ASSOCIATION INTERNATIONALE DE GÉODÉSIE

BUREAU GRAVIMETRIQUE INTERNATIONAL

BULLETIN D'INFORMATION

N° 48

Juillet 1981

18, avenue Edouard Belin
31055 TOULOUSE CEDEX
FRANCE

Informations for Contributors

Contributors should follow as closely as possible the rules below :

Manuscripts should be typed (double-spaced) in Prestige-Elite characters (IBM-type), 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).

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.

Table of contents. Long papers may include a table of contents following the abstract.

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. All characters that are available on standard typewriters should be typed in equations as well as test. 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 the margin. Bars cannot be set over superscripts or extended over more than one character. Therefore angle brackets are preferable to overbars to denote averages, and superscript symbols (such as *,', and ≠) 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.

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

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, 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 has 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.

Tables. 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 referred to in the text.

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.

B U R E A U   G R A V I M E T R I Q U E

I N T E R N A T I O N A L

Toulouse

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B U L L E T I N   D ' I N F O R M A T I O N

Juillet 1981

N° 48

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NEWS

. A lot of work has been devoted to reorganizing our publication library (on the shelves, as well as in our cross-reference tables). To help the BGI secretary in this task, we have Mrs Danièle LEFEBVRE working with us since March.

Mrs. D. LEFEBVRE

. We also have the pleasure to announce that Mr. Jean TOURNEZ is now a member of the staff in Toulouse. Mr. Tournez comes from the Institut Géographique National and had been working for 8 years in Montauban (near Toulouse) at the D.D.E. (Direction Départementale de l'Equipement).

Mr. J. TOURNEZ

PART I : *INTERNAL MATTERS*

STATUS OF THE DATA BASE AND DATA MANAGEMENT SYSTEM AT BGI/TOULOUSE

As announced in the last bulletin, the data base is being reorganized in such a way that :

. the archive files (on magnetic tapes) are kept by BRGM (Orleans). Indexes indicating the level of processing (evaluation) of data are being added. These files are now generated in Toulouse and updated when necessary. Data retrieval should still be done through BRGM.

. new files are created (in Toulouse) which contain limited informations, only those necessary to perform the automatic evaluation of the data. This data base (in direct access, on discs) is automatically cross-referenced with the archive files for updating and fast searching - in case one needs all informations pertaining to a given source.

Catalogues of sources of data which are already in these files are then easily made. The inventory which is given below corresponds to BGI holdings as of June 1980 (see map of data coverage, included in our bulletin n° 46), as well as the listing of the associated reference and calibration stations, which follows.

Various computer programs, activated from our Tektronix graphic terminal, have been written in the last six months and are being used for localizing data, for representing the geographical coverage of them - source by source if needed, and for evaluation (our GRGS/CNES contour line program is being modified so as to be used on the terminal in a very simple way). Whenever possible, we take care that these programs can be used by non specialists, and eventually by visitors, and in each case we are developing a simple macro-language thanks to which tasks are being performed according to a question-answer scheme.

The merging of our data with DMAAC's set (the graphic fusion of the coverages appeared in Bulletin n° 47) is not yet completed, due to a various of complicated problems which require a more detailed analysis than expected. We give below a summary of the adopted strategy.

The leading idea for merging the two data bases was to perform it on a source by source basis. But it appeared that two sets of data, one from each data base, concerning the same source or publication do not have the same number of measurements and that, in most cases the complement of the intersection of the two sets in each of them is not empty. In addition, the study of differences between the g values of identified common points shows that :

. different values have been adopted by BGI and DMA for reference stations,

. adjustments have been performed by DMA.

According to these considerations, we adopted the following strategy for each BGI source :

1) Extraction of all the DMA stations within the concerned area

   a) first inside a rectangle defined by latitude and longitude limits,

   b) then we reduce the amount of selected points by means of an interactive graphic program.

2) Identification of the common points with

   a) Edition of the differences in altitude, g, free air and Bouguer anomalies for every point,

   b) Edition of histograms : - statistical repartition of the differences
      - $\Delta(g) = f(\text{latitude})$....

   c) Listing of remaining duplicate measurements within DMA or BGI data base,

   d) Listing of the DMA source numbers having common points with the considered BGI source,

   e) Listing of the reference stations used in each data base with the numbers of stations related to each of them.

After this identification phase, the merging itself will be performed according to the following principles :

   a) Elimination of remaining duplicate measurements,

   b) When common points are identified, DMA values are chosen, in adopting the same evaluation code as DMA, but this strict statement may be tempered by the results of the identification phase,

   c) Remaining BGI stations are kept and will be evaluated later by BGI.

Finally, we give the inventory of newly received data and a list of older data sets, in both cases not yet merged with our holdings.

(1) INVENTORY OF BGI HOLDINGS <u>SOURCES</u>

CODE BGI	TYP.	LAT.	LON.	ALT	G.POST.	G.IGSN	PAYS	VILLE	DESCRIPTION
00150J3	REF	5 36.20	0 10.30	74.00	978114.26	978100.52	GHANA	ACCRA	AIRPORT
03649K1	REF	4 1.20	9 42.50	11.90	978051.08		CAMEROUN	DOUALA	METEO
04301K1	REF	10 35.80	-61 20.80	11.50	978162.16	978146.87	TRINIDAD	TRINIDAD	OLD BUILDING, PIARCO AIRPORT
04361J1	REF			7.00			GUADELOUPE	POINTE A PITRE	LE RAIZET AIRPORT
04487J1	REF	18 30.00	-77 53.00	3.00	978681.70	978666.64	JAMAIQUE	MONTEGO	MONTEGO BAY AIRPORT
06230A1	REF	13 45.10	100 29.70	3.30	978313.00	978300.07	THAILANDE	BANGKOK	ROYAL THAI SURVEY DPT
07125E1	REF	12 6.30	15 3.80	295.38	978186.06		TCHAD	NDJAMENA	MONUMENT EBOUE
08817A1	REF	21 18.00	-157 49.00	15.00	978959.30	978944.90	HAWAII	HONOLULU	UNIV.OF HAWAII.GEOPHY.BUILDING
08817J1	REF	21 20.50	-157 57.50	6.40	978933.70	978919.14	HAWAII	HONOLULU	HICKAM AIR FORCE BASE
10187L1	REF	28 35.00	77 12.00	228.30	979132.99	979122.10	INDE	NEW-DELHI	INDIA GATE MONUMENT
10976J1	REF								
10989A2	REF	38 42.70	-9 9.60	74.90	980091.53	980075.73	PORTUGAL	LISBONNE	INST.GEOGRAFICO E CATASTRAL
11175A1	REF	37 44.45	-25 39.49	33.10	980125.77		ACORES	PONTA DELGADA	OBS.METEOROLOGIQUE
11687A1	REF	38 53.60	-77 2.00	.20	980118.00	980104.29	U.S.A.	WASHINGTON	COMMERCE BUILDING BASE
13211A1	REF	31 11.50	121 25.70	7.00	979436.00		CHINE	ZI-KA-WEI	OBSERVATOIRE
13708A3	REF	30 19.50	78 3.40	726.80	979064.00	979049.09	INDE	DEHRA-DUN	OBSERVATORY
13708A1	REF	30 19.50	78 3.40	726.80	979063.00	979049.09	INDE	DEHRA-DUN	OBSERVATORY
13849B1	REF	34 31.83	69 7.50	1798.00	979123.82	979115.08	AFGHANISTAN	KABOUL	SERVICE GEOLOGIQUE
13951J1	REF	35 41.00	51 19.40	1182.42	979447.40	979430.68	IRAN	MEHRABAD	AIRPORT TERMINAL
14192B1	REF	39 56.08	32 49.57	853.00	979939.70	979925.15	TURQUIE	ANKARA	FEN FACULTESI
14463A1	REF	36 48.10	3 2.20	346.50	979920.00	979896.83	ALGERIE	ALGER	OBS.DE BOUZAREAH
14503A1	REF	40 24.50	-3 41.27	655.40	979981.00	979966.52	ESPAGNE	MADRID	OBS.ASTRO.LIBRARY
14503C1	REF	40 26.70	-3 42.60	690.70	979970.20	979955.61	ESPAGNE	MADRID	INST.GEOGR.Y CATASTRAL
14504J1	REF	40 57.00	-4 6.00	1001.00	979960.00		ESPAGNE	SEGOVIE	
14514J1	REF	41 3.00	-4 37.00	892.00	979916.00		ESPAGNE	MONTUENGA	
17979A1	REF	47 29.15	19 2.59		981853.00		HONGRIE	BUDAPEST	INST.GEODESIQUE
17986A1	REF	48 13.91	16 20.12	234.70	980853.29		AUTRICHE	VIENNE	OBS.ASTRO.
18055F1	REF	45 34.30	5 55.20	269.70	980529.50		FRANCE	CHAMBERY	GARE
18082B0	REF	48 50.20	2 20.20	60.00	980943.35	980928.65	FRANCE	PARIS	OBSERVATOIRE,ST.EXTER.
18082D1	REF	48 50.20	2 20.20	60.60	980943.91		FRANCE	PARIS	OBSERVATOIRE,NELLE CAVE
18082E1	REF	48 50.20	2 20.20	60.60	980943.00	980928.29	FRANCE	PARIS	OBSERVATOIRE
18136A1	REF	53 23.13	-6 20.16	80.80	981386.40		IRLANDE	DUBLIN	DUNSINK,PENDULUM SITE OBS.
21421A1	REF	52 14.60	21 .20	111.40	980241.20		POLOGNE	VARSOVIE	G.U.M. PILL.1
21504A1	REF	50 5.20	14 23.40	297.00	981013.80		TCHECOSLOVAQUIE	PRAGUE-HRADCANY	STAT.NAT. DE REF.
21510A1	REF	51 52.90	10 34.10	257.20	981180.45	981165.50	ALLEMAGNE-RFA	BAD-HARZBURG	HAUPTPENDELSTATION
21523A0	REF	13 4.10	52 22.90	86.20	981274.00	981260.19	ALLEMAGNE-RDA	POSTDAM	GEODATISCHEN INSTITUTE
21523A1	REF						ALLEMAGNE-RDA	POSTDAM	GEODATISCHEN INSTITUTE
21523E1	REF						ALLEMAGNE-RDA	POSTDAM	GEODATISCHEN INSTITUTE
21552A1	REF	55 44.60	12 30.20	44.80	981558.00	981543.02	DANEMARK	COPENHAGUE	BUDDINGE PILL.1
21590A0	REF	59 55.10	10 46.60	39.60	981928.40	981912.61	NORVEGE	OSLO	GEOLOGISK MUSEUM,ROOM 30
21598A0	REF	59 19.73	18 2.70	8.60	981847.00	981831.43	SUEDE	STOCKHOLM	PILIER RAK 1
21604A0	REF	50 47.90	4 21.60	97.00	981131.00	981117.32	BELGIQUE	UCCLE	OBS.ROYAL DE BELGIQUE,CAVE GRA
21625A1	REF	52 6.17	5 10.70	2.10	981267.00		PAYS-BAS	DE BILT	INST.METEO.,STAT.PENDUL.
21679A1	REF	57 3.00	9 54.50	4.40	981679.51		DANEMARK	AALBORG	STAT.REF.SPECIALE
21941B1	REF	64 8.60	-21 55.60	36.80	982272.39	982258.79	ISLANDE	REYKJAVIK	SKOLAVARDA, SQARE
25004B1	REF	60 10.50	24 57.40	20.50	981910.00	981900.59	FINLANDE	HELSINKI	UNIVERSITY PHYSICS LAB.
32918L1	REF	-1 23.00	-48 28.50	12.80	978034.20	978019.08	BRESIL	BELEM	VAL DE CAES,NEW TERMINAL
35945A1	REF	-4 22.10	15 15.30	449.80	977918.40	977899.82	ZAIRE	KINSHASA	SERV.METEO.DE BINZA
37977J1	REF	-17 45.50	177 26.70	18.90	978549.80		FIDJI	NANDI	INTERN.AIRPORT,TERM.BUILD.
39297J1	REF	-19 1.30	47 9.70	1449.00	978220.47	978202.42	TANANARIVE	MADAGASCAR	ARIVONIMANO AIRPORT
39354J1	REF	-15 40.78	34 58.35	769.00	978216.30	978202.52	MALAWI	BLANTYRE	CHILEKA AIRPORT
39371A4	REF	-17 49.87	31 1.12	1470.30	978148.52	978133.65	ZIMBABWE	SALISBURY	METEO.OFFICE
40123A2	REF	-22 53.70	-43 13.40	28.90	978805.00	978789.90	BRESIL	RIO DE JANEIRO	OBSER.NACIONAL
40159J1	REF	-25 25.00	-49 14.00	931.20	978773.30		BRESIL	CURITIBA	BACACHERY AIRPORT
40204K1	REF	-20 28.20	-54 40.80	563.00	978506.50		BRESIL	CAMPO GRANDE	AIR BASE
43068A1	REF	-26 11.50	28 1.80	1755.00	978546.00	978535.46	AFRIQUE DU SUD	JOHANNESBURG	BERNARD PRICE INSTITUTE
43068A3	REF	-26 11.50	28 1.80	1755.00	978549.50	978535.46	AFRIQUE DU SUD	JOHANNESBURG	BERNARD PRICE INSTITUTE
43069A2	REF	-26 11.50	28 1.80	1755.00	978549.10	978535.46	AFRIQUE DU SUD	JOHANNESBURG	BERNARD PRICE INSTITUTE
43848A1	REF				979705.00	979690.03	ARGENTINE	BUENOS-AIRES	MILITARY GEOGRAPHIC INSTITUTE
43848A5	REF	-34 34.40	-58 31.10	9.00	979690.03	979690.03	ARGENTINE	BUENOS-AIRES	MILITARY GEOGRAPHIC INSTITUTE
48732A0	REF	-43 31.77	172 37.18	6.70	980509.50	980494.29	NELLE-ZELANDE	CHRISTCHURCH	FUNDAMENTAL STATION

(2) LIST OF REFERENCE STATIONS, CORRESPONDING TO (1)

SEA MEASUREMENTS

95 6C008 NB POINTS= 4627 REF.PUBL.BGI=
CONRAD CR.8 26/11/63-22/08/64
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

96 6C009 NB POINTS= 9969 REF.PUBL.BGI=
CONRAD CR.9 18/10/64-21/09/65
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

97 6C010 NB POINTS= 5617 REF.PUBL.BGI=
CONRAD CR.10 01/12/65-15/10/66
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

98 6C011 NB POINTS= 244 REF.PUBL.BGI=
CONRAD CR.11 21/10/67-23/10/67
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

98 6C012 NB POINTS= 1795 REF.PUBL.BGI=
CONRAD CR.12 03/01/68-04/02/68
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

100 6C013 NB POINTS= 6343 REF.PUBL.BGI=
CONRAD CR.13 22/06/70-01/10/70
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

101 6C09B NB POINTS= 961 REF.PUBL.BGI=
CONRAD CR.9B 14/07/65-26/07/65
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

102 6VE17 NB POINTS= 3922 REF.PUBL.BGI=
VEMA CR.17 31/01/61-29/09/61
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

103 6VE18 NB POINTS= 4636 REF.PUBL.BGI=
VEMA CR918 13/12/61-06/12/62
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

104 6VE19 NB POINTS= 4064 REF.PUBL.BGI=
VEMA CR.19 15/03/63-11/12/63
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

105 6VE20 NB POINTS= 2889 REF.PUBL.BGI=
VEMA CR.20 02/03/64-06/12/64
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

106 6VE21 NB POINTS= 3305 REF.PUBL.BGI=
VEMA CR.21 16/02/65-10/12/65
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

107 6VE22 NB POINTS= 7125 REF.PUBL.BGI=
VEMA CR.22 10/01/66-13/06/66
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

108 6VE23 NB POINTS= 6364 REF.PUBL.BGI=
VEMA CR.23 27/07/66-14/12/66
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

109 6VE24 NB POINTS= 4990 REF.PUBL.BGI=
VEMA CR.24 16/01/67-15/12/67
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

110 6VE25 NB POINTS= 7137 REF.PUBL.BGI=
VEMA CR.25 05/01/68-10/04/68
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

111 6VE26 NB POINTS= 8430 REF.PUBL.BGI=
VEMA CR.26 26/10/68-15/05/69
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

112 6VE27 NB POINTS= 26248 REF.PUBL.BGI=
VEMA CR.27 29/05/69-10/05/70
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

113 6VE28 NB POINTS= 3824 REF.PUBL.BGI=
VEMA CR.28 29/06/70-22/09/70
LAMONT DOHERTY GEOLOGICAL OBSERVATORY

114 6CH NB POINTS= 44712 REF.PUBL.BGI=
CHARCOT CRUISES
C.N.E.X.O.

115 5KT NB POINTS= 6636 REF.PUBL.BGI=
KOMET 01/09/75-05/10/75 , 31/08/71-18/09/71 (CR.71)
DEUTSCHES HYDROGRAPHISCHES INSTITUT

116 3ME 2 NB POINTS= 3282 REF.PUBL.BGI=
METEOR CR.2 17/08/65-13/11/65
DEUTSCHES HYDROGRAPHISCHES INSTITUT

117 5ME 2 NB POINTS= 1856 REF.PUBL.BGI=
METEOR CR.2 14/11/65-14/12/65
DEUTSCHES HYDROGRAPHISCHES INSTITUT

118 3ME 4 NB POINTS= 3363 REF.PUBL.BGI=
METEOR CR.4 23/04/66-08/06/66
DEUTSCHES HYDROGRAPHISCHES INSTITUT

119 3ME 8 NB POINTS= 471 REF.PUBL.BGI=
METEOR CR.8 1967
DEUTSCHES HYDROGRAPHISCHES INSTITUT

120 5ME14 NB POINTS= 3323 REF.PUBL.BGI=
METEOR CR.14 02/07/68-06/08/68
DEUTSCHES HYDROGRAPHISCHES INSTITUT

121 5ME20 NB POINTS= 3991 REF.PUBL.BGI=
METEOR CR.20 28/05/70-04/07/70
DEUTSCHES HYDROGRAPHISCHES INSTITUT

122 5ME28 NB POINTS= 3649 REF.PUBL.BGI=
METEOR CR.28 16/09/72-19/10/72
DEUTSCHES HYDROGRAPHISCHES INSTITUT

123 1AR NB POINTS= 108 REF.PUBL.BGI=
U. FLEISCHER
SCHWERESTORUNGEN IM OSTLICHEN MITTELMEER NACH MESSUNGEN MIT EINEM
ASKANIA-SEEGRAVIMETER (ARAGONESE CRUISE 22/02/61-13/12/61)
DEUTSHEN HYDROGGRAPHISHEN ZEITSCRIFT-BAND 17-HEFT4
1964

124 1HV NB POINTS= 1226 REF.PUBL.BGI=MD086
O. B. ANDERSEN
SURFACE-SHIP GRAVITY MEASUREMENTSKIN THE SHAGGERAK 1965-1966
(HVIDBJORNEN CRUISES)
GEODAETISK INSTITUT MEDD.42
1966

125 1HV NB POINTS= 669 REF.PUBL.BGI=MD187
O. B. ANDERSEN
SURFACE-SHIP GRAVITY MEASUREMENTS IN THE DAVIS STRAIT, WESTERN
GREENLAND 1965
GEODAETISK INSTITUT 3TH SERIE, T.39
1973

126 1HV NB POINTS= 1394 REF.PUBL.BGI=MD204
O. B. ANDERSEN
SURFACE-SHIP GRAVITY MEASUREMENTS IN THE NORTH ATLANTIC OCEAN
1965 AND 1968
GEODAETISK INSTITUT 3TH SERIE,T.41
1975

127 1 NB POINTS= 2958 REF.PUBL.BGI=MD235
O. B. ANDERSEN K. ENGSAGER
SURFACE-SHIP GRAVITY MEASUREMENTS IN DANISH WATERS 1970-1975
GEODAETISK INSTITUT 3TH SERIE,T.43
1977

128 1MY NB POINTS= 824 REF.PUBL.BGI=MD217
GRAVITY MEAS. AT SEA IN 1968 (MEIYO CR. 27/08/68-29/10/68)
HYDROGRAPHIC DEPARTMENT, DATA REPORT OF HYDRO. OBS., SERIES OF
ASTRON. AND GEODESY, NO.5, SEPT.1970
1970

129 1MY NB POINTS= 2015 REF.PUBL.BGI=MD218
GRAVITY MEAS. AT SEA IN 1968 (MEIYO CR. 02/09/68-14/10/68)
HYDROGRAPHIC DEPARTMENT, DATA REPORT OF HYDRO. OBS., SERIES OF
ASTRON. AND GEODESY, NO.6,SEPT. 1971
1971

130 1MY NB POINTS= 3287 REF.PUBL.BGI=MD219
GRAVITY MEAS. AT SEA IN 1970 (MEYIO CR. 04/06/70-23/07/70)
HYDROGRAPHIC DEPARTMENT, DATA REPORT OF HYDRO. OBS., SERIES OF
ASTRON. AND GEODESY, NO.7, SEPT.1972
1972

131 1MY NB POINTS= 1389 REF.PUBL.BGI=MD220
GRAVITY MEASUREMENTS AT NORTHWEST PACIFIC OCEAN IN 1970
HYDROGRAPHIC DEPARTMENT, DATA REPORT OF HYDRO. OBS., SERIES OF
ASTRON. AND GEODESY, NO.8, MARC 1974
1974

132 1MY NB POINTS= 2174 REF.PUBL.BGI=MD221
GRAVITY MEASUREMENTS AT OKHOTSK SEA IN 1971 AND 1972
HYDROGRAPHIC DEPARTMENT, DATA REPORT OF HYDRO. OBS., SERIES OF
ASTRON. AND GEODESY, NO.9, MARCH 1975
1975

133 1TA NB POINTS= 345 REF.PUBL.BGI=MD170
P. A. STROEV J. A. PAVLOV
V. L. PANTELEEV V. O. BAGRAMJANIS
CATAL. DES POINTS GRAVI. OBTENUS PAR L EXPEDITION JAPONAISE DE1965
TAKUYO CRUISES

134 1UM NB POINTS= 308 REF.PUBL.BGI=MD170
P. A. STROEV J. A. PAVLOV
V. L. PANTELEEV V. O. BAGRAMJANIS
CATAL. DE POINTS GRAVI. AUTOUR DU JAPON OBSERVES AVEC LE GRAVIM.
TSSG, UMITAKA-MARU CRUISE JULY-AUGUST 1961

135 6DARJ NB POINTS= 4652 REF.PUBL.BGI=MD201
J. C. ROSE R. W. TRACY
GRAVITY RESULTS IN THE SOLOMON ISL. REGION, ABOARD H.M.S. DAMPIER
IN 1965
HAWAII INSTITUTE OF GEOPHYSICS, HIG-71-2, DATA REP.17
1971

136 6DDRM NB POINTS= 845 REF.PUBL.BGI=MD202
R. W. TRACY
GRAVITY RESULTS OBTAINED BETWEEN HAWAII AND CALIFORNIA, ABOARD THE
R/V MAHI IN 1969
HAWAII INSTITUTE OF GEOPHYSICS, HIG-71-3, DATA REP.18
1971

137 1BA70 NB POINTS= 1040 REF.PUBL.BGI=MD151
K. G. SHIH D. I. ROSS
B. L. JOHNSTON
GRAVITY AND MAGNETIC DATA OF BAFFIN BAY COLLECTED IN 1970
C.S.S. BAFFIN CRUISE
BEDFORD INSTITUTE OF OCEANOGRAPHY, DATA SERIES BI-D-72-5
1972

138 1BA70 NB POINTS= 831 REF.PUBL.BGI=MD152
K. G. SHIH J. B. MACINTYRE
B. L. JOHNSTON
GRAVITY AND MAGNETIC DATA COLLECTED IN THE NORTHEASTERN PACIFIC
AND BERING SEA, C.S.S. BAFFIN CRUISE 1970
BEDFORD INSTITUTE OF OCEANOGRAPHY, DATA SERIES BI-D-72-7
1972

139 1HU70 NB POINTS= 901 REF.PUBL.BGI=MD151
K. G. SHIH D. I. ROSS
B. L. JOHNSTON
GRAVITY AND MAGNETIC DATA OF BAFFIN BAY COLLECTED IN 1970
C.S.S. HUDSON CRUISE 69-050 02/10/70-13/10/70
BEDFORD INSTITUTE OF OCEANOGRAPHY, DATA SERIES BI-D-72-5
1972

140 1HU70 NB POINTS= 1045 REF.PUBL.BGI=MD155
K. G. SHIH
GRAVITY AND MAGNETIC DATA COLLECTED IN THE NORTHEASTERN PACIFIC
OCEAN AND THE BERING SEA (C.S.S. HUDSON CR.69-050 14/08/70-24/08/7
ATLANTIC OCEANOGRAPHIC LAB., BEDFORD INST.,DATA SERIES BI-D-1971-7
1971

141 1HU65 NB POINTS= 2533 REF.PUBL.BGI=MD156
C. WILLIAMS D. M. PORTEOUS
K. G. SHIH
GRAVITY AND MAGNETIC DATA COLLECTED IN THE NORTH ATLANTIC OCEAN
C.S.S.HUDSON CR. 18/03/65-01/05/65
BEDFORD INSTITUTE OF OCEANOGRAPHY, REP.BI-D-72-9, MAY 1972
1972

142 1DW72 NB POINTS= 2589 REF.PUBL.BGI=MD159
R. T. HAWORTH L. F. BARRETT
J. B. MACINTYRE
BATHY.,GRAVITY AND MAGN. DATA CRUISE BI 72-009 DAWSON
BEDFORD INSTITUTE OF OCEANOGRAPHY, REP.BI-D-72-14, SEPT.72
1972

143 1HU27 NB POINTS= 615 REF.PUBL.BGI=MD160
R. T. HAWORTH L. F. BARRETT
BATH.,GRAVITY AND MAGN. DATA OVER THE ORPHEUS GRAVITY ANOMALY
HUDSON CR.BI 27-64
BEDFORD INSTITUTE OF OCEANOGRAPHY, REP.BI-D-72-15, SEPT.1972
1972

144 2DM 3 NB POINTS= 3638 REF.PUBL.BGI=MD176
Y. D. BOULANGER AND AL.
CATAL. DES MESURES DE PESANTEUR DANS L OCEAN ATLANTIQUE EN 1970
DIMITRI MENDELEEV CR.3
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1972

145 2DM 5 NB POINTS= 5782 REF.PUBL.BGI=MD194
Y. D. BOULANGER AND AL.
CATAL. DES OBSERVATIONS GRAVIMETRIQUES DANS LES OCEANS ATLANTIQUE
ET PACIFIQUE EN 1971 (DIM.MENDELEEV CR.5 JAN-MAY 1971)
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1972

146 2VI51 NB POINTS= 5365 REF.PUBL.BGI=MD195
Y. D. BOULANGER AND AL.
VITYAZ CR.51 JAN-MAY 1972
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1973

147 2KO 5 NB POINTS= 6645 REF.PUBL.BGI=MD133
Y. D. BOULANGER AND AL.
CATALOGUE DES OBS.GRAVI. DANS L OCEAN ATLANTIQUE EN 1969
AC.KOURTCHATOV CR.5
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1970

148 2DM 6 NB POINTS= 4157 REF.PUBL.BGI=MD211
Y. D. BOULANGER AND AL.
CATALOGUE DES MES.GRAVI. DANS L OCEAN PACIFIQUE EN 1971
DIMITRI MENDELEEV CR.6
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1974

149 2DM 9 NB POINTS= 4724 REF.PUBL.BGI=MD212
Y. D. BOULANGER AND AL.
CATAL. DES MES. GRAVI. DANS L OCEAN PACIFIQUE EN 1973
DIMOTRI MENDELEEV CR.9
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1974

150 2DM10 NB POINTS= 4225 REF.PUBL.BGI=MD213
Y. D. BOULANGER AND AL.
CATAL. DES MES.GRAVI. DANS L OCEAN INDIEN ET LA MER DE CHINE
DIMITRI MENDELEEV CR.10 JUNE-OCT.1973
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1975

151 6KO15 NB POINTS= 3535 REF.PUBL.BGI=MD236
Y. D. BOULANGER AND AL.
CATAL. DES MESURES DANS L ATLANTIQUE NORD
AC.KOURTCHATOV CR.15 JUNE-SEPT.1973
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE
1975

152 6DM 7 NB POINTS= 5357 REF.PUBL.BGI=
DIMITRI MENDELEEV CR.7
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE

153 6KO20 NB POINTS= 9139 REF.PUBL.BGI=
AC.KOURTCHATOV CR.20 18/01/75-25/05/75
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE

154 6VI49 NB POINTS= 6995 REF.PUBL.BGI=
M. G. KOGAN
VITYAZ CR.49 1970-1971
AC. DES SCIENCES DE L URSS, INST. DE PHYSIQUE DE LA TERRE

155 1VI47 NB POINTS= 74 REF.PUBL.BGI=MD170
P. A. STROEV J. A. PAVLOV
V. L. PANTELEEV V. O. BAGRAMJANTS
LES MESURES DE PESANTEUR DANS LA MER DU JAPON (EXPEDITION JAPONAI-
VITYAZ CR.47 1970

156 1VI42 NB POINTS= 1688 REF.PUBL.BGI=MD170
P. A. STROEV J. A. PAVLOV
V. L. PANTELEEV V. O. BAGRAMJANTS
LES MESURES DE PESANTEUR DANS LA MER DU JAPON
VITYAZ CR.42 1967

157 1ST NB POINTS= 1440 REF.PUBL.BGI=MD170
P. A. STROEV J. A. PAVLOV
V. L. PANTELEEV V. O. BAGRAMJANTS
LES MESURES DE PESANTEUR DANS LA MER DU JAPON
STARATELNI CRUISE 1969

158 1PC NB POINTS= 751 REF.PUBL.BGI=MD095
PAUL GOFFENY CRUISE
S.H.O.M.

LAND MEASUREMENTS

1 5A 000 NB POINTS= 7002
E. SENFTL
AUSTRIAN DATAT
BUNDESAMT FUR EICH- UND VERMESSUNGEN
1968

2 5A 1 NB POINTS= 274
BERICHT DER OSTERREICHCHISCHEN KOMM. FUR DIE INTERNATIONALE ERDMES
SUNG UND DES BUNDESAMTES FUR EICH- UND VERMESSUNGSWESEN
BUNDESAMTT FUT EICH- UND VERMESSUNGEN
1954

3 5B 3 NB POINTS= 381
L. JONES
LE LEVE GRAVIMETRIQUE DE LA BELGIQUE (1947-1948)
INSTITUT GEOGRAPHIQUE MILITAIRE
1948

4 5D 000 NB POINTS= 22138
KNEISSL
GERMAN DATA (1938-1956)
DEUTSCHES GEODATISCHES FORSCHUNGSINSTITUT
1968

5 5E 000 NB POINTS= 189
RED DE OBSERVACIONES CON GRAVIMETRO EN LA PROVINCIA DE MADRID
INSTITUTO GEOGRAFICO Y CATASTRAL
1965

6 5E 15 NB POINTS= 150
G. SANS HUELIN L. LOZANO CALVO
RED DE OBSERVACIONES CON GRAVIMETRICO EN LA PROVINCIA DE SEGOVIA
INSTITUTO GEOGRAFICO Y CATASTRAL
1947

7 5E 18 NB POINTS= 137
J. M. ESPINOSA L. LOZANO CALVO
RED DE OBSERVACIONES CON GRAVIMETRICO EN LA PROVINCIA DE HUELVA
INSTITUTO GEOGRAFICO Y CATASTRAL
1950

8 5E 19 NB POINTS= 105
L. LOZANO CALVO
RED DE OBSERVACIONES CON GRAVIMETRICO EN LA PROVINCIA DE AVILA
INSTITUTO GEOGRAFICO Y CATASTRAL
1950

9 5E 22 NB POINTS= 441
WOOLLARD
REGIONAL GRAVITY CONTROL IN SPAIN
UNIV. WISCONSIN, GEOPHYS. AND POLAR RESEARCH CENTER REP.62-6
1962

10 5E 24 NB POINTS= 100
A. GARCIA COGOLLOR
INTRODUCCION AL ESTUDIO GRAVIMETRICO DE FERNANDO PO
INSTITUTO GEOGRAFICO Y CATASTRAL
1967

11 5E 25 NB POINTS= 256
RED DE OBSERVACIONES CON GRAVIMETRO DE LA PROVINCIA DE GERONA
INSTITUTO GEOGRAFICO Y CATASTRAL
1969

12 5E 26 NB POINTS= 1067
RED DE OBSERVACIONES CON GRAVIMETRICO EN LA PROVINCIA DE BURGOS
INSTITUTO GEOGRAFICO Y CATASTRAL
1963

13 5E 27 NB POINTS= 559
L. LOZANO CALVO
RED DE OBSERVACIONES CON GRAVIMETRO EN LA PROVINCIA DE TOLEDO
INSTITUTO GEOGRAFICO Y CATASTRAL
1963

14 5E 28 NB POINTS= 825
MAPA GRAVIMETRICO DE LA PROVINCIA DE CIUDAD REAL
INSTITUTO GEOGRAFICO Y CATASTRAL
1970

15 5E 32 NB POINTS= 53
C. GAIBAR-PUERTAS J. RUIZ LOPEZ
LAS ANOMALIAS DE LA PESANTEZ EN LA ISLA DE ALBORAN
INSTITUTO NACIONAL DE GEOFISICA
1970

16 5E 33 NB POINTS= 1190
L. LOZANO CALVO
INSTITUTO GEOGRAFICO Y CATASTRAL
RED DE OBSERVACIONES CON GRAVIMETRO EN LA PROVINCIA DE NAVARRA
1963

17 5E 34 NB POINTS= 866
L. LOZANO CALVO
RED DE OBSERVACIONES CON GRAVIMETRO EN LA PROVINCIA DE PALENCIA
INSTITUTO GEOGRAFICO Y CATASTRAL
1966

18 5E 35 NB POINTS= 4950
RED DE OBSERVACIONES CON GRAVIMETRO EN LA PROVINCIA DE SANTANDER
INSTITUTO GEOGRAFICO Y CATASTRAL
1968

19 5E 36 NB POINTS= 291
MAPAS GRAVIMETRICOS DE LAS PROVINCIAS DE ALAVA, GUIPUZCOA Y
VIZCAYA
INSTITUTO GEOGRAFICO Y CATASTRAL
1969

20 5E 100 NB POINTS= 307
RED DE OBSERVACIONES CON GRAVIMETRO EN LA PROVINCIA DE BARCELONA
INSTITUTO GEOGRAFICO Y CATASTRAL
1969

21 5F 41 NB POINTS= 5045
S. CORON
PRINCIPAL STATIONS OF GRAVIMETRY, RESEARCH IN FRANCE
B.G.I.

22 5F 43 NB POINTS= 6320
S. CORON
MESURES DE PESANTEUR DANS LES ALPES FRANCAISES
B.G.I.
1964

23 5H 3 NB POINTS= 509
J. RENNER J. SZILARD
GRAVITY NETWORK OF HUNGARY
ACTA TECHNICA T.23, NO 4
1959

24 5J 000 NB POINTS= 12597
T. MURPHY
IRISH DATA
SCHOOL OF COSMIC GEOPHYSICAL SECTION
1966

25 5K 2 NB POINTS= 93
E. C. BULLARD H. L. JOLLY
GRAVITY MEASUREMENTS IN GREAT BRITAIN
MONTHLY NOTICES OF T R.A.S. GEOPHYS.SUPPL. VOL.3,NO 9
1936

26 5L 4 NB POINTS= 96
A. GLODEN S. CORON
ANOMALIES DE LA PESANTEUR AU LUXEMBOURG
REVUE TECHNIQUE LUXEMBOURGEOISE, 48E ANNEE NO 2
1956

27 5N 000 NB POINTS= 5749
G. JELSTRUP
NORWEGIAN DATA
NORGES GEOGRAFISKE OPPMALING
1965

28 5P 3 NB POINTS= 898
ESTACOES DA REDE GRAVIMETRICA PORTUGUESE
INSTITUTO GEOGRAFICO E CADASTRAL
1962

29 5Q 21 NB POINTS= 11949
S. E. SAXOV
GRAVITY MEASUREMENTS IN CENTRAL JYLLAND
GEODAETISK INSTIIUTS. 3TH SERIE T.42
1976

30 5Q 3 NB POINTS= 44
G. NORGAARD
EIN STATISCHER QUARZSCHWEREMESSER UND SCHWEREMESSUNGEN
GEODAETISK INSTITUT MEDD.10
1939

31 5Q 4 NB POINTS= 331
G. NORGAARD
EINIGE SCHWEREVERHALTNISSE IN DANEMARK
GEODAETISK INSTITUT MEDD.12
1939

32 5Q 5 NB POINTS= 336
S. E. SAXOV
SOME GRAVITY MEASUREMENTS ON THE ISLAND OF BORNHOLM
GEODAETISK INSTITUT MEDD.19
1945

33 5Q 6 NB POINTS= 2518
ANDERSEN
GRAVITY MEASUREMENTS IN SJAELLAND, MOEN, FALSTER AND LOLLAND BY
MEANS OF THE ASKANIA GRAVIMETER
GEODAETISK INSTITUT, 3TH SERIE, T.10
1947

34 5Q 9 NB POINTS= 1691
S. E. SAXOV
SOME GRAVITY MEASUREMENTS ON FYN
GEODAETISK INSTITUT,3TH SERIE, T.23
1955

35 5Q 11 NB POINTS= 1242
S. E. SAXOV
SOME GRAVITY MEASUREMENTS IN THY, MORS AND VENDSYSSEL
GEODAETISK INSTITUT, 3TH SERIE, T.25
1956

36 5Q 13 NB POINTS= 1035
S. E. SAXOV
GRAVITY IN LOLLAND
GEODAETISK INSTITUT, 3TH SERIE, T.28
1958

37 5Q 15 NB POINTS= 2113
S. E. SAXOV
GRAVITY IN SONDERJYLLAND
GEODAETISK INSTITUT, 3TH SERIE, T36
1958

38 5S 2 NB POINTS= 21
WIDELAND
ELATIVE SCHWEREBESTIMMUNGEN IN SCHWEDEN IM JAHREN 1941
TATIGKEIT DER BALTISCHEN GEOD.KOMMISSION IN DEN JAHREN 1938-1941
1941

39 5S 3 NB POINTS= 968
B. WIDELAND
RELATIVE SCHWEREBESTIMMUNGEN IN SUD- UND MITTELSCHWEDEN IN DEN
JAHRE 1943-1944
RIKETS ALLMANNA KARTVERK MEDDEL.NO.6
1946

40 5S 4 NB POINTS= 1109
B. WIDELAND
RELATIVE GRAVITY MEASUREMENTS IN MIDDLE AND NORTH SWEDEN 1945-1948
RIKETS ALLMANNA KARTWVERK MEDDEL.14
1951

41 5T 5 NB POINTS= 28
M. WITTINGER
GRAVIMETRICKA ZAKLADNI SIT CSR
TR. DE L INSTIT. GEOPHYSIQUE DE L ACAD. TCHCOS. DES SCIENCES (TRA-VAUX GEOPHYSIQUES 1953)
1953

42 5T 12 NB POINTS= 607
V. CHUBODA
DAS TSCHECHOSLOWAKISCHE GRAVIMETERNETZ 1. UND 2.ORDNUNG
TR. DE L INST.GEOPHYS. DE L AC. TCH. DES SCIENCES. NO 63, TR. GEOP
1957

43 5V 2 NB POINTS= 116
A. KWIATKOWSKI
TRAVAUX GRAVIMETRIQUES DU BUREAU NATIONAL DES MESURES EN 1936 ET 1937 (7E SERIE)
BUREAU NATIONAL DES MESURES
1938

44 5W 2 NB POINTS= 51
F. A. VENING-MEINESZ
OBSERVATIONS DE PENDULES DANS LES PAYS-BAS, 1913-1921
PUB. COMM. GEODESIQUE NEERLANDAISE
1923

45 5X 3 NB POINTS= 130
T. EINARSON T. SIGURGEIRSSON
G. DODVARSSON
A REPORT ON THE FRENCH-ICELANDIC GRAVITY MEASUREMENTS IN SOUTHERN ICELAND IN 1950
VISINDAFELAG ISLENDINGA
1951

46 5X 4 NB POINTS= 58
T. EINARSSON
A SURVEY OF GRAVITY IN ICELAND
VISINDAFELAG ISLENDINGA 1.30
1954

47 5Z 1 NB POINTS= 114
U. PESONEN
RELATIVE BESTIMMUNGEN DER SCHWERKRAFT IN FINNLAND IN DEN JAHREN 1926-1929
VEROFF. DES FINNISCHEN GEODATISCHEN INSTITUTES NO 13
1930

48 5Z 2 NB POINTS= 211
R. A. HIRVONEN
BESTIMMUNG DES SCHWEREUNTERSCHIEDES HELSINKI-POSTDAM IM JAHRE 1935 UND KATALOG DER FINNISCHEN SCHWERESTATIONEN
VEROFF. DES FINNISCHEN GEODATISCHEN INSTITUTES NO 24
1937

49 5Z 3 NB POINTS= 69
R. A. HIRVONEN
RELATIVE BESTIMMUNGEN DER SCHWERKRAFT IN FINNLAND IN DEN JAHREN 1931-1933 AND 1935
VEROFF. DES FINNISCHEN GEODATISCHEN INSTITUTES NO 23
1937

50 1A 4 NB POINTS= 32
G. L. SHURBET J. L. WORZEL
M. EWING
GRAVITY MEASUREMENTS IN THE VIRGIN ISLANDS
BULL. OF THE GEOL.SOC. OF AMERICA, VOL.67, PP.1259-1536
1956

51 1A 5 NB POINTS= 400
G. L. SHURBET M. EWING
GRAVITY RECONNAISSANCE SURVEY OF PURTO-RICO
BULL. OF THE GEOL.SOC. OF AMERICA, VOL.67, PP.511-534
1956

52 1A 15 NB POINTS= 713
E. M. ANDREW
GRAVITY SURVEY IN JAMAICA
INST. GEOL. SCI., REP9 NO GP/0/40
1969

53 1A 16 NB POINTS= 7950
S. CORON M. FEUILLARD
J. M. LUBART
ETUDES GRAVIMETRIQUES EN GUADELOUPE ET DANS LES ILES DE SON ARCHI-PEL - PETITES ANTILLES
ANNALES DE GEOPHYSIQUE T.31, FASC.4, PP.531-548
1975

54 1A 17 NB POINTS= 993
D. J. MASSON-SMITH E. M. ANDREW
GRAVITY AND MAGNETIC MEASUREMENTS IN THE LESSER ANTILLES
OVERSEAS GEOL. SURVEYS, GEOPHYS. DIV. (PRELIMINARY REPORT)
1965

55 1C 2 NB POINTS= 94
G. L. SHURBERT J. L. WORZEL
GRAVITY MEASUREMENTS IN ORIENTE PROVINCE, CUBA
BULL. GEOL. SOC. OF AMERICA, VOL.68, PP.119-124
1957

56 1U 300 NB POINTS=375600
U.S.A. DATA
N.G.S.D.C.- N.O.A.A.

57 2A 100 NB POINTS= 1054
ARGENTINA DATA
UNIVERSIDAD DE BUENOS-AIRES, INST. DE GEODESIA

58 2A 200 NB POINTS= 267
ARGENTINA DATA
INSTITUTO GEOGRAFICO MILITAR
1967

59 2B 007 NB POINTS= 1017
L. I. GAMA
VALORES DA GRAVIDADE NAS REGIOES CENTRO E SUL DO BRASIL
OBS. NACIONAL, PUBL. DO PROGRAMA GRAVIMETRICO NO.4
1972

60 2B 009 NB POINTS= 479
L. I. GAMA
EXTENSAO DA REDE DO NORDESTE
OBS. NACIONAL, PUB. DO PROGRAMA GRAVIMETRICO NO.6
1973

94 2B 100 NB POINTS= 620
GEMAEL
BRAZIL DATA
CENTRO DE ESTUDOS E PESQUISAS DE GEODESIA - CURITIBA (PARANA)
1970

61 2U 001 NB POINTS= 723
RED GRAVIMETRICA FUNDAMENTAL - RESUMEN DE VALORES
SERVICIO GEOGRAFICO MILITAR
1970

62 U 4M NB POINTS= 73
CORSE DATA

63 A 3 NB POINTS= 399
J. LAGRULA
ETUDE GRAVIMETRIQUE DE L ALGERIE TUNISIE
BULL. DU SERV. DE LA CARTE GEOL. DE L ALGERIE, 4E SERIE, GEOPHYS.2
1951

64 C 10 NB POINTS= 1600
L. JONES P. L. MATHIEU
H. STRENGER
CATALOGUE DES STATIONS GRAVIMETRIQUES. DEFINITION ET RESULTAT DES
MESURES. DEGRES CARRES NORD 2 A SUD 1
ANN. DU MUSEE ROYAL DU CONGO BELGE (SCIENCES GEOL.) VOL.26
1959

65 C 12 NB POINTS= 1741
L. JONES P. L. MATHIEU
H. STRENGER
CATALOGUE DES STATIONS GRAVIMETRIQUES. DEFINITION ET RESULTAT DES
MESURES. DEGRES CARRES SUD 2 A SUD 4
ANN. DU MUSEE ROYAL DU CONGO BELGE (SCIENCES GEOL.) VOL.31
1960

66 C 13 NB POINTS= 256
P. EVRARD L. JONES
P. L. MATHIEU
ETUDE GRAVIMETRIQUE PRELIMINAIRE DU GRABEN DE L AFRIQUE CENTRALE
ETABLISSEMENT D UN RESEAU DE BASE
ACAD. ROYALE DES SCIENCES D OUTRE-MER (SCIENCES TECHNIQUES) T.13,
FASC.2
1960

67 D 999 NB POINTS= 10035
RECHENMAN
O.R.S.T.O.M.
MADAGASCAR DATA (1970)
1975

68 F 000 NB POINTS= 31443
LOUIS
A.E.F. DATA (1963)
O.R.S.T.O.M.
1969

69 G 200 NB POINTS= 259
GHANA DATA

70 K 7 NB POINTS= 1878
E. M. ANDREW
GRAVITY SURVEY OF MALAWI, FIELWORK AND PROCESSING
INSTITUTE OF GEOLOGICAL SCIENCES, REPORTNO 74/15
1974

71 K 1 NB POINTS= 110
D. M. MASSON-SMITH E. M. ANDREW
GRAVIMETER PRIMARY STATION NET IN EAST AND CENTRAL AFRICA
OVERSEAS GEOLOGICAL SURVEYS
1961

72 R 100 NB POINTS= 2235
PODMORE
RHODESIA DATA
UNIVERSITY OF RHODESIA
1974

73 T 1 NB POINTS= 64
J. LAGRULA
ETUDE GRAVIMETRIQUE DE L ALGERIE TUNISIE
BULL. DU SERVICE DE LA CARTE GEOL.DE L ALGERIE, 4E SERIE GEOPHYS.2
1951

74 U 2 NB POINTS= 53
A. L. HALES D. I. GOUGH
MEASUREMENTS OF GRAVITY IN SOUTHERN AFRICA
BERNARD PRICE INST. OF GEOPHYSICAL RESEARCH AND NATIONAL PHYS. LAB
1950

75 U 4 NB POINTS= 7430
P. J. SMITH A. L. HALES
D. I. GOUGH
THE GRAVITY SURVEY OF THE REPUBLIC OF SOUTH AFRICA (PART 1 AND 2)
GEOLOGICAL SURVEY
1962

76 3G 21 NB POINTS= 5222
G. P. WOOLLARD M. MANGHNANI
S. P. MATHUR
GRAVITY MEASUREMENTS IN INDIIA
HAWAII INSTITUTE OF GEOPHYSICS, HIG-69-17 REPORT PART 2
1969

77 3G 22 NB POINTS= 145
M. KONO
GRAVITY ANOMALIES IN EAST NEPAL AND THEIR IMPLICATIONS TO THE
CRUSTAL STRUCTURE OF THE HIMALAYAS
GEOPHYS.J.R.ASTR. SOC. 1974-39, PP.283-299
1974

78 3G 5 NB POINTS= 2982
B. L. GULATEE
GRAVITY DATA IN INDIA
SURVEY OF INDIA, TECHNICAL PAPER NO 10
1956

79 3H 3 NB POINTS= 196
R. P. LEJAY
ETUDES GRAVIMETRIQUES DES ILES PHILIPPINES
1939

80 3H 4 NB POINTS= 4
P. LEJAY
EXPLORATION GRAVIMETRIQUE DE L EXTREME-ORIENT
C.N.F.G.G.
1936

81 3I 1 NB POINTS= 327
IRANIAN NATIONAL REPORT ON THE GRAVITY MEASUREMENTS IN IRAN
(+2 SUPPLEMENTS), TO THE 12TH GEN. ASS. IUGG, HELSINKI, 1960
UNIVERSITY OF TEHRAN, INST. GEOPHYSICS PUB. NO.9,II,NAT.REP.
1965

82 3I 2 NB POINTS= 14
IRANIAN NATIONAL REPORT ON THE ESTABLISHMENT OF GRAVITY BASES IN
THE PERSIAN GULF
UNIVERSITY OF TEHRAN, INST. GEOPHYSICS PUB. NO.11
1963

83 3N 4 NB POINTS= 21
P. LEJAY
EXPLORATION GRAVIMETRIQUE DE L EXTREME ORIENT
C.N.F.G.G.
1936

84 3O 4 NB POINTS= 201
P. LEJAY
EXPLORATION GRAVIMETRIQUE DE L EXTREME-ORIENT
C.N.F.G.G.
1936

85 3O 7 NB POINTS= 32
K. G. FU YOUNGSTEN CENG
C. Y. CHANG
ISOSTATIC ANOMALIES OF 208 CHINESE GRAVITY STATIONS
JOURNAL OF THE CHINESE GEOPHYS. SOCIETY, VOL.1, NO.2
1949

86 3P 4 NB POINTS= 70
A. MARUSSI
GEOPHYSICS OF THE KARAKORUM
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1964

87 3Q 100 NB POINTS= 121
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1973

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GRAVITY DETERMINATIONS + PERIOD 1/1/57-1/8/59
ROYAL THAI SURVEY DEPT, NAT.REP. AT I.G.C.
1959

89 4M 1 NB POINTS= 13
C. MACE
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MONTHLY NOTICES OF THE R.A.S., GEOPHYS. SUPPLEMENT, VOL.4, NO 7
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90 4P 17 NB POINTS= 410
A. MALAHOFF G. P. WOOLLARD
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HAWAII INSTITUTE OF GEOPHYSICS, HIG-69-14 REPORT
1969

91 4P 3 NB POINTS= 28
G. ROUILLON
MESURES EN POLYNESIE
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93 4Z 200 NB POINTS= 7235
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(3) INVENTORY OF NEWLY RECEIVED DATA NOT YET MERGED WITH OUR HOLDINGS
(AS OF MAY 1981)

AFRICA

. O.R.S.T.O.M.

- Ivory Coast...	8792	measurements
- Mauritania - Senegal..................................	9021	"
- Benin - Hte Volta - Niger.............................	6038	"
- La Reunion Island.....................................	82	"
- Comores Islands.......................................	74	"

. UNIVERSITY MAHOMED V - Service de Physique du Globe

- Maroc...	∿ 6000	"

. Pub : LAGRULA, CLAVE DE OTAOLA, DELATTRE, SCHUSTER, WALSH
Etude de quelques anomalies du Sahara algérien
(Promontoire d'Amgrid et Tafassasset)
1973. CR. Acad. Sci. t. 276. Série D p. 1261-1265........... ∿ 280 "

. Rep. of DJIBOUTI.. ∿ 750 "

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Catalogue of gravity measurements. 1977

- Kenya.. 8709 pts

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East Africa :

- Overseas Geological Survey (unpublished)
- G.H. SUTTON. Hawaii Institute of Geophysics (unpublished)
- BP/SHELL (Tanjania) (unpublished)
- Newcastle univ. 1966-1967 (Sowerbutts & Searle, unp., Ph. D. Thesis)
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- Geophysical Observatory, Addis Abeba - Bull. n° 7, 9, 10, 13
- Uganda Geological Survey (obtained from DMAAC)
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  BGI réf. B 492 & Annales
- Queseri (Sudan) Geophys. J.R. Astr. Soc. n° 24, 1971
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  Jl. Earth Sci. Nagoya Univ., 17, 169-188 (1969)
- Mozambique. BGI réf. B 864
- Botswana Geological Survey. Bull. n° 5, 1976
- Swaziland Geological Survey & Mines Dept. Bull. n° 7, 1970.

JAPAN

. OCEAN RESEARCH INSTITUTE

- Bathymetry, Gravity and Magnetism data ∿ 100.000 records (28.993 with gravity)
  Cruises UM66, 67, 68, 69, 63, 6401, 6402, 6503 without gravity

KH 6705	1495 pts	KH 7002	4444
6804	8970	7003	1072
6902	4420	7004	805
6803	3005	7101	4782

. HYDROGRAPHIC DEPARTMENT   30 307

HT 6501	347 pts	HM 7401	1430
HM 6802	1369	HM 7503	2762
HM 6804	2898	HM 7501	3595
HM 7002	3285	HM 7602	4831
HM 7003	1388	HM 7603	3280
HM 7103	1726		
HM 7201	1519		
HM 7302	1877		

. MT - GEOGRAPHICAL SURVEY INSTITUTE

(1st, 2nd, 3rd order gravity survey in the whole land of Japan).

UNITED-KINGDOM

INSTITUTE OF GEOLOGICAL SCIENCES

. 11/80
Scotland . 33.820 gravity stations

. 2/81 (Marine Geophysics Unit)
Offshore

Project		Meas.	Project		Meas.	Project		Meas.
70/02	.	1570	72/05	.	190	74/04	.	470
70/03	.	1820	72/06	.	820	74/05	.	220
70/04	.	360	72/07	.	500	76/01	,	3220
70/05	.	1160	73/06	.	1570	77/02	.	7780
71/03	.	2020	73/07	.	1200	77/07	.	4080
71/05	,	1850	73/19	,	870	79/12	.	7260
72/04	.	2810	74/01	.	110	79/14	.	12810
72/03	.	1080	74/03	.	560	79/15	.	7900

SPAIN

. ISTITUTO GEOGRAFICO Y CADASTRAL

7110 Land gravity meas.

ITALY

. ISTITUTO DI FISICA - LECCE
7/79

22720 Land gravity meas.

USSR

SEA GRAVITY DATA

. In BGI Data Base

Vessel : Staratelni (1969)		1440	measurements
Ac. Kourtchatov	cruise 5	6645	"
	15	3535	"
	20	9139	"
Vitiyaz	cruise 42	1688	"
	47	74	"
	49	6995	"
	51	5365	"
Dimitri Mendeleev	cruise 3	3638	"
	5	5782	"
	6	4157	"
	7	5357	"
	9	4724	"
	10	4225	" 62 764

. Recent Data

Dimitri Mendeleev	cruise 18	4580	"
Kireev	cruise 1	7302	"

. Data to prepare

Ac. Kourtchatov	cruise 3	470	" (list+cards)
Vitiyaz	Cr. B43	1049	" (list)

(correspond. with DMA source n° 3923)

Prof. Zoubov (1968-1969)	1253	" (publication)

NEW-ZEALAND

. D.S.I.R. - GEOPHYSICS DIVISION

∿ 30.000 land gravity data
(complete set of the holdings, replacing any data sent before)
(copy sent to D.M.A.)

AUSTRALIA

. BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

Land gravity data

(4) LIST OF OLDER DATA SETS (IN VARIOUS FORMS)

I. MEASUREMENTS AT SEA

NETHERLANDS

. Netherlands Hydrographer NAVADO 3 Bathy., mag., gravity investigations HMS SNELLIUS 1964-1965.................... ∿ 10 000 pts

U.K.

. University of Cambridge, Dept of Geophysics
Measurements in the North Atlantic Ocean
Vessel "Discovery" cruise n° 23 (2386).................... 605 pts 1968
Vessel "John Murray" cruise n° 14 (1486).................. 250 pts 1968

U.K.

. Hydrographic Department
Western approaches of Gibraltar.......................... 391 pts

ITALY

. Morelli
Ossevatorio Geofisico Sperimentale Trieste
Occident. Mediterranean data.............................. 2 378 pts

U.K.

. J.M. Woodside
Regional vertical lectonics in the Eastern Mediterranean
Geophys. J. R. Astr. Soc. 47, 1976
Shackleton cruises 1972-1974.............................. 2 856 pts

FINLAND

. T. Honkasalo
Gravity survey of the Ballic and the Barents sea
Finnish Geodetic Institute 1959........................... 200 pts

II. LAND MEASUREMENTS

SPAIN

. J.D. Robertson
A gravity study of the Serrania de la Ronda, Provencia Malaga, Espania, Princeton University, Geol. Engin. Rep.
n° 70-1, 1970... 377 pts

SPAIN

. Baleares Islands
I.G. y C., 1977... 191 pts

GUINEA BISSAU

. Observacoes Gravimetricas no territorio da Guine Portuguesa
. Servicio Meteorologico nacional RT 880-GEO 100
. 1966... 140 pts

MISCELLANEOUS

The BGI staff has undertaken the writing of a series of technical notes describing the algorithms used in performing various tasks of general interest for the surface gravity data users. The notes are also guides to program utilization. We expect them to be mostly useful to people requesting services from the Bureau, as given in B.I. n° 47.

Copies can be obtained upon request. Available notes are :

1. Level Curve Program "LEVEL" - Broad Description
2. Data Screening in 2-Dim. S/P "SCREEN"
3. Points in or out a Compact Set of $\mathbb{R}^2$. Various Algorithms and Programs.

The gravity map catalogue is being digitized. The subsequent informations for each map are entered in the file according to the following sample scheme.

```
     9  =ALLEMAGNE FEDERALE
AUTEUR  =GERKE KARL
TITRE   =KARTE BOUGUER-ISANOMAL.WESTDEUTSCHLAND
ORGA.   =DEUTSCHE GEOD.KOMM.
PUBL.   =FRANKFURT/MAIN
ANNEE   =1957
           *****
BOUGUER B    415
ECHELLE=1/1000000
LAT.N= 55.0  LAT.S= 47.3  LON.O=    6.0  LON.E=   13.0
STAT.REF.=BAD HARZBURG           G=981180.40
EQUIDISTANCE  5.0 MGAL
DENSITE=2.67
*VOIR DOC.                      *
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Instrumental Capabilities of LaCoste-Romberg Gravity Meters for the Detection of Small Gravity Variations with Time

Gerd Boedecker
Deutsches Geodätisches Forschungsinstitut
Abt. I, München

Summary

The informations composing the instantaneous reading at a gravity meter are represented in a synopsis and it is tried to order the countermeasures against disturbing signals. From these the calibration errors, driftanomalies and environmental influences to the gravity meter are discussed, giving some details especially with respect to calibration function investigations. Numerical values are quoted from 4 LaCoste-Romberg gravity meters employed in the measurements for the new gravity Base Net 1976 of the Federal Republic of Germany.

1. The Components of the Gravity Meter Reading Signal

In fig. 1 it was tried to give a synopsis of the components of the gravity meter reading. If we want to get a long-term gravity variations signal we have to filter out all other influences. This may be performed through different measures, as is shown in tab. 1 for some instrumental influences. The magnitude numbers given in tab. 1 are merely found by own experience in Germany and do not claim for general validity. It appears important, however, to get a feeling for the magnitude of some influences in order to fight against the greatest error sources. From tab. 1 we recognize, that the most severe error source, which can not be counteracted by instrumental provisions of the user, are the errors from the calibration function. Therefore this problem is of great interest for us.

The countermeasures to be taken may be reductions/corrections, instrumental provisions, appropriate arrangement of measurements and mathematical modelling in an adjustment.

Error source	Estimated magnitude (typical)	Countermeasures: Reduction/ correction	Instrumental provisions	Arrangement of measurem.	Modelling in adjustment
Off-height	0.003	X	X		
Off-levelling	0.005		X		
Calibration function	0.015	(X)		X	X
(Periodic deviation)	0.010	(X)		X	X
Abnormal drift, induced by outer events	not estimable	(X)	X	X	(X)
Voltage instability	0.005		X	X	
Temperature changes	0.005	(X)	X		X
Air pressure changes	0.002				
Magnetic field	unpredictable (1Ex.:0.040)		X	X	
Shocks	unpredictable		X	X	

Table 1: Some Instrumental Error Sources and Countermeasures

In the sequel we add some numerical examples to the general considerations. These examples were drawn from the investigations for the new German Gravity Base Net (Schweregrundnetz 1976 der Bundesrepublik Deutschland, DSGN76), which was established by the Deutsches Geodätisches Forschungsinstitut, München and Frankfurt.

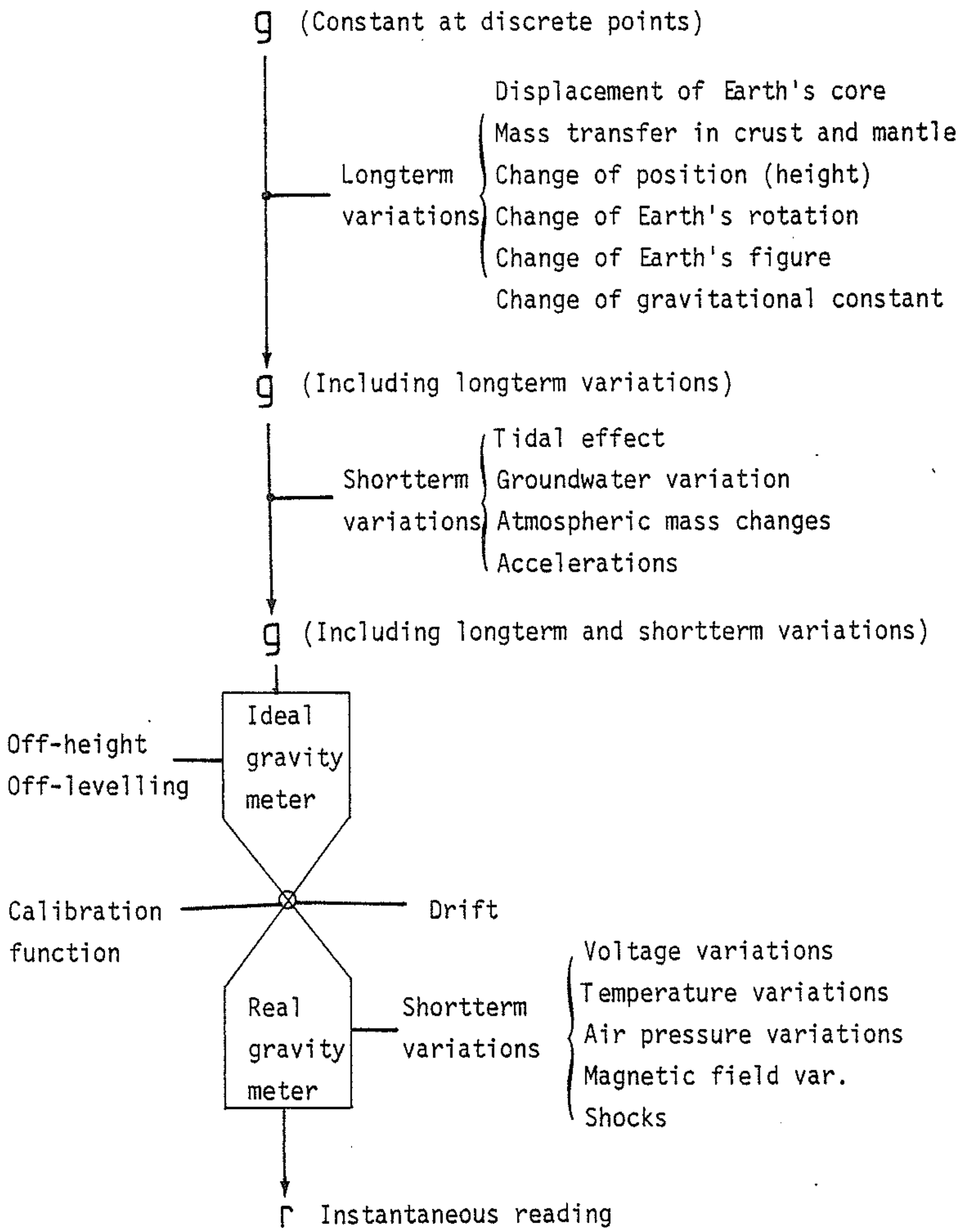

Figure 1: Components of Gravity Meter Reading Signal

2. Calibration Function

A changing gravity causes a changing spring length. The change in length is determined by moving the lever with the aid of a measuring screw via a gearbox applying the null method. The transformation function from gravity change to the reading at the measuring screw (& rev.),called calibration function, comprises the response of the spring to changed force, the transition from the translational motion of the lever to the rotational motion of the measuring screw and the gears in the gearbox. The differences of the manufacturers calibration tables to the true calibration function may consist of

a) linear piecewise approximation and rounding,

b) deviations of low frequency, which can be represented by a low order polynomial over a range of e. g. 1000 mGals[1],

c) periodic deviations caused by the rotations involved,

d) irregular deviations of high frequency.

The effect b) is regarded in the conventional "calibration" at some stations with appropriate and known gravity values. Irregular high frequency deviations according to d) can in reality hardly be studied. In this section we want to concentrate on the drawbacks of the calibration tables (cf. a) and on periodic errors (cf. c).

2.1 Calibration Tables

The calibration function as determined by the manufacturer is published in the form of tables respresenting a piecewise linear approximation. In the tables for our four instruments the milligal-value at intervals of 100 r. s. (revolution of spindulum) are rounded to 0.01 mGal; for elder instruments also the slope "factor for interval" is rounded to 0.005 mGal/100 mGal. This rounding off may correspond to the overall instrumental accuracy. For small gravity differences of two points belonging to two

---

[1] In this paper we normally use 1 mGal = $1 \cdot 10^{-5}$ m s^{-2}

2.2 Periodic Deviations

From the mechanical construction of the gearbox e. g. Honkasalo came to some periods to be expected. These values, quoted by Gerstenecker (1973) are:
1, 3.94, 7.88, 35.47, 70.94, 503, 1206 r. s.
Because there is no ideal calibration line with dense true absolute values to determine periodic deviations, we investigated shorter periods applying the tilt method, for longer periods we tried out a relative calibration with four gravity meters from field measurements.

2.2.1 Tilt Calibration

The force acting on a gravity meter spring may be varied by tilt. To keep astatization constant, the tilt β has to be performed perpendicular to the plane containing spring and lever.

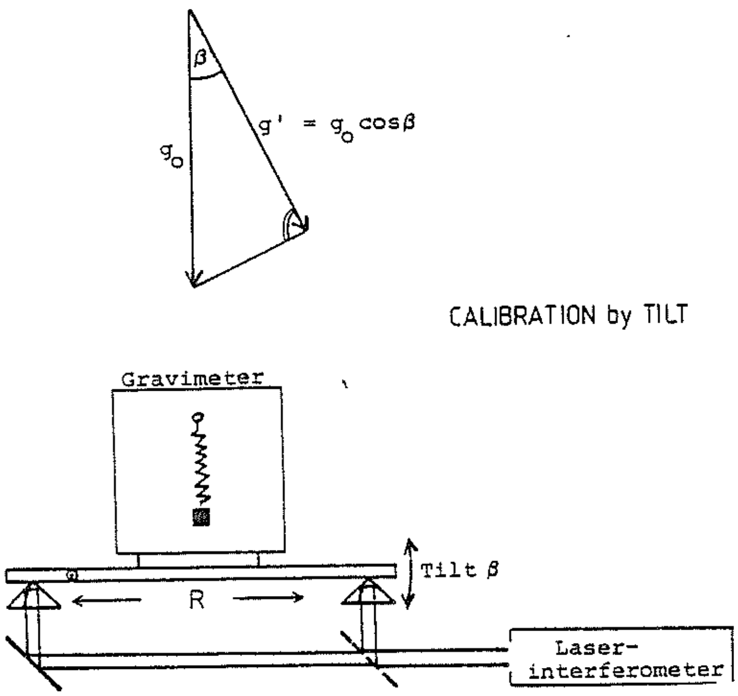

Figure 3: Calibration by Tilt

table-intervals, however, the rounding off may cause errors up to e. g. 0.010 mGal, as shown in fig. 2.

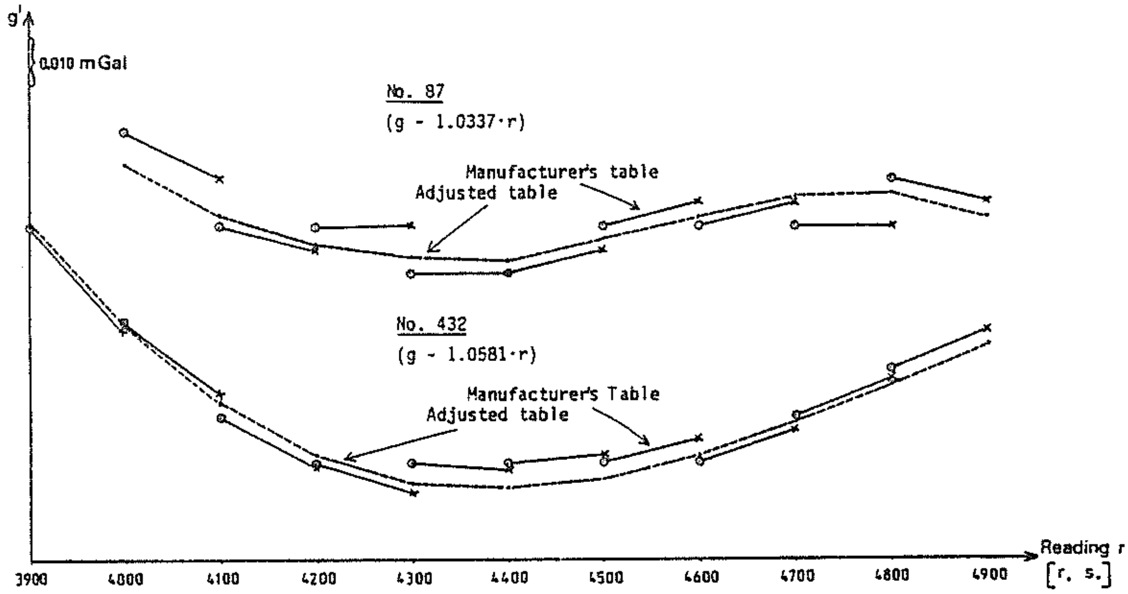

Figure 2: Piecewise Linear Calibration Function (Ex. No.87 & 432)

For this reason a least squares adjustment was performed with observation equations of the type

$$v_i = \bar{s}_i - s_i \tag{1a}$$

$$v_{ij} = -\bar{s}_i + \bar{s}_j - f_{ij} \tag{1b}$$

with

$\bar{s}_i$, $\bar{s}_j$ adjusted ordinates

s_i rounded values of $\bar{s}_i$, "value in milligals" of the manufacturers table

f_{ij} "factor for interval" * 100 .

The weights for (1a) and (1b) are assigned according to the round off step. For the resulting calibration function cf. fig. 2. The remaining effect from the linearity of the approximation function seems to be less than 0.003 mGal.

We start with (cf. fig. 3)

$$f\cdot(r - r_o) = g_o\cdot(\cos(\beta - \beta_o) -1) \qquad (2)$$

where

- f linear scale factor
- r gravity meter reading including tidal correction
- r_o parameter for unknown reading at β_o
- g_o gravity at the point
- β tilt angle
- β_o orientation parameter tilt.

In our case the tilt was determined by means of a laser interferometer (cf. fig. 3). Thus we have for small tilt angles

$$\beta = \frac{h}{R} \qquad \beta_o = \frac{h_o}{R}$$

where

- h height difference of the reflectors
- R distance of the reflectors.

Expanding the cosine into a series (only 1 term) and taylorizing (2) we get

$$\frac{g_o}{f_o} \cdot \frac{(h_m - h_{oo})}{R_o^2} \cdot v_h - v_r + \frac{g_o}{f_o} \cdot \frac{(h_m - h_{oo})}{R_o^2} \delta h_o$$

$$+\frac{g_o}{f_o} \cdot \frac{(h_m - h_{oo})^2}{R_o^3} \delta R + \delta r_o - \frac{g_o}{f_o} \frac{(h_m - h_{oo})^2}{R_o^2} \qquad (3)$$

$$+r_{oo} - r_m = 0$$

where

$$h_o = h_{oo} + \delta h_o$$

$$r_o = r_{oo} + \delta r_o$$

$$R = R_o + \delta R$$

$$h = h_m + v_h$$

$$r = r_m + v_r$$

This general adjustment problem of type

$$\underline{A}^T \underline{v} + \underline{B}^T \underline{x} + \underline{w} = \underline{0} \qquad (4)$$

has been solved for the parameters

$$\underline{x}^T = || \; \delta h_o, \; \delta R, \; \delta r_o \; || \qquad (5a)$$

and the residuals

$$\underline{v}^T = || \; \underline{v}_h \; | \; \underline{v}_r \; || \qquad (5b)$$

in the standard procedure.

In order to overcome nonlinearities an iteration was performed. It can be easily seen, that the reflector distance R and the calibration factor f cannot be determined likewise because f and R are linearly dependent. An absolute calibration therefore is only possible, if R is predetermined with the required accuracy. To hold for drift influences, a drift polynomial can be added to (3). It was tried to include parameters for the deformation of the system as also parameters for the non-parallelism of the plane spring/lever to tilt axis. But low order series expansions of these influences always turned out to be linearly dependent on other parameters. This again shows, that an absolute calibration with this method yield doubtfull result. We may, however, regard the adjustment according to (3) only as a filter giving residuals v_r , which may show periodic components.

We observed two series back and forth repeatedly, one in the range 0...1 mGal with 0.1 mGal steps, the other one in the range 0...15 mGal with 1 mGal steps. The admissable range due to mechanical stops was determined beforehand. One drawback of admitting residuals v_r of gravity meter reading as also v_h of height h is the effect, that the v_r are partly mirrored into v_h. In figure 4 an example is presented, where v_h was set to zero. There is some evidence for a periodic error, but as the discrepancies of the two series show, it will hardly be possible to get reliable numerical results for period and amplitude.

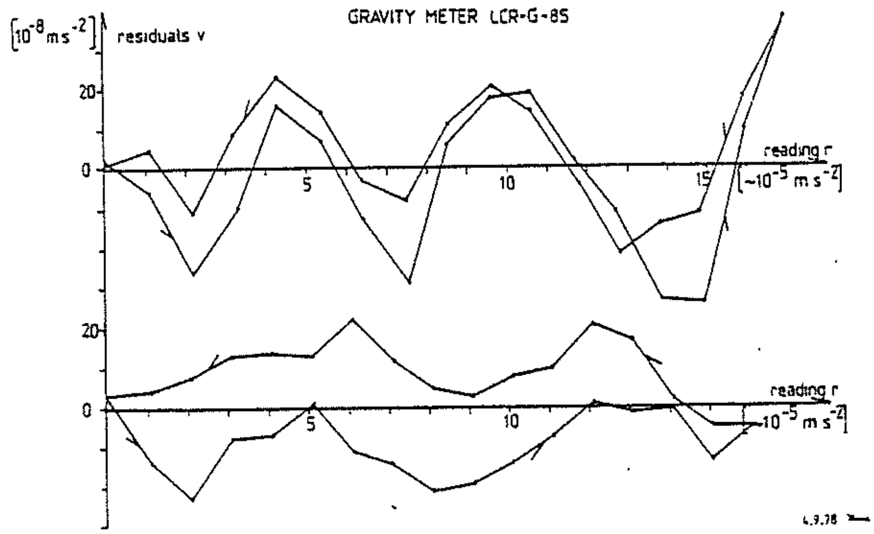

Figure 4: Residuals from Tilt Calibration

2.2.2 Periodic Errors in Field Measurements

"Averaging out" of Periodic Errors

We assume, that all gravity meters have periodic errors of same periods and amplitudes and equally distributed phases. Then we can determine error-free point gravity values when applying an infinite number of instruments. Let us now estimate the probability, that a certain pregiven error is reached when using a finite number of instruments. Vice versa we can estimate the *necessary number of instruments*, if a given *error bound* is to be adhered to with a given probability.

The probability P, that the phases of all participating instruments fall into one particular interval $\Delta\varphi$, depends on the size of the interval as also on the number of instruments n.

We have

$$P = \left(\frac{\Delta\varphi}{2\pi}\right)^{n-1} \tag{6}$$

The absolute maximum error of the mean of n instruments equals the amplitude a of the sine function of the periodic deviation. The mean error b for a given point, however, can be computed by integrating over the possible phases $\delta\varphi$ within an interval $\Delta\varphi$:

$$b = \frac{1}{\Delta\varphi} \int_{\delta\varphi = -\frac{\Delta\varphi}{2}}^{+\frac{\Delta\varphi}{2}} a \cdot \sin\,(\varphi + \delta\varphi)\; d\delta\varphi = \frac{2a}{\Delta\varphi} \sin\varphi \sin\frac{\Delta\varphi}{2}$$

The maximum b_{max} at $\varphi = \frac{\pi}{2}$

amounts to

$$b_{max} = \frac{2a}{\Delta\varphi} \sin\frac{\Delta\varphi}{2} . \tag{7a}$$

In order to get a r.m.s.e. $b_{r.m.s.}$ we start with

$$b_{r.m.s.} = \left(\frac{1}{2\pi} \int_{\varphi = 0}^{2\pi} b^2\, d\varphi\right)^{\frac{1}{2}}$$

and end up with

$$b_{r.m.s.} = \pm\frac{\sqrt{2}}{2} \cdot b_{max} = \pm\frac{\sqrt{2}a}{\Delta\varphi} \cdot \sin\frac{\Delta\varphi}{2} \tag{7b}$$

For the occurrence of b_{max} it is a precondition, that all phases fall into the interval $\Delta\varphi$, the probability of which event can be estimated by (6). Combining (6) and (7a) yields

$$b_{max} = \frac{a}{P^{\frac{1}{n-1}} \cdot \pi} \sin P^{\frac{1}{n-1}} \pi . \qquad (7c)$$

For a numerical example let the probability for b_{max} be $P = 0.1$ and the amplitude $a = 0.010$ mGal. Then we get the mean maximum errors for varying instrument numbers according to figure 5.

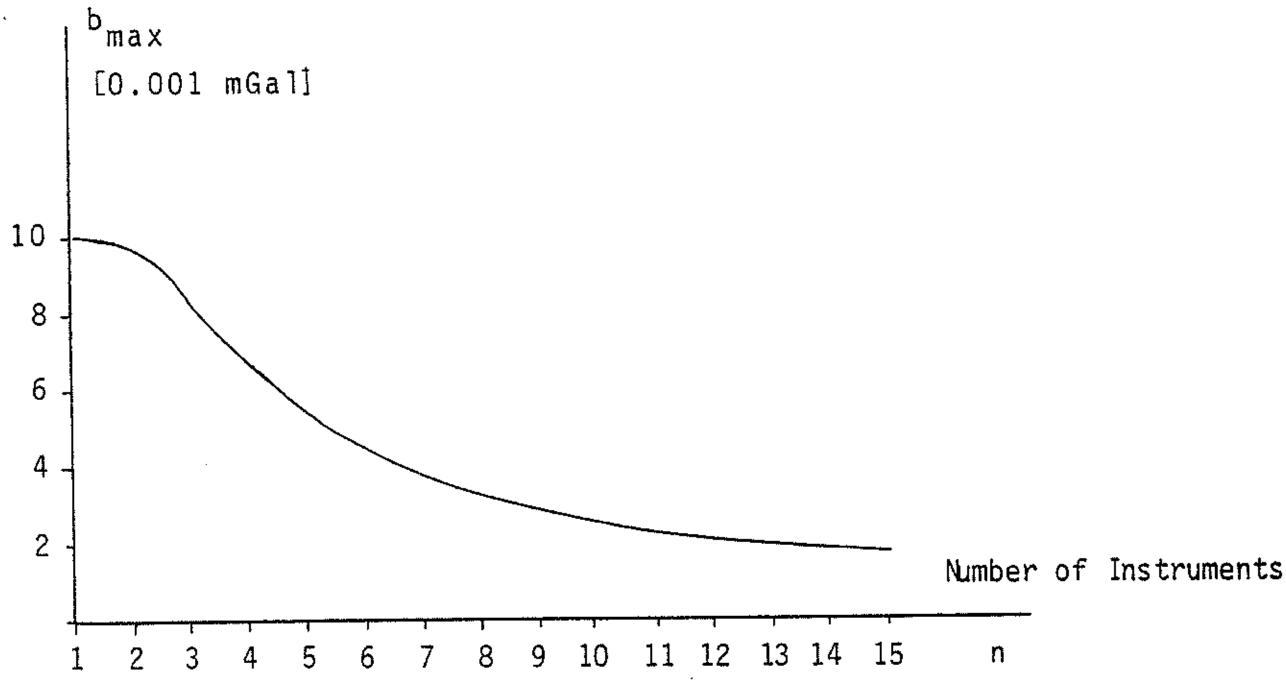

Figure 5: Mean Maximum Error b_{max} as a Function of Instrument Number n (a=0.010 mGal, P=0.1)

Preprocessing of Field Data for Periodic Error Investigation

In 1977 gravity meter observations were carried out for the new net mentioned above, which comprises 21 stations with 4 points each giving 84 stations covering a gravity range of 800 mGal. Four LaCoste-Romberg gravity meters nos 79, 85, 87, 432 were used in repeated measurements giving appr. 700 observations per instrument. A standard least squares adjustment yielded e. g. point gravity values and residuals. These residuals referring groupwise to different (gravity-) level were adjusted according to (9) in order to obtain mean residuals as a function of the reading.

$$v_i = k_c - n_l \quad r_i \qquad (9)$$

where

v_i residuals of this adjustment

r_i residuals of the original net adjustment

n_l orientation parameter for a group of observations

k_c coupling parameter for repeated readings in a certain interval (here 0.8 r. s.).

The adjusted residuals $r_i + v_i$, assigned to full r. s. -units are shown in fig. 6 for one gravity meter. This material was introduced in the spectral analysis presented in the next paragraph.

Spectral Analysis of Residuals

Main goal of the spectral analysis was the determination of the periods. Phases and amplitudes can in a subsequent linear least squares adjustment only be determined if we know the periods. The data is too poor, smoothed and correlated from the preceeding adjustment to yield realistic amplitudes and phases. We had only about 160 real sampling points over a range of about 800 r. s. (cf. fig. 6), whereas the rest was set to zero.

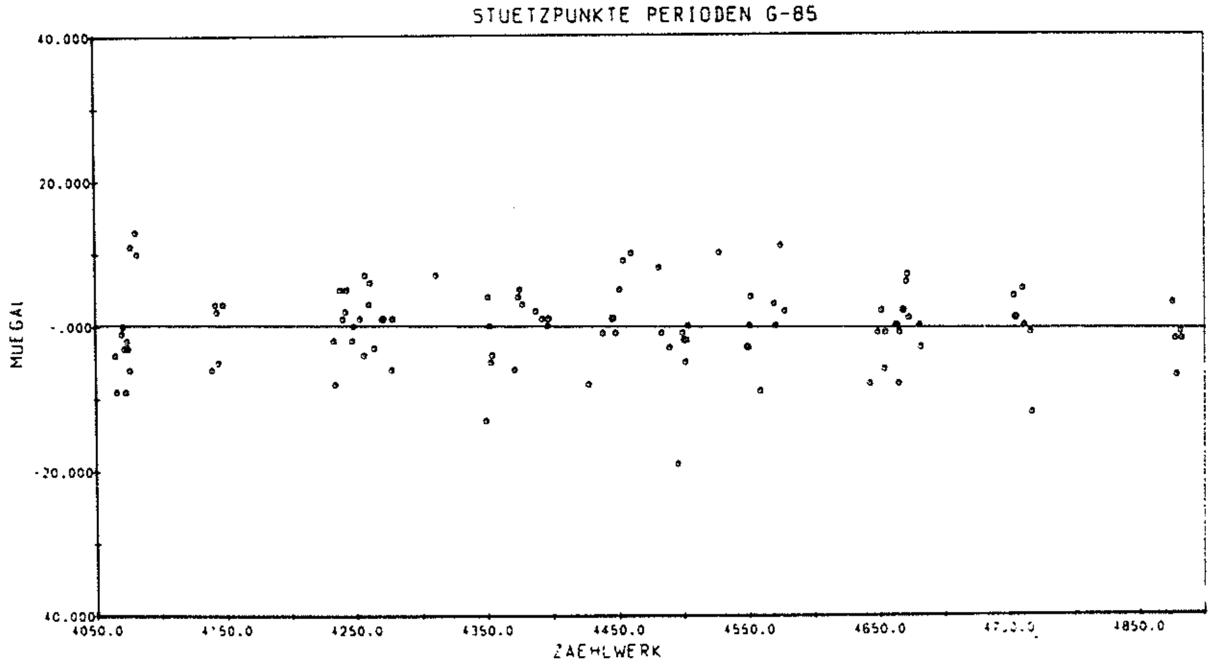

Figure 6: Adjusted Residuals (Example No. 85)

In order to separate two frequency peaks f_1, f_2 , our data window has to have a length of Δ r. s. $\geqq \frac{1}{f_2 - f_1}$. For the separation of the periods 35·47 r.s. and 70.94 r.s., we need a data window of at least 70 r.s.. The resolution is theoretically $f_{max} \leqq \frac{1}{2\delta}$ for a sampling interval δ, that means a minimum period of 2 r.s.. This resolution certainly is not reached by far because of the sparse data.

The resulting spectrum is presented in fig. 7 for the example of no. 85. We see clearly the peaks at frequencies 1/35.5 r.s. and 1/71 r.s.. Regarding the above mentioned presumed periods we state, that the periods of 35.47 r.s. and 70.94 r.s. really occur.

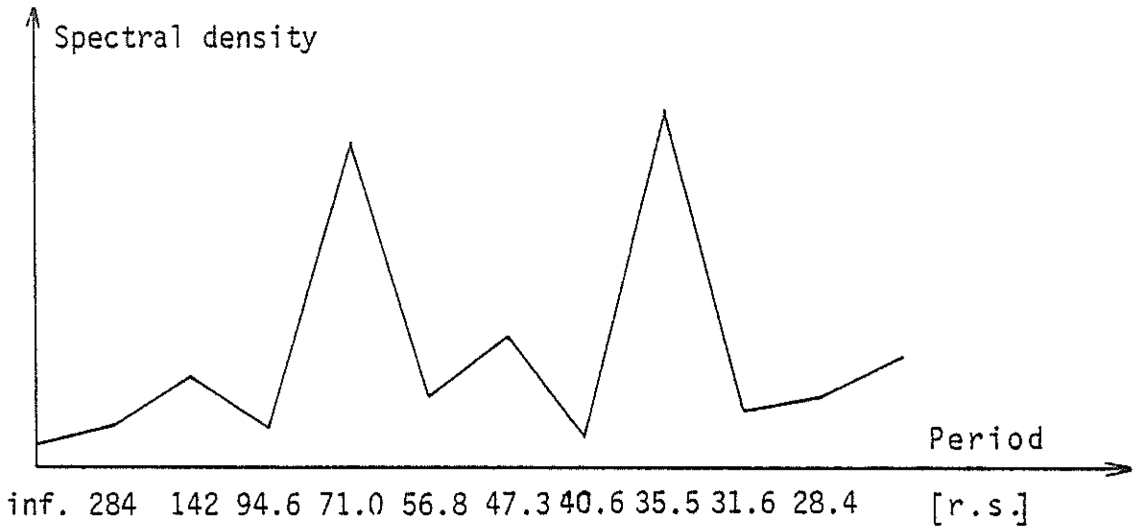

Figure 7: Spectral Density of Residuals (Example: No.79)

Adjustment Including Period Parameters

Now we put parameters for the predetermined periods into our adjustment, the observation equation of which now reads as

$$v_i = g_j - r_i + o_1 + f(z) + g(t) + h(T) + \sum_{k=1}^{m} (p_{1,g,k} \cdot \sin \nu_{g,k} z_i + p_{2,g,k} \cos \nu_{g,k} z_i) \qquad (10)$$

where

- v_i residual of observation no. i
- r_i (corrected) gravity meter reading
- o_1 orientation unknown
- $f(z)$ polynomial for non-periodic fit of calibration function, z being the raw gravity meter reading
- $g(t)$ drift polynomial, t time
- $h(T)$ effect of temperature, T temperature

$p_{1,g,k}$ auxiliary parameter $p_{1,g,k} = a_{g,k} \cdot \cos \varphi_{g,k}$

with

$a_{g,k}$ amplitude of periodic error number k for instrument number g

$\varphi_{g,k}$ phase of periodic error

$p_{2,g,k}$ auxiliary parameter $p_{2,g,k} = -a_{g,k} \cdot \sin \varphi_{g,k}$

m number of periods

$\nu_{g,k}$ frequency .

From the auxiliary parameters $p_{1,g,k}$, $p_{2,g,k}$ we get the amplitude

$$a_{g,k} = \sqrt{p_{1,g,k}^2 + p_{2,g,k}^2}$$

and the phase

$$\varphi_{g,k} = \arctan \left(- \frac{p_{2,g,k}}{p_{1,g,k}}\right) .$$

Table 2 shows the amplitudes of the periods of a joint adjustment according to (10) of 4 gravity meters in the German gravity base net.

Instr. No.	Period [mGal]	Amplitudes [mGal]
79	70.94	0.008
	35.47	0.008
85	70.94	0.015
87	70.94	0.018
432	70.94	0.009
	35.47	0.004

Table 2: Periodic Errors from Adjustment

Of course, the results of table 2 are very much biased, because they stem from the mean of only 4 instruments, which contains great periodic deviations as was shown above.

3. Environmental Influences

3.1 Drift Anomalies

It is wellknown, that mechanical shocks as also quick changes of temperature and air pressure cause abnormal drift behaviour.

During our 1977 campaign we noticed an earthquake, which prevented the measurements for about half a day because of the oscillating lever. During the evaluation of these measurements we realized, that this event furthermore had caused an abnormal drift behaviour of the meters for several days. This is shown for one instrument in figure 8, right half. The drift rates are up to 0.03 mGal per hour.

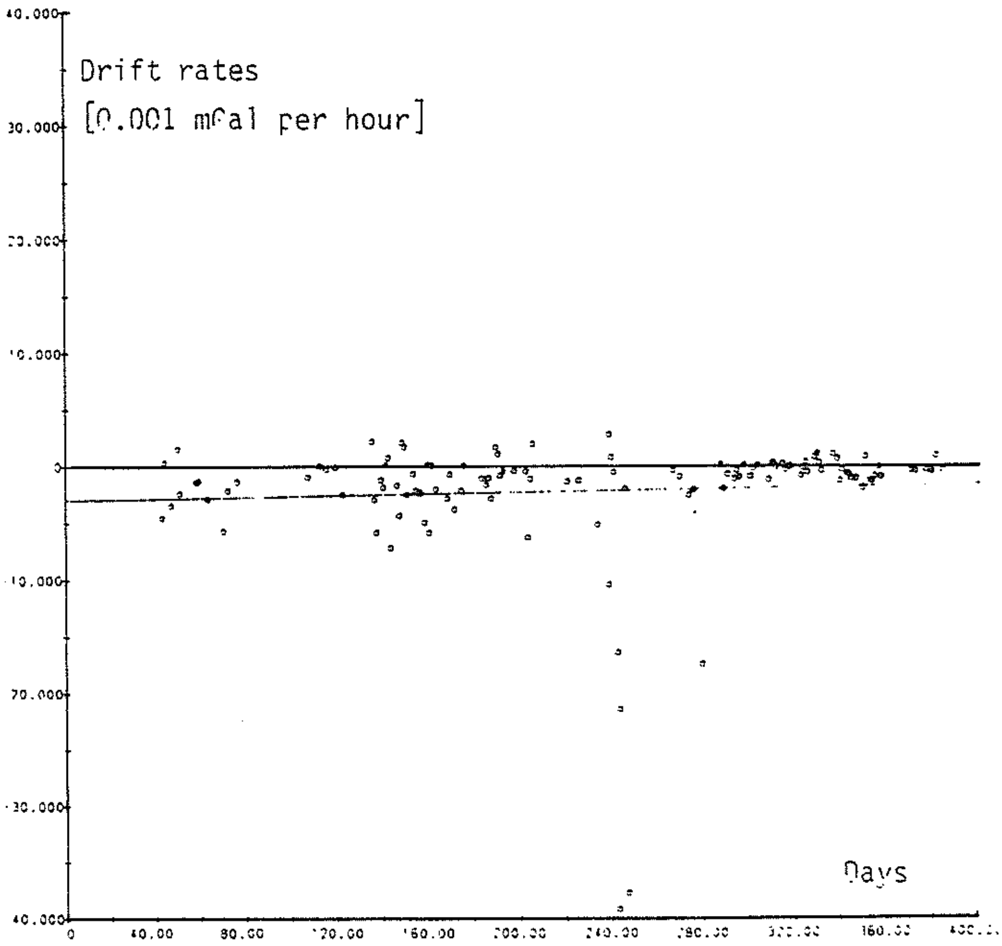

Figure 8: Drift Behaviour

3.2 Variations of Temperature and Air Pressure

Besides the influence of temperature and air pressure on the drift the readings are directly influenced. For the study of these effects we used different approaches, laboratory experiments, regression analyses and parametrizing in the adjustment. For the laboratory investigation of temperature changes we slowly varied the temperature over about 30 K, for air pressure investigations the pressure was varied over a range of about 100 mmHg. The meters were read regularly and the series repeated. Table 3 summarizes the results of these investigations.

Temperature coefficient b and correlation r (with residuals)

Instrument No.	b Laboratory	b Res.regr.anal.	r	b Adjustment
79	-2.3	-0.98	-0.2	-1.2
85	-0.2	0.16	0.1	0.0
87	0.9	0.57	0.1	0.4
432	0.8	-0.21	-0.1	0.0

Air Pressure coefficient c

Instrument No.	c Laboratory
79	-0.08
85	-0.18
87	-0.17
432	-0.21

Table 3: Temperature and Air Pressure Effects
(b [0.001mGal/K]; c [0.001mGal/mmHg])

It became clear, that the laboratory conditions for the temperature investigations do not resemble the field conditions good enough. Therefore a temperature coefficient was added to the adjustment model. Concerning the air pressure variations, the field variations were much too small. Therefore the laboratory coefficient was used for a correction beforehand.

4. Conclusions

LaCoste-Romberg gravity meters are widely used for the study of longterm gravity variations. In order to fully exploit their potential it is necessary to investigate in particular their calibration function but also their response to environmental variations.

Concerning the latter effects, one ought to keep the variations as small as possible and regard the remaining effects by corrections or modelling in the adjustment.

In order to overcome calibration function difficulties one should use smoothed tables as shown in section 2.1 (or better ones). To monitor periodic deviations one can probably use tilt table calibration measurements for short periods. Periods of 35 and 71 mGal may be determined on calibration lines from a great number of instruments.

One cannot hope to eliminate periodic deviations by using identical instruments for repeated measurements over long time periods, because the normal drift shifts the reading to an other point of the calibration function.

If the local conditions in a gravity variations monitoring net admit stations with equal gravity values, this method certainly is the easiest way to get rid of calibration problems. Under certain conditions, this method may be extended also to nets with varying gravity values (Boedecker 1979).
If this method is not applicable one has to do great efforts in order to get gravity values precise enough for secular gravity variations studies.

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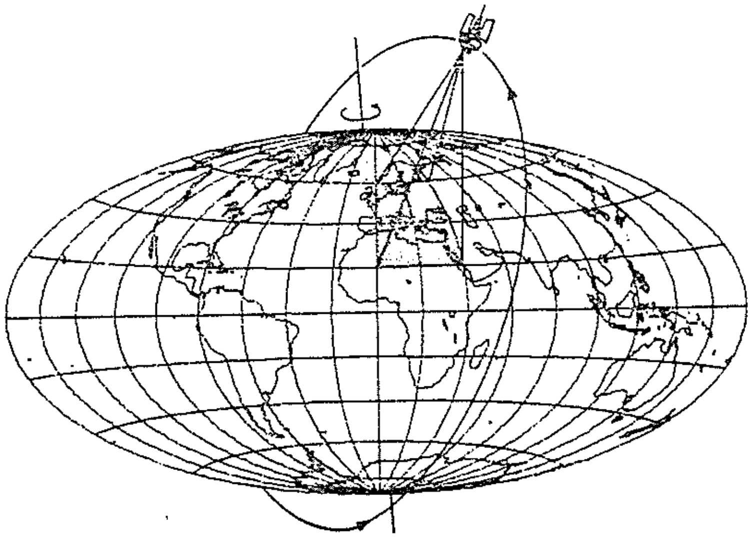
UNIVERSITY OF UPPSALA INSTITUTE OF GEOPHYSICS

THE GEOID OF THE BALTIC AND GULF OF BOTHNIA OBTAINED FROM SEASAT ALTIMETER DATA

ALLEN JOEL ANDERSON
AND
HANS GEORG SCHERNECK



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SUMMARY

During the remaining decades of this century the study and relationship between the geoid, geodynamics, plate tectonics and recent crustal movements will be a major area of investigation in geodesy and geophysics.

As such the determination of a detailed and accurate geoid will play a fundamental role in our understanding of the earth and the dynamic processes of crustal motion.

In Scandinavia a reliable determination of the geoid is one of the prerequisites for an understanding of crustal processes such as post-glacial uplift and studies of past and present plate tectonic mechanisms and their relationship with the Fennoscandian Shield. In addition to the study of the relationship between the geoid and vertical crustal movements in Fennoscandia, a study and use of the geoid includes correlations with Moho depth and large scale crustal density variations of the region. Ultimately this will lead to the construction of models showing the distribution of lithospheric stresses based upon detailed knowledge of the above parameters.

The present SEASAT altimeter data set for Scandinavia consists of the most refined data presently available for defining the geoid over water covered areas in the region. The purpose of this paper is to review the steps undertaken in the reduction of these data and in the preparation of a complete geoid map of the Baltic and Gulf of Bothnia.

This study has resulted in an accurate, detailed, and reliable refinement of the gravity field in the Baltic and Gulf of Bothnia. Several features have been discovered, specifically the series of lows running along the eastern side of the Gulf of Bothnia, intersecting the major low and single largest gravity anomaly of the shield area to the southeast of Åland.

In this paper we deal with the reduction of the data for the Baltic and Gulf of Bothnia. In future papers we plan to successively deal with the additional areas culminating in the production of a completely detailed and homogeneous geoid for the entire Scandinavian region.

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I. The SEASAT spacecraft

II. The SEASAT altimeter data set for Scandinavia

III. Applications of SEASAT altimeter data for representations of the geoid in enclosed sea areas

IV. Sea surface topography and the ocean dynamics of the Baltic and Gulf of Bothnia

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IX. References

I. The SEASAT spacecraft.

The SEASAT spacecraft consists of a three-axis-stabilized Lockheed Agena bus carrying a sensor module on which five remote-sensing instruments are mounted (Figure 1). Three of the instruments are active radar systems, the other two, radiometers (Table 1). Each microwave instrument has its own antenna subsystem.

The satellite orbit is near-circular, with an inclination of 108^{o} (72^{o} retrograde) a period of 101 min, and an altitude of approximately 800 km. For the wide-swath instruments (i.e., SASS, SMMR, and VIRR), ninety-five percent global coverage is effected every 36 hr.

The data used in this paper is from the compressed Pulse Radar Altimeter (ALT). The altimeter has three separate functions:

1) Measure the altitude between the satellite and the ocean surface to 10 cm root-mean-square precision for one-second averaged data.
2) Measure significant wave height from 1 to 20 m with an accuracy of 0.5 m or 10%, whichever is greater.
3) Measure radar backscatter coefficient, σ^{o}, to ±1 dB.

The ALT flown on SEASAT is a more precise version of the GEOS-3 radar altimeter. The Skylab altimeter was the first to give a continuous, direct measurement of the sea-surface topography from a satellite. Prominent surface depressions due to deep ocean trenches and corresponding elevations resulting from seamounts, plateaus, and ridges - already roughly observed from Skylab and better defined by GEOS-3 - are more precisely measured by SEASAT. Having a measurement precision of better than 10 cm enables the SEASAT altimeter to identify such time-varying features as geostrophic currents, tides, wind pile-up, and storm surges.

The second function of the SEASAT altimeter - the measurement of significant wave height - is required in order to remove a

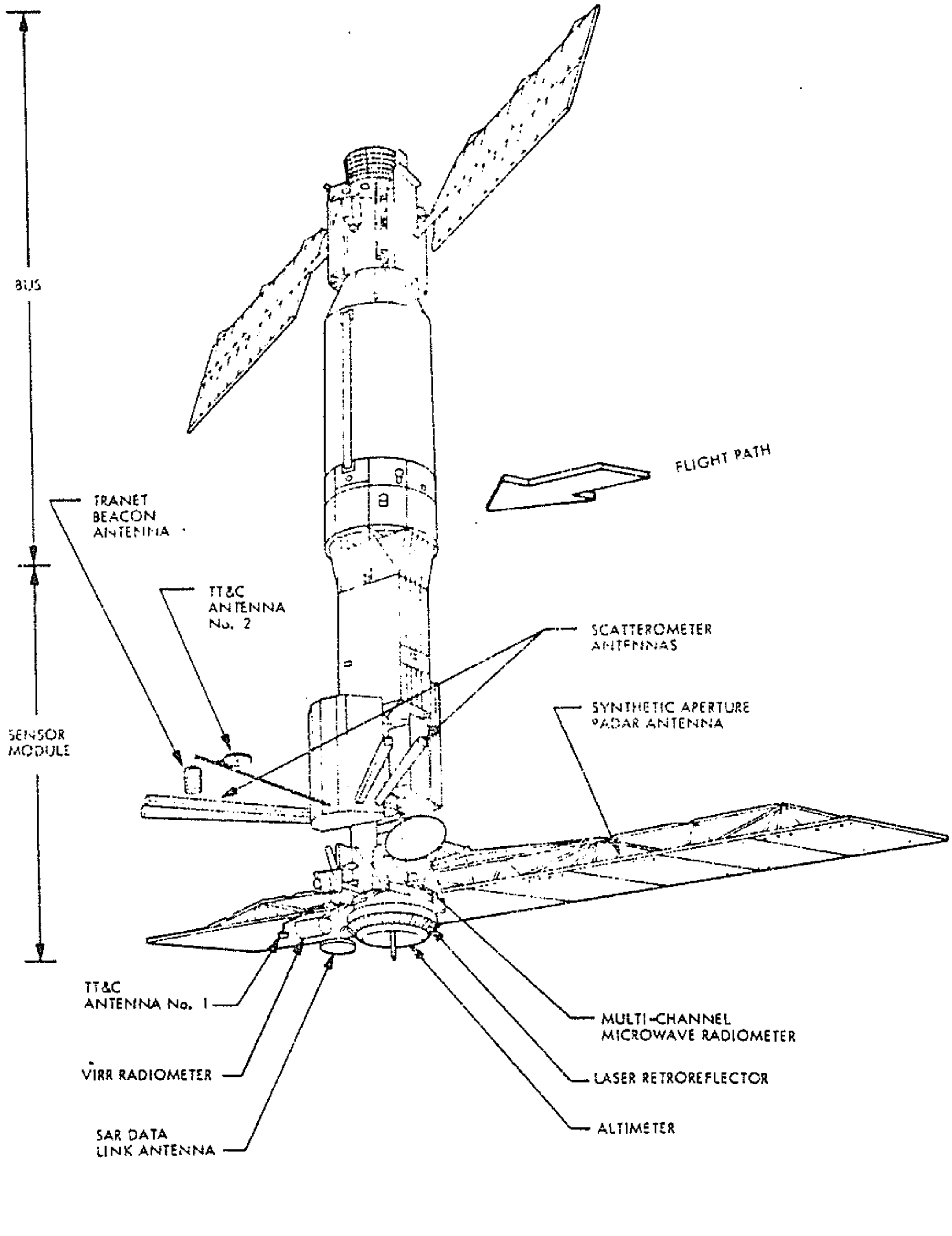


Figure 1. SEASAT Configuration.

Instrument	Type	Geophysical Measurement	Sensing Method
Altimeter (ALT)	Active, short-pulse radar	Wave height, altitude above mean sea level surface & wind speed at nadir	Return pulse--wave form, delay time to midpoint, and backscatter coefficient
Microwave Scat-terometer (SASS)	Active	Surface wind speed and direc-tion	Radar back-scatter--increases with wind speed; forward and aft beam data deter-mine direction
Synthetic Aperture Radar (SAR)	Active, imaging imaging	Wave spectra	Radar echo--range or time delay and frequency shift; forms brigntness image.
Scanning Multifrequency Microwave Radiometer (SMMR)	Passive	Surface wind speed, sea surface temp-erature, atmos-pheric water content	Receives and measures several microwave fre-quencies, each one sensitive to a partic-ular geophysical parameter.
Visible and Infrared Radiometer (VIRR)	Passive, imaging	Sea surface and cloud top mean tem-perature; ocean, coastal, and atmospheric feature location.	Receives and meas-ures visible and infrared emissions.

Table 1. SEASAT Remote Sensing Instruments.

surface roughness bias as one error source towards reaching the 10 cm precision in altitude. Additionally, wave height is valuable in its own right, as when combined with surface temperature, wave spectra, and wind measurements it can be used to aid world-wide seastate forecasts.

As for the third function of the altimeter - measurement of the radar backscatter coefficient - knowing σ^0 enables the calculation of wind magnitudes.

The full exploitation of the altimeter requires very precise orbit determination. In support of this, the satellite was extensively tracked, using laser, S-band, and TRANET Doppler systems.

The data used in this paper represents mean sample heights having a sea surface area ~ 2.4-3.4 km wide and ~ 7 km along track. Figure 2 indicates the radar altimeter "footprint" on the sea surface.

II. The SEASAT data set for Scandinavia.

The present SEASAT altimeter data set for Scandinavia consists of the most refined data presently available for defining the geoid over water covered areas in the region. The data consists of some 16,513 data values, each itself a mean of 10 values, taken during the period 28 July - 15 August 1978. The purpose of this paper is to review the steps undertaken in the reduction of these data and in the preparation of a complete geoid map of the Baltic and Gulf of Bothnia.

This data has made it possible to clearly reveal a number of previously not well understood local anomalies as well as allowing for the most homogeneous, complete and accurate representation of the geoid for this region. Figure 3 represents the data available in this study, showing each satellite track along which SEASAT altimeter data has been produced for the Scandinavian region.

In this paper we deal with the reduction of the data for the Baltic and Gulf of Bothnia. In future papers we plan to successively deal with the additional areas culminating in the production of a completely detailed and homogeneous geoid for the entire Scandinavian region.

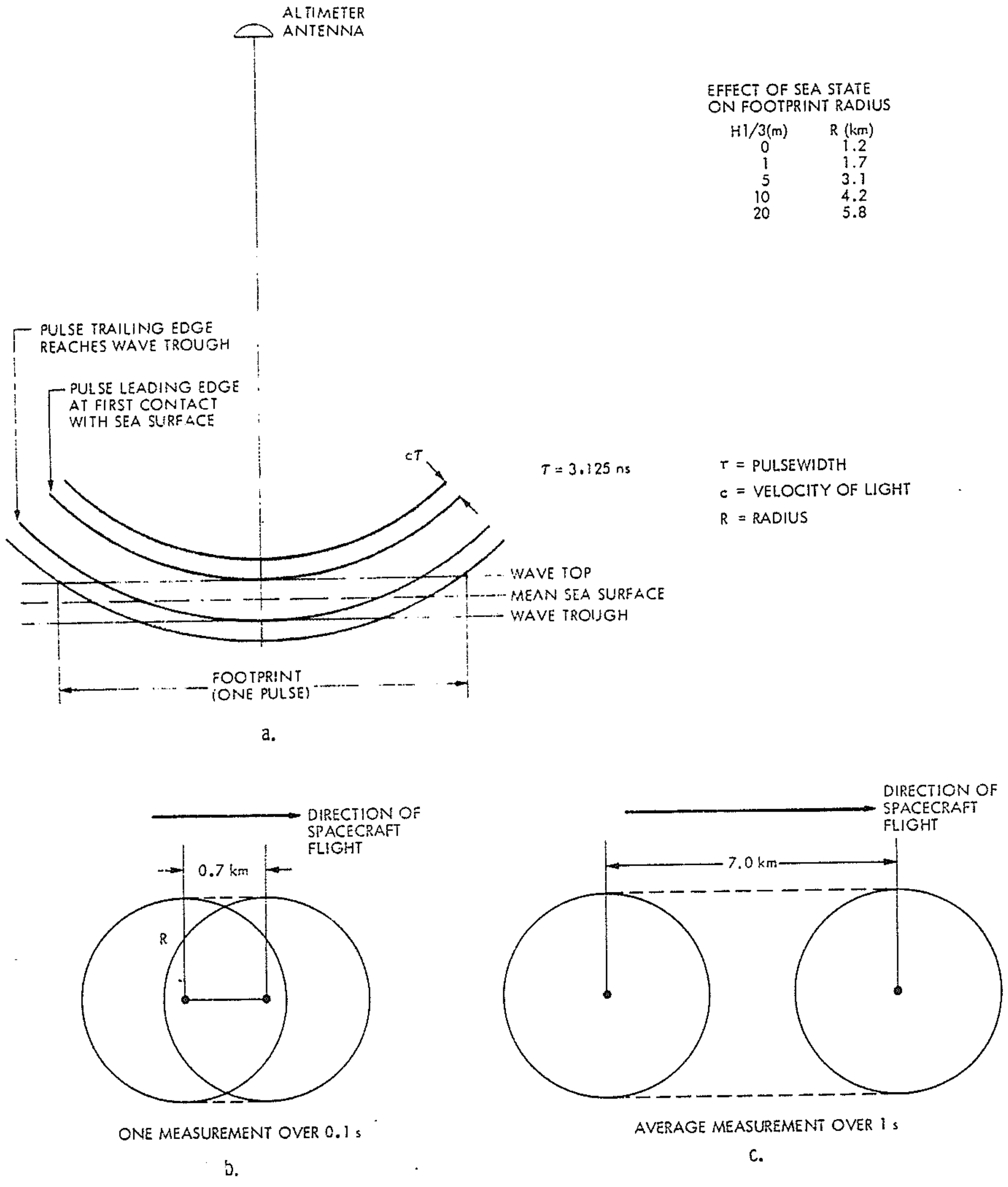


Figure 2. SEASAT Altimeter Footprint,
a. Cross-Sectional View, b. and c. Satellite's-Eye Views.
(adapted from Ronai, 1980)

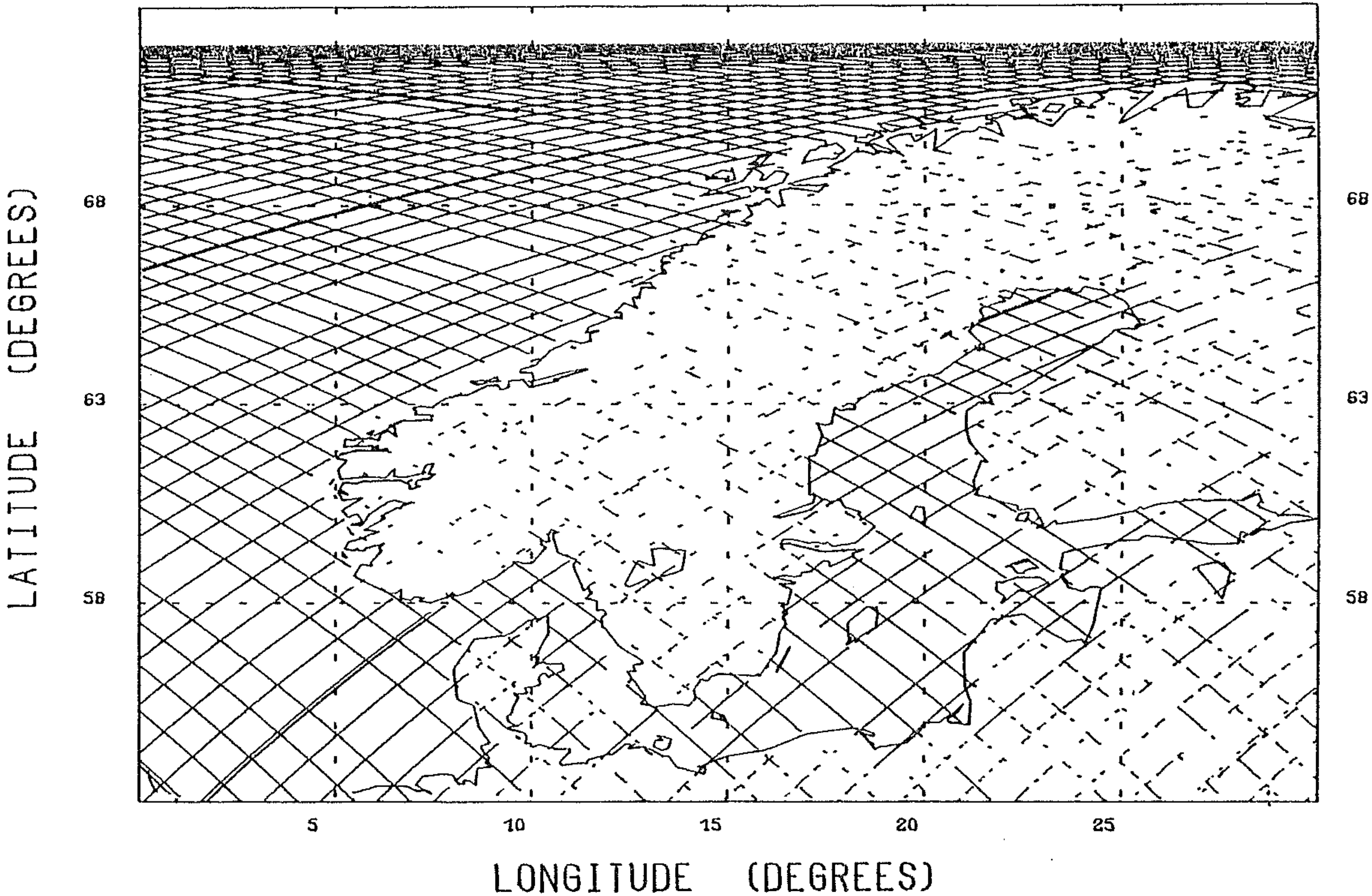


Figure 3. SEASAT Altimeter Data Set for Scandinavia (16513 values).
Full lines are tracks for each orbit where data is available.

II. Applications of SEASAT sea surface altimeter data for representations of the geoid in enclosed sea areas and gulf regions.

This study is unusual in that we have applied the method of sea surface altimetry to an enclosed sea region, the Baltic and Gulf of Bothnia, for the purpose of producing a regional geoid representation.

This study has been made difficult because of the complicated coastline and the thousands of small island structures in this region which disturb individual SEASAT altimeter returns thereby producing anomalous sea surface height values. A careful editing of data points from each satellite pass has been necessary to insure that a minimum of invalid sea surface height determinations appear in the final data matrix used to produce the geoid isolines.

The small number of track crossings available, which are necessary for the evaluation of the satellite orbit height error parameter, has been an additional difficulty.

This work revealed that the raw data set contained orbital height errors which were considerable. The study concluded that the primary cause of these large orbit height errors was unmodelled satellite orbit disturbances caused by gravity anomalies over Central Asia which the standard SEASAT orbit model did not successfully eliminate. Figure 4 gives a breakdown of the orbit height parameter solutions for each individual pass obtained using a least squares adjustment procedure for the region. The final edited data base consisted of 30 separate tracks. The height correction coefficients were then added to each of the values of the corresponding track. The RMS variance for the agreement between separate crossings amounted to approximately 20 cm. Figure 5 is a graphic representation of the edited data set used in the computation of the geoid for this region. Each sea surface altimeter value is represented by a cross, and the final edited data set consisted of 1143 values.

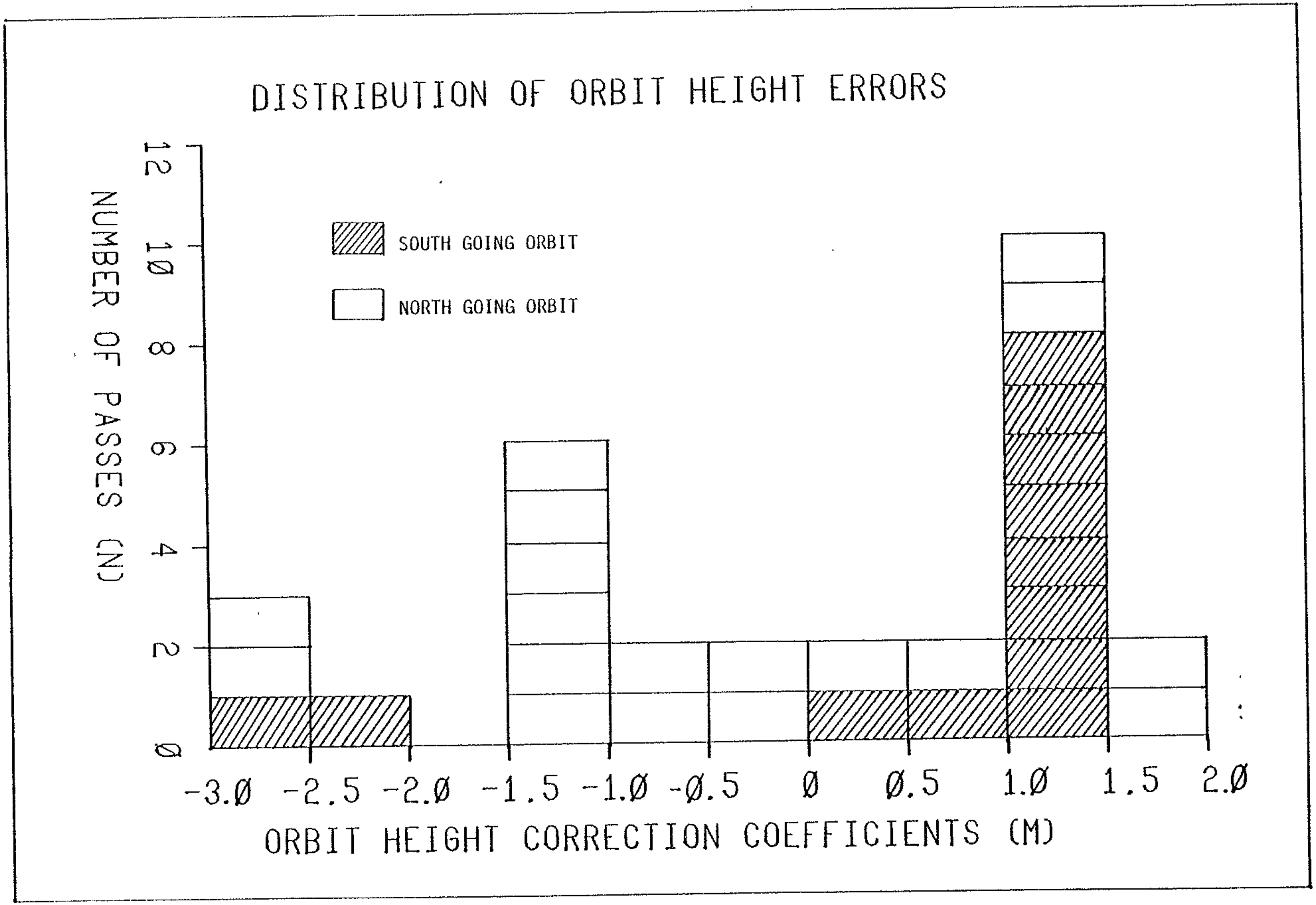


Figure 4. Relationship between orbit height error and number of passes for each 0.5 meter interval. Note north vrs south going orbit bias.

Bothnia and Balticum

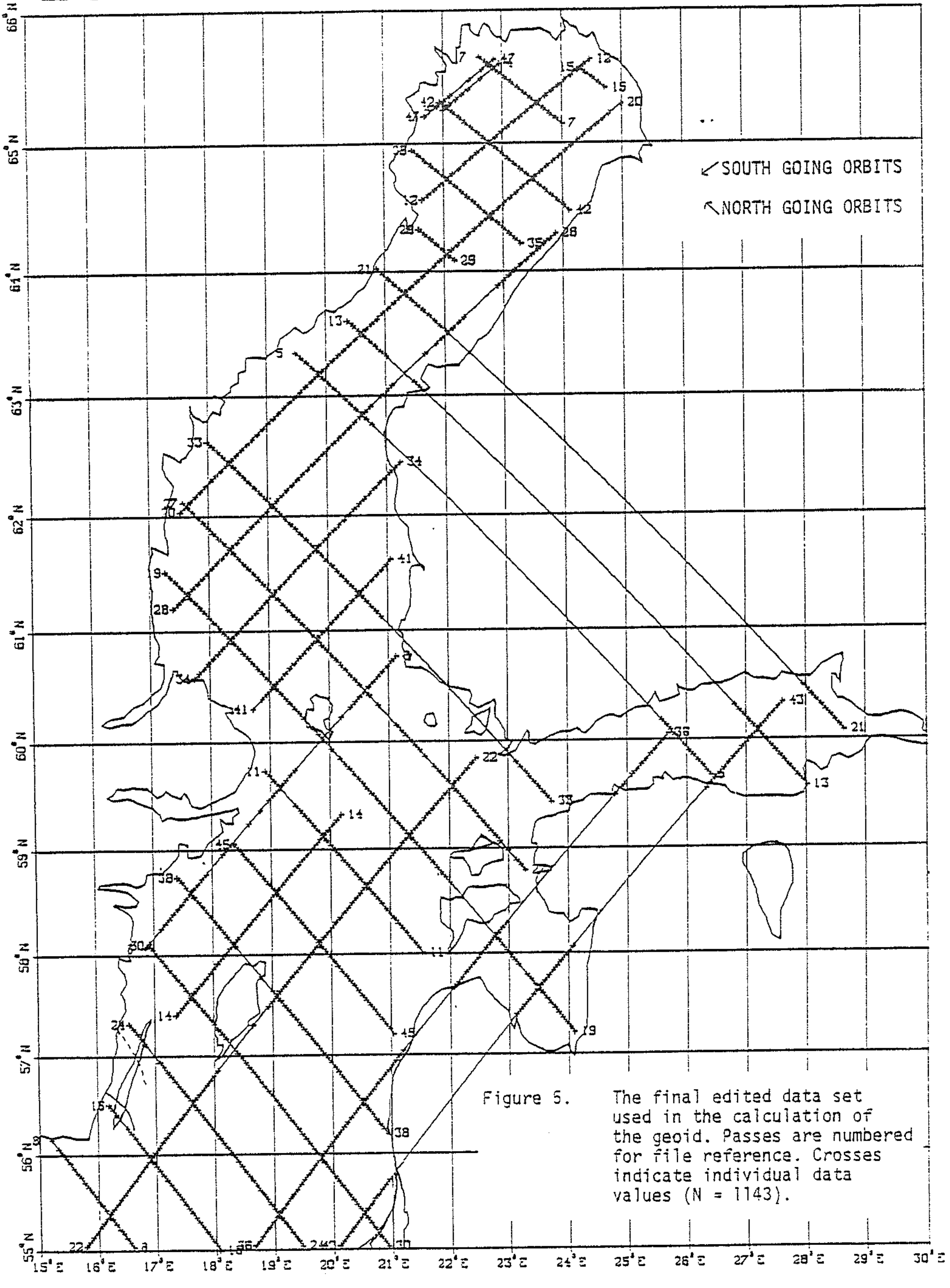


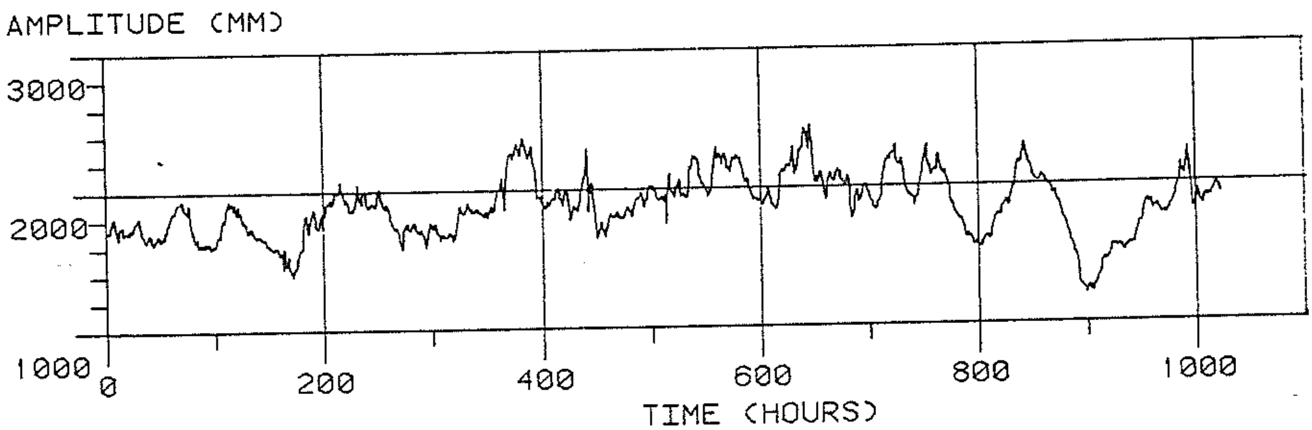
Figure 5. The final edited data set used in the calculation of the geoid. Passes are numbered for file reference. Crosses indicate individual data values (N = 1143).

IV. Sea surface topography and the ocean dynamics of the Baltic and Gulf of Bothnia.

The sea surface is affected by such things as currents, tides, regional weather patterns, and the like. These factors must always be taken into account when using sea surface altimeter data for a detailed geoid representation.

Fortunately, the ocean tides of the Baltic and Gulf of Bothnia are small, generally less than 25 cm (Anderson, 1977), and no model has been needed to remove the effect of tides from the data presented in this paper. There are some small currents in the Gulf of Bothnia, particularly near the island of Åland, however these produce sea surface topography changes at maximum of only several decimeters, and these values are below significant levels for the data presented here.

The problem with long term regional weather patterns effecting water heights have been partly solved by allowing the orbit height correction coefficient to swallow up such water level differences encountered during this 18 day period. It has been felt that this has been sufficient to correct for any first order effects of water level changes.



The example above shows variations of water level from Oulu in the northern part of the Gulf of Bothnia during August, 1975, indicating that long period water level variations over 18 days (432 hours) at this time of year are approximately 1 meter peak to peak. Such long period water level variations as these can be adjusted for in the orbit height error coefficient solutions. They also contribute to the RMS variance in the least squares solution of this parameter.

V. The production of the geoid maps.

The geoid maps have been produced through a process involving 3 stages.

First the edited data is reduced to a set of regularly spaced coefficients which are determined at increments $\Delta\lambda \times \Delta\phi$ over the region using linear interpolation. The routine used for this procedure is from the DISSPLA package available at the University of Uppsala Data Center (UDAC). For detailed information on the DISSPLA procedures, reference can be made to the DISSPLA Manual, ISSCO, San Diego, California.

Secondly a set of contour lines with level increments, Δz, are then generated using the regularly spaced matrix coefficients. These contour lines are produced by a cubic parabola smoothing procedure using the DISSPLA package. For the map with 50 cm level contours a grid with $\Delta\lambda = \Delta\phi = 0.5^{\circ}$ (30' x 30') mean coefficients has been used. For the map with 25 cm level contours a grid of $\Delta\lambda = \Delta\phi = 0.25^{\circ}$ (15' x 15') mean coefficients has been used.

Finally the contours are plotted on the 1° by 1° grid, and coastlines are overlayed.

Two contour map resolutions have been provided, the 50 cm giving complete homogeneous coverage and the 25 cm, although not entirely complete (lacking some resolution in the southern Baltic), giving nevertheless complete coverage in the Gulf of Bothnia and most other areas.

These geoid maps are reproduced on the following pages, Figures 6 and 7.

Bothnia and Balticum

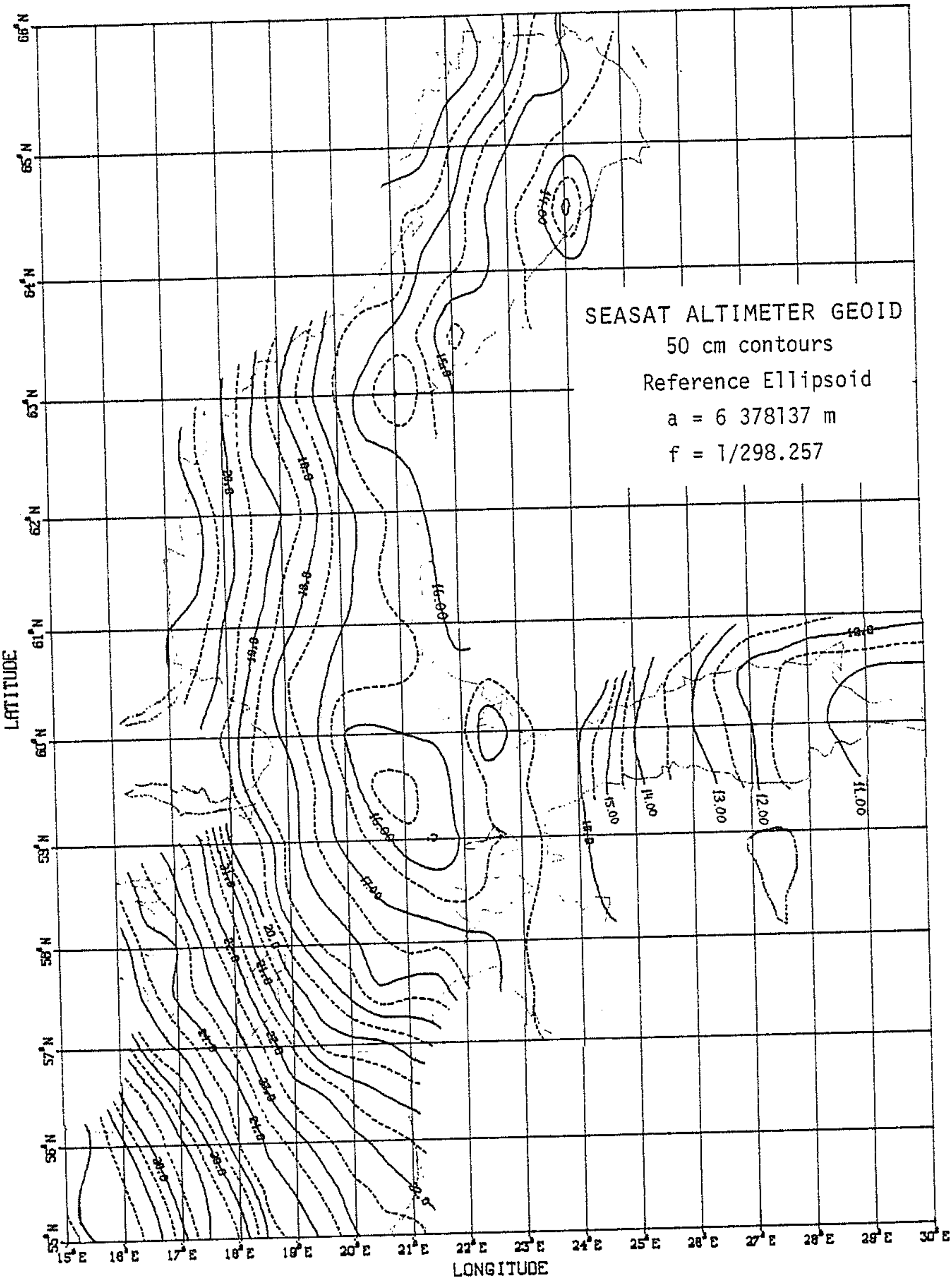


Figure 6. SEASAT Altimeter Geoid with 50 cm Contours.

Bothnia and Balticum

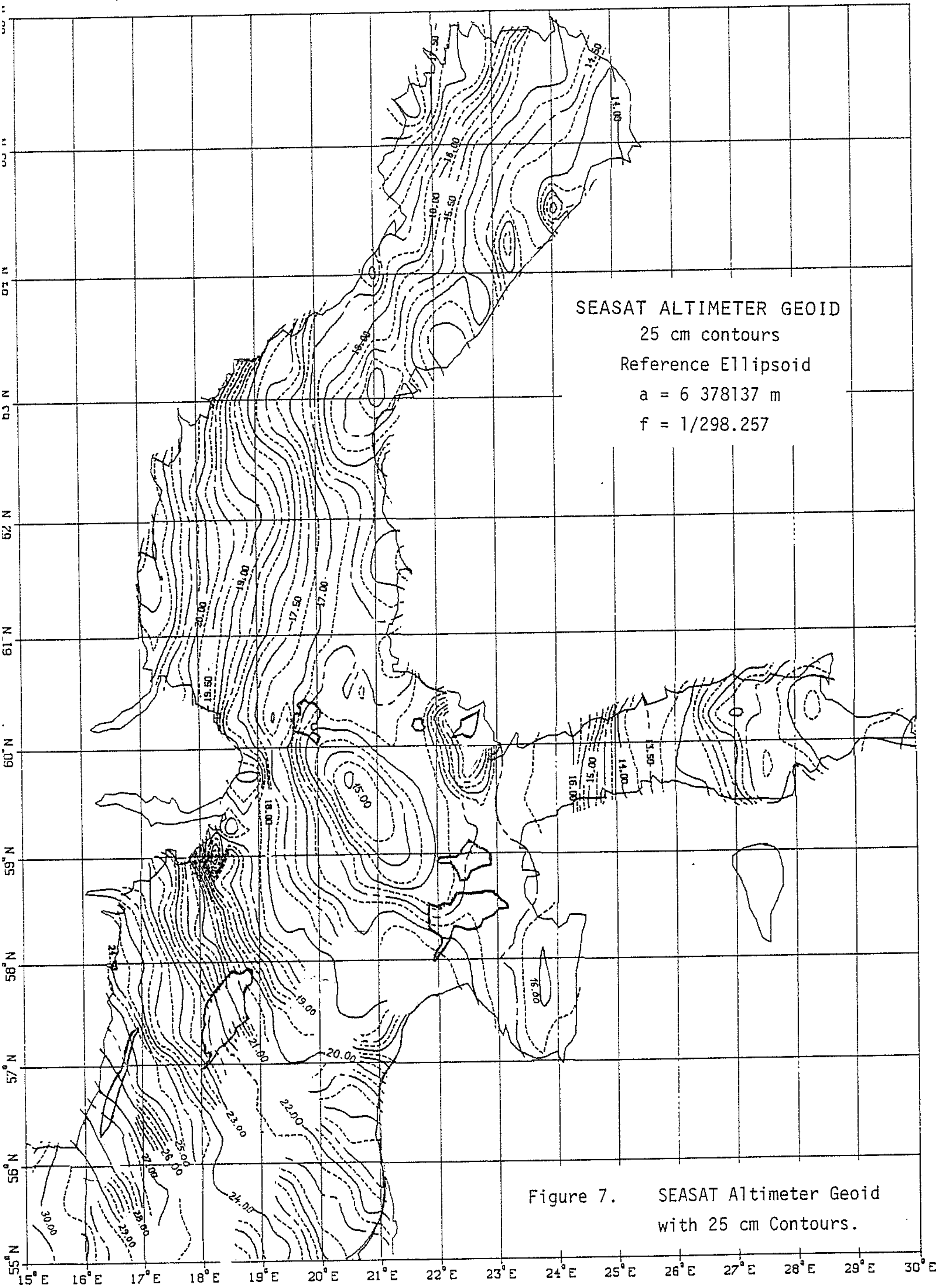


Figure 7. SEASAT Altimeter Geoid with 25 cm Contours.

VI. Comparison with other geoid maps of the region.

During the last decade there has been a significant amount of work which has been carried out by Scandinavian and German scientists on the determination of the geoid in Northern Europe and in various parts of Scandinavia. In this report we discuss and compare our results with those of Lachapelle (1973), Honkasalo (1975), Ussisoo (1975), Monka, et al (1979) and Bjerhammar, et al (1980).

There are at least 9 methods, some of them minor, which are presently available for the determination of the geoid. Table 2 lists those that have been proposed and used in various areas of the earth.

Lachapelle (1973) using astrogeodetic and gravimetric data constructed a very approximate geoid for Scandinavia. In general little can be seen that agrees with our geoid except for the low, south of Åland, which has been partly described by others. The east west gradient is approximately the same.

Ussisoo (1975) has presented work, GEOID RAK 1970, based on astrogeodetic leveling. Unfortunately this method is difficult, time consuming and fairly inaccurate due to the need of integrating an estimated gradient over fairly large distances. The Ussisoo (1975) geoid as presented contains a major north-south bias error (only partly due to a different reference ellipsoid), as well as missing the large gradient in Southern Sweden along Öland and the Kalmar-Skåne region. Agreement with our geoid along the Swedish Baltic coast is generally poor.

Of all the comparisons, the work of Honkasalo (1975) on the gravimetric geoid of Finland agrees best with the SEASAT altimetry geoid data for the Finnish coastline. Although the Honkasalo geoid does not show the detail and extent of the small scale anomalies along the Finnish coast in the Gulf of Bothnia that is apparent in the SEASAT altimeter data, nevertheless there is good general agreement along the entire extent of the Finnish coastline.

NAME	AUTHOR	MATHEMATICAL MODEL	FIELD DATA	OBSERVATIONS
ASTROGEODETIC	Helmert	$N_i = N_{i-1} - \int_{i-1}^{i} (\xi \cos A + \eta \operatorname{sen} A) ds$	Φ, Δ, A	Peripheral solution. Scarcity of data.
GRAVIMETRIC	G. Stokes	$N_G = N_0 + \frac{R}{4\Pi\gamma} \int_\sigma \Delta g . S(\psi) d\sigma$	g	Scarcity of data. Difficult evaluation.
ASTROGRAVIMETRIC	Molodenskii -Vening Melnesz	$\begin{bmatrix} \xi \\ \eta \end{bmatrix} = \frac{1}{4\Pi\gamma} \int_\sigma \Delta g \frac{\delta s(\psi)}{\delta \psi} \begin{bmatrix} \cos \alpha \\ \operatorname{sen} \alpha \end{bmatrix} d\sigma$	g, Φ, A, Δ	Peripheral solution. Scarcity of data. Problems of data compatibility.
DOPPLER	Various	$N_D = h - H$	$(x\ y\ z)_D$ H	Point solution. The Orthometric height is required.
GEOPOTENTIAL	Various	$N_S = R \left[\sum_{\ell=2}^{\infty} \sum_{m=0}^{\ell} \widetilde{P}_{\ell m} (\operatorname{sen} \phi) (\widetilde{C}_{\ell m} \cos \lambda + \widetilde{S}_{\ell m} \operatorname{sen} m \lambda) \right]$	$C_{\ell,m}, S_{\ell,m}$ g	Combined Dynamic-Satellite and terrestrial data global solution.
LEAST-SQUARES ESTIMATION (COLLOCATION)	Various	$S = N = C_{sx}^{t} C_{xx}^{-1} X$	All available	The signals are all derived from the autocovariance function of the gravity anomalies.
DOPPLER LEVELLING	J. Kouba	$\Delta N = h_B - h_A$	$(x, y, z)_D$ H_B, H_A	Peripheral solution. Not practical.
SATELLITE ALTIMETER	J.T. McGop Gan	$N_A = h_{S.E} - h_{S.A} - \Delta h$	$(x,y,z)_D$ $h_{S.A}, \Delta h$	Useful in oceanic zones. Accuracy.
SURFACE FITTING	U.N.B.	$N_X \doteq P_n(X,Y) = \sum_{i,j=0}^{n} C_{ij} X^i Y^j$	All available	Regional Analytic Solution

Table 2. Techniques for the determination of the geoid. (adapted from Torres, 1979)

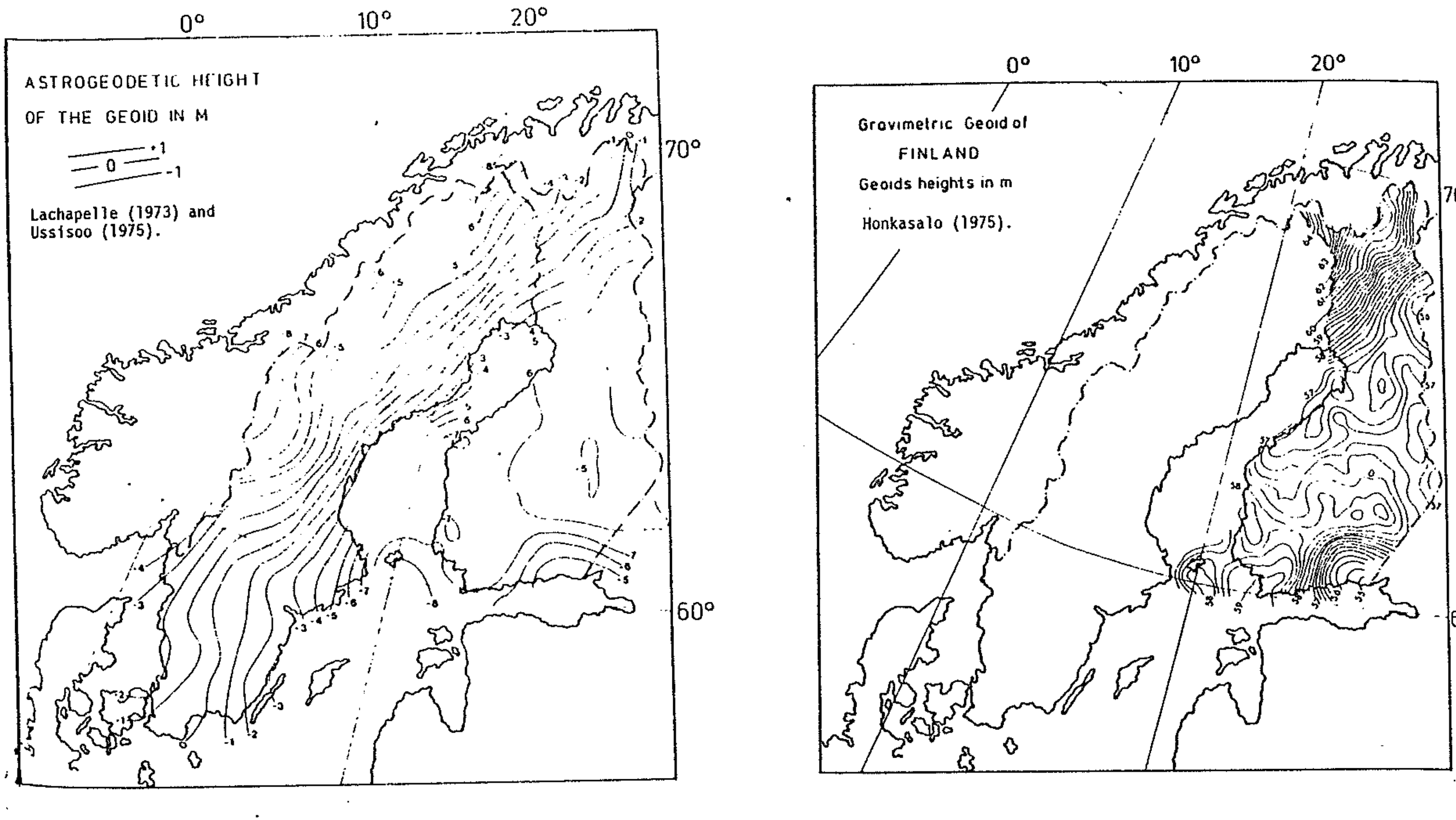


Figure 8. Geoid solutions as presented by Lachapelle (1973), Ussisoo (1975), and Honkasalo (1975). Reference ellipsoids are not identical with that used for satellite geoid representation.

From the onset of satellite geodesy, which really began in the late 1950's, a good number of attempts have been made to filter the resulting spherical harmonic solutions of the gravity field which have been obtained through the study of the integrated effects on the satellite orbit caused by the mean of many individual disturbing potentials distributed over a global field. Examples of such work are found in Gaposchkin and Lambeck (1971), Takeuchi and Yamashina (1973), Kaula (1966), Lowman and Frey (1979), and others.

These techniques of filtering or windowing contain within them certain inherent problems related to the phase (position) and amplitude of the anomalies so produced. This is so because one is extracting a limited number of coefficient terms from a finite series expansion, the total of which are needed to properly produce an inverted matrix solution to the estimated total potential, which contains both phase (position) and amplitude information based upon the mean of many single anomalies which are globally distributed. Any single anomaly is therefore not necessarily well represented.

Nowhere perhaps is this more clearly illustrated than in the work of Bjerhammar, et al (1980) where a great number of presentations of the geoid of Scandinavia have been made using different "windows" based upon globally determined mean spherical harmonic coefficients using GEM 10 and GRIM 2 data. Coefficient groups with N = 6 to 16 separately as well as lumped coefficient groups N = 10-22, 10-23, and 10-30 are presented for this region. Little resemblance to our SEASAT altimetry geoid is seen, which partly is expected due to the longer wavelength and mean global approximations represented by these data as stated above. One of these presentations, for N = 10-30, is the closest approximation to the SEASAT altimeter geoid, which however has been rejected by Bjerhammar as being "unreliable". This "unreliability" because the N = 10-30 representation of the geoid does not correlate well with the past or present fennoscandian uplift, has apparently been a factor in the final selection of results presented by Bjerhammar. Unfortunately the SEASAT altimeter data does not substantiate this, and the supposed correlation of the geoid based on more correct regional data with past or present uplift profiles is really not very good.

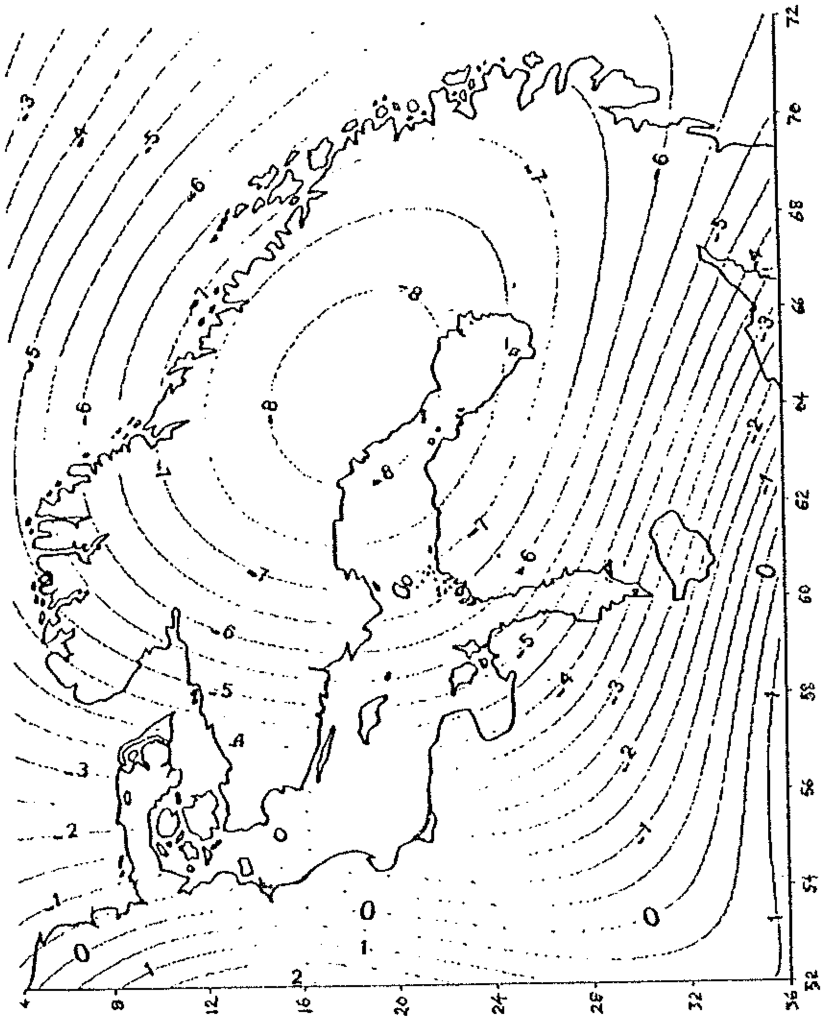


Fig 17. Harmonic window: Degrees 10-22.
A geoidal suppression has its peak value (8.5 m) close to the site for present maximum uplift in Fennoscandia. Good correlation with present uplift rates in Sweden and Finland. No direct geophysical correlation in Norway.
Minimum wavelength: 4000 km. Half wavelength 2000 km. Estimated half wavelength of present uplift 2000 km.
GEM 10. Unit 1 m. Standard deviation <±2 m.

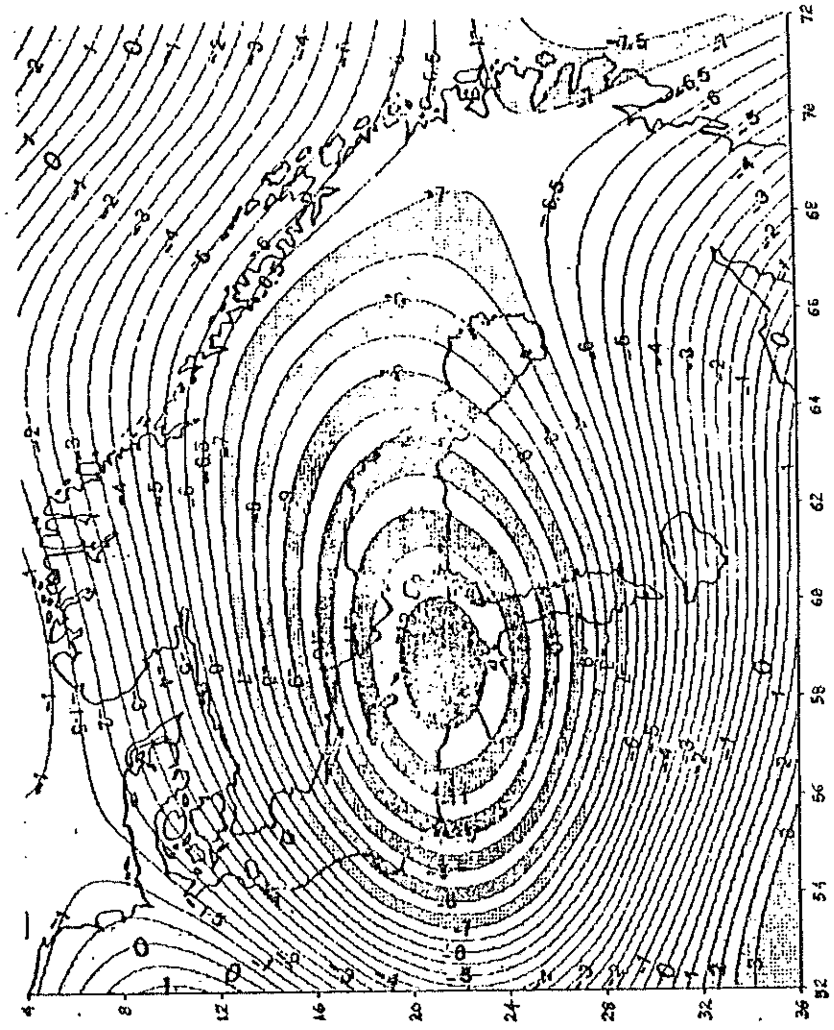


Fig 28. Maximum peak value of the geoid from harmonics N: 10-30.
The harmonics in the degrees 22-30 are unreliable and the peak value is no longer consistent with the present or past maximum uplift areas.
Data: Grim 2. See Bjerhammar (1977).

Figure 9. Two figures taken from Bjerhammar (1980) showing "geoid" solutions for the lumped harmonic coefficients 10-22, and 10-30. Captions under figures are from the original.

Our geoid indicates best agreement with one presented by Bjerhammar that was rejected by him as being unreliable. The large low south of Åland, not in correlation with the uplift was apparently the reason for rejection of this data by Bjerhammar. However, the existence of this low is proven not only by our geoid but is also indicated in the work of Honkasalo (1975). On the other hand, the geoid low that Bjerhammar favors which is stated to reside in the middle of the northern half of the Gulf, is resolved by us as being fundamentally different. It is shown to be a series of features in the geoid which have been resolved due to the high density of data samples provided for by the altimeter data. We resolve three separated features, rather small in area ($\sim 10^3$ km^2 each), lining up along the Finnish coastline. In the filtered Bjerhammar geoid, these three lows are smeared out and shifted to the west having a much larger area $\sim 10^4$ km^2.

Such questions as those raised above concerning a correlation of the geoid to post-glacial uplift can really only be dealt with properly by using a complete and accurate regional representation of the geoid. This can be done when the SEASAT data for the entire region has been reduced, and a combined solution with other land data is made.

Previously, the most detailed study of the geoid in Northern Europe has been carried out at the University of Hannover and is outlined in an important document, Monka, et al (1979). Besides a thorough comparison of different methods which have been used to produce a geoid in Northern Europe, data from the only other sea surface altimeter, (GEOS-3), have been analysed for the North Sea region. As the SEASAT altimeter has a resolution approximately an order of magnitude better than that of GEOS-3, as well as having a better coverage for Scandinavia (inclination $\cong 72^0$ vrs 63^0 for GEOS-3), naturally the present data set is unique and represents a major improvement over previous possibilities to define the geoid of Scandinavia. Furthermore, the Monka, et al (1979) document does not deal with the geoid in the Baltic and Gulf of Bothnia region.

VII. Discussion of results and conclusions.

During the remaining decades of this century the study and relationship between the geoid, geodynamics, plate tectonics and recent crustal movements will be a major area of investigation in geodesy and geophysics.

As such the determination of a detailed and accurate geoid will play a fundamental role in our understanding of the earth and the dynamic processes of crustal motion.

In Scandinavia a reliable determination of the geoid is one of the prerequisites for an understanding of crustal processes such as post-glacial uplift and studies of past and present plate tectonic mechanisms and their relationship with the Fennoscandian Shield. In addition to the study of the relationship between the geoid and vertical crustal movements in Fennoscandia, a study and use of the geoid includes correlations with Moho depth and large scale crustal density variations of the region. Ultimately this will lead to the construction of models showing the distribution of lithospheric stresses based upon detailed knowledge of the above parameters.

This study has resulted in an accurate, detailed, and reliable refinement of the gravity field in the Baltic and Gulf of Bothnia. Several features have been discovered, specifically the series of lows running along the eastern side of the Gulf of Bothnia, intersecting the major low and single largest gravity anomaly of the shield area to the southeast of Åland. From this point an additional low trough exists following a line along south by south-west running through the Baltic and intersecting the Polish coast. This trough is partly correlated with sea bathymetry of this area. Furthermore, it has been revealed that the largest gradients of the geoid for this region are to be found along the southern Swedish coast, and not, as believed earlier, in the area in the northern regions of the Gulf of Bothnia.

VIII. Acknowledgments

The authors wish to thank the National Aeronautics and Space Administration (NASA) and the entire SEASAT team at the Jet Propulsion Laboratory (JPL) for making this work possible. We also would like to thank the French National Space Agency (CNES) in Toulouse and in particular Georg Balmino of the International Gravity Bureau (GBI) and C. Brossier (GRGS) for supplying the raw SEASAT data used in this work.

One of us (Allen Joel Anderson) would also like to thank Centre National de la Recherche Scientifique (CNRS) for the generous support provided to him for his stay at GRGS, Toulouse.

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PART III

LIST OF PUBLICATIONS DEALING WITH GRAVITY MATTERS RECEIVED AT B.G.I.

(Bull. 47 continued)

. *INFORMATION*

In our list of publications received at the Bureau, we have now replaced the chronological number of insertion in the Bulletin (the last number in B.I. n° 47 was 900) - which was not of great use, by two code numbers which actually are those used internally in our cross reference tables (by author, by subject or country).

In the next pages, we give the lists of the subject indexes used and of the country codes.

Consequently, the first code appearing flush left of the title or author's name is :

. a subject code if it is alphabetical,

. a country code if it is numerical.

The second code (below the first one) is always a number which is the order of the publication in the subject or country file.

Any request of a publication should then refer to the old numbering prior to and up to B.I. n° 47, and should follow the new indexing from now on.

We are studying some mean of digitizing the library reference tables in the future and to simplify our work in coding (and publishing) only author's names, subject/country name, title, informations such a journal, report, volume,... plus a certain number of key words.

TABLE OF SUBJECT INDEXES

ALT.................................... ALTIMETRIE
ANØ.................................... INTERPRETATION DES ANOMALIES
BIB.................................... BIBLIOGRAPHIE
DAT.................................... DATA MANAGEMENT
DEV.................................... DEVIATION DE LA VERTICALE
ECO.................................... MOUVEMENT DE L'ECORCE TERRESTRE
EL..................................... ELLIPSOIDE
ET..................................... ETALONNAGE
ETA.................................... ETALONNAGE AMERIQUE
ETE.................................... ETALONNAGE EUROPEEN
ETP.................................... ETALONNAGE ASIE/PACIFIQUE OUEST
GEN.................................... GENERALITES
GEO.................................... GEOPHYSIQUE GENERALE
GER.................................... GEOIDE RESULTATS
GET.................................... GEOIDE THEORIE
GN..................................... GRAVITE ET NIVELLEMENT
GRA.................................... GRAVITATION
GRD.................................... GRADIENT VERTICAL
GVM.................................... GRAVIMETRE
INT.................................... PHYSIQUE DE L'INTERIEUR DE LA TERRE
ISO.................................... ISOSTASIE
MA..................................... MESURES AIR
MAB.................................... MESURES ABSOLUES
MMG.................................... MESURES MER GENERALITES
MMR.................................... MESURES MER RESULTATS
MP..................................... MESURES PENDULAIRES
MT..................................... MAREES TERRESTRES
NUM.................................... CALCULATEURS ELECTRONIQUES
PEN.................................... PENDULE
PMA.................................... PESANTEUR & MAGNETISME
PME.................................... PESANTEUR & METEOROLOGIE
PS..................................... PESANTEUR & SEISMICITE
RE..................................... RESEAU EUROPEEN
RED.................................... METHODES DE REDUCTION
RIC.................................... RESEAU INTERNATIONAL COMPENSATION

RIP.......................................	RESEAU INTERNATIONAL 1er ORDRE
SAT.......................................	SATELLITES
SEL.......................................	SELENODESIE
STA.......................................	STATISTIQUE
THP.......................................	THEORIE DU POTENTIEL
VMG.......................................	VALEURS MOYENNES DE LA GRAVITE
VS..	VARIATION SECULAIRE
WDC.......................................	WORLD DATA CENTERS GENERAL
WDC A.....................................	U.S.A. (BOULDER)
WDC B1....................................	U.R.S.S. (MOSCOU)

AFRIQUE 0

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002 Angola
003 Benin
004 Botswana
005 Burundi
006 Cameroon
007 Cape Verde
008 Central African Republic
009 Chad
010 Comoros
011 Congo
012 Djibouti
013 Egypt
014 Equatorial Guinea
015 Ethiopia
016 Gabon
017 Gambia
018 Ghana
019 Guinea
020 Guinea-Bissau
021 Ivory Coast
022 Kenya
023 Lesotho
024 Liberia
025 Lybia
026 Madagascar
027 Malawi
028 Mali
029 Mauritania
030 Mauritius
031 Morocco
032 Mozambique
033 Namibia
034 Niger
035 Nigeria
036 Rwanda
037 Sao Tome & Principe
038 Senegal
039 Seychelles
040 Sierra Leone
041 Somalia
042 South Africa
043 Sudan
044 Swaziland
045 Tanzania
046 Togo
047 Tunisia
048 Uganda
049 Upper Volta
050 Zaïre
051 Zambia
052 Zimbabwe

AMERIQUE DU NORD 1

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102 U.S.A.

AMERIQUE CENTRALE ET SUD 2

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202 Bahamas
203 Barbados
204 Belize
205 Bolivia
206 Brazil
207 Chile
208 Colombia
209 Costa-Rica
210 Cuba
211 Dominica
212 Dominican Republic
213 Ecuador
214 El Salvador
215 Grenada
216 Guatemala
217 Guyana
218 Haïti
219 Honduras
220 Jamaïca
221 Mexico
222 Nicaragua
223 Panama
224 Paraguay
225 Peru
226 St Lucia
227 St Vincent
228 Suriname
229 Trinidad & Tobago
230 Uruguay
231 Venezuela

ASIE 3

301 Afghanistan
302 Bahrain
303 Bangladesh
304 Bhutan
305 Brunei
306 Burma
307 Cambodia
308 China
309 India
310 Iran
311 Iraq
312 Israel
313 Japan
314 Jordan
315 Korea North
316 Korea South
317 Kuwait
318 Laos
319 Lebanon
320 Malaysia
321 Maldives
322 Mongolia
323 Nepal
324 Oman
325 Pakistan
326 Qatar
327 Saudi Arabia
328 South Yemen
329 Sri Lanka
330 Syria
331 Taiwan
332 Thailand
333 Turkey
334 United Arab Emirates
335 Vietnam
336 Yemen

OCEANIE 4

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402 Fiji
403 Indonesia
404 Kiribati
405 Nauru
406 New Zealand
407 Philippines
408 Singapore
409 Papua & New Guinea
410 Solomon Islands
411 Tonga
412 Tuvalu
413 Western Samoa

ANTARCTIC 6

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601 Antarctic Argentina
602 Antarctic Australia
603 Antarctic Chile
604 Antarctic France
605 Antarctic Japan
606 Antarctic New-Zealand
607 Antarctic Norway
608 Antarctic South Africa
609 Antarctic United Kingdom
610 Antarctic U.S.S.R.
611 Antarctic U.S.A.

EUROPE 5

501 Albania
502 Andorra
503 Austria
504 Belgium
505 Bulgaria
506 Cyprus
507 Czechoslovakia
508 Denmark
509 Finland
510 France
511 Germany East
512 Germany West
513 Greece
514 Hungary
515 Iceland
516 Irish Republic
517 Italy
518 Liechtenstein
519 Luxembourg
520 Malta
521 Monaco
522 Netherlands
523 Norway
524 Poland
525 Portugal
526 Romania
527 San Marino
528 Spain
529 Sweden
530 Switzerland
531 United Kingdom
532 U.S.S.R.
533 Yugoslavia

LIST OF COUNTRY CODES

GER - WENZEL H.G. - "Recent results of geoid determination by combination techniques
152 in the North Sea test area".
Presented to XVII Gal. Assembly of IUGG, Canberra, Australia 2-15 Dec., 1979.
Inst. Theor. Geod., Univ. Hannover, 22 p, 1979.

Gravity anomalies, Geos-3 satellite altimetry and astrogeodetic vertical deflections have been used to determine gravimetric, altimetric and astrogeodetic geoids in the North Sea test area ($47° < \phi < 62°$, $- 5° < \lambda < 15°$). From a comparison of these independent geoids we found an agreement below the 1 m level, no sea surface topography could be detected. Simple average technique as well as least squares collocation have been used to determine combined geoids with an accuracy believed to be below the 0.5 m level.

GER - MONKA F.M., W. TORGE, G. WEBER & H.G. WENZEL - "Improved vertical deflection
153 and geoid determination in the North Sea region".
Wissens. Arb. der Fachr. Vermessung. Univ. Hannover, N° 94, 162 p, 1979.

Compared to the already published geoid and vertical deflection determinations in the North Sea region (Monka, Torge, Weber and Wenzel, 1978, Wenzel, 1978) are presented improved geoid and vertical deflection determinations in this paper. The improvements have been obtained by the extended collection of observations (gravity anomalies, astrogeodetic vertical deflections, Geos-3 altimeter data, satellite doppler geoid heights) as well as by the refinement of the computational methods. Combination solutions (i.e. from data of different type) have been computed in addition to single solutions (i.e. from data of the same type). Intercomparisons of different solutions have shown accuracies of appr. ± 1" for the computed vertical deflections and of appr. ± 0.5 m for the computed geoid heights.

313 - NOBORU INOUCHI, HIROSHI SATO - "Crustal deformation related to the Izu-Oshima
40 Kinkai earthquake of 1978".
Bull. of the G.S.I., Vol. 23, Part 2, 14-24, March, 1979.

Crustal movement in the Izu region revealed through geodetic surveys repeated there before and after the Izu-Oshima Kinkai earthquake are presented.

401 - HERRING T. - "The accuracy of deflections of vertical determined from horizon-
46 tal gradients".
Unisurv. G., N° 30, 41-62, May, 1979.

The practical feasibility of finding deflections of vertical from horizontal gravity gradients, by use of surface integration techniques, is investigated. For these investigations an empirical auto-correlation function (ACF) for the gravity gradients is found by differentiating an ACF for gravity anomalies.

Using these ACF's variances are propagated through the discretized Vening Meinesz'formula and the gravity gradient surface integrals. The results show that in a local area a gravity gradient solution should be more economical than a gravity anomaly solution for determining deflections of vertical with an accuracy between ± 0".08 and ∿ ± 0".5.

401 - NAKIBOGLU S.M., T.S. LIM - "A numerical test of the initial value method for
46 downward continuation".
Unisurv. G., N° 30, 31-39, May 1979.

The initial value method is tested by computing the harmonically reduced gravity anomalies, the geoid heights and the deflections of vertical on the Molodenskii test model. The resulting gravity anomalies on the geosphere are shown to be a smooth function of position, comparable to Bouguer anomalies in smoothness. On the basis of comparisons of geoid heights and deflections with the corresponding exact values, the method if found to be suitable for regions with gently topography.

401 - BRETREGER - "Ocean tide models from Geos 3 altimetry in the Sargasso Sea".
46 Unisurv. G., N° 30, 1-14, May, 1979.

A method utilising all altimetry data simultaneously within a specified oceanographic area is formulated in order to obtain region ocean tide models. The initial modelling of the sea surface is obtained by using crossover techniques and corrections for tilts and biases. The viability of the method is tested by introducing random and systematic noise in simulated studies to determine suitable signal-to-noise ratios. A practical investigation using the Geos 3 altimetry data within the Sargasso Sea is attempted using data collected over 17 months.

401 - TUCKER D.H., WYATT B.W., DRUIE E.C., MATHUR S.P., HARRISON P.L. - "The upper
47 crustal geology of the Georgina basin region".
BMR, J. Aust. Geol. & Geophys., Vol. 4, N° 3, 209-226, June, 1979

Pattern recognition in regional maps of Bouguer anomalies and total magnetic intensity contours suggests that the basement of the Georgina Basin can be divided into four regions, three of which contain subsurface extensions of the Tennant Creek Inlier, Arunta Inlier and Mount Isa Orogen-South Nicholson Basin (sensu Plumb, in press), and a fourth in the south, for which there is no known outcrop and whose composition differs from the others. The boundaries between these regions are in most cases not visible in outcrop.

The basement to the Georgina Basin thus consists predominantly of metamorphic rocks and granites inferred to be similar to the outcrop areas which surround it. This is overlain by Adelaidean and Phanerozoic sediments, which locally are up to 8000 m thick.

A geological history for the basement of the area is proposed, which provides a framework for subsequent deposition in the Georgina Basin.

401 - DRUMOND B.J. - "A crustal profile across the Archaean Pilbara and Northern Yil-
47 garn cratons, Northwest Australia".
BMR, J. Aust. Geol. & Geophys., Vol. 4, N° 3, 171-180, June, 1979.

Two Archaean cratons are exposed in the Precambrian shield of Western Australia : the Pilbara in the North and the Yilgarn in the South. They are separated by the Capricorn Orogen. Seismic recordings of quarry blasts in the North of the West Australian shield indicate that the upper crustal rocks have seismic velocities of 6.0 km s^{-1}. They overlie a lower crust, which has a seismic velocity of 6.4 km s^{-1}at 13 km depth in the north of the Pilbara Craton and 16 km in the north of the Yilgarn Craton. The northern Yilgarn has a third layer, with a seismic velocity of about 7.0 km s^{-1}, at the base of the crust. The crust mantle boundary at the base of the Pilbara Craton and Capricorn Orogen appears to be transitional - it shows velocity gradients rather than a first-order velocity discontinuity.

Within the Pilbara Craton, the crust is about 28 km thick in the north and 33 km in the south. South of the Pilbara Craton, the crust thickness under the Capricorn Orogenic Belt, and again under the northern Yilgarn Craton where it is 52 km thick. The form of the structures in the zone of thickening cannot be determined uniquely from the present data. The different crustal thicknesses of the cratons suggest that they formed separately and were then tilted towards the Orogenic belt.

401 - JOHNSON, R.W. - "Geotectonics & Volcanism Papua New Guinea : A review of the
47 late Cainozoic".
BMR, J. Aust. Geol. & Geophys., Vol. 4, N° 3, 181-207, June, 1979.

A considerable amount of new information obtained since about 1965 has contributed greatly to a fuller understanding of late Cainozoic tectonics and volcanism in Papua New Guinea. The region straddles a complex zone of convergence between the major Indo-Australian and Pacific plates (estimated rates are about 9.14 cm yr^{-1}), and includes two, and possibly as many as four, minor plates. There are at least six - perhaps as many as ten - plate boundaries in Papua New Guinea. Most of them are zones of convergence, characterised by different components of strike-slip motion ; one, and part of another, are ridge-transform zones where new sea floor is being created. The Australian continent and Ontong Java Plateau reached the region during the Cainozoic, and may have had a major influence on plate kinematics in the late Cainozoic. Late Cainozoic volcanoes of Papua New Guinea are widely distributed and chemically diverse.

522 7 - WAALEWIJN A. - "The second geodetic levelling of the Netherlands (1926-1940)". Pub. Netherlands Geod. Com., 165 p, Delft, 1979.

HHG 75 - EGGE D., G. SEEBER - "Procédures de mesures pour une localisation précise en mer". Wiss. Arb. Fach. Vermessung. Univ. Hannover, 111 S, Hannover, 1979.

En Géodésie, les travaux de localisation s'appliquaient essentiellement aux terres fermes des continents, laissant la plupart du temps en friche les importants espaces marins, du moins dans les travaux théoriques. Ce n'est que récemment, dans le cadre de la géodésie marine, qu'une importance croissante est accordée à la localisation géodésique en mer, cf. par exemple Mourad (1966, 1972, 1975, 1977), Sigl (1970), Saxena (1974), Rinner (1975, 1976), Seeber (1975, 1979a), Hierber (1978).

Les travaux présentés traitent du stade actuel atteint par la localisation en mer en essayant de s'appuyer sur toutes les procédures existantes. Etant donné le volume limité de ces travaux, il est toutefois impossible de présenter ce thème de façon exhaustive et définitive. La démarche est plutôt de tenter :

- d'éveiller un intérêt vis à vis de cet ensemble de problèmes,
- de mettre à disposition certaines données de base permettant des études plus approfondies, de donner des impulsions et
- de fournir les références d'une bibliographie permettant d'approfondir ce thème.

522 8 - VAN DER SCHRAAFN - "The centenary of the Netherlands Geodetic Commission". Pub. Netherlands Geod. Com., 228 p, 1979.

Last year the Netherlands Geodetic Commission decided to mark its hundreth anniversary, 20th February, 1979, with some kind of celebration.

The themes chosen for the symposium, held 15th March, 1979 were, geodesy in its relation to geophysics, astronomy and satellite geodesy, and the mathematical developments associated with these topics. Besides the addresses and lectures delivered during the symposium, the memorial volume contains a detailed account of the work carried out by the Commission, or under its auspices, during the last hundred years. In addition, the volume contains articles in which personal and ex-officio members give their views on certain scientific aspects of geodesy and its application by the various government geodetic services. Related scientific fields are also discussed.

MT 232 - SCHULLER K., H.G. WENZEL, W. ZURN - "Analysis of simulated non linear systems driven by tides". Presented to "Earth Tides Working Group of the German Comm.". Veröff. Deutsch Geodat. Kom., Reihe B, Heft N° 231, Munchen, 1979.

By means of a theoretical gravity tide input the outputs of four simulated non-linear systems (quadratic, cubic, timevariant amplification and dead space) have been studied from both an analytical and numerical point of view. System responses have been evaluated in terms of combination constituents leading to specific frequency domain patterns. One year's test series for each simulated system have been generated and investigated by Fourier analyses of the output-input differences, standard tidal analysis with subsequent spectrum analysis of the residuals and time variant tidal analysis. Some criteria for the identification of non-linear effects in tidal records are suggested.

GN 48 - WENZEL H.G. - "Optimization of gravity networks". Proceedings of "International Symposium on Optimization of Design and Computation of control networks", Sopron, Hungary, 721-728, 1978.

The special feature of sequential optimization is its small computing expense in comparison to other optimization methods (e.g. Monte-Carlo design). Moreover, sequential optimization can be performed on small computers. The selected optimal observations are accidental for gravity networks if the expense of observations is not introduced in the target functions.

The method of sequential optimization has been applied to two planned gravity networks ; we have found no change in the networks'accuracy but a large reduction of expense, if the expense of observations has been introduced into the target function. Because of the dependency of selected optimal observations on the arbitrarily chosen target function only the structure of the optimal design should be taken into account for the planning of the gravity network, but we should not try to apply strictly the result of the optimal design. For the selection of gravity differences some other criteria as e.g. the quality of the roads could be of more importance than the result of the optimal design.

507 76 - SIMON Z., S. HOLUB - "Results of the Earth-tide measurements at the Pecny station(CSSR)". Ceskoslov. Akad. Ved, Studia Geophysica et Geodaetica, T. 24, N° 1, 12-16, 1980.

A gravimetric Earth-tide station was established at the Geodetical Observatory Pecny (about 30 km south-east of Prague) in 1969. Its geografic coordinates are : $\phi = 49° 55'$ N, $\lambda = 14° 47'$ E, altitude 534 m.

In the present communication we report the results derived from all the measurements carried out at the station in the period 1970 to 1977.

507 76 - SIMON Z. - "A comment on Honkasalos's correction". Ceskoslov. Akad. Ved, Studia Geophysica et Geodaetica, T. 24, N° 1, 92-96, 1980.

According to Honkasalo, gravity observations are now being corrected for Earth tides by retaining the constant part of the tidal effects of the Moon and the Sun in the values of the gravity acceleration. Honkasalo's idea is developed in this paper.

409 22 - MILSON J.S. - "Papua New Guinea isogal gravity survey, 1967". BMR Geol. & Geophys., Dept. of Nat. Div., Record 1978/94, 19 p, Canberra, 1980.

During June, July, and early August 1967 a network of gravity base stations was established throughout Papua New Guinea. Three gravity meters were used to make ties between stations at roughly equal values of observed gravity. Transport was by light aircraft. Some stations occupied on previous surveys by BMR and the Universities of Wisconsin, Hawaii, and Tasmania were incorporated in the network. A tie was made to the Solomon Islands gravity base station in Honiara.

THP 1 - BURSA M. - "Second sectorial harmonic in the geopotential". From : Boll. Geod. Sci. Affini, Revista dell'Ist. Geog. Mil., Anno XXXVII, N° 23, 317-323, Praha, 1978.

The second sectorial harmonic in the Earth's gravitational field has been discussed from the point of view of the Earth's figure as well as of the variations in the Earth's rotation, precession and nutation.

- DoD Gravity Services Branch, DMAAC - Quarterly accession list : 1 Oct. - 31 Dec. 1979.
Listing 5 p, St-Louis, Jan. 1980.

The Quarterly accession list summarizes publications and documents containing point gravity data, U.S. and foreign produced, that were accessioned during the period indicated on the cover.

028 - LY S. - "Etude gravimétrique de l'Adrar des Iforas (Nort-Est Mali)".
1 Acad. Montpellier, USTL, Thèse Dr. Ing. Tect. Geophys. Geochimie, 107 p + Carte gravi., Mai, 1979.

510 - PETREQUIN M. - "Etude gravimétrique du Massif de la Margeride et de sa bordu-
66 re méridionale".
Acad. Montpellier, USTL, Thèse Dr. 3ème cycle Tect. Geophys. Géochimie, 128 p + Carte gravi., Juillet, 1979.

524 - GAZDZICKI J. - "A method for adjustment of a set of Horizontal geodetic net-
91 work".
Proceedings of the Inst. of Geod. and Cartography, T. XXVI Z. 3(63), 25-34, Warszawa, 1979.

A set of mutually connected but separately adjusted geodetic networks, covering a certain area, is considered in this paper.
It is assumed that the point coordinates in all networks are computed in one and the same coordinate system in the way of :

- adjustment with a reference to the higher order national network points,
- independent adjustment followed by transformation of coordinates.

Thus, some differences caused by measurement errors exist between the joint point coordinates obtained from neighbouring networks.
In order to adjust and to obtain unique coordinates of all points, a condition called as "Minimum network distortion condition". According to this condition, such values are sought for point coordinates, that the sum of squares of azimuth alterations and of relative length alterations multiplied by corresponding weights is equal to the minimum.

ISO - WATTS A.B. - "An analysis of isostasy in the world's oceans 1. Hawaiian-empe-
38 ror Seamount Chain".
From : J. Geophys. Res., Vol. 83, N° 12, 5989-6004, Palisades, Dec., 1978.

Cross-spectral techniques have been used to analyze the relationship between gravity and bathymetry on 14 profiles of the Hawaiian-Emperor seamount chain. The resulting filter or transfer function has been used to evaluate the state of isostasy along the chain. The transfer function can be best explained by a simple model in which the oceanic lithosphere is treated as a thin elastic plate overlying a weak fluid. The best-fitting estimate of the elastic thickness of the plate is in the range 20-30 km. Analysis of individual profiles shows significant differences in the elastic thickness along the seamount chain. Relatively low estimates of the elastic thickness were obtained for the Emperor Seamounts north of 40° N, and relatively high estimates for the Emperor Seamounts south of 40° N and the Hawaiian Ridge. These differences cannot be explained by a simple model in which there is a viscous reaction to the seamount loads through time. The best explanation is a simple model in which the elastic thickness depends on age and hence temperature gradient of the lithosphere. The low values can be explained if the Emperor Seamounts south of 40° N and the Hawaiian Ridge loaded a relatively old cold plate. These estimates of the elastic thickness along with determinations from other loads on the Pacific lithosphere suggest that the elastic thickness corresponds closely to the 450 ± 150° C isotherm, based on simple cooling models. Thus the large deformations and associated flexural stresses (> 1 kbar) at seamount loads do not appear to change appreciably through time. This conclusion is in agreement with subsidence data along the seamount chain and with some gravity observations in the continents.

ISO - COCHRAN J.R. - "An analysis of isostasy in the world's oceans : 2. Midocean
39 Ridge Crests".
From : J. Geophys. Res., Vol. 84, N° B9, 4713-4729, Palisades, Aug., 1979.

Cross-spectral techniques are used to analyze the relationship between gravity and bathymetry at the Mid-Atlantic Ridge and the East Pacific Rise crests. The resulting transfer functions were used to study the nature of the isostatic mechanism operative at these ridge crests. The most satisfactory results were obtained for models in which the oceanic lithosphere is treated as a thin elastic plate overlying a weak fluid. The best fitting elastic thickness to explain gravity and bathymetry at the fast spreading ($v > 5$ cm/yr) East Pacific Rise in the range of 2-6 km and at the relatively slow spreading ($v < 2$ cm/yr) Mid-Atlantic Ridge is in the range 7-13 km. These estimates are significantly smaller than the elastic thickness of 20-30 km obtained from surface loads formed on old (> 80 m.y.) parts of the oceanic lithosphere. This difference is consistent with the fact that ridge topography is formed near the ridge axis, where isotherms are shallower and the lithosphere is thus weaker than in older regions. The difference between the elastic thickness of the East Pacific Rise and Mid-Atlantic Ridge is significant and may represent differing temperature structures at these ridges. Simple models in which it is assumed that the elastic thickness represents the depth to the 450° C isotherm show that these variations can be explained by differences in the spreading rate at these ridges. Thus the lower effective thickness at the East Pacific Rise can be attributed to higher average temperatures at shallow depths in a region surrounding the ridge crest. This is due to the faster spreading rate which results in isotherms having a shallower dip away from the axis than at the slower spreading Mid-Atlantic Ridge. This model cannot, however, explain gravity and bathymetry data over the Rekyjanes Ridge. The best fitting elastic thickness for this slow spreading ridge is similar to the thickness determined for the East Pacific Rise, suggesting an anomalous thermal regime at this ridge crest.

ISO - DETRICK R.S., A.B. WATTS - "An analysis of isostasy in the world's ocean :
40 3. Aseismic Ridges".
From : J. Geophys. Res., Vol. 84, N° B7, 3637-3653, July, 1979.

Cross-spectral techniques have been used to analyze the relationship between gravity and bathymetry on 26 profiles across the Walvis and Ninetyeast ridges. The resulting filters or transfer functions have been used to study the state of isostasy at these ridges. Transfer functions for the eastern Walvis Ridge and the Ninetyeast Ridge profiles can be best explained by an Airy-type thickening of the crust beneath these ridges. The crustal thickness required are in the range 15-25 km, in good agreement with available seismic refraction data. The transfer function for the western Walvis Ridge can be best explained by a flexure model in which the oceanic lithosphere is treated as a thin elastic plate overlying a weak fluid. The effective elastic plate thickness required is in the range 5-8 km. These estimates for the elastic thickness are substantially less than those determined from flexural studies of loads on older crust but are similar to estimates determined for sea floor topography at midocean ridges. These observations are consistent with the formation of aseismic ridges near spreading centers on lithosphere that is young, thin, and relatively weak. The differences in isostasy between the eastern and western Walvis Ridge are attributed to an off-axis shift relative to the South Atlantic spreading center of the "hot spot" forming the Walvis Ridge about 80 m.y. B.P. These observations suggest that the isostatic parameters determined for these aseismic ridges were "frozen in" at the time of their formation at or near a spreading center and have not significantly changed through time.

THP 2 - RUBINCAM D.P. - "Gravitational potential energy of the Earth : A spherical harmonic approach".
From : J. Geophys. Res., Vol. 84, N° B11, 6219-6225, Greenbelt, Oct., 1979.

A spherical harmonic equation for the gravitational potential energy of the earth is derived for an arbitrary density distribution by conceptually bringing in mass-elements from infinity and building up the earth shell upon spherical shell. The zeroth degree term in the spherical harmonic expansion agrees with the usual expression for the energy of a radial density distribution. The second degree terms give a maximum nonhydrostatic energy in the crust and mantle of $- 2.77 \times 10^{29}$ ergs, an order of magnitude below McKenzie's (1966) estimate. McKenzie's result stems from mathematical error. Our figure is almost identical with Kaula's (1963) estimate of the minimum shear strain energy in the mantle, a not unexpected result on the basis of the virial theorem. If the earth is assumed to be a homogeneous viscous oblate spheroid relaxing to an equilibrium shape, then a lower limit to the mantle viscosity of 1.3×10^{20} P is found by assuming that the total geothermal flux is due to viscous dissipation of energy. This number is almost six orders of magnitude below MacDonald's (1966) estimate of the viscosity and removes his objection to convection. We have not determined where MacDonald's treatment diverges from our own. If the nonequilibrium figure is dynamically maintained by the earth acting as a heat engine at 1 % efficiency, then the viscosity is 10^{22} P, a number preferred by Cathles (1975) and Peltier and Andrew (1976) as the viscosity of the mantle.

SAT 189 - COHEN S.C., G.R. COOK - "Determining crustal strain rates with spaceborne geodynamics ranging system data".
From : Manuscripta Geodaetica, Vol. 4, 245-260, 1979.

The Spaceborne Geodynamics Ranging System is a proposed satellite-borne laser ranging system which would be capable of making highly precise geodetic measurements over baselines ranging from a few tens of kilometers to several hundred kilometers. In this paper we analyze the precision with which crustal strain rates could be derived from measurements made with this system. Using simple site configurations with intersite distances between 25 and 70 kilometers we conclude that the system precision is sufficient to permit meaningful strain rate determinations with measurement campaigns of a few years. As an illustration, if a nine site grid is surveyed to a one centimeter precision once a year the expected precisions in the strain rates are several parts in 10^8 after two years and several parts in 10^9 in a decade. Compared to expected shear strain rates of a few parts in 10^7 per year this yields very favorable signal to noise ratios even though expected deviations from uniform strain and constant strain may reduce measurement accuracies below the calculated precisions. By using scaling laws, the results obtained here may also be used for other combinations of intersite distances, resurvey intervals, and measurement precisions.

GER 155 - TORGE W., G. WEBER & H.G. WENZEL - "Determination of 12' x 20' mean free-air gravity anomalies for the North Sea region".
D.G.K., Reihe B, N° 247 : Angew. Geod., 27 p, München, 1980.

12' x 20' mean free-air gravity anomalies have been computed for the North Sea region from point free-air gravity anomalies and 6' x 10' mean free-air gravity anomalies. Most of the remaining gaps could be interpolated by least squares prediction filtering. The average r.m.s. error of the 12' x 20' mean free-air gravity anomalies has been estimated to ± 5 mgal*. A comparison of the here presented gravity anomalies with 1° x 1° gravity anomalies provided by the U.S. Defense Mapping Agency gave a r.m.s. difference of ± 5 mgal. From the covariance function of 12' x 20' mean free-air gravity anomalies reduced to the spherical harmonic model GEM10B, anomaly degree variances have been computed up to degree 500.

INT 143 - THOMAS D., M. COX, D. ERLANDSON & L. KAJIWARA - "Potential geothermal resources in Hawaii : A preliminary regional survey".
Western States Coop., Phase Report, Assessment of Geothermal Resources in Hawaii : Number 1.
HIG-79-4, 168 p, Hawaii, June, 1979.

A regional geothermal resource assessment has been conducted for the major islands in the Hawaiian chain. The assessment was made through the compilation and evaluation of the readily accessible geological, geochemical, and geophysical data for the Hawaiian Archipelago that have been acquired during the last two decades.

The geologic criteria used in the identification of possible geothermal reservoirs were age and location of most recent volcanism on the island and the geologic structure of each island. The geochemical anomalies used as traces for geothermally altered groundwater were elevated silica concentrations and elevated chloride/magnesium ion ratios. Geophysical data used to identify subsurface structure with possible geothermal potential were aeromagnetic anomalies, gravity anomalies, and higher-than-normal well and basal spring discharge temperatures.

Geophysical and geochemical anomalies that may be the result of subsurface thermal effects have been identified on the islands of Hawaii, Maui, Molokai and Oahu.

THP 3 - HAUCK H. - "Numerical aspects of orbit computation using series of kernel functions".
D.G.K., Reihe A, N° 89 : Höhere Geod. H., 35 p, Frankfurt, 1979.

The perturbation potential of the earth is interpolated by a series of special kernel functions. The behaviour of this interpolation function depends on a free parameter which is determined in order to get a smooth function by application of special smoothness criteria.

Orbits of satellites are computed on the basis of kernel functions and of spherical harmonics for the representation of the perturbation potential. A comparison of these orbits shows how the smoothness criteria are to be judged.

MT 233 - SANCHEZ B.V. - "The enhanced nodal equilibrium ocean tide and polar motion".
NASA Tech. Mem. 80592, 18 p, Greenbelt, Nov., 1979.

Recent data analysis of polar motion indicates the presence of a component with periodicity corresponding to the motion of the lunar ascending node. An investigation of the tidal response of the ocean to long period forcing functions has been conducted. The results of the investigation indicate the possibility of excitation of a wobble component with the amplitude and frequency indicated by the data. An enhancement function for the equilibrium tide has been postulated in the form of an expansion in zonal harmonics and the coefficients of such an expansion have been estimated so as to obtain polar motion components of the required magnitude.

401 48 - SHIRLEY J.E. - "Crustal structure of North Queensland from gravity anomalies".
BMR, J. of Austr. Geol. & Geophys., Vol. 4, N° 4, 309-322, Canberra, Dec., 1979.

The interpretation of a reconnaissance gravity survey of north Queensland has shown that the area is composed of normal continental crust approximately 40 km thick, and is consistent with relief at the Moho of approximately 7 km. The parameters required for three-dimensional crustal gravity modelling, crustal thickness and density contrast across the Moho, were derived from available crustal seismic refraction experiments, together with analyses of correlations of crustal parameters on a worldwide basis. There are no large departures from isostatic equilibrium in the area.

401 - BARLOW B.C. - "Gravity investigations of the Gosses Bluff impact structure,
48 central Australia".
BMR, J. of Austr. Geol. & Geophys., Vol. 4, N° 4, 323-340, Canberra, Dec., 1979.

Detailed gravity study gives significant evidence about the size, shape and nature of the Gosses Bluff structure and contributes to the conclusion of a multi-disciplinary study that the circular disturbance was produced by meteorite impact.

401 - DRUMMOND B.J. and al. - "The crustal structure of the Gulf of Papua and North-
48 west Coral Sea".
BMR, J. of Austr. Geol. & Geophys., Vol. 4, N° 4, 341-351, Canberra, Dec., 1979.

Interpretation of seismic refraction data from the southwestern coast of the Papuan Peninsula and the northwest Coral Sea gives consistent results using several inversion techniques.

We have examined several tectonic models for the region that imply different stress patterns at the time of formation of the Moresby Trough. We favour one in which northern Australia, the Eastern and Papuan Plateaus and the Papuan Peninsula once formed a continuous, continental crust. With the opening of the Coral Sea Basin, crustal thinning extended northwards along the axis of the Moresby Trough, probably into the Aura Trough. This model implies a regional tensional stress pattern at the time of formation.

401 - DOOLEY J.C. - "A geophysical profile across Australia at 29°S".
48 BMR, J. of Austr. Geol. & Geophys. Vol. 4, N° 4, 353-360, Canberra, Dec., 1979.

Long wavelength components of the gravity and magnetic fields, topography, and heat-flow data, are examined along a trans-continent profile close to 29°S. The profile crosses from the west Australian Archaean shield in the west to the New England Permian geosyncline in the east. The depth to the Moho, the mean crustal density, and temperatures at 40 km depth and at the base of the crust are derived from the profiles. Depths obtained from seismic refraction and reflection surveys near the profile are shown for comparison. The gravity anomalies show that departures from isostasy along the profile must be small, although in the eastern part of the Precambrian shield compensation must be either regional or deeper than the base of the crust.

401 - WELLMAN P. - "On the isostatic compensation of Australian topography".
48 BMR, J. of Austr. Geol. & Geophys., Vol. 4, N° 4, 373-382, Canberra, Dec., 1979.

The depth of isostatic compensation and the strength of the lithosphere are investigated by calculating isostatic anomalies for a range of isostatic models. The models are of three-dimensional topography on a spherical earth. In all areas compensation of topography appears to be complete at the level of the lowest part of the crust. In southeast Australia the preferred isostatic model is that of Airy, with a standard sea-level crust of thickness 35-45 km. For this model, isostatic anomalies in areas measuring 0.5° x 0.5° have a low standard deviation of 90 μm s^{-2}; equivalent to 80 m in elevation. The crustal thickness calculated from this model agree well with thickness found from recent seismic-refraction work. In the southeastern highlands there is evidence from physiographic studies for uniform uplift of about 1 km during the last 90 ± 30 m.y. The preferred model is for this uplift to be an isostatic response to underplating of the crust. The underplating is thought to have taken place at a constant rate since 90 m. y. ago ; the underplated material is the 20 km of abnormally high velocity material that forms the basal part of the crust in this area. Away from southeast Australia no isostatic models could be found that gave small isostatic anomalies, and the best models are not consistent with crustal structure found by seismic methods. In these areas the topography varies gradually, and the gravity effect of this topography and its compensation seems to be masked by the effect of a correlation between altitude and mean crustal density. This correlation is partly the result of the lowlands usually being underlain by thicker, low-density sediments, and partly to the crust below sediments having a higher mean density in the high altitude areas.

401 - ARNAUTOV G.P., Y.D. BOULANGER, G.D. KARNER, S.N. SHCHEGLOV - "Absolute Deter-
48 minations of gravity in Australia and Papua New Guinea during 1979".
BMR, J. of Austr. Geol. & Geophys., Vol. 4, N° 4, 383-393, Canberra, Dec., 1979.

A cooperative survey between the Soviet Academy of Sciences and the Australian Bureau of Mineral Resources during 1979 successfully measured the acceleration due to gravity using an absolute apparatus at Sydney, Hobart, Alice Springs, Darwin, and Perth in Australia, and at Port Moresby in Papua New Guinea. The measurements have a precision of about 6 μGal and an accuracy of about 15 μGal. Gravity ties to earlier stations allow comparisms with GAG-2 gravity meters, OVM pendulums and IGSN71 results. Gravity differences between cities are generally not significant at the 95 percent confidence level. Gravity differences at individual cities are also not significantly different from zero. The mean difference for all cities could be interpreted as having a component of secular variations of + 3.3 ± 1.2 μGal/yr.

401 - COUTTS D.A., P. WELLMAN, B.C. BARLOW - "Calibration of gravity meters with a
49 quartz-mechanism".
BMR, J. of Austr. Geol. & Geophys., Vol. 5, N° 1, 1-7, Canberra, 1980.

Gravity meters with a quartz mechanism can be calibrated on tilt tables, on hillside calibration ranges with stations at different altitude, or on level calibration ranges with stations at the same altitude. Twenty Worden, Sharpe, and Scintrex gravity meters have been calibrated in Canberra on a PEG-1 tilt table borrowed from the Soviet Academy of Sciences. These calibrations agree, to within experimental error, with tilt calibrations by the manufacturers in North America, and calibrations based on sea-level stations along the Australian Calibration line. Calibrations on hillside calibration ranges differ systematically from other calibrations, and indicate a mean altitude effect of (2.5 ± 0.5) x 10^{-3}μm s^{-2} m^{-1}. This altitude effect is higher than the mean of (1.5 ± 0.3) x 10^{-3}μm s^{-2} m^{-1} found by pressure-chamber studies in North America and Europe. If quartz-mechanism gravity meters are used either in base station gravity network, or for field stations in areas with over 500 m of relief, then a correction should be made for this altitude effect, particularly if the anomalies are to be used for geodetic purposes.

GN - GRUNDIG L. - "Feasibility study of the conjugate gradient method for solving
49 large sparse equation sets".
NOAA Tech. Rep. NOS 82 NGS 13, Nat. Geod. Survey, Rockville, 21 p, Feb., 1980.

A feasibility study was performed to determine the effectiveness of various conjugate gradient methods for solving large sparse equation sets. Equations of this magnitude will be involved in the future new adjustment of the North American Datum. The conjugate gradient method provides a suitable algorithm for this purpose. Some typical nets associated with the new adjustment were used and compared with a direct solution algorithm. Results indicate that this method is well suited for constrained adjustments of triangulation networks, but not for free adjustments. No benefits were derived from preconditioning, which only increased the solution time.

B.G. - FREEDEN W. - "On the approximation of external gravitational potential with closed systems of (trial) functions".
Bulletin Géodésique, Vol. 54, N° 1, 1-20, Paris, 1980.

Let S be the (regular) boundary-surface of an exterior region E_e in Euclidean space R^3 (for instance : sphere, ellipsoid, geoid, earth's surface). Denote by $\{\Phi_n\}$ a countable, linearly independent system of trial functions (e.g., solid spherical harmonics or certain singularity functions) which are harmonic in some domain containing $E_e \cup S$. It is the purpose of this paper to show that the restrictions $\{\phi_n\}$ of the functions $\{\Phi_n\}$ on S from a closed system in the space C (S), i.e. any function f, defined and continuous on S, can be approximated uniformly by a linear combination of the functions ϕ_n.

Consequences of this result are versions of Runge and Keldysh-Lavrentiev theorems adapted to the chosen system $\{\Phi_n\}$ and the mathematical justification of the use of trial functions in numerical (especially : collocational) procedures.

B.G. - SCHWARZ K.P., G. LACHAPELLE - "Local characteristics of the gravity anomaly covariance function".
Bulletin Géodésique, Vol. 54, N°1, 21-36, Paris, 1980.

Using a data set of 260 000 gravity anomalies it is shown that common characteristics for a local covariance function exist in an area as large as Canada excluding the Rocky Mountains. After eliminating global features by referencing the data to the GEM-10 satellite solution, the shape of the covariance function is remarkably consistent from one sample area to the next. The determination of the essential parameters and the fitting of the covariance function are discussed in detail.

To test the reliability of the derived function, deflections of the vertical are estimated at about 230 stations where astrogeodetic data are available. Results show that the standard error obtained from the discrepancies is about 1" for each component and that the error covariance matrix of least-squares collocation reflects this accuracy remarkably well.

B.G. - VINCENTY T. - "Height-controlled three-dimensional adjustment of horizontal networks".
Bulletin Géodésique, Vol. 54, N° 1, 37-43, Paris, 1980.

The principles of three-dimensional geodesy are used in the adjustment of horizontal networks with heights and astronomic coordinates held fixed. The proposed method is simpler and faster than any conventional method, as it uses measurements on the terrain without any reductions to a computational surface. There are no restrictions on the lengths of the lines.

B.G. - SJOBERG L. - "A recurrence relation for the β_n - function".
Bulletin Géodésique, Vol. 54, N° 1, 69-72, Paris, 1980.

A recurrence relation is presented for the smoothing function, β_n, which is used in geodesy to relate spherical harmonics to their mean values over circular areas (caps). The proposed formula does not require the computation of the Legendre's polynomials. Moreover, it is numerically more stable than the formulas of Pellinen (1969) and Meissl (1971).

B.G. - BOSCH N., K.R. KOCH - "The geopotential from gravity measurements, levelling data and satellite results".
Bulletin Géodésique, Vol. 54, N° 1, 73-80, Paris, 1980.

The geodetic boundary value problem is formulated which uses as boundary values the differences between the geopotential of points at the surface of the continents and the potential of the geoid. These differences are computed by gravity measurements and levelling data. In addition, the shape of the geoid over the oceans is assumed to be known from satellite altimetry and the shape of the continents from satellite results together with three-dimensional triangulation. The boundary value problem thus formulated is equivalent to Dirichlet's exterior problem except for the unknown potential of the geoid. This constant is determined by an integral equation for the normal derivative of the gravitational potential which results from the first derivative of Green's fundamental formula. The general solution, which exists, of the integral equation gives besides the potential of the geoid the solution of the geodetic boundary value problem. In addition approximate solutions for a spherical surface of the earth are derived.

B.G. - BLAHA G. - "Second-order derivatives in a local frame developed in spheroidal and spherical coordinates".
Bulletin Géodésique, Vol. 54, N° 1, 119-135, Paris, 1980.

Second-order derivatives of a general scalar function of position (F) with respect to the length elements along a family of local Cartesian axes are developed in the spheroidal and spherical coordinate systems. A link between the two kinds of formulations is established when the results in spherical coordinates are confirmed also indirectly, through a transformation from spheroidal coordinates. If F becomes W (earth's potential) the six distinct second-order derivatives - which include one vertical and two horizontal gradients of gravity - relate the symmetric Marussi tensor to the curvature parameters of the field.

The general formulas for the second-order derivatives of F are specialized to yield the second-order derivatives of U (standard potential) and of T (disturbing potential), which allows the latter to be modeled by a suitable set of parameters. The second-order derivatives of T in which the property $\Delta T = 0$ is explicitly incorporated are also given. According to the required precision, the spherical approximation may or may not be desirable ; both kinds of results are presented. The derived formulas can be used for modeling of the second-order derivatives of W or T at the ground level as well as at higher altitudes. They can be further applied in a rotating or a nonrotating field. The development in this paper is based on the tensor approach to theoretical geodesy, introduced by Marussi (1951) and further elaborated by Hotine (1969), which can lead to significantly shorter demonstrations when compared to conventional approaches.

GER 156 - RAPP R.H. - "Potential coefficient and anomaly degree variance modelling revisited".
AFGL-TR-79-0245, Sci. Rep. N° 2, 18 p, Sept., 1979.

The decay of the power spectrum of the earth's gravitational potential is modeled using the GEM10B solution of NASA and a solution complete to degree 180 at OSU. The modelling was first done using the form of A/ℓ^B where A and B were parameters determined by various adjustment techniques. For degrees 3 through 36, the best estimate of A is 10.6×10^{-6} and $B = 2.17$ based on the GEM10B data. Earlier models by Kaula and Tscherning/Rapp contain too much power as compared to the actual field beyond degree 8. If B were fixed at either 2 or 2.5 the best fit for the range 3 to 36 is obtained with $B = 2$.

Anomaly degree variance models were also computed from the anomaly degree variances of the 180 solution and other data such as a point anomaly variance, and a horizontal gradient variance. With this data, we found that the parameters of the earlier Tscherning/Rapp model are still valid provided one is willing to accept a high gradient variance. Excellent fit to all data types is obtained with the two component model suggested by Moritz and described in detail by Jekeli. All models used in the study, and models by Wagner/Colombo and Heller/Jordan are compared in terms of common parameters such as point anomaly variance, gradient variance, undulation variance and fits to observed potential coefficient variations.

HT 234 - BONATZ M., K. SCHULLER & H. WILMES - "Results of gravimetric tide observations in Windhoek, Southwest Africa".
Mitt. Inst. Theor. Geod., Univ. Bonn, N° 57, 28 p, 1980.

From 31.1 until 3.11.1977 gravimetric tide measurements with Askania-Gravimeter GS 15 Nr. 206 were performed in the seismometric station Windhoek. Due to frequently occuring line interruptions, relatively large temperature variations and electrostatic charges the measurements became exceptionally difficult. The obtained gravimetric data were processed by standard analysis and partially by the HYCON-method. In spite of the technical problems the parameters of the M2 tide as well as the associated load vector with respect to Earth Model Molodensky I could be determined with sufficient accuracy.

NUM 45 - BOSCH W. - "Basic - Program for use of matrices and its application to minimization problems".
Mitt. Inst. Theor. Geod. Univ. Bonn, N° 60, 25 p, 1980.

The required storing-elements and the computation time may be reduced considerably by storing the elements of symmetric or diagonal matrices in a vector-array. Moreover the programs offered here avoid any double-storing (e.g. of the transposed form of a matrix) or any storing of provisional results during the computation of quadratic forms. Together with an efficient program for the printing of matrices, stored in a vector-array, they permit the solution of least-squares and collocation problems, being very short and saving a lot of storing-elements. This is demonstrated with a program for regular or singular least-squares-solutions (Gauss-Markov-model).

MHG 74 - DEUTSCHES HYDROGRAPHISCHES INSTITUT - Forschungsschiff "Meteor" der Deutschen Forschungsgemeinschaft & des Deutschen Hydrographischen Instituts. Fahrt N° 54 7 Mai-21 Juin 1980. Cruise n° 54 of the research vessel METEOR. Morphologie, Hydrographie, Nordsee - Grönland - Schwelle". 23 p, Hamburg, 1980.

Scientific program, Institutes participating, map of working areas.

MMR 255 - VOPPEL D., R. RUDLOFF - "On the evolution of the Reykjanes idge South of 60° N between 40 and 12 million years before present".
From : J. Geophys. Res., N° 47, 61-66, 1980.

A geophysical reconnaissance survey of the western flank of the Reykjanes Ridge between 56° and 60° N resulted in locating a system of fracture zones in the area of crustal ages between 40 and 12 Ma. This system corresponds to a similar one discovered by Vogt and Avery on the eastern flank of the ridge. Rotating anomaly 13 from the east to the west using a pole of rotation of 68.4° N, 133.8° E and an opening angle of 7.78°, a satisfactory coincidence of anomalies 13 of both surveys could be attained. Accordingly the formation of this system during the seafloor spreading process seems to be proved.

MT 235 - VANICEK P. - "Tidal corrections to geodetic quantities".
U.S. Dept. of Commerce, NOAA, Tech. Rep. N° 83 NGS 14, 31 p, Rockville, Feb., 1980.

The origin of tidal force is explained and mathematically treated. Then the phenomena caused by tidal force are shown, first by viewing the Earth as rigid and then elastic. This study is mainly devoted to the formulation of corrections arising from these tidal phenomena, and includes the complete range of geodetic observations and corrections. Finally, corrections for sea tide are discussed. Although no original material is presented, all tidal aspects that would be of interest to a geodesist are treated from a geodetic point of view.

001 14 - NISHIMURA S. - "Gravity measurements in Algeria".
Tsukuma Earth Sci., Vol. 9, N° 10, 1974.

Etude hydrogéologique dans la région d'El Asnam (100 km^2).

BIB 13 - Lamont-Doherty Geological Observatory of Columbia University Yearbook 1979, Vol. 6, 144 p, 1980.

GET 276 - GRAFAREND E.W. - "The bruns transformation and a dual setup of geodetic observational equations".
NOAA Tech. Rep. NOS 85 NGS 16, 71 p, Rockville, April, 1980.

The Bruns formula, which equates the disturbing gravity potential modulo the length of the normal gravity vector to the height anomaly, is generalized into three dimensions and into horizontal, equatorial and inertial reference frames. It is applied to formulate the space-like geodetic boundary value problem in geometry and gravity space. The Bruns transform allows a dual setup of geodetic observational equations in a network of mass points, the finite element approximation of the space-like geodetic boundary value problem, in the following sense : the observational equations can be expressed rigorously either as a function of geometric coordinate corrections alone without any gravity dependent quantity, or alone as a function of the gravity disturbing potential and its gradients alone without any geometric coordinate correction. For operational purposes, estimable quantities from reference-free observables are studied in geometry, gravity and vorticity spaces. They correspond to invariants with respect to a linear similarity transformation typified by positional angles and length ratios in various vector spaces. A Cartesian series representation of the gravity potential and its gradients is given--the Cartesian coordinate system is known to be singularity-free--and is used for a unified Cartesian setup of observational equations.

530 52 - Swiss Geodetic Commission - Proceedings of the 125th session of the S.G.C. of 23 June 1979, 56 p.

SAT 190 - RAPP R.H., D.P. HAJELA - "Accuracy estimates of 1° x 1° mean anomaly determinations from a high-low sst mission".
AFGL-TR-79-0269, Sci. Rep. N° 3, 12 p., Sept., 1979.

The method of least squares collocation is used to estimate the accuracy and correlation of 1° x 1° anomalies that could be determined from a high-low satellite to satellite tracking mission. The observed data is taken to be the line of sight acceleration which can be computed from the range rate data. Variables considered in this study were : a) the spherical distance from the center of the 1° x 1° block within which data is selected for use ; b) the accuracy of the "observed" accelerations ; c) the height of the low satellite ; and d) the data density or interval.

Typical results indicate that at a low satellite height of 200 km, a data noise corresponding to a range rate accuracy of ± 0.015 cm/sec, would yield a 1° x 1° anomaly to an accuracy of about ± 8 mgals with an average error correlation coefficient between adjacent blocks of - 0.6. Lowering the satellite to 150 km reduces the accuracy to about ± 5 mgals but increases the correlation to about - 0.9.

This study does not consider the effects of orbit error, nor errors in the degree 12 reference field. In addition, some results could not be obtained when stable matrix inversions could not be obtained. This occured when dense data and/or low data noise was being used.

GET 277 - COLOMBO O.L. - "Optimal estimation from data regularly sampled on a sphere with applications in geodesy".
AFGL-TR-79-0227, Sci. Rep. N° 1, 29 p, Sept., 1979.

The size of the variance-covariance matrix of the data, used to obtain minimum variance estimators for collocation, is as large as the number of observations in the data set. For some arrangements of the data, such as the usual "equal angle" (or "regular") grid, the matrix presents a very strong Toeplitz-circulant structure that can be exploited to reduce computing in setting-up and inverting the matrix. This reduction can be quite drastic. This report discusses such structure and presents an algorithm for implementing collocation efficiently. Three applications are considered : (a) the spherical harmonic analysis of point data ; (b) the same analysis using area means ; (c) the estimate of the disturbing potential from gravity anomalies. The harmonic analysis is optimal for noisy data as well ; with noiseless data it provides harmonic coefficients with minimum aliasing.

MT - MELCHIOR P. - "Earth tides in the 1980's".
236 Obs. Roy. Belgique, Comm., Ser. B, N° 114, Ser. Geophys. N° 135, Bruxelles, 1979.
Reprinted from : Pub. of the Finnish Geod. Inst., N° 89, 123-133, 1979.

MT - DE MEYER F. - "A study of various harmonic analysis methods for earth tides
237 observations".
B.I. Marées Terrestres (CPMT), N° 83, 5187-5235, Bruxelles, April, 1980.

The harmonic analysis methods of Venedikov and Chojnicki together with several new approaches are examined in the paper ; their relative merits can be weighed against each other from the results in Tables 1-8. It is shown how the reconstructed tides, obtained through an earlier developed model, can be turned to account to detect conspicuous data intervals in the observations. Taking the autocorrelations of the observed residuals into consideration, more realistic estimates of the standard errors of the tidal constants are acquired, i.e. the structure of the residual spectrum is explicitely incorporated into the computations. The Markov estimation method is also considered and is proven to yield slightly better results than the classical least squares analysis. A new procedure of drift elimination, not founded on the principle of numerical filtering, is tested and looks very promising in the sense that a modification of Chojnicki's idea results in coherent tidal parameters with standard errors smaller than those hitherto obtained. Investigation of the residual spectrum after least squares adjustment discloses the existence of some non-linear waves which find their origin in shallow water loading and which, therefore, must be included in the harmonic analysis.

MT - DENIS C., A. IBRAHIM - "MØDPØL - Programme numérique permettant de représen-
237 ter des modèles terrestres, planétaires et stellaires de manière cohérente".
B.I. Marées Terrestres (CPMT), N° 83, 5236-5293, Bruxelles, April, 1980.

MT - NGUYEN NGOC THUY - "Specific tidal phenomena of the East Sea (South China
237 Sea) and the problem of calculation of tidal characteristics".
B.I. Marées Terrestres (CPMT), N° 83, 5294-5311, Bruxelles, April, 1980.

MT - VARGA P. - "Stresses in the Earth caused by Earth tides and loading influen-
237 ces".
B.I. Marées Terrestres (CPMT), N° 83, 5312-5320, Bruxelles, April, 1980.

In summary it can be established that the triggering effect of Earth tides if it affects the release of earthquake energy is probably complex, not exercising the same influence at every place. It depends on geographical location of the studied area and orientation of the tectonic elements as well.

MT - Bibliographie Générale des Marées Terrestres, supplément IV 1978-1980.
238 AIG, Centre International des Marées Terrestres, 21 p, Bruxelles, 1980.

GEN - CARPENTER L. - "Earth survey applications division research report - 1979".
27 NASA, Tech. Mem. 80642, 257 p., Greenbelt, 1980.

This is the second Annual Research Report of the staff of the Earth Survey Applications Division, written and compiled in December 1979. The report emphasizes accomplishments rather than plans ; however, there is some discussion of a few developing efforts.

Contents : Ch. 1. Geology - 17 p,
2. Magnetic field modeling and crustal studies - 57 p,
3. Crustal deformation and earthquake models - 42 p,
4. Gravity field model development - 28 p,
5. Global earth dynamics - 29 p,
6. Sea surface topography, ocean dynamics and geophysical interpretation - 33 p,
7. Land resources - 21 p,
8. Agriculture - 63 p,
9. Advanced studies - 18 p.

511 - GEORGIEW N. - "De l'utilisation d'orbites-satellites intermédiaires dans la
97 solution de problèmes géodésiques".
Veröff. des Zentralinstituts Für Physik der Erde, Postdam.
3rd International Symposium Geodesy and Physics of the Earth, Proceedings N° 52, Teil 3, 763-784, 1977.

Les travaux présentent le développement d'une méthode d'utilisation d'une orbite intermédiaire sur base de la variante asymétrique du problème général de l'interaction de deux corps. La fonction de forces tient non seulement compte de la deuxième, mais encore de façon rigoureuse de la troisième harmonique zonale du potentiel terrestre.

En appliquant cette fonction de forces, les coordonnées ξ_j, η_j, ω_j du mouvement-satellite intermédiaire sont représentées en fonction de l'ordre du temps normalisé τ_j.

Sont également fournies des formules pour déterminer les perturbations des harmoniques zonales, isométriques et sectorielles.

511 - LATKA J. - "The determination of the Earth gravity field by use of satellite
97 gradiometry".
Veröff. des Zentralinstituts für Physik der Erde, Postdam.
3rd International Symposium Geodesy and Physics of the Earth, Proceedings N° 52, Teil 3, 785-789, 1977.

The approach consist to determine gravity anomaly directly using satellite gradiometry, here it is limited to regional determination but it is possible to extend it to the global scale. In this experiment, simulated values have been used and the gravity anomalies have been predicted by collocation method.

401 - COLEMAN R., C. RIZOS, E.G. MASTERS, B. HIRSCH - "The investigation of the sea
50 surface slope along the North Eastern coast of Australia".
Aust. J. of Geod., Photo. and Surv., N° 31, 65-100, Kensington, Dec., 1979.

The comparison of the results of geodetic levelling with the mean level of the sea as defined by tide gauge readings, has indicated the apparent existence of widespread departures of sea level from an equipotential surface of the earth's gravity field along the north eastern coast of Australia. The magnitude of this coastal sea surface topography (SST) is not consistent with SST implied from meteorological and oceanographic data in open oceans. A recent relevelling along this coast, with purported higher precision, indicates coastal SST at variance with both the original levelling and oceanographic estimates. The establishment of the pattern of SST by an independent technique using satellite altimetry data collected by the Geos-3 spacecraft is of importance for resolving this ambiguity. This paper reviews all the available evidence from both geodetic and oceanic levelling results for possible sources of systematic error or unmodelled non-gravitational forces acting on the sea surface. Three dimensional position determinations from Doppler observations at bench marks connected by levelling to tide gauges are analysed in order to determine the position of MSL on a geocentric Cartesian coordinate system. Although the evidence from satellite altimetry data and three dimensional position determinations is not conclusive, it appears that the most likely reason for the reported discrepancies in coastal SST is a small systematic error in the geodetic levelling. Recent studies by other investigators seems to corroborate this conclusion.

401 - KAHAR J., A.H.W. KEARSLEY - "Geoid determination in Jawa Island by combining
50 gravimetric and satellite altimeter geoid".
Aust. J. Geod. Photo. Surv., N° 31, 101-110, Kensington, Dec., 1979.

A detailed gravimetric geoid in Jawa island has been computed based on terrestrial free air anomalies ($\psi < 20°$) combined with anomalies derived from the potential coefficients of GEM-10B ($\psi > 20°$). Geoidal undulations in the sea areas at sea surrounding the island is taken from Rapp's satellite altimeter geoid in Indonesian archipelago. A geoid derived from the combination of the two gravimetric and altimetric geoids is found using a least squares collocation technique. The results indicate that this technique may be used in obtaining a smooth continuity between the gravimetric geoid on land and the satellite altimeter geoid at sea as a part of the process of finding the detailed geoid in the Indonesian archipelago.

401 - KEARSLEY A.H.W., H. VAN GYSEN - "Outer zone effects on the Australian gravi-
50 metric geoid".
Aust. J. Geod. Photo. Surv., N° 31, 111-126, Kensington, Dec., 1979.

Investigations into the gravimetric determinations of geoidal parameters in the Australian continent have revealed the existence of systematic errors in these solutions, particularly in the η component. These errors inevitably distort the values obtained for the transformation parameters to bring the Australian Geodetic Datum on to a geocentric reference ellipsoid.

This paper reports on one aspect of the re-evaluation of these transformation parameters i.e. the contribution of the outer zone to the values of N, ξ and η across Australia, and the changes in these contributions which are brought about by the use of the updated Rapp'78 5° data sets.

401 - MASTERS E.G., R. COLEMAN, K. BRETEGER - "On orbital errors and the recovery
50 of regional ocean tides models using satellite altimetry".
Aust. J. Geod. Photo. Surv., N° 31, 127-151, Kensington, Dec., 1979.

The effect of systematic orbital errors on the altimetry ranges was investigated with the view to eliminating any inherent errors in the derived sea surface heights in tidal analyses.

Radar altimeter ranges from the Geos-3 spacecraft, collected over a 12 month period between May, 1975 and May, 1976 were analysed in an attempt to obtain regional ocean tide models in the Sargasso Sea. Two techniques were investigated for the determination of the tidal signal. Firstly, spectral analysis techniques were applied to altimetry sea surface height (SSH) data and to SSH differences at crossover points. Modelling of the ocean tide was also investigated using fourier solutions on both altimetry profiles and overlapping passes of altimetry data.

The methods use either discrete subsets of the data or the complete data set simultaneously. The resultant ocean tide models for the M_2 tide were compared against the Mofjeld empirical model for the area.

401 - MATHER R.S., C. RIZOS - "The shape of global mean sea level from Geos-3 alti-
50 metry".
Aust. J. Geod. Photo. Surv., N° 31, 153-159, Kensington, Dec., 1979.

The Geos-3 spacecraft, launched in April 1975, is equipped with a 13.9 GHz radar altimeter. The short pulse mode altimeter has been used in conjunction with Geos-3 ephemerides to define heights of the sea surface. This information has been used to determine the shape of mean sea level (MSL) for the oceans between 65°S and 65°N. The ellipsoid of revolution which best fits the mean sea surface in this area has a preferred value of 6378 137.0 ± 0.3 m for its semi-major axis (a) and an average flattening (f) of $(298.236 \pm 0.002)^{-1}$. The value of a is based on the adopted value of 2.99792458×10^{8} ms^{-1} for the velocity of light and an unverified quasi-geometric calibration of the altimeter.

The mean earth reference ellipsoid is the best fit to the geoid defined for the oceanic area between 65°N and 65°S and has a value of the semi-major axis which is equal to that of the ellipsoid of best fit to the oceans, i.e. 6378137 m and a flattening of $(298.257334)^{-1}$. In addition, the value of the product of the gravitational constant G and the mass of the earth M for this model is equal to 398600.47 $km^3\ s^{-2}$ and an angular rotation rate (ω) of $0.7292\ 115\ 1467 \times 10^{-4}$ rad s^{-1}. The potential of the geoid W_o based on these parameters is 6,263,685.7 ± 0.4 kgalm. However, an analysis of surface gravity measurements indicates an uncertainty in the value of W_o (and hence GM and a) which has still to be resolved.

401 - RIZOS C. - "An efficient computer technique for the evaluation of geopotential
50 from spherical harmonic models".
Aust. J. Geod. Photo. Surv., N° 31, 161-169, Kensington, Dec., 1979.

The generation of the geopotential from spherical harmonic models of the earth's gravity field is an expensive computational procedure. This will be an even greater problem with the development of gravity field models to higher degree and order. The computation of values on a point-by-point basis is particularly laborious and little can be done to improve computational efficiency. An immediate saving in computer time can be realised if the points at which values are needed lie on the same latitude. However a significant computational saving has been made by developing an algorithm that makes use of the property of equal spacing of "computation points" along a row of latitude.

This algorithm is presented and is compared with the conventional approach for the computation of gravity anomalies/geoid height values on a global 1° x 1° grid using the GEM 10B gravity field model. Tests indicate that this technique is 100 times faster than the conventional method of evaluating spherical harmonics.

MAB - BOULANGER J.D. - "Gravity in Postdam".
69 From : Vermessungstechnik, 28 Jg., Heft 2, 45-50, 1980.

MAB - BOULANGER J.D. - "Certain results of absolute gravity determinations by the
70 instrument of the USSR Academy of Sciences".
From : Pub. Finnish Geod. Inst. N° 89, 20-26, 1980.

The first Soviet gravimeter for absolute gravity determinations was constructed in the beginning of the 70's at the Institute of Automatics and Electrometry of the Siberian Department, USSR Academy of Sciences. This instrument made its first determinations in Siberia with the purpose of working out the technique of measurements ; after that the instrument operated at the International Gravimetrical Point in Ledovo near Moscow. As soon as it was proved that the instrument can operate and can be transported by car or aircraft, it was used to start absolute gravity determinations for the study of the Earth's gravity field stability in time.

The present paper presents and discusses the results of absolute determinations made by this instrument as a part of the international program of study of non-tidal gravity variations at the International Point in Ledovo, in Potsdam, Sevres and Singapore.

MAB - TARASUK, V.G., HARNISH, BOULANGER, J.D., ARNAUTOV, G.P., KALISCH, E.N.,
71 STOUSS, U.F. - "New measurements absolute gravity in Potsdam".
Gerlands Beitr. Geophysik, Leipzig, 87, 1, 9-18, 1978.

In July 1976 new absolute gravity measurements were performed at the International Gravity Stations Ledovo (near Moscow) and Potsdam. These measurements were initiated by the Academy of Sciences of the Soviet Union. The instrument used was a laser gravity meter with a free-falling corner reflector. A deviation of - 13.960 ± 0.017 mGal between the resulting gravity value and the level of the Potsdam gravity system was obtained. This value is in good agreement with other measurements of the gravity difference between both stations using relative instruments. The disagreement amounts to 0.011 ± 0.024 mGal.

VS. - BOULANGER, J.D. - "Secular gravity variations".
33 Fisika Zemli, N° 10, 25-32, 1974.

As the accuracy of gravity measurements increases, it becomes evident that secular gravity variations, if existing, constitute a fine effect of probably several microgals per year. The observations, carried out by Sakuma with an absolute instrument, as yet cover a too short period of time to evaluate secular gravity variations. The hypotheses suggested by Barta and Vogel about the core turning over in the body of the Earth and the corresponding gravity field changes are not confirmed by experimental data. In the USSR, a program is elaborated to study gravity field stability in time during the next 5-7 years.

SAT - MATHER, R.S., R. COLEMAN, B. HIRSCH - "Temporal variations in regional models
191 of the Sargasso sea from Geos-3 altimetry".
From : J. Physical Ocean., Vol. 10, n° 2, 171-185, Feb., 1980.

The dense coverage of short-pulse mode Geos-3 altimeter data in the western North Atlantic provides a basis for studying time variations in sea surface height (SSH) in the Sargasso Sea. Two techniques are utilized in this study : 1) the method of regional models and 2) the analysis of overlapping passes.

An approximate estimation technique shows that the quasi-stationary SSH maintaining the Gulf Stream is present in the Geos-3 data but cannot be estimated with confidence in the absence of an adequate geoidal model.

ECO - BOULANGER, J.D., GAIPOV, B.N., DEMAYNOVA, T.E., KURBANOV, M.K. - "A study of
78 non-tidal variations of gravity at the Ashkhabad geodynamic test field".
From : Boll. di Geof. Teor. ed Applicata, Vol. 20, n° 80, 329-332, Dec., 1978.

The results of repeated relative gravity measurements with a number of gravimeters type GAG-2 and GS-12 in the Ashkhabad seismically active zone in 1971, 1975 and 1976 are given. Some increase of gravity of local character for the central part of the test field relative to 1975 is noticed. These variations of + 0.059 mGal and + 0.040 mGal for GAG-2 and GS-12 respectively are within the triple value of rms error of ± 0.015 mGal. The variations found can be explained by density changes within the uppermost crustal layers.

MAB - BOULANGER, J.D. - "Correction of Potsdam system".
72 Fisika Zemli, N° 10, 3-12, 1978.

The paper presents results of determination of the Potsdam system correction as related to the new International Gravimetric Standard Network 1971 (IGSN 71). The correction, obtained from relative determinations, is equal to 14 002 ± 15 mcgal. According to absolute determinations, it is 13 980 ± 6 mcgal. A systematic divergence is found between the values of correction obtained from measurements at European points and at points on other continents, which is 65 ± 18 mcgal. It is established that the zero of IGSN-71 system (Sèvres, 1971) is shifted by 53 ± 3 mcgal in relation to the latest absolute determinations.

ECO - BOULANGER, J.D., DEMAYNOVA, T.E. - "Results of repeated gravity observations
77 on the Garm geodynamic test-field".
From : Boll. di Geof. Teor. ed Applicata, Vol. 20, n° 80, Dec. 1978.

The results of repeated relative gravity measurements carried out at the Garm geodynamic test field (Tadjikistan) with gravimeters type GAG-2 for the period of 1972-1976 are discussed. The gravity for all stations of the test-field relative to the reference stations increase. The maximum increase is + 0.046 ± 0.021 mGal. These values do not correlate with the vertical movement rates.

524 - BAETSLE, P.L. - "A propos du théorème de décomposition des fonctions harmoni-
96 ques sphériques".
Scient. Bull. of the Stanislaw Staszic. Univ. of Mining and Metallurgy, Krakow, Geodesy, B. 55, 11-21, 1979.

The property of Legendre polynomials and associated functions, which is expressed by formula /0/ below, is well known, mostly since its use in the expression of the newtonian gravific potential as applied to satellite geodesy. There are many proves of this formula. The one proposed here is partly new and needs only elementary calculus.

$$P_n(\cos \psi) = \sum_{o}^{n} \xi_k \frac{(n+k)!}{(n-k)!} P_{n,k}(\theta)\, P_{n,k}(\theta') \cos k(\lambda-\lambda') \qquad /0/$$

524 - KUBACEK, L. - "About confidence regions".
96 Sci. Bull. of the Stanislaw Staszic. Univ. of Mining and Metallurgy, Krakow, Geodesy, B. 55, 35-42, 1979.

The method for determination of the boundary of the confidence region which covers the whole family of functions of indirectly measured parameter with probability not less than apriori prescribed is developed in the paper. This method is elaborated within the framework of the universal model of adjustment theory.

BIB - "Bibliography of Publications on the field of geodetical computations 1977-
14 1978".
Special Study group IUGG, 1-21.
From : Sci. Bull. of Stanislaw Staszic. Univ. of Mining and Metallurgy, Krakow, Geodesy, B. 57, 70 p., 1979.

WDC - "Catalogue of publications received by WDC B1 between January and June 1978".
USSR World Data Centre B1, Moscow, Catal. n° 39, 27 p., Jul. 1978.

Seismology, gravimetry, geodesy, upper mantle, geology.

MT - DITTFELD, H.J. - "Aim and result of gravimetric tide recording".
239 Vermessungstechnik, Berlin, Heft 1, 4 p., 1979.

MT - SIMON, Z., HOLUB, S. - "Results of the Earth tide measurements at the Pecny
240 station (CSSR)".
IUGG, XVII Meeting, Canberra, Dec., 1979.
Referaty Vugtk, papers of the Res. Inst. of Geod., Topo. & Carto. in Prague, 10 p., 1979.

401 - FRASER, A.R., DARBY, F., VALE, K.R. - "The reconnaissance gravity survey of
51 Australia : a qualitative analysis of results".
BMR, Australia, Report 198 (BMR Microform MF 15), 95 p., 1977.

As a first step towards analysing Australia's gravity pattern and its correlation with the regional structure, the Bouguer anomaly field over Australia and its northwest continental shelf has been divided into ninety-six regional gravity provinces. A gravity province is a region where the gravity field is characterised by uniformity of at least one property, such as contour trend, gravity level, or degree of contour disturbance, which distinguishes it from a neighbouring province. Many gravity provinces are subdivised into gravity units, which are similar to provinces in definition, but of smaller size. The provinces and units are discussed in relation to known geology and geophysics. In general, provinces of high Bouguer anomaly correspond to Proterozoic or early Palaeozoic metamorphic belts, provinces of low Bouguer anomaly to granitic batholiths or Phanerozoic sedimentary basins, and provinces of complex contour pattern to Precambrian or Palaeozoic orogenic domains.

SAT 192 – SCHNEIDER, M. – "Report of Special Study Group 78 "Satellite Geodesy" of Munich, University of Technology".
Veröff. Bayer. Komiss. Internat. Erdmes., Astro. Geod. Arbeiten H 39, 150 p., 1979.

- Aspects géodynamiques de la géodésie spatiale,
- Mesures de localisation,
- Mesures de distance,
- Mesures doppler,
- Modèles et méthodes d'utilisation de valeurs mesurées en Géodésie Spatiale,
- Définition des paramètres de figure et de champ.

SAT 193 – SCHNEIDER, M., SIGL, R. – "Report of Special Study Group 78 "Satellite Geodesy" of Munich, University of Technology".
Veröff. Bayer. Komiss. Internat. Erdmes., Astro. Geod. Arbeiten H 36, 281 p., 1977.

- Acquisition et traitement des observations par satellite et mesures terrestres complémentaires.
- Projet partiel A1 – Mesures de localisation.
- Projet partiel A2 – Mesures de distances
- Projet partiel A3 – Mesures doppler.
- Utilisation géodésique des observations par satellites et mesures terrestres complémentaires.
- Modèles et méthodes d'utilisation de mesures en Géodésie Spatiale.
- Définition de paramètres de figures et de champs.

GET 278 – STOLZ, A. – "Precise modelling aspects of lunar measurements and their use for the improvement of geodetic parameters".
Veröff. Bayer. Komiss. Internat. Erdmes., Munich, Reihe 1, H. 90, 23 p., 1979.

A step-by-step description of the modelling of the lunar laser two-way time-delay is presented. The formulas employed for diurnal polar motion, short-period tidal variations in universal time (UT), the effects of the earth's non-rigidity on the nutation series, horizontal and vertical components of earth-tidal deformation, retardation of the photon by the atmosphere, and relativistic effects on the measurement of time and on the path of photon are given. The use of the data for improving telescope coordinates, polar motion and UT is described. Also discussed are the correlations which exist between ephemeris errors and errors in UT and polar motion, and between errors in UT and the y coordinate of the pole.

MT 241 – BONATZ – "Contributions to earth tides study by the Geodesy/Geophysic working group of the FDR".
Veröff. Bayer. Komiss. Internat. Erdmes., Reihe B, H 231, 133 p., 1979.

MT 242 – SCHMITZ-HUBSCH, H. – "Earth tides recording in upper Bavaria from 1970 to 1977 with borehole tiltmeters by the section 1 of the German Research Institutes in Geodesy".
Veröff. Bayer. Komiss. Internat. Erdmes., Reihe B, H 241, 67 p., 1979.

In an Upper Bavarian area of 12 x 30 km^2 extent, consisting of two profiles with 5 boreholes each in geologically different layers, horizontal tidal acceleration were measured by 2 ASKANIA borehole tiltmeters in a first campaign from 1970 to 1975, and by 4 ASKANIA borehole tiltmeters in a second campaign from 1976 to 1977.

Both measurements resulted in showing a dependence of the derived tidal parameters on the geological layers of the unfolded Molasse and of the calcareous Alps. Moreover, a seasonal dependance of these parameters was shown. The parameters were calculated to be invariant in regard of turns and exchanges of the pendulums in the stations.

The directions of the periodic drift vectors proved to correlate with the uplifts of the boreholes caused by the drilling engineering. On two stations, an earthquake produced sudden identical drift vectors which, after one or two days, turned again into local directions. Mountains, towering up to 1400 m close by a station caused local rock pressures whose influence upon the tidal measurements – continuous or intermittent – is yet unclear. 8 years after the completion of the boreholes, the main values of the aperiodic drift vectors have decreased only to about 60 percents. At present, the drift rates of the boreholes still are too big for the investigation of geodynamic effects.

GN 50 – SIGL, R. – "Continental networks – Report on the activities of the IAG-Commission X. 1975-1979".
IUGG Gen. Assembly, Canberra, 1979. Veröff Bayer. Komiss. Internat. Erdmes., Munchen, Reihe B, H 243, 60 p., 1979.

The contribution is divided into four parts :
In part 1 after some remarks about the establishment and the general guidelines for the working method of Commission X the scientific aims of the work are defined. Furtheron first experiences in cooperation are reported and proposals for the further working method are presented for discussion.

In part 2 after an explanation of the activities of the Commission the state of work in the Subcommissions for European Triangulation (RETrig) and European Levelling (UELN), North America, South America and South East Asia and the Pacific is shortly reported. Some additional informations for other regions, e.g. for Africa, India and Japan are added.

In part 3 after some remarks on the definition and importance of continental networks it is tried to prepare a discussion on open questions and problems which come up with the establishment of geodetic networks, using not only terrestrial observations but also results from satellite geodesy and, as far as possible, also to present proposals for possible solutions.

In part II the original reports on the activities of the Subcommissions and additional informations are put together.

512 98 – SIGL, R. – "F.D.R. National Report".
IUGG XVII Meeting, Canberra, 1979.
Veröff. Bayer. Komiss. Internat. Erdmes., Munchen, Reihe B, H 244, 170 p., 1979.

ECO 79 – STOBER, M. – "Mise en évidence de mouvements verticaux récents de l'écorce à l'aide des nivellements de précision".
Veröff. Bayer. Komiss. Internat. Erdmes., Munchen, Reihe C, H 251, 164 p., 1979.

GET 279 – BOSCH, W. – "Untersuchungen zu schiefuchsigen un gemischten Randwertaufgaber der Geodäsie (Etudes des missions des zones marginales mixtes et en axe oblique en Géodésie)".
Veröff. Bayer. Komiss. Internat. Erdmes., Munchen, Reihe C, H 258, 105 p., 1979.

GET 280 – HOFMANN-WELLENHOF, B. – "Die gegenseitige Orientierung von zwei Strahlenbündeln bei Übereinstimmung, bei unbekannten Näherungswerten und durch ein nichtiteratives Verfahren (L'orientation réciproque de deux faisceaux de rayons en concordance, pour des valeurs approchées inconnues et par procédure non-itérative)".
Veröff. Bayer. Komiss. Internat. Erdmes., Munchen, Reihe C, H 257, 67 p., 1979.

GRD 48 - DOUKAKIS, E. - "Evaluation des performances des systèmes de navigation inertiels s'appuyant sur gradiomètres".
Veröff. Bayer. Komiss. Internat. Erdmes., Munchen, Reihe C, H 255, 1979.

A gradiometer-aided inertial navigation system is theoretically and statistically analysed to estimate its abilities to monitor geocentric cartesian coordinates. Having discussed the inertial instrumental units used on the moving platform and several reference coordinate frames applicable in all navigation systems, studies on the severe problem of the separability of the gravity gradients from the inertial disturbances are carried out. Simulation I presents how well the aided navigation system can produce inertial coordinates and how the newcomers of the inertial instrumentation, the gradiometers, perform on-board the moving vehicle. Quantization error studies are also analysed and presented for such a system. Simulation II includes besides the detailed analysis of the accelerometer and gradiometer error models used, the abilities of the system to estimate geocentric coordinates. Multipoint statistical analysis for the approximated inertial acceleration components shows that the navigation system under consideration behaves better as closer the reality is approached.

512 99 - "Fünfundzwanzig jahre Deutsche Geodätische Kommission".
Veröff. Bayer. Komiss. Internat. Erdmes., München, Reihe E, H 17, 314 p., 1978.

Sujets traités en Géodésie :

. Le Groupe de Travail "Géodésie théorique de la Commission allemande de Géodésie.
. Le nouveau réseau allemand de gravimétrie.
. Date européenne 1977 : premiers résultats de la phase d'équilibrage du RETrig.
. Calcul tri-dimensionnel de réseaux de distances.
. Le programme de recherche du secteur de recherche 78 "Géodésie Spatiale" de l'Université de Munich.
. De la situation actuelle de la station d'observation des satellites de Wettzell.
. L'observation photographique de localisation par satellites et ballons-sondes et son utilisation en Géodésie.
. Bases et plan d'utilisation de données altimétriques précises dans la région de la baie de Hudson et en Mer du Nord.

SAT 194 - PAQUET, P., DEVIS, C. - "Reasons and Possibilities for an extended use of the Transit system".
Obs. Royal de Belgique, Série Géophysique, n° 134, 8 p., 1979.

Observations of Earth rotation and polar motion are now performed on a routine basis by classical astronomical methods and by the satellite Doppler technique.

In the near future the laser is likely to realize its old objective of determining ER and PM with an accuracy of a few milliseconds of arc through ranging to Lageos. VLBI is still in development.

To permit investigation of possible systematic differences, all these techniques should be used simultaneously for a period whose length should not be set in advance.

The Doppler method can still be improved and could be easily introduced at many observatories in support of the Medoc campaign. We present here two possible methods of data condensation which, if implemented, would permit much of the data analysis to be done at the tracking stations and would reduce to a very few the number of parameters required by the central computing agency.

SAT 195 - PAQUET, P. - "The utilization of Time in Space Geodesy".
Obs. Royal de Belgique, Série Géophysique, n° 133, 9 p., 1978.

For Space Geodesy requirements the needs of Time synchronization are of the order of one microsecond. With ground stations connected to UTC by classical methods (Loran, TV) the synchronization accuracy, internal at the Tranet network using Transit satellites, can reach 10 microseconds.

600 32 - KAMINUMA, K. - "A review of Geophysical studies of Antarctica".
Proceedings of the 1st. Symposium on Antarctic Geosciences, 1978.
Nat. Inst. of Polar Research, Tokyo, Mémoir, n° 14, 8-17, Oct., 1979.

The feature of the Antarctic Continent beneath ice sheet has been clarified by applying geophysical methods since the international Geophysical Year which started in 1957. The crustal structure of the Antarctic Continent was studied by means of gravity data analysis, explosion seismology and surface wave dispersions. The seismicity in Antarctica was also studied with the data which were obtained through the world wide seismological network, especially at the seismological stations in Antarctica. Two active volcanoes are located in Antarctica.

600 32 - SEGAWA, J. - "Marine Gravimetry in relation to the Antarctic region".
Proceedings of the 1st. Symposium on Antarctic Geosciences, 1978.
Nat. Inst. of Polar Research, Tokyo, Mémoir, n° 14, 57-69, Oct., 1979.

Recent techniques of marine gravimetry and gravimeters available are reviewed and some requirements for gravity measurements in the Antarctic region are mentioned in the first part. In the second part the gravity data so far obtained in the Antarctic region including both surface ship and satellite data are shown, and gravity anomalies there are discussed.

509 31 - BURSA, M. - "The force function of the Earth-Moon system".
Finnish Geod. Inst., n° 89, 27-33, 1979.

The solution of many problems connected with the dynamics of the Earth-Moon system, especially on the basis of the laser ranging to the Moon, needs the force function in a developed form. For to be able to study dynamic effects for very long periods, the force function should be derived with such an accuracy that the integration for large time intervals be accurate enough, especially as regards secular and long-periodical terms. This concerns, e.g., tidal friction problem and the dynamic evolution of the Earth-Moon system, the rotation of the Earth and the Moon, variations of the elements of Moon's orbit, precession, nutations, etc.

509 31 - DAHLE, E.O., BAKKELID, S., DANIELSEN, J. - "Definition of ED 50 at sea in particular in the North Sea using the Transit Doppler system".
Finnish Geod. Inst., n° 89, 34-47, 1979.

The paper points out :

. that median line sea boundaries, fishery and consession limits in the North Sea are defined in terms of ED 50 coordinates,
. that the ED 50 initially is defined by physical marks on the ground of the surrounding land areas, and
. that in the light of present days'needs, constitutes an inhomogeneous network.

The paper further demonstrates how the ensueing problems can be overcome by using the Transit satellite system :

. to define consistent ED 50 net for the total land and sea areas, and
. for positioning of points at sea in this system.

509 31 - GARLAND, G.D. - "Seventy years of Isostatic theories".
Finnish Geod. Inst., n° 89, 48-56, 1979.

509 31 - HEIKKINEN, M. - "On the gravimetric inverse problem".
Finnish Geod. Inst., n° 89, 63-70, 1979.

509 - HYTONEN, E. - "Remeasurement of the Mata Das Virtudes Standard Baseline in
31 Portugal".
Finnish Geod. Inst., n° 89, 79-83, 1979.

The first measurement of the Mata das Virtudes Standard Baseline was made in 1962. After this measurement an earthquake with magnitude 6 on the Richter scale occurred in the area close to Mata das Virtudes. It was later verified by invar wires that the length of the Standard Baseline changed to the extend that underground marker 240 was moved. It was for this reason that the Instituto Geografico e Cadastral in Portugal asked the Finnish Geodetic Institute to remeasure the Standard Baseline.

509 - KAKKURI, J. - "On the vertical movements of levelling Bench Marks".
31 Finnish Geod. Inst., n° 89, 84-87, 1979.

509 - KELSEY, J., ASHKENAZI, V. - "Contribution of space techniques to National and
31 Continental geodetic networks".
Finnish Geod. Inst., n° 89, 88-97, 1979.

Space techniques in Geodesy developed rapidly after the launching of the first artificial earth satellite in 1957. Until then, geodetic connections between widely separated national and continental networks had only been possible by using either line crossing techniques from high flying aircraft (Ross, 1955) or balloon and flare triangulation (Kakkuri, 1973). These systems suffered from a limitation of range which was inherent in the restricted height of the elevated beacon. The advent of the artificial earth satellite increased both the range and accuracy of these measurements and, for the first time, made it possible to make inter-continental connections to geodetic standards.

A general description of geodetic space techniques is given in § 2 of this paper followed, in § 3, by a discussion of their possible contribution to the strengthening of large networks and the provision of a worldwide geodetic control system for connecting individual national and continental networks.

509 - LAURILA, S.H. - "An application of three dimensional laser geodesy".
31 Finnish Geod. Inst., n° 89, 104-111, 1979.

This contribution reports a problem encountered in the ground-to-ground laser survey and its solution by the application of three-dimensional laser geodesy.

509 - LEVALLOIS, J.J. - "Construction d'un géoïde local par utilisation du gradient
31 de la pesanteur".
Finnish Geod. Inst., n° 89, 112-117, 1979.

509 - MARUSSI, A. - "Natural reference systems and their reciprocals in Geodesy".
31 Finnish Geod. Inst., n° 89, 118-122, 1979.

Whenever a system of holonomic geometrical or physical coordinates is introduced in the metric three-dimensional space, it is shown that in general the coordinate lines are not the orthogonal trajectories of any triple family of surfaces, and neither are the orthogonal trajectories of the coordinate surfaces the intersections of pairs of surfaces belonging to a triple family.

An application is made to the case of the geodetic space referred to natural coordinates.

509 - MELCHIOR, P. - "Earth tides in the 1980's".
31 Finnish Geod. Inst., n° 89, 123-133, 1979.

509 - MORITZ, H. - "The geometry of least squares".
31 Finnish Geod. Inst., n° 89, 134-148, 1979.

The present article attempts to trace the development, during the last 30 years, of the geometrical interpretation of the two basic Gaussian minimum principles in least squares estimation : minimum norm and minimum variance. The developments leads from least-squares adjustment to least-squares collocation. Hilbert spaces with kernel functions used in collocation show a close analogy to the tensor formalism used by Tienstra in his adjustment of correlated observations. Even the general least-squares collocation model is seen to have a very simple geometrical interpretation in terms of projection onto subspaces.

509 - RINNER, K. - "Control survey a fundamental task of geodesy".
31 Finnish Geod. Inst., n° 89, 157-165, 1979.

MT - DUCARME, B., KAARIAINEN, J. - "The Finnish tidal gravity registrations in
243 Fennoscandia".
Publ. of the Finnish Geod. Inst., n° 90, 43 p., 1980.

The study of tidal parameters is of considerable interest in Fennoscandia where postglacial land uplift offers a fruitful field for geophysical measurements and research.

The values of tidal parameters are needed not only for investigating the inner structure of our planet but also for correcting precise geodetic networks, especially for evaluation of systematic errors in high precision gravimetric measurements. There are four high precision gravity profile lines in Fennoscandia for determining the secular gravitational variations due to land uplift phenomena. The crustal behaviour due to the tidal forces must be taken into account to obtain correct results.

Two tidal gravimeters have been installed by the Finnish Geodetic Institute (FGI) at different places in Fennoscandia since 1964. In 1971 a Geodynamics gravimeter was put at the disposition of FGI by the US NOAA.

The analysis of observations allows us to deduce a clear picture of the tidal phenomena in Fennoscandia, very large indirect effects are observed all along the Atlantic coast and also in the Southern part of Sweden.

The precision of the measurements already performed is sufficient for practical applications as accurate tidal predictions for absolute measurements as well as for long term variation in gravity.

GN - PARM, T. - "High precision geodetic length measurements".
51 I.A.G., Symposium (June 19-22, 1978), Helsinki, Reports of the Finnish Geod. Inst., n° 80-1, 364 p., 1980.

ANO - ADIGHIJE, C. - "Gravity field of Benue Trough, Nigeria".
88 from : NATURE, Vol. 282, 199-201, Nov., 1979.

The Benue Trough, located at the Gulf of Guinea re-entrant on the West African coast, is a unique Cretaceous rift whose origin is related to the opening of the South Atlantic and the continental separation of Africa from South America. The trough extends northeastwards for ∿ 700 km from the Niger Delta to the Chad Basin and is filled with an estimated 5,000 m of Cretaceous sediments and volcanic rocks. Studies on the origin and tectonic evolution of the Benue Trough have been based so far principally on surface geological and geochemical evidence[1-5]. Gravity measurements by Cratchley and Jones[6] in the middle Benue area are of limited significance because they were aimed mainly at resolving the then controversy between the tensional and compressional[8] hypotheses. New and more extensive gravity data presented here indicate rifting in the upper and middle sections of the trough whereas the complex field over the lower section could be due to an "unsuccessful" attempt to open into an ocean during the late Cretaceous.

PMA - POWELL, D.W. - "Gravity and Magnetic anomalies in North Wales".
7 from : Q.J.G.S., Vol. CXI PL. XIX, 375-392, March, 1955.

Bouguer anomalies in North Wales have been calculated from a network of gravity stations in which the standard deviation of a gravity difference is about 0.2 mgl. Magnetic anomalies have been surveyed in part of the area. Rock densities have been measured in the laboratory and in the field.

The depth to the Pre-Cambrian geosynclinal floor in North Wales is thought to influence the gravity anomalies in some areas, but may control the magnetic anomalies more directly. The regional gravity gradients are due to deeper density contrasts, possibly those involved in crustal warping.

At the head of the Vale of Clwyd, 2500 feet of Upper Carboniferous is inferred ; farther south, 2000 feet of Trias. The possibility of a Triassic basin under Cardigan Bay is discussed. Structures within the Flint Coalfield are reflected in the gravity anomalies.

ANO - MARANGUNIE, C.D. - "Gravimetric profile and crust thickness along the coast
89 of the Skyring Sound in the Patagonian Fiords".
from : Comunicaciones, n° 25, 1-11, March, 1979.

A gravity profile was measured along the coast of the Skyring Sound in the patagonian fiords. In it, the Bouguer anomaly increases from East to West, towards the axis of the Andean Cordillera. This is interpreted as caused by denser crustal rocks, as well as the absence of roots under the Cordillera and a rise of the Moho. In a proposed model, the contact between the American and Antarctic crustal plates from lat. 48° to 56° South, is a left-handed shear zone, without subduction and no roots under the mountain chain of the continental margin. The subduction causing the trench ceased about 10 million year ago.

PMA - GRAY, F., STACEY, A.P. - "Gravity and Magnetic Interpretation of Porcupine
8 Bank and Porcupine Bight".
from : DEEP-SEA Research, Vol. 17, 467-475, 1970.

This marine gravity and magnetic survey made in 1966 was designed to study the structural relationship between Procupine Bank, Procupine Bight and the continental shelf west of Ireland. The gravity results show that the continental margin which forms the western edge of Porcupine Bank is isostatic equilibrium in accordance with Airy's hypothesis. Porcupine Bight, however, is characterised by a large positive Free-Air anomaly which is though to be caused by high density material within the crust, or by a relatively thin crust. The magnetic results show large amplitude, long wavelength anomalies over the Porcupine Abyssal Plain, high frequency anomalies over the northern end of Porcupine Bank and a large negative anomaly over Porcupine Bight.

The possibility of lateral movement of Porcupine Bank relative to the main continent is discussed with reference to observed geological and geophysical features in western Ireland.

SAT - PHILLIPS, R.J., SJOGREN, W.L., ABBOTT, E.A., ZISK, S.H. - "Simulation gravity
196 Modeling to spacecraft-tracking data : analysis and application".
from : J.G.R., Vol. 83, n° B11, 5455-5464, Nov., 1978.

It is proposed that line-of-sight gravity measurements derived from spacecraft tracking data can be used for quantitative subsurface density modeling by suitable orbit simulation procedures. Such an approach avoids complex dynamic reductions and is analogous to the modeling of conventional surface gravity data. This procedure utilizes the vector calculations of a given gravity model in a simplified trajectory integration program that simulates the line-of-sight gravity. Solutions from an orbit simulation inversion and a dynamic inversion on Doppler observables compare well (within 1% in mass and size), and the error sources in the simulation approximation are shown to be quite small. An application of this technique is made to lunar crater gravity anomalies by simulating the complete Bouguer correction to several large young lunar craters. It is shown that the craters all have negative Bouguer anomalies.

VS - HIPKIN, R.G. - "A Microgravimetric network for secular gravity studies in
33 Scotland".
from : Geophys. J. R. Astr. Soc., n° 52, 383-396, 1978.

Tests with the LaCoste and Romberg gravity meter G-275 show that random reading errors generate a standard deviation of less than 0.02 gu (2 μgal) under typical microseismic conditions. Reproducible, systematic errors are commonly an order of magnitude larger, due mainly to residual tidal effects and drift induced by clamping. The latter, possibly related to thermal gradients in the oven, can be eliminated by observing a long-enough section of the drift curve at each field station so that equilibrium is reached there. A measurement of the gravity difference between the NGRN (73) sites at Edinburgh and Linlithgow, giving $5.565^5 \pm 0.018$ (se) gu, is described as an example of the method.

A loop of eight gravity stations associated with Ordnance Survey Fundamental Bench Marks, east-west between Dunbar and Bowling (Dumbartons) and northwards to Crubenmore (Inverness) is being measured as the basis of a secular gravity study by a calibrated small-difference method. The uses of such a network are discussed.

ANO - FEATHERSTONE, P.S., BOTT, H.P., PEACOCK, J.H. - "Structure of the continental
90 margin of South-Eastern Greenland".
from : Geophys. J. R. Astr. Soc., n° 48, 15-27, 1977.

The paper describes the interpretation of geophysical observations across the South-eastern Greenland continental margin between 58° and 65° N. Gravity profiles indicate that the main change in crustal thickness associated with the margin occurs landward of the scarp north of 63° but corresponds more nearly to the scarp further south.

ISO - BLUNDELL, D.J. - "A gravity survey across the Gardar Igneous Province SW
41 Greenland".
from : JL. Geol. Soc. Lond., Vol. 135, 545-554, 1978.

The Gardar Igneous Province is believed to involve the remains of Proterozoic rifting which evolved through repeated phases of activity around 1300 Ma, 1250 Ma and 1170 Ma ago. A gravity survey across part of the province has established the presence of a gravity "high" of some 300 g u amplitude which is 30 km wide and elongated ENE-WSW, centred on Tunugdliarfik and axially along one of the main zones of Gardar intrusives. This gravity anomaly is similar to that of other ancient rift systems and appears to be a residual of the axial anomaly to be found in modern active rifts. It is interpreted in terms of a basic mass underlying a late Gardar rift, some 50 km long and 25 km wide, intruding the crust. Evidence suggests the Gardar rifting cannot be explained in terms of a major crustal separation as an extension of the mid-continental rift and Keweenawan systems of North America. It is more consistent with crustal stretching of no more than 10 km and possibly diapiric mechanisms.

The coastal gravity gradient appears to be due to a change in crustal thickness coincident with the coastline, some 25 km beyond the present ice cap limit. Although Greenland may be in overall isostatic balance, it seems that the coastal zone remains overcompensated.

ANO - McKENZIE, D., BOWIN, C. - "The relationship between bathymetry and gravity in
91 the Atlantic Ocean".
from : J.G.R., Vol. 81, N° 11, 1903-1915, April, 1976.

The free air gravity anomaly and depth are sampled at 2-km intervals along two long, reasonably straight ship tracks across the Atlantic Ocean. The resulting series are then processed as if they were time series, and filters are obtained to predict the gravity observations from the bathymetry. More than half the energy in the gravity field can be predicted by this means, and that which cannot emphasizes unusual structures beneath the sea floor. More information can be obtained by comparing the gravity and the bathymetry after both series have been Fourier-transformed. Isostatic compensation begins when the wavelength exceeds about 100 km and increases with increasing wavelength. The results are compared with predictions from various simple models and agree best with a model in which the topography results from variations of crustal thickness and the plate thickness is little greater than 10 km when the compensation occurs. These observations can be understood if the topography results from large-scale intrusions into the lower crust within tens of kilometers of the spreading center. Though such a model for a slowly spreading ridge differs from most of those which have been previously put forward and must be regarded with skepticism until it is supported by evidence from other sources, it appears to be compatible with the limited information now available.

GN 52 - SHAPIRO, I.I., COUNSELMAN, C.C., HERRING, T.A. - "Analysis of Laser Ranging and VLBI Observations for Geodetic Purposes".
Air Force Geophys. Lab., AFGL-TR-79-0196, Final Report, 16 p., Aug., 1979.

From three VLBI experiments carried out in 1977 and 1978, the distances between the antenna at Onsala (Sweden) and radio telescopes at Haystack (Massachusetts), Green Bank (West Virginia) and Owens Valley (California) have been determined with formal standard errors as small as a few centimeters and repeatability generally within the 99% confidence interval of the root-sum-squares of these standard errors. Overall it appears that subdecimeter precision has been achieved in these estimates of baseline lengths.

THP 4 - MORITZ, H. - "Recent developments in the Geodetic boundary-value problem".
Air Force Geophys. Lab., AFGL-TR-78-0002, 124 p., Dec., 1977.

The report reviews progress in the mathematical formulation and treatment of the geodetic boundary-value problem, in particular, the existence and uniqueness theorems of L. Hörmander and the gravity space approach due to F. Sanso. The method of Hörmander uses a very advanced inverse function theorem of nonlinear functional analysis. Sanso has transformed Molodensky's free boundary-value problem into a fixed boundary-value problem in "gravity space", thereby essentially reducing the mathematical complexity. As a linear approximation, the gravity space approach gives identical superior for treating questions of existence and uniqueness of the solution, although it is restricted to the pure gravitational case without centrifugal force.

GEN 28 - UOTILA, U.A., RAPP, R.H. - "Studies of the Earth's gravity for geodetic purposes".
Ohio State Univ., n° 279, 29 p., Dec., 1978.

This report summarizes the work carried out from 1 July 1975 to September 1978 on an AFGL project directed towards the study of the Earth's gravity field. Each report is described and put in context with the total research effort. The main areas described in the report relate to the theory and application of least squares collocation ; the theory and development of covariance functions ; the theory and results from using airborne gradiometry ; and the use of satellite to satellite tracking data for the recovery of anomalies on the surface of the earth.

ALT 1 - KAHN, W.D., SIRY, J.W., BROWN, R.D., WELLS, W.T. - "Ocean gravity and geoid determination".
G.S.F.C., X-921-77-259, 20 p., Oct., 1977.

Gravity anomalies have been recovered in the North Atlantic and the Indian Ocean regions. Comparisons of 63 2° x 2° mean free air gravity anomalies recovered in the North Atlantic area and 24 5° x 5° mean free air gravity anomalies in the Indian Ocean area with surface gravimetric measurements have shown agreement to ± 8 mgals for both solutions. Geoids derived from the altimeter solutions are consistent with altimetric sea surface height data to within the precision of the data, about ± 2 meters.

GN 53 - POETZSCHKE, H. - "Motorized levelling at the national geodetic survey".
N.O.A.A., NOS NGS 26, 17 p., Oct., 1980.

Since the early 1900's, various forms of motorized levelling modes have been attempted to speed up levelling operations. Because levelling has to be performed in the highly turbulent and fast changing layers of air near the ground, faster progress in levelling is a desirable goal. This will help to minimize the effects of refraction. Also, in motorized levelling heavier equipment can be used than in conventional levelling and, therefore greater stability is induced in the setup of instrument and rods. A short review of the existing systems of motorized levelling is given, and the operational system of the National Geodetic Survey is described. The results show the improvements achieved with the NGS system.

GN 54 - DRACUP, J.F. - "Horizontal control".
N.O.A.A., NOS 88 NGS 19, 32 p., June, 1980.

The horizontal geodetic control network of the United States consists of about 240,000 stations of first -, second -, and third-order accuracies. This vast network has been in a continuing state of development since 1832. Originally, progress was very slow, but as new, improved instrumentation developed, vast strides occurred. Today, surveys can be made to accuracies that were impractical only a few decades ago. This improvement is attributed to advances in electronics and to the utilization of satellites and quasars. The publication and maintenance of up-to-date data are a tremendous task, which has been made manageable by automation. When the new adjustment of the North American Datum is completed in the mid-eighties, the adjusted data will represent the optimum results obtainable.

WDC B1 - "Six-Month Catalogue of Data on Oceanography (ship program), received during the period 1 July-31 December 1979".
USSR World Data Center B1, Part II, 155 p., Jan., 1980.

WDC B1 - "Catalogue of Meteorology and Nuclear Radiation Data for the period July 1-December 31, 1979".
USSR World Data Center B1, 22 p., Jan., 1980.

WDC B1 - "Catalogue of Publications received by WDC B1 between January and December 1979 - General Periodicals".
USSR World Data Center B1, Issue 42, 24 p., Jan., 1980.

WDC B1 - "Catalogue of Publications received by WDC B1 between July and December 1979 - Meteorology and Nuclear Radiation".
USSR World Data Center B1, Issue 42, 16 p., Jan., 1980.

WDC B1 - "Catalogue of Publications received by WDC B1 between July and December 1979 - Glaciology/Oceanography/Hydrology".
USSR World Data Center B1, Issue 42, 23 p., Jan., 1980.

WDC B1 - "Catalogue of Data on Longitudes and Latitudes for the period January 1-December 31, 1979".
USSR World Data Center B1, 7 p., Jan., 1980.

WDC B1 - "Six-month Catalogue of Data on Oceanography (ship programs) received during the period 1 July-31 December, 1979".
USSR World Data Center B1, Part I, 68 p., Jan., 1980.

MMG 76 - BRETT, C.P. - "Cruise report on project 80/02 - A Geophysical survey in the Eastern English Channel".
I.G.S., n° 104, 15 p., Dec., 1980.

MMG 77 - BRETT, C.P. - "Cruise report on project 80/03 - A Regional geophysical survey in the Northern North Sea".
I.G.S., n° 105, 24 p., Dec., 1980.

MMG 78 - BRETT, C.P. - "Cruise report on project 80/11 - A gravity and magnetic survey in the Northern North Sea".
I.G.S., n° 106, 9 p., Dec., 1980.

MMG 79 - BRETT, C.P. - "Cruise report on project 80/01 - A regional geophysical survey in the Southern North Sea".
I.G.S., n° 103, 24 p., Oct., 1980.

RIP - EVANS, R.B., SHELTON, A.W. - "The establishment of a gravity base stations
101 in Seeb International Airport Muscat Oman connected to the International Gravity Standardization Net 1971".
I.G.S., n° 58, 11 p., June, 1978.

In February 1978 IGS LaCoste and Romberg Gravity Meter n° G97 was taken by one of the writers (RBE) to Oman where the other writer (AWS) was making a gravity survey for the Open University. International gravity observations in UK, Iran, Oman and India during January, February and March 1978 are given in Figs 1 and 2 (the gravity survey in Oman will be the subject of a separate report). Of particular importance was the occupation of IGSN 71 stations in Teddington, Tehran and Bombay. This allowed a station to be established at Seeb International Airport, Muscat, Oman which was accurately connected to the nearest IGSN 71 stations with a meter calibrated over the range of gravity observed in Oman. The derivation of the gravity value at Seeb is the subject of this report. As far as the writers are aware Seeb is the only gravity station in Eastern Arabia connected to IGSN 71 and it should be used as a base for gravity surveys in Oman and neighbouring areas.

GRA - RAPP, R.H. - "Comparison of potential coefficient determinations with 5° and
8 1° anomalies".
Air Force Geophys. Lab., Hanscom, AFGL-TR-80-016, Scientific Rep. n° 5, 11 p. April, 1980.
O.S.U., n° 300, 11 p., April, 1980.

Potential coefficients can be derived from mean gravity anomalies, satellite data analysis, or a combination of both data types. In using gravity data, a choice of the size of the mean anomaly block to use must be made. Usually this has been 5° equal area blocks as opposed to smaller size blocks such as 1° x 1°. Tests are described in this paper that have been made using 1° x 1° anomalies and 5° anomalies that are consistent with the 1° data. Potential coefficients have been determined with just the anomaly data, and the anomaly data combination with the GEM 9 potential coefficients. In the combination solution the average percentage difference between the solutions using the two anomaly sizes was 29%. The root mean square undulation difference was ± 1.1 m and the root mean square anomaly difference was ± 3.8 mgals. These differences are caused by the perturbation of the low frequency information by the high frequency information in the mean anomaly blocks. These differences suggest that for the highest accuracy, even if coefficients just to degree 36 are sought, 1° x 1° anomaly blocks should be used.

We have also examined an approximate technique for the combination solution using 1° x 1° data that requires a significantly less amount of computer time than the rigorous solution. In comparing two 180 x 180 fields from a rigorous and approximate adjustment we found an average percentage difference of 9% ; a RMS undulation difference of 0.8 m ; and a RMS anomaly difference of 2 mgals.

524 - BALUT, A., CZAJA, J., POKRZYWA, A. - "Fitting of coordinates of points of two
97 nets adjusted independently by means of transformation with regard to dependent observations".
from : Geod. I Kart. Polska Akad. Nauk., Tom. XXVIII, Zeszyt 4, 281-298, 1979.

In the paper the conception and algorithm are presented of computation of transformation parameters with taking into consideration complete variance-covariance matrices of readjustment points.

The paper includes also technology of coordinate transformations taking into account dependent observations, basing on a parameter of a generalized net power suggested in (1).

524 - GORCZYCA, J. - "Optimalization in interpolation problems".
97 from : Geod. I Kart. Polska Akad. Nauk., Tom XXVIII, Zeszyt 4, 272-280, 1979.

In many engineering problems it is the need for estimation of some phenomena basing on observations. Such measurmeents can be taken on a finite number of points because of practical reasons. In such cases the so-called shape function is searched describing a phenomenon course on the basis of measurements taken at given points. To obtain reliable information there is anxiety to construct the beats shape function that is such a function approximating as precisely as possible a studied phenomenon. Polynomials are very popular among shape functions widely used because of facility of calculation operations on them.

In the present paper a general outline is presented of interpolation methods used mostly in geodetical structing of a interpolation polynomial is presented with advantages resulting from the use of Czebyszev polynomials. The way has been given of selection of observational nodes for interpolation in the Lagrange sense that interpolation errors might be least.

524 - PANASIUK, J. - "On some arrangement of subsets of cartographic projections".
97 Geod. I Kart. Polska Akad. Nauk., Tom XXVIII, Zeszyt 4, 254-271, 1979.

In the present paper the attempt is presented to arrange traditionally used cartographic projections according to the principle "from the whole to particulars".

In a classificatory plumb depending on a shape of a map graticule it has been proved that, at some additional assumptions, there is the possibility of permanent transition from the set of pseudo-conical projections to the set of pseudo-cylindrical projections and the set of pseudo-azimuthal projections.

The whole arrangement has been performed using homogeneous means ; analytical only.

524 - GDOWSKI, B. - "On some class of generalized azimuthal projections".
97 Geod. I Kart. Polska Akad. Nauk., Tom XXVIII, Zeszyt 4, 246-253, 1979.

In the present paper class T_1 of generalized azimuthal projections of surface S_1 on surface S_2 has been defined.

Then in projection group T_1 projections A_0 and A_1 have been determined best according to the Aira criterium. Finally projection A_1 has been used in the case of a rotation ellipsoid and sphere.

524 - SWIATEK, K. - "Use of short arc adjustment in the dynamic-geometrical method
97 for determination of mutual positions of observational stations from laser observations of artificial Earth satellites".
Geod. I Kart. Polska Akad. Nauk., Tom XXVIII, Zeszyt 4, 233-245, 1979.

The method of distance measurements by use of lasers is one of most precise observational methods now. The task of satellite geodesy is use of high accuracy of laser observations in, for example, determination of distances between ground observational stations.

Dynamic methods do not allow to use precise laser measurements because of unacquaintance with a detailed mathematical-physical model of disturbances.

In geometrical methods solutions are limited by the so-called unsafe places as well as by necessity of synchronic observations from many stations (at least four). Because of these reasons a new geometrical-dynamic method has been elaborated enabling to fix a mutual position of two or three observational stations. In the problem solution distances between satellite observed positions are used besides distances obtained from laser observations. This method allows to calculate distances (of the order of 1000 - 5000 km) between observational stations with a relative error equal to $\pm 1,0.10^{-7}$.

524 - BUJAKIEWICZ, A., PREUSS, R., KURCZYNSKI, Z. - "The geometry of the scanning Ima-
98 gery".
Geod. I Kart. Polska Akad. Nauk., Tom XXIX, Zeszyt 2, 111-122, 1980.

For the cartographic problems the geometry of the scanning imagery must be known. In this paper, the results of the practical experiments concerned the determination of the discrepancies of the scanning imagery are presented.

524 98 - LISIEWICZ, S. - "Integral number optimalization in determination of arrangement of geodetic observations".
Geod. I Kart. Polska Akad. Nauk., Tom XXIX, Zeszyt 2, 105-110, 1980.

A way of determination of the optimal arrangement of geodetic observations is presented in the paper. It fulfuls the condition that the network meets the assumed requirements of accuracy, a number of observations being minimal. The knowledge of line sight of a given network is the basis for the arrangement of observations. Azimuth, linear and angular observations were provided. The proposed way is presented by a numerical example of BRZEMALE net. For the presented way a programme was prepared for a computer in ICL 1300 system in Fortran called OPO1 allowing to distribute geodetic observations in a net of any hape and size to 120 points.

524 98 - LENART, A.S. - "Algorithms of conversion of hiperbolic coordinates into geographical - Theory of errors".
Geod. I Kart. Polska Akad. Nauk., Tom XXIX, Zeszyt 2, 91-104, 1980.

In the paper dependences for errors of algorithms of conversion of hiperbolic coordinates into geographical are derived. It was proved that a noniterative algorithm was burdened with its errors resulting from simplifications necessary for its derivation ; an iterative algorithm has no such errors. A method of analysis of additional errors is also presented. It enables to adjust the accuracy of geodetic dependences to the required accuracy of conversion and to the accuracy of a navigational system.

524 98 - ZABEK, Z. - "Reduction of doppler satellite observations on the ellipsoid of reference of a ground geodetic network".
Geod. I Kart. Polska Akad. Nauk., Tom XXIX, Zeszyt 2, 81-89, 1980.

During adjustment of a ground geodetic network on the reference ellipsoid with the use of doppler satellite observations there is a problem of transformation of satellite elements on the reference ellipsoid.

The problem is considered in two systems of projection of points of the Earth's surface on the reference ellipsoid :

in the system of orthogonal projection on ellipsoid and
in the classical system of projection through the geoid.

Transformation of differences of rectangular coordinates ($\Delta x, \Delta y, \Delta z$) determined from doppler observations with the translocation method into differences of ellipsoid coordinates ($\Delta B', \Delta L', \Delta H'$) in relation to the reference ellipsoid, was taken into account. The accuracy of orientation of the reference ellipsoid in the NNSS system required in this process, was analyzed. This orientation should ensure, for an initial transformation section, the knowledge of B' and L' coordinates on the reference ellipsoid with accuracy 1", and ellipsoid height H' with accuracy slightly better than 1 m. In the system of classical geodesy, astronomical coordinates ϕ and λ are required to reduce satellite points on the geoid. Their accuracy is dependent on the height of a point ; the accuracy slightly less than 1" is sufficient in most cases. Methods of receiving data necessary for these reductions are discussed.

524 98 - HALMOS, F. - "Up-to-date technology for rigidation and densification of geodetic networks".
Geod. I Kart. Polska Akad. Nauk., Tom XXIX, Zeszyt 2, 69-81, 1980.

The systematical errors are unavoidable in geodetic networks, so it is adviseable to combine different kind of measuring methods in networks. For the analysis of accuracy of geodetic networks new equations are given, which are valid in the network as well as at its edge. The combination of terrestrial geodetic networks with doppler satellite observations is briefly described. For the determination of orientation errors and for the measurement of control directions the high accuracy gyrotheodolites are recommended.

For the evaluation of the inner and outer accuracy of the networks a simultaneous calculation method is given.

NUM 46 - BOCK, Y. - "A VLBI variance-covariance analysis interactive computer program".
O.S.U., n° 298, 193 p., May, 1980.

An interactive computer program (in FORTRAN) for the variance-covariance analysis of VLBI experiments is presented for use in experiment planning, simulation studies and optimal design problems. The interactive mode is especially suited to these types of analyses providing ease of operation as well as savings in time and cost. The geodetic parameters include baseline vector parameters and variations in polar motion and earth rotation.

A discussion of the theory on which the program is based provides an overview of the VLBI process emphasizing the areas of interest to geodesy. Special emphasis is placed on the problem of determining correlations between simultaneous observations from a network of stations. A model suitable for covariance analyses is presented. Suggestions towards developing optimal observation schedules are included.

STA 54 - COHEN, S.C. - "Relationships among the slopes of lines derived from various data analysis techniques and the associated correlation coefficient".
NASA Tech. Mem., n° 80733, 3 p., July, 1980.

There are several techniques for fitting a straight line to a collection of data points. In the expression $Y = a + bX$ the parameters of interest are the intercept, a, and slope, b. Herein these parameters are subscripted by y if they are derived by minimizing the variance in Y, by x if the variance in X is minimized, and by xy if a reduced major axis analysis is used (see text). The correlation coefficient is designated by r. This paper notes that the slopes and correlation coefficients are related through $r^2 = b_y/b_x = (b_y/b_{xy})^2$. The corresponding standard deviations and correlation coefficient are related by $r^2 = S_{b_y}/S_{b_x} = S_{b_{xy}}/S_{b_x}$.

GEO 1 - COHEN, S.C. - "Regional analysis of earthquake occurence and seismic energy release".
NASA Tech. Mem., n° 81994, 12 p., Aug., 1980.

This paper reports on a study of the historic temporal variations in earthquake occurence and seismic energy release on a regional basis throughout the world. The regionalization scheme employed divides the world into large areas based either on seismic and tectonic considerations (Flinn-Engdahl Scheme) or geographic (longitude and latitude) criteria. The data set is the worldwide earthquake catalog of the National Geophysical Solar-Terrestrial Data Center. The analysis reveals : (1) that an apparent relationship exists between the maximum energy released in a limited time within a seismic region and the average or background energy per year averaged over a long time period ; (2) that in terms of average or peak energy release, the most seismic regions of the world during the 50-81 year period ending in 1977 were Japanese, Andean South American, and the Alaska-Aleutian Arc regions ; (3) that the year-to-year fluctuations in regional seismic energy release are greater, by orders of magnitude, than the corresponding variations in the world-wide seismic energy release ; and (4) that the "b" values of seismic regions range from 0.7 to 1.4 where earthquake magnitude is in the range 6.0 to 7.5.

ALT 2 - KATSAMBALOS, K.E. - "Comparison of some undulation prediction techniques from altimeter data".
O.S.U., n° 303, 28 p., July, 1980.

Adjusted Geos-3 altimeter data are used to predict and compare geoid undulations derived from two collocation models, the Bjerhammar's estimator, and Hardy's multiquadric formula. A number of tests are made in the Kerguelen Islands area, and in the Puerto Rico trench area. The results are compared in terms of the covariance function being used, the grid spacing, and the number of data points used in the prediction of a geoid undulation at a grid intersection. The correlation between the geoid undulations and the bathymetry in the Kerguelen Island area - as reported by Balmino et al. (1979) - is found in our predicted geoid maps too. At the 40 cm level, there is no difference between the use of a collocation technique, rather than the simple Bjerhammar's estimator. Furthermore, the results from the

Bjerhammar's estimator agree with collocation better than the results from Hardy's Multiquadric formula.

RED 137 - FORSBERG, R., TSCHERNING, C.C. - "The use of height data in gravity field approximation by collocation".
Preprint. 22 p. .

The quality of a gravity field approximation depends on the amount of available data and on the variation of the gravity field. When topographic height data are available, e.g. in the form of a digital terrain model, it is possible to smooth the gravity field on a local scale by removing the gravitational effects calculated from models of the topographic masses. In this way significant improvements of the prediction results are obtained in mountaineous areas.

In the paper we describe methods for the calculation of such gravitational terrain effects, applicable in collocation approximation of the gravity field. The terrain effects on gravity field quantities such as gravity anomalies, deflections of the vertical and geoid undulations are calculated using a system of rectangular prisms, representing either a quasi-traditional model of the topography and the isostatic compensation or a residual terrain model (RTM), where only the deviation of the topography from a mean elevation surface is considered.

To test the terrain reduction methods, numerical prediction experiments have been conducted in the mountaineous White Sands area, New Mexico. From gravity anomalies spaced appr. 6' apart, other known gravity anomalies and deflections of the vertical were predicted using collocation. When using terrain effects calculated on the basis of 0.5' x 0.5' point heights, the r.m.s. errors decreased by a factor of nearly three to 1" for the deflections and 3-4 mgal for the gravity anomalies, quite insensitive to the actual type of terrain reduction used. The feasibility of using topographic reductions in collocation is thus effectively demonstrated.

GER 157 - FORSBERG, R., MADSEN, F. - "Geoid prediction in northern greenland using collocation and digital terrain models".
Preprint (to be presented at the Symposium "Space Geodesy and its Application" Cannes, November, 1980). 10 p..

The Danish Geodetic Institute is currently undertaking a major mapping project, covering northern Greenland from 78°N on the west coast to 76°N on the coast. As primary geodetic control the doppler satellite technique is used, supplemented by classical geodetic methods and gravity measurements.

The geoid of the area is predicted by the method of stepwise collocation, using potential coefficients, gravity anomalies and doppler-derived geoid undulations. Due to the sparse gravity information available and the mountainous terrain, coarse digital terrain models are utilized in the prediction process in order to eliminate the gravitational influence of the topography. Geoid predictions based on gravity and topographic information have shown general r.m.s. errors below 1 m when a suitable empirical datum shift is introduced.

The general project and the geoid prediction methods are described, with special emphasis on the use of digital terrain models in collocation. Numerical results based on a comparison of the gravimetric geoid with doppler-derived geoid undulations are given including investigations on the significance of the use of topographic information.

THP 5 - TSCHERNING, C.C., SUNKEL, H. - "A method for the construction of spheroidal mass distributions consistent with the harmonic part of the Earth's gravity potential".
Presented 4'th International Symposium "Geodesy and Physics of the Earth", Karl-Marx-Stadt, DDR, 12-17, 1980.
Presented JLG - 44th Meeting - October 20-21, 1980.

Approximations to the harmonic part of the gravity potential of the Earth may be expressed as a series in external spheroidal harmonics.

Models for the mass distribution (ρ) of a spheroidal approximation to the Earth may be expressed as a series in internal spheroidal harmonics, contingently multiplied by a function $F(u, \beta, \lambda)$.

It shown, that for suitable choice of $F(u, \beta, \lambda)$, simple relations between the coefficients a_{nm} and A_{nm} can be established. This permits the construction of spheroidal mass distribution models consistent with the known low-degree harmonic expansions of the Earths gravity potential.

In order to construct geophysically realistic mass distributions a generalisation of a procedure due to Moritz has been used. First the coefficients A^0_{nm} of a spheroidal harmonic expansion of the potential of a geophysically realistic (discontinuous) approximation ρ_0 to the mass distribution of the Earth are computed. A mass distribution ρ_1 is then computed based on the residual coefficients $A^1_{nm} = A_{nm} - A^0_{nm}$, using a function $F(u, \beta, \lambda)$ which gives a simple relation between the coefficients A^1_{nm} and the coefficients a^1_{nm} of ρ_1. The harmonic part of the potential of the density distribution $\rho = \rho_0 + \rho_1$ will then be equal to V.

Results of a numerical example showing the density variations within the Earth implied by a set of potential coefficients (GEM 10B) are given.

BIB 15 - ANFILOFF, W., TERRON, O. - "Bibliography of gravimetry in Australia".
B.M.R., Report 218, BMR MF 106, 69 p., 1980.

This bibliography contains references covering the full range of activities associated with gravity work in Australia. It includes references to field surveys, data reduction methods, map production, geological interpretation, and geodetic work.

CN 55 - HRADILEK, L. - "Functional models for trigonometric levelling and three-dimensional triangulation".
Mitt. Inst. Theor. Geod. Univ. Bonn, n° 61, 33 p., 1980.

The presented method of the three-dimensional triangulation is aimed in the first place at effective applications. Observation equations for measured distances, horizontal and vertical angles, deflections of the vertical and spirit levelling are deduced in a ellipsoidal coordinate system without any transformation of measured values. The erroneous influence of refraction is solved by expanding of the functional model and determining/eliminating refraction by the adjustment. The precise slope distances, as much inclined as possible, and statistical tests of measured vertical angles play an important role for overcoming refraction.

The above procedure has been also adapted for the modernization of old two-dimensional networks, the plane coordinates of the latter being taken for the approximate coordinates of the three-dimensional adjustment. The results of the adjustment are the corrections to the old plane coordinates.

The observation equations for facial angles were deduced in a cartesian coordinate system.

The three-dimensional procedures are designed for the evaluation of networks with larger inclinations of the lines of sight. For smaller inclinations (< 5°), the separate and more expedient adjustments of 1) horizontal coordinates, and 2) trigonometrical elevations give the results of equivalent accuracy.

SAT 197 - RUMMEL, R. - "Geoid heights, geoid height differences and mean gravity anomalies from low-low satellite to satellite tracking - an error analysis".
Air Force Geophys. Lab., Hanscom, AFGL-TR-80-0294, Scientific Rep. n° 6, 44 p, June, 1980.

The mathematical model for a simultaneous estimation of improved orbital parameters and an approximation of the earth's gravity field from range rate observations in an SST "low-low" experiment is described. In a somewhat simplified model an error analysis for the estimation of geoid heights, geoid height differences 1° x 1° mean gravity anomalies is performed employing the least squares collocation method. Investigated is the dependence of the estimated parameters upon the measurement precision, the spatial configuration of the two satellites, the intersatellite distance, and the experiment altitude. In an optimal situation - assuming a range rate precision of ± $10^{-6} ms^{-1}$, an intersatellite distance of 250 km, and an experiment altitude of 200 km - the estimated a posteriori std. dev. are ± 0.9 m for point geoid heights, ± 0.7 m for a geoid height differences (point separation 150 km), and ± 6 to 7 mgal for 1° x 1° mean gravity anomalies. These numbers compare very well with the results obtained from Geos 3 altimetry for the seasurface topography. Unmodelled short-wavelength uncertainties, in the orbit have thereby to be controlled down to 1 cm in radial direction, whereas the requirements for the control of long-wavelength error effects are moderate.

ET 6 - TORGE, W., KANNGIESER, E. - "Periodic calibration errors of LaCoste -Romberg model g and d gravity meters".
Presented to the XVII Gal. Assembly of IUGG, Canberra, Australia 2-15 Dec., 1979.
Veröff D. DGK, Reihe B, Heft n° 252, 81-94, 1980.

Periodic calibration terms of LaCoste-Romberg model G gravity meters may reach amplitudes of more than 20 µgal. Their determination and a subsequent correction of the gravimeter reading is necessary, if a reproducable accuracy of 10 µgal in gravity differences is desired.

At the Institut für Theoretische Geodäsie, Universität Hannover, different calibration lines have been used for the detection of periodic calibration terms. A 20 mgal-vertical calibration line (0.2 mgal resp. 1 mgal subdivision) and a 200 mgal-horizontal calibration line (10 mgal subdivision) were established, with an accuracy of ± 1 µgal and ± 3 µgal resp., using several LCR gravity meters. The absolute gravity stations in the Federal Republic of Germany and in northern Europe were used for the investigation of linear and long-periodic (600 resp. 1200 mgal) calibration terms. Significant terms have been found mainly for the periods 1, 7.9, 35 and 71 mgal, with amplitudes between 3 and 20 µgal. Linear calibration factors were determined with an accuracy of ± 2 to 3 x 10^{-5}, and long-periodic terms are clearly indicated. While for one reset position, LCR model D gravimeters show periodic terms with rather small (few µgal) amplitudes, significant variations of nearly 1 x 10^{-3} have been found for the linear calibration factor, at different reset positions. If the detected periodic terms are introduced, systematic deviations between different instruments disappear almost completely.

ALT 3 - WEBER, G., WENZEL, H.G. - "Comparison of Geos 3 altimetry with a recent gravimetric geoid in the North Sea".
Inst. Theor. Geod. Univ. Hannover, 10 p.

A gravimetric geoid of the North Sea region has been computed using STOKES integral formula by a combination of GEM 10B (Lerch et al., 1978) spherical harmonics and mean free air gravity anomalies in 1° x 1° and 6' x 10' blocks. Previous calculations could be improved due to the application of a more extended gravimetric data base and refined computational methods. Geos-3 satellite altimeter geoid heights from Rapp, 1978, completed by Geos-3 altimeter measurements in the German Bay test area, have been used for comparison purposes. Accuracy and conformity of the gravimetric and altimetric geoid is approved by a r.m.s. difference of ± 0.59 m considering a mean difference of 0.50 m. The differences show significant correlations up to several hundred kilometers. The spectrum of these differences has long wave energy between degree 30 and 60.

VMG 1 - TORGE, W., WEBER, G., WENZEL, H.G. - "Determination of 12' x 20' mean free air gravity anomalies for the North Sea region".
Deutsche Geod. Komm. Bayer. Akad., Reihe B, Heft n° 247, 27 p., 1980.

12' x 20' mean free air gravity anomalies have been computed for the North Sea region from point free air gravity anomalies and 6' x 10' mean free air gravity anomalies. Most of the remaining gaps could be interpolated by least squares prediction filtering. The average r.m.s. error of the 12' x 20' mean free air gravity anomalies has been estimated to ± 5 mgal*. A comparison of the here presented gravity anomalies with 1° x 1° gravity anomalies provided by the U.S. Defense Mapping Agency gave a r.m.s. difference of ± 5 mgal. From the covariance function of 12' x 20' mean free air gravity anomalies reduced to the spherical harmonic model GEM 10B, anomaly degree variances have been computed up to degree 500.

* 1 mgal = 10^{-5} ms^{-2}

ANO 92 - QURESHY, M.N., WARSI, W.E. - "A Bouguer anomaly map of India and its relation to broad tectonic elements of the sub-continent".
Geophys. J. R. Astr. Soc., 61, 235-242, 1980.

A new Bouguer anomaly map of India and its generalized interpretation is presented in this paper. Bouguer anomalies in India show good correlation with the geology and tectonics. Isostatic anomalies in India are primarily geologic anomalies caused by intracrustal inhomogeneities. For example, the negative isostatic anomalies in southern India arise from large thickness of granitic bodies in the upper crust and the positive anomaly over the Himalaya may be attributed to a possible thickening of the basalt layer in the lower crust. The gravity data suggest that an overall isostatic equilibrium generally prevails in India and the Himalayan region. Crustal thickness estimates from DSS data in India are comparable to the values obtained from gravity data based on the Airy's concept of isostatic compensation.

ANO 93 - GRIFFITHS, D.H., GIBB, R.A. - "Bouguer gravity anomalies in Wales".
from : Geol. J., Vol. 4, Pt. 2, 335-341, 1965.

Bouguer gravity anomalies in Wales are shown on a quarter-inch to the mile scale and are described. Regional and residual anomalies are presented on maps, and the origin of the main residual anomalies is discussed.

PS 24 - PURDY, G.M. - "The Eastern end of the Azores-Gibraltar plate boundary".
from : Geophys. J. R. Astr. Soc., 43, 973-1000, 1975.

The known relative motion of the African and Eurasian plates at the eastern end of the Azores-Gibraltar plate boundary implies consumption of oceanic lithosphere at the low rate of 1-1.5 cm/yr...

...This suggests that for the past 72 My a single line of weakness has existed in the lithosphere along which all motion between the African and Eurasian plates has been accommodated.

ANO 94 - WESTBROOK, G.K. - "The structure of the crust and upper mantle in the region of Barbados and the Lesser Antilles".
from : Geophys. J. R. Astr. Soc., 43, 201-242, Feb., 1975.

The results of marine geophysical surveys across the Lesser Antilles in 1971 and 1972 by Durham University and the Royal Navy as part of the CICAR Project have revealed that the arc front sediment complex is nearly 20 km thick benearth the Barbados Ridge, where the igneous crust of the Atlantic is subducted beneath the Caribbean Plate. It appears that the sediment complex has grown away from the island arc, engulfing and bathymetric trench that was originally present. The Barbados Ridge is underlain by metamorphosed sediments and has been uplifted 4 or 5 km since the Pliocene. The crust beneath the Lesser Antilles island arc is about 35 km thick, and the crustal segments either side of the arc differ from each other in their crustal structure. The whole are complex shows a change in character along the arc at Lat. 14° N. A positive gravity anomaly of 40 mgal computed to be the theoretical anomaly caused by the subducted lithosphere benearth the Lesser Antilles, is compatible with the interpretation of the crustal structure. The Lesser Antilles are an example of a maturely developed island arc complex.

GER 158 - HOSPERS, J. - "Gravity field of the Niger Delta (West Africa)". from : NATURE, Vol. 207, 847-848, Aug., 1965.

GEO 2 - COHEN, S.C., COOK, G.R. - "Postseismic viscoelastic deformation and stress - Part 2 - Stress theory and computation ; Dependence of displacement strain and stress on fault parameters".
NASA, Tech. Mem. n° 80334, 16 p., Aug., 1979.
from : J.G.R., Vol. 85, N° B6, 3151-3158, June 10, 1980.

This paper reports on a viscoelastic model for deformation and stress associated with earthquakes. The model consists of a rectangular dislocation (strike-slip fault) in a viscoelastic layer (lithosphere) lying over a viscoelastic half-space (asthenosphere). The first part of the paper contains an analysis of the time-dependent surface stresses. The model predicts that near the fault a significant fraction of the stress that was reduced during the earthquake may be recovered by viscoelastic softening of the lithosphere. By contrast, the strain shows very little change near the fault. The model also predicts that the stress changes associated with asthenospheric flow extend over a broader region than those associated with lithospheric relaxation even though the peak value is less. The second part of the paper studies the dependence of the displacements, strains, and stresses on fault parameters. Peak values of strain and stress drop increase with increasing fault height and decrease with fault depth. Under many circumstances postseismic strains and stresses show an increase with decreasing depth to the lithosphere-asthenosphere boundary. Values of the strain and stress at distant points from the fault increase with fault area but are relatively insensitive to fault depth.

STA 55 - RUBINCAM, D.P. - "Information theory and the Earth's density distribution". NASA Tech. Mem., n° 80549, 37 p., Aug., 1979.

The present paper argues for using the information theory approach of Jaynes (1957) as an inference technique in solid earth geophysics. A spherically symmetric density distribution is derived as an example of the method. A simple model of the Earth plus knowledge of its mass and moment of inertia leads to a density distribution which is surprisingly close to the optimum distribution of Bullen (1975). Future directions for the information theory approach in solid earth geophysics as well as its strengths and weaknesses are discussed.

GEO 3 - COHEN, S.C. - "Postseismic viscoelastic surface deformation and stress - Part I : Theoretical considerations displacement and strain calculations".
NASA Tech. Mem., n° 80292, 34 p., May, 1979.
from : J.G.R., Vol. 85, n° B6, 3131-3150, June 10, 1980.

This paper, the first of two related articles, presents a model of viscoelastic deformation associated with earthquakes. A strike-slip fault is represented by a rectangular dislocation in a viscoelastic layer (lithosphere) lying over a viscoelastic half-space (asthenosphere). Deformations occur on three time scales. The initial response is governed by the instanteous elastic properties of the earth. A slower response is associated with viscoelastic relaxation of the lithosphere and a yet slower response is due to viscoelastic relaxation of the asthenosphere. The major conceptual contribution of this paper is the inclusion of lithospheric viscoelastic properties into a dislocation model of earthquake related deformations and stresses. Numerical calculations using typical fault parameters reveal that the postseismic displacements and strains are small compared to the coseismic ones near the fault, but become significant further away. Moreover, the directional sense of the deformations attributable to the elastic response, the lithospheric viscoelastic softening, and the asthenospheric viscoelastic flow may differ and depend on location and model details. The results and theoretical arguments suggest that the stress changes accompanying lithospheric relaxation may also be in a different sense than and be larger than the strain changes.

GER 159 - WAGNER, C.A., COLOMBO, O.L. - "Gravitational spectra from direct measurements". NASA Tech. Mem., n° 79603, 28 p., Aug., 1978.

A simple rapid method is described for determining the spectrum of a surface field (in spherical harmonics) from harmonic analysis of direct (in situ) measurements along great circle arcs. The method is shown to give excellent overall trends (smoothed spectra) to very high degree from even a few short arcs of satellite data. Three examples are taken with perfect measurements of satellite tracking over a planet made up of undreds of points-masses using (1) altimetric heights from a low orbiting spacecraft, (2) velocity (range rate) residuals between a low and a high satellite in circular orbits, and (3) range-rate data between a station at infinity and a satellite in a highly eccentric orbit.

In particular, the smoothed spectrum of the Earth's gravitational field is determined to about degree 400 (50 km half wavelength) from 1° x 1° gravimetry and the equivalent of 11 revolutions of Geos 3 and Skylab altimetry. This measurement shows there is about 46 cm of geoid height (rms world-wide) remaining in the field beyond degree 180.

ALT 4 - MATHER, R.S., RIZOS, C., MORRISON, T. - "On the unification of geodetic levelling datums using satellite altimetry".
NASA Tech. Mem., n° 79533, 34 p., April, 1978.

Techniques are described for determining the height of Mean Sea Level (MSL) at coastal sites from satellite altimetry. Such information is of value in the adjustment of continental levelling networks. Numerical results are obtained from the 1977 Geos-3 altimetry data bank at Goddard Space Flight Center using the Bermuda calibration of the altimeter. Estimates are made of the heights of MSL at the levelling datums for Australia and a hypothetical Galveston datum for central North America. The results obtained are in reasonable agreement with oceanographic estimates obtained by extrapolation. It is concluded that all gravity data in the Australian bank AUSGAD 76 and in the Rapp data file for central North America refer to the Geos-3 altimeter geoid for 1976.0 with uncertainties which do not exceed ± 0.1 m Gal.

ALT 5 - KAHN, W.D., AGRAWAL, B.B., BROWN, R.D. - "Mean sea level determination from satellite altimetry".
G.S.F.C., X-921-77-41, 27 p., March, 1977.

The primary experiment on the Geodynamics Experimental Ocean Satellite-3 (Geos 3) is the radar altimeter. This experiment's major objective is to demonstrate the utility of measuring the geometry of the ocean surface, i. e. the geoid. Results obtained from this experiment so far indicate that the planned objectives of measuring the topography of the ocean surface with an absolute accuracy of ± 5 meters can be met and perhaps exceeded.

The Geos-3 satellite altimeter measurements have an instrument precision in the range of ± 25 cm to ± 50 cm when the altimeter is operating in the "short pulse" mode.

After one year's operations of the altimeter, data from over 5,000 altimeter passes have been collected. With the mathematical models developed and the altimeter data presently available, mapping of local areas of ocean topography has been realized to the planned accuracy levels and better. This paper presents the basic data processing methods employed and some interesting results achieved with the early data. Plots of mean surface heights as inferred by the altimeter measurements are compared with a detailed 1° x 1° gravimetric geoid.

GN - CARTER, W.E., FRONCZEK, C.J., PETTEY, J.E. - "Haystack-Westford Survey".
56 N.O.A.A., Tech. Mem., NOS NGS 21, 57 p., Sept., 1979.

A special purpose three-dimensional geodetic survey was conducted in the vicinity of the Haystack-Westford Radio Observatory complex near Boston, Mass. The survey included a high accuracy network connecting points of interest within the observatory complex and connections to the North American Datum (NAD) and the National Geodetic Vertical Datum (NGVD). Extraordinary efforts were made to determine the components ΔX_E, ΔY_E, ΔZ_E of the Very Long Base Line Interferometry (VLBI) vector base line to the highest possible accuracy between the Haystack and Westford radio telescopes. This report contains descriptive information on the methods employed in the collection, reduction, and analysis of the survey data, tabulations of the observational data, and numerical and interpretative results of our analysis.

GEO - MUELLER, I.I. - "Reference coordinate systems for earth dynamics : a preview".
4 O.S.U., n° 302, 33 p., Aug., 1980.

Geodynamics has become the subject of intensive international research during the last decade. A common requirement for all investigations is the necessity of a well-defined coordinate system attached to the earth in some prescribed way. In addition, a well-defined inertial coordinate system is also needed in which the motions of the terrestrial system can be monitored.

This report deals with the problems encountered when establishing such coordinate systems and the transformations between them. In addition, problems related to the modeling of the deformable earth are discussed. Finally, action items are listed which are necessary to assure that the reference system issue is resolved early and that uniformity is assured by means of international agreements.

GN - REMMER, O. - "Refraction in levelling".
57 Geodaetisk Inst., Meddelelse n° 54, 48 p., Copenhagen, 1980.

This paper presents an analysis of the refraction corrections in the second Finnish levelling of high precision where Kukkamäki's correction term has been extensively used. The analysis encompasses all these corrections (around 3000).

STA - MEISSEL, P. - "A priori prediction of roundoff error accumulation in the so-
56 lution of a super-large geodetic normal equation system".
N.O.A.A., Professional paper, n° 12, 128 p., June, 1980.

The theory of roundoff errors for linear equations is adapted and applied to a linear system of 350,000 unknowns, representing the normal equations of the U.S. - ground control network now being readjusted. The system is positive definite and sparse. Cholesky's algorithm is used. The equations are reordered in a way dictated by the Helmert blocking technique. The block design is based on nested dissection. A linear stochastic roundoff error propagation model is used. Two families of computers are considered that come close to representing the two extremal cases of true chopping and true rounding, the CDC 6600 (with the rounding option set into effect) and the IBM 360. Structural properties of the U.S. network relevant to roundoff error propagation are thoroughly investigated. Next to the large size of the network, weight singularities from observations of extremely high accuracy cause some concern. Bounds on bias and standard deviation of the individual components of the solution vector are derived. They indicate that the new adjustment of the North American Datum (NAD) is feasible on both types of computers.

GEO - PAYNTER, S.D. - "The Directional response of amplitude weighted hydrophone
5 arrays".
I.G.S., n° 110, 20 p., Dec., 1980.

102 - DZIEWONSKI, A.M. - "Elastic and anelastic structure of the Earth".
35 Published by AGU in Reviews of Geophys. and Space Phys., Vol. 17, n° 2, 303-312, April, 1979.

102 - RICHARDS, P.G. - "Theoretical seismic wave propagation".
35 Published by AGU in Reviews of Geophys. and Space Phys., Vol. 17, n° 2, 312-328, April, 1979.

During the last four years of U.S. research into theoretical seismology, effective techniques of computing synthetic seismograms have come into quite general use. Good agreement between a synthetic record and an instrumental record of ground motion (the raw data of seismology) implies a good understanding of the seismic source ; of Earth structure ; and of the theory of wave propagation relevant to the frequency content of the data. At periods T greater than about twenty seconds, there is now in general terms a fairly complete understanding of all the details in a seismogram, provided one ignores the (usually) minor effects of lateral variation of Earth structure. For $2 < T < 20$ seconds, only limited portions of a seismogram (e.g., 15 seconds following a P-arrival) may be fully understood, the limitations coming from noises in the data due to lateral scattering, and also from our ignorance of the source, of fine-scale vertical Earth structure, and attenuation. At periods less than about two seconds, the understanding of seismograms is usually limited only to time windows within which identifiable pulses arrive. At these short periods, our knowledge of Earth structure is inadequate ; scattering effects are stronger, but are poorly understood except for some progress in the context of seismic reflection prospecting within crustal layers.

102 - JOHNSON, L.R. - "Seismic source theory".
35 Published by AGU in Reviews of Geophys. and Space Phys., Vol. 17, n° 2, 328-337, April, 1979.

102 - KANAMORI, H. - "Earthquake source mechanisms and plate tectonics".
35 Published by AGU in Reviews of Geophys. and Space Phys., Vol. 17, n° 2, 337-343, April, 1979.

102 - WARD, P.L. - "Earthquake prediction".
35 Published by AGU in Reviews of Geophys. and Space Phys., Vol. 17, n° 2, 343-354, April, 1979.

102 - SCHILT, S., and al. - "The heterogeneity of the continental crust : results
35 from deep crustal seismic reflection profiling using the vibroseis technique".
Published by AGU in Reviews of Geophys. and Space Phys., Vol. 17, n° 2, 354-368, April, 1979.

Deep reflection surveys carried out by the Consortium for Continental Reflection Profiling (COCORP) are revealing major structures within the continental crust in a variety of tectonic settings across the U.S. In many cases, these structures bear directly upon such geologic problems as the state of stress during large scale crustal deformations, the migration of magma, and the nature of the crust-mantle transition zone. COCORP, formed during the U.S. Geodynamics Project and funded by the National Science Foundation, has surveyed eight different localities along lines totalling over 800 km in length. The VIBROSEIS technique has been used in all cases and has proven to be a flexible and effective tool for deep crustal exploration. Among the more significant observations made thus far are : (1) the details of the extensional structure of the Rio Grande Rift ; (2) evidence for at least 21 km horizontal and 13 km vertical displacement along the Wind River Thrust, which dips uniformly at about 30 degrees and extends to a depth of at least 25 km ; (3) evidence for at least 225 km displacement along a major subhorizontal thrust system beneath the southern Appalachians, in which the Brevard Zone appears to be rooted ; and (4) the apparently discontinuous nature of the Moho or crust-mantle transition zone, which has been observed to some degree at most of the sites studied. Taken together, the results of all surveys analyzed thus far demonstrate a much larger degree of heterogeneity in crustal structure than is indicated by more conventional geophysical techniques for exploration of the basement.

GN 59 - MILBERT, D.G. - "Optimization of horizontal control networks by nonlinear programing".
N.O.A.A., Tech. Rep., NOS 79 NGS 12, 42 p., Aug., 1979.

Some practical aspects of horizontal control network design are considered, and the techniques of linear and nonlinear programing are briefly reviewed. Rotationally invariant constraints are written for the coordinate variance sum at each station. These constraints are also quasi-homogeneous in the sense that a Moore-Penrose generalized inverse is used in computation. The objective function to be minimized is a cost proportional to the number of observations. Results are displayed for several test networks. Methods of improvement of the design algorithm are then discussed.

GN 60 - FLOYD, R.P. - "Geodetic bench marks".
N.O.A.A., Manual, NOS NGS 1, 50 p., Sept., 1978.

Geodetic survey control points must be remarkably stable due to the very intent of establishing geodetic control. All monuments are subject to the effects of geologic and soil activity. Vertical control points are particularly vulnerable because this activity results in vertical movements much more so than horizontal motion. In addition to natural disturbances, damage inflicted by mankind is a critical problem in monumentation. This manual explains how and where to set bench marks for maximum stability and calls attention to the factors that affect vertical instability.

MMG 80 - "Marine Geophysical Data Documentation Coding Form".
N.O.A.A., Sept., 1977.

The "Marine Geophysical Data Documentation Coding Form" has been developed to aid the scientific community in preparing the Marine Geophysical Data Exchange Format - MGD77. The full description of this format (which includes bathymetry, magnetics, and gravity data) is presented in "Key to Geophysical Records Documentation n° 10," which is available free-of-charge from the National Geophysical and Solar-Terrestrial Data Center.

NUM 47 - BRAMMER, R.F., LESCHACK, A.R., OFENSTEIN, W.T. - "Gravity data evaluation analysis and software design plan for the physical geodesy system".
Air Force Geophys. Lab., AFGL-TR-79-0126, 94 p., Dec., 1978.

This report presnets results of a continuation of earlier work on gravity data evaluation analysis and a phase-zero definition of the Physical Geodesy System, in two principal directions. The first is an extension of gravity data evaluation methods in the areas of outlier detection and correction, and in the application of linear programming techniques to ocean gravity survey track crossing adjustments. The second is an extension of the initial software definition for the Physical Geodesy System by the development of software for gravity data evaluation, processing, and management in a dedicated minicomputer environment.

NUM 48 - BOYER, B.J. - "Evaluation of ocean gravity data".
D.M.A.A.C., 19 p., June, 1974.

An investigation is made of the problems encountered in evaluating ocean gravity data received from various organizations. Statistical and graphical representations are developed to show problems caused by the divergence of the surveyed gravity data. Discrepancies noted are most pronounced when a vessel's track consists of a sequence of intersecting segments and particularly when different vessels' tracks intersect. Present techniques of evaluation and adjustment of ocean gravity surveys to unify the data into a compatible system are discussed.

NUM 49 - ESTES, J.M. - "The evaluation of gravity anomaly data utilizing semi-automatic methods".
To be presented at the fall Annual Meeting of the AGU, San Francisco, Calif., 12 p., Dec., 1971.

Since the invention of the electronic digital computer, man has attempted to utilize it in many ways. One large area of utilization is the automation of laborious, repetitive, time consuming manual labor. Obviously, the computer itself cannot do the manual labor, but it can be very efficient and economical in directing the performance of peripheral devices and assisting man in accomplishing the desired task.

In recent years, many areas in geophysics and physical geodesy have been expanded and automated to a certain degree via the computer. This presentation is a brief discussion of one such proposed process, the evaluation of gravity anomaly data utilizing semi-automatic methods.

INT 145 - BINDER, A.B. - "On the internal structure of a moon of fission origin".
from : J.G.R., Vol. 85, n° B9, 4872-4880, Sept., 1980.

Internal structure models of the moon, based in part on petrological and thermal models of a moon of fission origin, indicate that the moon has an iron or iron-rich core with a radius between 200 and 400 km. The derived STP density of the lower mantle (> 200-km depths) is between 3.35 and 3.51 g/cm^3 and indicates that the Mg' of the lower mantle is between 73 and 88. This results, together with the Mg' of the upper mantle (≃ 70) and of the crust (≃ 70), leads to Mg' between 72 and 84 for the bulk moon (minus the core). The V_p in the mantle of the moon is found to be between 7.6 and 7.9 km/s ; this result is in general agreement with that derived from seismic data.

ANO 95 - KUNZE, A.W. - "On the flexural rigidity and effective viscosity of the lithophere in the Hawaiian area".
from : Tectonophysics, n° 69, 8 p., July, 1980.

The depth below sea level of the Moho increases from about 15 km under Hawaii to about 20 km beneath Oahu. Computer simulation of the elastic flexure of the lithosphere due to the load of the Hawaiian archipelago reveals that the maximum downward displacement of the Moho should occur benearth Hawaii, not Oahu. It is concluded that the lithosphere in the Hawaiian area has a Maxwellian rheology, that the subsidence of the youngest island (Hawaii) may be largely due to elastic flexure, but that the additional 5 km subsidence of the 2.5 m.y. older Oahu represents viscous deformation of the lithosphere. The flexural rigidity of the lithosphere required to produce the subsidence of Hawaii by elastic flexure alone is 5 x 10^{30} dyne cm. The 5 km viscous settling of Oahu during 2.5 m.y. was then simulated utilizing an axisymmetric viscous finite-element computer program. The results indicate an effective lithospheric viscosity of approximately 3 x 10^{23} poise. This value is lower than most other estimates and may reflect the anomalous thermal regime in the Hawaiian region.

PS 25 - HUTCHINS, D.G., REEVES, C.V. - "Regional geophysical exploration of the Kalahari in Botswana".
from : Tectonophysics, n° 69, 201-220, April, 1980.

Regional geophysical studies are playing an important role in the geological exploration of Botswana, particularly in the 80 % of the country falling within the Kalahari where the bedrock geology is totally concealed by Tertiary to Recent Kalahari sediments. A programme of geophysical exploration commenced in 1970 and has so far included studies of seismicity, national and regional gravity surveys, refraction seismology and a reconnaissance aeromagnetic survey of the entire Kalahari region. This programme of geophysical activity is reviewed and a summary of the results to date is presented. The interpretation of the geophysical data is related to the broad geological structure of southern Africa and to the potential for economic mineralisation within the Kalahari.

ANO 96 - GARLAND, G.D. - "Comment on "Regional free air gravity anomalies and tectonic observations in the United States" by L.D. McGinnis, M.G. Wolf, J.J. Kohsmann and C.P. Ervin".
from : J.G.R., Vol. 85, n° B9, 4881, Sept., 1980.

ANO 96 - Mc GINNIS, L.D., ERVIN, C.P. - "Reply".
from : J.G.R., Vol. 85, n° B9, 4882, Sept., 1980.

STA 57 - BERTOTTI, B. - "Statistics of narrow structures of the gravity field of the earth. I. General theory".
28 p..

With the increase in resolution and accuracy of gravity measurements it is becoming possible and increasingly important to concentrate attention on local analysis and on the role of elongated geophysical features. This paper deals with the statistical analysis of such features and develops for this purpose a new mathematical tool, the three - and four-point correlation function. Using an integration over the manifold of the rotation group, expressions are derived for these functions in terms of the spherical harmonic coefficients ; I discuss also the corresponding quantities for a flat earth and show how this approximation is recovered for small features. To gain an understanding of the structure of these functions, a simple, heuristic model is constructed in which the surface gravity field is expressed as a random superposition of elliptical elementary disturbances with random orientations. The three-point correlation function shows a characteristic behavior when the angle between its two vector arguments is of the order of the ratio of the axes of the ellipse. Other important information contained in this function is the skewness of the gravity field and a possible privileged screw sense.

BIB 16 - "Programs and Abstracts".
Presented to the XVII General Assembly of IUGG, Canberra, Australia 3-15 Dec. 1979. I.A.S.P.E.I., 102 p., Dec., 1979.

BIB 17 - "Abstracts and Timetable".
Presented to the XVII General Assembly of IUGG, Canberra, Australia 3-15 Dec. 1979. Inter-disciplinary Symposia, 655 p..

PS 26 - KAHLE, H.G. and al. - "Recent dynamics crustal structure and gravity in the Alps".
Inst. für Geod. und Photogram., Separata n° 1, 377-388.

The purpose of this paper is to present and discuss recently obtained geodetic, seismic and gravity data of the Swiss Alps. These data are then used to describe the recent Alpine crustal dynamics in terms of crustal structure. An attempt will furthermore be made to explain the present-day kinematics of the Alps within the framework of plate tectonics.

GN 61 - VINCENTY, T. - "Revisions of the Hoacos height-controlled network adjustment program".
N.O.A.A., Tech. Mem., NOS NGS 25, 5 p., May, 1980.

The Hoacos height-controlled adjustment program has been revised in several places. Its new features include the adjustment in the geodetic horizon system, a change of units for compatibility with other programs, a revised method of treating the direction of gravity at stations with no astronomic data, and the handling of observations when some heights are not given.

STA 58 - BOSSLER, J.D., HANSON, R.H. - "Application of special variance estimators to geodesy".
N.O.A.A., Tech. Rep., NOS 84, NGS 15, 8 p., Feb., 1980.

Special variance estimators are computed and analyzed for a standard geodetic network adjustment. One important estimator requires the computation of noninteger degrees of freedom. An analysis is performed on the results obtained from constraining the coordinates of peripheral network stations by a priori variances.

WDC A - "Directory of U.S. data repositories supporting the International Geodynamics project".
World Data Center A (Boulder), Report SE-14, 40 p., Aug., 1978.

ALT 6 - MARTIN, C.F., KOLENKIEWICZ, R. - "Calibration validation for the Geos-3 altimeter".
NASA, Tech. Mem., n° 80170, 35 p., June, 1980.

The absolute bias calibration for the Geos-3 intensive mode altimeter has been measured using two satellite passes whose groundtracks were within 1 km of the Bermuda laser station. The Bermuda laser tracked on the two passes - Rev 4553 on February 25, 1976 and Rev 5471 on April 30, 1976 - and was supported by two other NASA lasers on one pass and by the NASA Spacecraft Tracking and Data Network on the other pass. For each pass, the altimeter data around Bermuda was smoothed and extrapolated to the point closest to overhead at the laser site. This point was used for calibration, eliminating almost entirely the effects of geoid model error on the resulting altimeter bias estimate. After correcting for tide heights and sea state effects, the two passes give calibration biases which are in agreement to within 26 cm and have a weighted mean of -5.69 ± 0.16 m for correcting altimeter measurements to the center-of-mass of the spacecraft (i. e., including the antenna tracking point correction). Since a sea state bias correction has been used in the bias estimation, a different bias is more appropriate for data users not employing a sea state bias correction. For such users, a bias of -5.59 m, appropriate for moderate seas ($H_{1/3} = 2$ m), is recommended.

It was found impossible to reconcile the two calibration passes, as well as a set of altimeter crossovers in the middle of the Geos-3 calibration area, without allowing for a data time tag error. On the basis of a selected set of four crossovers, and an assessment of probable sources of timing error, it was concluded that one interpulse period (10.24 msec)should be added to the data time tags. This time tag correction should be used with the above bias value.

DAT 1 - TSCHERNING, C.C. - "Management of geodetic data, status and prospects 1979". Report prepared for XVII General Assembly of IUGG/AIG, Canberra, Australia, Dec., 1979, 18 p.

Procedures for data entry and validation are reviewed. It is found, that least squares adjustment is generally used for data validation.

Also the establishment and function of geodetic data bases and associated management systems are reviewed, and different data bases are compared. Future problem areas (interrelation with other non-geodetic data bases, optimization of storage structures, access methods and data models) are pointed out.

WDC - "Fourth consolidated guide to international data exchange through the World Data Centres".
ICSU Panel on World Data Centres, 113 p., June, 1979.

ECO 81 - BALAZS, E.I. - "The 1978 Houston-Galveston and Texas gulf coast vertical control surveys".
N.O.A.A., Tech. Mem., NOS NGS 27, 61 p., Nov., 1980.

Comparisons between levelling surveys of different epochs are used to determine vertical displacement of permanent bench marks. Displacement of bench marks usually represents the movement of the surrounding area. In this report, the 1978 Houston-Galveston and Texas Gulf Coast releveling surveys are compared to the 1963, 1973, and 1976 releveling results. The changes in elevations of bench marks common to two or more epochs are tabulated and plotted in appendix 1. From these differences, contour maps were prepared for the 1963-78 and 1973-78 epochs in the 2° x 2° area of maximum subsidence. Annual subsidence rates computed for the 1973-78 period are about 25 percent less in the maximum subsidence area than the rates computed for the 1963-73 period.

ANO - OWEN, M., WYBORN, D. - "Geology and Geochemistry of the Tantangara and Brin-
97 dabella area".
BMR Bulletin, n° 204, 52 p., 1979.

The Tantangara and Brindabella 1:100 000 Sheet areas cover 5030 km^2 between latitudes 35° and 36° S and longitudes 148°30' and 149° E, in the southern part of the Lachlan Fold Belt in New South Wales.

The earliest record of sedimentation in the two Sheet areas is of mid-Ordovocian quartz-rich distal flysch, becoming more proximal in the Late Ordovician...

GVM - COUTTS, D.A., WELLMAN, P., BARLOW, B.C. - "Calibration of gravity meters with
117 a quartz-mechanism".
BMR J. of Austr. Geol. & Geophys., Vol. 5, n° 1, 1-7, March, 1980.

Gravity meters with a quartz mechanism can be calibrated on tilt tables, on hillside calibration ranges with stations at different altitude, or on level calibration ranges with stations at the same altitude. Twenty Worden, Sharpe, and Scintrex gravity meters have been calibrated in Canberra on a PEG-1 tilt table borrowed from the Soviet Academy of Sciences. These calibrations agree, to within experimental error, with tilt calibrations by the manufacturers in North America, and calibrations based on sea-level stations along the Australian Calibration Line. Calibrations on hillside calibration ranges differ systematically from other calibrations, and indicate a mean altitude effect of $(2.5 \pm 0.5) \times 10^{-3}$ µm s^{-2} m^{-1}. This altitude effect is higher than the mean of $(1.5 \pm 0.3) \times 10^{-3}$ µm s^{-2} m^{-1} found by pressure-chamber studies in North America and Europe. If quartz-mechanism gravity meters are used either in base station gravity networks, or for field stations in areas with over 500 m of relief, then a correction should be made for this altitude effect, particularly if the anomalies are to be used for geodetic purposes.

504 - MELCHIOR, P., DUCARME, B. - "Tidal gravity profiles 1973-1980".
13 Bull. d'Obs. : Marées Terrestres, Vol. IV, Fasc. 5, 1-94, Oct., 1980.

This paper intends to present the continuation of the catalogue of results published in march 1977 (Bull. Obs. Marées Terrestres, Vol. IV, fasc. 4). It gives the results of an extension of our previous profile across Asia, East Africa, Indonesia and the South Pacific.

504 - MELCHIOR, P., MOENS, M., DUCARME, B. - "Computations of tidal gravity loading
13 and attraction effects".
Bull. D'Obs. : Marées Terrestres, Vol. IV, Fasc. 5, 95-133, Oct., 1980.

This paper aims to give in full details the results of extensive computations we have made with fifteen world cotidal maps listed in the Table I.

INT - MELCHIOR, P. - "Luni-solar nutation tables and the liquid core of the earth".
146 from : Astron. Astrophys., n° 87, 365-368, 1980.

Recent experimental measurements performed by new astronomical techniques confirm that there was an urgent need to adopt a new luni-solar nutations table taking into account the dynamical effects of the liquid core of the Earth.

We present in this paper the most recent results obtained in this respect from Earth Tide measurements and a discussion about the nutation table to be adopted.

BIB - "Bulletin of the Geographical Survey Institute".
18 Geographical Survey Inst., Vol. XXIV, Part I, 56 p., March, 1980.

. Color Photomaps from LANDSAT-MSS Data,
. Disastrous Ground Failure in a Residential Area of Large-Scale,
. Compilation of "Magnetic Maps 1975 of the Antarctic",
. Geomagnetic Observation at Kanozan Geodetic Observatory (1978),
. Corrections (Vol. XXIII, Part 1, 1978).

BIB - "List of Publications of the National Institute of Polar Research (1957-1980)".
19 Nat. Inst. of Polar Res., 24 p., March, 1980.

BIB - De BEAUREGARD, J. - "Rapport National sur les travaux Français exécutés de
20 1975 à 1978".
Presented to the XVII Gal. Assembly of IUGG, Canberra, Australia, Dec., 1979.
C.N.F.G.G., 366 p., 1979.

. Travaux géodésiques de l'Institut Géographique National
. Carte gravimétrique détaillée de la France
. Analyses d'ensemble du réseau géodésique français
. Méthodes de géodésie Doppler sur satellites : développements français (1975-79)
. Géoïde européen version 1978
. Champ de gravité et structures internes
. Etudes des marées terrestres
. Géodynamique
. Etudes sur les planètes
. Modèle de la haute atmosphère neutre de la Terre entre 200 et 1200 km
. Résultats sur la haute atmosphère de la Terre déduits des mesures de l'accéléromètre CACTUS
. Mesure de la pression de radiation par l'accéléromètre CACTUS
. Méthode de calcul des éphémérides de satellites en station

504 - MELCHIOR, P. - "Earth tide components and forced nutations".
14 Presented to IAU Symp., n° 78 "Nutation and the Earth's Rotation", Reidel, 1980.
Obs. Royal de Belgique, Série Geophys., 137, 161-163, 1980.

504 - MELCHIOR, P. - "For a clear terminology in the polar motion investigations".
14 Presented to IAU Symp., n° 78 "Nutation and the Earth's Rotation", Reidel, 1980.
Obs. Royal de Belgique, Série Geophys. 137, 17-21, 1980.

504 - MELCHIOR, P. - "A review of the different liquid core models used for the com-
14 putation of the dynamical effects on nutations and earth tides".
Presented to IAU Symp., n° 78 "Nutation and the Earth's Rotation", Reidel, 1980.
Obs. Royal de Belgique, Série Geophys., 137, 225-234, 1980.

401 - HARRISON, P.L., ZADOROZNYJ, I. - "Officer basin seismic gravity magnetic and
52 radiometric survey".
(BMR microform MF 69) BMR, Rep. n° 191, 1-42, 1972.

The Bureau of Mineral Resources made a seismic, gravity, magnetic and radiometric survey in the Western Australian part of the Officer Basin in 1972, on a northeast traverse between the Yilgarn and Musgrave Blocks. The survey comprised a series of depth probes using refraction and single to twelve-fold CDP reflection recording. The other geophysical measurements were taken at 1-km intervals mainly along the seismic traverse.

A model of the geology and structure between the Yilgarn and Musgrave Blocks was obtained from the integrated interpreation of the BMR and earlier surveys. The model shows that there are three main rocks sequences : Phanerozoic sediments up to 1300 m thick, Proterozoic sediments up to 5700 m thick, and an underlying layered sequence in the southwest, of unknown nature, but which probably consists of igneous and metamorphic rocks up to 12 000 m thick and may be distinct from basement of the Yilgarn Block. It is possible that the rocks comprise metasediments intruded by basic rocks.