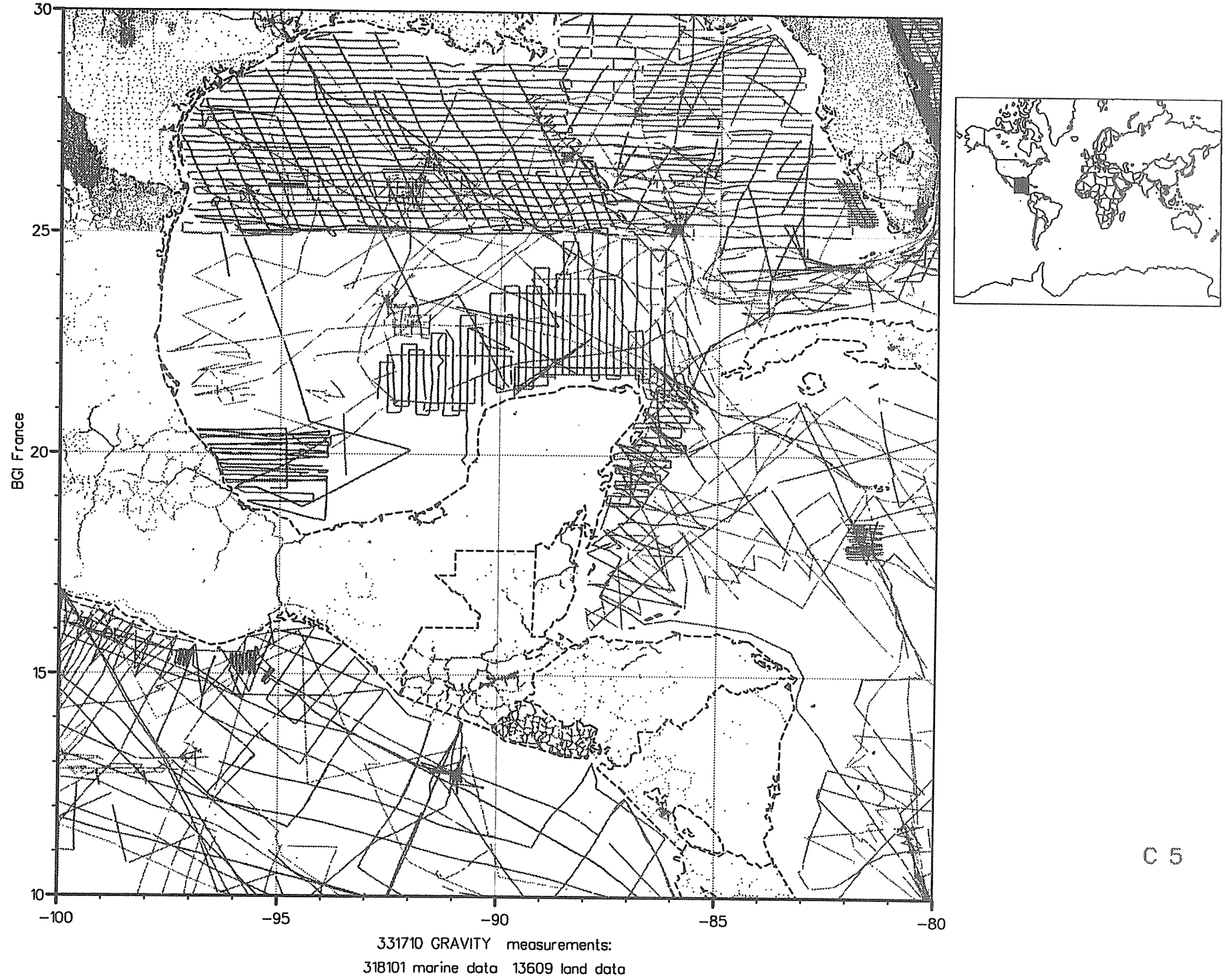
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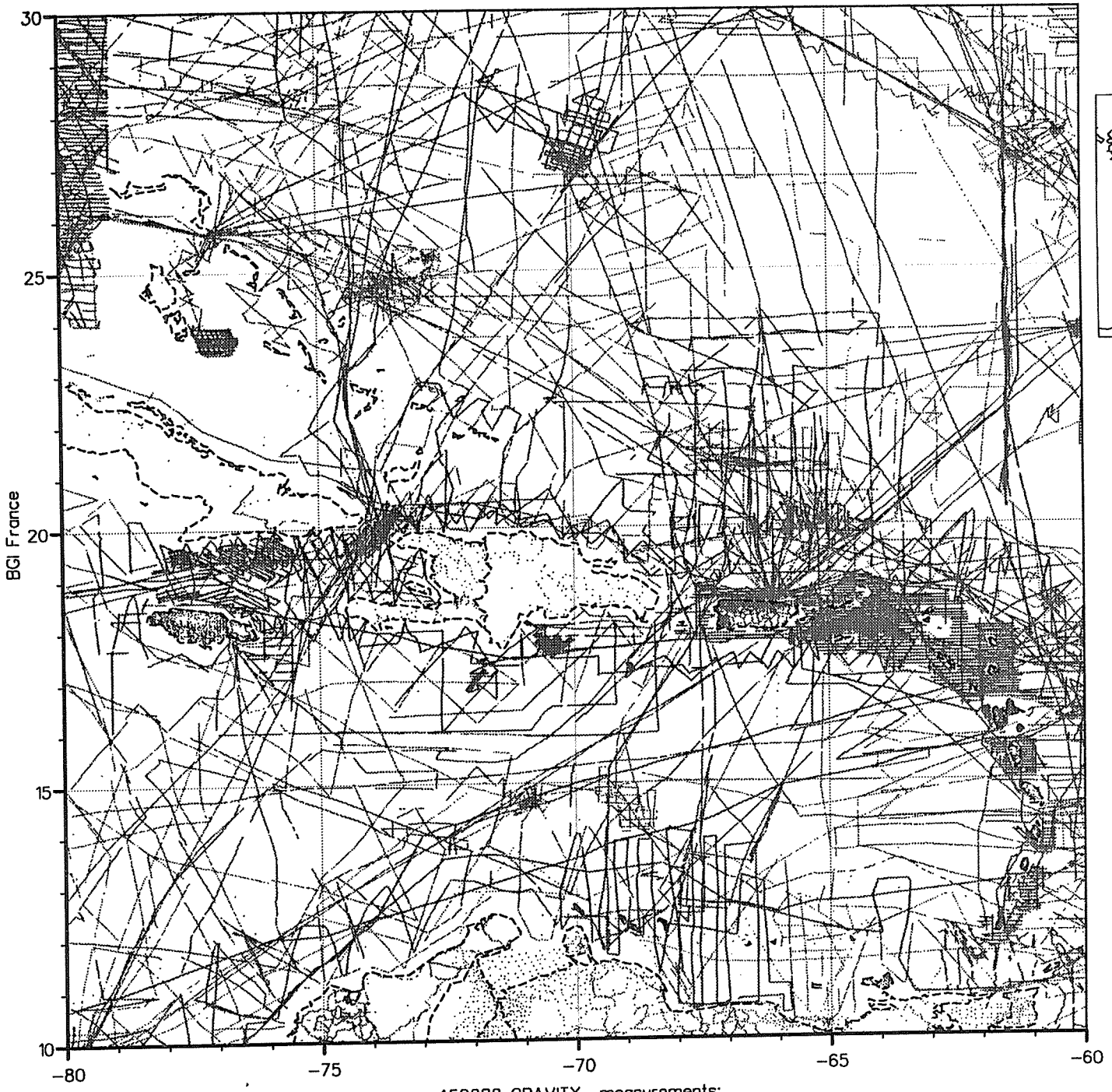
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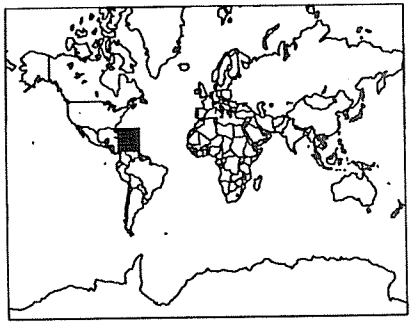

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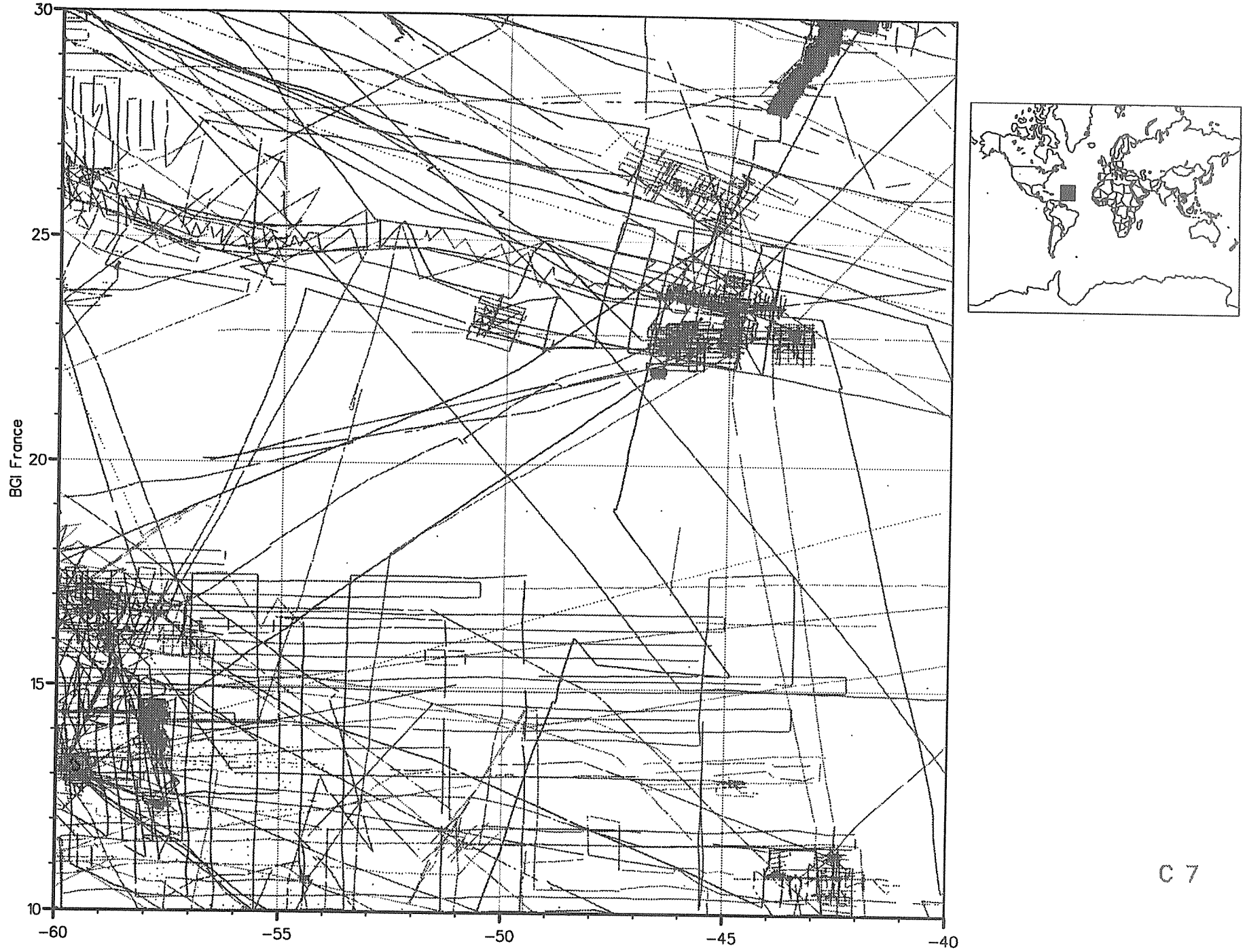
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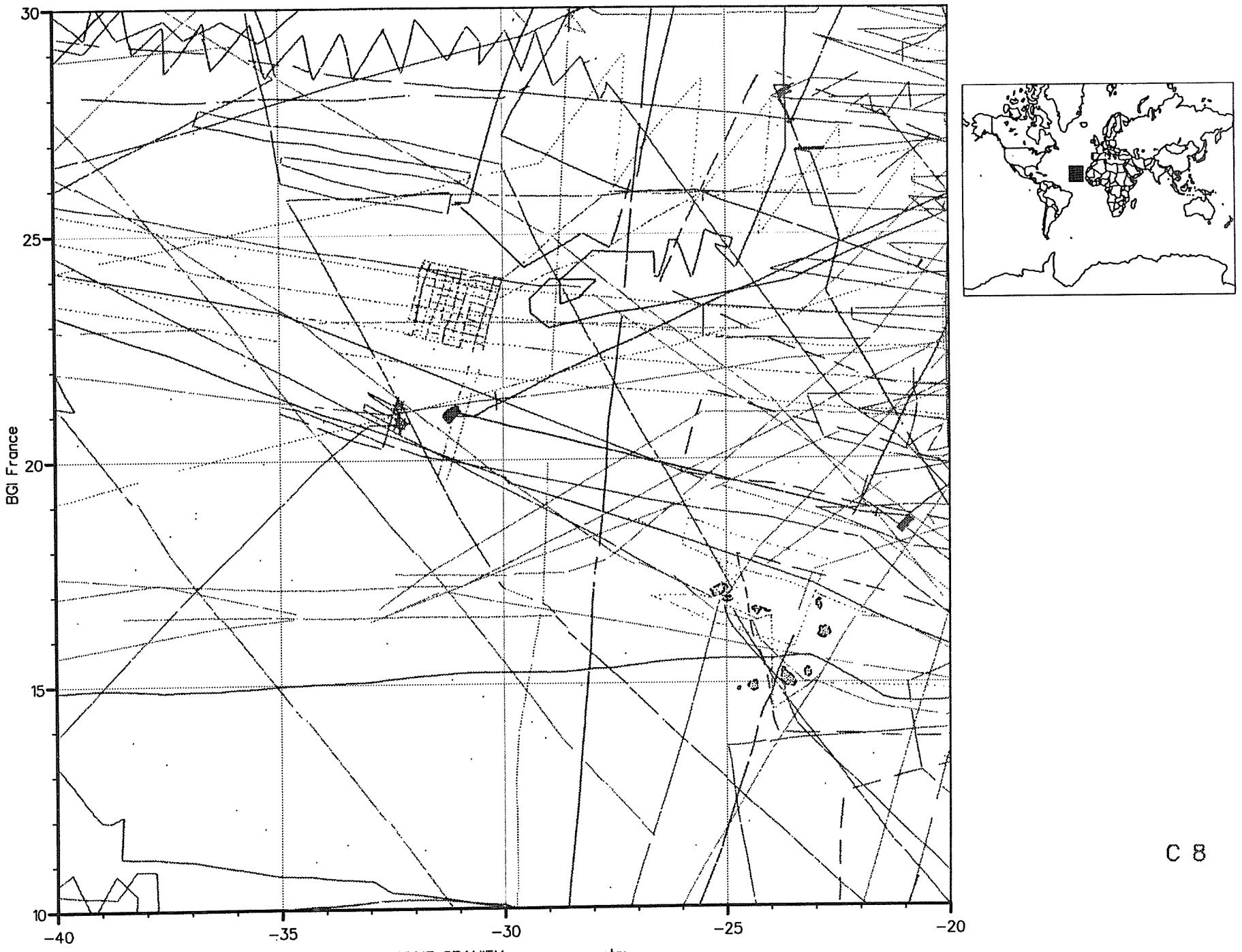
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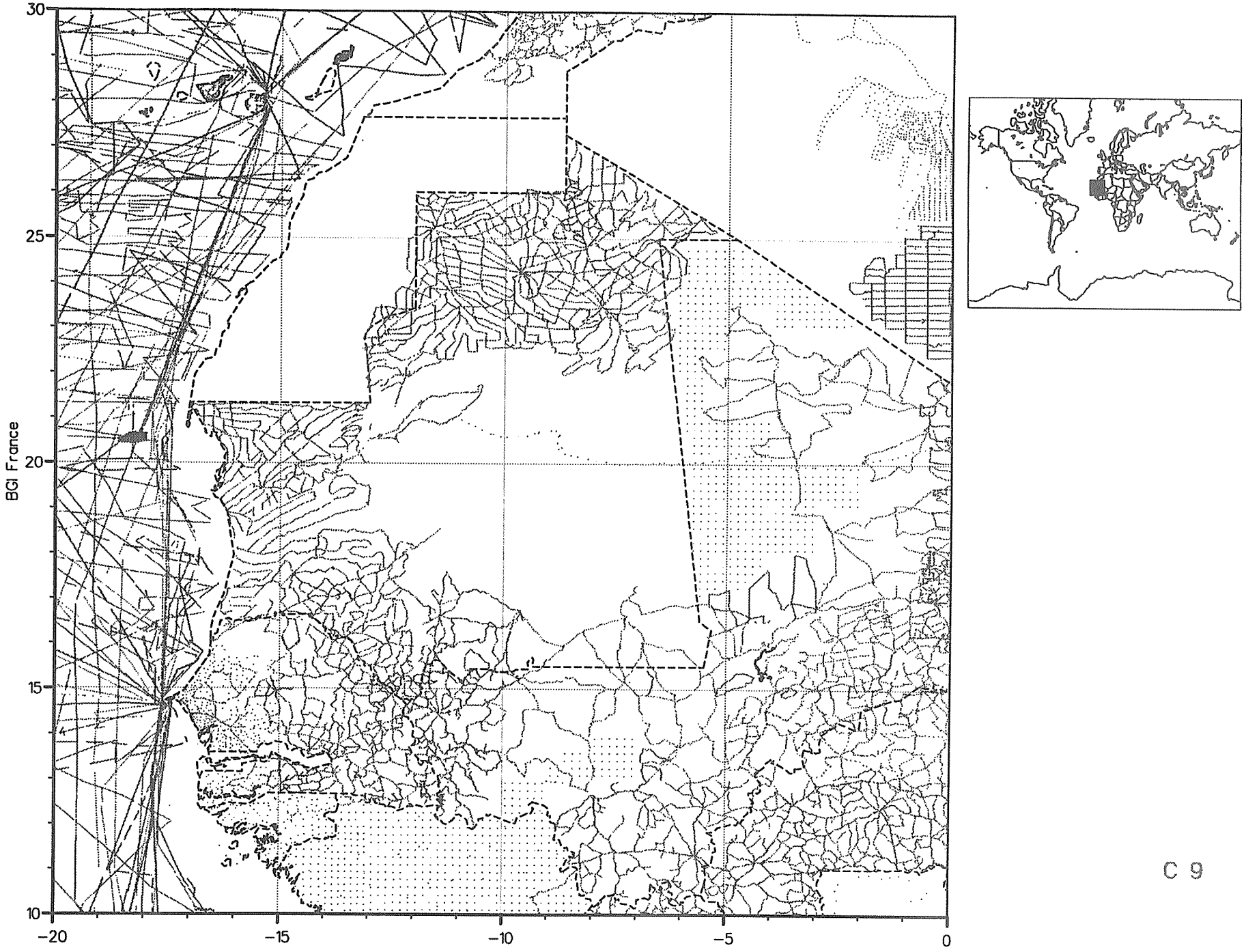
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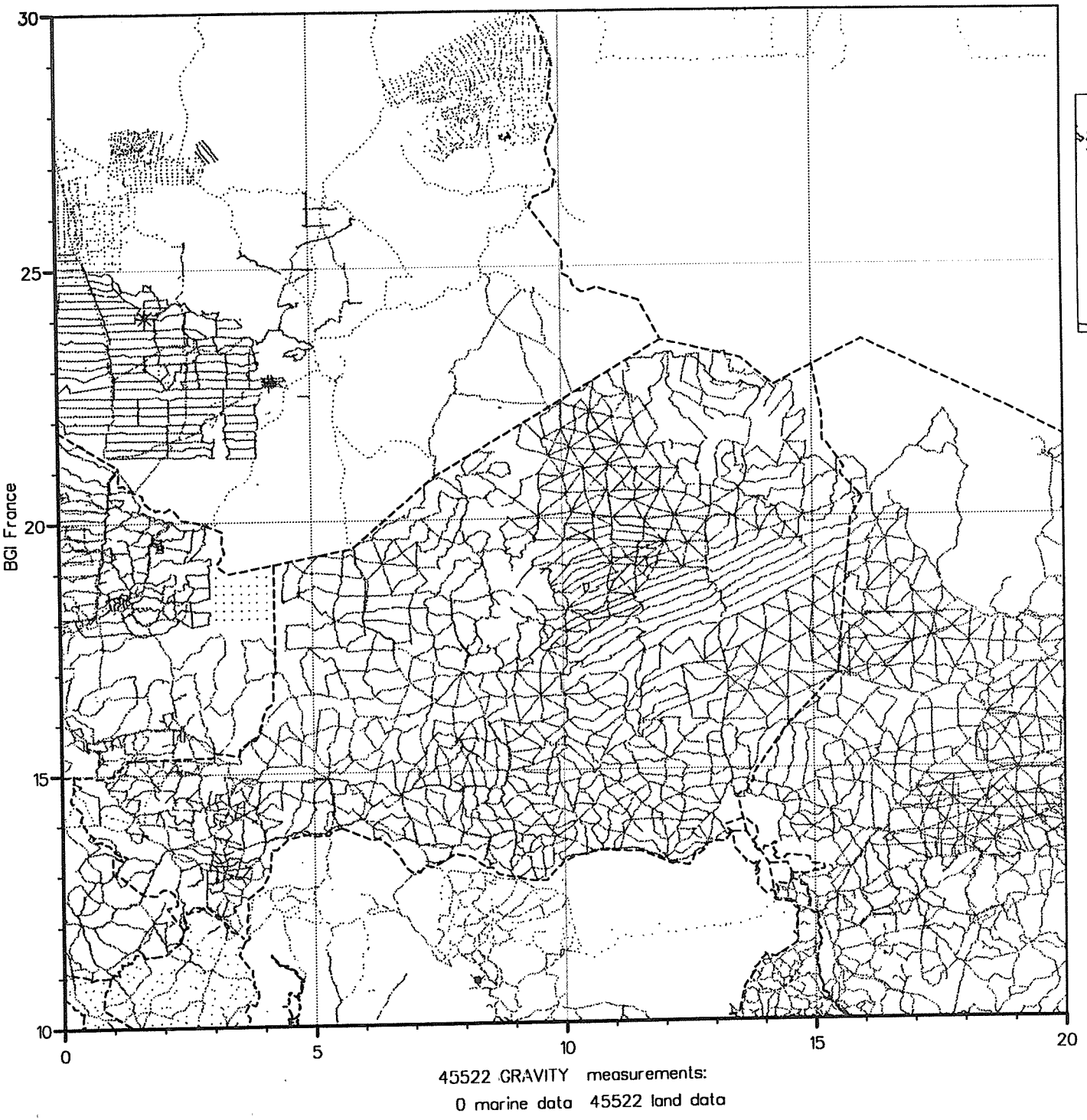
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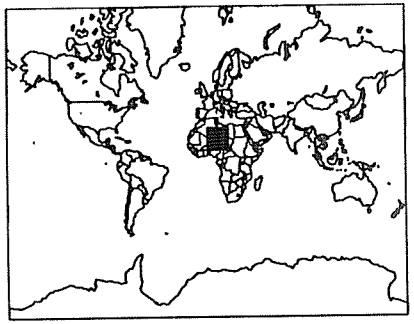

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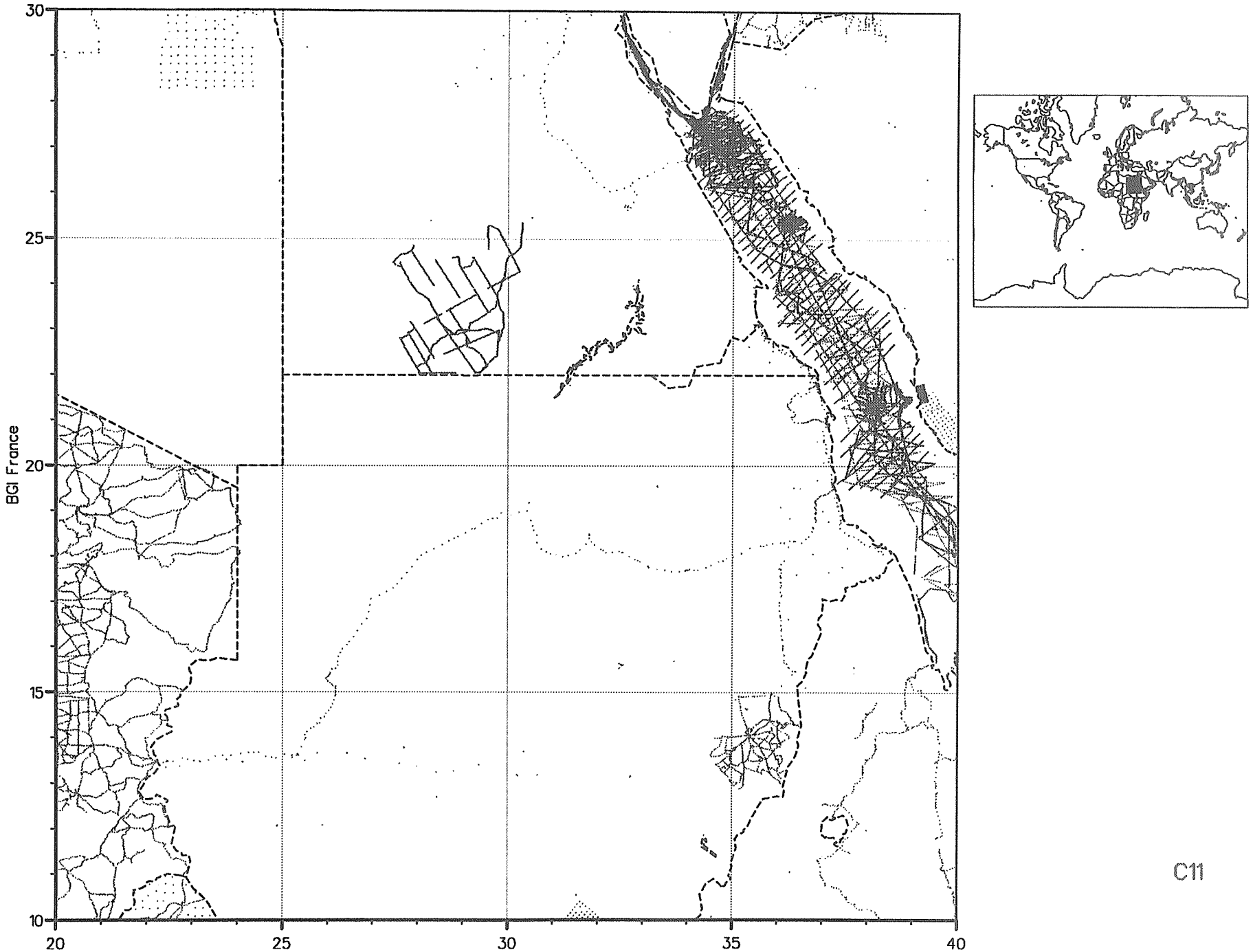
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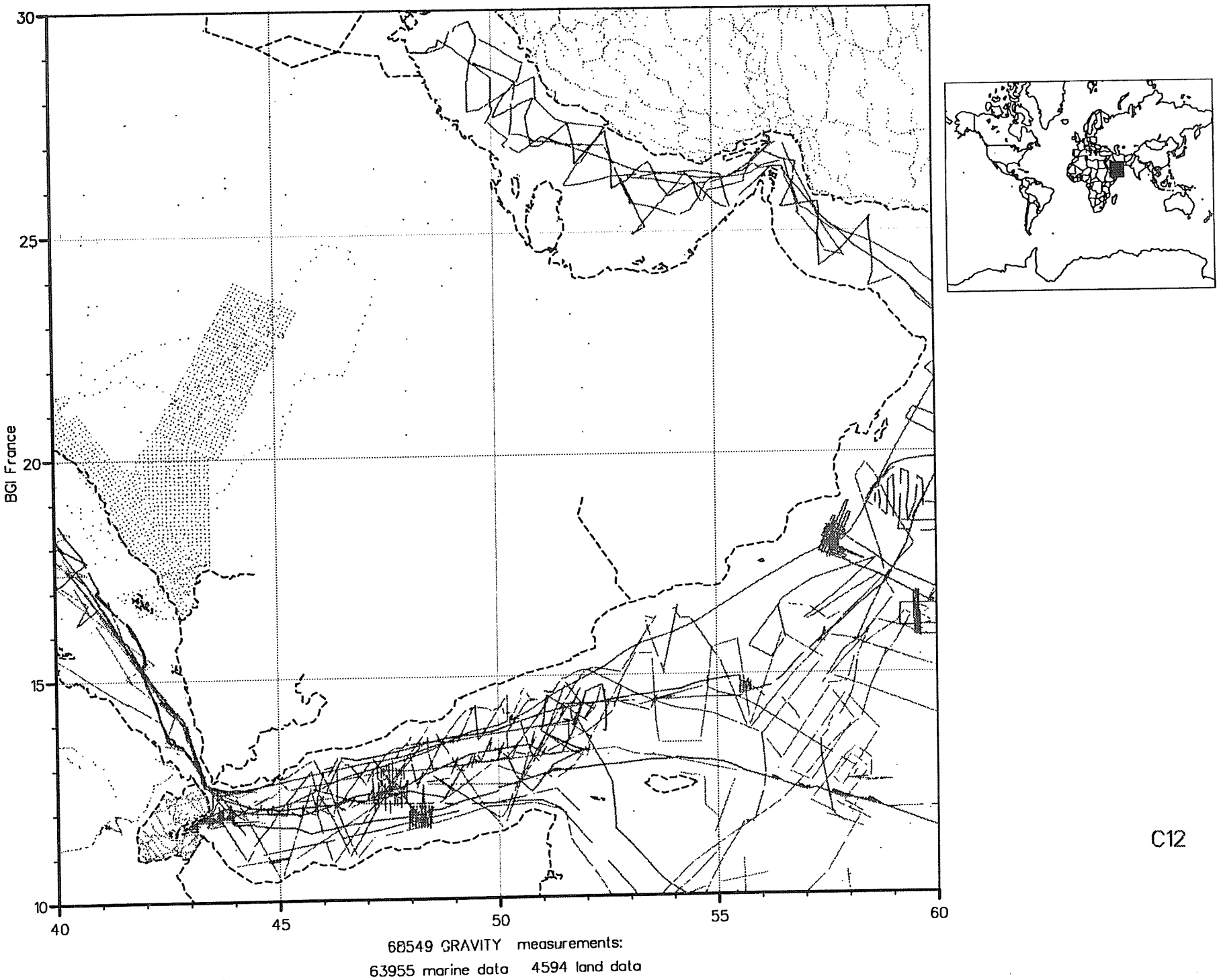
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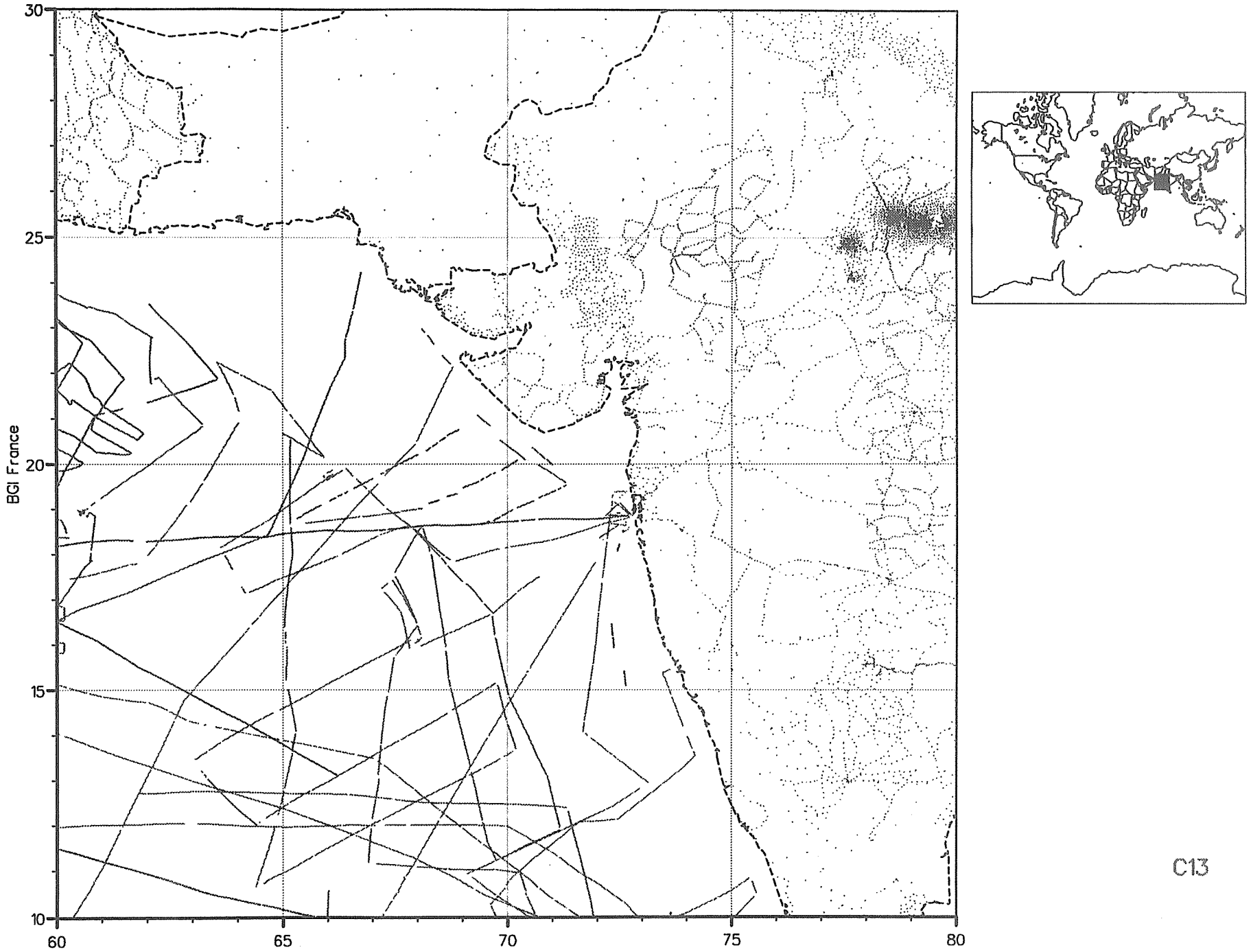
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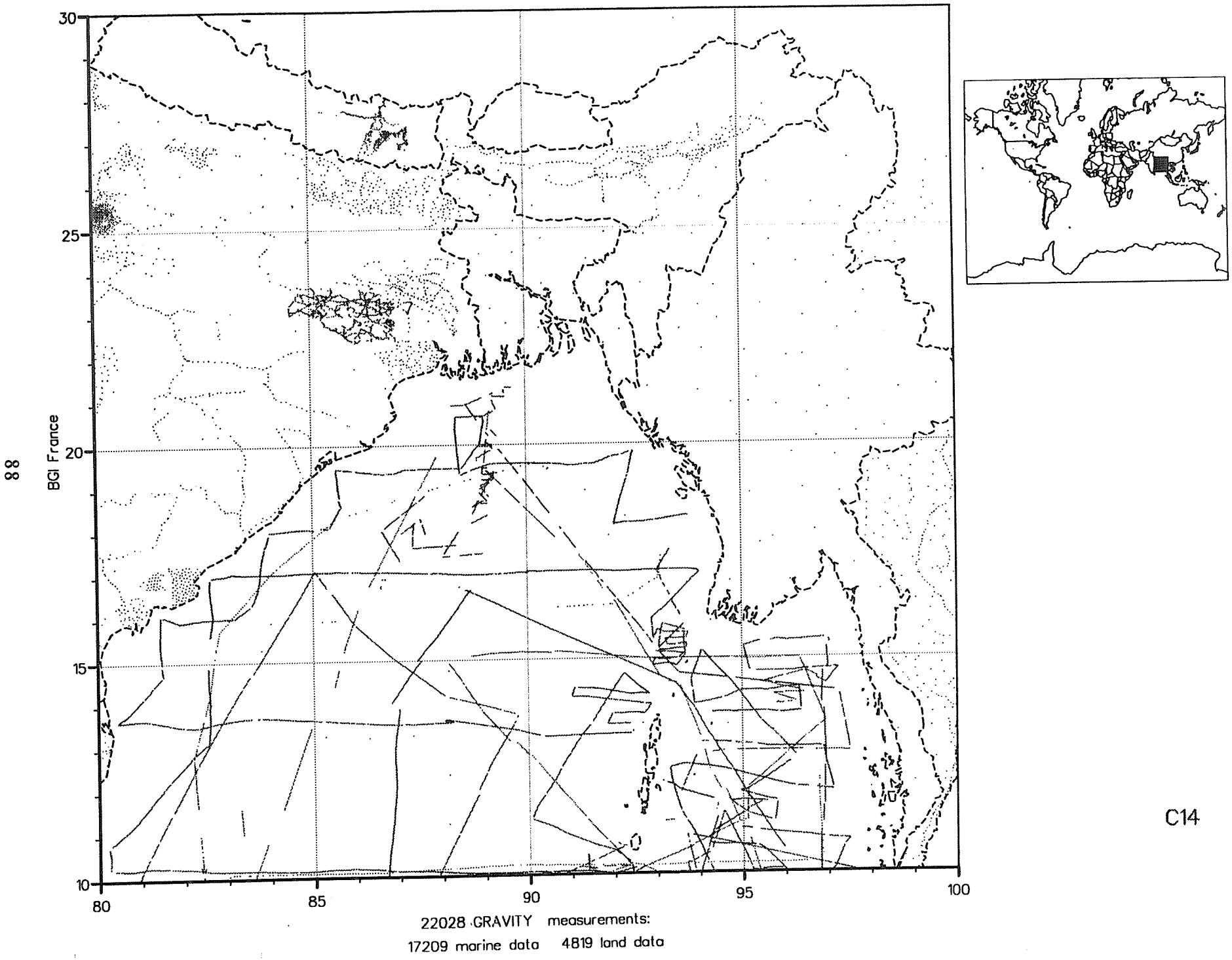
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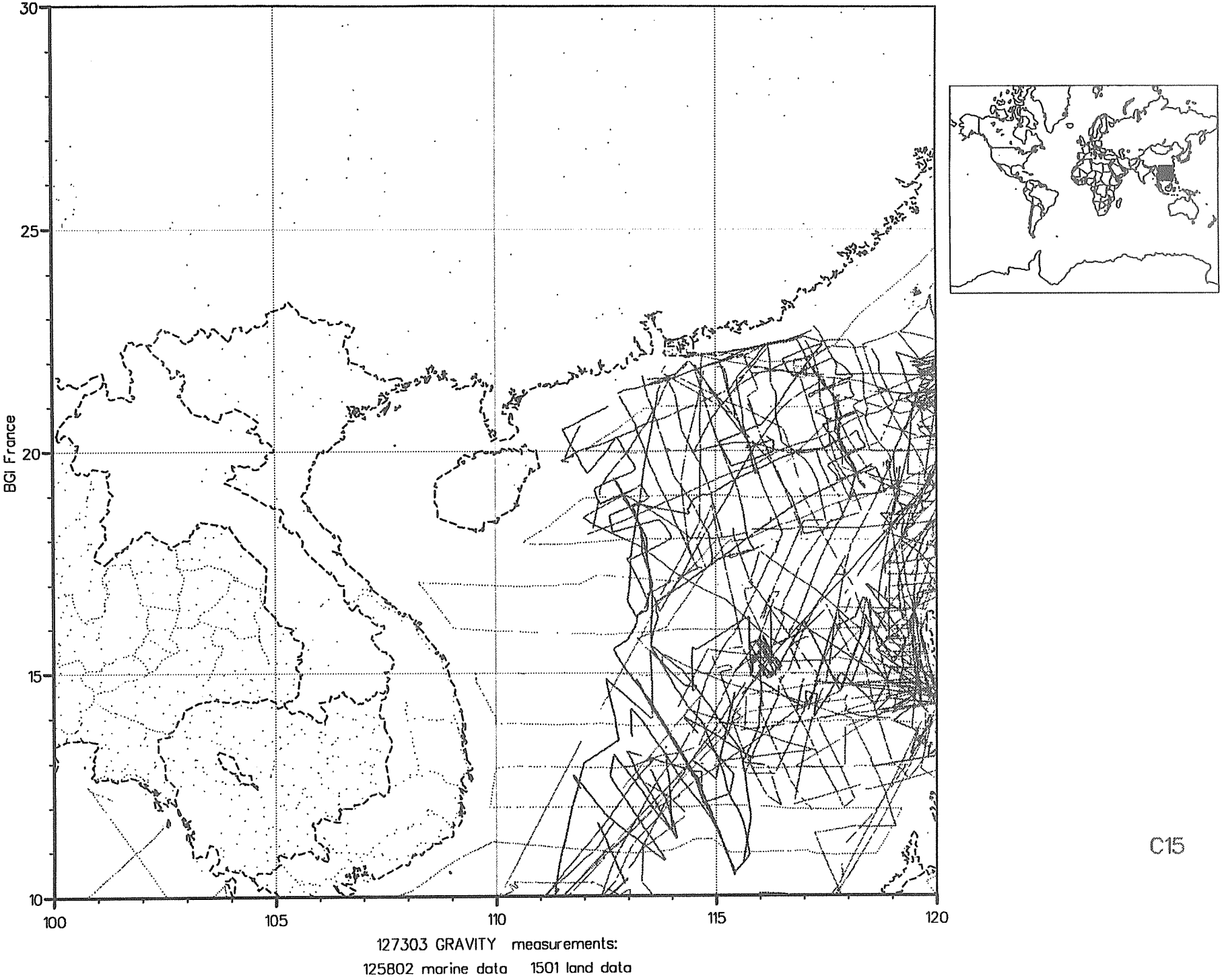
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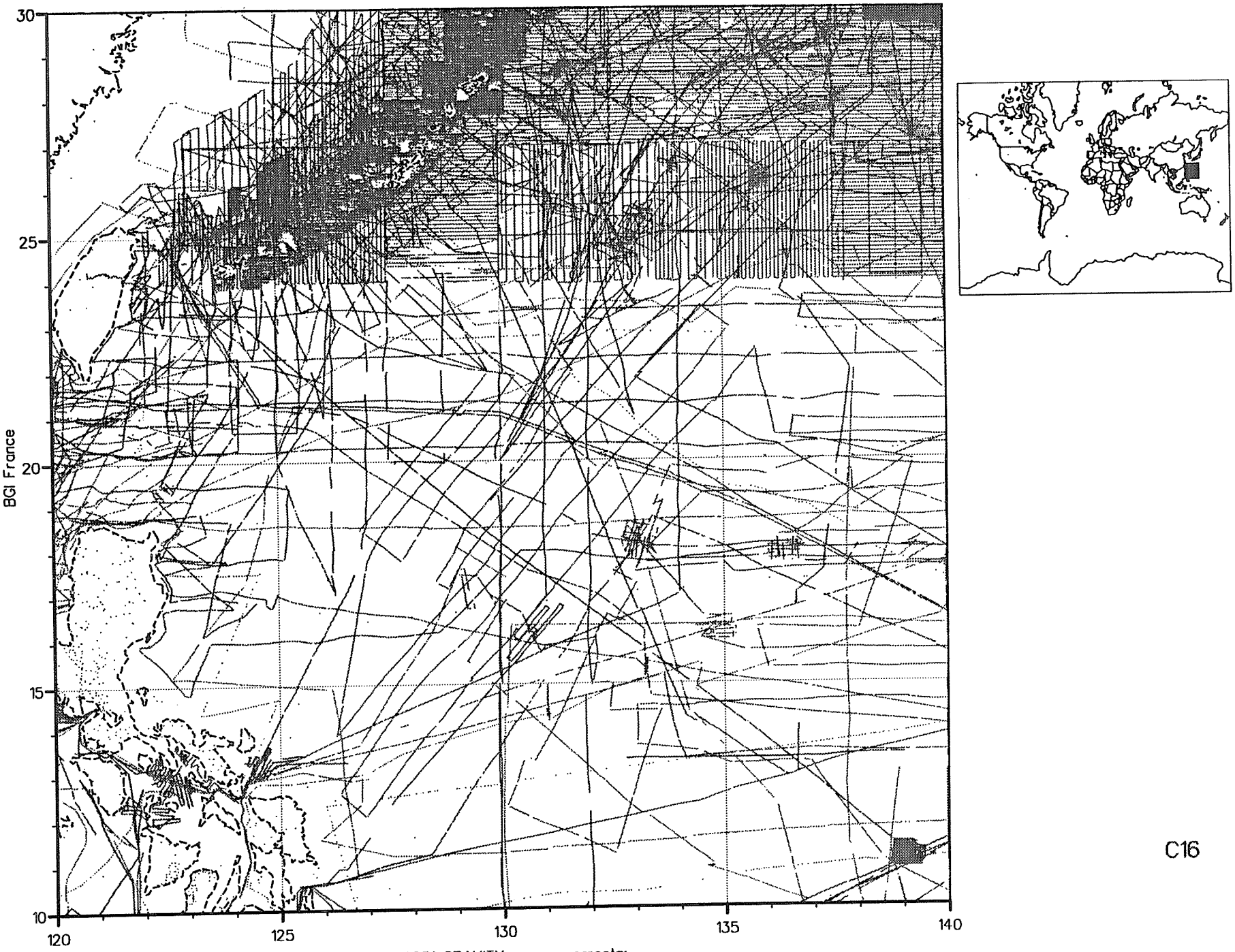
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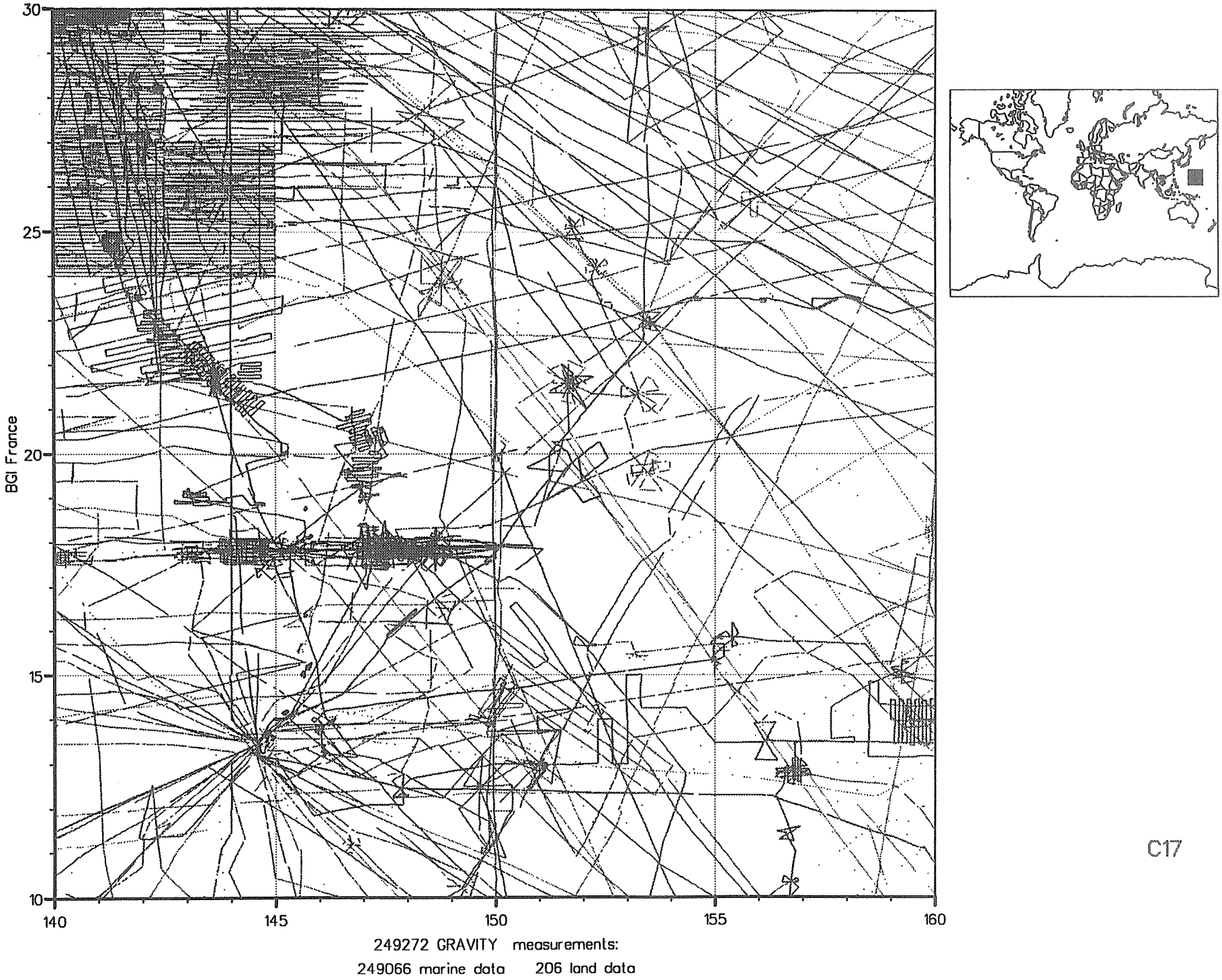
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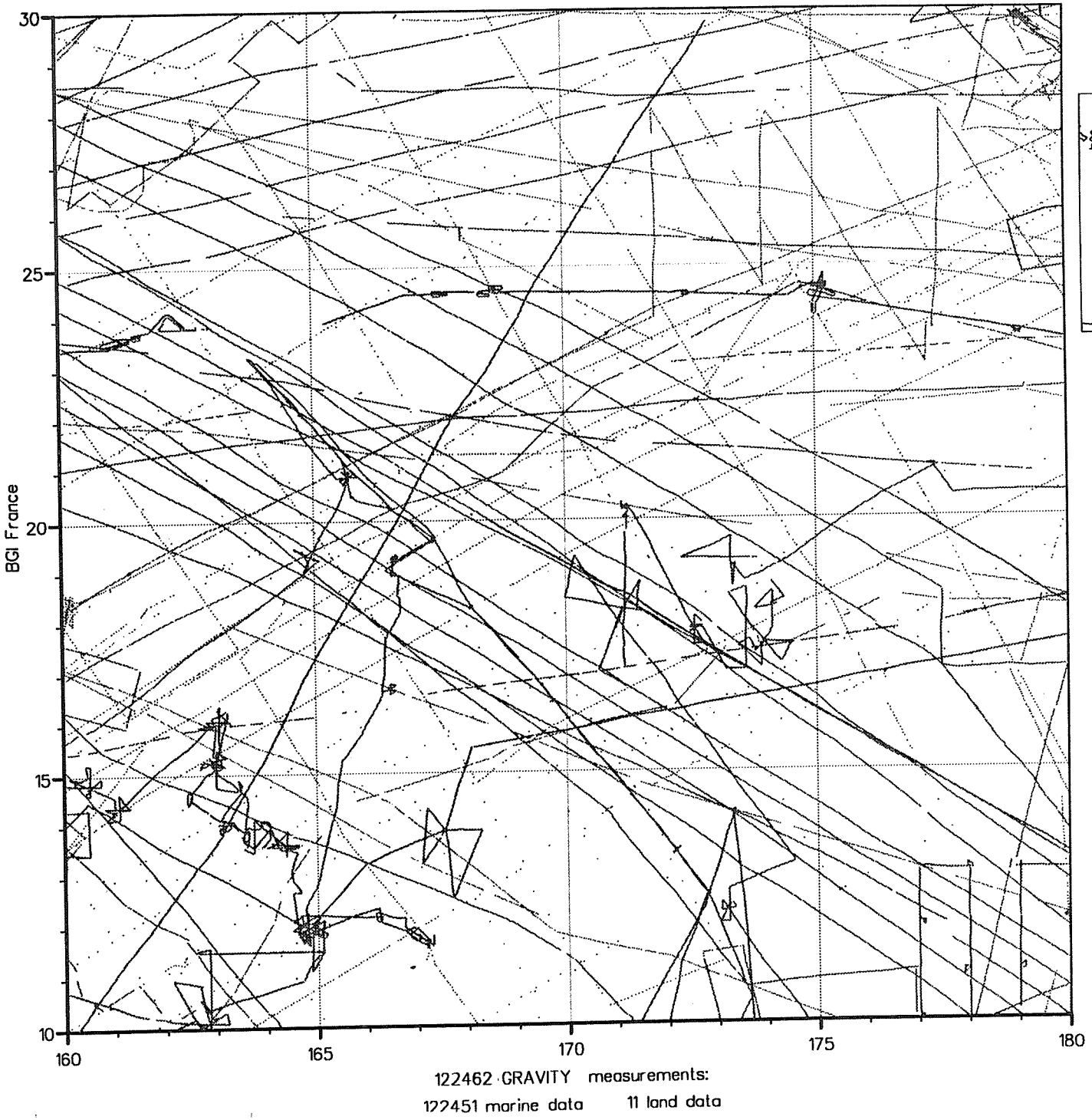
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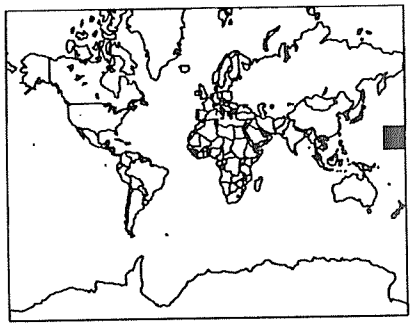

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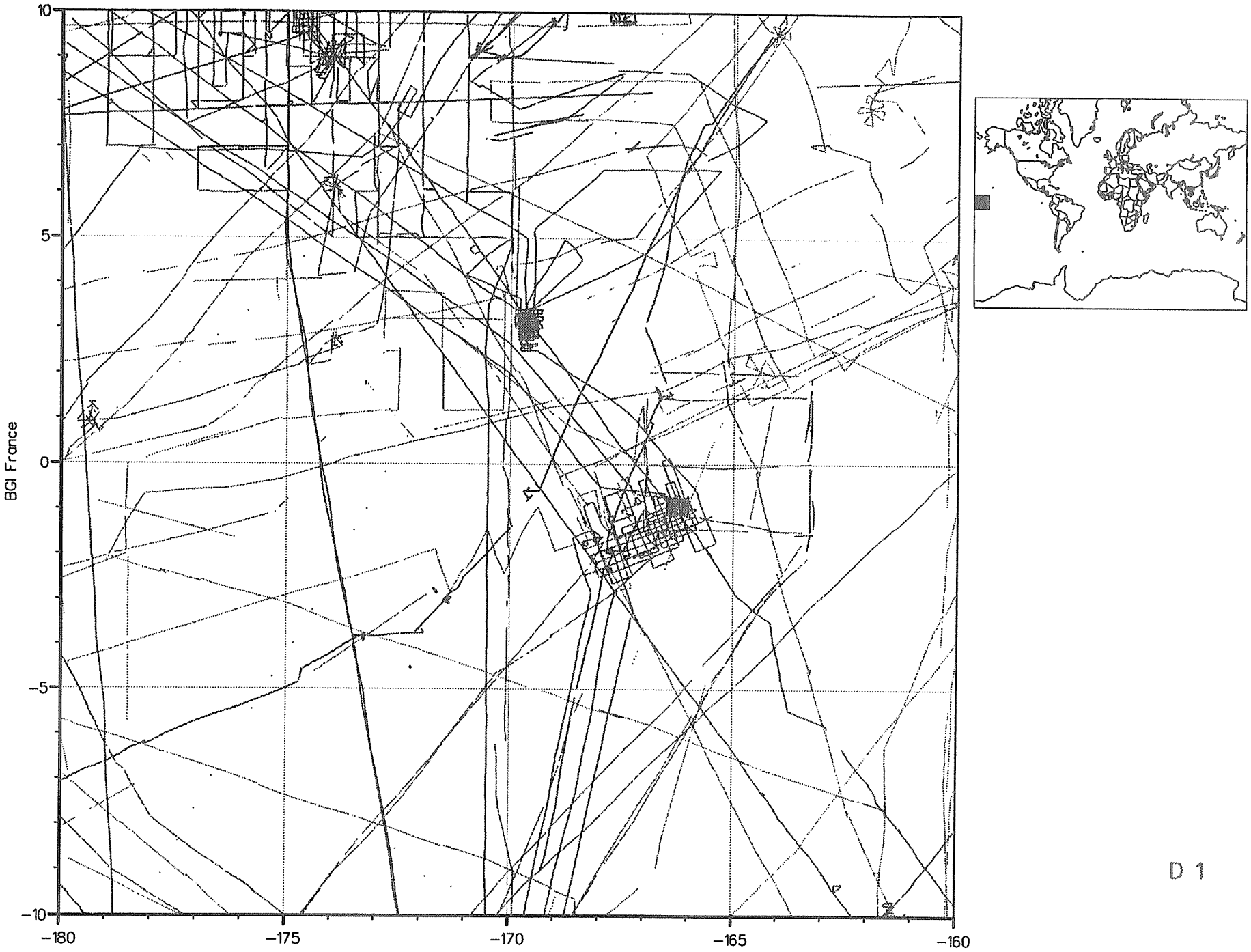
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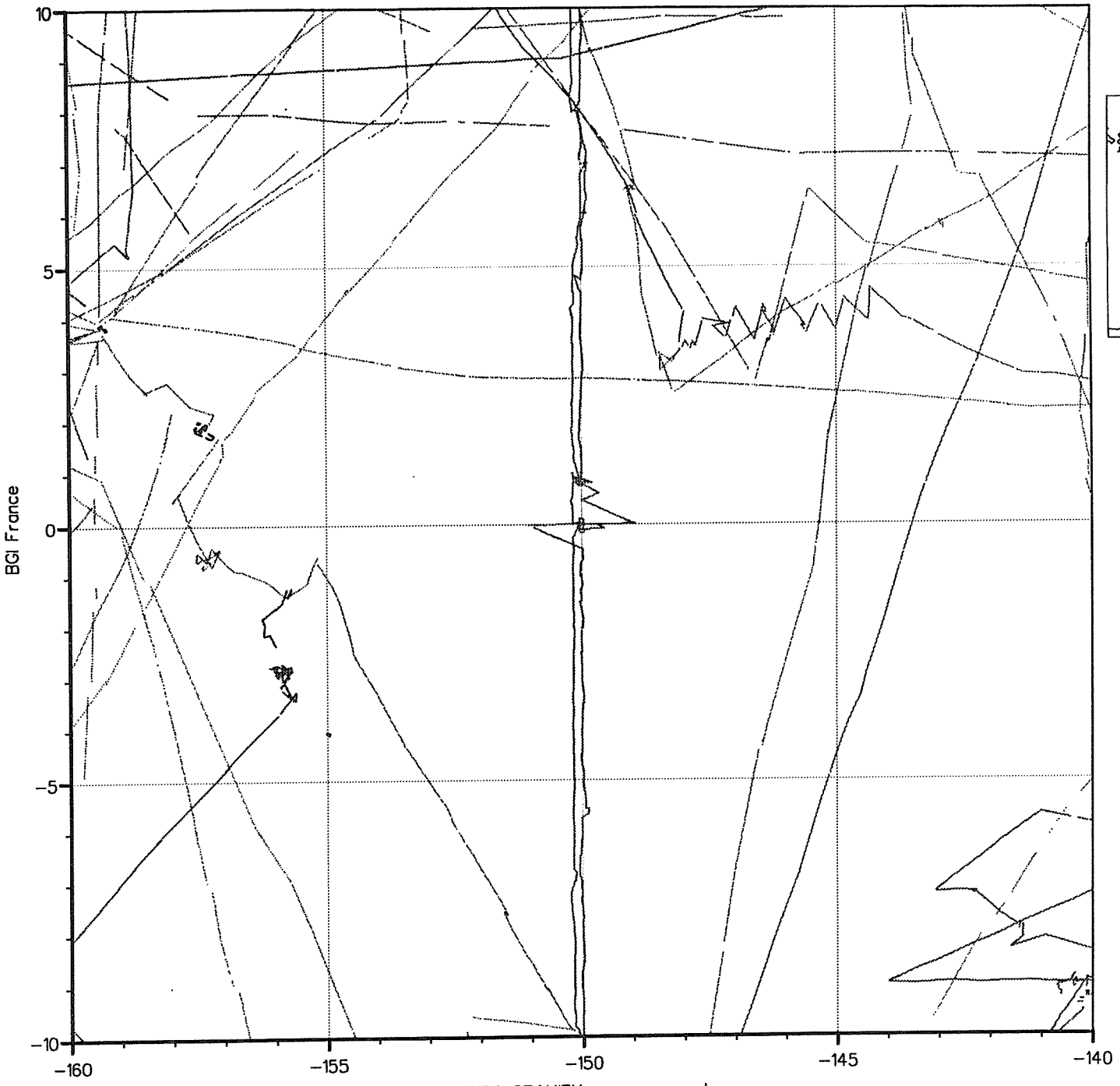
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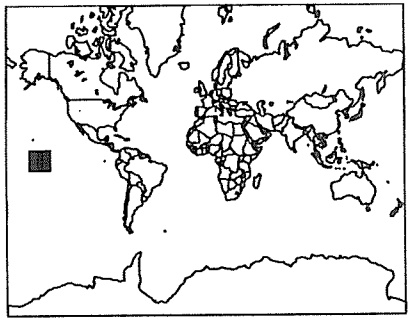

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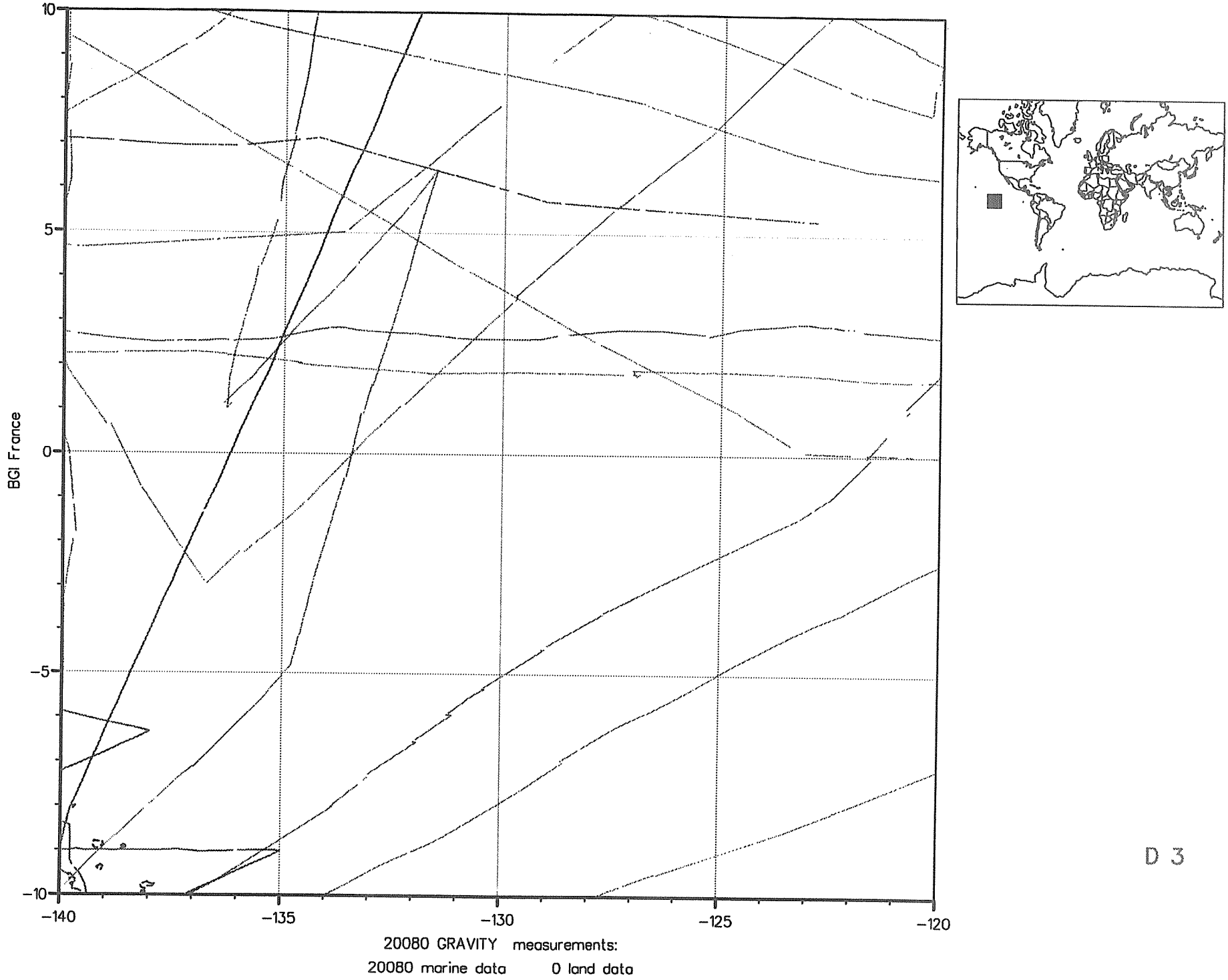
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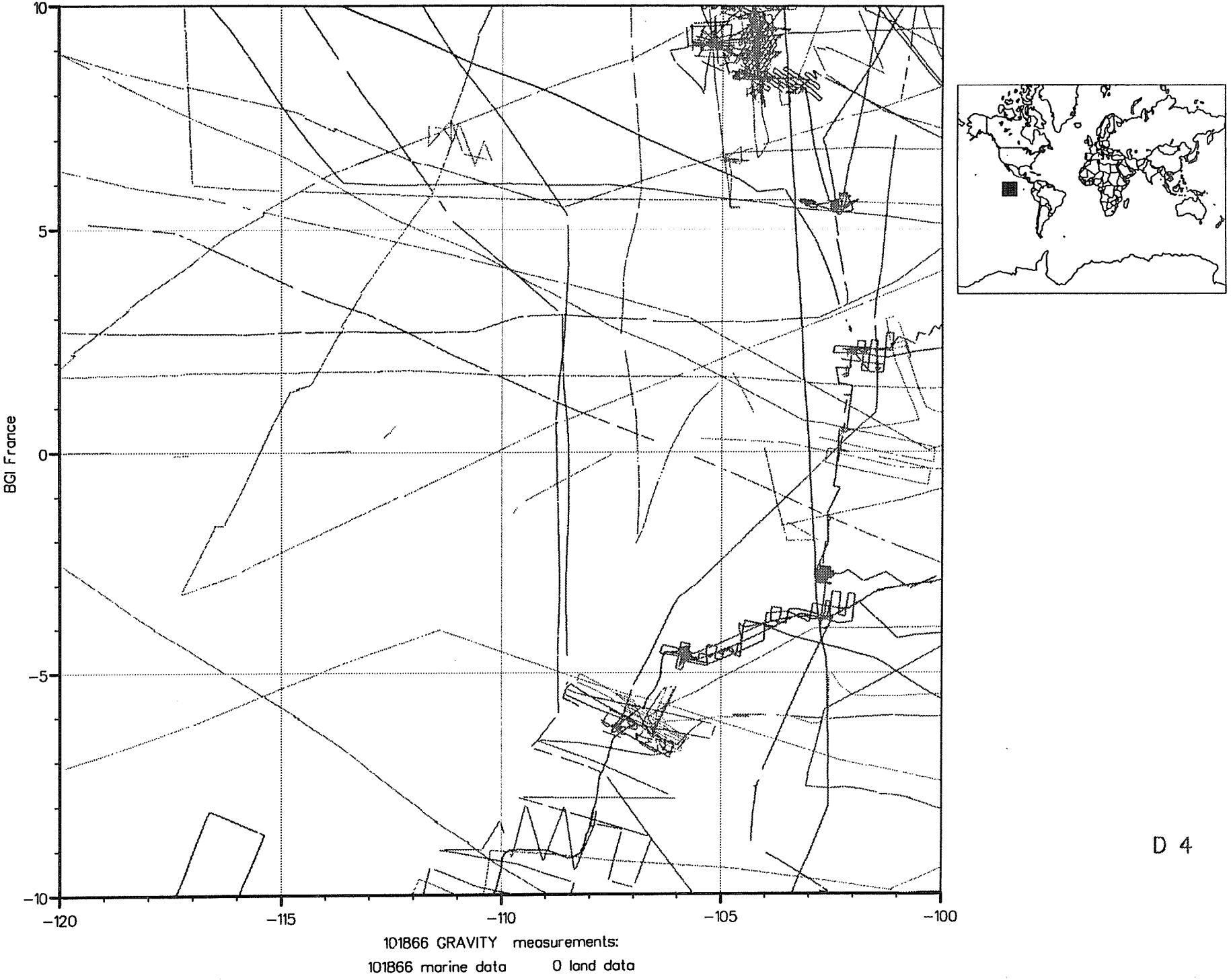
S6

D 3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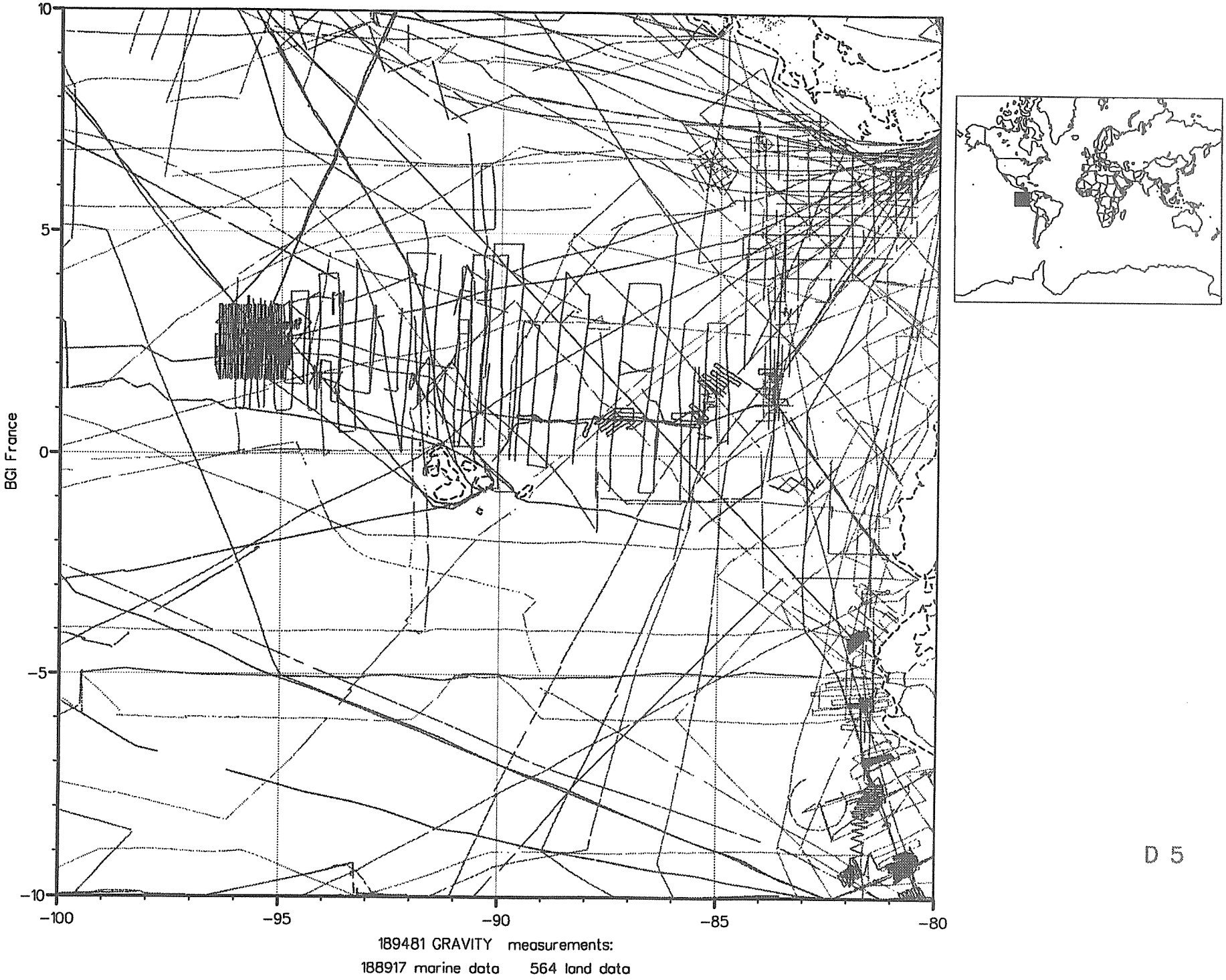
D 4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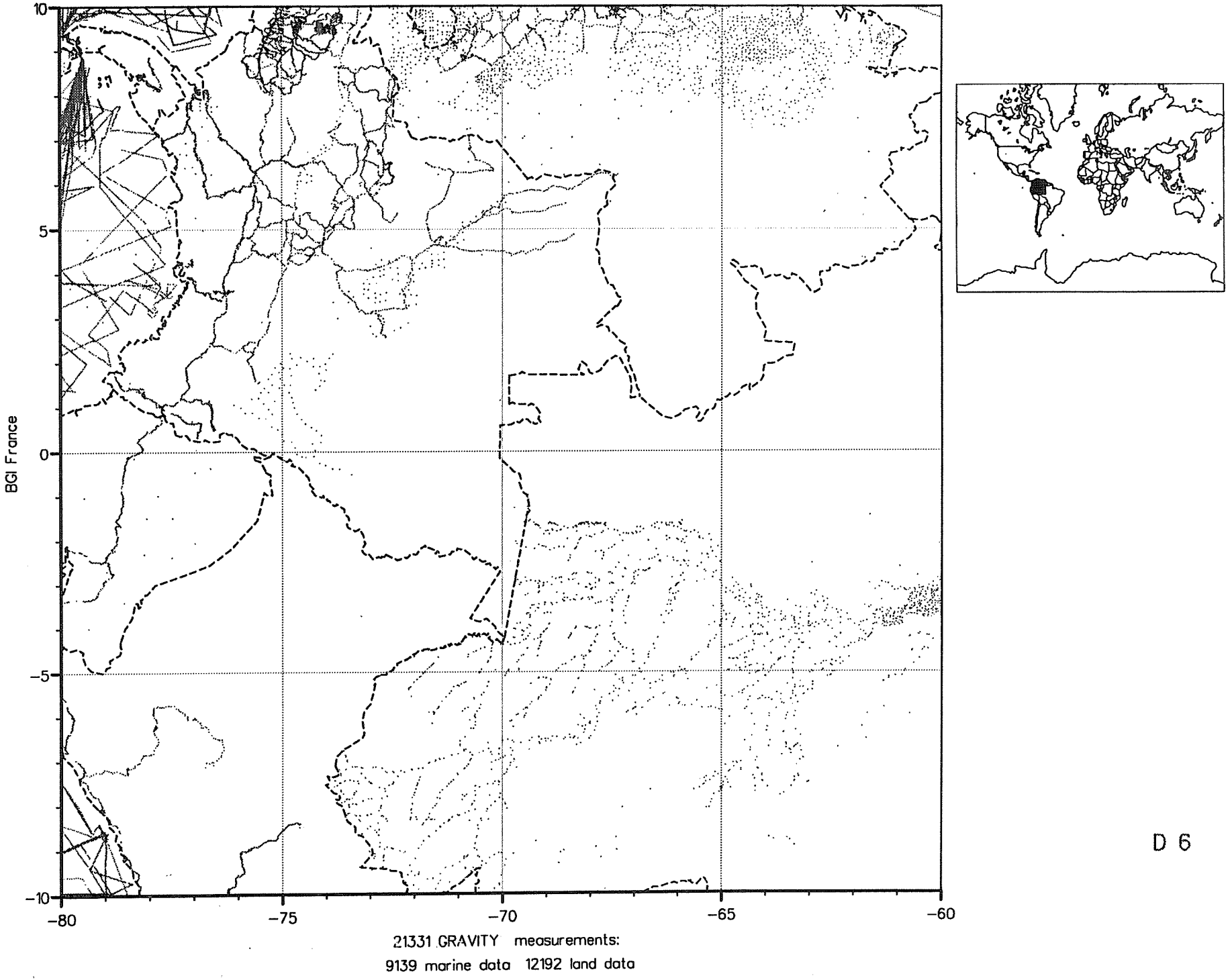
D 5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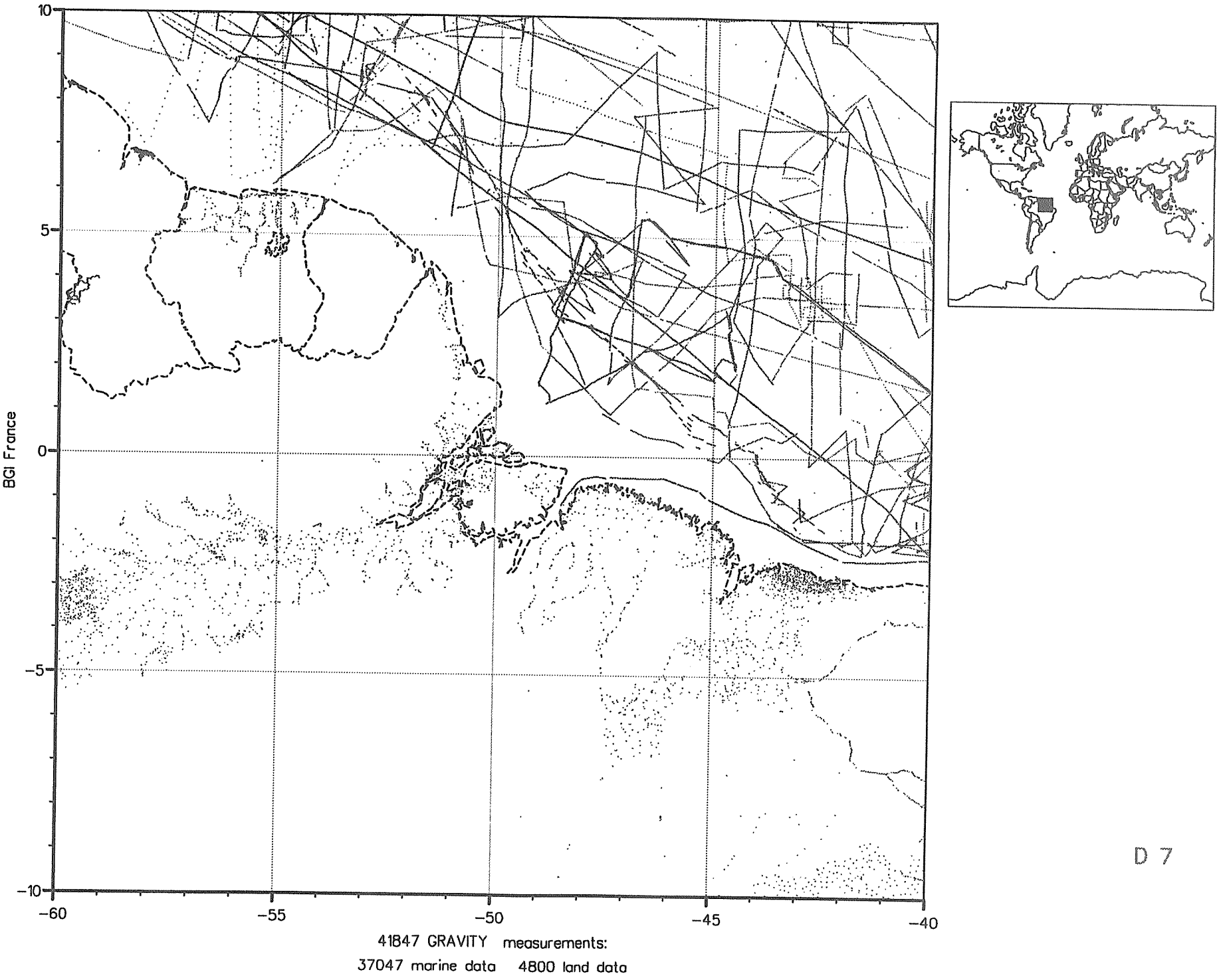
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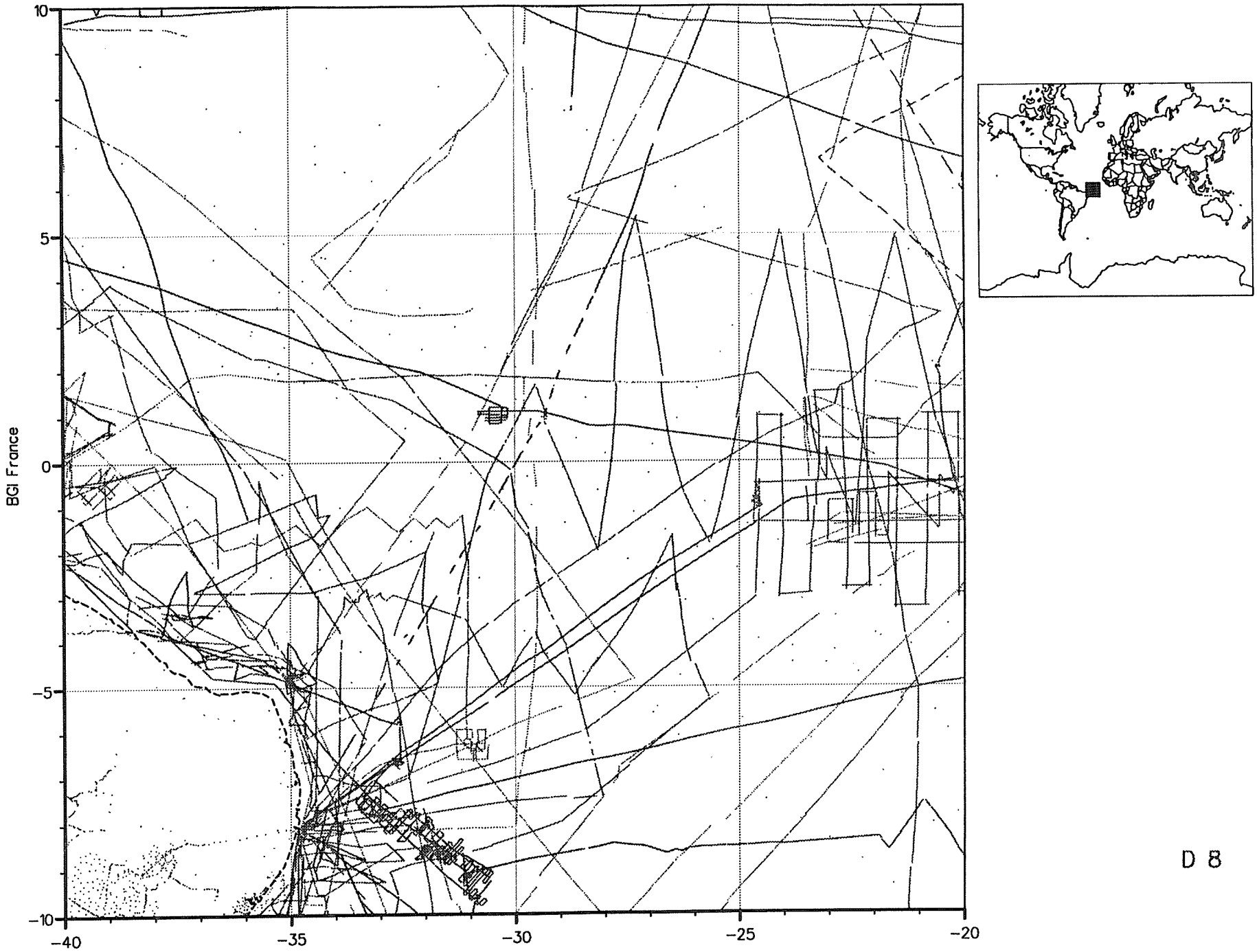
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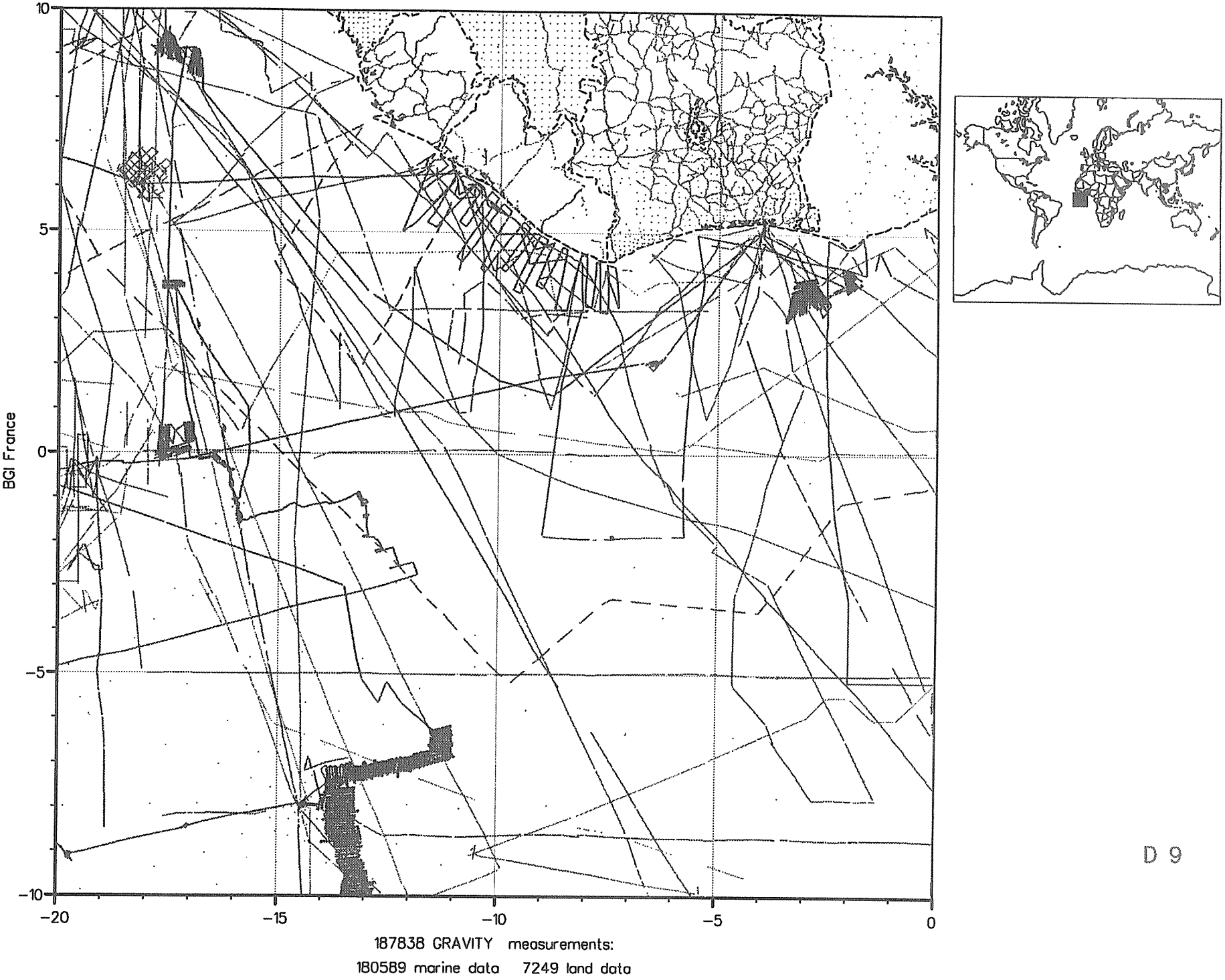
D 8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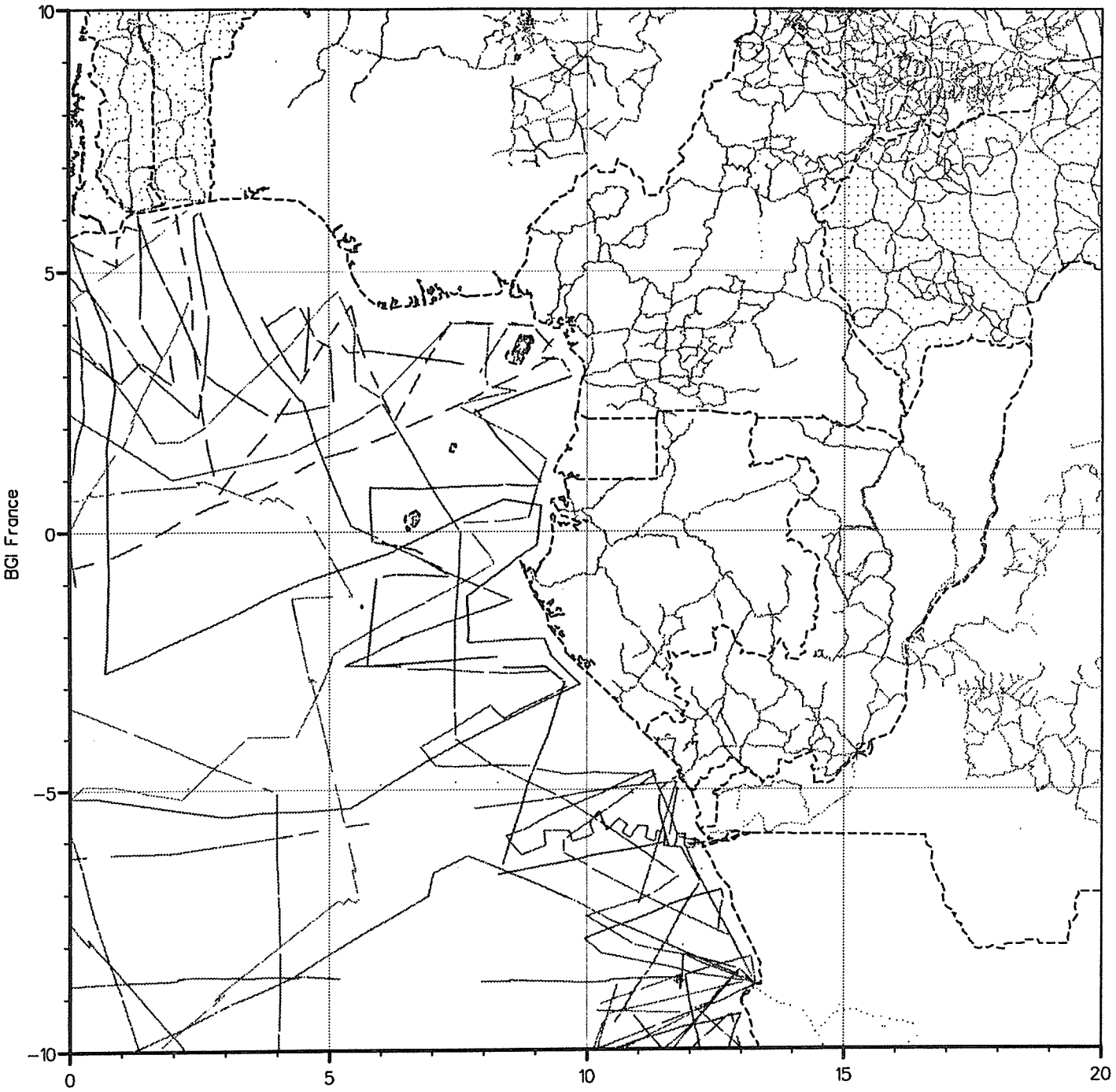
D 9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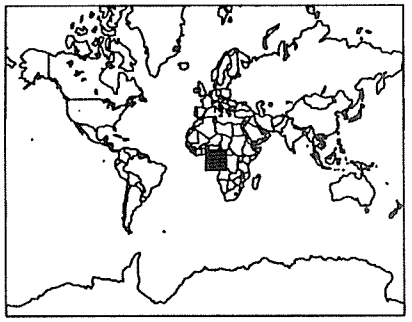

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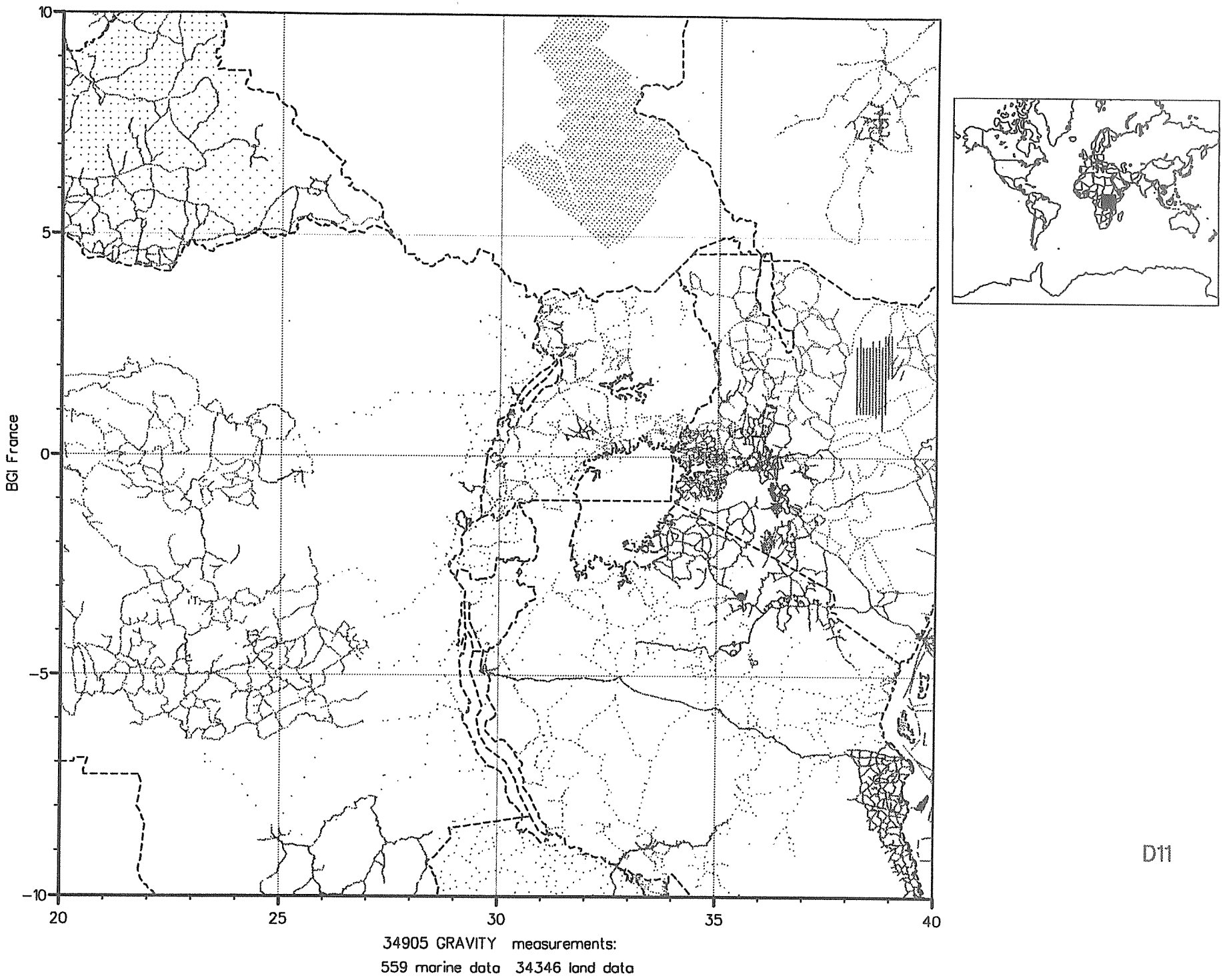
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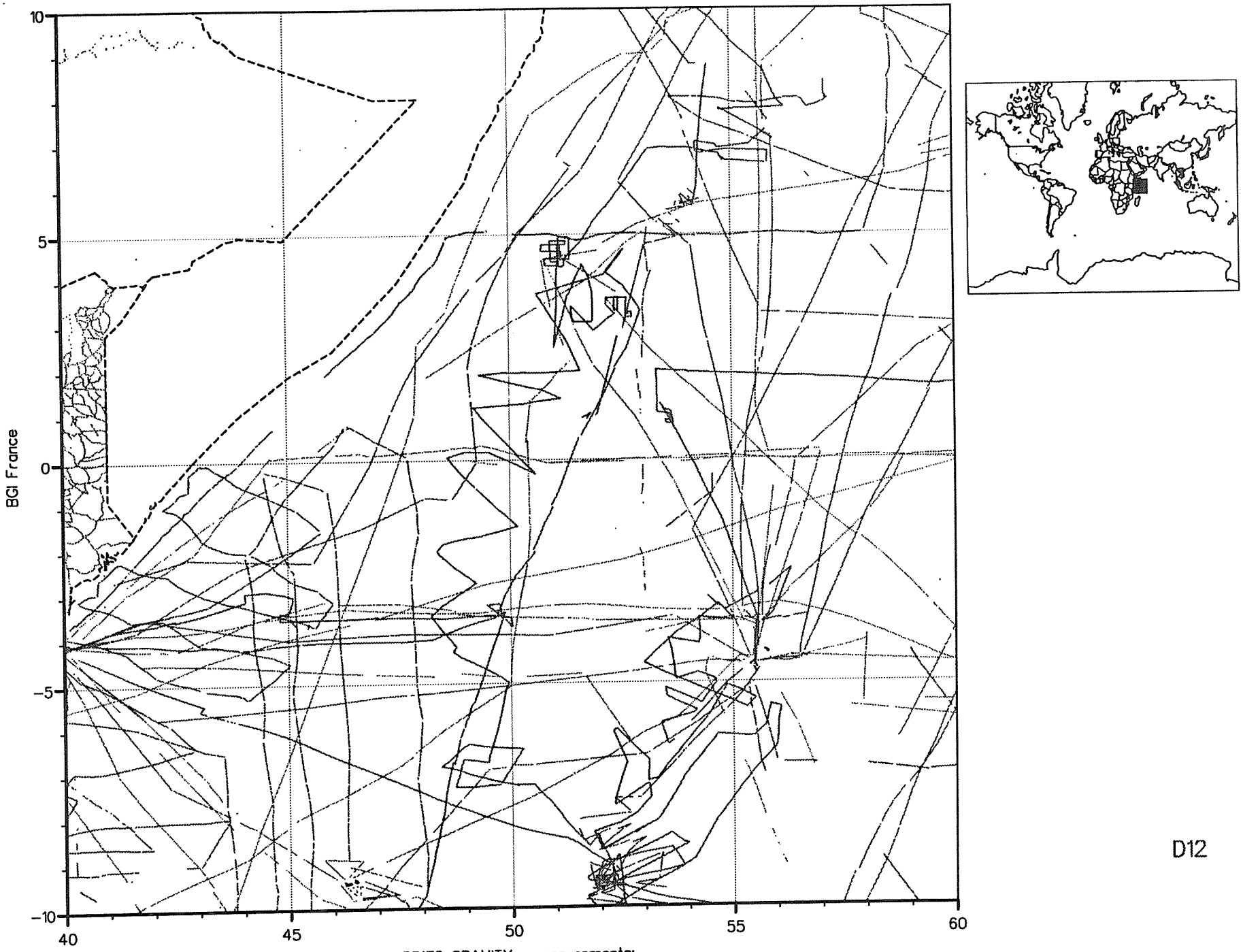
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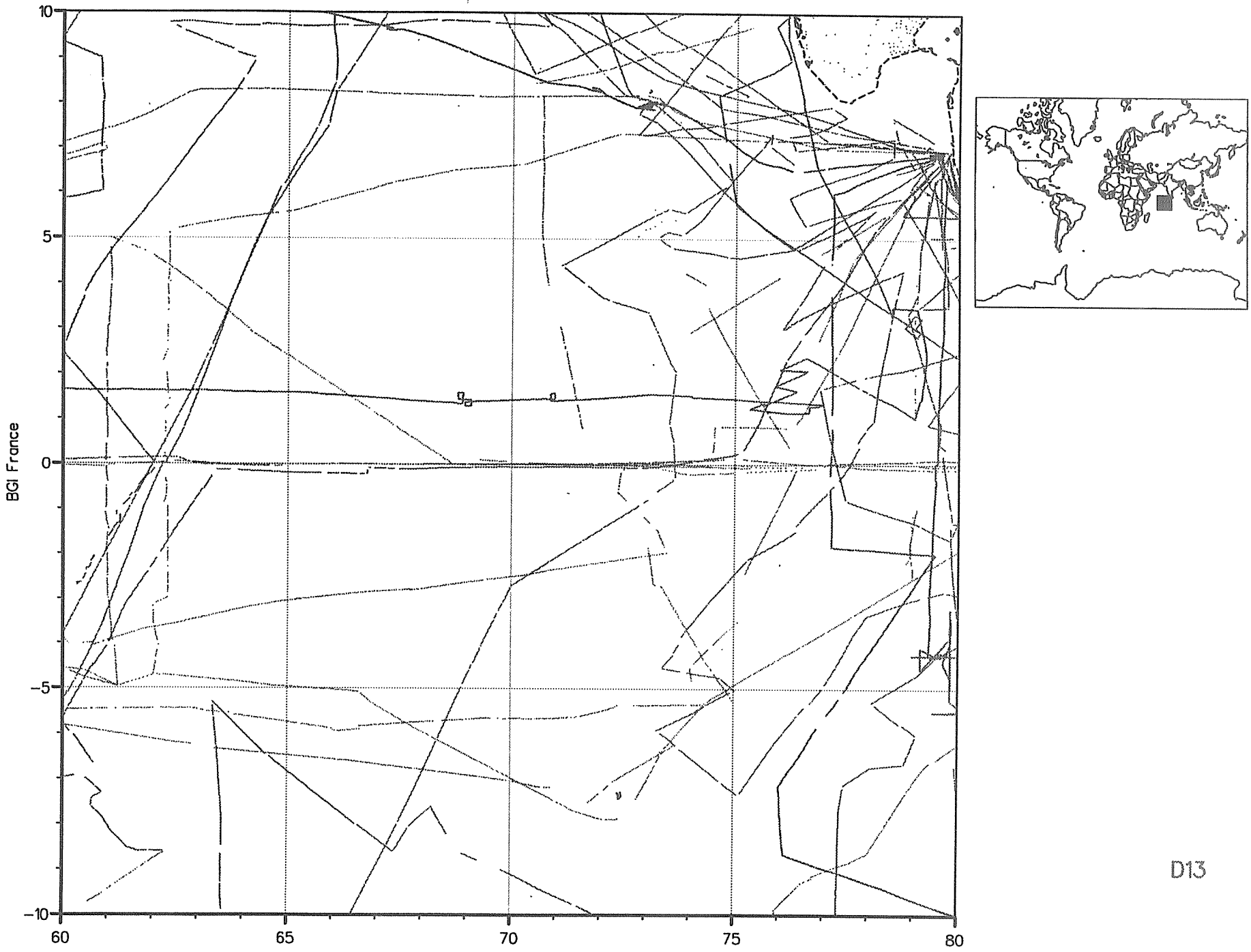
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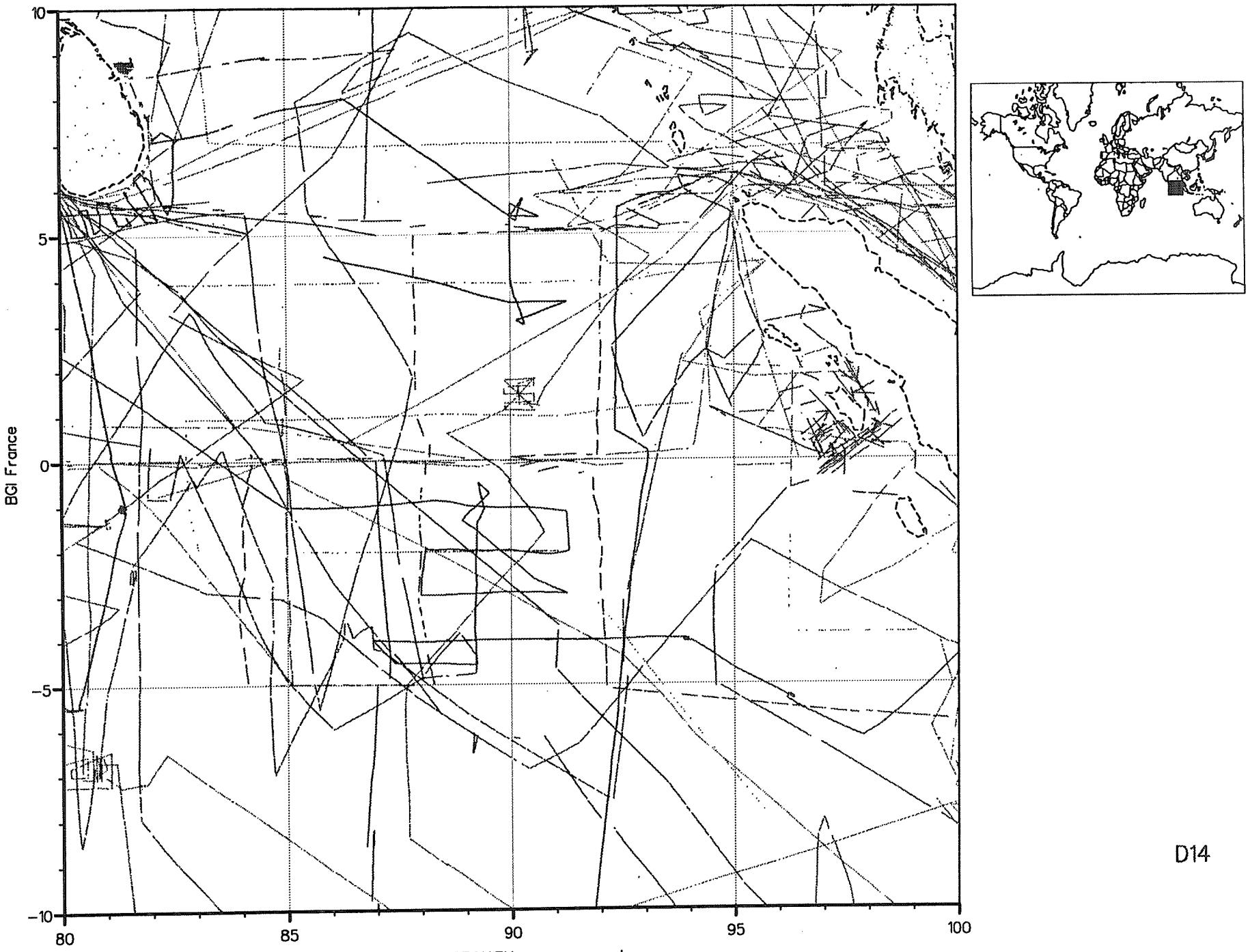
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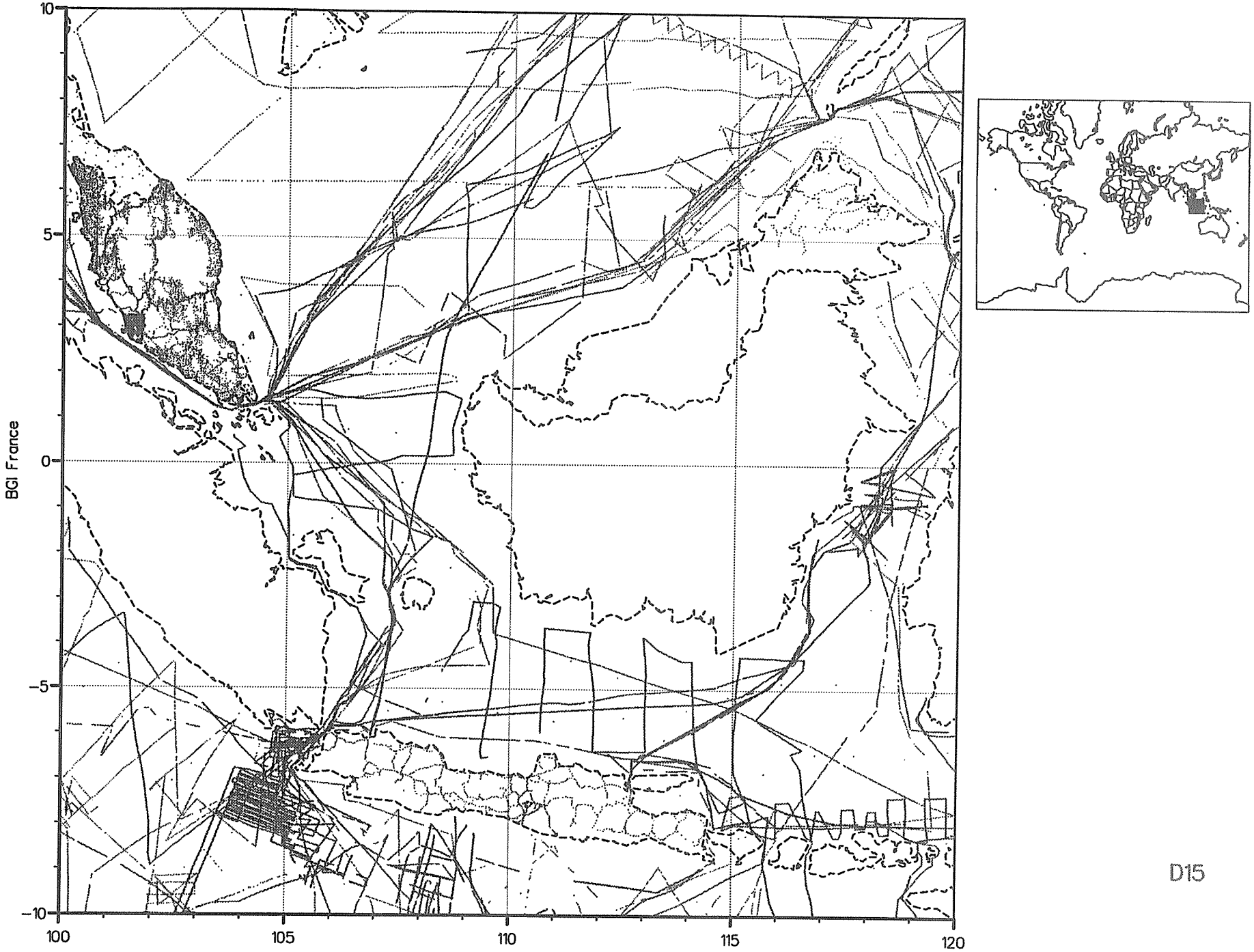
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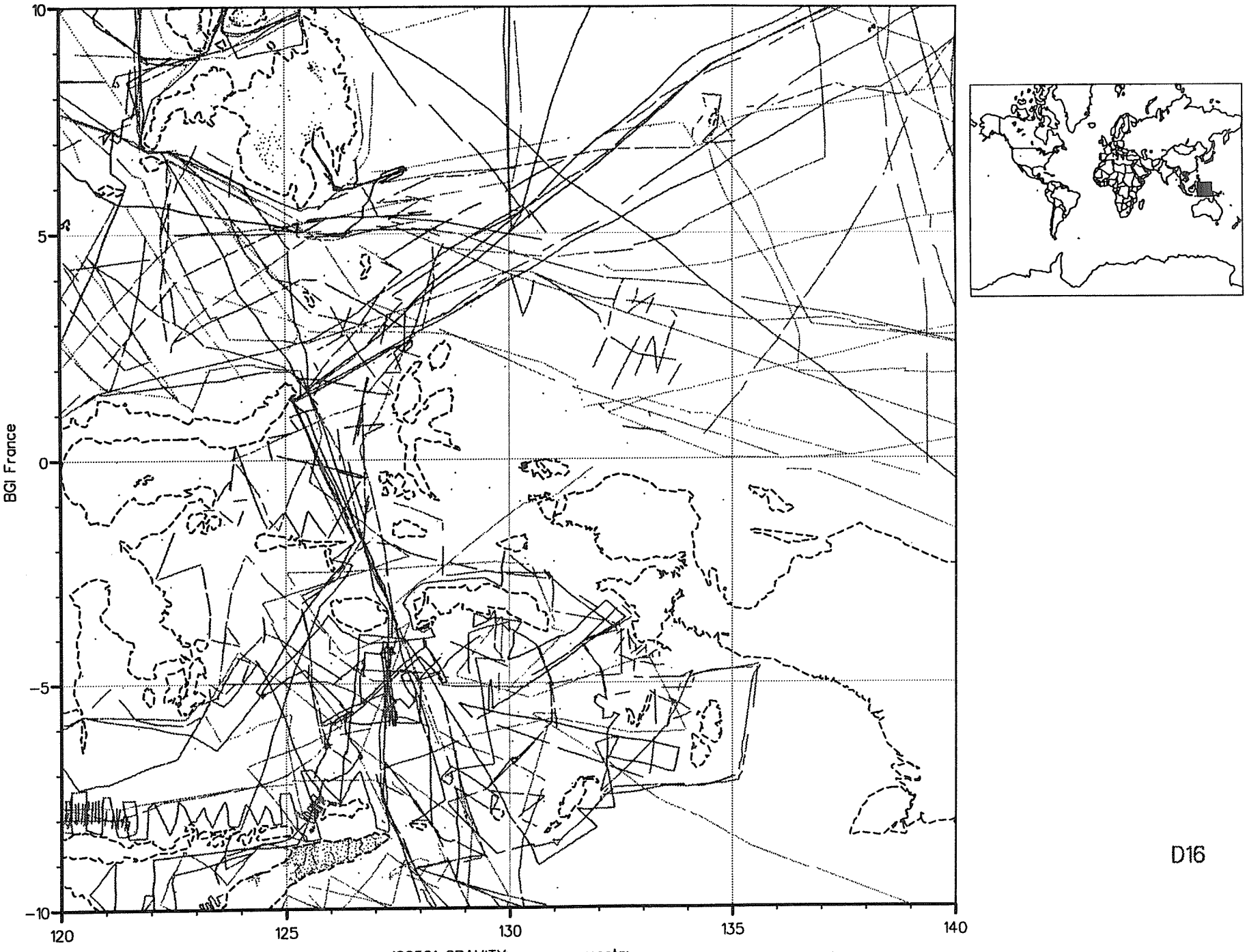
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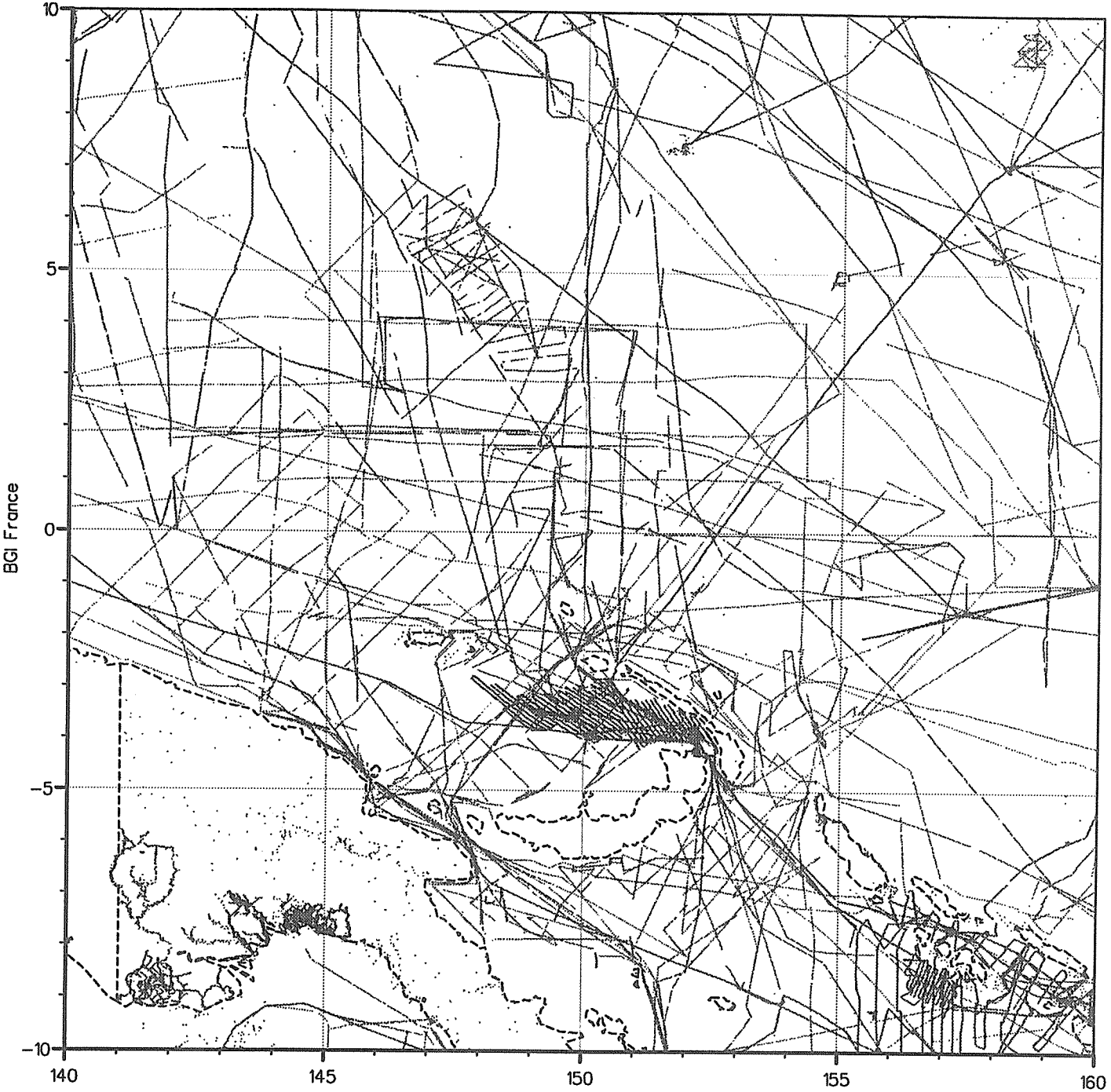
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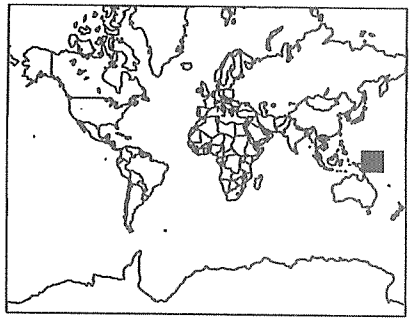

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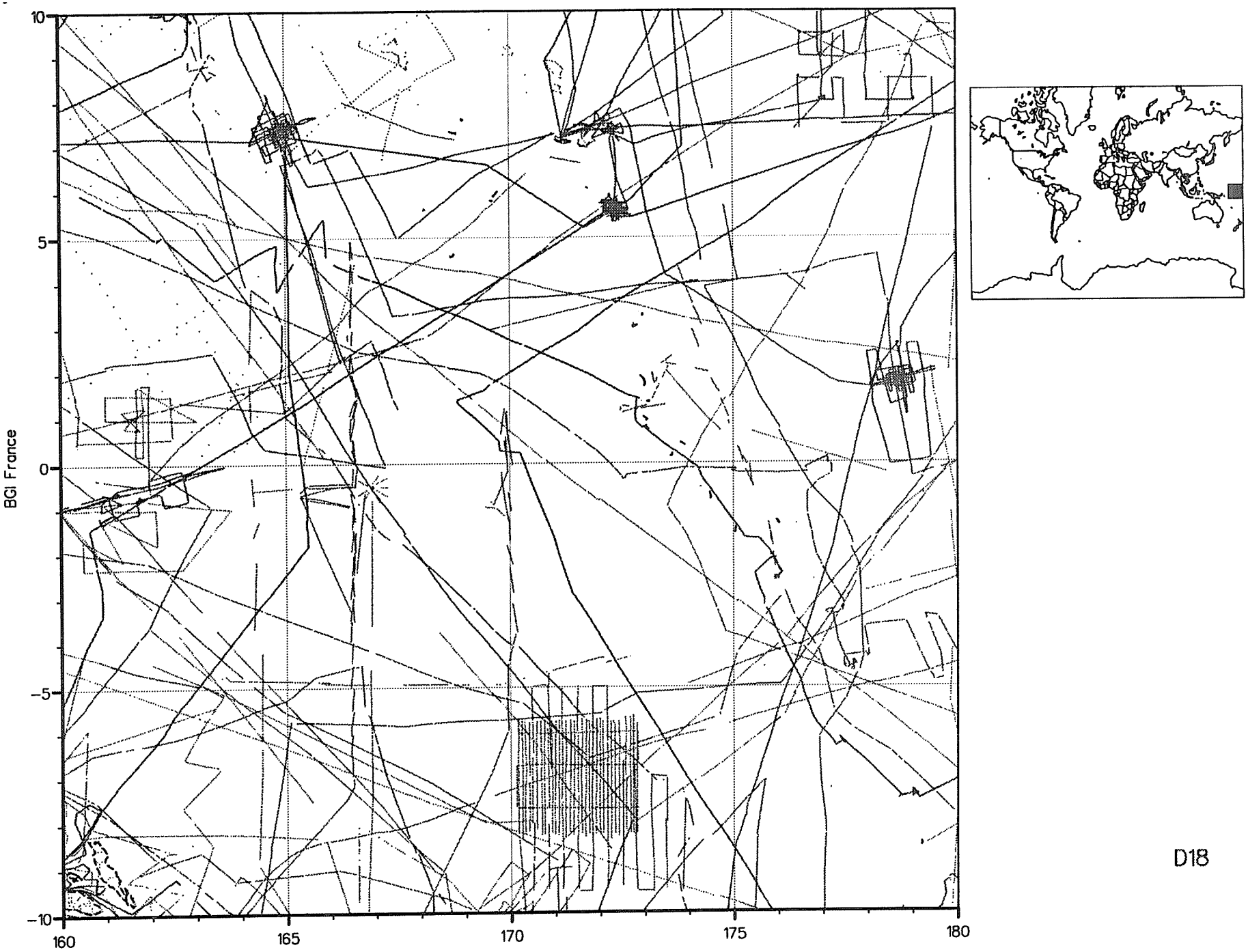
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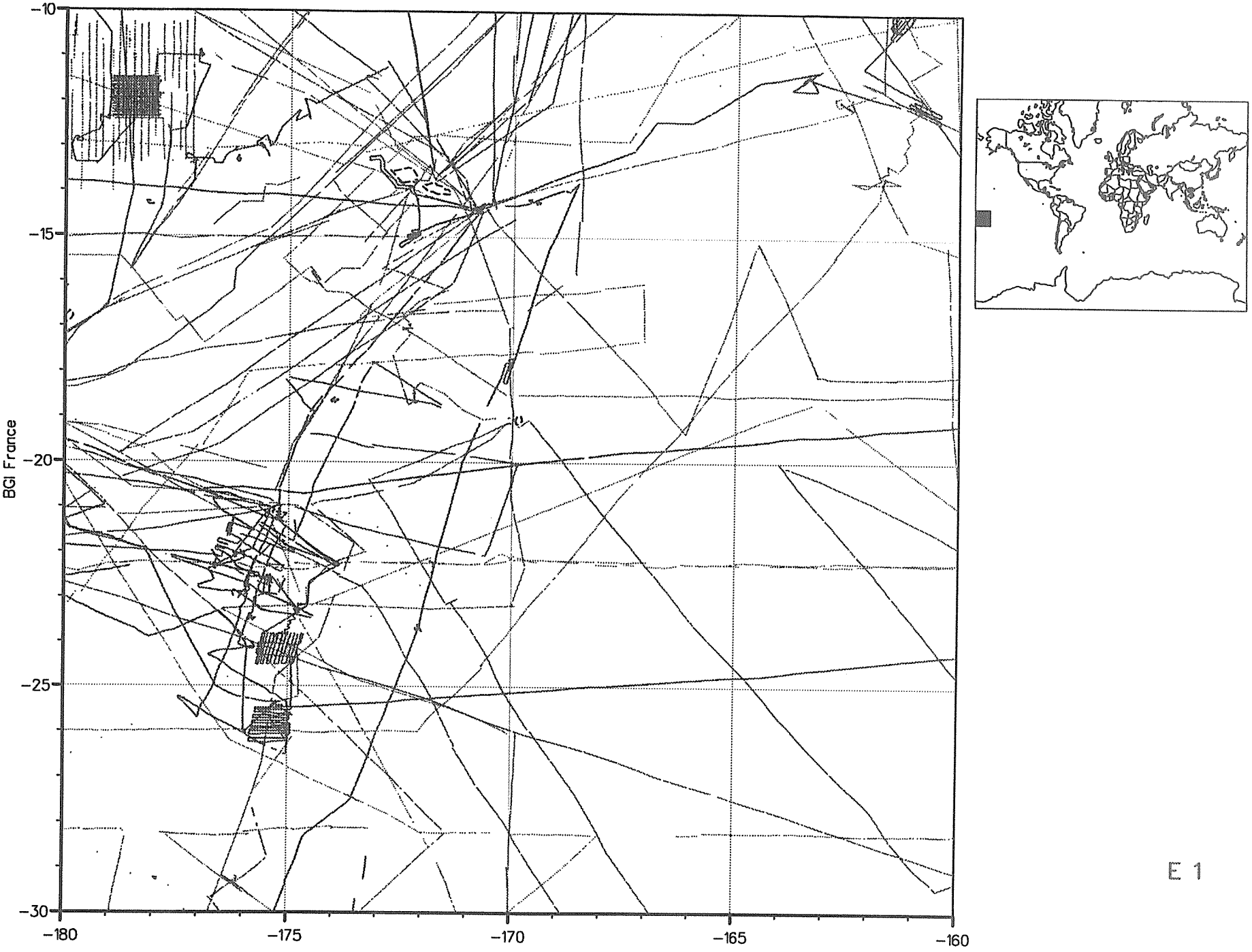
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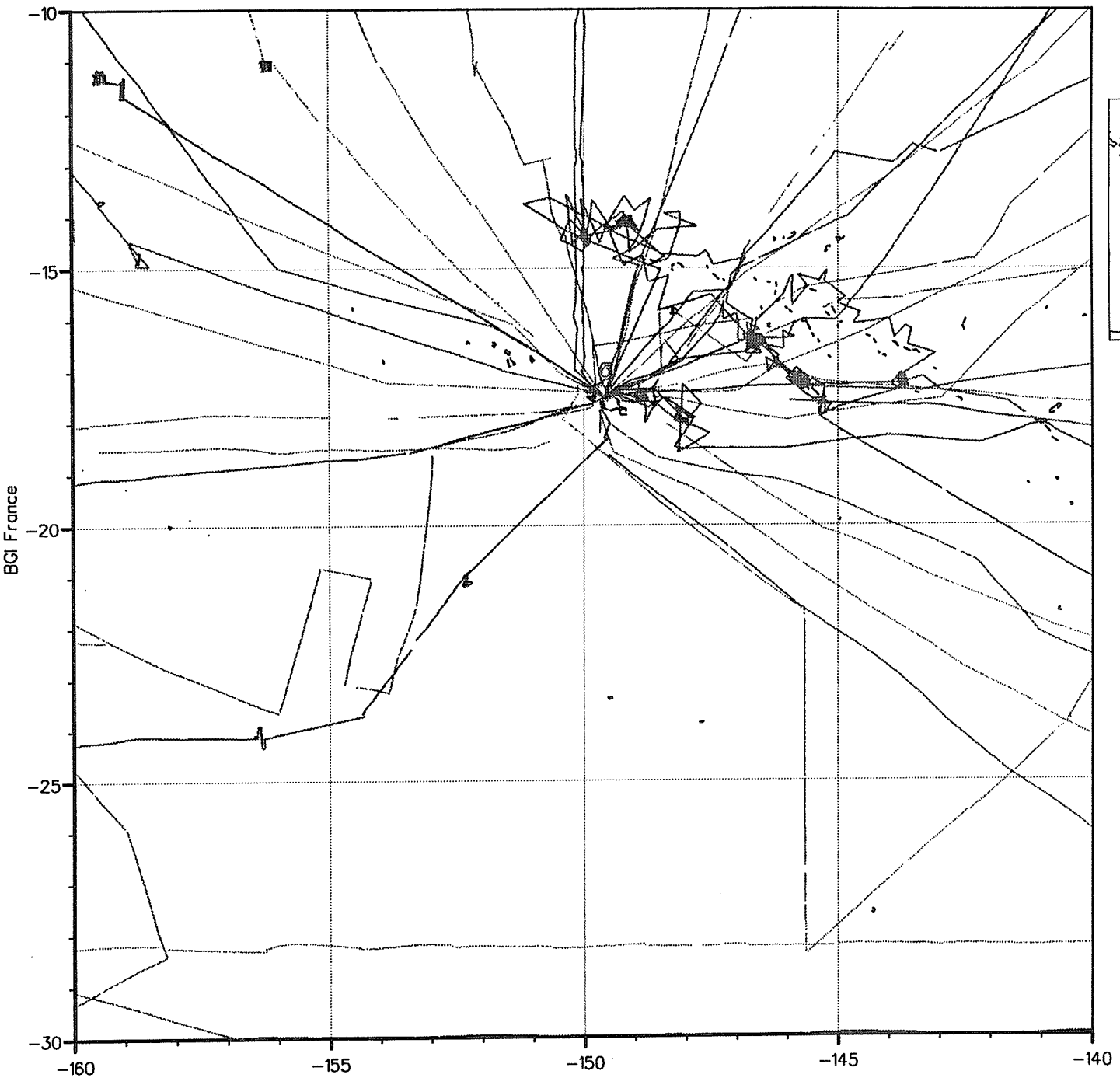

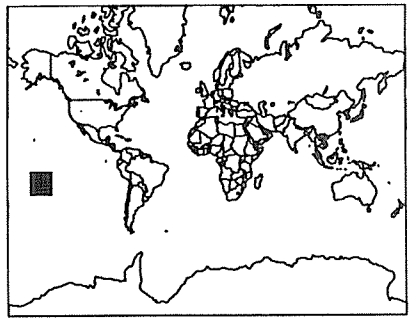

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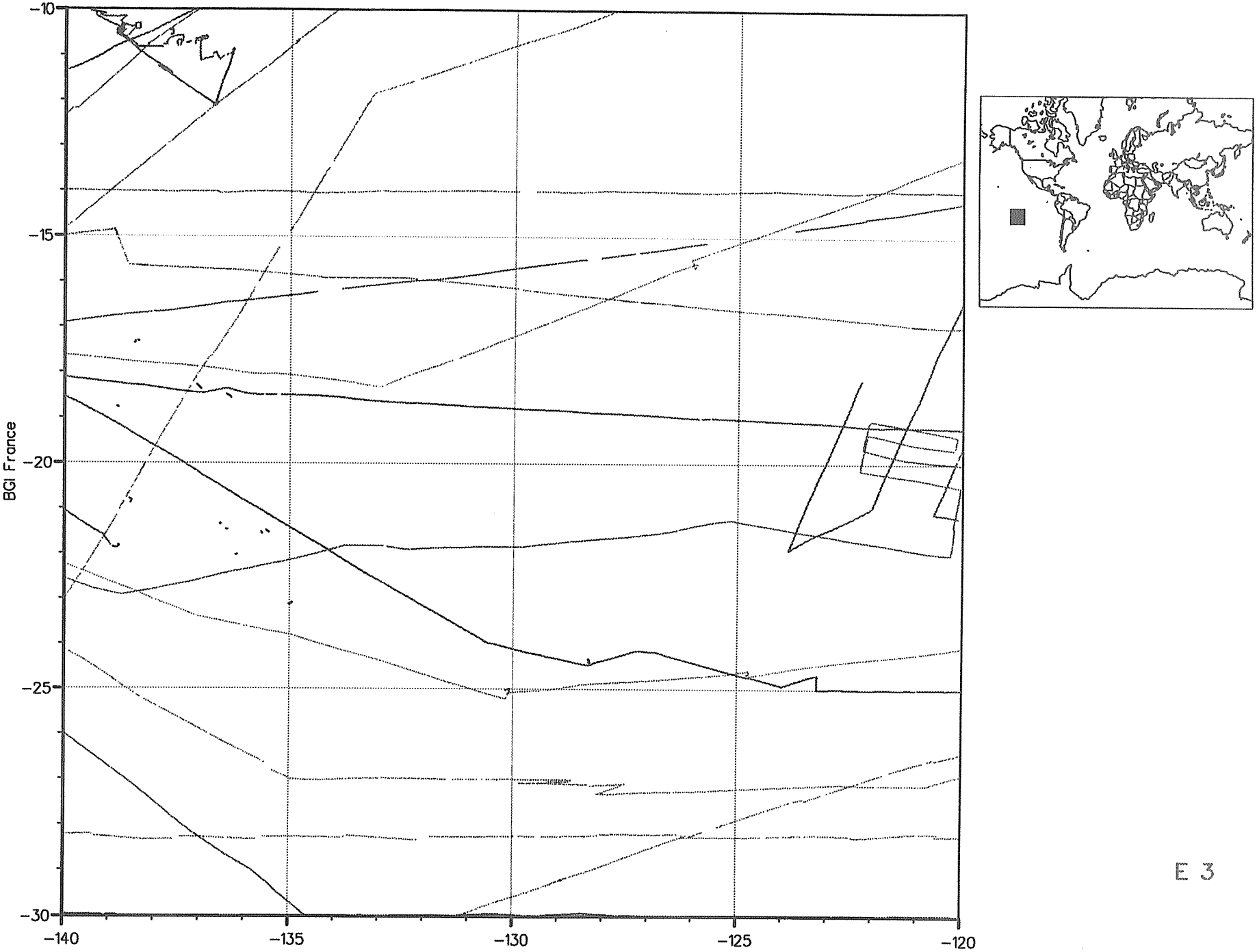
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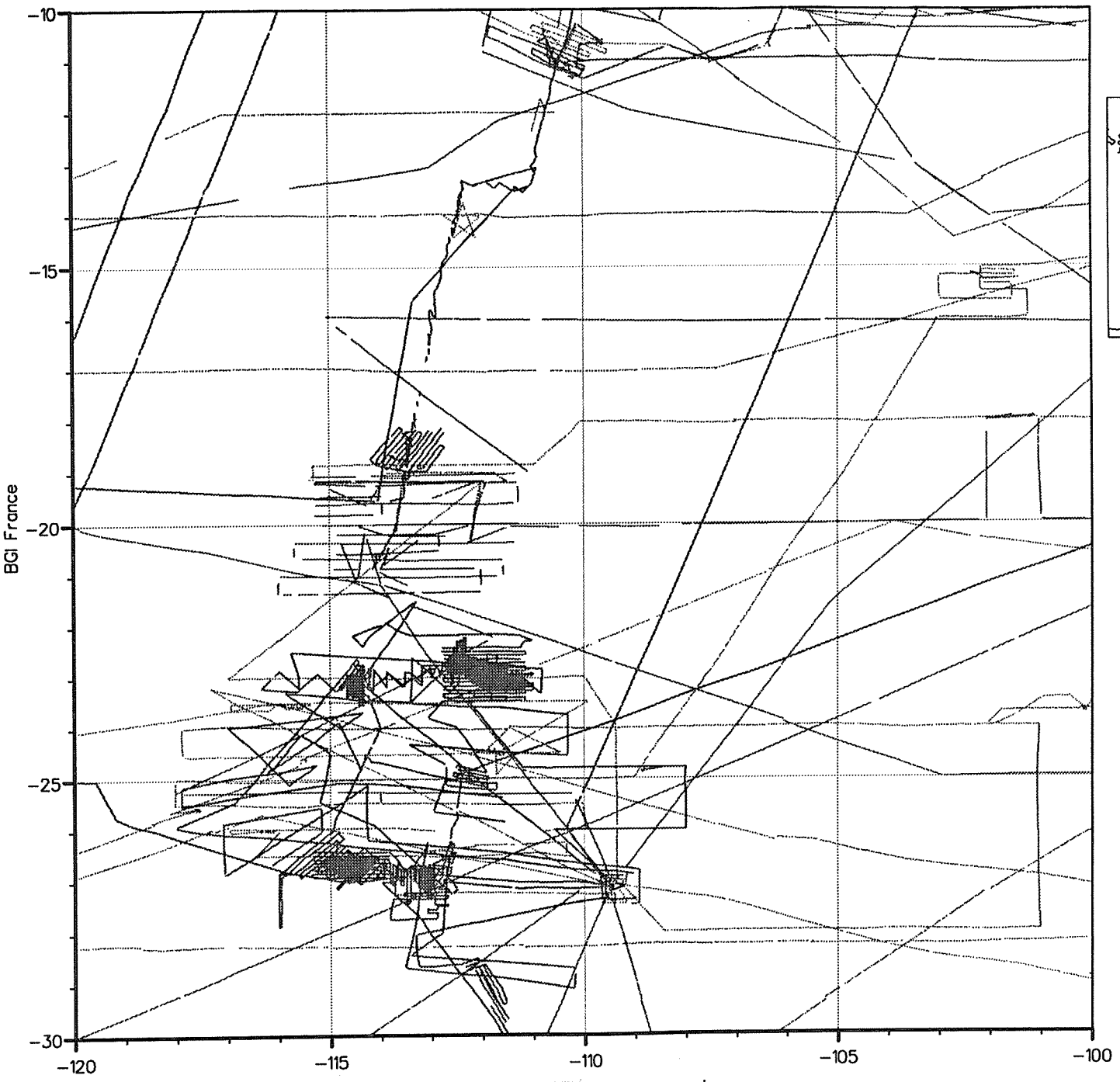

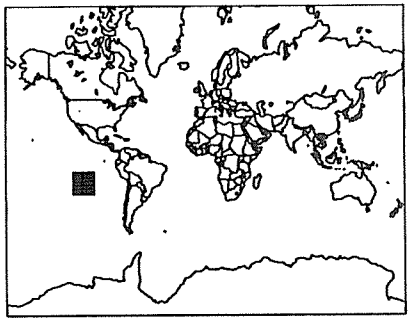

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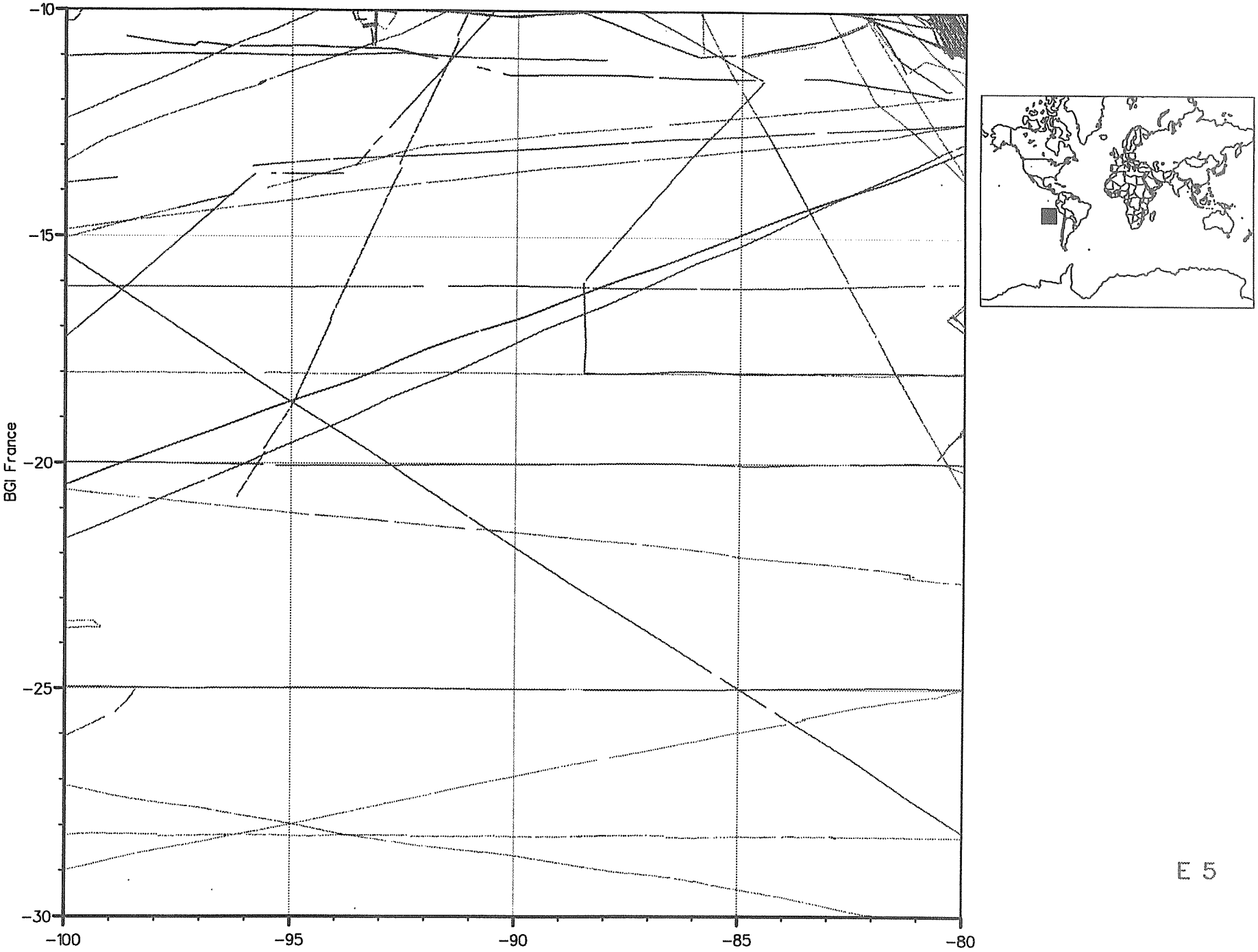
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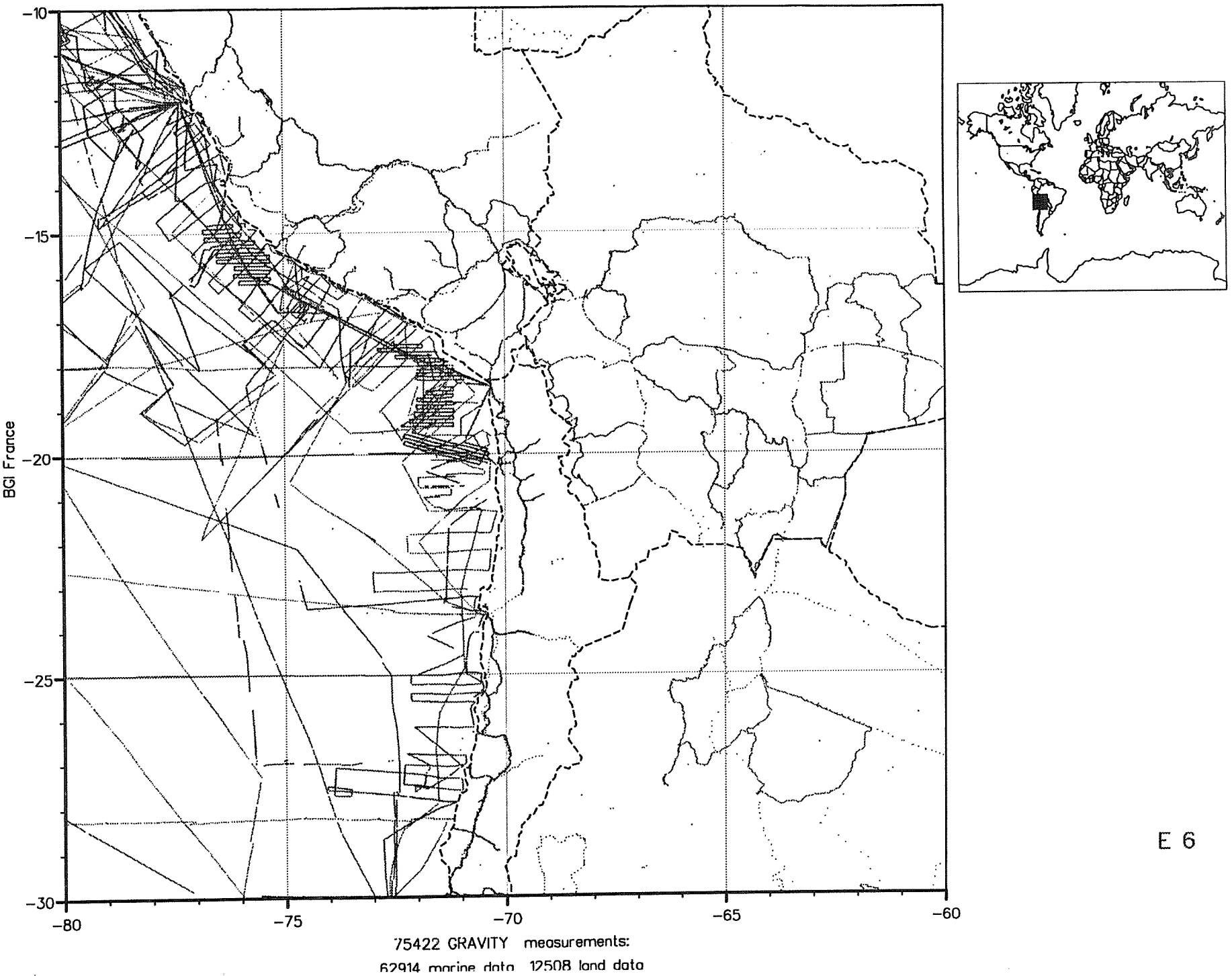
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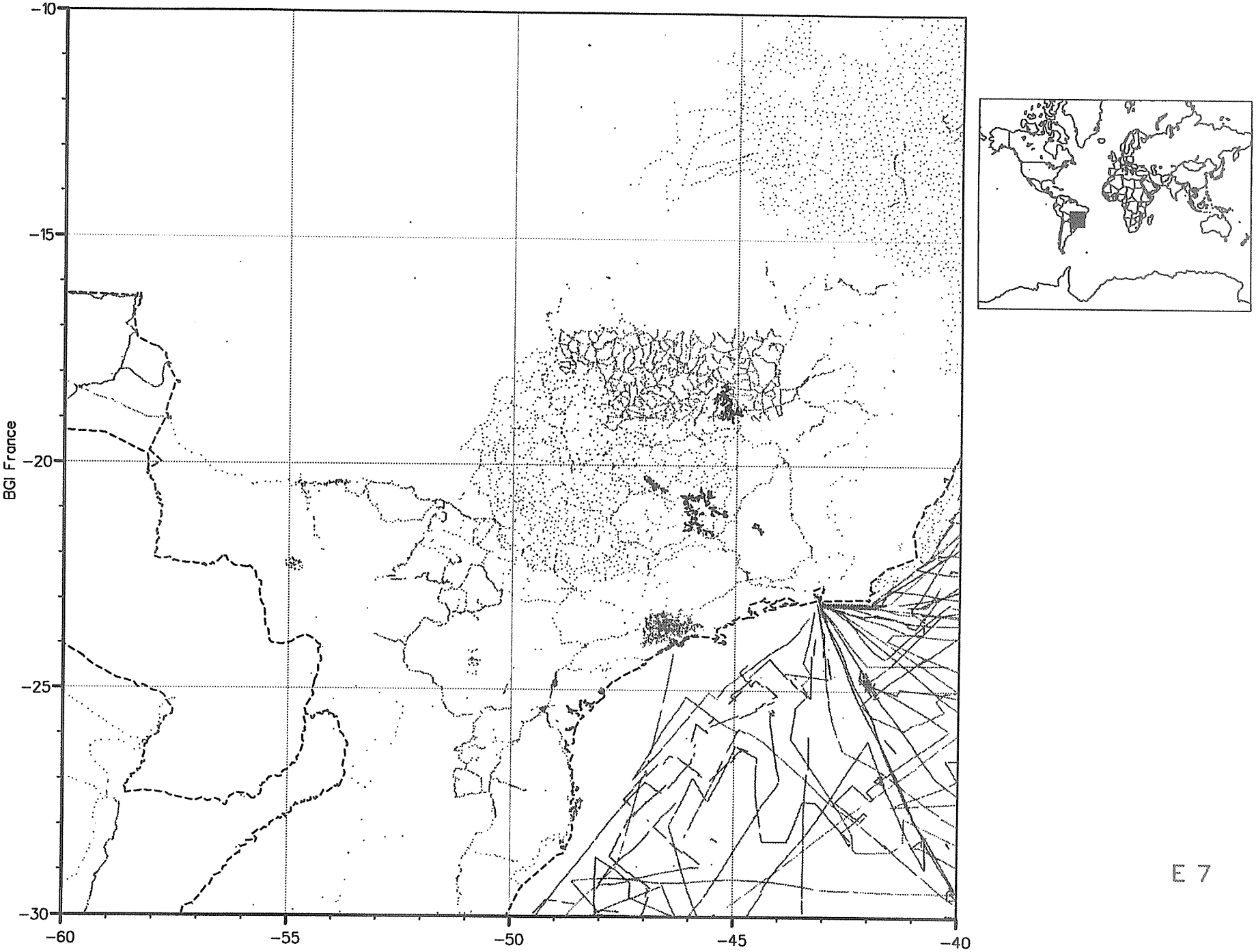
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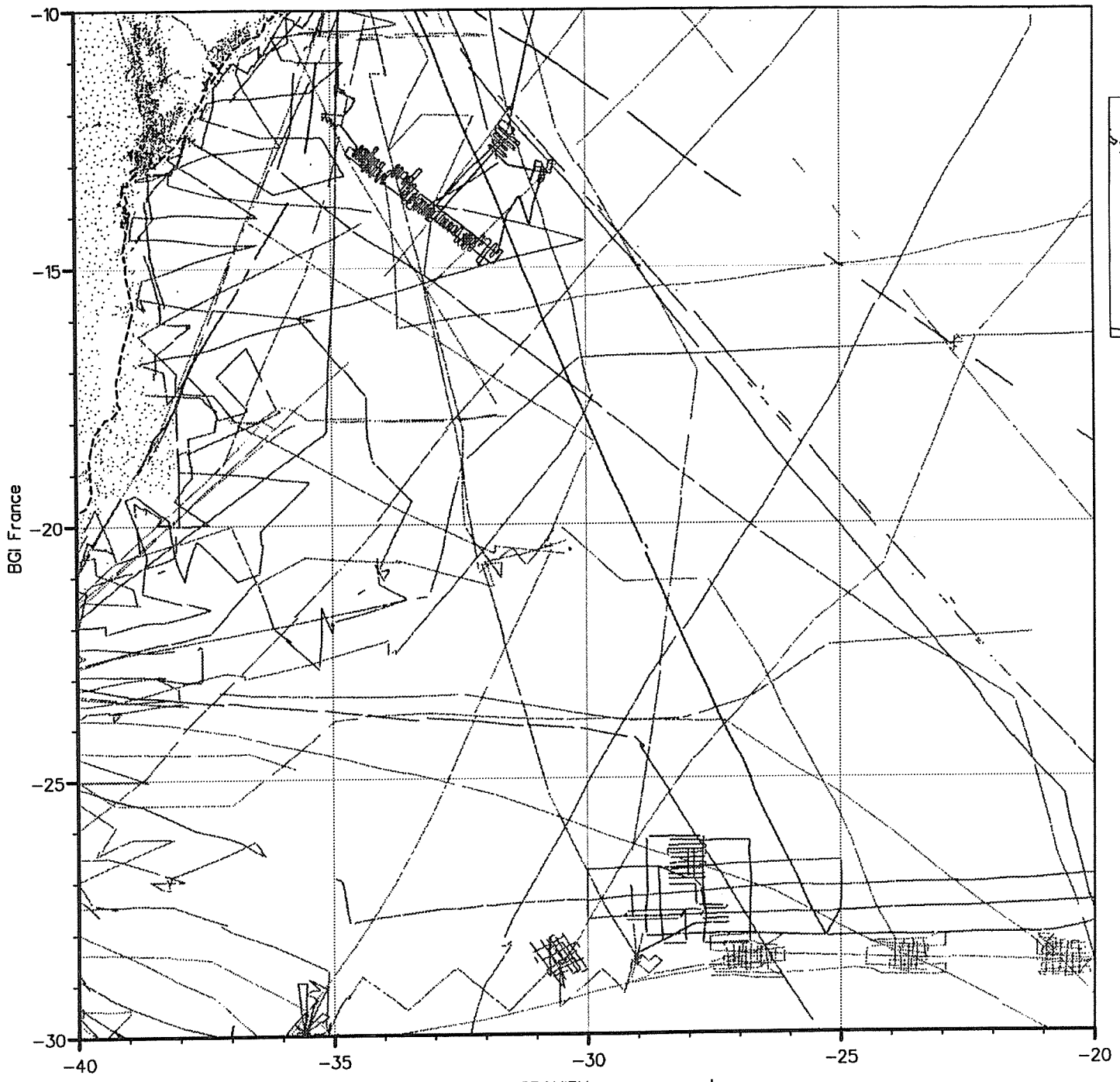
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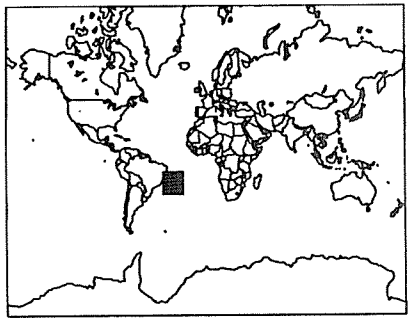

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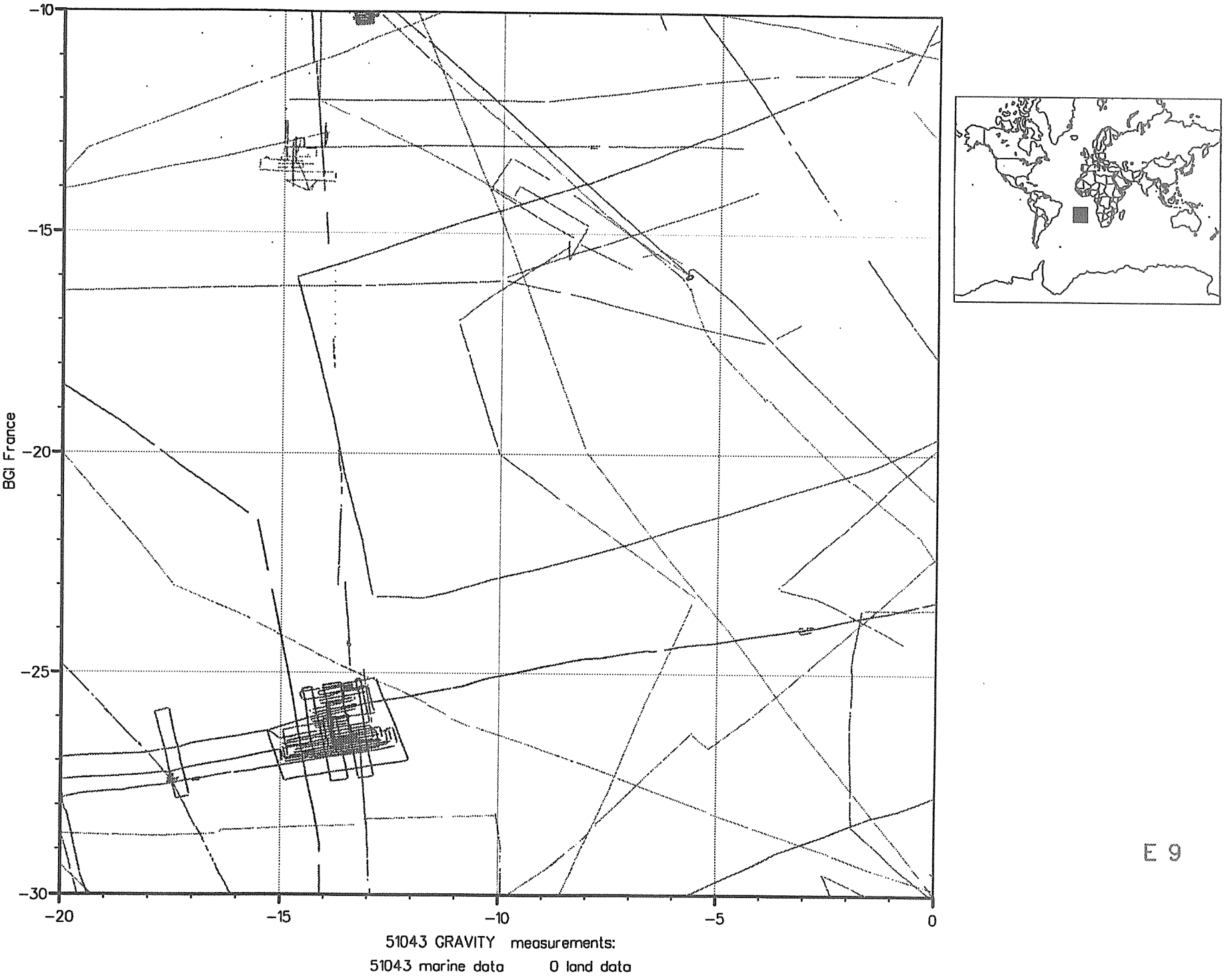
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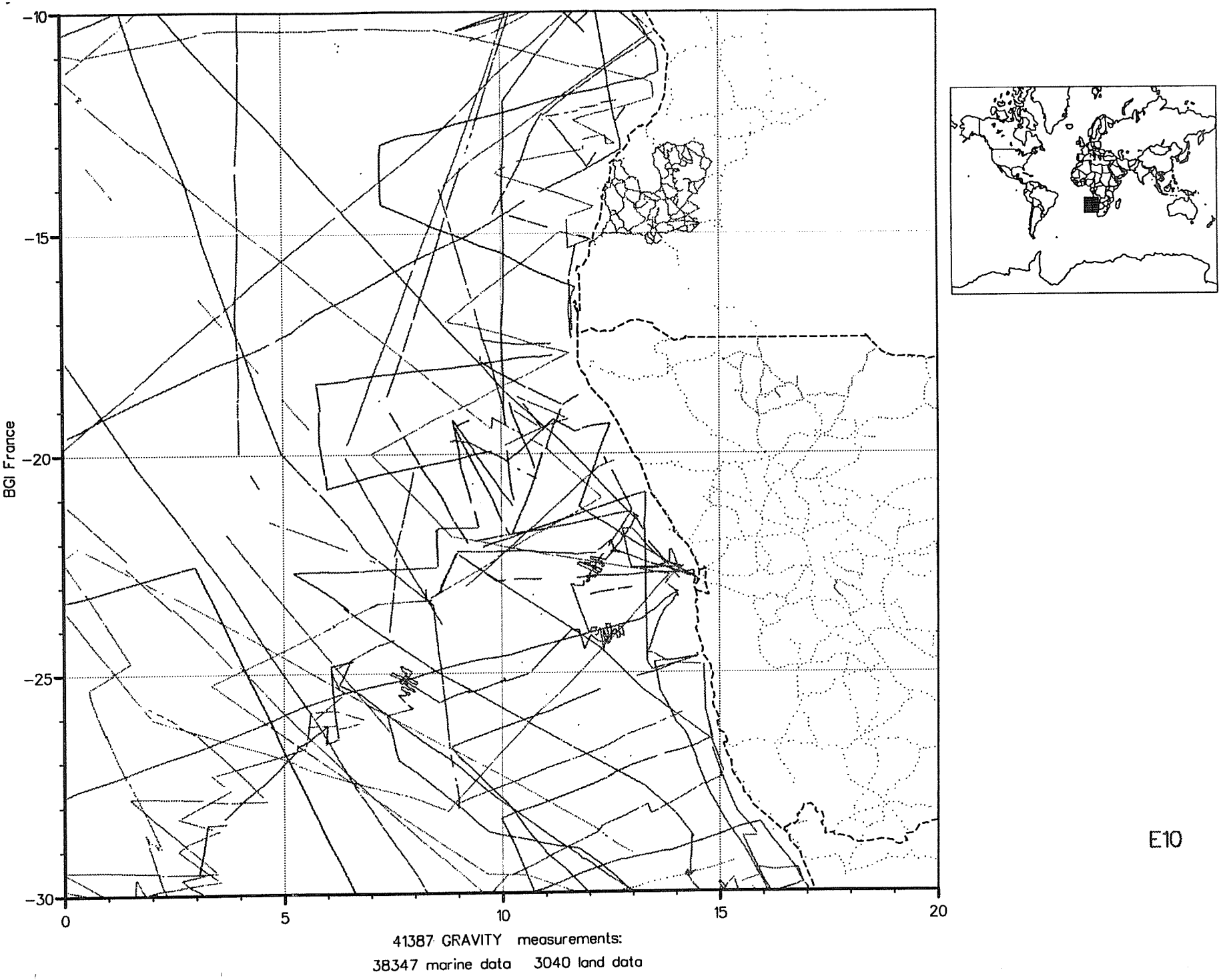
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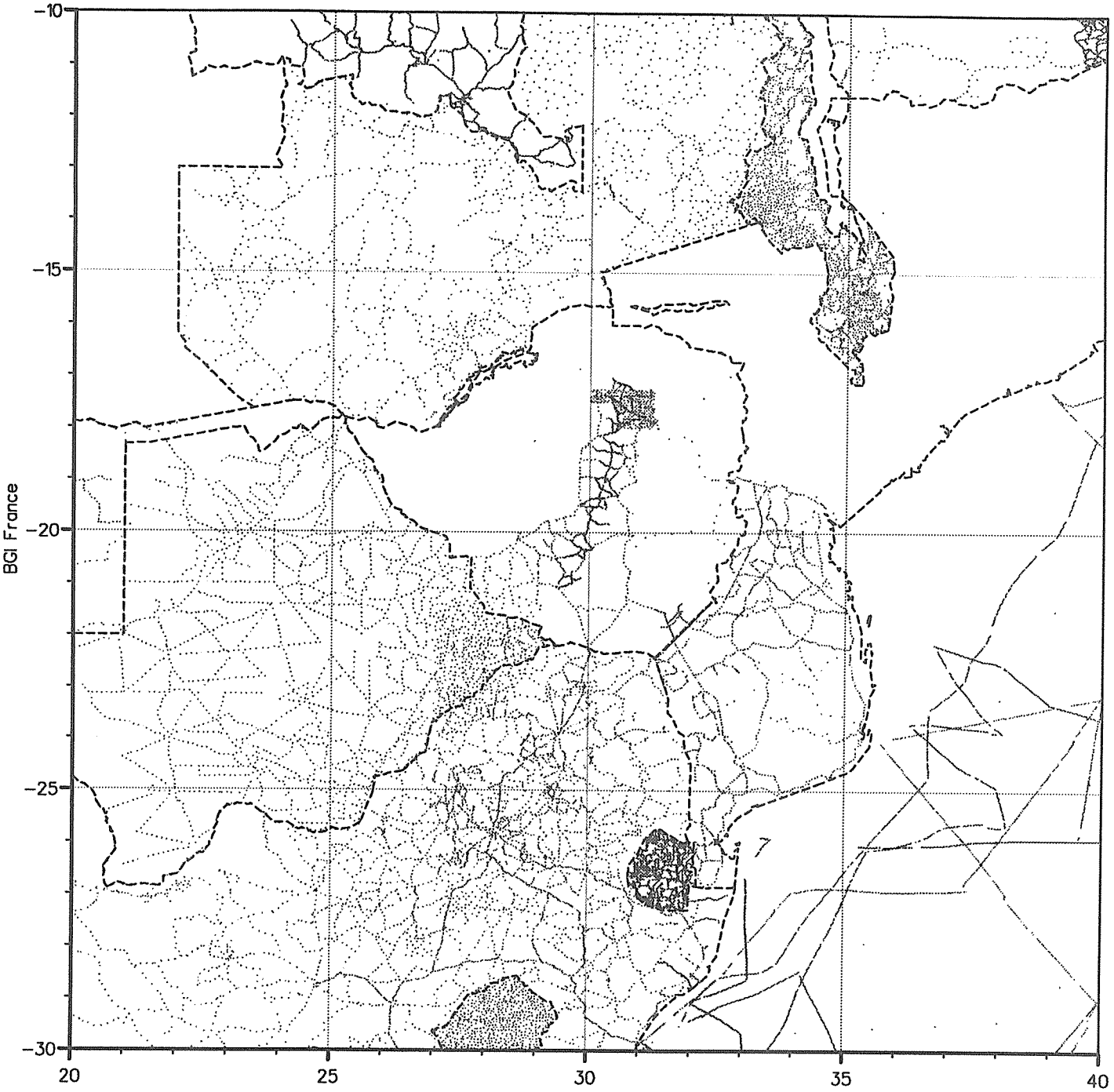

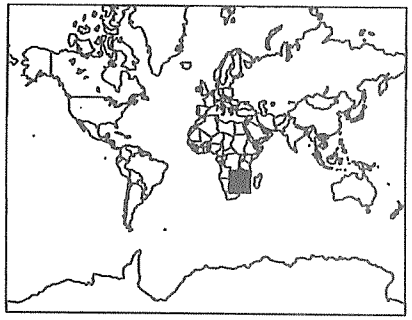

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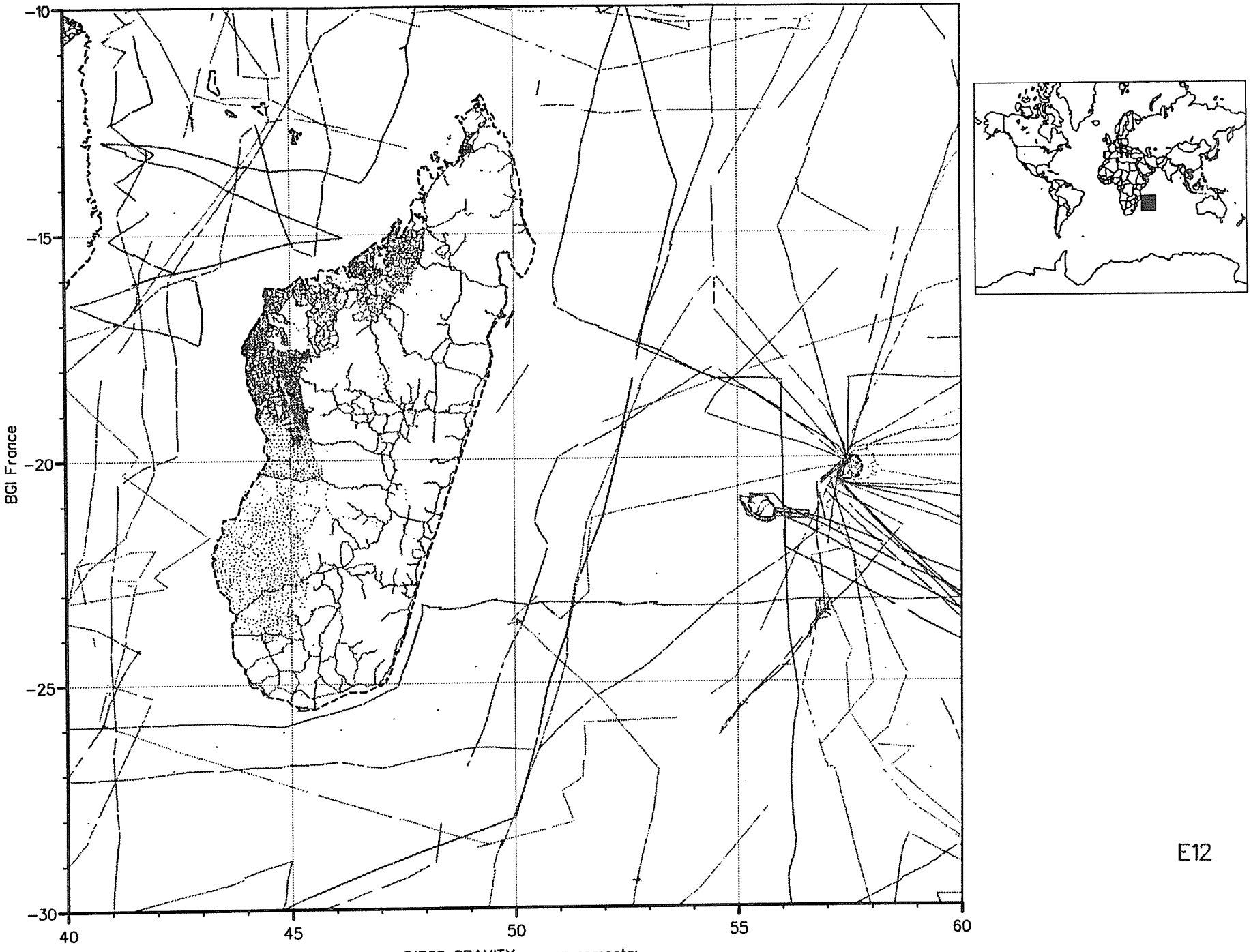
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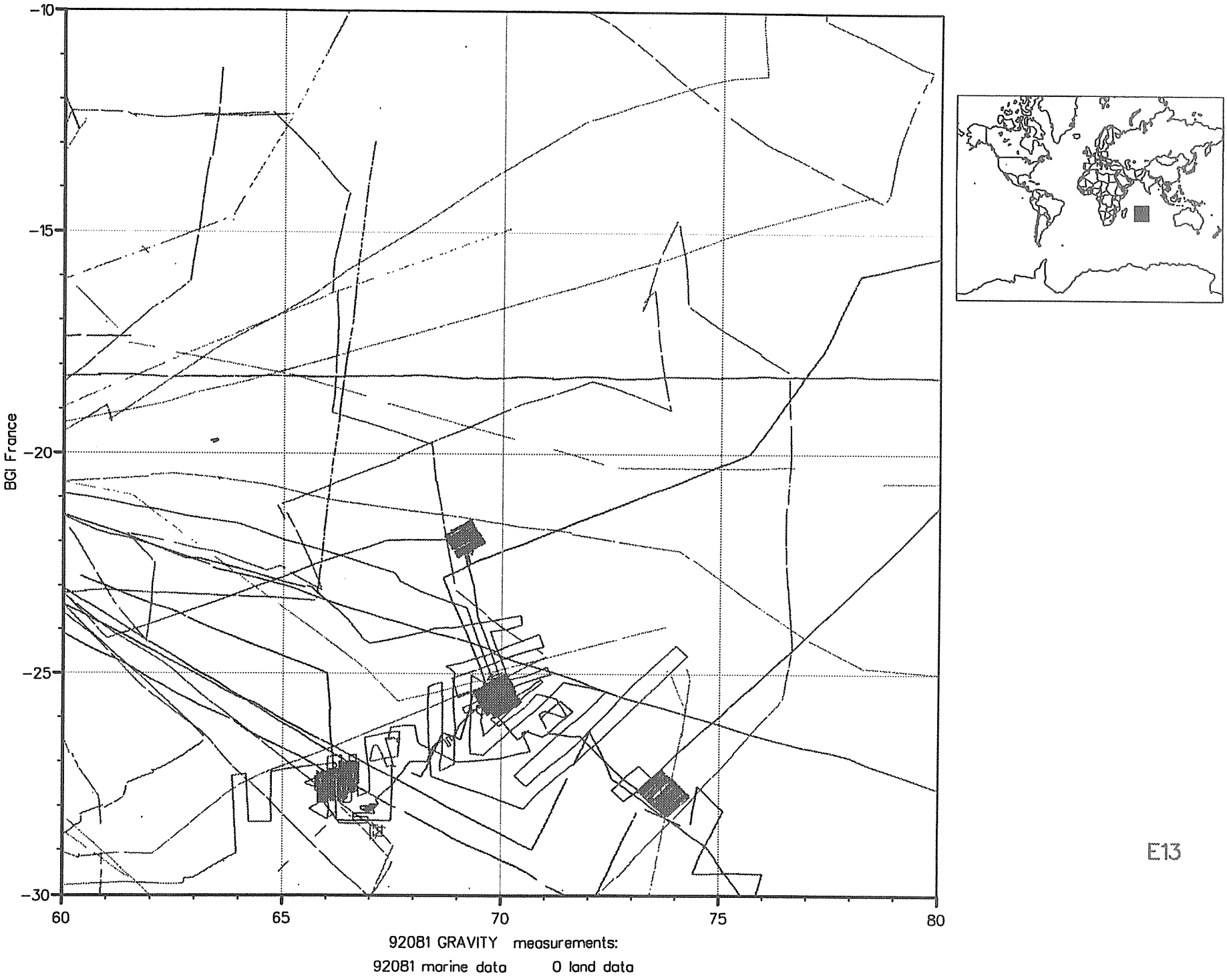
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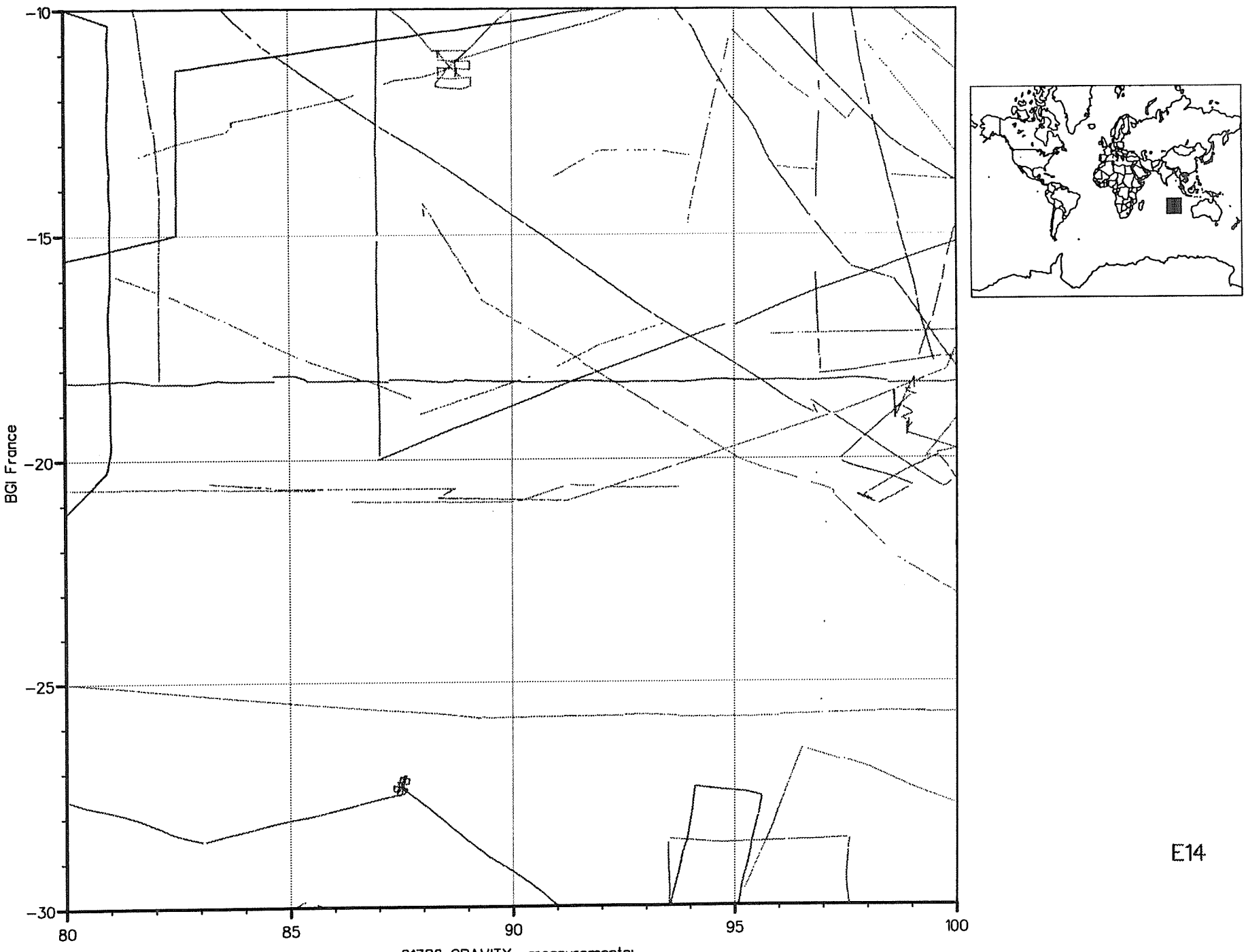
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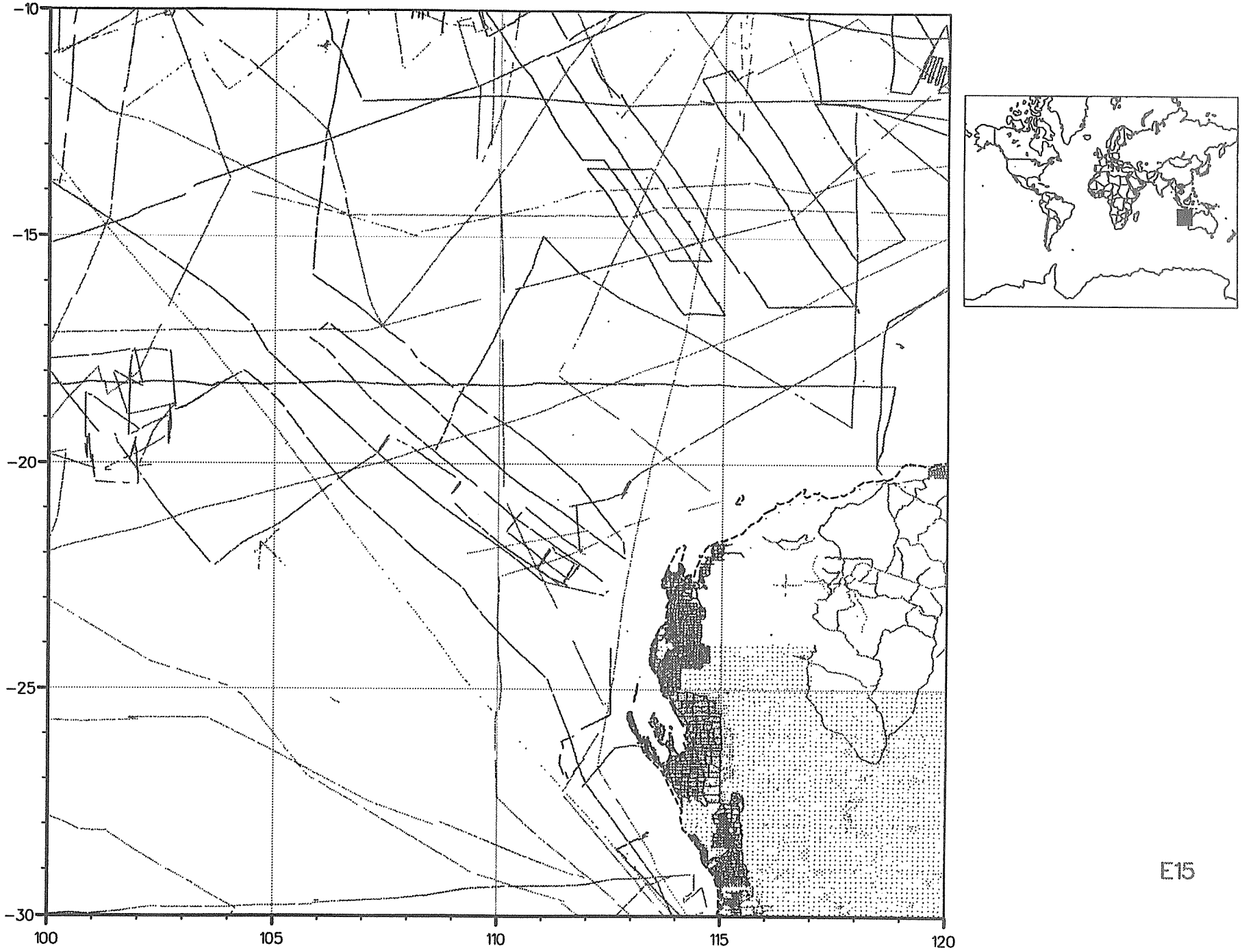
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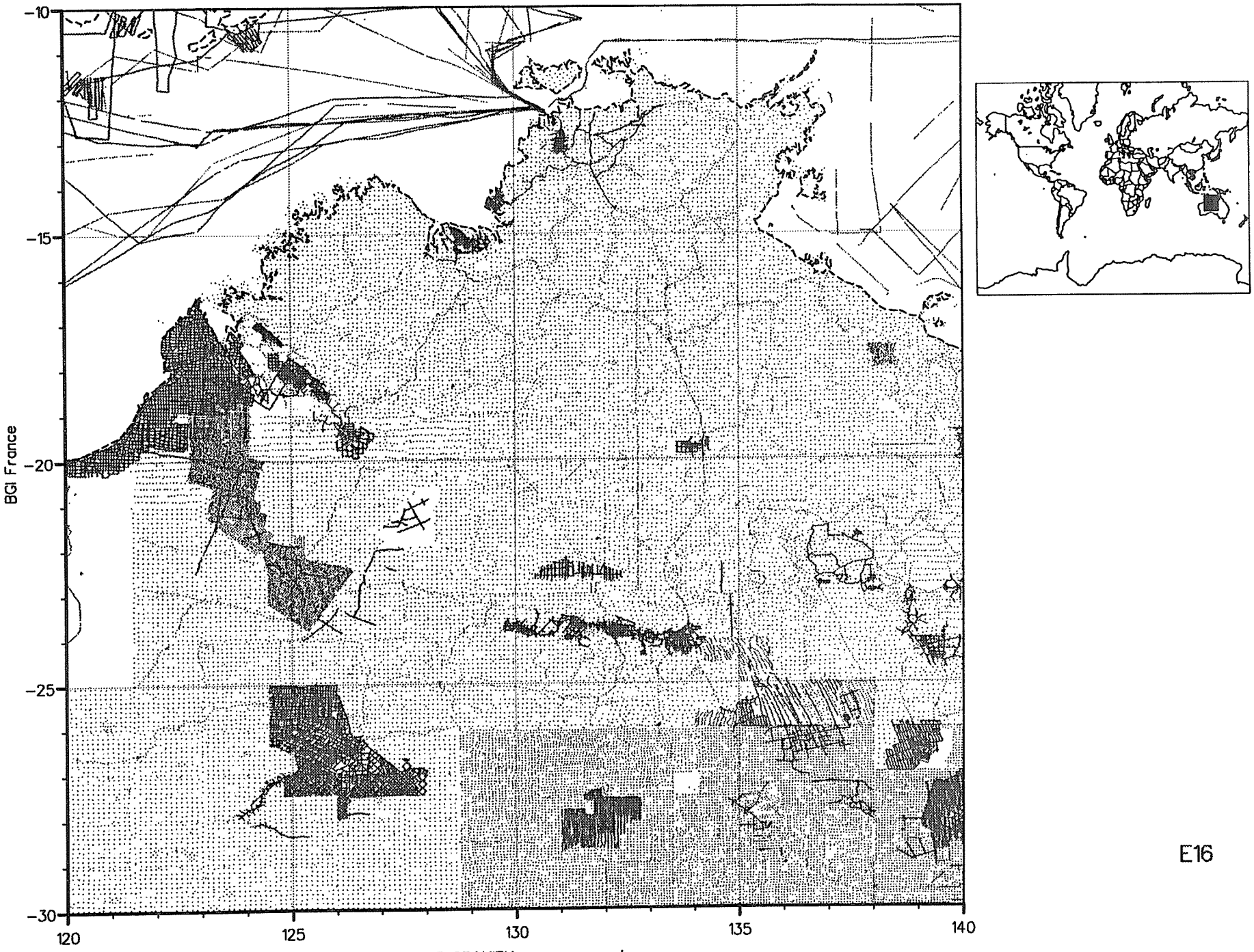
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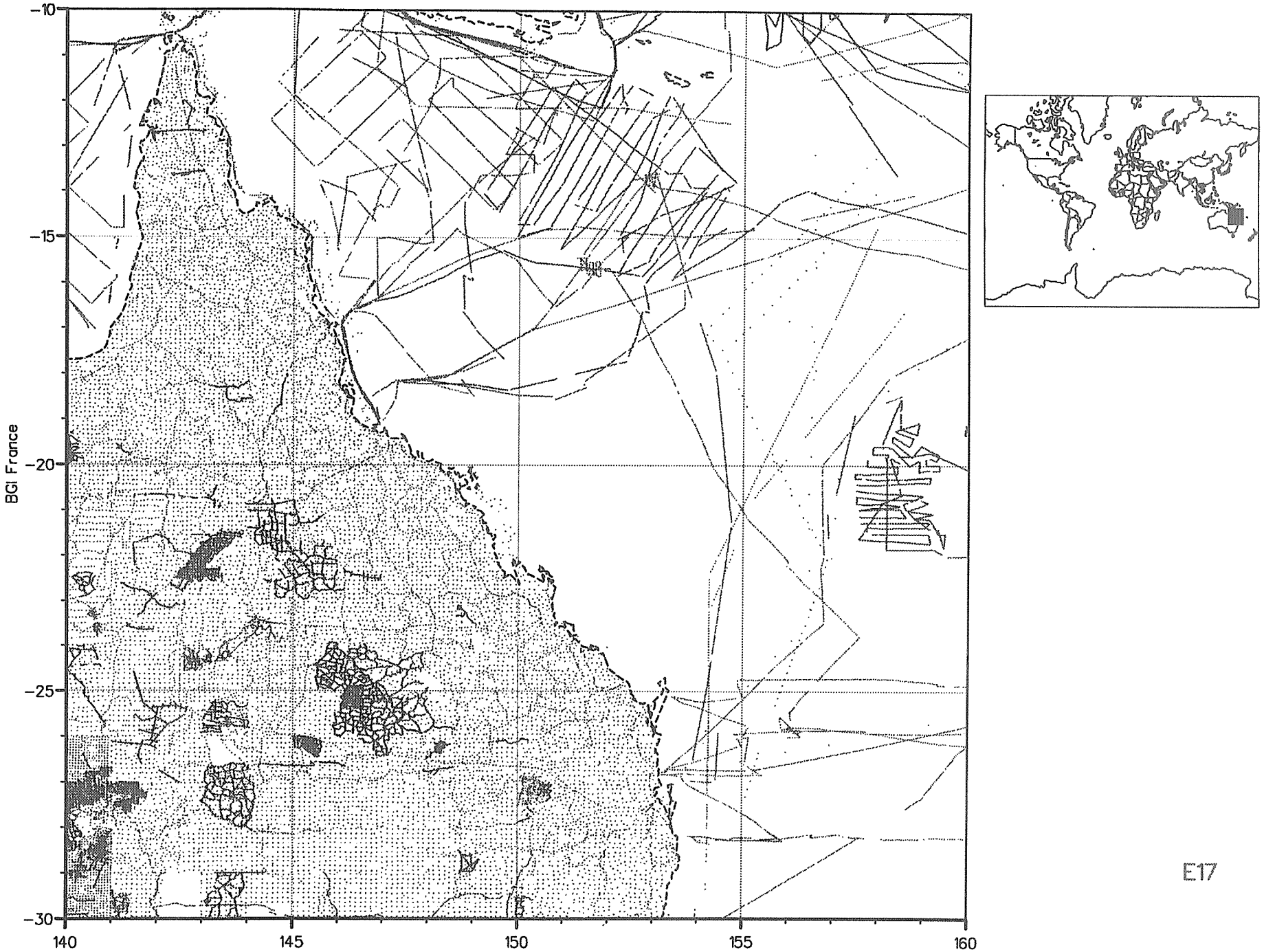
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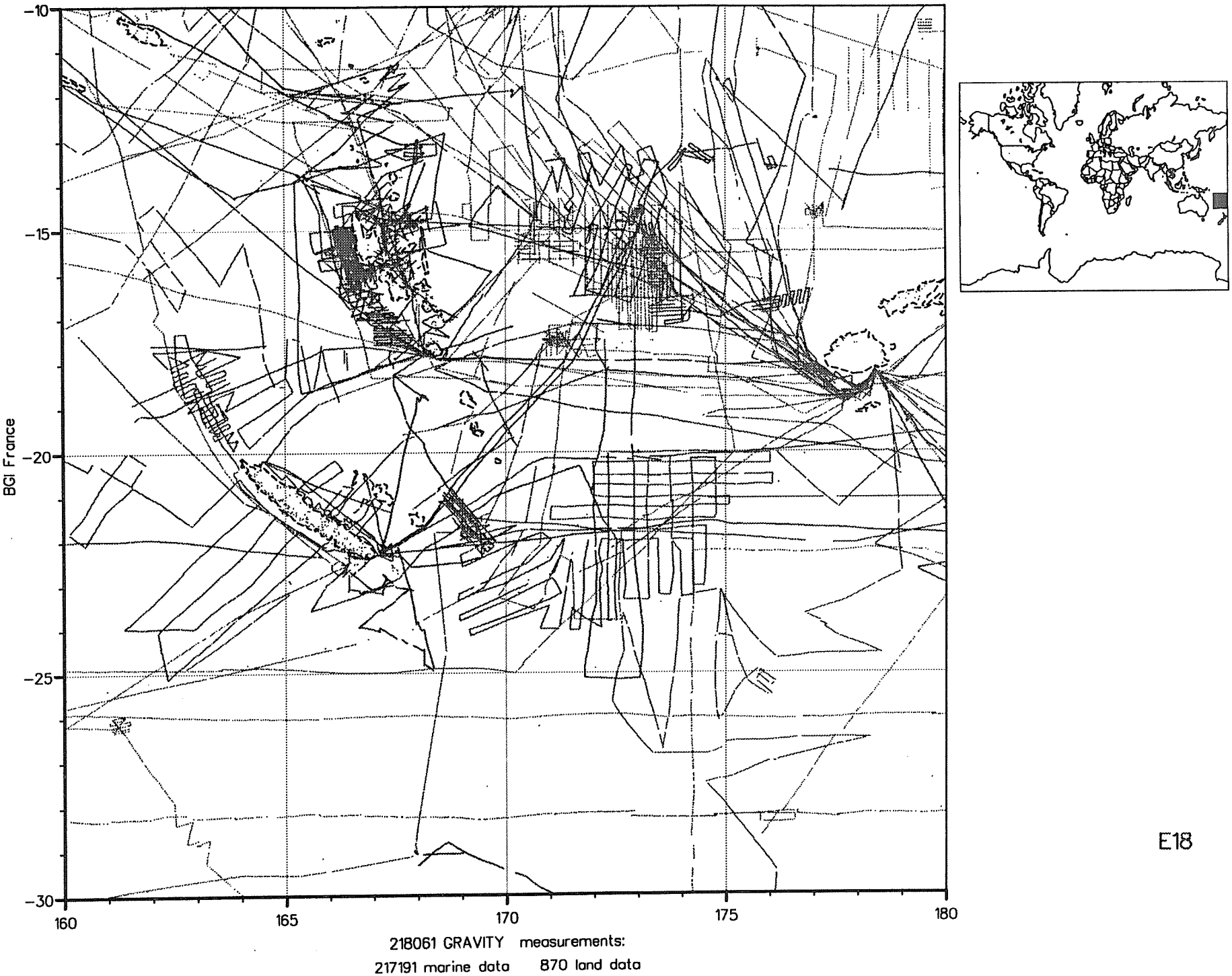
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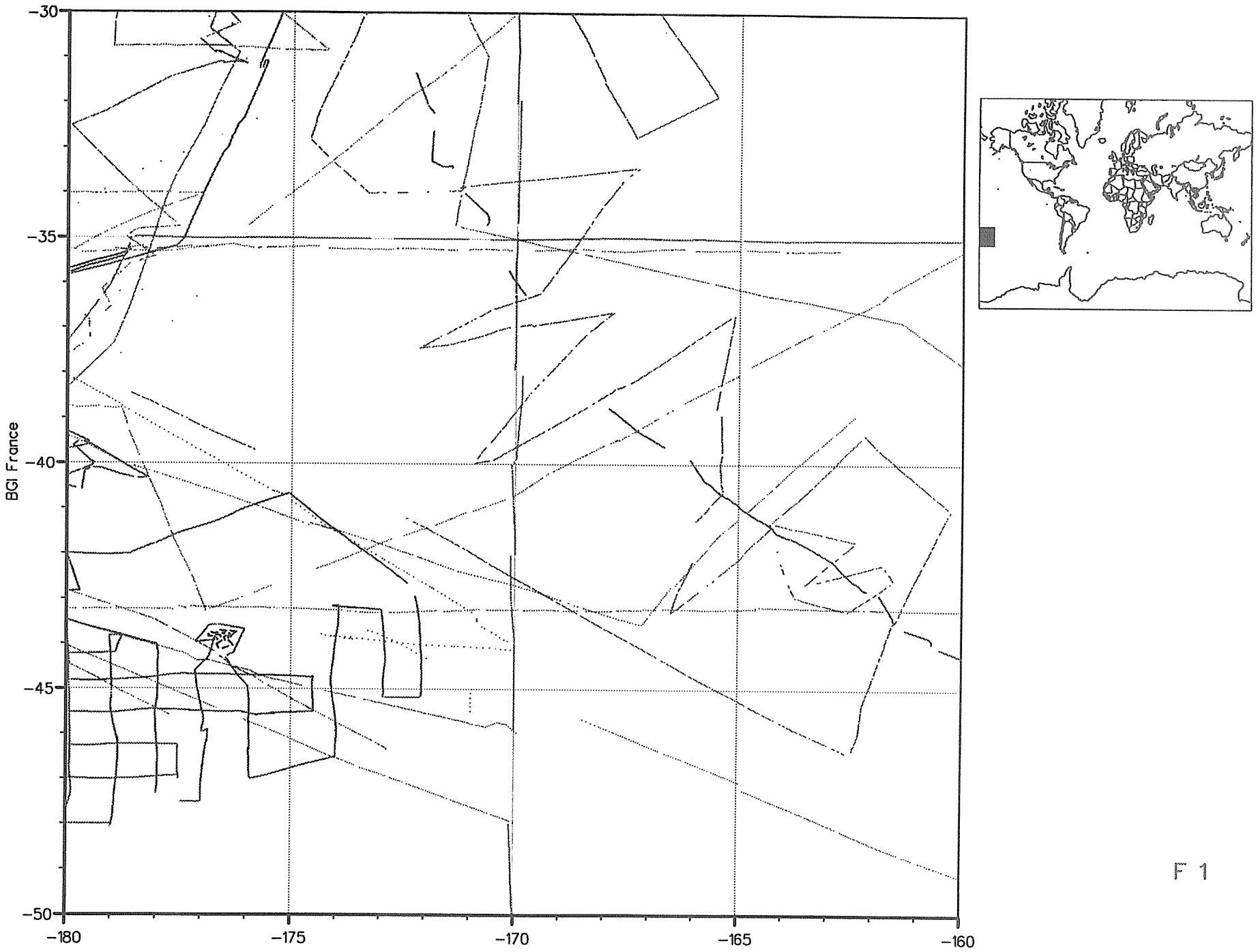
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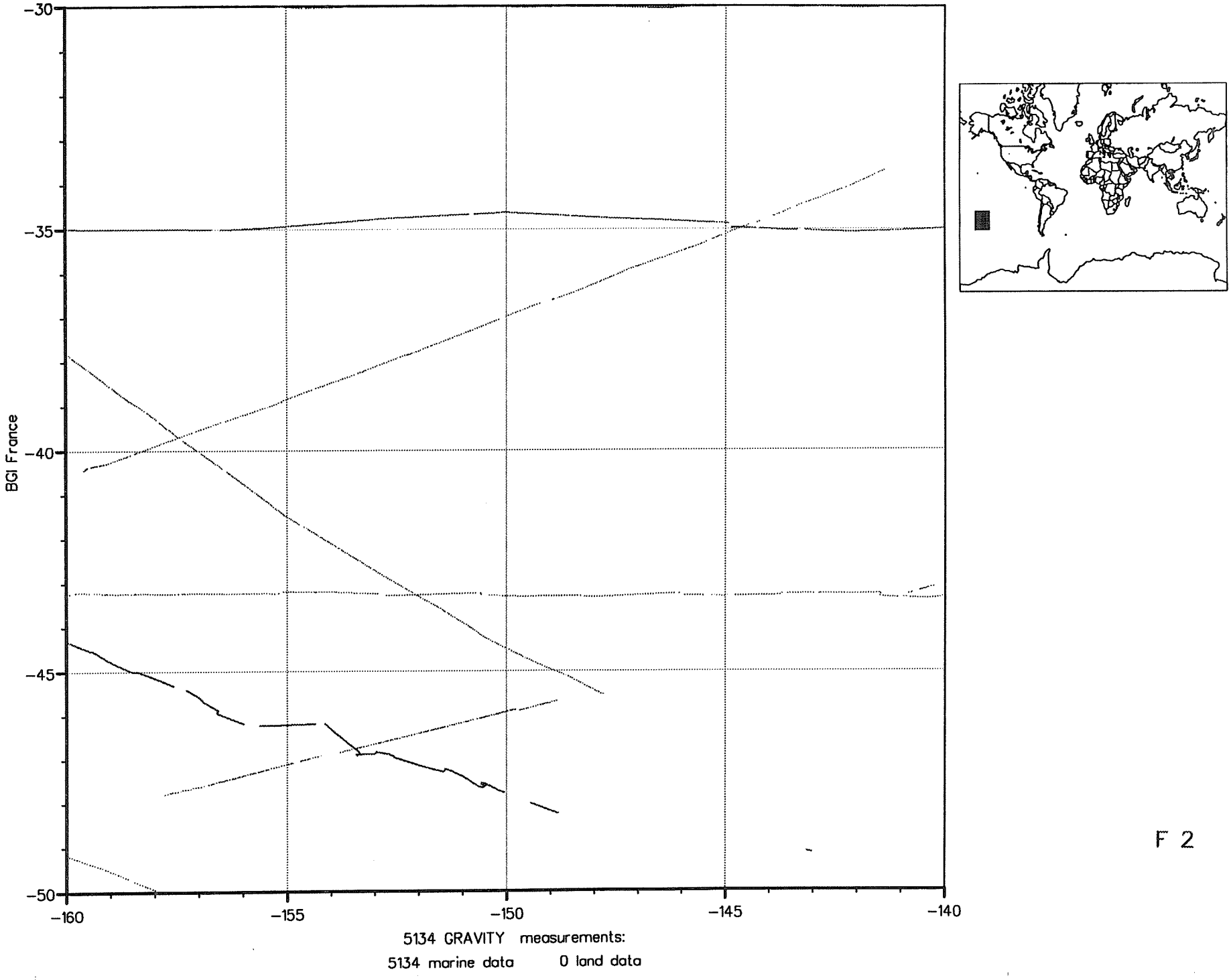
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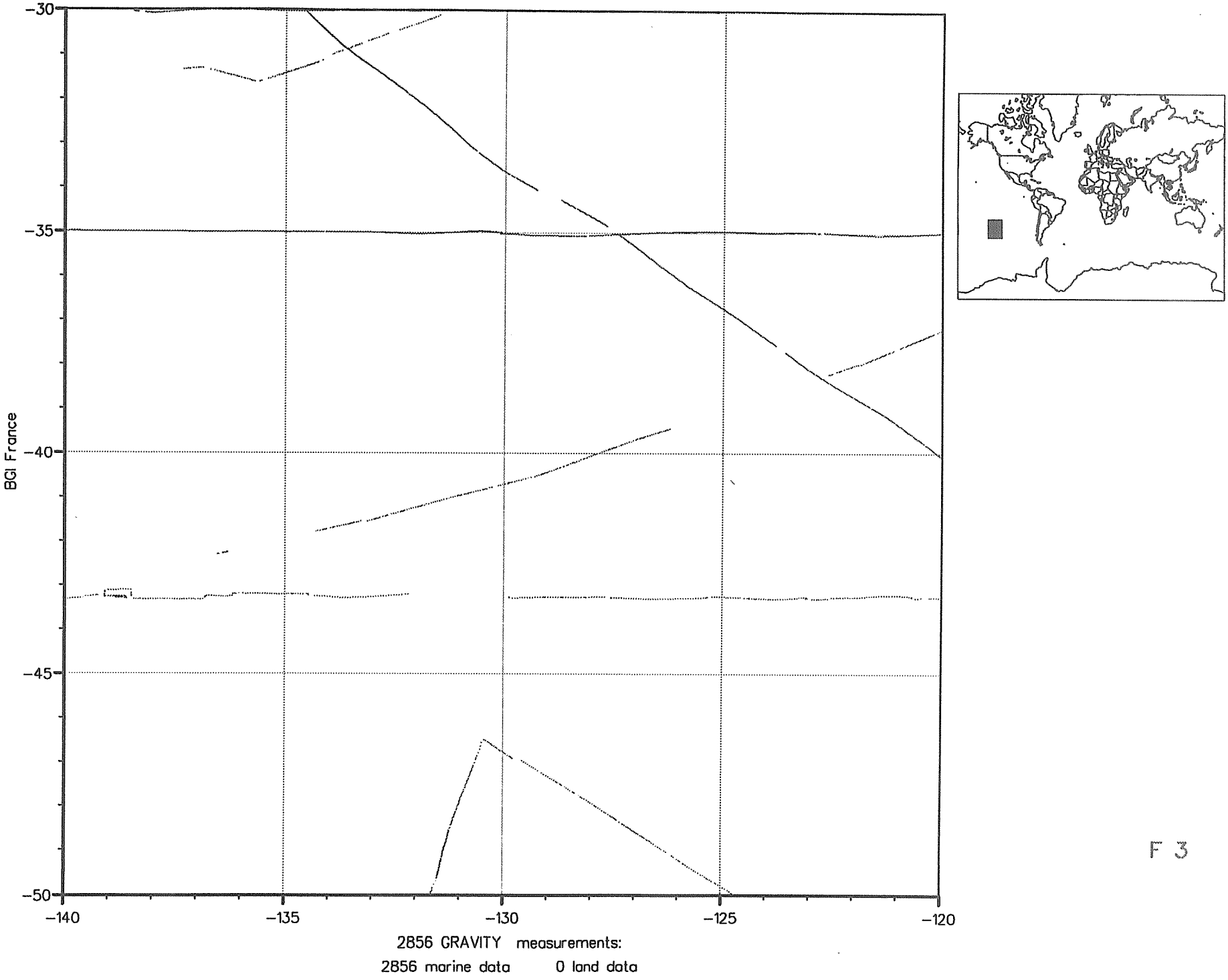
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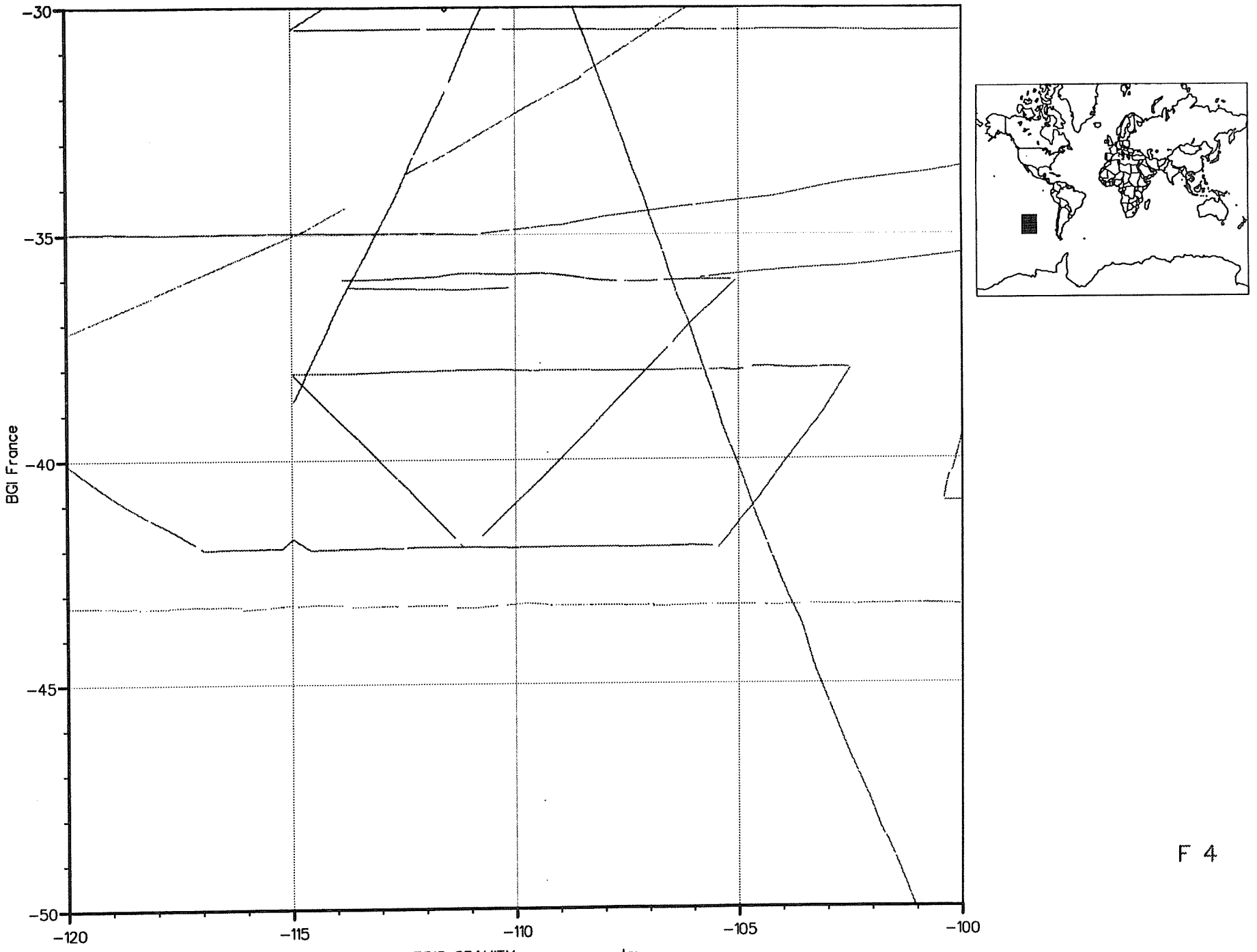
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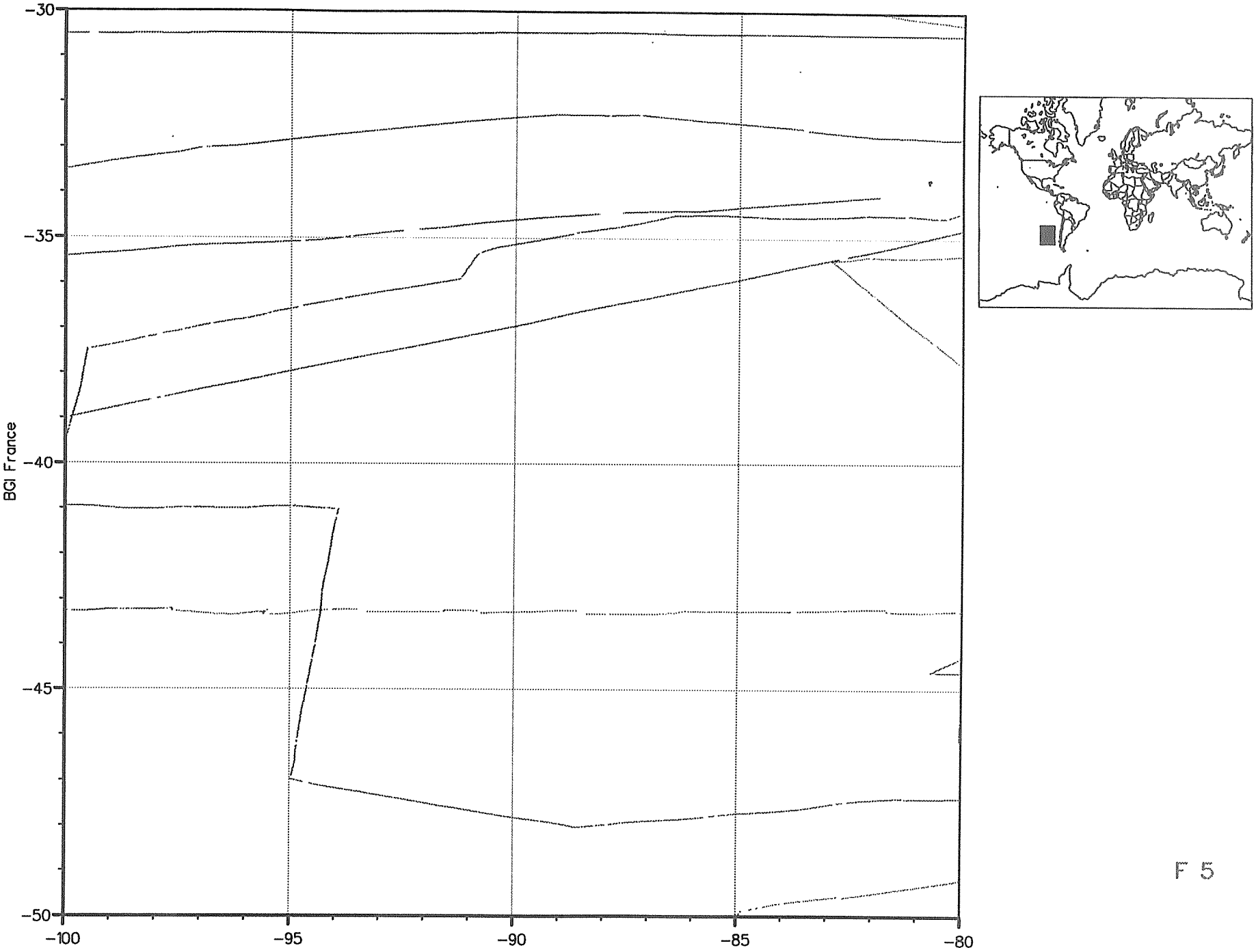
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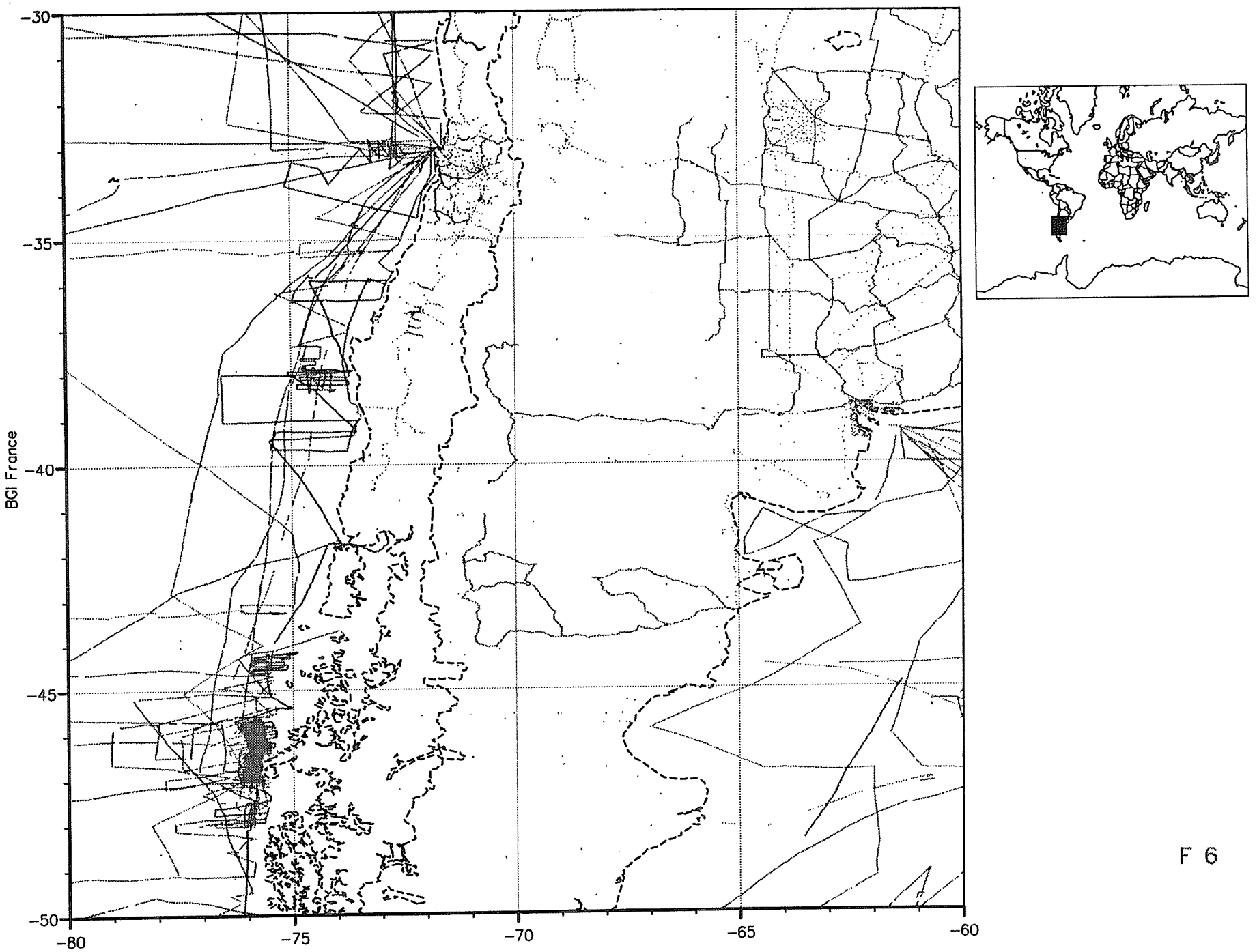
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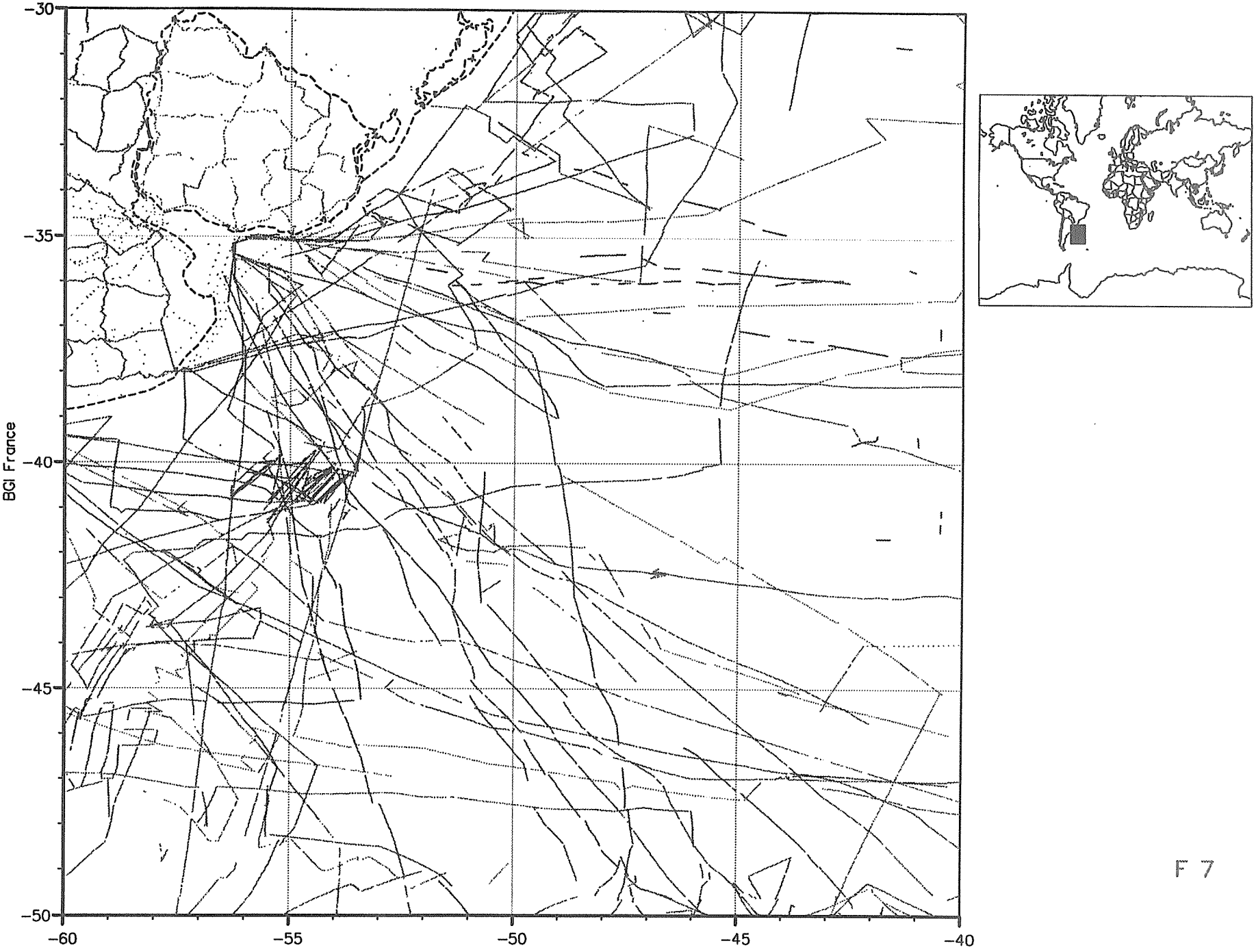
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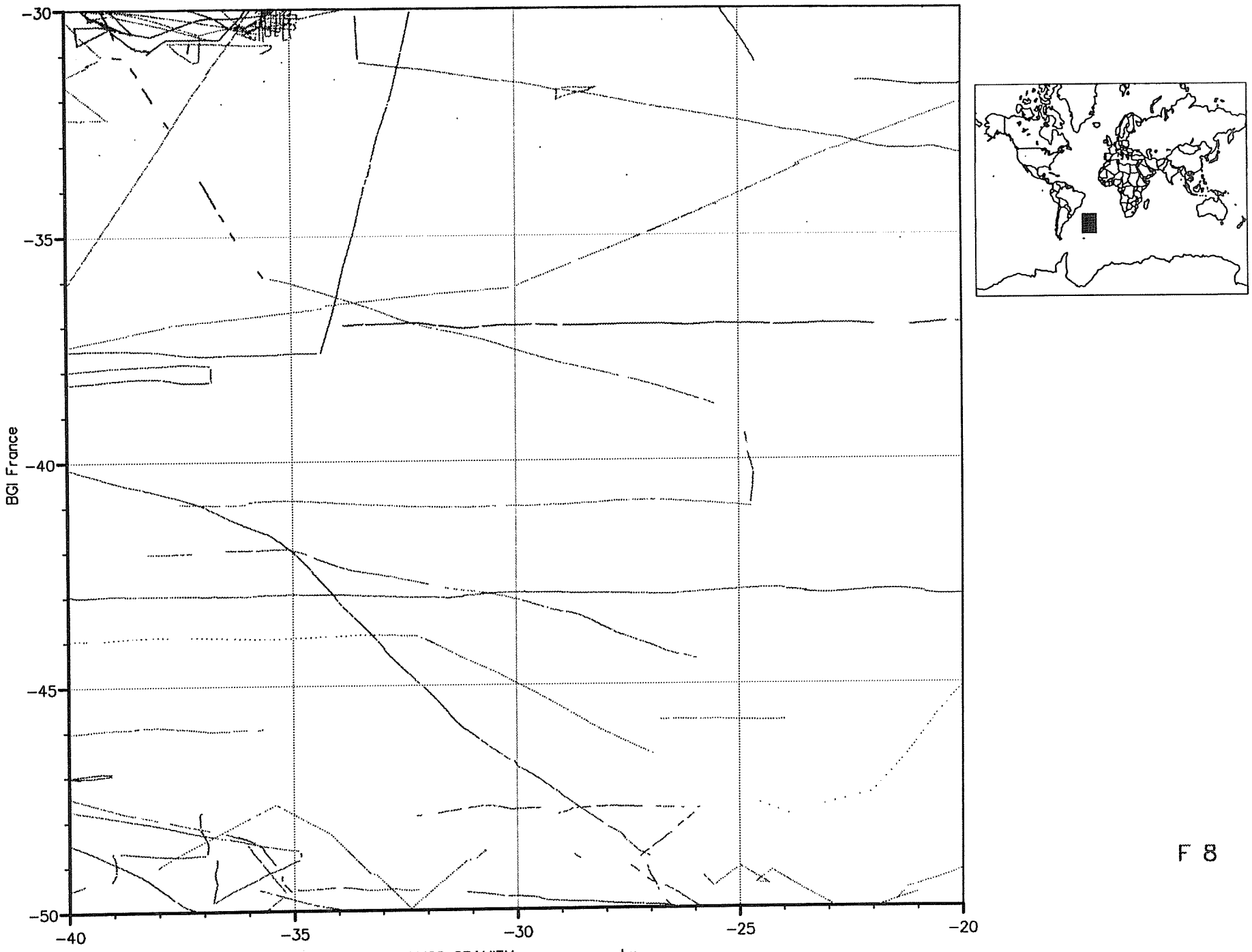
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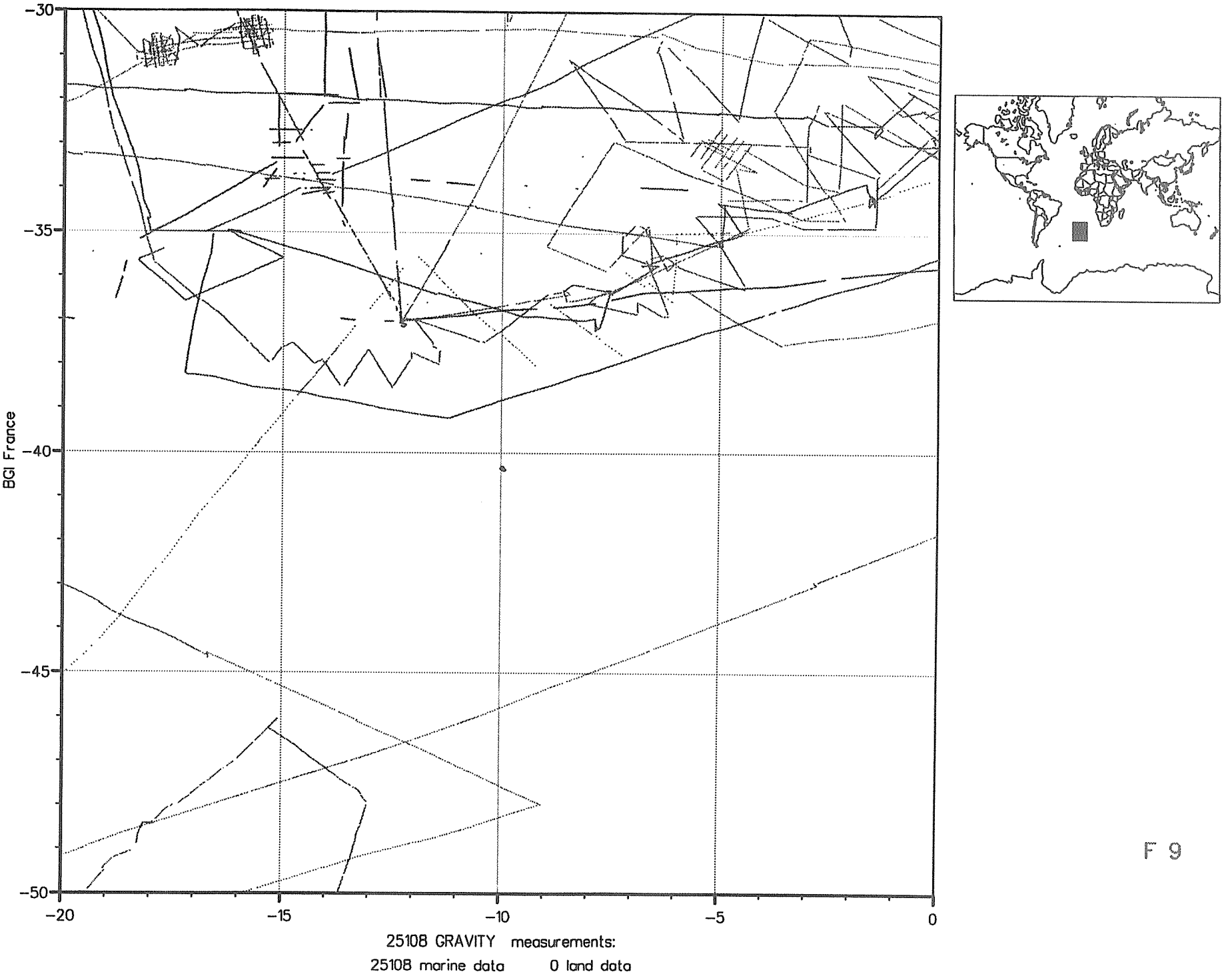
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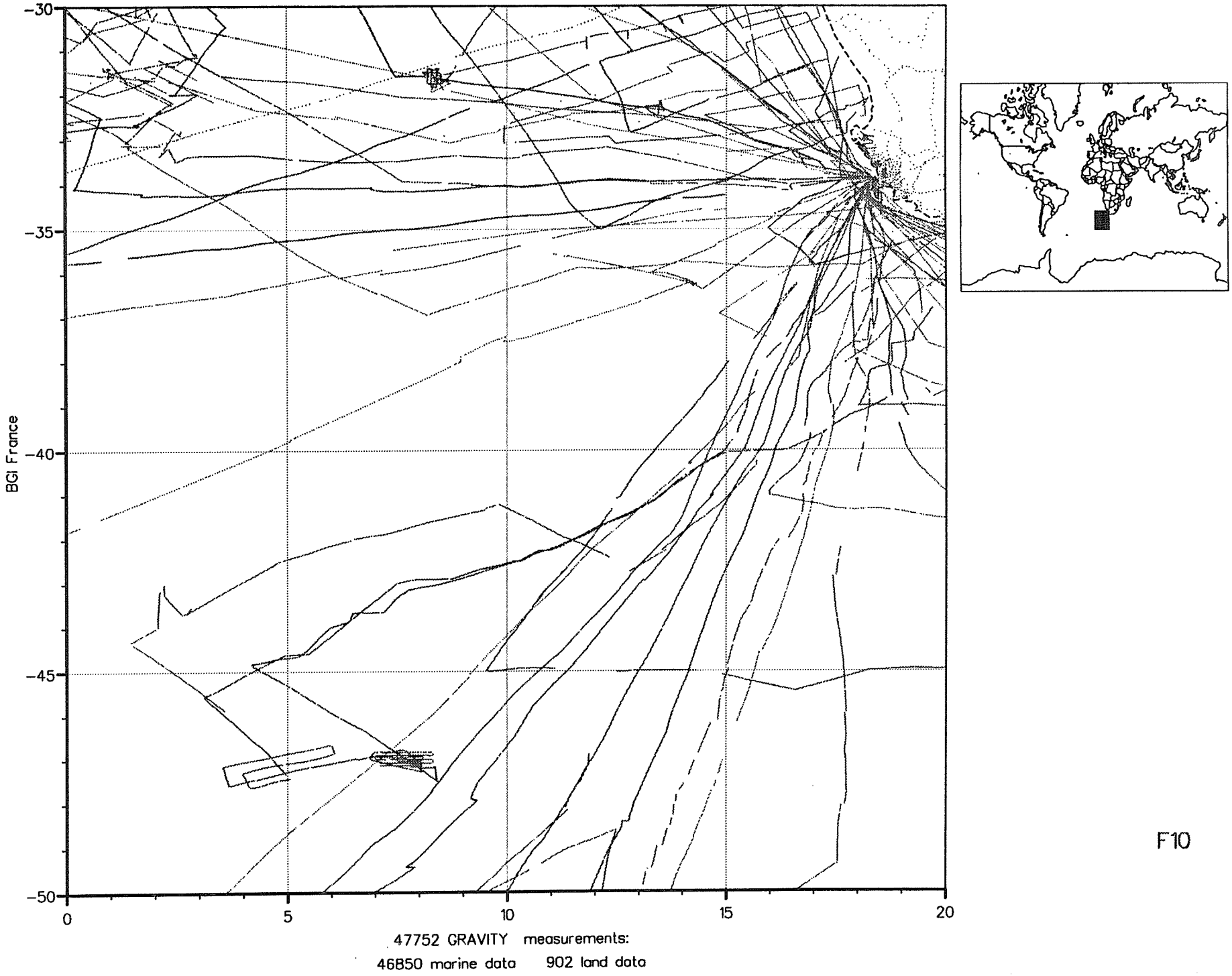
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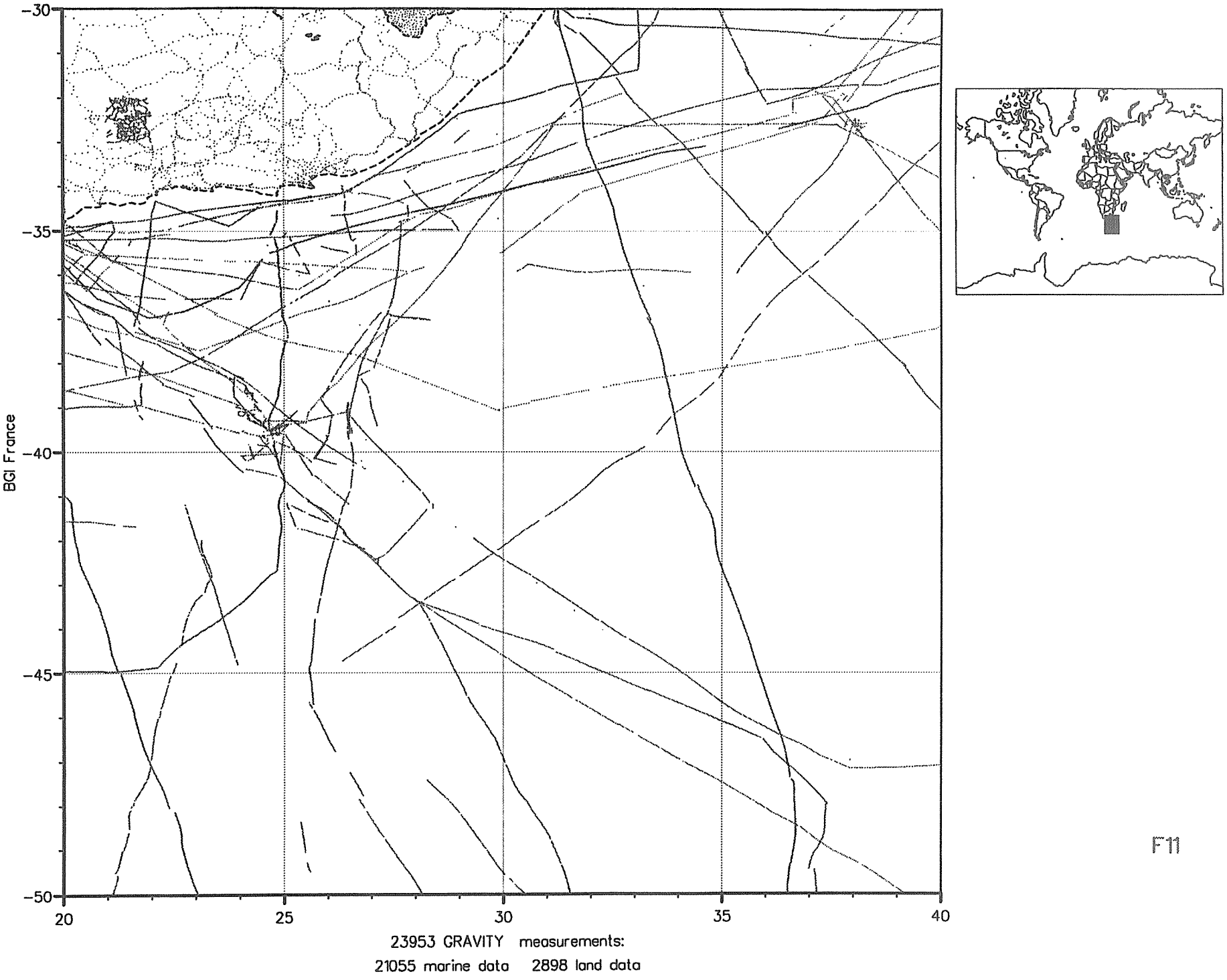
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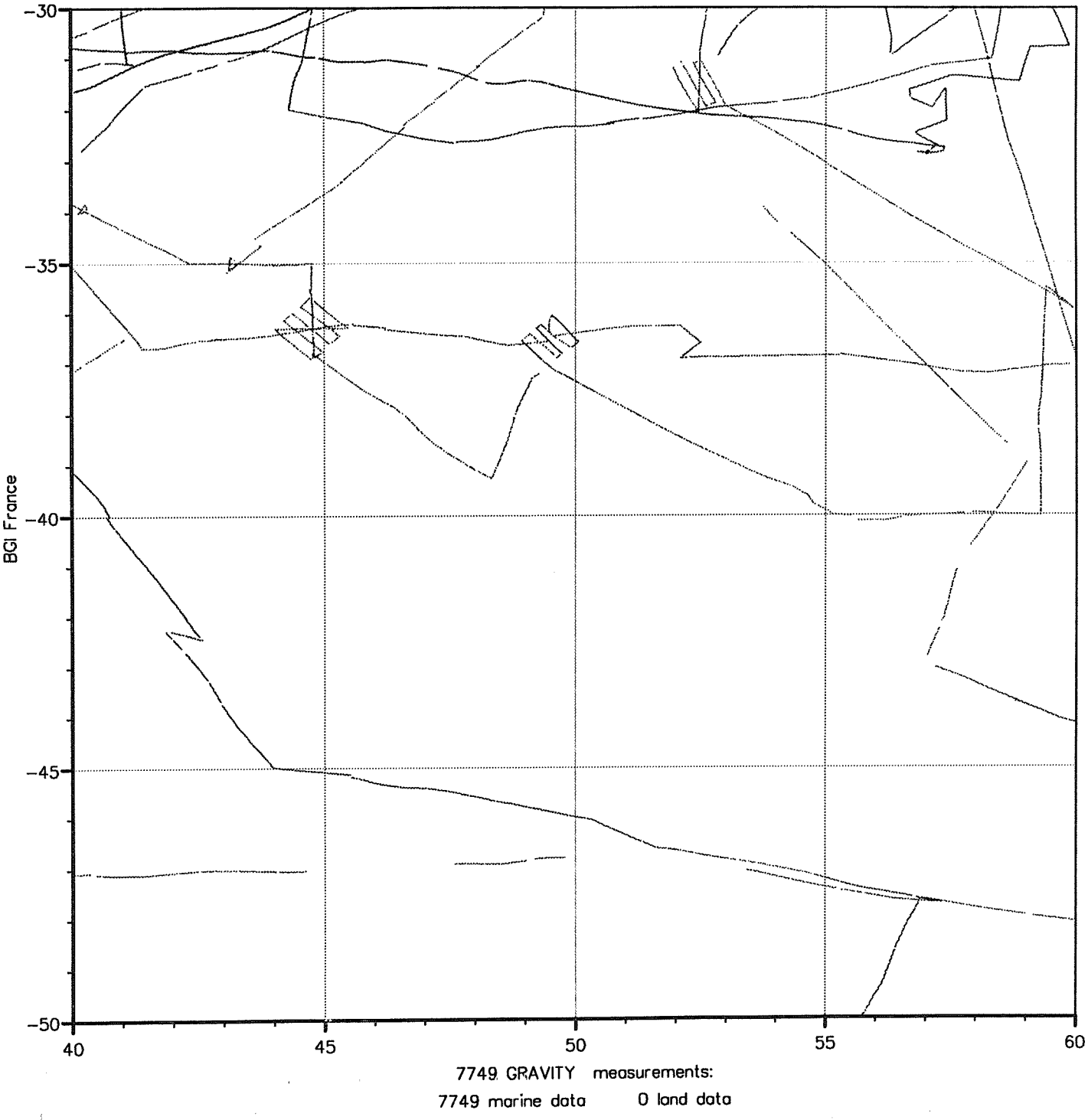
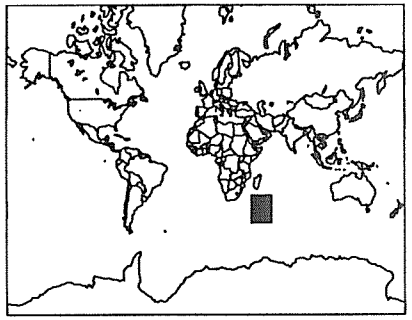
F11





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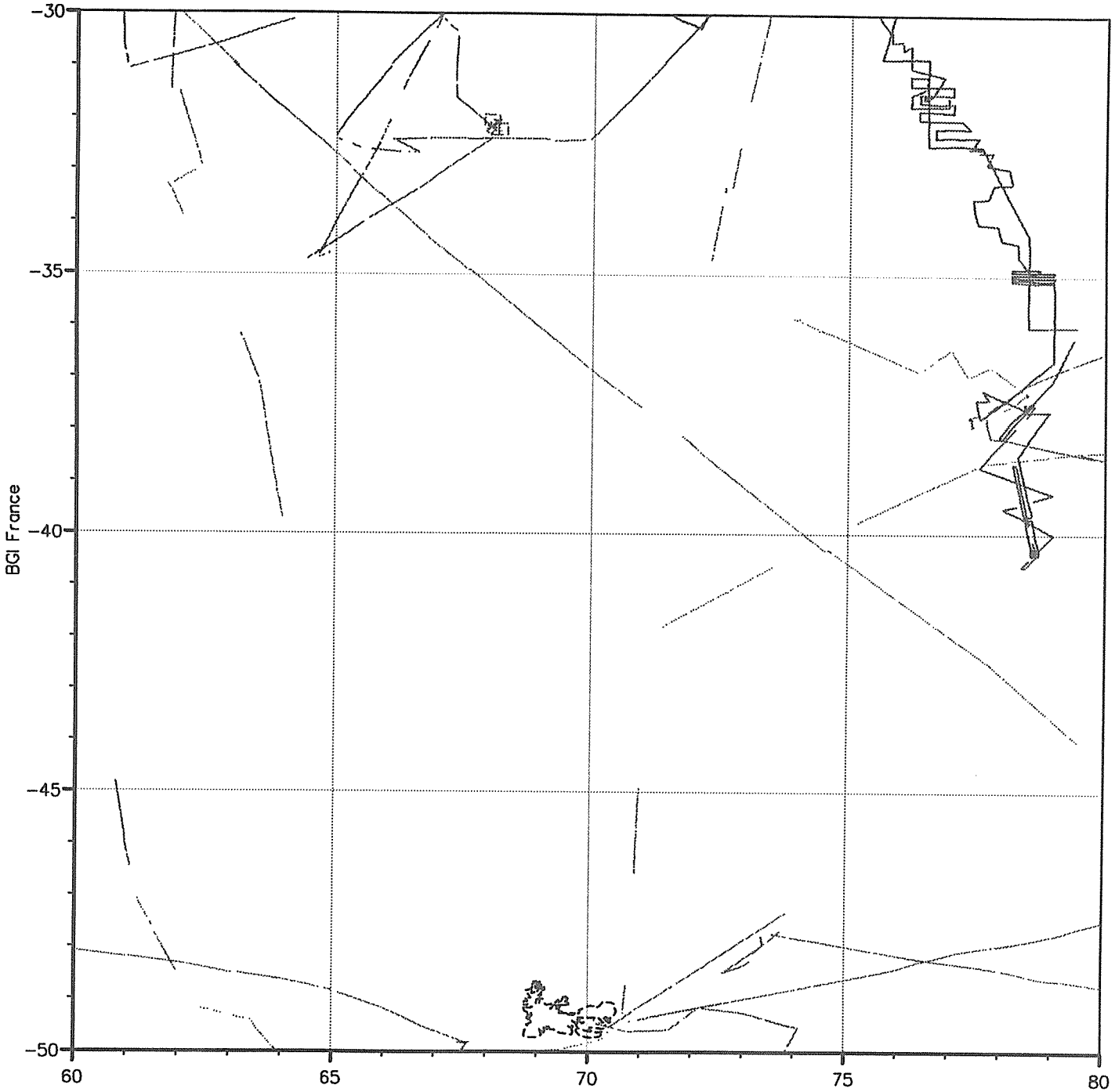
BGI France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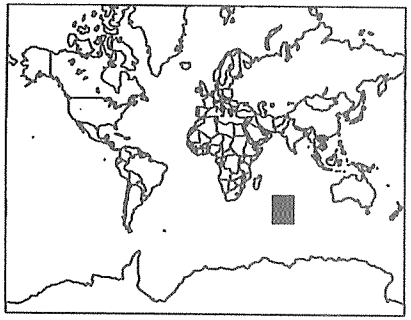

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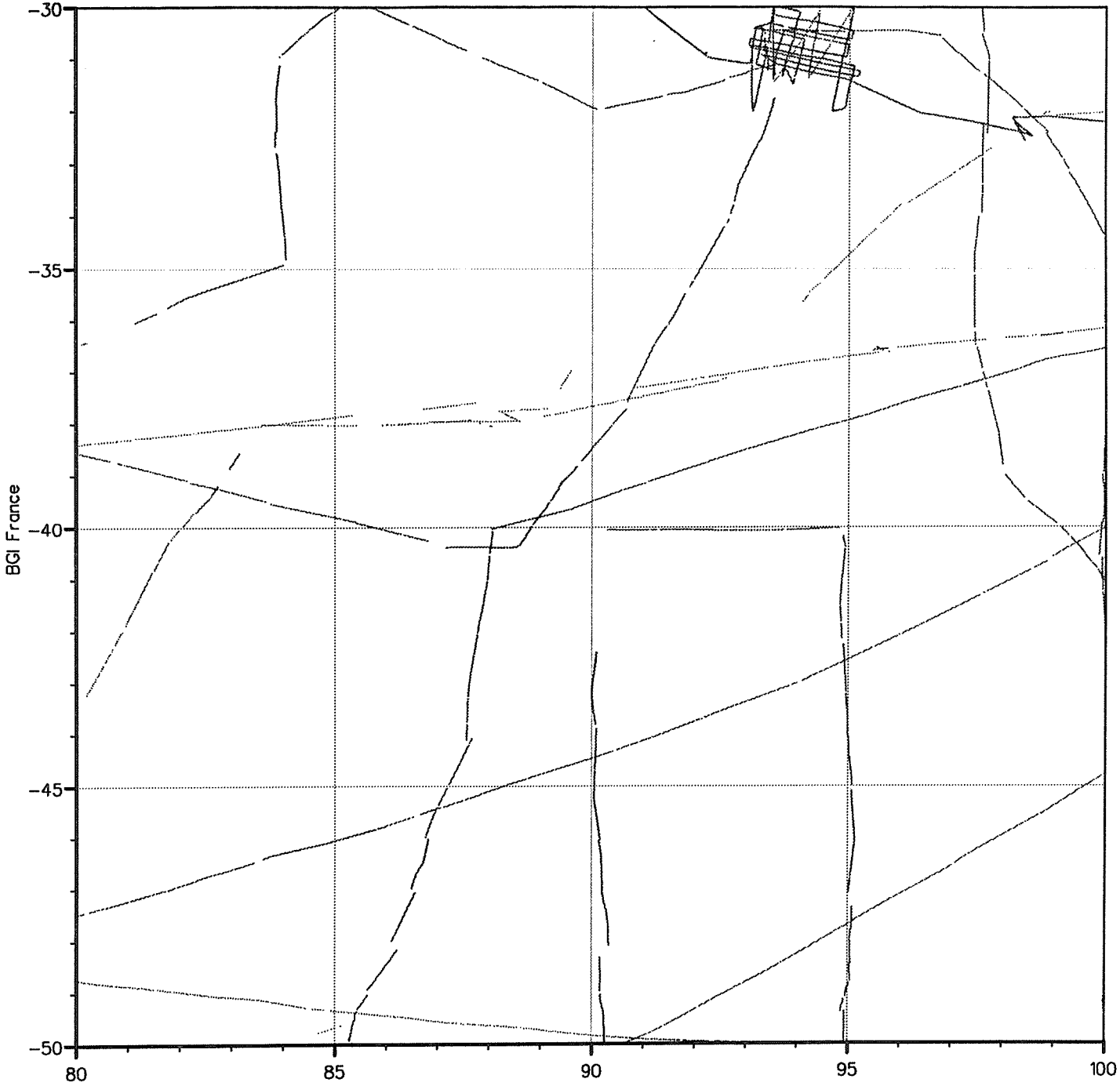
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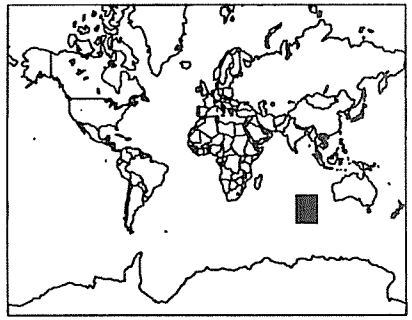

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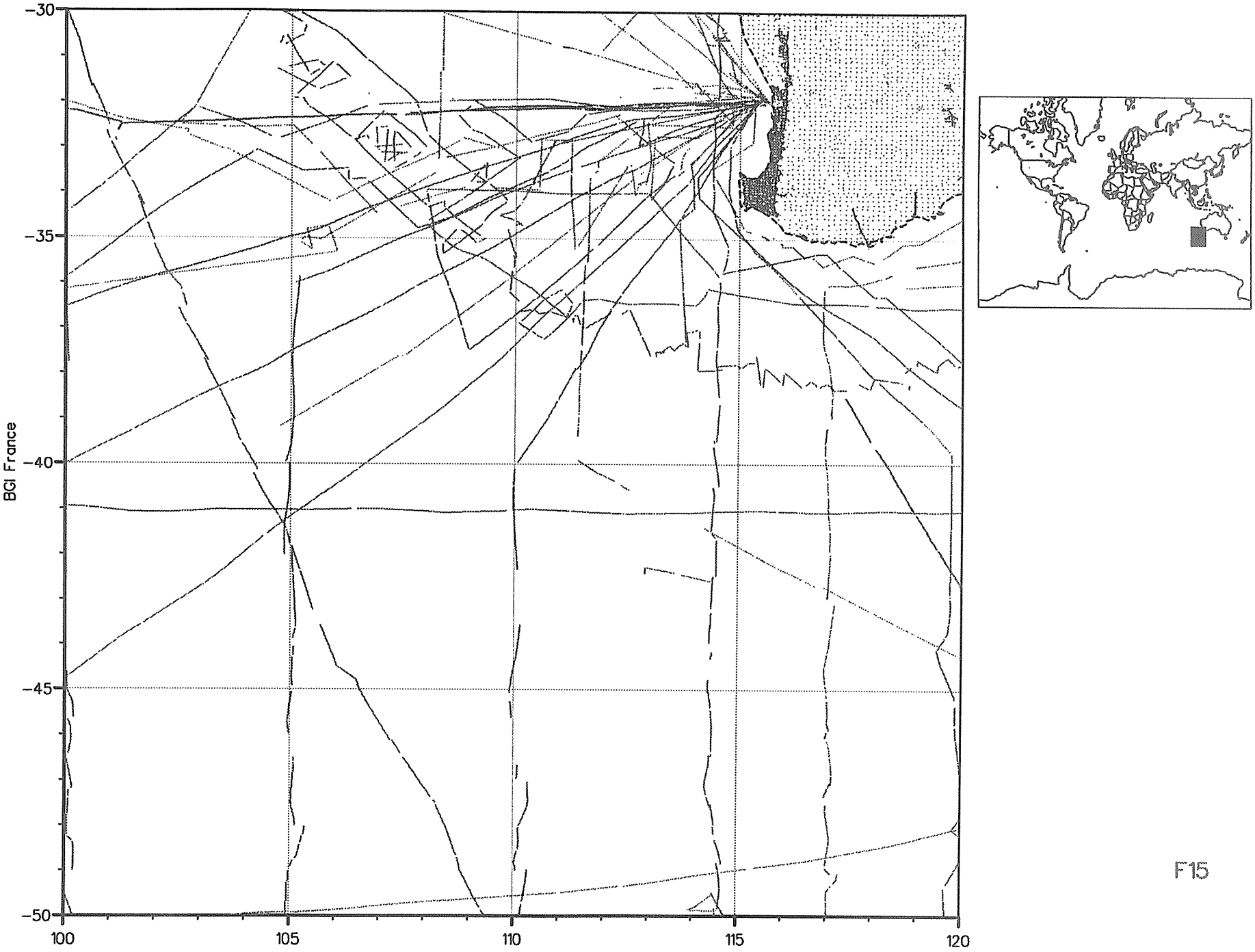
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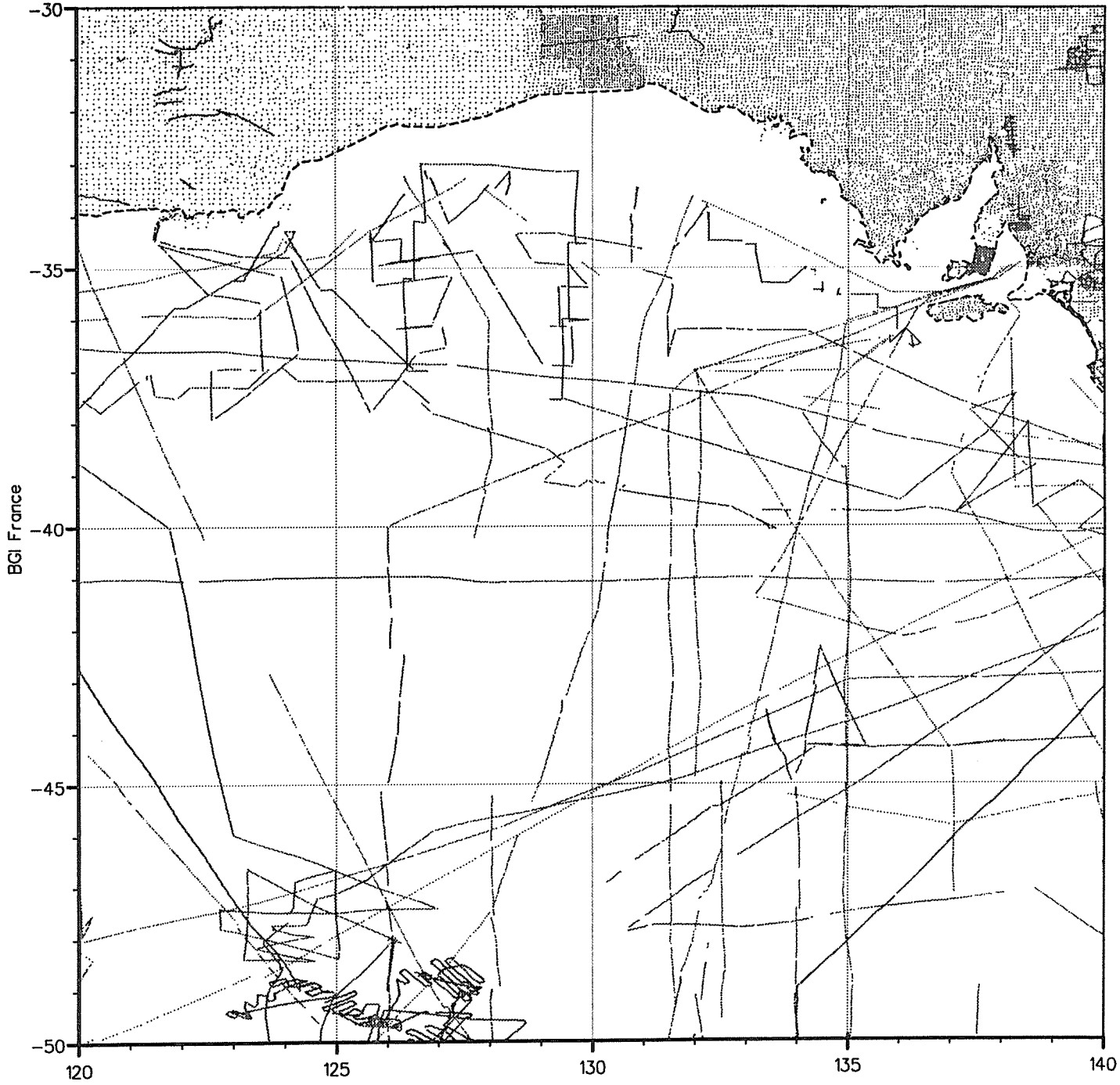
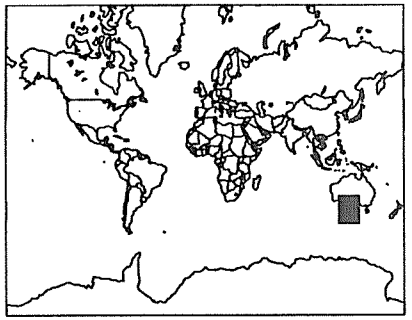
F15





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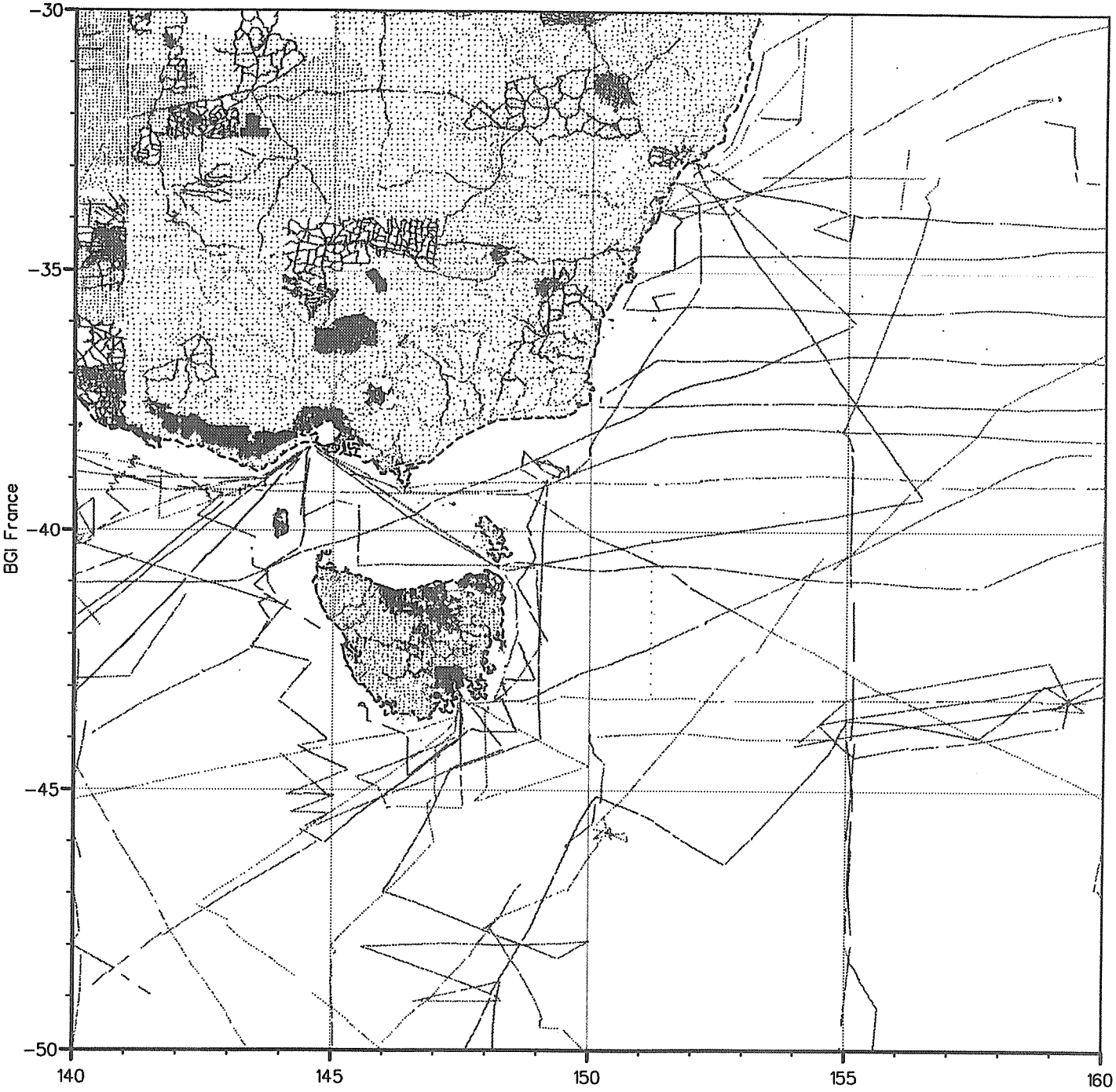

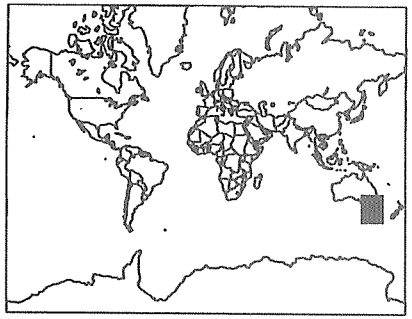

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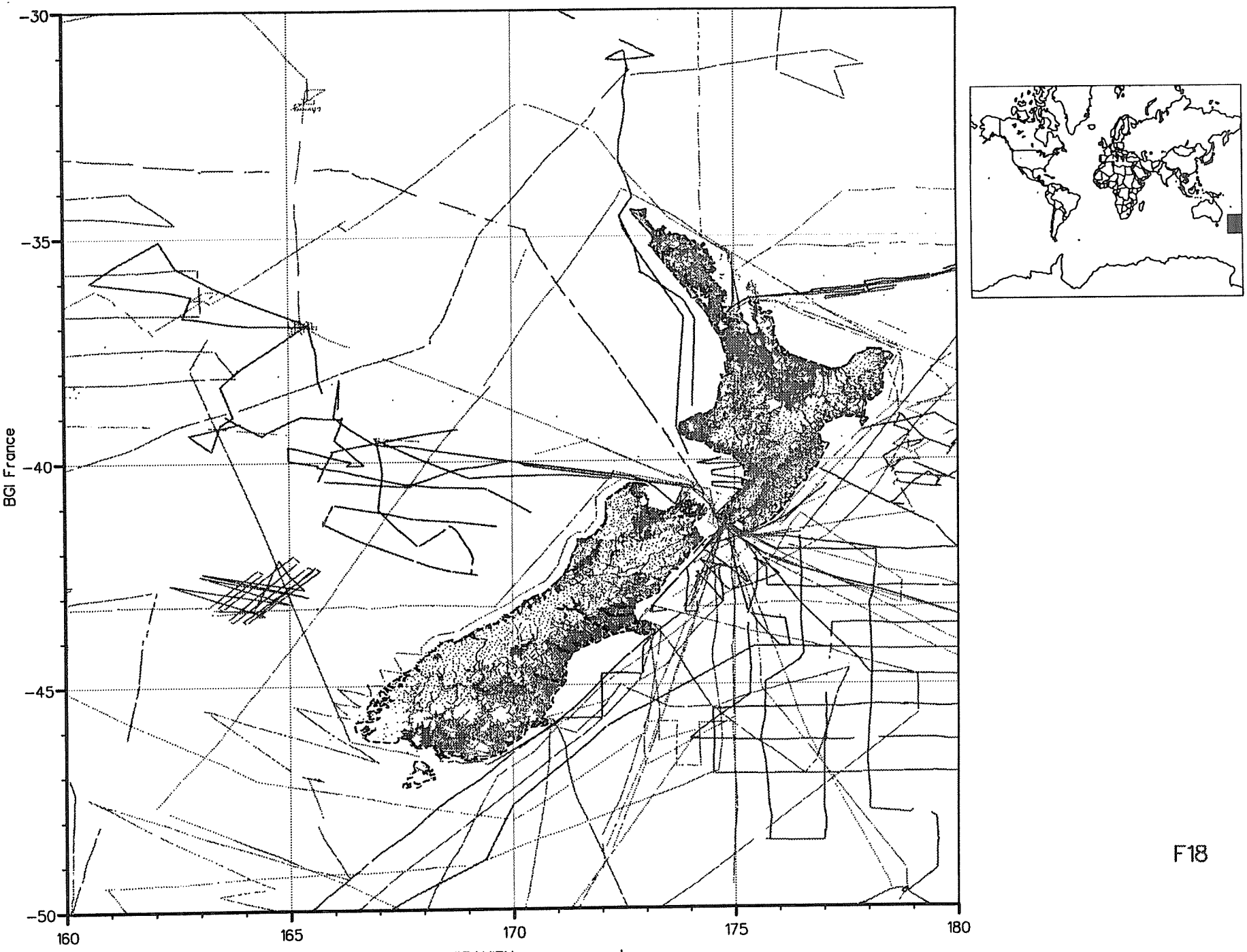
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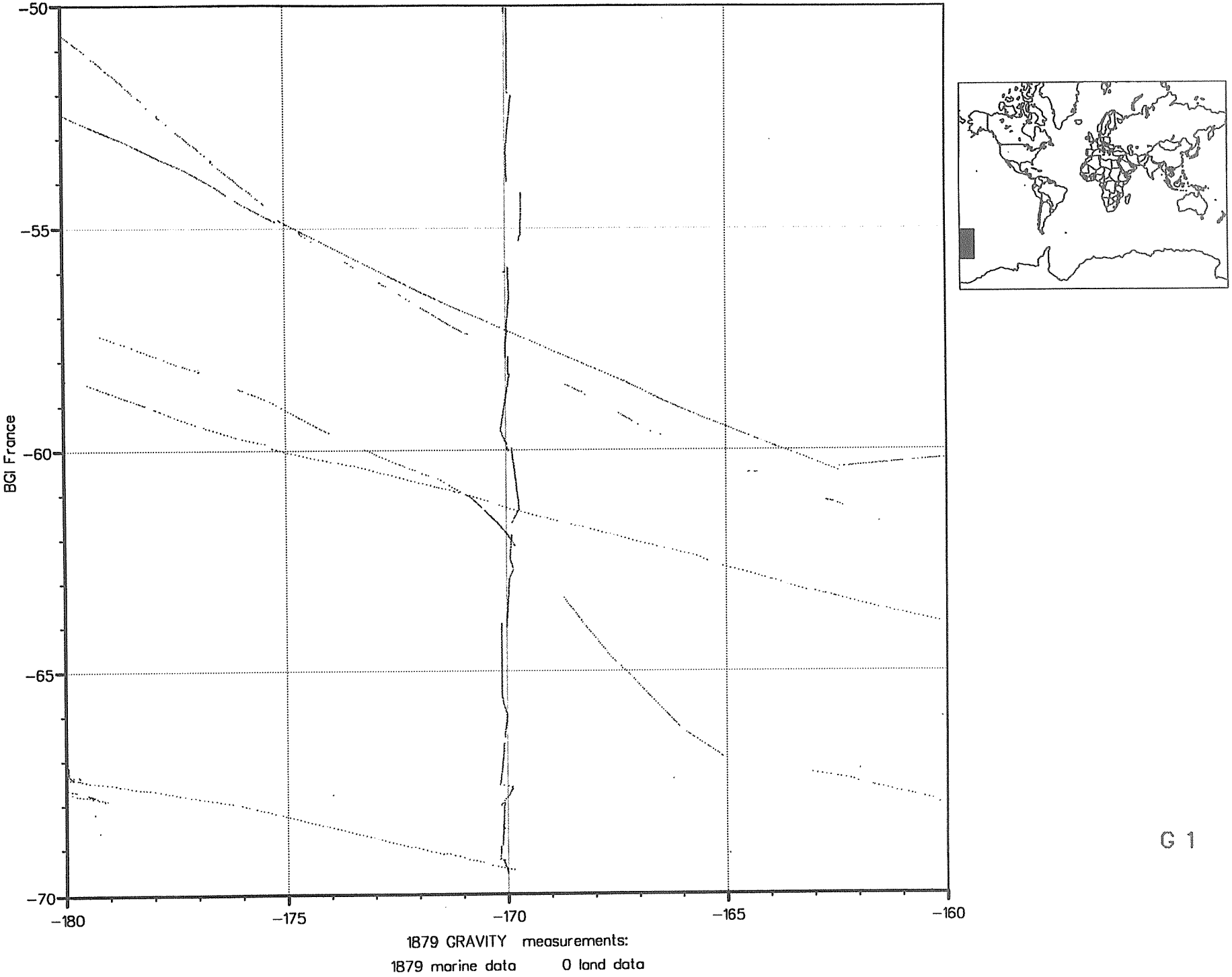
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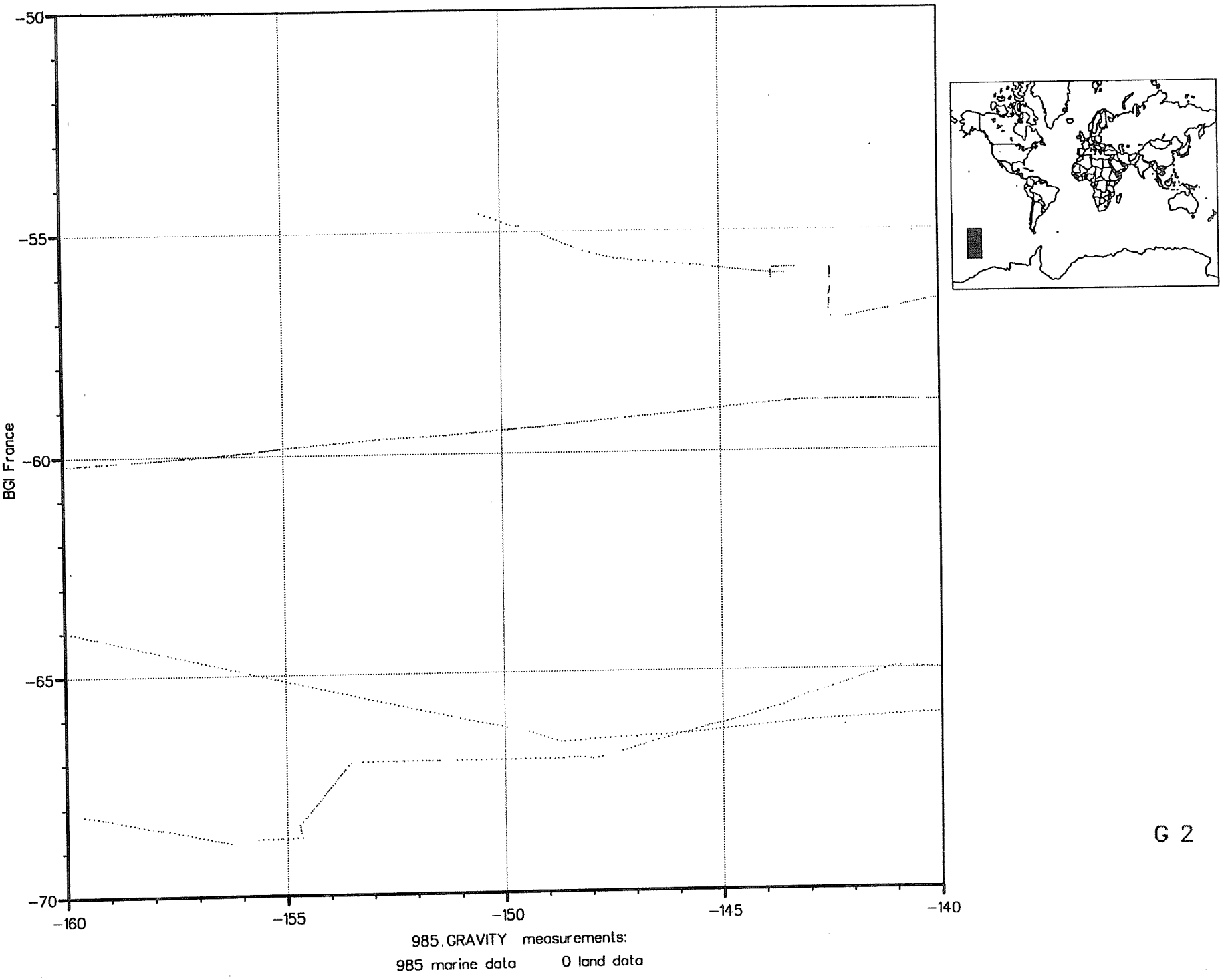
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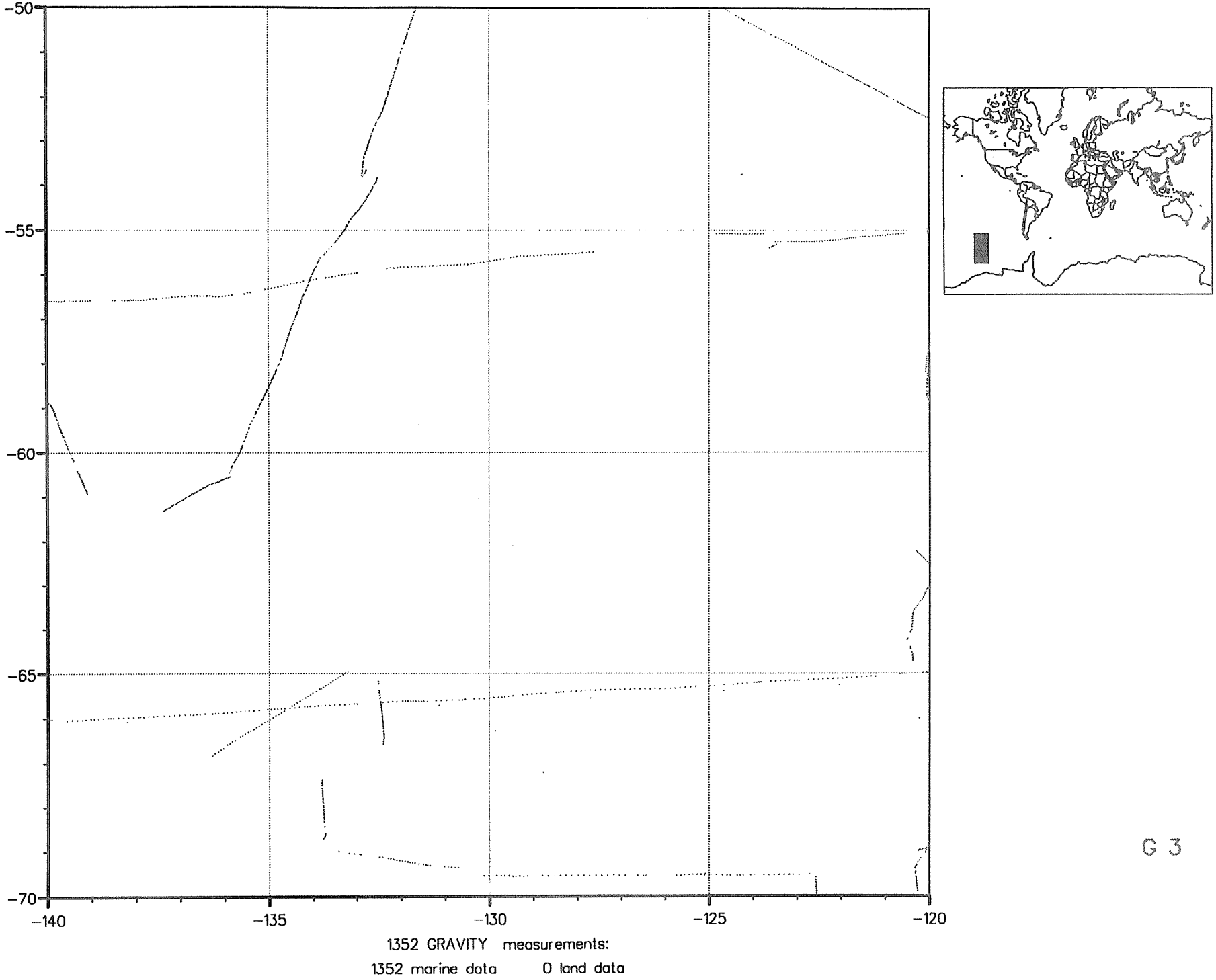
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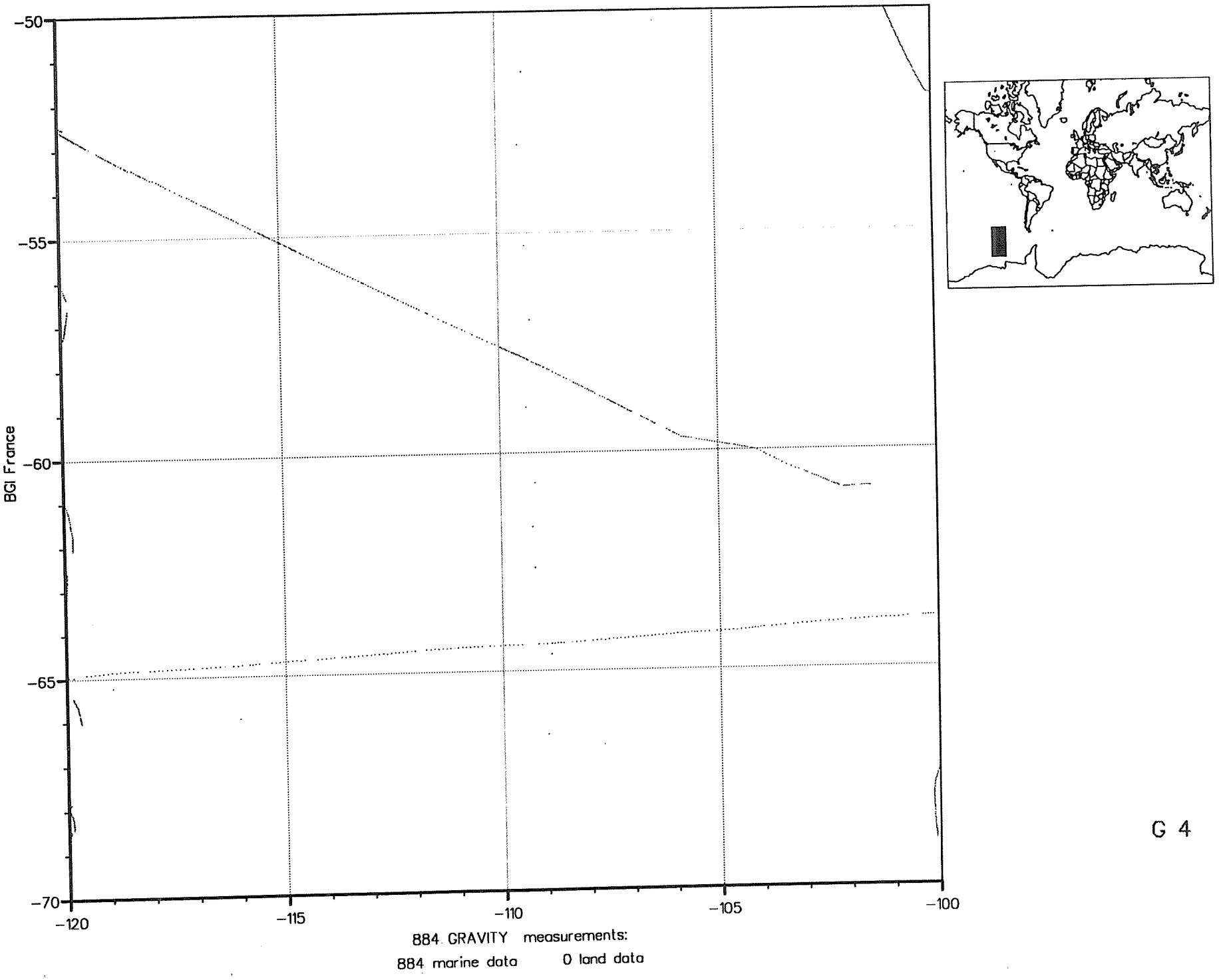
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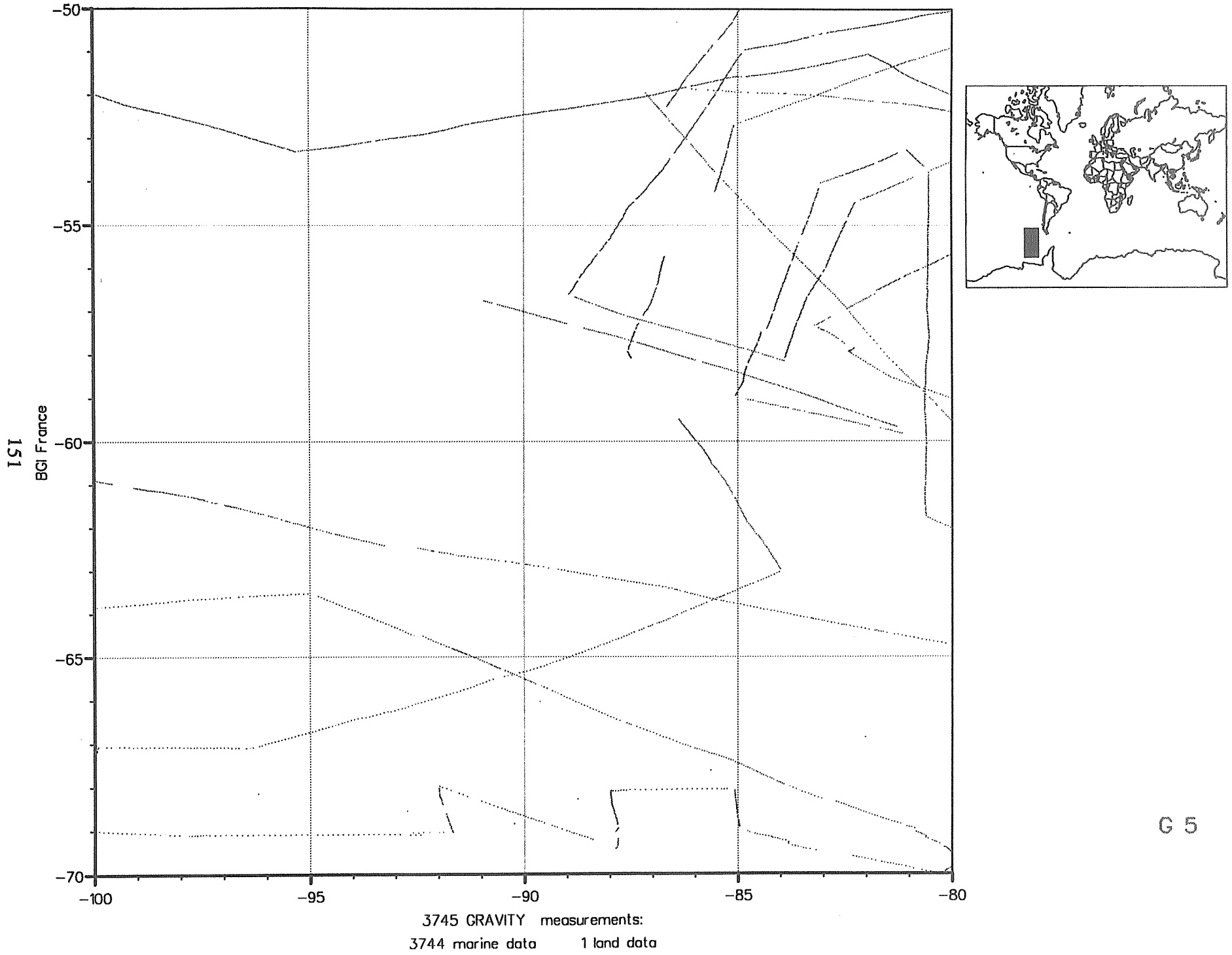
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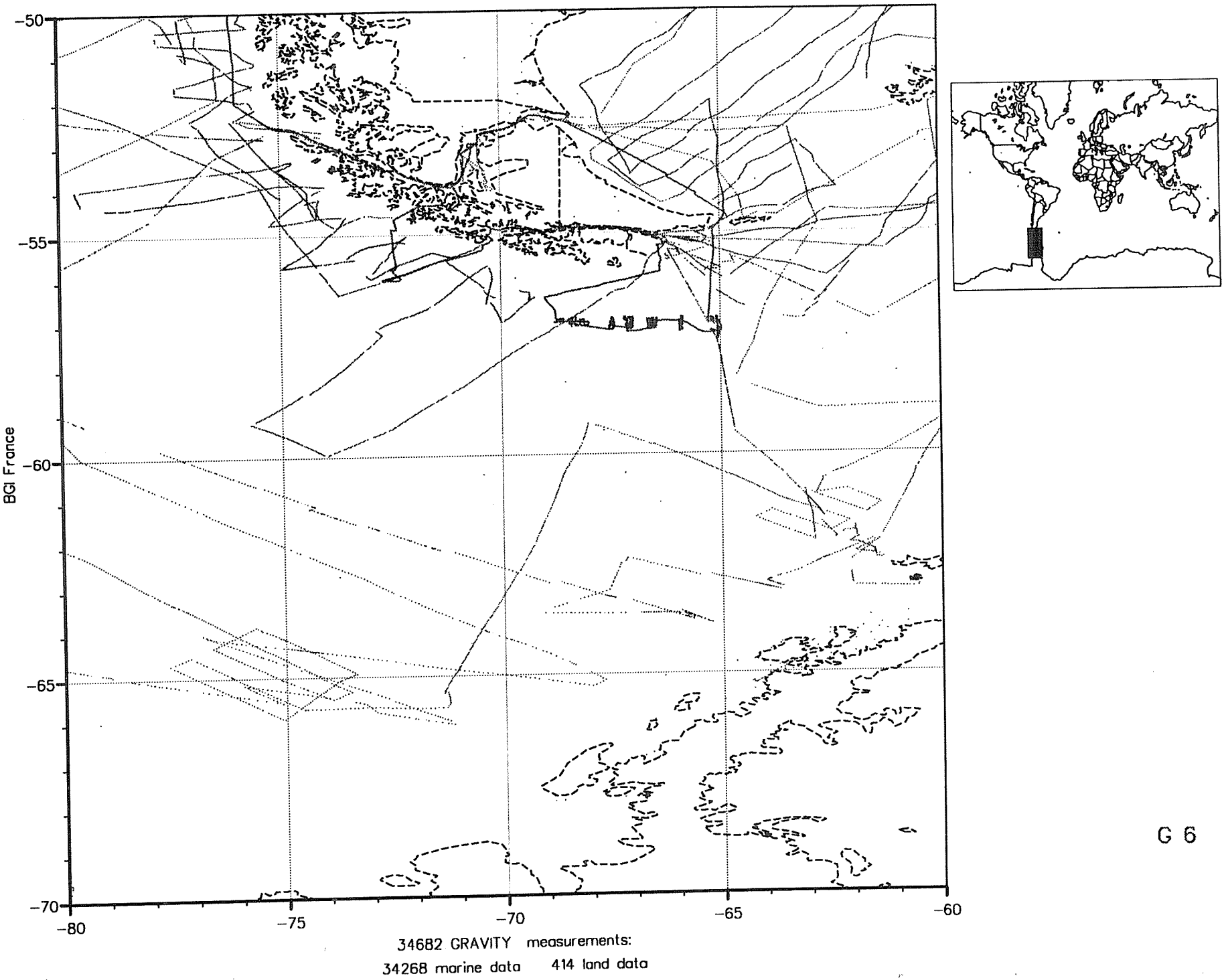
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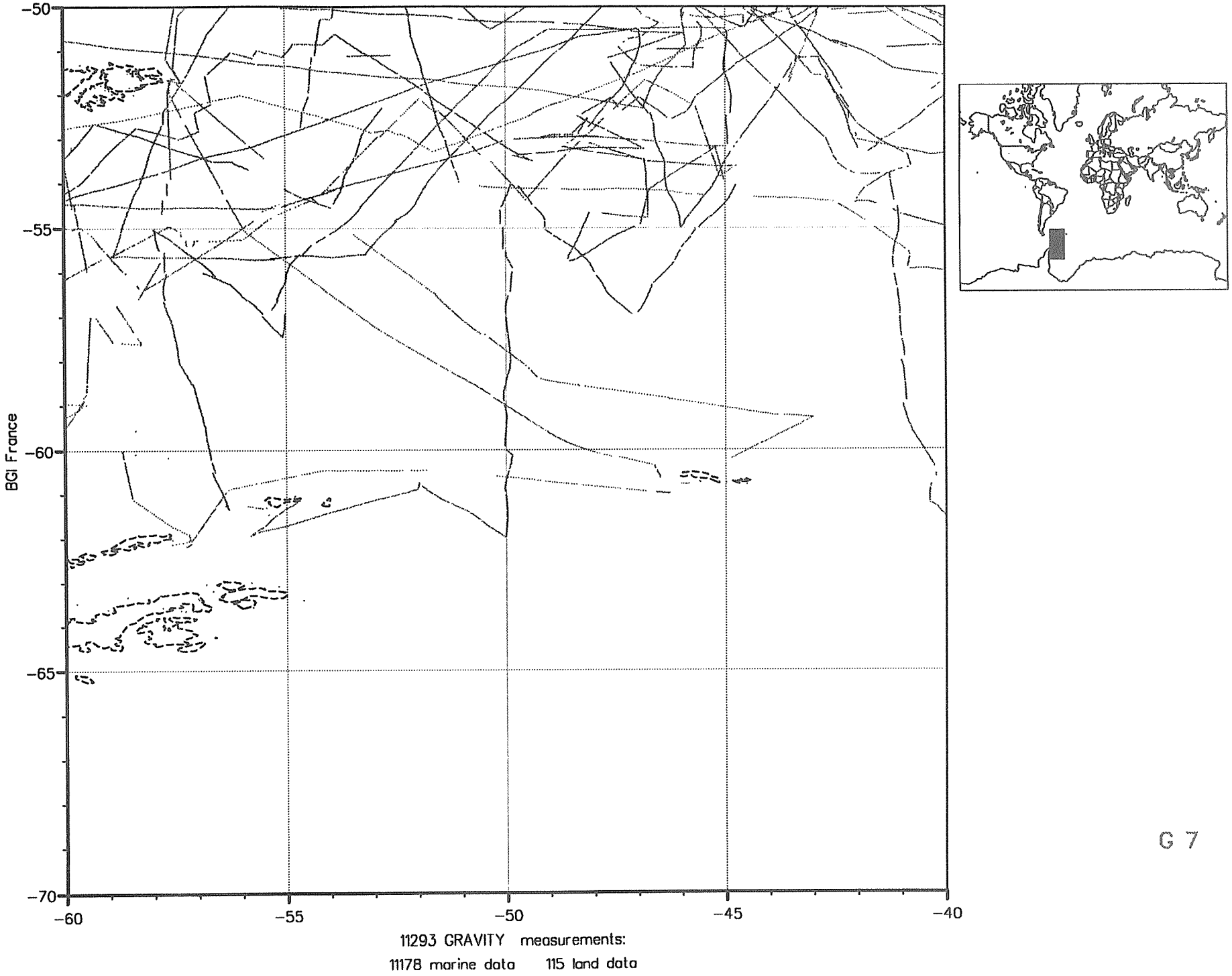
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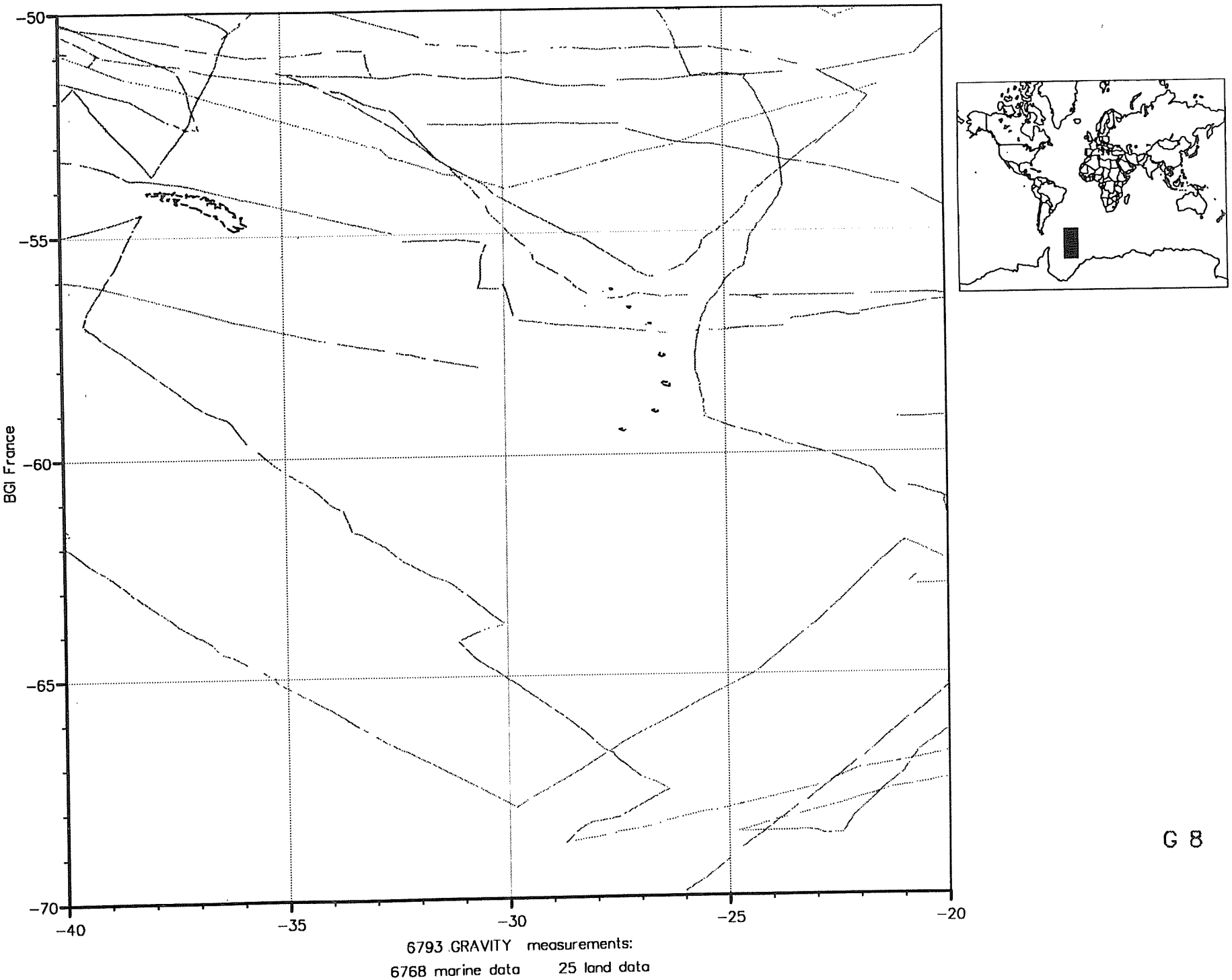
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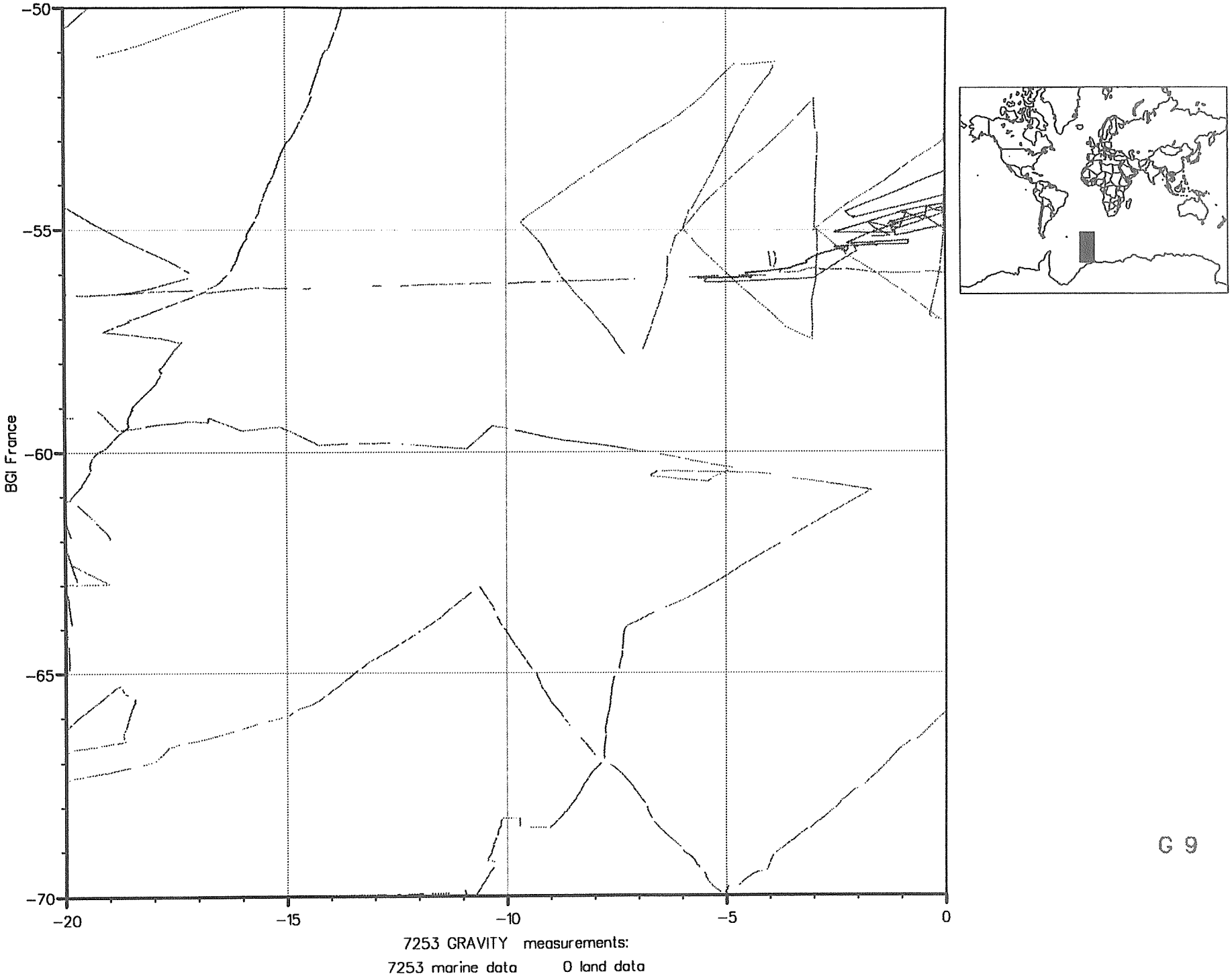
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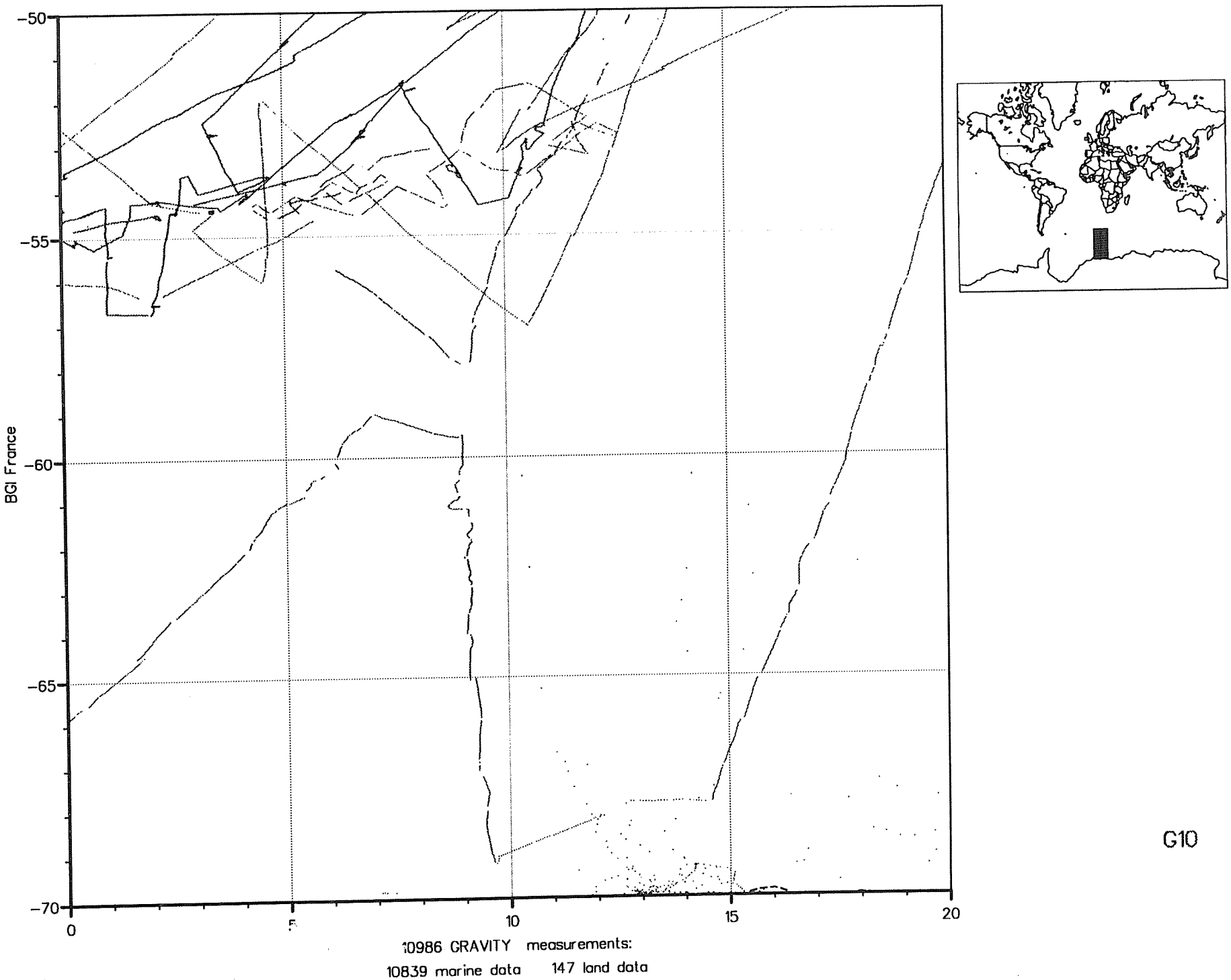
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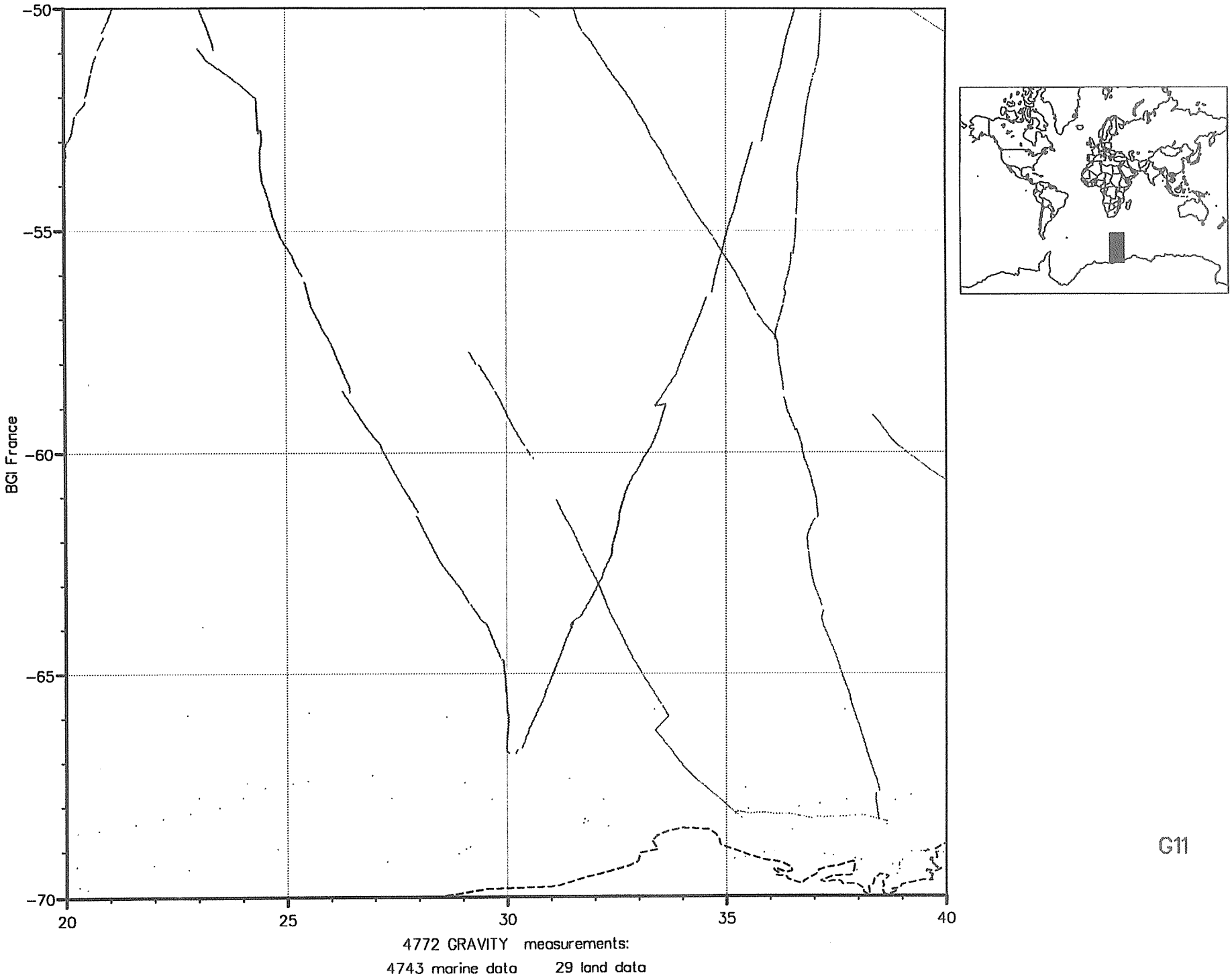
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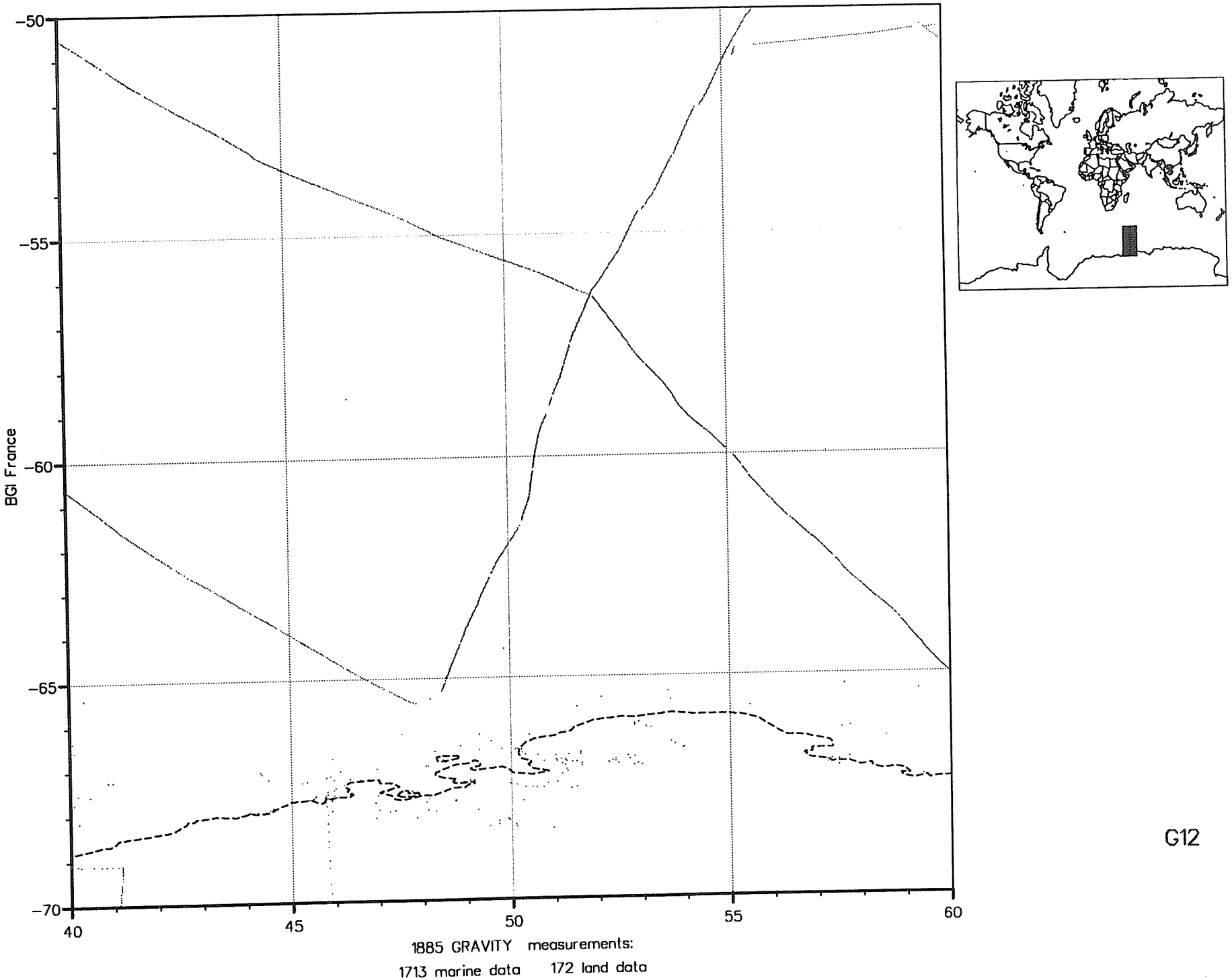
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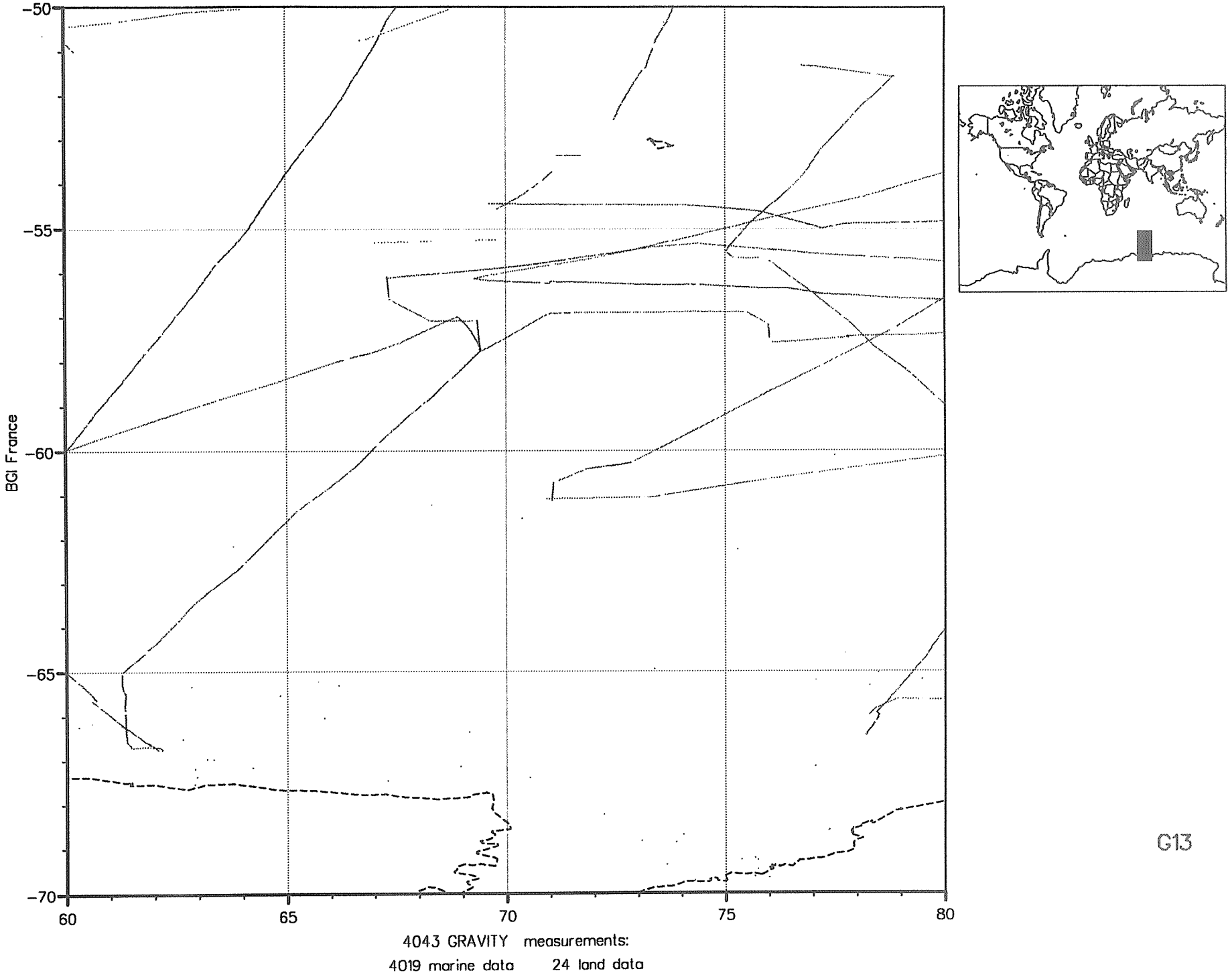
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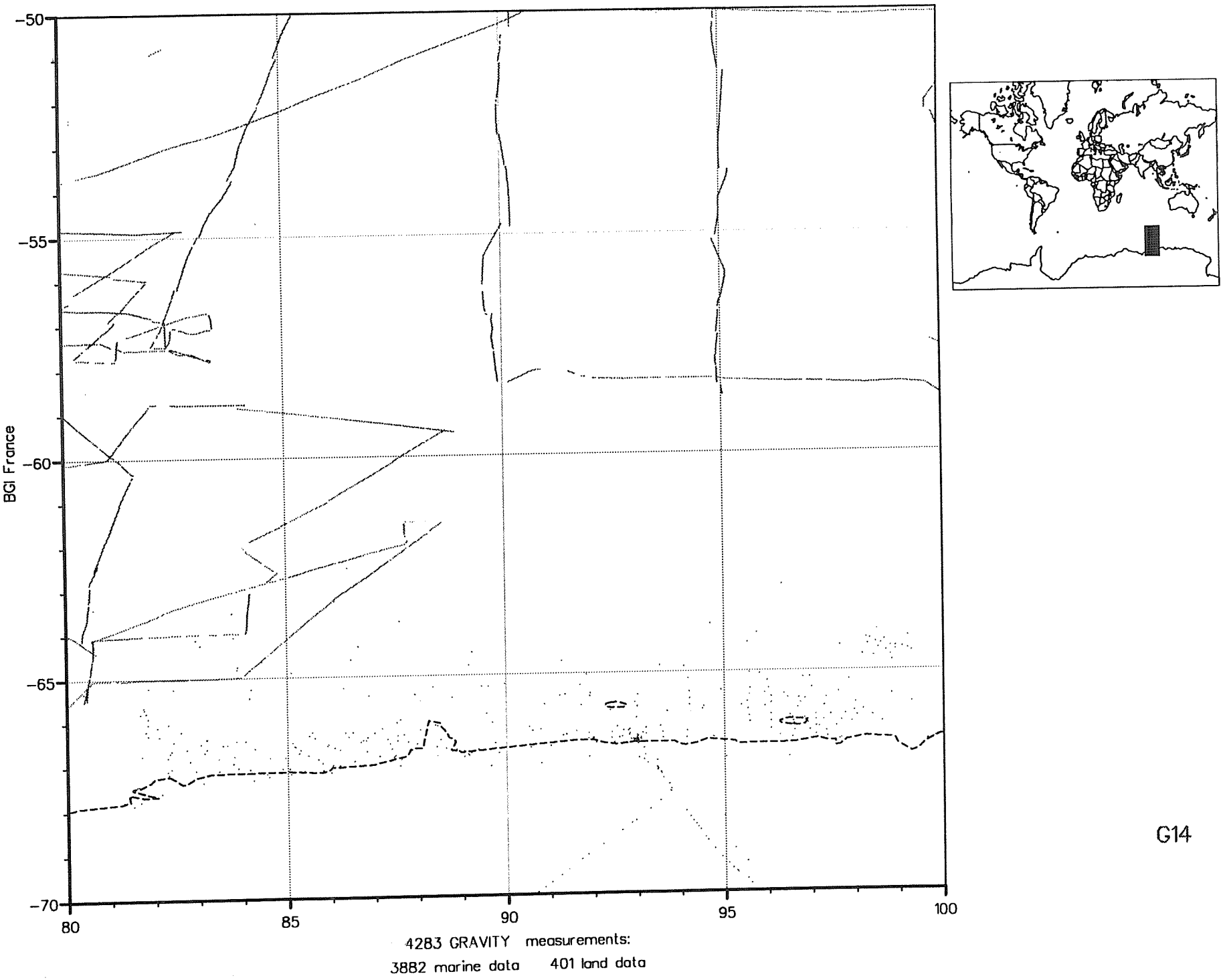
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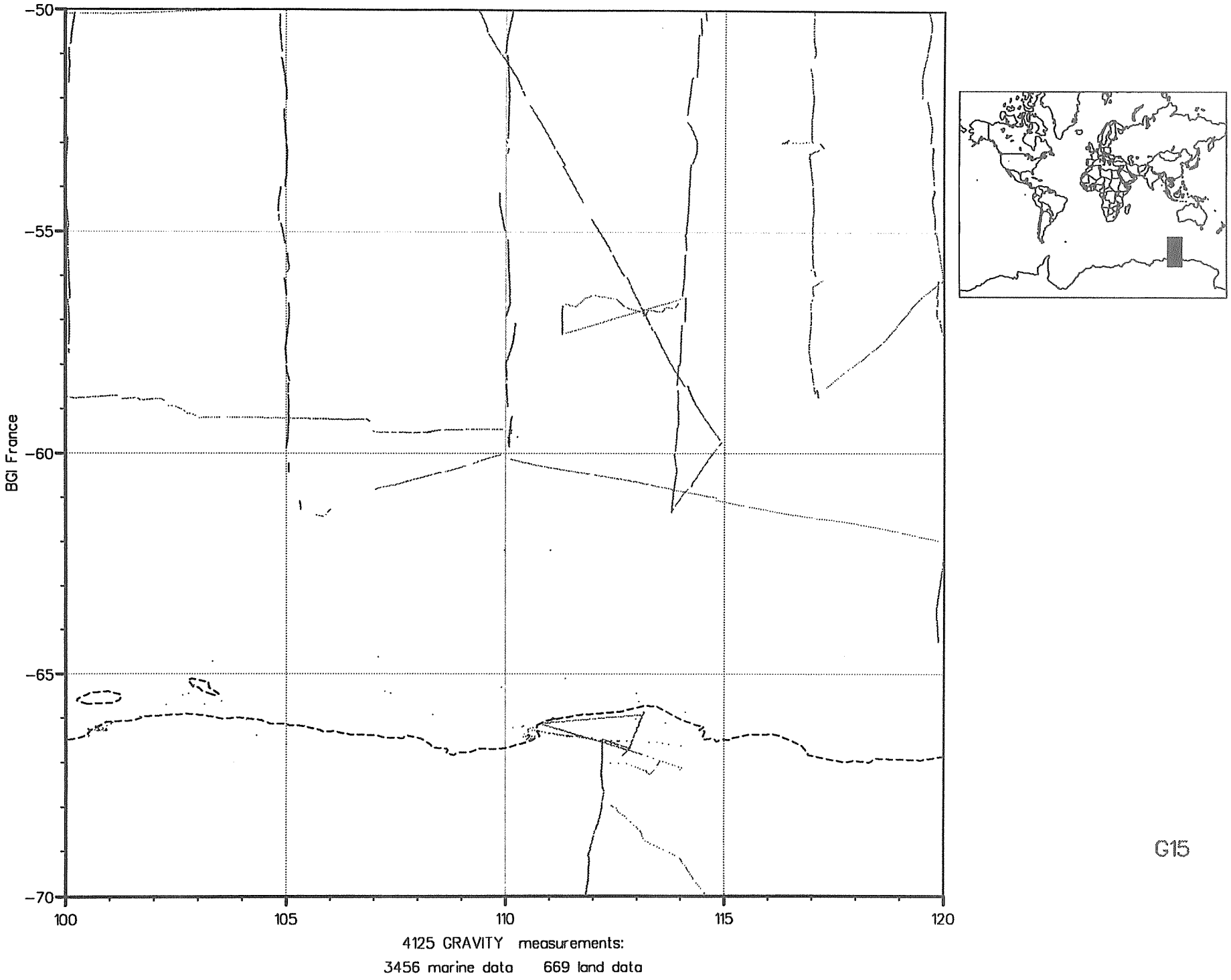
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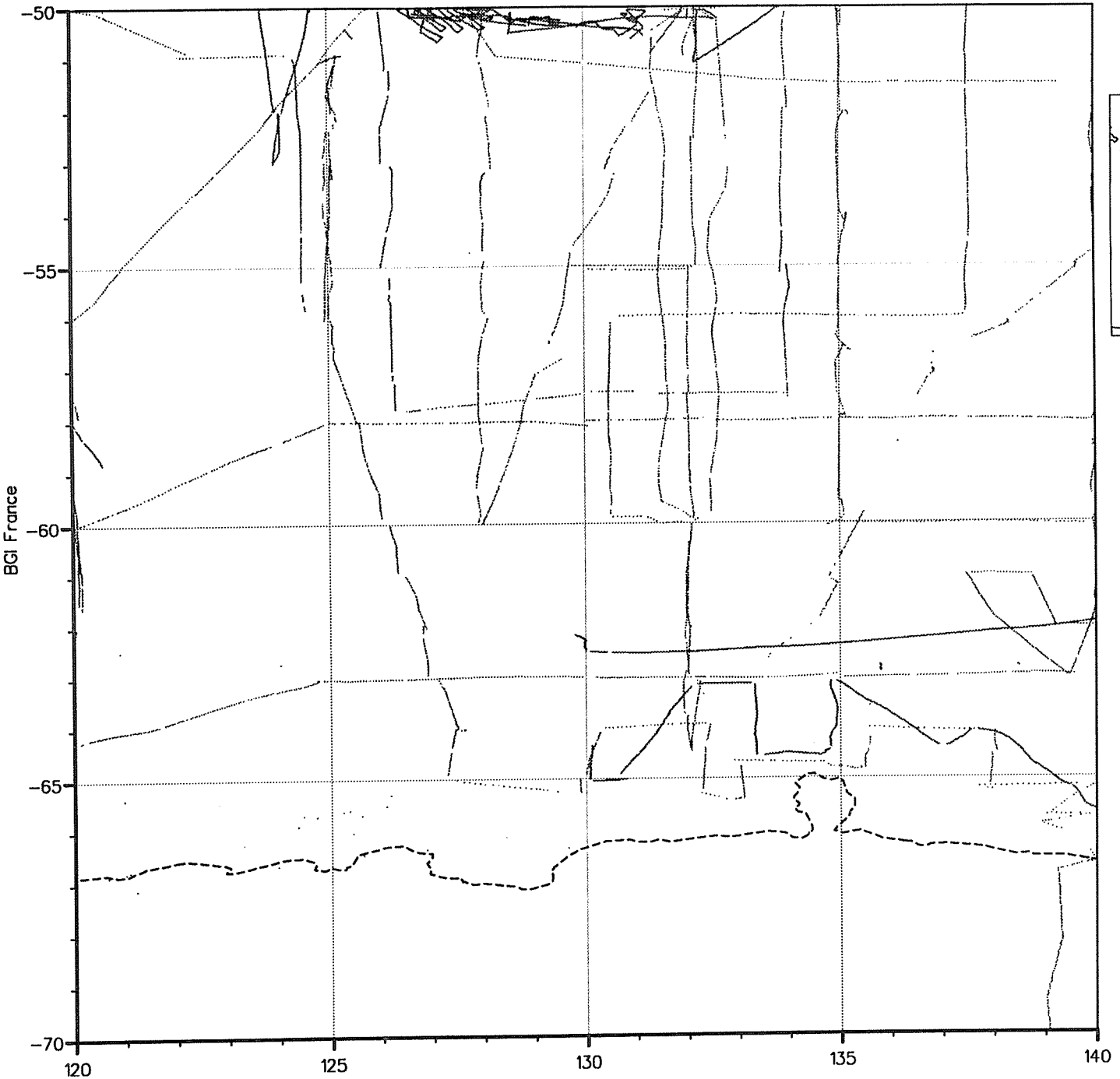

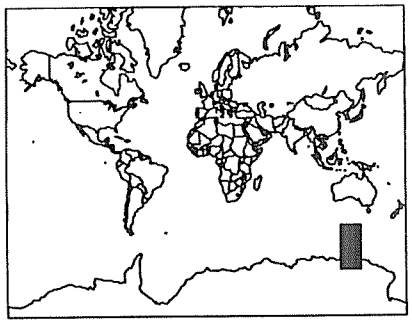

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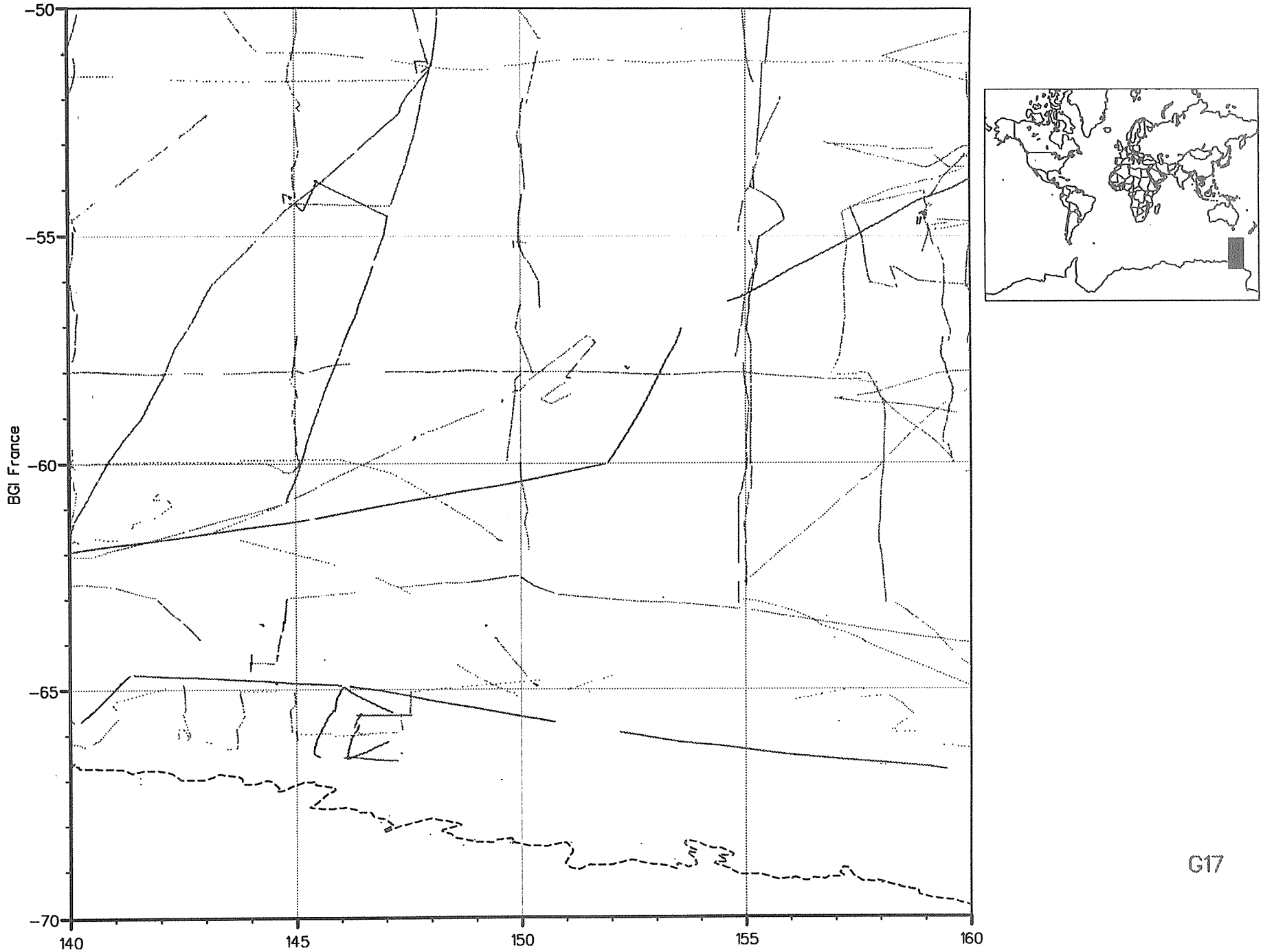
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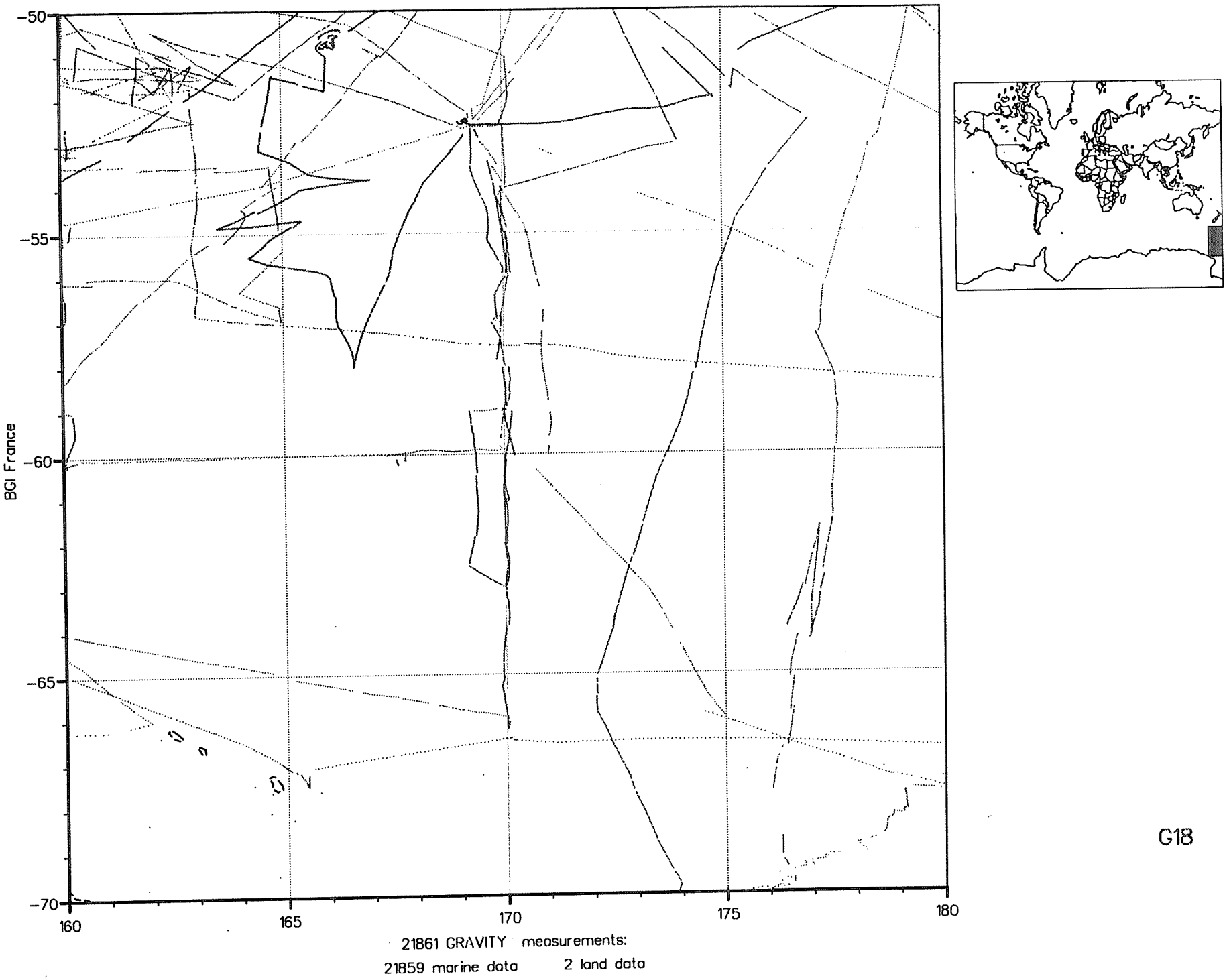
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G18

****
GENERAL INFORMATIONS
without classified data sets
****

Global gravity points number:

12609996

Land data

2075361

Sea data

10534635

Land data sorted by Country
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source mondiale : 24738

AFGHANISTAN	1649
AFRICA	30830
ALEUTIAN ISLANDS	280
ALGERIA	8869
ANGOLA	1686
ANTARCTIC	7950
ANTARCTIC ARGENTINA	263

ANTARCTIC AUSTRALIA	800
ANTARCTIC CHILE	8
ANTARCTIC NEW-ZEALAND	239
ANTARCTIC NORWAY	25
ANTARCTIC U.S.A.	253
ANTARCTIC U.S.S.R.	41
ARGENTINA	2242
ASCENSION	210
ASIA	8643
AUSTRALIA	316894
AUSTRIA	9826
AZORES	931
BAHRAIN	1855
BALEARIC ISLANDS	279
BELGIUM	10151
BELIZE	31
BENIN	969
BOLIVIA	5262
BONIN ISLANDS	75
BOTSWANA	2138
BRAZIL	22412
BRITISH VIRGIN ISLANDS	22
BULGARIA	1
CAMBODIA	207
CAMEROON	4277
CANADA	35146
CANARY ISLANDS	477
CAPE VERDE	183
CENTRAL AFRICAN REPUBLIC	5672
CHAD	16665
CHANNEL ISLANDS	149
CHILE	4330
CHINA	230
CHRISTMAS ISLANDS	50
COLOMBIA	7759
COMORES	74
CONGO	2140

COOK ISLANDS	4
CORSICA	716
CUBA	266
CYPRUS	722
CZECHOSLOVAKIA	958
DENMARK	21057
DJIBOUTI	389
DOMINICAN REPUBLIC	140
ECUADOR	553
EGYPT	3066
EL SALVADOR	1093
ETHIOPIA	2443
EUROPE	35048
FAEROE ISLANDS	681
FERNANDO PO	117
FINLAND	47
FRANCE	355413
GABON	1089
GERMANY	30403
GHANA	230
GREECE	214
GREENLAND	3278
GUADELOUPE	795
GUATEMALA	1187
GUINEA	960
GUINEA-BISSAU	36
GUYANA	470
HAITA	219
HAWAIIAN ISLANDS	1788
HONG-KONG	38
HUNGARY	508
ICELAND	2848
INDIA	6451
INDONESIA	1475
IRAN	8213
IRELAND	17865
ITALY	27694

IVORY COAST	5143
JAMAICA	713
JAPAN	27250
JORDAN	984
KENYA	9128
KOREA SOUTH	1275
LEBANON	505
LESOTHO	767
LIBERIA	790
LUXEMBOURG	96
LYBIA	680
MADAGASCAR	10964
MADEIRA ISLANDS	28
MALAWI	1878
MALAYSIA	8532
MALI	14129
MALTA	26
MAN,ISLAND OF	362
MARIANAS	97
MARSHALL ISLANDS	166
MAURITANIA	10392
MAURITIUS	79
MEXICO	14659
MOROCCO	5502
MOZAMBIQUE	1930
NAMIBIA	1434
NEPAL	145
NETHERLANDS	164
NEW CALEDONIA	272
NEW ZEALAND	30787
NICARAGUA	212
NIGER	19573
NIGERIA	3044
NORTH AMERICA	6247
NORWAY	16814
OCEANIA	1524
PAKISTAN	1040

PANAMA	149
PAPUA-NEW GUINEA	6919
PERU	4571
PHILIPPINES	1090
POLAND	1131
PORTUGAL	2653
PUERTO-RICO	1873
REUNION	82
ROMANIA	100
SAO TOME-PRINCIPE	32
SARDINIA	309
SAUDI ARABIA	2274
SENEGAL	3764
SICILY	323
SIERRA LEONE	680
SOCIETY ISLANDS	26
SOUTH AFRICA	364
SOUTH AMERICA	2964
SPAIN	15356
SRI LANKA	19
SUDAN	2849
SURINAME	344
SWAZILAND	4293
SWEDEN	11938
SWITZERLAND	3173
TAIWAN	180
TANZANIA	2369
THAILAND	1142
TOGO	450
TRINIDAD-TOBAGO	46
TURKEY	217
U.S.A.	583098
U.S.S.R.	2415
ULSTER	11210
UNITED KINGDOM	122084
UPPER VOLTA	4592
URUGUAY	740

VANUATU	411
VENEZUELA	3286
VIETNAM	223
VIRGIN ISLANDS	31
YUGOSLAVIA	7
ZAIRE	7849
ZAMBIA	1667
ZIMBABWE	2649

Sea data sorted by country

ARGENTINA	127
CANADA	22569
CHINA	10158
COLOMBIA	77
DENMARK	16488
FINLAND	2268
FRANCE	1817962
GERMANY	30990
ITALY	8622
JAPAN	753086
NETHERLANDS	48659
NEW ZEALAND	135234
NORWAY	212
TRINIDAD-TOBAGO	18
U.S.A.	7019242
U.S.S.R.	184211
UNITED KINGDOM	484219
VENEZUELA	493