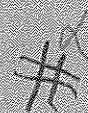


ASSOCIATION INTERNATIONALE DE GÉODÉSIE



BUREAU GRAVIMETRIQUE INTERNATIONAL

BULLETIN D'INFORMATION

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OBITUARY

On 4 July 1977, Dr. Ulrich Fleischer, Head of the branch "Marine Geophysics" at the Deutsches Hydrographisches Institut, Hamburg, died unexpectedly of a heart attack shortly before completing his fiftieth year. He was just in the middle of the preparatory work for Leg II of METEOR cruise 45.

After his studies of geophysics at the university of Göttingen, he gained his doctorate in 1954 under Prof. Dr. Julius Bartels. His thesis was one of the first to deal with a subject of geomagnetic deep sounding. Here he used for the first time a prototype of the geomagnetic ASKANIA Variograph Gv3 as mobile station between Göttingen and Wingst in northern Germany.

After having worked for a short time as assistant at the Geophysical Institute of Göttingen university, he had been associated with the former Amt für Bodenforschung, Hannover, as a scientific employee. From 1955 to 1959 he worked as Head of a measuring team of the SEISMOS company in exploration geophysics, both in Germany and abroad.

Since 1959 he had been entrusted with the development and the implementation of gravity measurements at sea. He was a pioneer in operating the ASKANIA sea gravimeters of the types Gss2 and Gss3. The antiparallel arrangement of two gravimeters of the type Gss2 for the purpose of eliminating the cross-coupling effect is due to his suggestion. The first Gss3 sea gravimeter had been tested under his direction and is being used in the measuring practice since then.

Ulrich Fleischer participated in numerous research cruise of various vessels : GAUSS, METEOR, ARAGONESE (Italy), MINNA (Canada). Areas of operation were the North Sea, the Red Sea, the Mediterranean, the Atlantic Ocean and the Labrador Sea.

His papers of the last years dealt with the Reykjanes Ridge and the area around Iceland. In particular the detailed surveys of the Iceland-Faroes Ridge and of the Kolbeinsey Ridge led to new insight into the gravity anomalies of active and inactive oceanic ridges.

Ulrich Fleischer was a member of the (German) Forschungskollegium Physik des Erdköpers (FKPE) and of the International Gravimetric Commission.

INTERNATIONAL GRAVITY BUREAU

Meeting of Working Group 3 (WG3) on June 16 - 17, 1977

at University of Trieste

Présent : S. Coron
 R.S. Mather (Acting Chairman)
 C. Morelli
 N.B. Sazhina
 O.W. Williams

The meeting was opened by the acting chairman who read an apology from the Convenor of WG3, Professor J.D. Boulanger, regarding his inability to attend the meeting due to a sudden illness (see, p.I-8). Mr. Williams also tendered an apology on behalf of Professor R.H. Rapp. The meeting requested Professor Sazhina to convey to Professor Boulanger its best wishes for a speedy recovery.

The meeting was then addressed by Professor Sazhina who presented a report on behalf of Professor Boulanger. She also tabled a specimen copy of a map in the proposed 1 : 15.000.000 gravity map series which was given a classification as Priority 4 at the meeting of Working Group 3 at Paris in February 23, 1976 (WG3 Feb 76). Also submitted was an 8 point agenda (see attachment 1, p. I-7) to be considered by WG3 from the Convenor dated April 8, 1977.

It was made clear by Professor Sazhina that any maps prepared in this World Gravity Map Series were to be based on data already published.

In response to a call for comments, Mr. Williams questioned the order of priorities of activities of the IGB and drew the meeting's attention to the four point system of priorities agreed to at the WG3 Feb 76 meeting (Bulletin Information 38, I-10, 1976). Dr. Coron assured the meeting that for all practical purposes, the data used in the preparation of the proposed map series would be compatible with Priority 1 (i.e., IGSN71 and GRS67).

After considerable discussion, it was agreed that the following recommendations be made by WG3 to the IGB Directing Board.

1. The primary user-oriented tasks of the IGB should continue to be in accord with Priorities 1 & 2 of the document WG3Feb 76. National gravity data repositories in each nation should be contacted for gravity data, preferably in computer compatible form.
 WG3 felt that the successful continued operation of IGB is heavily dependant on the extent to which individual nations cooperate in providing data. In view of the reservations expressed by certain nations which include a reluctance to provide data for inclusion in any World Gravity data map series in the absence of

a prior reciprocal arrangement, it is recommended that the IGB seek ways and means to prepare the grounds for an agreement between all nations at the next IGC meeting in Paris in September 1978 prior to formally implementing a World series of gravity maps subject to the commencement of the Pilot Project referred to at Recommendation 6.

2. The data obtained on the basis recommended at 1. should be used to prepare a five degree equal area mean Free Air anomaly map of the world as envisaged in the document WG3Feb 76. The preparation of such a map should precede the construction of any iso-anomaly maps in a World Gravity Series and should be prepared by the IGB from its computerised data files and other documents (See Recommendation 5).
3. On the question of Priority 3 in the WG3Feb 76 document, it was considered desirable that a set of ship location tracks be compiled in time for the September 1978 IGC Meeting.
4. The sheets to be issued in the 1 : 15.000.000 series equivalent to the International Geo Tectonic Map of the World Series as envisaged in Priority 4 of the document WG3Feb 76, should be titled

WORLD GRAVITY ANOMALY MAP SERIES (WGAMS).

Ten sheets will be used to provide global coverage using the numbering scheme submitted by Professor Sazhina which is in accordance with the International Geotectonic Map of the World Series. (see p.I-9).

5. The additional maps which should be prepared by the IGB are in the following series :
 - . Map 11 - 5° equal area free air anomalies in accordance with the specifications of document WGB3Feb 76.
 - . Map 12 - Gravimetric Geoid Map of the World on a scale of approximately 1: 100.000.000 (?).
 - . Each Map in the 11 series should be supplemented by three additional maps :
 - a) mean elevation of the regions
 - b) estimate of the accuracy of the Free Air area means
 - c) no. of readings used to compute each area mean.

Details of the data sources used to compile each map produced in the 11 series should be given in the Bulletin Information of the IGB for user reference. A revised data source listing should be prepared for each new map in the 11 series.

6. In the first instance, a pilot project should be initiated to produce Sheet 9 in the WGAMS series, covering the Indian Ocean ; Australia, India, Indonesia and other nations of south-east Asia. The IGB should contact all national agencies in the region advising them of the project and requesting gravity data for it. This data should be prepared in terms of Priorities 1 and 2 of the document WG3Feb 76 prior to use in preparing WGAMS Sheet 9.

7. It is recommended that the WGAMS Map series be based on Bouguer anomalies based on a density of 2.67 g/cm^{-3} on land and free air anomalies at sea. This question should be reviewed after the Pilot WGAMS Sheet 9 has been produced.
8. The contour interval recommended is 20 mgal. Contours should be shown in broken lines when the estimated precision of interpolation from the contours is worse than half the contour interval.
9. The background to the WGAMS sheets should consist of 500 m contours of both topography and bathymetry. The coastline and the 200 m isobath should also be shown along with the major rivers.
10. It is recommended that the colouring system on the sample map provided by Professor Sazhina be retained. It was also decided to leave to the discretion of the map producer other aspects pertaining to the background. This matter would be reviewed after the Pilot WGAMS Sheet 9 was produced.
11. All sheets in the WGAMS Series should contain reference to the Series 11 sheet containing the data on which it is based. This would enable the interested user to have ease of access to the source material with minimum inconvenience.
12. It is recommended that each WGAMS Sheet should contain an acknowledgment listing the individual nations which provided data for its production. More detailed information will appear in the Bulletin Information which has been appropriately referred in terms of Recommendation 5.

R.S.MATHER

17 June 1977

ATTACHMENT 1

April 8, 1977

Circular letter to members of WG 3, IGC and DB, IGB

Dear Colleague,

in accordance with Recommendations of the DB IGB and Prof. C. Morelli, President, IGC a meeting of the DB, IGB and the WG 3, IGB on the "Gravimetric Map of the World" will be held on June, 16-18, 1977 in Trieste (Italy). This meeting will precede the International Symposium on "Non-tidal Gravity Variations and Methods of Their Study" to be held from June 20 to June 24, 1977 in Trieste as well.

At the WG 3 meeting the author's model of one of the sheets of the above-said map is supposed to be considered as prepared by the Soviet Geophysical Committee (Prof. N.B. Sazhina) together with the International Gravimetric Bureau (Dr. S. Coron). It is planned to discuss the following questions and adopt resolutions on them :

1. The type of gravity anomalies shown on the map,
2. The scale and topographic grounds of the map,
3. Choice of the interval between isolines,
4. Design beyond the frame,
5. Legend to the map,
6. Choice of colour
7. Program of explanatory note to the map,
8. Possible participation of agencies of various countries in compilation of the map.

I should be very grateful to you if you could advise me at your earliest convenience the possibility of your participation in the meeting.

Thank you for your collaboration

With best wishes

Yu.D. Boulanger
Convenor WG 3 DB IGB

| | |
|---------------|----------|
| cc to : Coron | Morelli |
| Levallois | Rapp |
| Kautzleben | Williams |
| Krynski | Uotila |
| Mather | Tanner |

Y.D. BOULANGER - 117333, Moscow
D. Ulianov str. 4 - Block 2, Apart. 64

Prof.R.S.Mather

Dear Prof. Mather,

14 hours before my planned departure to Rome I lost my consciousness due to a sudden cerebral vascular spasm. As a result of this my doctors categorically forbade me to leave Moscow during the next two weeks. Therefore I have no chance of taking part either in the WG 3 DBIGB meeting or in the work of the Symposium.

In connection with this may I address you with my personal request to undertake the leadership of the WG 3 meeting.

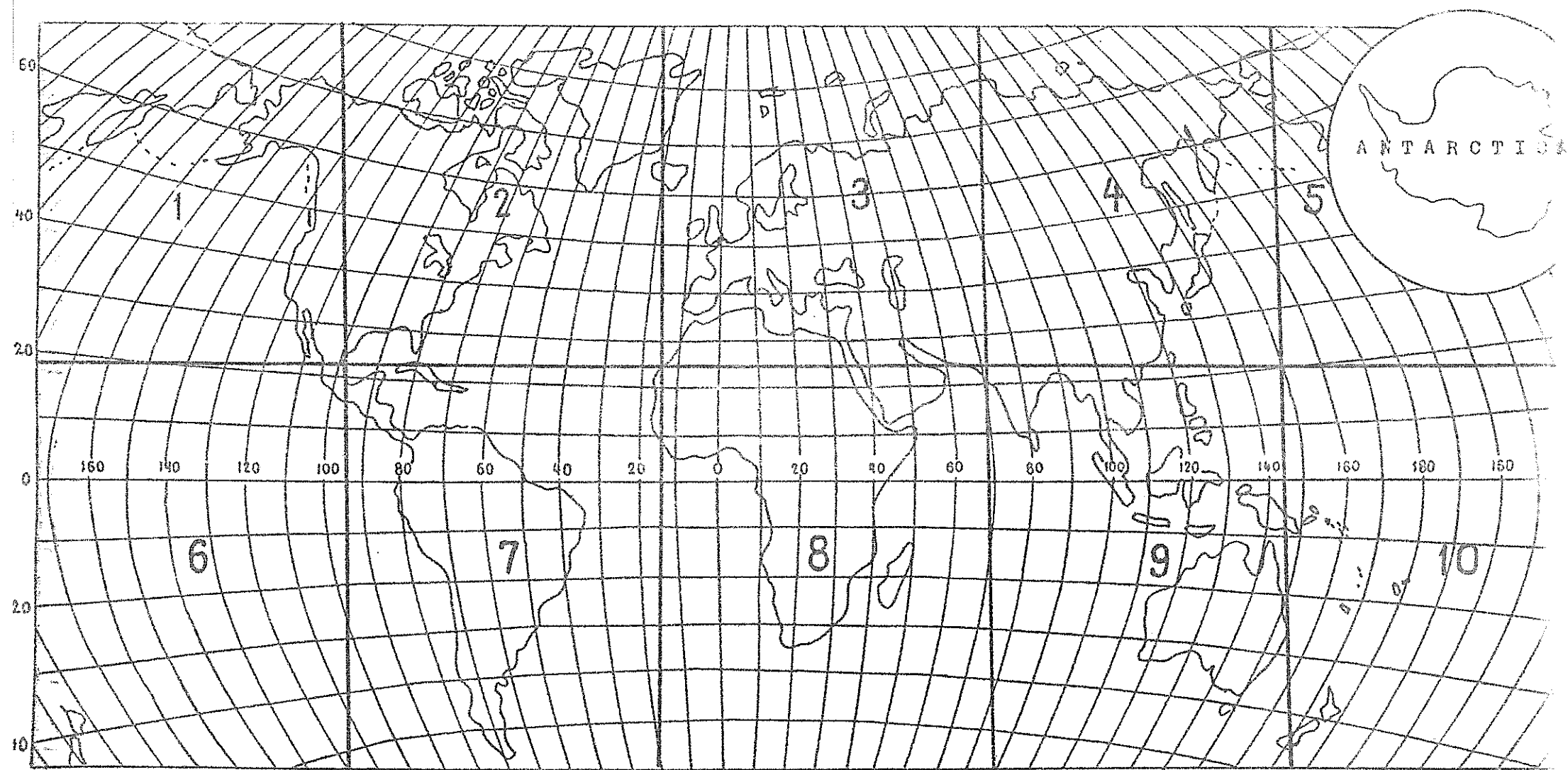
Prof. Sazhina will let you know my considerations about compilation of the gravimetric map of the world. They seem to be logical both from geophysical and geodetic aspect. I hope that the work on map compilation can be finished by about 1980. I mean the authors' model. However this depends on the arrival of data on gravimetric measurements in oceans. It is advisable that WG3 elaborate an appeal to large agencies possessing the data on gravimetric measurements in seas and oceans with the request to transfer all this data in a computer-readable form to the IGB and Soviet Geophysical Committee to be used for map compilation.

With the best wishes of success in the work,

Sincerely yours,

Yu.D. Boulanger

Moscow, June 14, 1977



Different sheets of the INTERNATIONAL MAP (1/ 15.000.000)

First Circular - November 1977

INTERNATIONAL GRAVITY COMMISSION

The eighth meeting of the International Gravity Commission (I.G.C.) planned in 1978 (I.A.G., Grenoble) will be held in Paris

from Tuesday 12th until Saturday 16th September 1978

Monday 11th September and Tuesday 12th (morning) will be reserved for the Working Groups and Directing Board of the I.G.B.

This meeting takes place in the previous year of the meeting of the I.U.G.G. (Canberra, Australia, 2-15 December 1979). Thus, the resolutions which will be proposed during the meeting of the I.G.C. will be submitted to the General Assembly of I.A.G. - for the I.G.C. has no authority of self-decision.

The last meeting of the I.G.C. was held in 1974.

The I.G.C. is composed, in principle, of one delegate from each member-nation of the I.U.G.G., but it is open to every gravimetrist interested in subjects of agenda. The official delegate is qualified to express his intention by vote, if necessary, on important questions which will be submitted later to the General Assembly.

General program of the meeting :

1. International Gravity Commission : President's report
2. International Gravity Bureau
 - status report
 - reports of I.G.B. : working groups
3. International Gravity Standardization Net 1971
 - updating and extension
 - compilation of data
4. Absolute gravity measurements
 - new determinations
 - portable apparatus
 - future programs

5. Gravity measurements at sea
 - new surveys
 - connections to IGSN 71 and harbour stations
 - publication of data
6. Airborne gravity measurements
 - apparatus
 - experimental results
7. High precision gravity measurements
 - report S.S.G. 3.37
 - instrumental developments
 - environmental effects
 - experimental results
8. Second derivatives of the potential (Vertical gradient of gravity)
 - instrumental developments
 - experimental results
9. Secular variation of gravity
 - report S.S.G. 3.40
 - global variations
 - regional variations
 - local variations
10. Gravity measurements on the moon
11. Interpolation of gravity
 - methods
 - experimental results
12. Comparison of satellite results with terrestrial gravity data
13. Geophysical interpretation
 - report S.S.G. 5.46 (as far as related to topics of I.G.C.)
14. Resolutions.

It is only a provisional program. A more detailed agenda will be indicated in the previous months of the meeting, as well as a time schedule of the meetings.

This paper could be established owing to the co-operation of every participant, so it is kindly requested to Geodesists and Geophysicists to send their suggestions to the I.G.B. which will send them a detailed program, after the decisions of Prof. MORELLI, President of the I.G.C.

Remarks

a) Though it is a supplementary task for every Nation, the presentation of a National Report is required for informing all participants and the I.G.B. of the progress of geodetic and geophysical works. This report could mention bibliographical reference about the gravity publications issued since 1974. It can be presented under a simple form (rhoneotyped) and about 190 copies would be necessary to be distributed to Delegates present at the meeting. It will be requested to use, if possible, a uni-format (21 x 29,7 cm) for a practical gathering.

b) We recall that 2 Special Study Groups are in relation with the Section III (Gravimetry) :

- N° 3.37 : "Special techniques of gravity measurements"
President : E. GROTEN (F.R.G.)
- N° 3.40 : "Secular variations of gravity"
President : Y. BOULANGER (USSR)

and that one other Special Study Group in relation with the section V is also dealing with the gravity anomalies :

- N° 5.46 : "Physical interpretation of gravity anomalies"
President : S. SAXOV (Denmark)

This topic was discussed at the last meeting of the I.G.C.

A registration form is enclosed. The persons who wish to attend the meeting are kindly asked to complete and return it to the I.G.B.

A second registration form will be sent to those who would have returned the first preliminary registration form. This second paper will contain all general information on reservation of rooms, accomodation...

If some persons wish to receive a personal invitation to submit to the Governmental Authority of their own Country in order to obtain the necessary funds trip and stay in Paris, the I.G.B. will send such invitations on request.

The President of the I.G.C.
C.MORELLI

COMMISSION for GEODESY in AFRICA
held between 23rd-25th march 1977
at Lagos (Nigeria)

It has been extracted from the "Report of the inaugural meeting..." the following pages in relation with the gravimetric work or the general organisation in Africa.

.....

FORMATION OF COMMITTEES

During the previous sessions, the Commission decided to set up the following Committees for the execution of its programmes :

- a) Inter-African Geodetic Projects Co-ordinating Committee
- b) African Geoid and Datum Definition Committee
- c) Data Bank Committee
- d) Education and Publication Committee
- e) Gravity Network Committee.

.....

REPORT ON THE SECOND SESSION OF THE COMMISSION FOR GEODESY IN AFRICA - 24TH MARCH, 1977

| | | |
|---------------|---------------------|---------|
| Chairman : | Dr. A.M. Wassef | (Egypt) |
| Rapporteurs : | Prof. B.A. Neequage | (Ghana) |
| | Mr. W.J. Absaloms | (Kenya) |

1. TOPIC - ESTABLISHMENT OF GEODETIC DATA BANK :

The Commission agreed that Geodetic Data Bank should be set up as was resolved during the first symposium in Geodesy in Africa, held in Kartoum, Sudan between 14th and 19th January, 1974. The resolution which set out the objectives of the Commission for Geodesy in Africa, was consequently ratified at the General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Grenoble, France in 1975. The Central Geodetic Data Bank will be set in Lagos and the Nigerian Government would make adequate provision for the Data Bank to start functioning immediately.

2. SOURCES OF MATERIAL FOR THE GEODETIC DATA BANK :

The delegates were aware that the one main source of geodetic data would be the former colonial powers in Africa and other foreign countries who have carried out geodetic work in Africa, either under bilateral or multilateral agreements. The delegates of France, U.K. and U.S.A. informed the Commission that the data could be released with the permission of the African

countries involved in the agreements. The list of projects carried out by the U.K. was submitted at the Khartoum Symposium in 1974 while list of those carried out by the U.S.A. has been submitted at this meeting. The delegate of Italy informed the Commission that they had already released all the geodetic data to the African countries concerned.

The Commission also agreed that apart from the data which would be coming from the individual African countries, the World Data Centers should be requested through the IUGG and ICSU to make any geodetic data on African projects within their custody available to the African Geodetic Data Bank.

Belgium, Germany, Portugal and Spain were not represented at the meeting.

3. TYPES OF GEODETIC DATA

The types of geodetic data to be made available to the Central Data Bank by each African country were fully discussed from the technical and national security points of view and it was finally agreed that the following types of geodetic data information relevant to their accuracy should be stored in the Geodetic Data Bank without any risk to the national security of any member countries :

- (i) Astronomical fixes,
- (ii) Primary gravity networks,
- (iii) Levelling and tide gauge data,
- (iv) Geomagnetic data,
- (v) Description and co-ordinates of primary triangulation, traverses
Doppler and other point position fixes and EDM/ refraction research work.

The Commission also agreed that all the geodetic data for the regional and continental projects, such as the measurements of the 30th Meridian and the 12th parallel, which were not subject to any bilateral or multilateral agreements, be made available to the Geodetic Data Bank directly by the countries or organizations who are holding them at present.

COMMISSION FOR GEODESY IN AFRICA

REPORT ON THE THIRD SESSION

| | | |
|---------------|------------------|---------------|
| Chairman : | Prof. G. Obenson | (Nigeria) |
| Rapporteurs : | M.K.O. Sandwidi | (Upper Volta) |
| | M.P.E. Bazie | (Upper Volta) |

1. PROGRAMME OF WORK OF THE COMMISSION :

The programme of work for the African Geodetic Commission should include :

- (i) The establishment of the machinery for co-ordinated inter-African geodetic projects in any specified fields, e.g.
 - a) Gravity and Magnetic observations -
Basic network and overall continental data measurements.
 - b) Continental Precise Level Networks and Tide Gauges Data for Mean Sea Level determinations.
 - c) Continental Geodetic Network by satellite geodesy to provide super control points to which national basic geodetic networks should be connected.

- d) Determination of the African continental geoid and the African Geodetic Datum.
- e) EDM performance evaluation and refraction modelling in Africa.
- f) Eventual intercontinental ties to link African geodetic data with the rest of the world.
- g) Study of recent crustal movements in Africa and polar motion.
- (ii) The establishment of the committee for Geodetic education in Africa whose duty shall be to encourage :
 - a) Geodetic Education.
 - b) Organisation of short courses
 - c) Short term exchange of experts for both educational institutions and field work,
 - d) curriculum development and updating Geodetic Science in Africa.
- (iii) The encouragement of the countries concerned to implement the establishment of geodetic data banks.
- (iv) The encouragement of those African countries that have not done so to apply for membership of the IUGG and hence of the IAG.

2. PROGRAMME IMPLEMENTATION :

For the implementation of the programme above, it is suggested that :

- (i) Each country should form her own national Geodetic Commission and apply for membership of the IAG and IUGG.
- (ii) There should be a Committee for Inter-African Geodetic Projects Co-ordination to design the continental layout of primary stations for various geodetic nets such as :
 - a) an African Gravity Network ;
 - b) an African Level Network/Tide Gauge Stations ;
 - c) an African satellite Geodetic Network ;
 - d) an African Magnetic Network, etc.

and co-ordinate the assembling and interpretation of results. Thereafter the field work and data computations for various parts of each network may be assigned to individual nations or groups of nations or groups of scientists as necessary. A realistic time table for completion of various phases of the work shall be drawn up and agreed to. The Commission would have to appeal for adequate funds from appropriate governments and agencies to support all its projects.
- (iii) As far as possible meetings and symposia for presentation of progress reports and exchange of ideas should be organised under the auspices of the African Geodetic Commission and the IAG.
- (iv) There shall be commissions or committees of interested experts under designated chairmen to promote and co-ordinate research and advancement of geodetic knowledge. These groups should as far as possible conform with the existing IAG groups. However the Commission can also form other working groups to look into geodetic problems of particular interest to Africa.

REPORT OF THE SUB-COMMITTEE AND FOURTH TECHNICAL
SESSION MEETING ON PROGRAMME OF ABSOLUTE GRAVITY
MEASUREMENTS IN AFRICA

Chairman : Dr. D.E. Ajakaiye (Nigeria)
Rapporteurs : Prof. D.M.J. Fubara (Nigeria)
Mr. P.W.K. Ruhukya (Uganda)

PREAMBLE :

Following the opening session of the inaugural meeting, the agenda for the rest of the meeting and the programme for the Technical Sessions were adopted. During the process, a sub-committee was formed as recommended by Prof. Antonio Marussi to look into the "Programme of Absolute Gravity Measurements in Africa". The sub-committee consisted of Dr. D.E. Ajakaiye (Chairman), Prof. D.M.J. Fubara (Secretary), Professors Antonio Marussi, C. Morelli, Anthos Bray, T.J. Kukkamaki, A.M. Wassef and Messrs B.A. Neequaye, W.J. Absalom, K.O. Sandwidi, O. Fadahunsi and E.A. Ige and held a total of four meetings on 23rd and 24th March, 1977.

PURPOSES AND BENEFITS OF
ABSOLUTE GRAVITY MEASUREMENT

1. In modern technology, absolute gravity measurements with the greatest accuracy are required :

1.1. For GEODESY and GEOPHYSICS :

- a) Reference stations for all gravity measurements in a country or in a region. These stations form the basis for calibration or standardisation of gravimeters. The accuracy necessary is of the order of a few μ -Gals. This increase in accuracy in absolute gravity measurements fits the requirements of modern relative gravity meters which are the instruments available for everyday use in geodesy and geophysics. For such an accuracy, the classical way of operation for establishment of a reference gravity net through long distance connections with groups of modern (LaCoste & Romberg) gravity meters in closed polygons is no longer necessary.
- b) Reference stations for the detection of crustal deformations and/or secular gravity variations. The potential in this respect will be increased by connecting the absolute sites with lines of stations of approximately the same gravity value (within a few μ -Gals), these stations being tied at regular intervals (approx. 5 to 10 years) to the absolute sites with microgravimeters.
- c) A means of detection of possible periodic errors in the present gravity standard offered by IGSN 71 (I.A.G., Resolution 16, 1975) by using stations spaced out at about 250 μ -Gals all over the gravity range.

1.2. FOR METROLOGY (WEIGHTS & MEASURES OR STANDARDS) :

The knowledge of the absolute value of g is a prerequisite for maintenance and control of any standard of force, and therefore for the standards of pressure, intensity of electric current, etc.

For instance, the standards of the electric current is obtained by comparing the force acting between two coils with that of a known mass in a known gravitational field, the accuracy by which this standard is obtained is 1×10^{-6} , therefore the influence in the accuracy of g must be at least an order of magnitude higher.

The standard of force is now measured with accuracy better than 1×10^{-6} , Furthermore such an accurate determination of force is required in many applications, the most important of which are the strength of materials and weighting of commodities.

Accurate force measurements are necessary over a wide range, going from a fraction of a Newton, as in microbiology, up to millions of Newtons as in the space field, mainly in tele-communications. Also, the quantities derived from force require accurate values of g , such as in the case of pressure, which in turn is involved in the establishment of some fixed points of the International Practical Temperature scale, Besides these are other quantities like work, energy, power, specific gravity and so on, which depend on the knowledge of absolute gravity.

2. TRAINING :

The foreign scientific personnel operating the absolute apparatus will transfer all the technological information to the interested scientists of the host countries, using lectures if requested.

3. TECHNICAL CONSIDERATIONS :

3.1. Choice of Instrument :

The Italian transportable absolute gravimeters belonging to the Institute of Metrology of the National Research Council is reported to be the only one of its kind now available in the world with an accuracy of a few μ -Gals. This is contained in the attached paper by Prof. C. Morelli (Italy) and Mr. J.J. Levallois (France) and confirmed by Prof. T.J. Kukkamaki (Finland) the current President of the International Association of Geodesy (I.A.G.). The Italian absolute gravity apparatus is reported to have been successfully used in Norway, Finland, Denmark, Sweden, England, the Belgium, France, Western Germany and Italy.

The Euro-African main gravity line from Hammerfest (Norway) to Capetown (Azania) covering the full range of gravity from North to South is being used as a calibration line for standardization purposes to check scale and linearity problems. According to resolution III-3(a) of the International Association of Geodesy at its 16th General Meeting in Grenoble, France, 1975, absolute gravity measurements with an accuracy of a few μ -Gals with the Italian transportable apparatus are required all over this line at approximately 250 milligals interval.

Since the European part of this line has been completed in 1976, the same Italian scientists with the promise of support of their government, have proposed to make available the services of their instruments in Africa. The arrangements for this will be worked out jointly by the Italian Scientists and the Commission for Geodesy in Africa. Details of the cost sharing and logistics are given later.

3.2. Criteria For Choice Of Stations

Environmental Stability

The absolute gravity stations should guarantee the stability of the g value for many decades, and the environmental conditions for the highest performance of the instruments. Therefore they should be :

- a) placed in observatories or other constructions in which (mass-) modifications are not expected ;
- b) at least 50 km, away from the sea (tide effects), traffic and industrial vibrations ;
- c) in the underground on rock or isolated piers where tectonic stability exists ;
- d) in areas where underground water level variations are not expected (compacted rocks).

4. GRAVITY MEASUREMENTS :

With the Italian transportable absolute gravimeter.

4.1. Technical Facilities Required At Each Station :

- i) A stable pillar (0,80m) in a climatized (air-conditioned) room (3m x 5m) (temperature : $21 - 25 \pm 1^\circ\text{C}$; humidity : $50 - 60 \pm 5\%$), insulated from the structure and, if possible, at ground level,
- ii) Power supply 220 V, 2 KW
- iii) Information about :
 - a) possibility as to availability of liquid air or nitrogen
 - b) availability of a mechanical and an electronic workshop
 - c) temperature gradient during the day in the different seasons
 - d) possibilities of transportation from one station to another (by surface, by sea, by air)
- iv) Dimensions of van : (4,75 x 2,50 x 2,00)m length, height, width
- v) Total weight of instrumentation : 600 kg.

Note : Soil testing through drilling may be required at locations to confirm water table and sub-surface structural characteristics.

5. LOGISTICS AND FINANCIAL REQUIREMENTS :

Three Italian scientists, and two scientists from the host country of the station will be required. Based on the experience in Europe, the field-work efforts will require about two weeks to complete measurements at a station which shall have been previously prepared as specified. If the African countries are interested in the proposed absolute gravity measurement project using the Italian portable absolute gravimeter and are also willing to support the project in cash and/or kind, the Italian government will contribute to the cost of the project, according to Prof. Antonio Marussi (former President of the IAG).

5.1. Financing :

The Italian contribution is not expected to be direct cash payment but rather through funds to pay the salaries and allowances of the participating Italian scientists and the free use of their equipment and van, and some transportation costs. The main items of costs are :

- a) station location and preparation and facilities ;
- b) transportation from station to station which may be by land, air and/or sea ;
- c) accomodation and subsistence for all the scientists and working personnel, local labour, and local transportation and
- d) the absolute gravimeter, accessorties and its van.

Item (d) is to be fully borne by the Italian government. Item (a), (b) and (c) may be provided for by the government of the country where station is located.

5.2. Proposed Stations And Scheduling :

All the representatives of the 13 African countries in attendance have, in principe, and subject to the approval from their home governments indicated their desire to have at least one station located in each of their various countries.

The countries are Republic of Benin, Central African Empire, Ethiopia, Egypt, Ghana, Ivory Coast, Kenya, Liberia, Senegal, Madagascar, Uganda, Soudan and Nigeria.

However, in view of the fact that the Italian scientists do not intend to establish more than twenty (20) stations in the first instance, the sub committee proposes the following stations :

Cairo, Khartoum, Addis Ababa, Nairobi Dodoma, Lusaka, Masero (Lesotho), Tananarive., Nova Lisbon (Angola), Kinshasa, Yaounde, Njamina (former Ft. Lamy in Chad), Kumasi, Ouagadougou, Dakar, Casablanca, Algiers, Tripoli, one station in Ivory Coast and two stations in Nigeria (possible sites are Zaria and Nsukka).

The scheduling of movement and routes will be worked out by the permanent committee for this project.

6. RESOLUTION :

The Commission for Geodesy in Africa should consider the adoption of a resolution that every African nation should endeavour to establish an up-to-date first order gravity network tied up to the absolute stations.

Use of the variography to appreciate the quality and homogeneity
of sea gravity measurements (++)

by

André GUILLAUME^(°) and Suzanne CORON⁽⁺⁾

The data collected at the International Gravity Bureau are from various surveys and cruises. To obtain the best homogeneity between the data of a region and on the whole world, it is necessary to make comparisons.

On land, it is relatively easy as gravity base stations, often well monumented, can be reoccupied and as the International Gravity Standard Network (IGSN 71) is extending on all continents.

At sea, the problem is more complex :

a) the connexion at the harbour bases is often distant, not frequent, and the reoccupation of the same harbours by cruises which go through the Oceans and go from the different continents or countries, is not easy.

b) on other hand, it is difficult to compare individual geophysical parameters at sea because the crossing points of different traverses are not defined with accuracy because problems of navigation (improved recently by satellite navigation). This comparison will become delicate and almost impossible in regions where submarine topography is rugged : it will be necessary to study the correlation between gravity anomalies and depths (S. Coron, 1973, p.I-43).

As examples, we give hereafter the discrepancy (c) between the gravity anomaly values obtained at crossing traverses of previous cruises belonging to different Geophysical Services. On 70 crossing-points :

| | |
|-------------|---------------|
| c < 10 mGal | for 24 points |
| 10 < c < 20 | " 20 " |
| 20 < c < 35 | " 22 " |
| 35 < c | " 4 " |

Also, to know the quality of gravity measurement series at sea and detect the possible discrepancy between the different series in a limited region, it seems interesting to study the "regional variability" of data sets.

In the present Note, this "variability" is studied by two different methods : the classical spectrum analysis and the structural analysis by "variography". First, these 2 methods are briefly described. Then simulations are made, showing the interest of the "variography" and some experimental examples are given.

(++) This study was presented by S. CORON at a meeting of I.P.L., Moscou, june 1976 (some abstracts) and by A. GUILLAUME, at Munich, september 1977 (4th European Geophysical Society Meeting). Trans. Am. Geoph. Union, 58, n°9.

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METHODS

These methods are described with details in the most of publications dealing with the processing of the signal and the regionalized variables (cf. for instance, A. GUILLAUME, 1977).

Spectral Analysis :

By computing the Fourier's coefficients of the sum corresponding to the series of measurement results, we obtain the energy spectrum (squared amplitude) for each frequency present in the frequency spectrum. The spectrum can also be obtained from the auto-covariance function.

The increase of the spectrum in the zone of high frequencies (aliasing) is due to measurement errors and eventually to the presence of structures of smaller size than twice the sampling interval (Shannon's theorem). However, it remains difficult to estimate the energy value for the highest present frequencies because the computation of Fourier's transformation of the data function give often rise to errors, principally in the highest frequencies ("side effect"). The "apodisation" of data allows to minimize this effect but the processing is becoming not very objective and the spectrum is modified. Further, in most cases in Gravity field, the spectrum can be disturbed by the presence of regional trend (no stationarity). Analogous problems appear in the computation of the auto-covariance function (before computation of energy) mainly in the case of non-stationarity.

Variography Method :

The philosophy of Variography studies (analysis of variograms) joins the philosophy of researches on the collocation made by geodesists (H. MORITZ, 1973) and the kriging by mining geologists (G. MATHERON, 1970). The method is fundamentally based on the theory of random functions ; it takes into account the space distribution of the sampling points ; the analyzed variable is the g value observed in a given point or the free air gravity anomaly.

By computing the semi-variance of the increase of the variable, it is possible to draw the graph of the variations of this variance with respect to the distance. This graph is the semi-variogram, but, in practice, it is called "the variogram". It is interesting to remark that the variogram can always be obtained whereas the auto-correlation or the auto-covariance cannot always be obtained, for instance in the case where the variable is no-stationary (the trend being connected to the regional anomaly of the gravity field). The variogram is therefore very useful for the study of the no-stationary series as well as for the series with no trend.

The fig. 1a shows a variogram computed for a stationary phenomenon and, in this case, the relation between the variance $K(0)$, the auto-covariance $K(h)$ and the variogram $\gamma(h)$ is :

$$\gamma(h) = K(0) - K(h)$$

h being the mean distance between a point and the neighbouring points included in a chosen distant interval; h increases step by step, for instance, in the following experimental examples, one step will be 10 km.

It is to be noted that, in this case, the variogram tends to a limit. The autocovariance decreases regularly towards a very small value : for the distance $h > a$, the points are no more interrelated (on an average). In other terms, the variogram brings to the origin the structures of small size, whereas the energy spectrum puts off these structures towards the infinity (in practice towards the highest

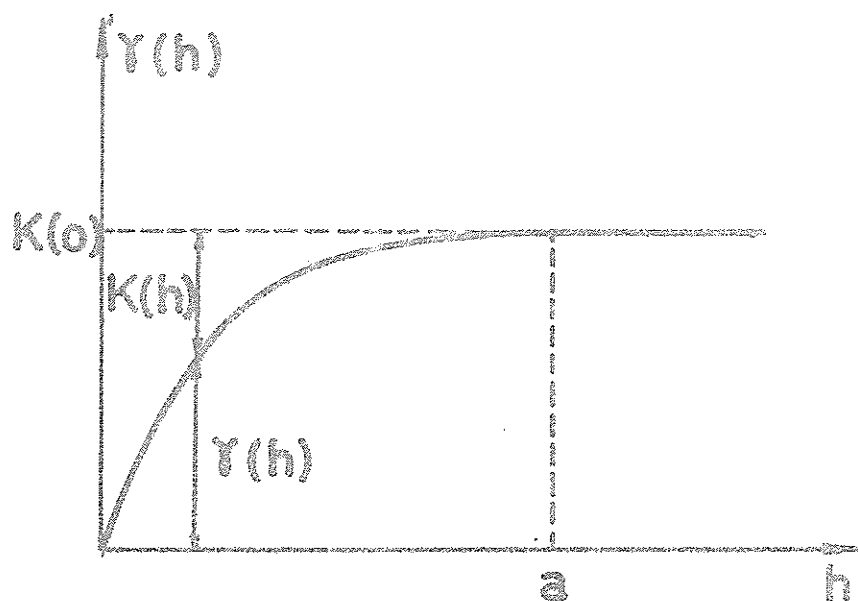


Fig.1a- Stationary phenomenon .
Relation between auto-covariance, variance and variogram.

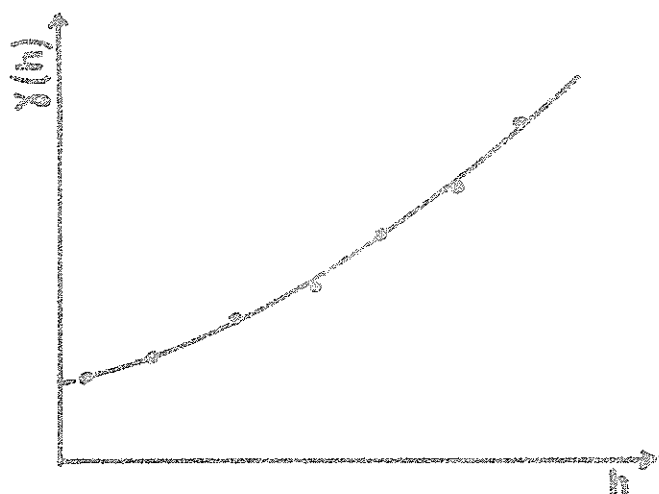


Fig.1b - Non-stationary phenomenon.
- Nugget effect.

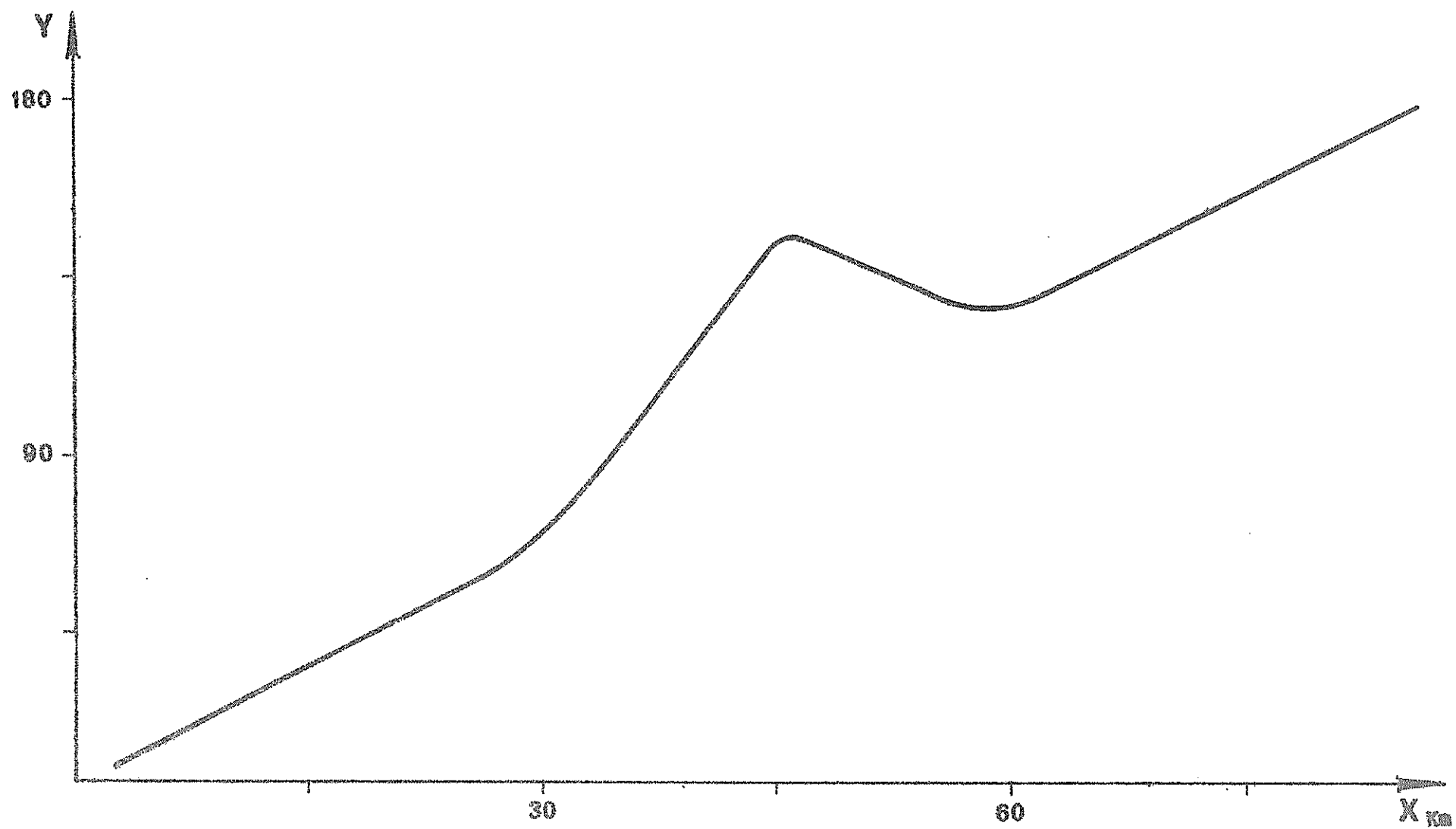


Fig.2 - Curve of theoretical model -

present frequencies). This correspondance between the 2 graphs is due to the relation of Fourier's transformation which connect autocovariance and energy

$$K(h) = \int_{-\infty}^{+\infty} E(v) \cdot \exp[j \cdot 2\pi v h] \cdot dv$$

$$K(0) = 2 \int_0^{\infty} E(v) \cdot dv$$

where $E(v)$ = energy for the frequency v .

The fig. 1b shows a variogram not bounded, with respect to the scale of the study, relative to a non-stationary phenomenon : the a priori variance is not defined and the curve of variogram is parabolic near the origin. Furthermore, the discontinuity at the origin called "nugget effect" (N.E.) is due to the measurement errors, and eventually to the presence of structures of smaller size than that which can be entirely described by sampling. So, the N.E. of the variogram correspond to the "folding" of the energy spectrum.

STUDY ON MODELS

The interest of the variography can be shown by simulation, in using fictitious measurement sets. To obtain these sets, we have computed step by step the value of a function $y=f(x)$ (practically resulting from the connection of some functions). The figure 2 shows the theoretical profile so computed. The variable X measured on a profile of about 100km, extends up to 200 units (namely the unit is the mGal).

A linear trend is easily visible on this diagram ; this phenomenon appears often in the observed gravity field. This theoretical model has been sampled : 180 points, regularly spaced have been used to make up the basic data for this study.

In table I (p. 1-25) are indicated :

- the main statistical empirical parameters concerning the variable y , computed for the considered sample :

\bar{y} = arithmetical mean,

s_y^2 = variance,

s_y = root mean square error

- the values of the last three points of the energy spectrum (L_1, L_2, L_3)
- the values of the variogram for each distance h from $h=5\text{km}$ to $h=65$;
- the value of nugget effect (E.P. = "effet de pépite", for instance in mGal^2).

The numerical values relative to the 180 samples extracted from the curve (Fig. 2) are given in the column A_{11} of this Table ; the corresponding variogram is drawn Fig. 3 (curve A_{11}) ; its curve is without nugget effect and is parabolic with horizontal tangent at the origin (as it was said above, there is a linear trend).

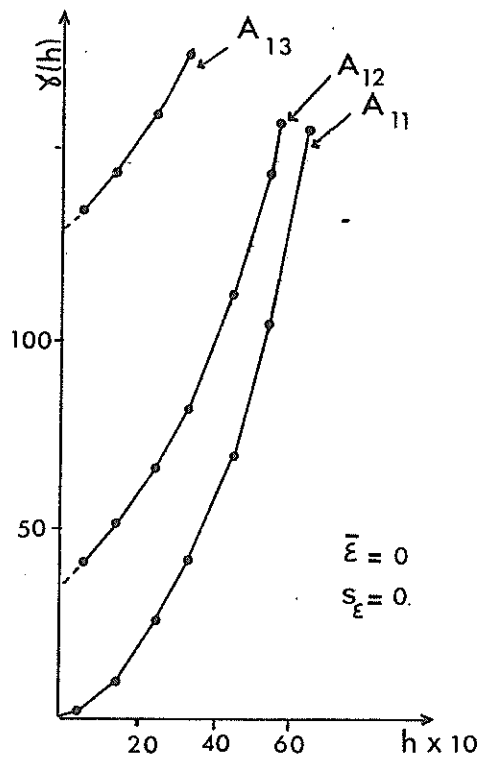
The curve A_{12} (fig.3a) is made from the same data but 20 mgal have been added to the values of some points (18 points) regularly distributed on the entire profile. The nugget effect (N.E.) is here obvious and the values of this variogram are greater than those of the ideal curve A_{11} (see also, column A_{12} , table 1).

These differences are greater if the quantity added in some points (the same 18 points above) is not constant, but changes between 10 and 50 mgal (curve and column A_{13}).

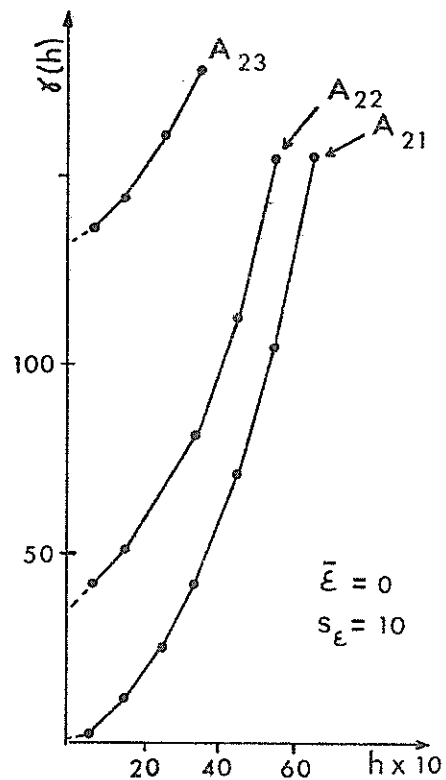
On the data corresponding to the curves A_{11} to A_{13} , other errors have been added. These errors were randomly sampled in a normally distributed population, with a zero mean ($\bar{\epsilon}=0$) and variable standard deviations (s_{ϵ}) : $s_{\epsilon} = 10$ (fig.3b)

| | | A ₁₁ | A ₁₂ | A ₁₃ | | | | A ₂₁ | A ₂₂ | A ₂₃ | | | | | A ₃₁ | A ₃₄ | A ₃₂ | A ₃₃ |
|--------------------|------|-----------------------------|-----------------|-----------------|---------|--|--|----------------------|-----------------|-----------------|---------|--|--|----------------------|------------------|-----------------|-----------------|-----------------|
| | | c o u r b e i d é a l e | | | | | | s _{ε̄} = 10 | | | | | | s _{ε̄} = 20 | | | | |
| | | seule | +20 | +Z | | | | seule | +20 | +Z | | | | seule | +C ^{te} | +20 | +Z | |
| | | ȳ | 98,60 | 100,63 | 101,85 | | | | 98,59 | 100,58 | 101,73 | | | | 98,54 | 118,54 | 100,50 | 101,70 |
| | | s _y ² | 2961,70 | 3018,26 | 3091,77 | | | | 2957,49 | 3013,18 | 3086,66 | | | | 2955,29 | 2955,29 | 3010,07 | 3083,52 |
| | | s _y | 54,42 | 54,90 | 55,60 | | | | 54,38 | 54,89 | 55,56 | | | | 54,36 | 54,36 | 54,87 | 55,53 |
| | | s _ȳ | 4,04 | 4,08 | 4,13 | | | | 4,04 | 4,08 | 4,13 | | | | 4,04 | 4,04 | 4,08 | 4,13 |
| Spectre | L 1 | 5,64 | 0,36 | 0,35 | | | | 5,82 | 0,40 | 0,37 | | | | 6,07 | 0,21 | 0,47 | 0,40 | |
| | L 2 | 6,06 | 0,47 | 0,38 | | | | 5,70 | 0,36 | 0,35 | | | | 5,40 | 0,11 | 0,29 | 0,33 | |
| | L 3 | 5,77 | 0,38 | 0,19 | | | | 5,57 | 0,34 | 0,13 | | | | 5,52 | 0,11 | 0,31 | 0,10 | |
| χ(h) distance h | 5 km | 1,1 | 40,3 | 133,7 | | | | 2,1 | 40,9 | 135,4 | | | | 3,0 | 5,0 | 43,3 | 139,0 | |
| | 15 | 9,7 | 50,1 | 143,5 | | | | 11,0 | 50,4 | 143,7 | | | | 14,5 | 14,5 | 52,9 | 146,1 | |
| | 25 | 24,6 | 65,8 | 159,1 | | | | 25,9 | 66,5 | 159,2 | | | | 29,3 | 29,3 | 69,2 | 161,0 | |
| | 35 | 41,2 | 82,9 | 176,3 | | | | 42,6 | 82,8 | 176,5 | | | | 46,2 | 46,2 | 85,1 | 179,0 | |
| | 45 | 69,1 | 111,2 | 204,7 | | | | 70,1 | 112,0 | 205,9 | | | | 73,0 | 73,0 | 114,7 | 209,0 | |
| | 55 | 103,6 | 123,7 | 175,4 | | | | 104,6 | 124,5 | 176,8 | | | | 107,8 | 107,8 | 127,4 | 180,3 | |
| | 65 | 155,7 | 197,3 | 277,3 | | | | 156,7 | 197,4 | 277,5 | | | | 159,9 | 159,9 | 199,4 | 278,7 | |
| | E.P. | 0 | 36 | 130 | | | | I | 38 | 132 | | | | 3 | 3 | 40 | 136 | |

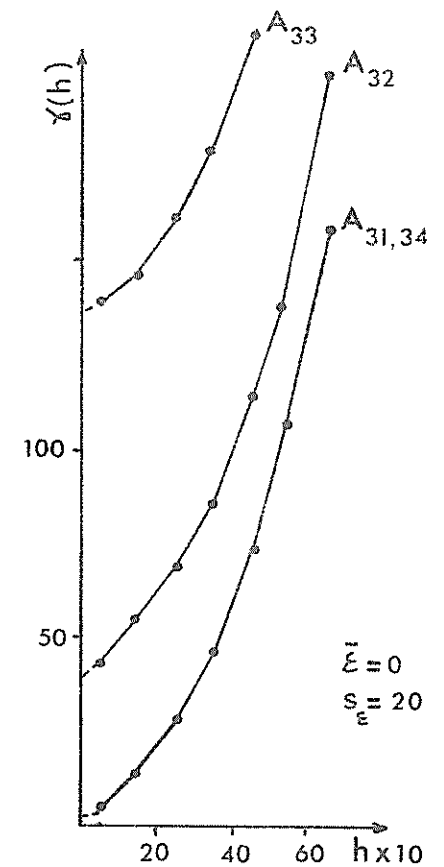
- Table I -



(a)



(b)



(c)

Fig.3 = Variograms relative to the theoretical model (Fig.2)

A_{II} : variogram for the 180 data concerning the ideal curve

$A_{I2} \dots A_{34}$: variograms for the same 180 data, but modified by variable errors.

and $s = 20$ (fig. 3c). The table 1 shows that the numerical values of the variogram A_{22}^E are greater than those of the variogram A_{12} ; those of A_{32} are greater than those of A_{22} and so on... Also, greater is s , greater is the nugget effect.

It can be noted that the addition of a constant to the value of all the points do not change the variogram (as it is based on the increase of the variable): the variogram A_{34} is the same as the variogram A_{31} .

Besides, it is also remarked that the exploitation of the spectrum values would be very difficult because there are generally disordered oscillations at the end of the spectrum (points L_1 to L_3 of the Table I) - however the data have been apodized.

EXPERIMENTAL TESTS

1) The first example, very simple, given figure 4 was chosen as a test, a quick drawing having revealed a big difference between the anomalies near crossing traverses.

This example concerns two cruises E and P respectively with 27 points (E) and 42 (P). The N.E. for the group P is relatively high (about 20 mGal²) and it is still higher (about 50 mGal²) if all the stations of groups P and E (69 points) are considered. There is a systematic difference of 15 to 30 mGal between the 2 measurement sets (case similar to A_{23} and A_{33} of Table 1 and figure 3) due probably to the omission of observation correction for the group P. If the results of cruise P are diminished of 10 or 20 mGal, the N.E. becomes smaller. Therefore, in the considered region, a better homogeneity between the 2 cruises will be obtained in adding a mean correction of about -15 mGal to the P results.

2) The figure 5 give the variograms made for a group of 698 observations distributed on the whole considered area, i.e. in the region situated to the East of Island; the most points make up a dense net (A) well regular; the others points of the group E (59 points) are along tracks drawn on the figure.

The variogram shows a N.E. very small for the group E; on the contrary, a big value (about 40 mGal²) for the group A_1 (639 points) and for the both groups A+E (698 points). The cause was therefore looked for in the results of the group A and a mistake was found: for 12 points, the anomaly values have been not computed and considered as zero value whereas the mean anomaly value of this region is 46 mGal. The new variogram ($A_2 = 627$ points) computed after omitting these 12 points shows a negligible N.E.

In this case, the study of variograms has easily revealed errors concerning only 12 points among 639 (about 2% of results) then has shown the good homogeneity of results. Attention is to be paid on this small percent of errors which could not be detected by the computation of the dispersion of results around the mean value. The empirical parameters are in each case:

| For the 639 points | For the 627 points (639-12) |
|----------------------|-----------------------------|
| $\bar{y} = 45,44$ | $\bar{y} = 46,31$ |
| $s_y^2 = 215,25$ | $s_y^2 = 179,02$ |
| $s_y = 14,67$ | $s_y = 13,38$ |
| $s_{\bar{y}} = 0,58$ | $s_{\bar{y}} = 0,53$ |

Evidently, the few errors not detected would not have changed sensibly the mean anomaly value but could have produced fictitious structures in the drawing of gravity isanomals.

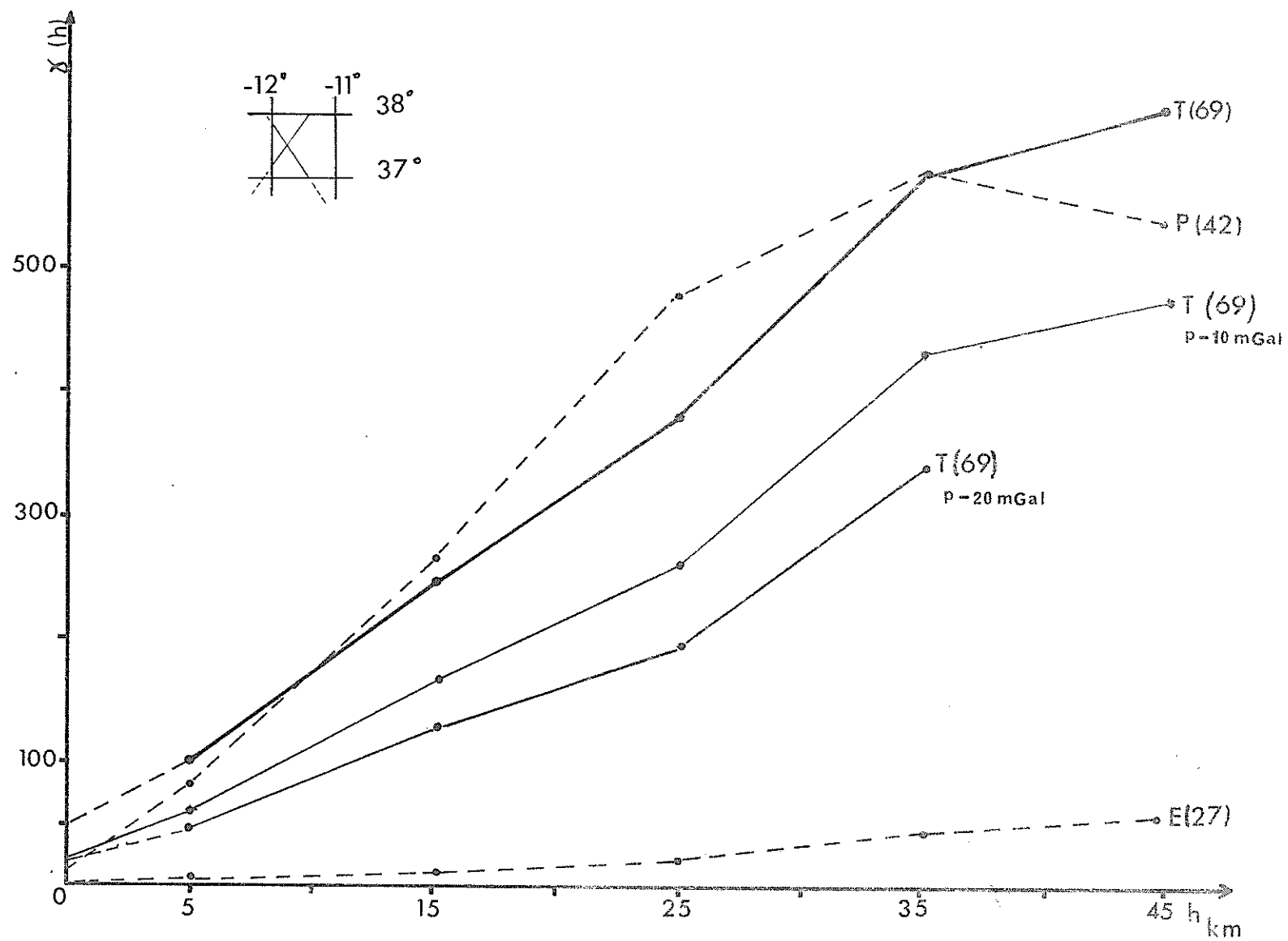


Fig.4 - Variogram relative to the gravimetric results of two different cruises .

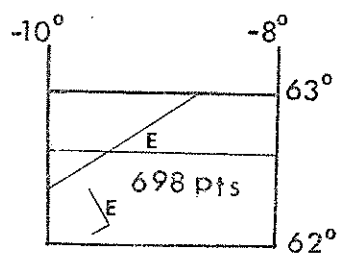
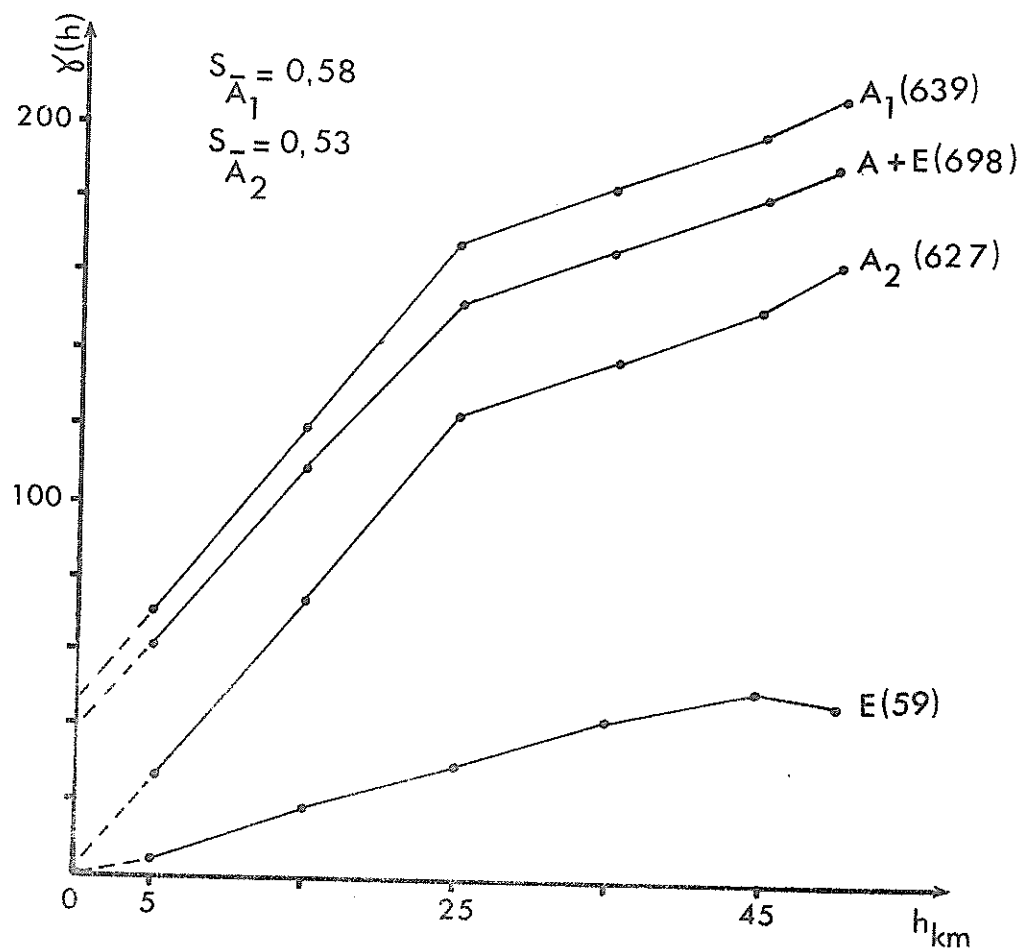


Fig.5 = Variogram relative to the dense gravity net (A)

E : other tracks

$S_{\bar{A}_1}$: r.m.s. error for the net A_1 .

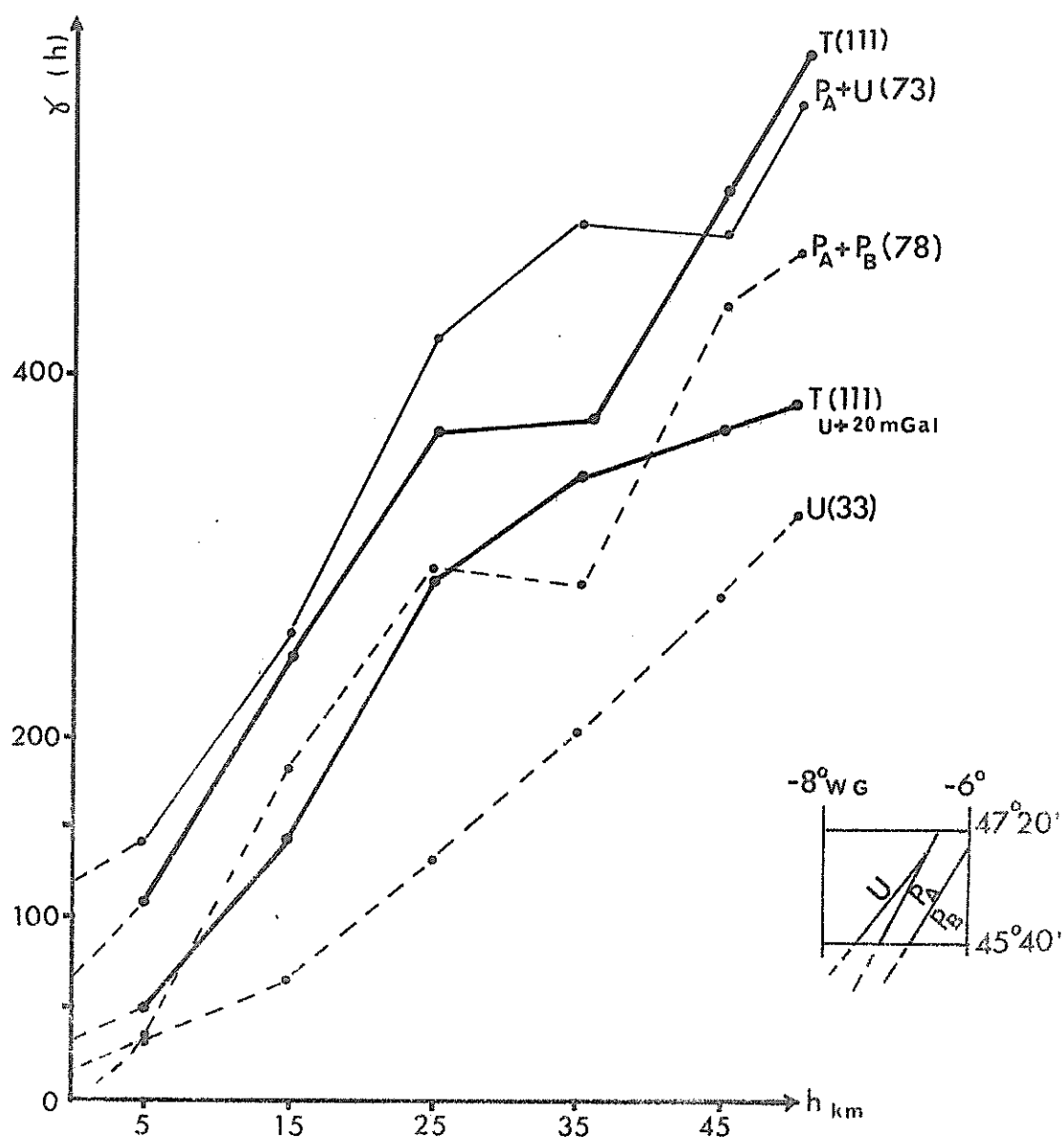


Fig.6 - Variogram relative to some gravimetric cruises .

3) The variograms of the figure 6 are relating to different tracks near each other, approximately in the same direction. Tracks P_A and P_B have been made by the same observer group at different time. The study of variograms has given the following results :

The N.E. computed respectively for each Group are small : 15 to 20 mGal^2 for the profiles P_A , P_B and P_{A+B} ; 25 mGal^2 for the profile U. The observations of each service are therefore intrinsically homogenous. On the contrary, the N.E. is great if two different Groups are both considered. For instance the set constituted by U and P_A shows a N.E. of about 120 mGal^2 . It is so deduced that the results of these cruises are not homogenous in this area (instrumental corrections omitted) or do not represent the same gravity field due to the presence of different tectonic structures under the profiles, though they are near each other.

To try to determine the most probable cause, we have used also the data of a 4th profile made by an another Group (F) crossing the previous ones (P and U) between $45^\circ 30'$ and 46° (not indicated on the figure). The N.E. is very small and reveals no systematic difference between the 3 Groups P, U and F.

Besides, the N.E. quickly decreases if a constant of 10, 20 or 30 mGal is added to the results of U (see Fig. 6, Total with U+20) or taken off the results of P. It can be concluded that the discrepancy is local. In fact, the variograms of the figure 6 show a marked geometric anisotropy : the variogram for U stretches to be parabolic ; the others show a step.

CONCLUSION

"Variography" can detect the presence of errors through data series, by the behaviour of the nugget effect even if errors in a small number.

It can permit to appreciate the quality of data sets and to study their homogeneity. However, the profiles must be near each other and concern a tectonically non complex area. Obviously, the sampling must be exhaustive with respect to the size of the structures. So, the variography is not an universal method.

By the selection of data, it is sometimes possible to know if the discrepancy between 2 or 3 profiles affect the results of a whole cruise or if there is only a local discrepancy (instrumental errors or tectonic features).

If the gravity data are numerous and relatively well distributed, the variograms can be established for privileged directions. In this case, the study of the nugget effect can help to separate the discrepancy due to the data errors or to the different microstructures.

It is to be noted that it remains difficult to have many various cruises in a limited area at sea (about $1 \times 1^\circ$), but now, the gravity surveys become more numerous and in the future, the variography will be frequently used. Furthermore, this method is quick, and not expensive in respect to the representation of gravity results by drawing of isanomals with a digital plotter.

REFERENCES :

- CORON S., 1973 - Sur les anomalies moyennes de la pesanteur, tests et résultats. - Anomalies à l'air libre par $1 \times 1^\circ$ - Bul. Information, B.G.I., n°31 (chap.III).
- INTERNATIONAL ASSOCIATION of GEODESY - The International Gravity Standardization Net 1971 (I.G.S.N.71). Pub. Spec. n°4, A.I.G., 39 ter, rue Gay-Lussac, Paris.
- GUILLAUME A., 1977 - Analyse des variables régionalisées. Traitement du signal en sciences de la Terre, 1vol., 190 p. Doin Editeur, Paris.
- MATHERON G., 1970 - La théorie des variables régionalisées et ses applications. Cahiers du Centre de Morph. Math. Fontainebleau, 5, 1 vol., 212 p.
- MORITZ H., 1973 - Least squares collocation. Deut. Geod. Kom., 75, 1 broch., 31 p.

LISTE COMPLEMENTAIRE des CARTES d' ANOMALIES de BOUGUER

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°Région incluse dans une carte plus générale.

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° Région incluse dans une carte plus générale.

LISTE COMPLEMENTAIRE
des CARTES d'ANOMALIES de BOUGUER
parvenues au B.G.I. depuis novembre 1973

Dans le Bulletin d'Information N° 33, novembre 1973, le B.G.I. avait publié la liste des cartes d'anomalies de Bouguer indexées dans sa cartothèque. Les différents Services géophysiques et géodésiques ont poursuivi leurs envois de publications et de cartes, et il a été possible de dresser une liste complémentaire.

Cette liste complémentaire comprend toutes les cartes de Bouguer indexées entre octobre 1973 et octobre 1977 et comme précédemment, les cartes de détail et de prospection n'ont pas été citées (voir Bull. Inf. N° 33, p. 1-9)

Classification

- I - Cartes Mondiales qui s'étendent sur plusieurs continents et océans.
- II - Cartes par Continent : dans chaque continent, les pays sont classés par ordre alphabétique. Les cartes qui s'étendent sur plusieurs pays sont citées au début de la rubrique (cartes générales).
- III - Cartes Marines, y compris les cartes des îles éloignées des côtes. Les îles proches des continents ont été indexées dans la rubrique II. De même, les mesures en mer au-dessus de plateformes continentales ont été classées avec les pays les plus proches (rubrique II)

Présentation

Pour chaque carte indexée, on a indiqué :

- un numéro de référence, spécial au B.G.I., par exemple : Md. 113, B.475,
- le titre de la carte, avec les références bibliographiques de la publication correspondante,
- les caractéristiques de cette carte :
 - S = échelle
 - E = équidistance des isanomaes
et les limites de la feuille, suivant les parallèles et les méridiens. On notera que ces limites sont très approximatives puisqu'elles correspondent aux coordonnées des coins de la feuille et non pas aux limites souvent irrégulières des surfaces prospectées.

Les erreurs et omissions sont inévitables ; les compléments et inexactitudes que vous voudrez bien signaler au B.G.I. seront mentionnés ultérieurement dans le Bulletin d'Information.

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Cartes Mondiales

B.G.7

Aucune ~~nouvelle~~ carte. Ed. de 1974-1975
Europe Afrique.
1/10.000.000°

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A F R I Q U E

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° = Région incluse dans une carte plus générale.

Cartes Générales AFRIQUE

"Cartes gravimétriques" - Ministère de Géologie de l'URSS, Inst.
Rech. Sci., Méthodes Géophys., VNII Geophys., NILZ Géol. étrangère.
Sous la responsabilité de N.B.SAJINA
S = 1/5.000.000
E = 10 et 40 mGal

B.1133....Afrique, 1975.

Deux séries de 5 feuilles ; une première série avec les anomalies de Bouguer sur terre et sur mer ; une seconde série avec les anomalies de Bouguer sur terre et les anomalies à l'air libre en mer :

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| feuille 1 | : | 0° - 36°N ; 18°W - 18°E.G. |
| feuille 2 | : | 0° - 36°N ; 18°E - 58°W.G. |
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| feuille 4 | : | 36°S - 0° ; 18°E - 58°E.G. |
| feuille 5 | : | schémæ et texte explicatif. |

- Afrique 2 - "A Bouguer gravity anomaly map of Africa" - R.L. SLETTENE & all,
DMAAC Tech. Paper n°73-3, Dept Def., St-Louis, 1973.
S = 1/20.000.000
E = 10 mGal 39°N - 35°S ; 20°W.G. - 55°E.G.

Mean Bouguer anomaly map.

- Kenya 5 - "The structure of the lithosphere beneath the eastern rift,
East Africa, deduced from gravity studies" - (Uganda, Kenya,
Tanzania) J.D. FAIRHEAD, Tectonophys. 30, p.269, 1976.
S = 1/4.500.000 5°S - 1°N ; 33°- 38°E.G.
E = 100 g.u.
Voir aussi : Tectonophys. 15, p.131, 1972. (Afr.Centr.O. 8)
concernant la même région.
: B.1146, cf.p.I-37 (Rhodésie, Un.Sud Afr., Mozambique,
Botswana, Zambie).
: p.113 of "Afar between continental and oceanic rifting
Inter-Un. Com.Geod.Sc.Rep.n°16, Stuttgart 1976.

AFARS et ISSAS (République de Djibouti)

- B.1075 - "T.F.A.I. Bouguer map" - prepared by Univ. Paris VI, Labo.
Tectonophys. : A. BALAN & A. LEBRAS - Univ. Hamburg, Inst. Geophys
J. MAKRIIS & J. ZIMMERMANN, 1973.
S = 1/200.000 11°- 12°40'N ; 41°30' - 43°30'E.G.
E = 5 mGal

ALGERIE

- Alg.12 - "Mesures gravimétriques dans le Tanezrouft Oriental (Algérie)" -
J. RECHENMANN, ORSTOM, Bondy, France - Centre de Recherches
zones arides. Sér. Géol. n°17, CNRS, 1973.
S = 1/500.000 22°30' - 25°N ; 0°-4°E.G.
E = 5 mGal

BOTSWANA

- Un.Sud Afr.5-"The national gravity survey of Botswana", 1972-73" -
C.V. REEVES & D.G. HUTCHINS, Geol. Survey Dept, Bull. n°5,
Lobatse, 1976.
S = 1/1.000.000 Northern part : 22°- 18°S ; 20°- 29°E.G.
E = 100 g.u. Southern part : 27°- 22°S ; 20°- 29°E.G.

ETHIOPIE

- Ethio.10 - "Gravity field and crustal structure of north Ethiopia" - J. MAKRIS, H. MENZEL, J. ZIMMERMANN & P. GOUIN, Inter-Union Com. Geodynamics, Sc. Rep. n°14, Proc. Int. Symp. Afar Region and related Rift Problems, Bad Bergzabern, 1974 - Stuttgart, 1975
 S = 1/6.000.000
 E = 5, 10, 20, 25 mGal 6° - 18°N ; 36° - 44°E.G.

GHANA

- Ghana 2 - "Gravity mapping and interpretation in Ghana" - D.A. HASTINGS, Ghana Geol. Surv. Takoradi, EOS Trans. Am. Geophys. Un., v.58, n°5, 1977.
 S = 1/6.000.000 env.
 E = 10 mGal 5° - 11°N ; 3°W.G. - 1°E.G.

KENYA

- Lttr.4967 - "A Bouguer gravity map was prepared by M.A.KHAN, University of Leicester, Dept. Geology, May 1977 (not received at the BGI)
 Kenya - "Some gravity results from the Northern Gregory Rift" - C.J.SWAIN, p.122 in "Afar between continental and oceanic rifting" - Inter-U. com.Geod.Sc.Rep. n° 16, Stuttgart 1976.
 S = 1/4 000 000
 E = 10 mGal 0° - 5°N ; 34° 38°E.G.

LIBERIA

- "Geophysical surveys of Liberia with tectonic and geological interpretations" - J.S.BEHRENDT & C.S. WOTORSON, U.S. Geol. Surv., prof. Paper 810, 1974. (not received at the BGI)

MADAGASCAR et autres Iles

- B.1141... - "Mesures gravimétriques à Madagascar et autres îles du sud ouest de l'Océan Indien : Comores, Maurice, Réunion" - J.RECHENMANN, ORSTOM, France, à paraître.
 Trois feuilles : nord, centre, sud.
 S = 1/1 000 000
 E = 10 mGal 25° - 11°S. ; 43° - 51°E.G.
 "Madagascar" gravimétrie, anomalies de Bouguer, d = 2,67.
 (carte en couleur).
 S = 1/2 000 000
 E = 10 mGal mêmes coordonnées

MALAWI

- Afr.C.Or.7 - "Gravity survey of Malawi : fieldwork and processing" -
 E.M. ANDREW, Rep. Inst. Geol. Sc, n°74/15, London, 1974.
 S = 1/1.000.000 17°- 9°20'S ; 32°40' - 36°E.G.
 E = 5 mGal

RHODESIE

- B.1146 - "First provisional 1/1.000.000 Bouguer gravity map of Rhodesia"
 (Rhodesia, South Africa, Mozambique, Zambia)- prepared by DMAAC,
 St-Louis AFS, Miss., F. PODMORE, Dept. Phys., Salisbury, 1975.
 S = 1/1.000.000 22°- 16°S ; 25°- 33°E.G.
 E = 5 mGal

SWAZILAND

- "Gravity anomalies in Swaziland" - A.J. BURLEY, R.B. EVANS,
 GILLINGHAM, M. JENNIFER & D. MASSON-SMITH, Swaziland Geol. Surv.
 & Mines Dept., Bull. n°7, 1970.

List of 2248 stations with Bouguer anomalies
 27°-25°30'S, 31°- 32°30'E.G.

ZAMBIE

- Zambie 1 - "Reconnaissance gravity survey of Zambia" - O. MAZAC, Geol.
 Surv. Dept., Tech. Rep. n°76, Lusaka, 1974.
 S = 1/500.000 18°- 8°30'S ; 22°- 34°E.G.
 E = 5 mGal

A M E R I Q U E

Cartes Générales Amérique du Nord et Centrale 38

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| Cartes Générales AMERIQUE du NORD et CENTRALE |
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- Chili 3 - "Andes Septentrionales y América Central - Anomalías simples de Bouguer" - (Guatemala, Honduras, El Salvador, Costa Rica, Panama, Colombia) in pub. n°167, Univ.Chile, Dept. Geof. Santiago de Chile, 1974.
 S = 1/7.500.000
 E = 50 mGal
 0°- 16°N ; 92°- 65°W.G.
- Md.228 - "Simple Bouguer gravity anomaly map of the Gulf of Mexico and adjacent land areas" - H.L. KRIVOVY, H.C. EPPERT Jr & T.E. PYLE, Dept. Int., United States Geol. Surv., Branch of Distribution : Arlington VA 22202, 1976.
 S = 1/2.500.000
 E = 10 - 50 mGal
 17°- 32°N ; 100°- 78°W.G.
- Geol.Re. - "The ocean Basins and margins", vol.3, The Gulf of Mexico and the Caribbean, Plenum press, New York & London, New York, 1975. fig.6, p.74 : map of the Gulf of Mexico adapted from H.L.KRIVOVY.
 S = 1/7 500 000
 E = 20 mGal
 18°- 31°N ; 99°- 80°W.G.

CANADA

- B.865 - "Bouguer anomaly map of Canada. Gravity map series 74-1" -
Dept. Energy Mines & Resources, Gravity Division, Earth Physics
Branch, 1974.
S = 1/5.000.000 40° - 84°N ; 136° - 54°W.G.
E = 10 mGal
- Can.120 - "Gravity measurements in British Columbia".- R.A. STACEY,
J.B. BOYD, L.E. STEPHENS & W.E.F. BURKE, Ottawa, 1973.
152. Kootenay River 48° - 52°N ; 120° - 112°W.G.
153. Fraser River 48° - 52°N ; 130° - 120°W.G.
154. Parsnip River 52° - 56°N ; 128° - 120°W.G.
155. Skeena River 51° - 56°N ; 136° - 128°W.G.
S = 1/1.000.000
E = 10 mGal
- Can.121 - "Crustal structure of Queen Elisabeth Islands and Polar
Continental Margin, Canada" - L.W. SOBCZAK & J.R. WEBER,
AAPG, Memoir 19, Arctic Geol., 1974.
S 1/75.000.000 74° - 81°N ; 132° - 84°W.G.
E = 20 mGal
- Can.122 - "The gravity field of Northeastern Ellesmere Island, part of
Northern Greenland and Lincoln Sea".- L.W. SOBCZAK & L.E. STEPHEN
Ottawa, 1974.
114. Lincoln Sea 80° - 84°N ; 80° - 50°W.G.
S = 1/500.000
E = 5 mGal
- Can.141 - "The correlation of gravity and geology in Southeastern Quebec
and Southern Labrador" - M.D. THOMAS, Ottawa, 1974.
64. Mingan - Cape Whittle 50° - 52°N ; 64° - 60°W.G.
65. Clarke City - Mingan 50° - 52°N ; 68° - 64°W.G.
66. Northwest River 52° - 54°N ; 64° - 60°W.G.
67. Ashuanipi 52° - 54°N ; 68° - 64°W.G.
96. Battle Harb. Cartwright 52° - 54°N ; 60° - 55°W.G.
97. Hamilton - Hopedale 54° - 56°N ; 60° - 56°W.G.
98. Neskampi 54° - 56°N ; 64° - 60°W.G.
S = 1/500.000
E = 5 mGal

- Can.142 - "Gravity measurements in southern district of Keewatin and southeastern district of Mackenzie" - R.A. GIBB & D.W. HALLIDAY, Ottawa, 1974.
- | | |
|---------------------------|----------------------------|
| 124. Fort Smith - Nonacho | 60°- 62°N ; 112°- 108°W.G. |
| 125. Wholdaia Lake | 60°- 62°N ; 108°- 104°W.G. |
| 126. Kazan River | 60°- 62°N ; 104°- 100°W.G. |
| 127. Nueltin Lake | 60°- 62°N ; 100°- 96°W.G. |
| 128. Eskimo Point | 60°- 62°N ; 96°- 92°W.G. |
| 129. Chesterfield Inlet | 62°- 64°N ; 96°- 88°W.G. |
| 130. Dubawnt Lake | 62°- 64°N ; 104°- 96°W.G. |
| 131. Aberdeen Lake | 64°- 66°N ; 104°- 96°W.G. |
- S = 1/500.000
E = 5 mGal
- Can.143 - "Results of underwater and surface regional gravity surveys off the coast of Labrador, 1972" - H.D. VALLIANT, R.F. MACNAB, L.E. STEPHENS, S.T. GRANT & R.V. COOPER, Ottawa, 1974.
156. Hamilton Inlet
- S = 1/1.000.000
E = 10 mGal
- 52°- 56°30'N ; 61°- 47°W.G.
- Can.145 - "Gravity measurements in northern district of Keewatin and parts of district of Mackenzie and district of Franklin, N.W.T. with maps 139-148" - R.A. GIBB & D.W. HALLIDAY, Grav. Map Ser. 139-148 Ottawa, 1975.
- | | |
|--------------------------------|--------------------------------|
| 139. 62°- 64°N ; 88°- 80°W.G. | 144. 66°- 68°N ; 88°- 80°W.G. |
| 140. 64°- 66°N ; 88°- 80°W.G. | 145. 68°- 70°N ; 88°- 80°W.G. |
| 141. 64°- 66°N ; 96°- 88°W.G. | 146. 68°- 70°N ; 88°- 96°W.G. |
| 142. 66°- 68°N ; 104°- 96°W.G. | 147. 68°- 70°N ; 104°- 96°W.G. |
| 143. 66°- 68°N ; 96°- 88°W.G. | 148. 70°- 72°N ; 96°- 88°W.G. |
- S = 1/500.000
E = 5 mGal
- Can.144 - "The gravity field of the Central Labrador Trough, Northern Quebec with map" - P. KEAREY & D.W. HALLIDAY, Ottawa, 1976.
162. Lac Nachicapau - 55°30' - 57°N ; 70°- 66°W.G.
Central Labrador Trough
- S = 1/500.000
E = 5 mGal

- mesures côtières du Canada : cf p.I-51 Can.1q

ETATS-UNIS

- E.U.28 - "Regional geophysical investigations in the Central Colorado Plateau" - J.E. CASE & H.R. JOESTING, Geol. Survey, Professional Paper 736, Washington, 1972.
 S = 1/250.000 36°30' - 39°15'N ; 111° - 108°15'W.G.
 E = 2 mGal
 note : 300 mGal have been added to the Bouguer anomaly at each station to make all values positive.
- B.1032 - "Bouguer gravity anomaly map of Arizona" - R.E. WEST & J.S. SUMNER, Lab. Geophys., Dept. Geosc., Univ. Arizona, Tucson, 1973.
 S = 1/1.000.000 31° - 37°N ; 115° - 109°W.G.
 E = 5 mGal
- E.U. - "Gravity investigation in the southeastern Mojave Desert, California" - Y. ROSTEIN, J. COMBS & S. BIEHLER, Geol. Soc. Am. Bull. v.87(7), p.987, Doc.60704, Boulder, Co., 1976.
 S = 1/700.000 env. 33°29' - 34°N ; 115°32' - 114°30'W.G.
 E = 2 mGal
- E.U. - "Gravity and magnetic investigation, eastern shore area, Virginia" - H.A. SABER, Geol. Soc. Am. Bull. 84(6), p.2120, Boulder, Co., 1973.
 S = 1/650.000 env. 37°10' - 38°10'N ; 76° - 75°15'E.G.
 E = 2 mGal

Cartes Générales AMERIQUE du SUD

- Amer.1 - "A Bouguer gravity anomaly map of South America" - G.L. BREVILLE, C.W. BIERLE, J.R. SANDERS, J.T. VOSS, L.E. WILCOX, DMAAC Tech. Paper n°73-2, St-Louis, 1973.
 Mean Bouguer anomaly map.
 S = 1/20.000.000
 E = 20 mGal
- Chili 3 - "Carta gravimétrica de America del Sur" - M.S. DRAGIČEVIĆ, Univ. Chile, Dept. Geof., Pub. n°167, Santiago de Chile, 1974.
 (Argentina, Chile, Uruguay, Brasil, Ecuador, Columbia, Perou)
 S = 1/15.000.000 48°S - 8°N ; 80° - 36°W.G.
 E = 50 mGal

BRESIL

- Brésil 12 - "Levantamento gravimétrico do Municipio de Curitiba" - C. GEMAEI, A. DOUBEK, Boll. Univ. Fed. Parana, Geod. n°17, Curitiba, Parana, 1975.

S = 1/60.000

E = 1 mGal

25°38' - 25°21'S ; 49°23' - 49°11'W.G.

Voir aussi Chili 3 plus haut.

CHILI

Voir fig.6, pub. Chili 3 citée plus haut :

- Anomalia gravimétrica de Valparaíso

S = 1/3.000.000

E = 5 mGal

34° - 32°S ; 72° - 70°W.G.

- Anomalia gravimétrica de la Costa de Chile

S = 1/3.000.000

E = 5 mGal

42° - 40°S ; 74° - 72°W.G.

COLOMBIE

Voir fig. 5, pub. Chili 3 citée plus haut :

- Occidente de Colombia, Anomalías de Bouguer

S = 1/5.000.000 env.

E = 20 mGal

3° - 8°30'N ; 78° - 74°W.G.

- Col. 5 - "Regional gravity anomalies and central structure in Northern Colombia, Santa Marta, Guajira areas" - J.E. CASE & W.D. MACDONALD Geol. Soc. Am. Bull. v.84(9), p.2911, Boulder, Co., 1973.

S = 1/2.500.000

E = 5 and 25 mGal

10° - 12°15'N ; 75° - 71°W.G.

- Col. 4 - "Trans-Andean Geophysical profile, Southern Colombia" - J.E. CASE, J. BARNES, G. PARIS, H. GONZALEZ & A. VINA, Geol. Soc. Am. Bull. v.84(9), fig. 3, Boulder, Co., 1973.

S = 1/1.250.000

E = 2 mGal

0° - 2°N ; 79°10' - 76°30'W.G.

PARAGUAY

- E.U.O 4761 or - "Gravity survey of Paraguay" - Inter American Geodetic survey Apr.-Jun.1971. (not received at the IGB.)

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° Région incluse dans une carte plus générale.

Carte Générale ASIE

- B.1140 - "Bouguer anomaly, assumed crustal density 2,67 GM/CC" - Dept. Geod. & Geophys., Cambridge U.K., communicated by J.M. WOODSIDE, 1976. (Eastern Mediterranean, Turkey, Black Sea, Northern Egypt). Published in Md.229 page 34

ARABIE SEOUDITE

- B.1079 - "Bouguer anomaly map, Kingdom of Saudi Arabia"- V.J. FLANIGAN & M.N. AKHRAS, Ministry of Petroleum & Mineral Resources. Directorate General of Mineral Resources, 1972.
 S = 1/4.000.000
 E = 10 mGal 12°- 32°N ; 36°- 60°E.G.

IRAN

- E.U.O 4982_{os} - "Final Report Iran regional gravity report n°194" - DMATC and N.G.O., DMATC 1960 1975. (Not yet received at the IGB.)

IRAK

- B.433 - "Iraq, anomalies de Bouguer" - carte de prospection, Auteuil, France 1969.
 S = 1/1.000.000
 E = 1 mGal 24°- 36°N ; 40°- 48°E.G.

JORDANIE

Voir B.1133, p.I - 34.

SYRIE

Voir B.1133, p.I - 34.

TURQUIE

- Turq.4 - "Gravity anomalies of the Eastern Mediterranean" - H.F. ÖZELÇİ
Bull. Min. Res. Expl., Inst. Turkey, n°80, Ankara, 1973.
S = 1/14.000.000 36°- 41°30'N ; 25°30'- 40°E.G.
E = 20 mG±1
- Md 229 - "Regional vertical tectonics in the eastern Mediterranean" -
J.M.WOODSIDE, Geophys J. astr.Soc., 47, p.501, Dorking, U.K.,1976.
S = 1/7 400 000 30°-44°N ; 27°-37°E.G.
E = 20 mGal

EUROPE

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° Région incluse dans une carte plus générale.

Cartes Générales EUROPE

- Esp.1h - "Memoria gravimetrica española" (Portugal - España) - C.G.I. Paris
2-6 Sept. 74, Inst. Geogr. Cat., Madrid, 1974.
.Hoja provisional n°1
S = 1/1.000.000 40°- 43°30'N ; 9°30'- 2°30'W.G.
E = 5 mGal
.Hoja provisional n°1
S = 1/500.000 41°30'- 43°35'N ; 9°30'- 5°30'W.G.
E = 5 mGal

- Alpes 9 - "Nouvelles mesures de pesanteur dans les Alpes Centro-Orientales. Conséquences géologiques" (Autriche, Italie, Suisse) - Note A. GUILLAUME, C.R. Acad. Sci., Série D.2593, Paris, 1974.
 S = 1/1.800.000 46°- 47°26'N ; 9°15'- 12°15'E.G.
 E = 5 mGal

DANEMARK

- Dan.21 - "Gravity measurements in Central Jylland" - S. SAXOV, Geod. Inst. Skrifter 3, Raekke Bind XLIII, Mémoires Inst. Géod. Danemark, 3ème série, t.42, Copenhagen, 1976.
 12 cartes d'anomalies de Bouguer
 S = 1/100.000 55°23'- 55°05'N ; 8°03'- 10°50'E.G.
 E = 1 mGal

- Dan. - "Surface-ship gravity measurements in danish waters 1970-1975" - O.B. ANDERSEN & K. ENGSAGER, Mémoires Inst. Geod. Danemark, 3ème série, t.43, Copenhagen, 1977.
 S = 1/900.000 54°- 59°N ; 3°-16°E.G.
 E = 5 mGal

EIRE

- B.1078 - "Gravity anomaly map of Ireland" - Dublin Inst. Adv. Stud., 1975.
 S = 1/750.000 51°30'- 55°30'N ; 10°- 6°W.G.
 E = 5 mGal

- Irl.23 - "A geophysical interpretation of the structural development of the Kingscourt Graben" - D.G.G. YOUNG, Dublin Inst. Adv. Stud., Proc. Roy. Irish Acad., v.76, sect.B, n°3, p.46, Dublin, 1976.
 S 1/500.000 53°20'- 54°10'N ; 7°32'- 6°10'W.G.
 E = 1 mGal

ESPAGNE

Voir pub. Esp.1h citée p. I-44

- B.1081 - "A gravity study of the Serrania de la Ronda, Provincia Malaga, España" - J.D. ROBERTSON, Geol. Eng. Rep. 70-1, Princeton Univ., 1970.
 S = 1/500.000 36°- 37°10'N ; 6°30'- 2°30'W.G.
 E = 10 mGal

FRANCE

- BRGM - Voir tableau d'assemblage des cartes au 1/80.000 (p.I.77, Bull. Inf. BGI N° 33) et remplacer la partie sud-est par l'assemblage ci-dessous donnant les n° des cartes parues depuis 1973.

S = 1/80.000

E = 1 mGal

51 gr.

[164]

partie centre

| | | | | |
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- France 55 - "Contribution de la gravimétrie à l'étude de la Bretagne et du plateau continental adjacent" - J.C. SIBUET, Contr. n°94, Dept. Sc. COB, Brest, 1972.

S = 1/10.000.000

46°- 51°N ; 10°- 0°W.G.

E = 10 mGal

Anomalies de Bouguer sur terre, anomalies à l'air libre en mer.

- France 57 - "La carte gravimétrique de la France à l'échelle de 1/1.000.000" - R. BOLLO, A. GERARD, C. WEBER, BRGM, Orléans, 1975.

(Les coordonnées originales sont en grades).

S = 1/1.000.000 Feuille Nord : 46°10' - 51°N ; 6°W.G. - 8°E.G.

E = 1 mGal Feuille Sud : 42°- 46°10'N ; 2°W.G. - 8°E.G.

GRANDE-BRETAGNE

- 5 sheets : - "Bouguer gravity anomaly map (provisional edition)" - Inst. Geol. Sc., London.

S = 1/250.000

E = 1, 5 mGal

5 sheets, see below :

- B.1138 - Lands End, sheet 50°N - 06°W, 1975.
50°- 51°N ; 6°- 4°W.G.
- B.1139 - Anglesey, sheet 53°N - 06°W, 1976.
53°- 54°N ; 6°- 4°W.G.
- B.1145 - Great Glen, sheet 57°N - 06°W, 1976.
57°- 58°N ; 6°- 4°W.G.
- B.1151 - Lake District, sheet 54°N - 04°W, 1977.
54°- 55°N ; 4°- 2°W.G.
- B.1152 - Moray Buchan, sheet 57°N - 04°W, 1977.
57°- 58°N ; 4°- 2°W.G.

- G.B.32 - "The geological interpretation of a gravity survey of the English Lake District and the Vale of Eden" - M.H.P. BOTT, J. Geol. Soc., v.130, London, 1974.

S = 1/550.000

E = 1 mGal

54°05' - 54°50'N ; 3°30' - 2°30'W.G.

Additif :

GRANDE BRETAGNE p. I-46

1/250 000 series of the Institute of Geological Sciences

- CAITHNESS sheet 58°N-04°W, 1977 58°-59°N ; 4°-2°W.G.
- LIVERPOOL BAY sheet 53°N-04°W, 1977 53°-54°N ; 4°-2°W.G.

SUEDE

B.1076 - "Bouguer anomalies for the northern part of Sweden".- from : 38 maps of Sweden (scale 1/100.000) L. PETTERSSON, Rikets Allmänna Kartverk, Vällingby, 1974.

S = 1/2.000.000

65°- 69°N ; 17°- 25°E.G.

E = 10 mGal

Bouguer maps of whole Sweden in preparation, S = 1/250 000 - L.Pettersson, nov.77.

SUISSE

Inf.25.XI.77 "Carte des anomalies de Bouguer de la Suisse". - Commission Suisse de Géophysique, paraîtra en 1978.

S = 1/500 000

46°-47°20'N; 6°-10°E.G.

E = 15, 10 mGal

YUGOSLAVIE

B.1148 - "Gravimetric map of Montenegro Territory" - Bouguer anomalies from : Symposium on Mohorovicic's discontinuity, 1968, Zagreb, 1972.

S = 1/2.000.000

42°- 43°30'N ; 18°- 20°E.G.

E = 5 mGal

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| AUSTRALIE |
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B.883 C 1. Gravity Map of Australia, 1976. Bureau of Mineral Resources, Geology and Geophysics, Canberra (in colour)

S = 1/5.000.000
E = 5 mGal Bouguer (2.67 g cm^{-3}) onshore and 10 mGal free-air offshore $8^{\circ} - 40^{\circ}\text{S}$; $108^{\circ} - 160^{\circ}\text{E.G.}$

2. Gravity Map of Australia, 1976. In BMR Journal of Australian Geology and Geophysics 1 (1976), (in colour)

S = 1/25.000.000
E = 20 mGal Bouguer (2.67 g cm^{-3}) onshore and 20 mGal free-air offshore $8^{\circ} - 40^{\circ}\text{S}$; $108^{\circ} - 160^{\circ}\text{E.G.}$ (article includes Free-air Anomaly Map of Australia S = 1/25.000.000; E = 20 mGal; $8^{\circ} - 40^{\circ}\text{S}$; $108^{\circ} - 160^{\circ}\text{E.G.}$ in colour).

3. Australia - Bouguer Anomalies 1974 (4 sheets). Bureau of Mineral Resources, Geology and Geophysics, Canberra.

S = 1/2.534.400
E = 5 mGal (Bouguer density not standardised) $11^{\circ} - 40^{\circ}\text{S}$; $114^{\circ} - 153^{\circ}\text{E.G.}$

4. BMR Marine Geophysical Surveys 1970-73, Bouguer anomaly contours (8 sheets).

Bureau of Mineral Resources, Geology and Geophysics, Canberra.

S = 1/2.500.000
E = 10 mGal (2.2 g cm^{-3}) $0^{\circ} - 50^{\circ}\text{S}$; $105^{\circ} - 170^{\circ}\text{E.G.}$
(free-air anomaly maps also available)

5. Bouguer Gravity Anomaly Map - South Australia. Geological Survey, South Australia, Department of Mines, Adelaide (in colour)

S = 1/1.000.000
E = 5 mGal (Bouguer density not standardised) $26^{\circ} - 36^{\circ}\text{S}$; $129^{\circ} - 141^{\circ}\text{E.G.}$

6. Gravity Map Series. Bureau of Mineral Resources, Geology and Geophysics, Canberra.

Nearly all of the Australian continent and part of the north-west shelf is covered by 1/500.000 maps each covering 1.0° latitude by 1.5° longitude. Copies at 1/250.000 can be obtained. Remaining areas are covered by maps at other scales (1/1.000.000, 1/250.000, 1/253.440, 1/63,360)

Specification for standard series is:

S = 1/500.000
E = 1 or 5 mGal (Bouguer density not standardised) $9^{\circ} - 44^{\circ}\text{S}$; $112^{\circ} - 155^{\circ}\text{E.G.}$

Inf.L.C.NOAKES, Director BMR (10.XI.77)

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| NOUVELLE-ZELANDE |
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- "Gravity map of New-Zealand, 1/250.000, Dept. Sc. & Ind. Res., Wellington.

S = 1/250.000

E = 1 mGal

- | | | |
|--------|------------------------|--|
| N.Z.28 | - 8. Taupo, 1974 | 39°30' - 38°30'S ; 175°30' - 177°23'E.G. |
| N.Z.29 | -10. Wanganui, 1974 | 40°28' - 39°29'S ; 173°30' - 175°30'E.G. |
| N.Z.32 | -12. Wellington, 1974. | 41°42'47" - 40°28'42"S ; 176°37'56" - 174°31'46"E. |

The gravity contours depict the Bouguer anomaly field on a surface at 500 m above sea level.

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| REGIONS ANTARCTIQUES |
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- Arg.1q - "Isoanomalas de Bouguer, Isla Decepción, Antartida Argentina, campaña antarctica 1973-1974" - Nat. Rep. presented to IAG, Grenoble 1975, Buenos-Aires, 1975.

S = 1/45.000.

E = 2 mGal

63° - 62°55'S ; 60°45' - 60°30'W.G.

- Antarc.26 - "Gravity evidence for a major crustal fracture in eastern Antarctica" P. WELLMAN & R.J. TINGEY, B.M.R., J. Austr. Geol. Geophys., fig. 4, 1976.

S = 1/10.000.000

E = 20 mGal

75° - 67°S ; 62° - 74°E.G.

- voir aussi p.41 Chili 3.

- III -

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| CARTE GENERALE MARINE |
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- Md. - "Grandes zones d'anomalies de la pesanteur dans le Bassin Méditerranéen et ses bordures. Détails pour la région de Gibraltar" - p.31
S. CORON, Com. Int. Expl. Médit., Rap. v.22, fasc. 2a, 1973.
S = 1/2.335.000
E = 10 mGal (terre) 34°- 38°N ; 7°30' - 1°W.G.
20 mGal (mer)

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| OCEAN ATLANTIQUE |
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- B.1136 - "Bouguer gravity anomaly, d = 2,67" - G.K. WESTBROOK, Univ. Durham, 1974.
S = 1/2.000.000 10°- 17°N ; 65°- 57°W.G.
E = 10 mGal
published at a smaller scale in the following publication :
"Geophysical maps of the Eastern Caribbean" - P. KEARREY, G. PETER & G.K. WESTBROOK, J. Geol. Soc., v.131, London, 1975.
- voir aussi publication KRIVOVY, p.I-38.

- B.868 - "Bouguer gravity anomalies, Norwegian Sea" - S. PLAUMANN, Meteor Forsch., Reihe C, 1974.
 S = 1/1.200.000 65°- 68°N ; 7°- 10°E.G.
 E = 20 mGal
- Ant.6 - "Gravity and seismic reflection investigations into the crustal structure of the Aves Ridge, Eastern Caribbean" - P. KEARY, Geophys. J. R. Astr. Soc., v.38, fig. 5, Dorking, U.K., 1974.
 S 1/2.000.000 13°- 16°N ; 65°- 61°W.G.
 E = 10 mGal
- Md.204 - "Surface-ship gravity measurements in the North Atlantic Ocean 1965 and 1968" - O.B. ANDERSEN, Geod. Inst., Skrifter 3, Raekke, Bind 41, Copenhagen, 1975.
 S = 1/5.000.000 58°- 67°50'N ; 49°W - 8°E.G.
 E = individual value
- Can.1q' - Ministère de l'Environnement, Service Hydrographique du Canada, Ottawa, cartes publiées entre le 1er juillet 1975 et le 1er juillet 1977 comportant des isanomales de Bouguer.
 S = 1/250.000

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| N° 18602 | 50°-51°N ; 54°- 52°W.G. |
| N° 15090 | 49°- 50°N ; 52°- 50°W.G. |
| N° 14998 | 49°- 50°N ; 50°- 48°W.G. |
| N° 14994... | 49°- 50°N ; 46°- 44°W.G. |
| N° 15080 | 48°- 49°N ; 52°- 50°W.G. |
| N° 14988 | 48°- 49°N ; 50°- 48°W.G. |
| N° 14986 | 48°- 49°N ; 48°- 46°W.G. |
| N° 15072 | 47°- 48°N ; 54°- 52°W.G. |
| N° 15070 | 47°- 48°N ; 52°- 50°W.G. |
| N° 14978 | 47°- 48°N ; 50°- 48°W.G. |
| N° 14976 | 47°- 48°N ; 48°- 46°W.G. |
|N° 14996 | 49°- 50°N ; 42°- 46°W.G. |
- Mg.72 - "The results of the gravity survey in the 10th cruise of the R/V Academic Kurchatov (1971)" - A.G. GAINANOV, E.D. KORYAKIN & V.L. PANTELEEV, études grav. en mer, recueil d'articles n°8, p.128, Moscou, 1975.
 S 1/126.000.000 60°- 73°N ; 30°W.G. - 15°E.G.
 E = 20 mGal
 p.130, détail au nord de Jan Mayen
 S = 1/1.200.000 71°N ; 8°W.G.
 E = 10 mGal
- Mg.72 - "Moho discontinuity relief and Earth's crust thickness within the Bering Sea from gravity data" - Y.A. PAVLOV & P.A. STROEV, études grav. en mer, recueil d'articles n°8, p.162, Moscou, 1975.
 S = 1/22.000.000 48°- 68°N ; 162°- 150°W.G.
 E = 50 mGal

- mesures côtières :
- Dan. - cf. p.I-45 , Côtes du Danemark
- B.1139 - cf. p.I-46 , Côtes de Grande-Bretagne
- Md.228 - cf. p.I-38 , Golfe du Mexique
- B.1133 - cf. p.I-34 , Côtes Atlantique de l'Afrique
Mer des Antilles

ILES de l'OCEAN ATLANTIQUE

Petites Antilles

- B.1022.... - "Gravity and magnetic survey of the Lesser Antilles"
Overseas Geol. Surv., London, 1963-1964.
S = 1/100.000 - 1/200.000
E = 1 or 5 mGal

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|--------|------------------|--------------------------------------|
| B.1028 | Antigua | 17°- 17°10'N ; 61°55'- 61°40'W.G. |
| B.1029 | La Guadeloupe | 15°55'- 16°30'N ; 61°50'- 61°10'W.G. |
| B.1030 | Grenada | 12°- 12°15'N ; 61°50'- 61°35'W.G. |
| B.1022 | Santa Lucia | 13°40'- 14°05'N ; 61°05'- 60°50'W.G. |
| B.1023 | La Martinique | 14°25'- 14°55'N ; 60°50'- 60°40'W.G. |
| B.1024 | La Dominique | 15°10'- 15°40'N ; 61°30'- 61°15'W.G. |
| B.1025 | La Barbade | 13°- 13°20'N ; 59°40'- 59°25'W.G. |
| B.1026 | St Kitts & Nevis | 17°05'- 17°25'N ; 62°55'- 62°30'W.G. |
| B.1027 | St Vincent | 13°- 13°25'N ; 61°20'- 61°05'W.G. |

- B.G.I. - "Etudes gravimétriques en Guadeloupe et dans les îles de son archipel" - S. CORON, M. FEUILLARD & J.M. LUBART, IPG, Univ. Pierre et Marie Curie, Ann. Geophys., t.31, fasc.4, Ed. CNRS, Paris, 1975.
- p.537 : La Guadeloupe, la Désirade, Marie-Galante, Iles des Saintes
S = 1/420.000 env. 15°30'- 16°30'N ; 61°50'- 61°W.G.
E = 1 mGal d = 2,67
- p.545, fig.12 : St Martin 18°05'N ; 63°05'W.G. d = 2,67
fig.13 : St Barthélémy 17°55'N ; 62°50'W.G. d = 2,67
S = 1/150.000
E = 1 mGal
- p.544, fig.9 : Marie-Galante 15°55'N ; 61°15'W.G. d = 2,4

La Jamaïque

- Ant.15 - "Gravity surveys in Jamaica" - E.M. ANDREW, Inst. Geol. Sc.,
Geophys. Rep. N° GP/O/40, London, 1969.
S = 1/250.000 17°45'- 18°30'N ; 78°15'- 76°15'W.G.
E = 5 mGal

OCEAN INDIEN

- Md.191 - "Origin of the Ninety East Ridge from studies near the Equator" -
C. BOWIN, J. Geophys. Res., v.78, n°26, 1973.
S \approx 1/10.000.000 6°S - 0° ; 85°- 93°E.G.
E = 25 mGal
- B.1133 - Canal du Mozambique, cf. p.I - 34.
- B.883c - Côtes de l'Australie, cf. p. I - 47.

ILES de l'OCEAN INDIEN

- B.1141 - Comores
B.1143 - La Réunion
B.1143 - Maurice
B.1141 - Madagascar
- } Voir p. I - 36.

Expéditions Polaires Françaises, G. ROUILLON : Terres Australes
Françaises. Publication prévue fin 1978, Paris.

- B.1072 - Archipel Crozet : Ile de la Possession } T.A.A.F.
B.1073 - Iles Kerguelen }

OCEAN PACIFIQUE

- Md.206 - "Gravity anomalies seaward of deep-sea trenches and their tectonic
implications" - A.B. WATTS & M. TALWANI, Geophys. J. Roy. Astr. Soc.
v.36, n°1, Dorking, U.K., 1974.
S = 1/89.000.000 0°- 60°N ; 110°- 140°E.G.
E = 5 mGal
- Austr.22 - "A structural analysis of the Gulf of Papua and northwest Coral Sea
region" - J.C. MUTTER, Plate 7, Rep. 179, B.M.R., Canberra, 1975.
S = 1/3.500.000 14°- 8°S ; 144°- 151°E.G.
E = 10 mGal
- I.Pacif.16 "Methods of analysis and comparison of geophysical data on a plane,
with specific application to the Solomon Islands area" - M.A. KHAN
& G.P. WOOLLARD, Hawaii Inst. Geophys., HIF 68-17, Univ. Hawaii, 1968
S = 1/8.500.000 15°- 5°S ; 150°- 170°E.G.
E = 50 mGal
- Can.1 q' - voir p. I-51, bibliographie de la carte suivante:
n° 157 83 48°-49°N ; 125°07 - 122°39 W.G.

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| Groupe d'ILES du PACIFIQUE |
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- B.1059 - "Hawaiian Archipelago and Johnston Island" - G.P. WOOLLARD, Hawaii Inst. Geophys., 1965.
(Johnston and Sand Isl., Sand & Eastern Isl., Pearl & Hermes Reef, Lisianski Isl., Laysan Isl., Nihoa Isl.).
S = 1/21.000... 1/44.000 16°- 29°N ; 180°- 170°W.G.
E = 2 or 5 mGal
- B.1060 - "Hawaiian Islands" - Hawaii Inst. Geophys., 1963 to 1965
(Oahu, Maui, Lanai, Niihau, Kauai, Molokai, Kaholawe).
S = 1/63.360 18°30'- 22°N ; 165°- 150°W.G.
E = 10 mGal
(Hawaii north and south) S = 1/126 720, E = 10mGal, 19°N; 155°W.G.
- Pacif.17 - "The New Hebrides Islands gravity network" - A. MALAHOFF & G.P. WOOLLARD, Part I, Final Rep., Hawaii Inst. Geophys. 69-14, 196
S = 1/5.000.000 20°- 13°S ; 166°- 170°E.G.
E = 10 mGal
- B.1043 - "Southeast Pacific Islands" - Hawaii Inst. Geophys., 1968.
(Gilbert I, Truk I, Marshall I, Guam I, Fiji I, Ellice I-
S = various scales 13°45'N - 19°S ; 144°30' - 180°E.G.
E = individual values
- B.1052 - "Preliminary report. Bonin Islands land gravity survey" - U.S. Army Map Service, Far East, 1965.
(9 ilots de l'Archipel Ogasawara).
S = 1/50.000 24°- 28°N ; 141°- 143°E.G.
E = individual values
- B.1057 - "Bismarck Archipelago ; Bouguer anomaly map ; d = 2,67" - Compilation of Hawaii Inst. Geophys., 1965.
S = 1/1.000.000 7°- 1°S ; 146°- 154°E.G.
E = 10 mGal
- B.1055 - "New Caledonia, Bouguer anomaly map ; d = 2,67".
Hawaii Inst. Geophys., 1965.
S = 1/500.000 23°- 20°S ; 163°30' - 168°30'E.G.
E = 10 mGal

B.1054 - "Solomon Islands ; Bouguer anomaly map ; d = 2,67.
 Hawaii Inst. Geophys., 1965.
 S = 1/1.000.000 12°- 4°S ; 153°- 164°E.G.
 E = 20 mGal 11°- 10°S ; 165°30' - 166°30'E.G.

B.M.R. - "Map of Bouguer anomalies, New Guinea" - B.M.R., Canberra, Australia
 S = 1/500.000
 E = 1 à 5 mGal

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| | 142°30' | | 147°E.G. |
| 3°S | B.1006 Wewak 1969 | B.993 Sepik 1969 | |
| 4°S | B.883 Ambunti 1969 | B.894 Bogia 1969 | B.1016 Karkar Isl. 1969 |
| 5°S | B.1001 Wabag 1969 | B.989 Ramy 1969 | B.965 Madang 1969 |
| 6°S | | | |

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|------|-------------------------|------------------------|----------|
| | 141° | | 144°E.G. |
| 9°S | B.1013 Boigu 1968 | B.1015 Daru 1968 | |
| 10°S | | | |

MERS INTERIEURES

Mer Baltique

- cf. Danemark p.I - 45.

Mer Méditerranée

Md.229 - Eastern Mediterranean. Voir p.I - 44.

Mer Noire

Md.229 - cf. p.I - 44.

Md.189 - "Structure of the crust and upper mantle of the Black and Caspian Seas" - Y.P. NEPROCHNOV, I.P. KOSMINSKAYA, Y.P. MALOVITSKY, Tectonophys., v.10, Amsterdam, 1970.
S = 1/15.000.000 40°- 48°N ; 28°- 42°E.G.

LISTE des PUBLICATIONS
reçues au
BUREAU GRAVIMETRIQUE INTERNATIONAL
(Janvier à Mai 1977)

CONCERNANT LES QUESTIONS DE PESANTEUR

LISTE DES PUBLICATIONS

- * 330 - POLSKA AKADEMIA NAUK, KOMITET GEODEZJI - Geodezja i Kartografia, t. XXV, Z. 3, Warszawa, 1976.

- a) BARLIK M. - "Determination of the real vertical deflections in mountain areas".
p. 156-168.

This paper deals with an analysis of the methods of determination of real vertical deflections in mountain areas. There is also analyzed the application of the free-air anomalies to that methods. As it follows the reduction R_{ME} defined by the formula (2.4) fulfills in the best the assumptions of Stokes' theory for the case of existing of the vertical fault of terrain near the gravity station. This reduction is applied to modeling of the field of anomalies and to calculations of real vertical deflections in Polish Tatra Mountains.

- b) DOBACZEWSKA W. - "Considérations sur la connaissance du géoïde et son application aux travaux modernes".
p. 207-211.

- c) DOBACZEWSKA - "Les constantes géodésiques fondamentales. Résultats des travaux du Groupe d'Etudes nommé par le Comité Exécutif de l'A.I.G. en 1974 à Paris".
p. 219-220.

- 331 - MATHER R.S., S. COLEMAN & O.L. COLOMBO - "On the recovery of long wave features of sea surface topography from satellite altimetry".
from : UNISURV G, N° 24, p. 21-46, Univ. N.S.W., Sydney, 1976.

The primary objective of determinations of sea surface topography in the first instance, is the establishment of long wave features with confidence. A secondary and no less important goal is the unification of the regional levelling datums in the context of the datum level surface - the geoid. The data available for this task consists of that which is deduced from satellite altimetry on the one hand, and surface gravity measurements on the other. Relations between this input data and quasi-stationary sea surface topography have already been derived. The actual procedure which is likely to give the best results is still very much the subject of debate, being a function of the distribution and precision of each type of input data.

It is shown that a procedure suggested previously for the recovery of quasi-stationary sea surface topography from satellite altimetry requires revision as the kernel function of the alternate form of Stokes' function inhibits successful numerical evaluation. Alternative approaches to the solution of the geodetic boundary value problem are considered and it is proved that they are not mutually exclusive when appropriately inter-related. The choice of one development over another is made on the basis of convenience in relation to the nature of the input data rather than any other factor. Iterative cycling between different solutions of

* Les numéros font suite à ceux indiqués dans le Bull. Inf. N° 40, Mai 1977.

the geodetic boundary value problem cannot improve the quality of the determination without the introduction of fresh data of acceptable quality from another source.

The use of satellite altimetry data in the presence of plausible error patterns, to improve the gravity model used in orbit analysis can only provide model improvements with a precision equal in magnitude to the sea surface topography. Gravity model improvements beyond this level (currently estimated at 1-2 kGal m) would have to be based on :

a) the analysis of observations to satellites at the ± 10 cm level from a global network of tracking stations and/or

b) a global distribution of surface gravity measured at points of known "elevation" under conditions which ensured that errors in the gravity anomaly with wavelengths greater than or equal to those sought in the sea surface topography were controlled at the ± 30 μ Gal level.

Noting that option b) is unlikely to be realised in the foreseeable future, it has to be concluded that no basis exists for the extraction of sea surface topography from satellite altimetry in the absence of one of these options. The unification of the world's geodetic levelling datums in the context of the datum level surface cannot be achieved on a reliable basis without gravity observations of adequate precision on land. Factors which could influence the choice of a method for solution are outlined.

- 332 - BRETREGER K. & R.S. MATHER - "On the modelling of the deformation of tidal gravity by ocean loading".
UNISURV G, N° 24, p. 71-80, Univ. N.S.W., Sydney, 1976.

Variations of gravity due to the effect of ocean tides have been calculated at various sites in Australia using two different models of the M_2 constituent of the global ocean tide. The computations are based on two different approaches. In the first, the ocean loading effect of the M_2 tide is computed using load deformation coefficients. In the second, outer zone contributions to the ocean tidal load are computed using truncation functions. An alternate method to the load deformation coefficient approach is discussed on the basis of these results.

- 333 - MATHER R.S. - "Some possibilities for recovering oceanographic information from the SEASAT missions".
UNISURV G, N° 24, p. 103-122, Univ. N.S.W., Sydney, 1976.

The basic types of data to be collected during the SEASAT-A and other proposed SEASAT oceanographic satellite missions are summarized. The derivations of the basic relations which are expected to prevail between the non-gravitational forces and the resulting pressure gradients, velocity and force fields, and the quasi-stationary sea surface topography at the air/sea interface, are reviewed on the basis of Newtonian concepts.

Some likely data limitations are discussed in the context of these basic relations. Assuming that stationary sea surface topography is successfully recovered from the altimeter and tracking data, it would appear that, subject to certain qualifications, a basis may exist for quantifying the forces of atmospheric origin which affect the geometry of the air/sea interface. The successful downward continuation of remote sensed data at satellite altitudes which can be related to winds and temperature at the air/sea interface, calls for adequate calibrations based on a wide variety of conditions using simultaneously recorded surface ship data.

If the above goals are achieved, the residual non-gravitational effects would have oceanic origins. Further quantitative analysis of this data would have to be in conjunction with relevant sub-surface temperature, current and/or salinity measurements in the oceans and data recorded by pressure sensors on the ocean floor.

- 334 - COLEMAN R. & R.S. MATHER - "Computational procedures for the use of the inverse of Stokes' operator".
UNISURV G, N° 24, p. 123-139, Univ. N.S.W., Sydney, 1976.

The primary objective in determinations of sea surface topography in the first instance, is the establishment of long wave features with an acceptable resolution. Computational procedures are investigated for the recovery of long wave features in the gravity anomaly using the inverse of Stokes' operator, together with the characteristics of the kernel function on surface integration, with the aim of determining an annular sub-division for successful quadratures evaluation. The linearity of the kernel function and the expected strength of signal are analysed for different models of the nature of the input data. A ring structure compatible with the nature of the input data is suggested for practical evaluations. Near zone error accumulation patterns in quadratures solutions are studied and a truncation function representation is discussed.

- 335 - SCHWARZ K.P. - "Geodetic accuracies obtainable from measurements of first and second order gravitational gradients".
AFGL-TR-76-0189, The Ohio State Univ., Sci. Rep. N° 4, 56 p, Hanscom AFB, 1976.

The accuracy of an airborne accelerometer-gradiometer system is studied for geodetic applications. A detailed analysis of interpolation, downward continuation and mean value determination is given using the method of least-squares collocation. The influence of measuring errors is considered and the effects are contribution of accurate satellite altimetry to a combined accelerometer-gradiometer system is taken into account.

The results of this study show that a system of this kind can significantly contribute to our knowledge of the anomalous gravity field if second-order gravitational gradients can be measured with an accuracy of a few Eötvös.

- 336 - RUBINCAM D.P. - "Tidal parameters derived from the perturbations in the orbital inclinations of the BE-C, GEOS-I, and GEOS-II satellites".
GSFC, X-921-76-72, 98 p, Greenbelt, 1976.

The tidal perturbations in the orbital inclinations of the BE-C, GEOS-I and GEOS-II satellites are analyzed. Effective tidal Love numbers and phase angles for the O_1 , K_1 , M_2 , K_2 , P_1 , and S_2 tides are recovered.

The effective tidal phase angles tend to be on the order of a few degrees. The effective tidal Love numbers are generally less than the solid earth Love number K_2 of about 0.30. This supports the contention of LAMBECK et al. (1974) that the ocean tides give an apparent depression of the solid earth Love number. Ocean tide amplitudes and phases are calculated for the

above tides assuming $K_2 = 0.30$ and the solid earth lag angle $\delta_2 = 0$. The results show good agreement with FELSENTRAGEN et al. (1976) on GEOS-I but not on GEOS-II. The M_2 effective Love number and phase angle are poorly determined, but give a lunar acceleration of $- 29 \pm 15$ arc sec/(100 yr)², an energy dissipation of $- 3.6 \pm 1.8 \times 10^{19}$ erg/sec, and a tidal function time scale of 1.4×10^9 yr when averaged over all three satellites. This is in fair agreement with current estimates.

- 337 - WAGNER C.A. - "The accuracy of Goddard Earth Models".
GSFC, X-921-76-187, 222 p, Greenbelt, 1976.

Extensive tests of Goddard geopotential models have been made with observations not used in the solutions. These tests show the accuracy of the satellite derived model (GEM 7, with 400 coefficients) to be about 4.3 m (rms) with respect to the computation of the global geoid surface. The formal precision of this solution is 0.7 m. The corresponding accuracy of the combined satellite surface gravimetry model (GEM 8, with 706 coefficients) is found to be 3.9 m (rms).

Independent observations used in this assessment include : 125 lumped coefficients from 35 resonant orbits of 1 and 9 through 15 revolutions per day, two sets of (8,8) fields derived from optical - only and laser - only data, sets of zonal and resonant coefficients derived from largely independent sources and geoid undulations measured by satellite altimetry. In addition, the accuracy of GEM 7 has been judged by the gravimetry in GEM 8. The ratio of estimated to formal error in GEM 7 and 8 ranges from 2 to 5 in these tests.

- 338 - MORITZ H. - "Lecture notes on kinematical geodesy".
from : Boll. Geod. Sc. Affini, Firenze, Anno XXXIV, N° 2, p. 145-160, 1975.

Kinematical geodesy deals with theoretical aspects of the measurements of gravitational gradients in moving systems such as airplanes and with the geodetic use of such quantities. The possibility of separating genuine gravitational effects from inertial disturbances is discussed using classical mechanics and general relativity. It turns out that this is directly possible in second-order gradients and indirectly, by combining gradiometer and accelerometer (gravimeter) measurements, also in first-order gradients ; this puts aerial gravimetry on a rigorous basis. For the geodetic use of gradients the method of least-squares collocation is outlined.

- 339 - MORITZ H. - "Introduction to Molodensky's theory".
from : Boll. Geod. Sc. Affini, Firenze, Anno XXXIV, N° 2, p. 161-172, 1975.

- 340 - MORITZ H. - "Integral formulas and collocation".
from : Manuscripta Geodaetica, v.1, p. 1-40, 1976.

The report deals with various theoretical and numerical aspects of the interplay between least-squares collocation and classical integral formulas.

It is proved that geodetic integral formulas may be considered as limiting cases of collocation for homogeneous and regularly and densely distributed data. Collocation methods can be employed for adjusting continuous data and combining them with other measurements, before using them with integral formulas.

With respect to numerical computation, integral formulas and collocation techniques mutually complement each other, so that in many practical cases a judicious combination of the two procedures may be practically most convenient.

- 341 - WOODSIDE J.M. - "Regional vertical tectonics in the Eastern Mediterranean". from : Geophys. J. R. Astr. Soc., n° 47, p. 493-514, 1976.

New gravity observations from a systematic survey of the Eastern Mediterranean Sea and from a reconnaissance land survey in Central and Western Turkey have been compiled with existing data. (Regional free anomaly map and Bouguer anomaly map). Lack of sufficient geological and geophysical information precludes an analysis of the local anomalies or crustal structure ; however, implications of the topography and gravity field at long wavelengths have been examined.

Negative free-air anomalies characterize almost the entire Eastern Mediterranean basin and positive anomalies predominate in Turkey and the Aegean Sea. The change in sign coincides with the northern boundary of the African plate, and the wavelength and amplitude of the gravity variation are of the order of 1000 km and 100 mGal respectively. The lithosphere is probably unable to support such anomalies because the implied shear stresses are too large. The source of the anomalies is concluded to be in the asthenosphere where the low finite strength of material suggests that some sort of flow must exist to maintain the stresses. A good correlation is observed between the gravity and topography at wavelengths greater than 300 km ; and the relationship is the same as that observed in the North Atlantic and the Central Pacific, as well as that computed for simple models of mantle convection. The gravity and topography of the Eastern Mediterranean can be explained in terms of flow in the upper mantle. This is the first region of subsidence for which this interpretation has been made.

- 342 - BUREAU of MINERAL RESOURCES - Journal of Australian Geology & Geophysics, v. 1, N° 3, p. 175-259, Canberra, 1976.

CENTRE NATIONAL pour l'EXPLOITATION des OCEANS - Bulletin d'Information

- 343 - N° 95, 19 p, Paris, Nov. 1976.

- 344 - N° 96, 26 p, Paris, Dec. 1976.

- 345 - GEMAEL C. & I. HIBLER - "Efeito da astração luni-solar sobre as medidas gravimétricas". Bol. Univ. Federal do Paraná, Geod. N° 19, 35 p, 1976.

Three diagrams (for latitudes 5°N, 15°S and 35°S) giving the corrections for the vertical component of the tidal force for the year 1976 are presented. The argument of the functions is the mean local hour and the unit used is $\text{gal} \times 10^{-5}$.

- 346 - VOLKOF V.A., SIMON, P., VARGA, D.G.G., GRIDNIEF, G.Y., DITTFELD & L. SKALSKY - "Instructions méthodiques pour les observations de marées avec les gravimètres".
Bureau de Géodésie, Topographie et Cartographie de Prague, Ser. 6, 114 p, Prague, 1976 (texte russe).

- 1 - Appareil pour l'enregistrement des variations de marées de la pesanteur.
- 2 - Stations d'observation des marées.
- 3 - Préparation des appareils pour les observations. Détermination des constantes.
- 4 - Le service d'une station.
- 5 - Travail préliminaire
- 6 - Conclusion.

- Appendix N° 1 - Le système d'enregistrement galvanométrique
N° 2 - Détermination de phases caractéristiques des systèmes de mesures de marées
N° 3 - Schéma de la méthode pour les mesures avec le gravimètre (thermographe à résistance).
N° 4 - L'enregistreur CKG-M
N° 5 - Dispositif utilisé pour le réchauffement permanent du thermostat intérieur du gravimètre
N° 6 - Dispositif de la mesure
N° 7a... 9c - Dispositif des appareils en différentes stations.
N° 10 - Amplitude calculée et phase de réaction du gravimètre pour une variation artificielle de température.
N° 11.. 13 - Exemples des résultats obtenus.

- 347 - GEOFYZIKALNI USTAV CESKOSLOVENSKE, AKADEMIE VED - Numerische methoden in der Geophysik.

Kommission der Akademien für die multilaterale Bearbeitung des Komplexen problems, Planetare Geophysikalische Forschungen (KAPG) 5.2, 283 p, Praha, 1976.

- a) GEORIEV X. - "Algorithme de minimisation des fonctions dans la résolution du problème interne de la gravimétrie".
p. 25-28 (texte russe).
- b) BURDA M. & V. VYSKOCIL - The gravitational effect of three-dimensional density models of the Earth's crust".
Compte-Rendu, p. 61-63.
(see integral text N° 348 (b)).
- c) PICK M. - "Generalization of definition of gravity anomaly".
p. 267-282.

- 348 - Studia Geophysica et Geodaetica, t. 20, N° 3,
Geophysical Institute of the Czechoslovak Academy of Sciences, Praha, 1976.

- a) KUBACKOVA L. - "The fundamental statistical properties of the Vening-Meinesz and Stokes integral transformations".
p. 209-212.

The stochastic properties of the vector function, formed by the components ξ and η of the deflection of the vertical and by the height of the geoid ζ , are studied by utilizing the mathematical model in (4). The properties of the error components of the said vector are also studied and a method is described for comparing the results when the vector function was obtained directly by means of astro-geodetic methods and when the vector function was generated by the Vening Meinesz and Stokes transformation.

- b) VYSKOCIL V. & M. BURDA - "On the computation of the gravitational effect of three-dimensional density models of the Earth's crust".
p. 213-218.

This paper deals with the methods of computing three-dimensional density models of the Earth's crust. Formulae for the numerical computation are given and the individual procedures are evaluated from a numerical point of view.

- 349 - DIVIS K. & V. TOBYAS - "The effect of the magnetic field on the accuracy of measurements with Worden and Sharpe gravimeters".
Geophys. Inst. Czechosl. Acad. Sci., Studia Geophys. & Geod., T. 20,
N° 4, p. 338-345, Praha, 1976.

The effect of an additional homogeneous magnetic field with an intensity of 0 - 4.5 Oe on the Worden quartz gravity meter N° 961 and on Sharpe quartz gravity meters N° 173 and 174 was tested. Whereas no effect was observed with the Worden gravity meter, the magnetic field had a measurable effect on both the Sharpe gravity meters. The largest deviation of the reading beam is caused by the horizontal component of the magnetic field which acts in the plane of oscillation of the gravity-meter arm. The Sharpe gravity meter N° 173 is considerably sensitive; a field of 0.2 Oe intensity, corresponding to the magnitude of the horizontal component of the geomagnetic field in mid-latitudes, causes an error in the measurement of gravity of as much as 0.08 mGal. With a view to the different behaviours of the individual quartz gravity meters of the same type in a magnetic field, it should prove expedient to carry out check measurements with all gravity meters and, with regard to the sensitivity of the gravity meter to the magnetic field and the required accuracy of the gravity determination, take into account this perturbing factor in field measurements, as well as laboratory tests of gravity meters.

- 350 - KIENLE J. - "Gravity and magnetic measurements over Bowers Ridge and Shirshov Ridge, Bering Sea".
J. Geophys. Res., v. 76, N° 29, p. 7138-7153, 1971.

Bowers ridge, which is submerged in the deep-water part of the Bering Sea, has the geophysical and structural characteristics of an island arc-trench system. Three crustal structure sections of the strongly curved aseismic Bowers ridge based on seismic, magnetic, and gravity data, indicate that Bowers ridge is a volcanic ridge characterized by large-amplitude, short-wavelength magnetic anomalies and bordered on its convex side by a sediment-filled trench. Positive gravity anomalies greater than 200 mGal are associated with Bowers ridge; negative anomalies with amplitudes greater than 100 mGal are associated with the bordering trench.

The geophysical and structural characteristics of the linear, also entirely submerged, Shirshov ridge in the Bering Sea differ significantly from the characteristics of Bowers ridge. Over Shirshov ridge the gravity anomalies are of small amplitude and there is no geophysical evidence of a buried trench. A straight NE-SW trending chain of elongated seamounts, possibly located on an old transform fault zone, connects Bowers ridge and Shirshov ridge and may indicate the direction of late Mesozoic-earliest Tertiary subduction from the northeast, which would have led to the construction of the Bowers arc-trench system.

- 351 - MATHER R.S. - "Gravimetric investigations on the North American datum, (1972 - 1973)".
GSFC X921-75-244, 88 p, Greenbelt, 1975.

All the available unclassified gravity data on the North American Datum (NAD) and in the surrounding oceans was assembled late in 1972 for the investigation of the gravity field in North America and its relation to North American Datum 1927 (NAD 27). The gravity data in Canada and the United States was compiled on a common datum compatible with the International Gravity Standardization Network 1971 (IGSN 71). The variation in the error of representation in the region is studied. Attempts are also made to study the correlation characteristics of gravity anomalies with elevation.

A free-air geoid (FAG 73) was computed from a combination of surface gravity data and Goddard Earth Model (GEM) 4 and this was used as the basis for the computation of the non-Stokesian contributions to the height anomaly. These non-Stokesian contributions as computed from the data sets available at present are found to occur with amplitudes less than 3 m and with short wavelength in the Rocky Mountains region. The resulting effects on determinations of the geocentric orientation parameters (geocentric datum shift) for NAD 27 are not found to be of significance at the 3D cm level.

The geocentric orientation parameters obtained by this astro-gravimetric method are compared with those obtained by satellite techniques. The differences are found to be no greater than those between individual satellite solutions. The differences between the astro-gravimetric solution and satellite solutions GSFC 73 and GEM 6 are studied in detail with a view to obtaining a better understanding of these discrepancies.

- 352 - OLIVIER R. - "Elaboration d'un système de traitement gravimétrique géré par l'ordinateur".
Univ. Genève, Fac. Sci., Dept. Minéralogie & Geophys.,
Texte condensé de la thèse N° 1606, 56 p, 1974.

- 353 - GRUSHINSKIJ N.P. & P.A. STROJEV - "Die Antarktis ist ein zerklüfteter Kontinent".
UMSCHAU Wissens. & Tech. 75, H. 20, S.638-640, 1975.

Die im Titel gemachte Aussage bezieht sich auf die feste Erdoberfläche unter dem antarktischen Eisschild, der stellenweise eine Dicke von über 4000 m aufweist. Mit zu den wichtigsten Aufgaben in der Antarktis gehört die Erforschung des Bodenreliefs des Kontinents, der bis auf wenige Stellen vollkommen von einem dicken Eispanzer bedeckt ist. Weitere wichtige Fragen,

die intensiv untersucht werden, betreffen die geologische Struktur und die Struktur der Erdkruste unter dem antarktischen Kontinent. Hier haben sowjetische Forscher in den letzten Jahren interessante neue Resultate erzielt.

- 354 - GEOGRAPHICAL SURVEY INSTITUTE - "Establishment of the Japan gravity standardization Net 1975".
J. Geod. Soc. Japan, v. 22, N° 2, p. 65-76, 1976.

A new gravimetric network, named the Japan Gravity Standardization Net 1975 (JGSN 75), was established and new gravity values were determined on the basis of the International Gravity Standardization Net 1971 (IGSN 71).

A reliable gravimetric net has been organized in Japan by combining results of the GSI pendulum and gravimeter measurements by the Geographical Survey Institute and gravity values were determined in the Potsdam system referring to the value at the old pendulum station in Tokyo. The IGSN 71 published in 1974 contains 16 common stations with the national net. If the old reference value in Tokyo has no error, a discrepancy in gravity values at every common station must be equal to -14.0 milligals; a correction to the Potsdam absolute value. The present comparison showed that the discrepancy took mostly a constant value within a range of $+0.06$ milligals. The mean value and the standard deviation were -13.80 ± 0.03 milligals for the most districts and -14.00 ± 0.03 milligals for the Kyūshū District. No systematic inclination against the gravity value was found. This means that the scale of the Japanese gravimetric net agrees well with that of the IGSN 71. Therefore, the gravity value hitherto adopted in Japan can be converted into new one based on the IGSN 71 only by adding a constant value.

New gravity values were obtained for 122 stations throughout the country and are given in this report. These are the results of repeated measurements including many new ones with LaCoste & Romberg gravimeters of which calibration constant values were corrected with our pendulum or the IGSN 71 results. A relative accuracy in this net is considered to be $+0.035$ milligals and an absolute accuracy is the same as that of the IGSN 71.

The JGSN 75 will serve as the framework of the gravimetric net in the country and should be used for all gravity works. The old Potsdam system values in Japan should be changed into new ones based on the JGSN 75.

Diagrams of these stations are given in the following publication N° 355.

- 355 - SUZUKI H. - "The International Gravity Standardization Net 1971 and the Japan Gravity Standardization Net 1975".
J. Geod. Soc. Japan, N° 2, p. 112-129, 1976.

IGSN 71 gravity stations and values in Japan.

Diagrams of 122 stations concerning new gravity measurements.

- 356 - SYTCHEF P.M. - "Anomalies du champ de pesanteur des mers d'Extrême Orient et de la partie attenante de l'Océan Pacifique".
Acad. Sci. USSR, Inst. Rech. Sci. du Complexe de Sakaline, 107 p, 1974.

GAINANOV A.G., Y.A. PAVLOF, P.A. STROEIEV & I.K. TOUESOF ont écrit différents articles dans les chapitres suivants :

- Généralités sur les recherches entreprises,
- Recherche gravimétrique et méthode d'interpolation,
- Anomalies de la pesanteur et leurs liaisons avec la structure profonde de la région,
- Etat isostatique de la croûte terrestre de la région,
- Structure profonde de la région d'après les données gravimétriques.

ACADEMIE des SCIENCES U.R.S.S. - Références bibliographiques : Géodésie et Astronomie, Série 52.

357 - N° 10, 49 p, Moscou, 1976.

358 - N° 11, 58 p, Moscou, 1976.

359 - FAJKIEWICZ Z., W. DUDA & J. SLIZ - "Measurement of vertical gradient of gravity in prospecting shallow-seated geological structures and in examination for rock massif structure".
Prz. Geolog. N° 2, p. 101-106, Warszawa, 1972.

The paper deals with the results of the first measurements of vertical gradient of gravity, made to discover and to research in detail the structure of the shallow-seated small tectonic forms, erosional phenomena and anthropogeneous traces. The results obtained are due to the newly constructed mobile and separable measuring rig. It allow us to carry on gravimetric measurements at two points situated above each other at a distance of 3 meters, irrespective of both atmospheric and morphological conditions. The error of these measurements ranges from ± 3.5 to ± 5.0 E.

360 - SAS A. - "Laboratory examination and calibration of narrow-range Sharpe and GAK-7T gravimeters".
Informator, Inst. Geod. i Kartog., t. XVIII, N° 5, p. 18-30, Warszawa, 1973.
(polish text).

361 - WILCOX L.E., W.J. ROTHERMEL & J.T. VOSS - "The Bouguer gravity anomaly map of Asia".
Paper presented at the Annual Meeting of the American Geophysical Union, Washington, D.C., April 1972, USAF, ACIC, 16 p, St-Louis, 1972.

- Some methods for obtaining $1^\circ \times 1^\circ$, mean Bouguer anomalies using observed data,
- Some methods for obtaining $1^\circ \times 1^\circ$, mean Bouguer anomalies using geophysical gravity correlation methods,
- Derivation of average error of representation.

362 - GERSTENECKER C. & E. GROTEN - "Comparison of tidal gravity observations with sea tidal models".
Rivista Italiana di Geofisica e Scienze Affini, v. III, N° 5/6, p. 213-218, 1976.

Results of M_2 and K_1 constituents of earth tide gravity records obtained at 18 european stations are discussed. Comparisons with (indirect) sea tidal perturbations of earth tides according to different models by Zahel and Pertsev (for M_2 only) are discussed where present deficiencies of knowledge on the indirect effect are pointed out. Uncertainties of theories and lacking reliability of sea tidal models lead to the fact that, at present, only strong anomalies in earth tidal records can be explained by indirect effects.

- 363 - BALTENBERGER P. - "Structure de la croûte terrestre le long d'un profil Grande Chartreuse - Morvan - Puisaye, d'après les tirs du lac Nègre de Septembre 1966".
C.R. Acad. Sci. Paris, t. 264, Sér. D, p. 2880-2883, 19 Juin 1967.

Le long du profil lac Nègre-bassin parisien, la surface de Mohorovicic remonte vers l'extérieur des Alpes à partir de l'Oisans. Trois zones effondrées sont mises en évidence, respectivement sous Belledonne et la Grande Chartreuse, sous les Dombes et sous le Morvan.

- 364 - KANE M.F., D.R. MABEY & R.L. BRACE - "A gravity and magnetic investigation of the Long Valley Caldera, Mono County, California".
J. Geophys. Res., v. 81, N° 5, p.754-762".

Gravity studies show that the subsurface part of the Long Valley caldera is a coincident steep-sided depression filled with porous epiclastic and volcanic materials to a depth of as much as 3 km. The depression contains two major basins, a larger and deeper one making up much of the eastern part and a somewhat smaller, more shallow one to the west ; a positive feature underlying the central part of the depression separates the two basin areas. The east side of this feature is linear in plan and coincides with the extension of the Hilton Creek fault which is mapped within and beyond the south edge of the caldera. The indicated relief on the postulated subsurface Hilton Creek fault together with difference in depth of the eastern and western basinal areas indicates that the eastern basin is downdropped in relation to the western one. Gentle gravity gradients outside the caldera but sloping towards it are interpreted as evidence of a low-density mass located below the caldera fill. We conclude that it is probably related to the magma source. Aeromagnetic data indicate that a northwest-trending belt of metasedimentary rocks on the south flank of Long Valley may extend into the caldera proper and form much of the bedrock floor of the western part of the caldera. A magnetic low of shallow source in the hot spring region in the southwest is thought to be caused by hydrothermal alteration of the ferrimagnetic minerals in the underlying rocks. A broad positive magnetic anomaly near the center of the caldera may be caused by a thick section of magnetic volcanic flow lying east of the projected Hilton Creek fault and underlying much of the eastern basin.

- 365 - GEOGRAVITY INC. - "Vertical gravity gradiometer".
Booklet, 5 p, Woburn, Mass., 1976.

This instrument is basically a very sensitive quartz micro-balance with 2 equal masses suspended from the balance arms ...
One mass is suspended one meter below the other ...

- 366 - Geophysics, v. 39, N° 4, Aug. 1974.

- a) OLDENBURG D.W. - "The inversion and interpretation of gravity anomalies".
p. 526-536.

A rearrangement of the formula used for the rapid calculation of the gravitational anomaly caused by a two-dimensional uneven layer of material (Parker, 1972) leads to an iterative procedure for calculating the shape of the perturbing body given the anomaly. The method readily handles large numbers of model points, and it is found empirically that convergence of the iteration can be assured by application of a low-pass filter. The nonuniqueness of the inversion can be characterized by two free parameters : the assumed density contrast between the two media, and the level at which the inverted topography is calculated. Additional geophysical knowledge is required to reduce this ambiguity. The inversion of a gravity profile perpendicular to a continental margin to find the location of the Moho is offered as a practical example of this method.

- b) HAMMER S. - "Topographic and terrain correction for airborne gravity".
p. 537-542.

A simple, convenient procedure is outlined for evaluating topographic and terrain effects in airborne gravimetry. The method assumes that continuous terrain data (flight elevation and terrain clearance) are available along a traverse. The terrain is taken to be uniform to infinity in both directions perpendicular to the flight line. The correction is easily calculated from a simple product series. The error tolerances are not serious. Non-perpendicular, irregular topography cannot be evaluated by this simple procedure, but order of magnitude considerations demonstrate that this problem ordinarily is not prohibitively important. In flight, real-time correction for topographic and terrain effects is not a major obstacle in the development of airborne gravity exploration.

- 367 - OBSERVATOIRE ROYAL de BELGIQUE - Comm. Sér. B, N° 96, Sér. Geophys. N° 128
from : Bull. Géod. v. 50, N° 2, 1976.

- a) MELCHIOR P. & B. DUCARME - "The ratio l/h : a simple method for the prospection of tidal deformations of cavities in the Earth's crust".
p. 137-138.

- b) USANDIVARAS J.C. & B. DUCARME - "Etude de la structure du spectre diurne des marées terrestres par la méthode des moindres carrés".
p. 139-157.

Several high quality clinometric and gravimetric tidal series were analysed to investigate the possible liquid core resonance effect in the diurnal spectrum.

The disturbed parts of the records were eliminated according to specific criteria. The tidal constituents show a very good internal consistency. Systematic effects appear which do not fit perfectly the theoretical models. As far as the fine structure of the spectrum (π_1, ψ_1, ϕ_1) is concerned conclusions would be premature.

- 368 - DJUROVIC D. - "Détermination du nombre de Love K et du facteur λ affectant les observations du temps universel".
Obs. Royal Belgique, Comm. Sér. A, N° 33, Sér. Geophys. N° 127,
from : Astr. & Astrophys. N° 47, p. 325-332, 1976.

A mean value TU 1 - TUC is computed for each day during a five-year observation period (1967-1971) at 49 Observatories. A tidal terms research in the rotation of the Earth was carried out starting from TU 1 - TUC and the residuals obtained directly from TU 0 - TUC, after the elimination of the secular and main harmonic terms. They were determined by the method of least squares, after expansion of TU 0 - TUC in Taylor's series. For a comparison three methods of spectral analysis were applied : Fourier's, Gibb's and Blackman - Tukey's method.

A certain number of tidal terms, among which are O_1 , M_2 , M_f and M_m were identified.

Two values were obtained for Love's number K : 0.301 and 0.343. The amplitude factor $\lambda = 1 + k + 1$ was also determined : from O_1 component $\lambda = 0.807$ and from M_2 component $\lambda = 0.675$.

- 369 - FISCHER E.U. & K.R. KOCH - "Resonanzeffekte aus Abweichungen in Flugrichtung von Satelliten".
Mitt. Inst. für Theor. Geod. Univ. Bonn, N° 37, 37 S, Bonn, 1975.

- 370 - GHITAU D. - "Über eine gemeinsame Auswertung von Pegel und Nivellements-messungen zur Bestimmung säkularer Erdkrusten - Vertikalbewegungen".
Mit. Inst. Theor. Geod. Univ. Bonn, N° 43, 37 S, Bonn, 1976.

After consideration of the observation data concerned, a model is built up for a simultaneous adjustment of mareograph and levelling measurements. Special parameters are introduced for describing the crustal movements and the "quasi-eustatic" changes, besides the parameters for the static problem, as related to a reference epoch T_0 , and corresponding "meteorological" parameters. Finally some special cases are discussed.

- 371 - KOCH K.R. - "Hypothesenprüfungen für multivariate Ausgleichungen".
Mit. Inst. Theor. Geod. Univ. Bonn, N° 44, 37 S, Bonn, 1976.

- 372 - BREIN R. - "The influence of the gravimetric springs on the calibration of Earth tides recordings".
Marées Terrestres, Bull. Inf. N° 74, p. 4258-4332, Bruxelles, Sept. 1976.

- 373 - MCGINNIS L.D. - "Gravity fields and tectonics in the Hindu Kush".
J. Geophys. Res., v. 76, N° 8, p. 1894-1904, 1971.

Gravity fields in Afghanistan are characterized by large, negative mean free-air anomalies in the eastern Hindu Kush and by essentially zero anomalies in the western Hindu Kush. Thus, the western Hindu Kush are in isostatic equilibrium, whereas the eastern Hindu Kush are associated with a large mass deficiency. A mechanism involving underthrusting of light continental crust into higher density mantle in the eastern Hindu Kush and Pamirs is consistent with regional seismicity and gravity fields. Positive free-air and Bouguer anomalies mark a belt of intrusives that occupy a region of northeast-striking fractures along the Chaman fault zone. This zone may represent the northwest border of the Indian subcontinental plate.

- 374 - THOMAS S.W. & W.G. HELLER - "Efficient estimation techniques for integrated gravity data processing".
AFGL-TR-76-0232, Final Rep. 15 Aug. 75 - 31 July 76, 80 p, 1976.

A mathematical technique is developed for the combined use of various types of gravimetric data in the estimation of such gravity quantities as the disturbance potential and the gravity disturbance vector. Modern frequency domain techniques are introduced which substantially reduce the computer processing requirements associated with least-squares gravity quantity estimation. This approach represents an extension of existing least-squares methodology based on the use of self-consistent statistical gravity models. Analysis, supported by a numerical study, shows the equivalence of the estimates produced by the conventional space-domain methods and the new frequency-domain methods. Numerical simulations demonstrate the performance of the new technique for gravity surveys involving both single and multiple data types.

- 375 - ASSOCIATION INTERNATIONALE de GEODESIE - Bulletin Gécodésique
v. 50, N° 4, 1976.

- a) PETROVSKAYA M.S. - "A new form of representing the geopotential".
p. 353-362.

A new procedure is outlined for expanding the potential of a body of irregular structure and shape. The expansion converges in the whole space including interior regions and the surface of the body.

- b) ANDERLE R.J. - "Polar motion determined by Doppler satellite observations".
p. 377-390.

Doppler observations of Navy Navigation Satellites have been used to compute pole positions on a daily basis since 1969. Limited computations have been performed using data on file for the period 1964-1969. Results of recent computations give a standard error in pole position based on 48 hours of Doppler observations of 7 cm. However, effects of errors in the orbit due to uncertainties in the gravity field prevent the attainment of this precision; the standard deviation of pole position for this time span is 60 cm, giving a standard error for a five day mean based on observations of two satellites of 25 cm.

- 376 - RADECKI J. - "Investigation of polar motion using Doppler observations of the artificial Earth satellites".
Proc. Inst. Geod. & Cartog., t. XXIII, Z. 2(53), p. 19-24, Warszawa 1976

The aim of this paper is to show, on the basis of the current literature, the direction in which methods of polar motion investigations developed nowadays.

In the sixties in Dahlgren a method of determination of the pole position on the basis of the Artificial Earth Satellite Doppler observations was developed and soon after that regular service called Dahlgren Polar Monitoring Service was set up. Errors of satellite coordinates, inexact knowledge of the refraction influence in the ionosphere and troposphere as well as the instrumental errors have the essential influence on the accuracy of determination.

In the course of TRAPOL experiment it was shown that Doppler observations of one navigation satellite, carried on only from one station allow to determine changes in the latitude and longitude of such a station with proper precision, providing that accurate satellite ephemerides are known. In 1973 in Carga regular analyses of the pole displacements were started.

Bureau International de l'Heure in Paris has begun to apply the results of satellite determination. The results obtained by DPMS came to be more precise than the ones that were determined by conventional methods. Through the last mentioned methods will decide about stability of the reference system for a long time.

- 377 - RUMMEL R. - "A model comparison in least squares collocation".
AFGL-TR-76-0198, The Ohio State Univ., Rep. Dept. Geod. Sci. N° 238,
Sci. Rep. N°5, 38 p, Hanscom, 1976.

In the model equation of least squares collocation there appears a random signal, s' , which is of the same physical nature as the observations whereas the signal to be estimated, s , is only linked to the model through its correlation with s' . This Model (1) is compared with the least squares estimation Model (2), where the signal to be estimated is directly part of the model with a coefficient matrix R . The basic differences of these two models in the framework of physical geodesy are pointed out by analyzing the validity of the equation: $s' = R s$, that transforms one model into the other, for different cases. For clarification purposes least squares filtering, prediction and collocation are discussed separately. In filtering problems the coefficient matrix R becomes the unit matrix and by this the two models become identical. For prediction and collocation problems the relation $s' = R s$ is only fulfilled in the global limit where s becomes either a continuous function on the earth or an infinite set of spherical harmonic coefficients. Applying Model (2), we see that for any finite dimension of s the operator equations of physical geodesy are approximated by a finite matrix relation whereas in Model (1) the operator equations are applied in their correct form on a continuous, approximate functions \mathcal{S} .

Both methods have been applied in a numerical example where spherical harmonic coefficients of the geoid height were estimated from geoid heights given in a global regular point grid over the sphere. The results show that not only the specific features of the two least squares estimation methods have to be taken into consideration but to a high extent also the characteristics of the involved gravity quantities when a decision has to be made which of both methods should be applied.

- 378 - KATTNER W.T. - "Advances in dynamic gravimetry".
Proceedings of the Symposium on Dynamic Gravimetry, March 16-17, 1970.
 Fort Worth, Texas.
 Instrument Soc. America, 172 p, Pittsburgh, 1970.

- a) TRAGESER M.B. - "A gradiometer system for gravity anomaly surveying".
 p. 1-35.

A gravity gradiometer for use in a moving vehicle is feasible. Presently such a device is under development at the M.I.T. Charles Stark Draper Laboratory. A performance level of $\frac{1}{3}$ Eötvös Unit ($\frac{1}{3} \times 10^{-9} \text{ sec}^{-2}$) can be projected for a properly designed instrument operating in a properly designed system. This performance level gives a survey accuracy of one milligal in 20 miles for a pure gradiometer system.

The paper presents the features necessary in a system to implement the above projection. Gravity anomaly indication is mathematically formulated. The effects of transient and slowly changing errors are analysed. Suitable gradiometer instrument concepts are presented. The measurement dynamics of the gradiometer feedback loop are studied. A data processing scheme for minimizing sensitivity to noise is developed. Requirements for excellent stabilization servos are derived. Methods of achieving excellent stabilization are disclosed. Vertical indication accuracy requirements are discussed. Necessary gradiometer compensations are evaluated with respect to their difficulty. The effect of Brownian motion noise is interpreted.

The paper also presents the features of the experimental gradiometer being built at the MIT Charles Stark Draper Laboratory. Rationalization is made for the selected support system. This instrument is compared with other instruments which incorporate related principles. The structural elements are described. Balancing provisions are treated. Details of the support system are revealed. The thermal design and temperature control system is explored.

- b) KLINGENMEIER P.L., M.A. MELDRUM & E.H. METZER - "Error sources in a dynamic gravimeter".
 p. 36-47.

Bell Aerospace gravity meters (BGM-1 and BGM-2) utilize an inertial grade force rebalance accelerometer (Model VII) as the basic sensing device. This instrument was originally developed for measuring the accelerations of inertial navigation and guidance system. It's primary purpose is to measure dynamic accelerations with a range of over 100g's and a frequency response of up to 2000 Hertz.

The gravity meter is a very specialized application for this instrument stressing dynamic and static bias and scale factor stabilities, their temperature coefficients and the very low threshold (under .01 milligal).

In the past two years, an extensive investigation to isolate the dynamic as well as static error sources of the gravity sensor has been conducted covering both the Model VII and the precision electronics. One of the goals was to identify error sources by power spectrum analysis of the signal output. Subsequent identification of various error mechanisms led to performance improvements by either reduction or elimination of the error source. The paper describes the accelerometer error sources such as

the suspension springs and the force rebalance system and also the modifications that have been made for the dynamic gravimetry application. Design improvements in the sensor electronics including bias generator, summing amplifier, and digital converter are also described.

- c) SAVET P.H. - "New developments in gravity gradiometry".
p. 48-58.

A fictitious potential function is introduced as an approximation to a locally tangent potential function. It is shown that this fictitious potential can be analytically and experimentally explored and provide the data necessary for the definition of gravitational features, including local anomalies. These can be derived simultaneously by measuring appropriately directed horizontal gradients of gravity which yield the local differential curvature of the equipotential. This is the only parameter capable of defining the anomalies encountered. Moreover, the differential curvature depends on the anomalies alone and is completely independent of the over-all planetary mass and gravitational features. The instrumentation necessary for this exploration cannot be conceived along conventional design lines of accelerometers based on the elastic suspension of a proof mass. Instead, an entirely new sensor is suggested, operating on the free proof mass principle. This "seismic" instrument does not require calibration, operates independently of the size of the proof mass, and represents an optimized figure of merit in terms of sensitivity over the square of its time constant of response.

- d) ANTHONY D. - "Navigation requirements for dynamic gravimetry by means of gradient measurements".
p. 59-64.

The gravity change along a traveled path can be obtained from an integration of the products of the three navigation coordinate components and the corresponding terms of the second order gradient tensor applying to the vertical direction. By this method, errors in navigation as well as in gradient measurement contribute to the gravity error. Graphs are given for several different height and distance error propagations, for gravity error from different combinations of navigation error, and for gravity error from combined gradient / navigation errors where gradient error is a multiple of the navigation error. The navigation accuracy required for a particular gravity accuracy depends on gradient measurement accuracy and distance traveled before update which can be provided by passing through points of known gravity or by simultaneous dynamic gravity measurements. It is concluded that for worldwide gravity surveys by means of gradient measurements alone, we require navigation data where the standard errors of the distance difference components will not be greater than 10 meters times the square root of the distance traveled in kilometers, while the height differences need not be known very accurately, standard errors of 200 meters being acceptable .

- e) BRADBURY J.T. - "Radiolocation systems for dynamic gravimetry".
p. 67-74.

The talk will also cover a variety of automatic accessories available with this system, such as an automatic printer capable of recording position simultaneously with other data ; an automatic track plotter whereby preplotted tracks may be navigated ; and a number of other interesting accessories which are presently being evaluated for field use. The speaker will also show how a number of these accessories can be of immense value in the conduct of gravimetric surveys. Mention will also be made of the use of this radiolocation equipment by the Naval Oceanographic Office in actually calibrating a number of gravity meters on their oceanographic vessels.

- f) GREENEWALT D. - "Gravimetric error associated with rapid movement parallel to an undulating geoid".
p. 75-78.

Gravity measurement made from a high speed aircraft flying parallel to an undulating geoid will be influenced by vertical accelerations associated with those undulations. Such accelerations will be a significant fraction of the associated gravity anomalies when the latter are elongate and less than 100 km in the shorter dimension, and when aircraft velocity is parallel to that short dimension and greater than about 200 kts. It also appears that when part of the geoid undulation can be represented by a sine function, there will be a certain aircraft velocity-altitude combination for which the vertical acceleration will exactly cancel that part of the associated gravity anomaly. Thus at a given velocity and altitude, a component of gravity variation will be undetectable.

- g) GROTEN E. - "Some remarks on downward continuation of gravity".
p. 86-94.

Several problems connected with the downward continuation of airborne and surface gravity are outlined. Numerical solutions of corresponding integral equations are discussed ; some conclusions on spectral methods in connection with data filtering are given which are relevant whenever strong noise exists. The validity of planar approximations and the usefulness of combining truncated series expressions with discrete data (for specific sets of degree variances) is dealt with. Power series expansions are compared with corresponding asymptotic series developments.

- h) BRADLEY C.L. - "Identification of vertical deflections utilizing an inertial navigator and optimum data processing".
p. 95-104.

A technique for estimating vertical deflection and ocean currents, utilizing an Inertial Navigation System (INS), geodetic reference (Loran, Lorac), and optimal data smoothing, makes it possible to recover the deflection of the vertical directly from the error in INS output rather than using gravity anomalies processed via the Vening Meinesz integral as is conventionally done. This technique allows a maximum of information to be obtained with a minimum of computation because all states are

jointly estimated, including system output errors, system driving noise and measurement noise.

Based on assumed statistical error values, the technique is theoretically capable of estimating deflections with an rms error less than one-half the rms values of the deflection field. Ocean currents can be estimated within an rms error less than one-third the rms value of the ocean current field.

The mathematical techniques employed are not limited to the problem described, but have a wide range of applications to extracting information from oceanographic data.

- i) KOCH K.R. - "Reformulation of the geodetic boundary value problem in view of the results of geometric satellite geodesy".
p. 111-114.

Since the shape of the Earth can be assumed as given by satellite triangulation methods, the boundary value problem of physical geodesy is reformulated by taking into account that not the surface of the Earth but only the gravity field has to be determined. Hence, it is possible to use gravity measurements instead of gravity anomalies as boundary values, so that the approximations in the derivation of the boundary condition of the classical boundary value approach are avoided. The new formulation uses the potential of a simple layer to represent the geopotential and leads to a system of quadratic equations for the unknown density values which can be solved by introducing approximate values for the density.

- j) BELL C.C., R.L. FORWARD & H.P. WILLIAMS - "Simulated terrain mapping with the rotating gravity gradiometer".
p. 115-129.

We present the results of an experimental simulation of the gravity gradient profile that we expect to obtain from a rotating gravity gradiometer passing over terrain with subsurface density fluctuations. The simulation was carried out by constructing a scaled down simplified model of the terrain with density variations similar to those expected in the real terrain. The model was moved past our laboratory version of the rotating gravity gradiometer and the output of the sensor was plotted as a function of the relative position of the sensor with respect to the simulated mass distribution. The resultant gravity gradient profile is compared with that predicted by our computer program for the same configuration. The situation simulated in the experiment was that of a lunar spacecraft at 30 km altitude orbiting over various mascon structures. Because of the $1/R^3$ characteristic of the gravity gradient, however, the simulation could apply equally to an aircraft at 3 km altitude flying over large geological structures many kilometers down, or an aircraft at 300 m altitude looking at small local structures near the surface.

- k) KAULA W.M. - "Application of space and astronomic techniques to solid Earth and ocean physics".
p. 130-135.

This paper summarizes a NASA-sponsored study involving 65 scientists in August, 1969.

Recent developments in instrumentation indicate orders of magnitude improvement in measurement of direction, range, range-rate, and acceleration. The most important of these are :

- 1) satellite radar altimetry ;
- 2) satellite to satellite range-rate tracking ;
- 3) ground to satellite laser ranging ;
- 4) very long base line interferometry ;
- 5) drag-free performance of low altitude satellites ; and
- 6) satellite tracking of large numbers of free-floating buoys.

Attainable with present technology and knowledge of the environment appear to be determination of the mean sea level to ± 1 m ; of tracking station positions to ± 15 cm ; of inertially referred directions to $\pm 0.005^\circ$; and of gravity variations to a resolution of 250 km. Eventually attainable appear to be ± 10 cm, ± 2 cm, $\pm 0.001^\circ$, and 100 km for these same quantities.

These capabilities would enable space & astronomic techniques to make significant contributions to solving the problems of the driving forces and response mechanisms of global tectonics ; the pattern of the general ocean circulation ; the rotational dynamics of the Earth, ranging from the geomagnetic dynamo to the seismic excitation of wobble ; and the mechanism of energy dissipation in the oceans.

- l) GRAF A. - "Development accomplished in the sixties destined for improving the seagravimeter GSS 2".
p. 136-141.

Beginning with the previous methods of eliminating the cc-effect of rotary weigh-beam type sea-gravimeters, a new method for this purpose is being presented. A horizontal weigh-beam is being servo-controlled by magnetic compensation. Advantages of this type of operation, specially reduction of cc-error are discussed. Results of laboratory and sea test trials confirm the assumptions. Using this principle in connection with the translatory moving sensor offers further advantages, as pointed out briefly.

- m) JACOBY H.D. - "The new Askania seagravimeter GSS 3".
p. 142-145.

A new seagravimeter, developed by Askania is being described in the following paper. The problem with respect to measuring technique is being defined, different solutions are discussed and reasons for the choice in each respect are given. Thus beginning with the measuring principle, the instrument is described in details of mechanical design and electronic servo control. A special feature of the system is the translatory moving proof mass as sensor in a force compensated servo loop, resulting in fast response, high accuracy and flexibility for different modes of data processing which make the instrument suitable for the demands of exploration. Calibration procedure is described and first measuring results are presented.

- 379 - CASE J.E., J. BARNES, G. PARIS, H. GONZALEZ & A. VINA -
 "Trans-Andean geophysical profile, Southern Colombia".
 Geol. Soc. America, Bull. v. 84, N° 9, p. 2895-2904, 1973.

Negative Bouguer anomalies (- 80 mGal) near the Pacific coast of southern Colombia define the position of the Tertiary Bolivar trough. Values increase eastward to a huge positive anomaly (+ 75 mGal) over Mesozoic "eugeosynclinal" rocks of the western Andes. This anomaly is part of the West Colombian gravity high, which extends from Panama into western Ecuador and is caused by shallow mafic crust. Bouguer anomalies are strongly negative (- 220 mGal) over pre-Mesozoic (?) metamorphic rocks, Mesozoic (?) granitic bodies, and Tertiary to Holocene volcanic rocks of the central Andes between Pasto and Ipiales. The steep gravity gradient between the West Colombian gravity high and the negative anomaly of the central Andes represents the transition between mafic crust to the west and continental crust to the east. This zone parallels the Romeral-Cauca megashear system. East of the Andes, Bouguer anomalies range from - 50 to - 120 mGal over a Mesozoic-Tertiary basin of the Putumayo district, indicating that the crust there is thinner or denser than it is beneath the central Andes.

Models derived from gravity data suggest that the crust is about 45 km thick under the south-central Colombian Andes. If this is correct, the crust must thicken southward along the strike of the Andes, as thicknesses of 70 km have been reported in the Andes of southern Peru, Bolivia, and northern Chile by Lomnitz (1962) and James (1971a). Such differing crustal thicknesses may reflect different intensities of tectonic activity, greater crustal thickness indicating more intense or rapid growth of the volcano-plutonic arc or foreshortening of an existing crustal section.

- 380 - "CASE J.E., W.D. MACDONALD - "Regional gravity anomalies and crustal structure in Northern Colombia".
 Geol. Soc. America, Bull. v. 84, N° 9, p. 2905-2916, 1973.

The central range of the Colombian Andes gives way northward to a series of Cenozoic fault-bordered basins and uplifts near the Caribbean Sea. Pre-Cenozoic structures exposed in the uplifts curve increasingly toward the east to become parallel to the continental margins along the south side of the Caribbean. Major Cenozoic faults, with large vertical and horizontal displacements, cut across older structures which include Permian-Triassic (?) and Late Cretaceous to early Tertiary metamorphic zones, Precambrian gneiss, and Jurassic batholiths.

Gravity anomalies have large amplitudes in the Santa Marta area. Bouguer anomalies rise to + 130 mGal over the crystalline rocks of the high Santa Marta massif. Over adjacent Cenozoic basins, they range down to - 80 mgal over the Lower Magdalena basin and to - 65 mGal over the Baja Guajira basin. Steep gravity gradients characterize the Santa Marta and Oca faults on the west and north sides of the massif, respectively.

In the Guajira Peninsula region, Bouguer anomalies increase to + 105 mGal over a serpentinite zone at Cabo de la Vela and to + 55 mGal over Cretaceous volcanic rocks in the southern peninsula. Two smaller basins on the peninsula are characterized by negative Bouguer anomalies. Steep gradients characterize many of the major Cenozoic faults, and two concealed faults are postulated on this basis.

Though useful for evaluating the relative vertical displacements, which may exceed 10 km along faults bounding the Santa Marta massif, the gravity data yield no definitive information on the large horizontal displacements postulated along some of the major faults of the area. The Bouguer anomalies do indicate, however, the extension of some of the Cenozoic basins into offshore areas.

Strong positive Bouguer anomalies of the Santa Marta massif and its great relief, which exceeds 9 km relative to the floor of the adjacent Caribbean, indicate thin continental crust, lack of isostatic balance, and relatively recent uplift for the massif. After corrections are made for the gravitational effects of Tertiary sedimentary basins in the Guajira Peninsula, most of the peninsular region also has positive anomalies, suggesting a relatively thin continental crust and a lack of isostatic balance. A mechanism of overthrusting, in relatively recent time, of the continental margin over the adjacent Caribbean upper mantle and crust to the northwest can account for the observations.

- 382 - GAMA L.I. & J. GUALDA - "Base gravimétrica do Corcovado".
Obs. Nac., Pub. Serv. Grav. N° 1, 15 p, Rio de Janeiro, 1968.
- 383 - GAMA L.I. - "Valores da gravidade no Nordeste e região Centro-Leste do Brasil".
Obs. Nac., Pub. Serv. Grav. N° 2, 45 p, Rio de Janeiro, 1971.
- 384 - GUALDA J. - "Levantamentos gravimétricos no Nordeste e região centro-leste do Brasil".
Obs. Nac. Pub. Serv. Grav. N° 3, 55 p, Rio de Janeiro, 1971.
- 385 - INSTITUTO ASTRONÓMICO e GEOFÍSICO of the UNIVERSITY of SÃO PAULO -
"Selected references on Geodynamics for the Brazilian Territory, 1964 to 1974 . (Geodynamics Project)".
Contr. Inst. Astr. Geof., Univ. São Paulo, 131 p, São Paulo, 1976.
- 386 - BIBBY H.M. - "Crustal strain from triangulation in Marlborough, New Zealand".
from : Tectonophys. v. 29, N° 1-4, p. 529-540, 1975.

Triangulation data from a series of surveys around the Wairau Fault in the Marlborough District of New Zealand were analyzed simultaneously to determine position and the shear components of strain under the assumption that strain is changing linearly with time. The surveys analyzed included first and second order geodetic surveys made between 1938 and 1971, together with an early survey made between 1878 and 1884.

The results of the analysis of the observations on the Wairau Fault show that shear strain has been accumulating at a constant rate of 0.35 ± 0.09 microradians per year over the last 90 years. The magnitude of the right lateral movement on the fault equivalent to this shear strain is of

the same order as that deduced for the last 20,000 years from geological evidence. The direction of the principal axis of maximum shortening is at $90^\circ \pm 7^\circ$, which agrees with the azimuth of the principal stress axis determined from microearthquake studies. This direction is also in reasonable agreement with the direction deduced from geological evidence spanning 20,000 years. As the shear strain is not concentrated on the fault then little or no slip has occurred during the period of the surveys. The observed accumulation of strain is probably associated with an accumulation of elastic energy.

The block to the north of the Wairau Fault displays very different strain characteristics from the region to the south of and across the fault itself. ...

- 387 - HICKS S.R. & A.C. KIBBLEWHITE - "Seismic reflection profiling in very shallow waters in the Upper Waitemata Harbour, New-Zealand".
from : N.Z. J. Geol. & Geophys., v. 19, N° 2, p. 213-231, 1975.

A marine seismic reflection survey was conducted in the upper Waitemata Harbour, using a high-resolution acoustic profiling system. The depths to the identified seismic reflectors agree closely with the measured strata depths from borehole data, the differences between the two sets having a standard deviation of ± 0.9 m. This is despite the poor signal-to-noise ratio resulting because the water depth was at times less than 2 m.

The structure of the area is complex, but three principal stratifications have been identified. ...

- 388 - NATIONALKOMITEE für GEODASIE und GEOPHYSIK - "Arbeiten zum internationalen Geodynamik-Projekt in der DDR, (1973 / 1974)".
Geod. & Geophys. Veröff. R. III, H. 36, 134 S, Berlin, 1975.

Résumés d'environ 60 communications ; quelques unes sont relatives plus particulièrement aux problèmes de gravimétrie (DITTFELD, ELSTNER, KAUTZLEBEN, WIRTH...).

- 391 - SEARLE R. & P. GOUIN - "A gravity survey of the central part of the Ethiopian rift valley".
Tectonophys., v. 15, N° 1-2, p. 41-52, in East African Rifts, 1972.

Gravity traverses have shown that the smooth negative gravity pattern over the Ethiopian and Somali Plateau is disturbed by a strong positive anomaly over the entire width of the Ethiopian Rift Valley. On this broad positive anomaly are superimposed other smaller positive anomalies which were found to coincide with the location of the Wonji fault belt.

The present close-grid gravity survey of the central part of the rift defines more accurately the location of these positive anomalies. Correlations are made with the main geological and tectonic features of the rift and crustal models are presented which account for these anomalies.

- 392 - AMERICAN GEOPHYSICAL UNION - "The geophysics of the Pacific Ocean basin and its margin". A volume in honor of George P. WOOLLARD. Geophys. Monograph 19, 480 p, Washington D.C., 1976. Papers presented at a symposium held in Honolulu, Dec. 1974.

They deal With different branches of geophysics :

- Gravity and geodesy
- Seismology
- Magnetism
- Marine geology and tectonics
- Volcanology and petrology
- Tectonophysics.

- a) WORZEL J.L. - "Gravity investigations of the subduction zone". p. 1-15.

- b) WATTS A.B., M. TALWANI & J.R. COCHRAN - "Gravity field of the Northwest Pacific Ocean basin and its margin". p. 17-34.

Surface-ship and pendulum gravity measurements have been combined in new free-air gravity anomaly maps of parts of the northwest Pacific Ocean basin and its margin. The most prominent features of these maps are the broad belts of positive anomalies which occur seaward of deep-sea trenches and landward of island arcs at the margins of the northwest Pacific basin and the broad belts of positive and negative anomalies which flank the eastern end of the Hawaiian ridge in the interior of the basin. The positive anomalies seaward of trenches can be easily isolated from the longer wavelength regional gravity field of the northwest Pacific upon which they are superimposed. These studies show that

- 1) positive free-air gravity anomalies of about + 40 to + 50 mGal occur seaward of trenches and,
- 2) negative residual gravity anomalies of about - 10 mGal occur over the Pacific basin, except over Hawaii and the Gulf of Alaska where they are positive.

- c) SEGAWA J. & Y. TOMODA - "Gravity measurements near Japan and study of the Upper Mantle beneath the oceanic trench marginal sea transition zones". p. 35-52.

A free-air gravity anomaly map of Japan and the surrounding seas is presented, compiled primarily from data obtained by the Tokyo Surface Ship Gravity Meter. By use of gravity and the presently available seismic refraction data obtained for the crustal structures, the density anomalies in the upper mantle near the Japan and Izu-Bonin arcs have been estimated. Plausibilities of the density anomalies thus obtained have been examined by comparing them with the results from anomalous seismic velocities and density velocity relationships. The residual gravity anomalies near oceanic trenches, which have been considered to be discordant with seismic results, have been estimated as accurately as possible, and then explained in terms of a concentration of mass within a bending lithosphere due to possible elastic compression, phase transformations, or magmatic flows.

- d) WILCOX L.E. - "Airy-Woollard isostasy".
p. 53-57.

It is proposed that the variable crustal density variety of Airy isostatic theory introduced and developed by G.P.WOOLLARD be known as Airy-Woollard isostasy. An augmented form of Airy-Woollard isostasy involving a variable mantle density is also derived. Standard Airy-Heiskanen isostasy is compared with Airy-Woollard isostasy using the crustal column concept and basic equations.

- e) MORGAN P. - "A simulation study for sub-meter geodesy in the Pacific Basin".
p. 59-65.

The advent of Lunar Laser Ranging (L.L.R), with precisions greater than 10 cm, offers geodesists and geophysicists an unprecedented tool for measuring the dynamic earth and exploring its mysteries. L.L.R. is a fixed-site astronomical technique not readily adaptable to rapid observations in some of the Earth's harsher environments nor to the special logistics of those regions. Orbiting artificial satellites, as well as being weather independent, offer techniques that make use of portable equipment. Unfortunately this gain in versatility is at the expense of precision and accuracy. The combination of three Pacific basin L.L.R. observatories collocated with Doppler tracking stations offers the possibility of recovering geodetic information at the sub-meter level ...

- f) OCOLA L. & H. ALEMAN - "Regional gravity of Peru" (abstract).
p. 67.

A regional gravity anomaly map of Peru and the neighboring ocean reveals the following anomalies of regional extent :

- 1) a narrow negative anomaly closely following the Peru Chile trench and reaching values of - 200 mGal ;
- 2) a positive anomaly with values up to + 50 mGal trending generally along the coastal cordillera ;
- 3) a broad anomaly with extreme values approaching 400 mGal in southern Peru.

This anomaly becomes less negative and narrower towards the north. Crustal models constructed to satisfy gravity and available seismic data show an extraordinarily thick crust underlying the Andean mountains.

- g) YOSHII T., Y. KONO & K. ITO - "Thickening of the oceanic lithosphere".
p. 423-430.

A concept of thickening of the oceanic lithosphere is presented. From the "residual gravity anomaly" (RGA), defined as a mantle gravity anomaly, the thickness of the lithosphere Q (km) is inferred to increase as the sea-floor age t (m.y.) gets older. The relation is given by $Q = 7.49 \sqrt{t}$. A thermal model of the thickening lithosphere is derived so that the lithosphere grows from a molten asthenosphere and the latent heat is released at the lithosphere-asthenosphere boundary.

The thermal model is concordant with the thickness of the lithosphere inferred from the RGA. The possible presence of a highly molten asthenosphere just beneath the lithosphere is implied from the thermal model. Surface wave and other geophysical studies strongly support the concept of the thickening of the lithosphere. Petrological considerations suggest a distinct layered structure within the lithosphere, namely, dunite or harzburgite, garnet pyroxenite, and eclogite, from the top to bottom layers.

- h) WALCOTT R.I. - "Lithospheric flexure, analysis of gravity anomalies and the propagation of seamount chains".
p. 431-438.

Topography on the earth's surface loads the lithospheric plates producing vertical displacements, gravity anomalies, and plate stresses. The displacements and gravity anomalies of the deformation produced by individual loads where so distinguished give estimates of the thickness and viscosity of the lithosphere. The statistical analysis of gravity anomalies over large areas is also possible and can lead to the identification of areas of different plate thicknesses. The stresses generated within a plate by the loads of the great seamount chains like the Hawaiian - Emperor chain are sufficiently large to produce elastic failure and even complete rupture of the lithosphere. Depending on the availability of magma, the rupture could result in further growth of seamounts and a self-propagating mechanism for the chain. Such a mechanism is inadequate to explain all features believed to be observed in the Pacific seamount chains, but it is a mechanism that is likely to be superimposed on others such as the drift of the lithosphere over an asthenospheric hot spot.

- 393 - ANFILOFF W., B.C. BARLOW, A. MURRAY, D. DENHAM & R. SANDFORD -
"Compilation and production of the 1976 1:5,000,000 gravity map of Australia".
from : BMR J. Australian Geol. & Geophys., v. 1, p.273-276, 1976.

In 1976 a coloured 1:5,000,000 Gravity Map of Australia was published by BMR. At that stage the systematic reconnaissance gravity coverage of Australia, initiated by BMR in 1959, was complete, and preliminary gravity values were available from marine coverage of the continental shelf and margins. The map was based on approximately 260 000 gravity observations obtained by various organisations at a cost of about \$ 12,000,000 from 300 surveys. It was produced using a CDC Cyber 76 computer system, Calcomp plotters and cartographic techniques. The computer processing phase took about 4 months and the cartography about 3 months. The coloured 1 : 25,000,000 Bouguer and free-air anomaly maps contained in this issue were also produced from the same data bank.

The anomalies on the maps are based on the Potsdam datum for observed gravity values, and the 1930 International Gravity Formula.

- 394 - SOCIETE HELVETIQUE DES SCIENCES NATURELLES - Procès verbal de la 122ème séance de la Commission Géodésique Suisse tenue à l'Université de Berne le 26 Juin 1976.
28 p, 1977.

- CENTRE NATIONAL POUR L'EXPLOITATION DES OCEANS

- 395 - N° 97, 23 p, Paris, Janvier 1977.
396 - N° 98, 24 p, Paris, Fév. 1977.
397 - N° 99, 19 p, Paris, Mars 1977.
398 - N°100, 14 p, Paris, Avril 1977.
399 - N°101, 23 p, Paris, Mai 1977.
- 400 - SATO T. - "On an instrumental phase-lag of the LaCoste-Romberg gravimeter".
Bull. Inf. Marées Terrestres, N° 75, p. 4341-4360, Bruxelles, 31 Mars 1977.

Earth tide observations have been carried out twice, in 1974 and in 1975 at the International Center of Earth Tides (ICET) in the Royal Observatory of Belgium (ORB) by using our LaCoste & Romberg gravimeter G 305 (LCR 305). Moreover, comparison observations with a SAKUMA tidal gravimeter using a zero method have been made at the Bureau International des Poids et Mesures (BIPM) in 1974.

As a summary of this series of gravity tidal observations, it has been found that our LCR 305 has a phase-lag attaining $1^{\circ} \pm 1^{\circ}8$ for the M_2 and O_1 components compared with the adopted values of the ICET and SAKUMA gravimeter. This phase-lag may not be attributed to the analytical procedures but to some instrumental sources proper to our LCR meter. Further, it has been experimentally confirmed that the magnitude of the phase-lag depends upon the instrumental sensitivity.

- 401 - MELCHIOR P. - Bibliographie des résultats d'observations de marées terrestres.
A.I.G., Centre Int. Marées Terrestres, Obs. Royal de Belgique, Bruxelles, 27 p, 1977.
- 402 - MELCHIOR P. - Bibliographie générale des Marées Terrestres, Supplement II, 1974-1976.
A.I.G., Centre Int. Marées Terrestres, Obs. Royal de Belgique, Bruxelles, 24 p, Bruxelles, 1977.
- 403 - MOENS M. - "Solid earth tide and Arctic oceanic loading tide at Longyearbyen (Spitzbergen).
Phys. Earth Planet. Inter., n° 13, p. 197-211, 1976.

The three components of the indirect oceanic effect are calculated for the M_2 , K_1 and O_1 waves and compared with the observed earth tide. The vertical component of the near Arctic oceanic load explains fairly well the large 45° observed phase lag of M_2 . The results for the horizontal components are satisfactory ; the discrepancies between different tiltmeters are not due to the oceanic perturbations (unless some local or cavity effects are supposed).

- 404 - MELCHIOR P., J.R. KUO & B. DUCARME - "Earth tide gravity maps for Western Europe".
Obs. Royal de Belgique, Comm. Ser. A, N° 38, Ser. Geophys. N° 129.
from : Phys. Earth Planet. Inter., N° 13, p. 184-196.

Tidal gravity profiles completed in western Europe by the authors (twenty stations) are complemented with some others from independent stations to provide the first tidal gravity maps of this region of the world exhibiting a quite smooth behaviour of the tidal parameters.

Diurnal waves appear nearly undisturbed and could furnish an upper limit for the solid tide phase lag. Semi-diurnal waves are clearly affected by the oceanic indirect effects. Computations of these effects shows that the existing oceanic cotidal charts are imperfect and should be improved by using the earth tide measurements as constraints.

- 405 - ROSE J.C., G.P. WOOLLARD & A. MALAHOFF - "Marine gravity and magnetic studies of the Solomon Islands".
Int. Upper Mantle Project, Sci. Rep. N° 15, p. 379-410, 1966.
American Geophys. Union Geophys. Monograph 12, Nat. Acad. Sci.,
Nat. Res. Council Pub. 1687.

From October through December of 1965, marine gravity and magnetic studies of the Solomon Islands region were carried out aboard HMS Dampier, the British hydrographic survey vessel. With the LaCoste & Romberg sea gravimeter S9 and a Varian Associates proton-precession magnetometer, approximately fourteen thousand miles of gravimetric and magnetic measurements were collected under unusually favorable weather conditions. A free-air anomaly contour chart and a Bouguer anomaly contour chart were then constructed for the region from the gravity data obtained on Dampier, data obtained on USS Wandank in 1964, data obtained by Scripps Institution of Oceanography on RV Argo in 1960, and the data obtained on HMS Telemechus in 1956, USS Bergall in 1949, and USS Caitaine in 1918. A total force magnetic anomaly chart was drawn from the data obtained aboard HMS Dampier. Bathymetric readings taken concurrently, together with additional data from the Scripps Institution of Oceanography Lusiad and Proa expeditions, were used to draw a preliminary bathymetric chart of the region. The gravity anomalies in the region southeast of New Britain and between Bougainville and New Guinea appear to be excessively positive by more than 100 mGal. Amplitudes of magnetic anomalies are generally less than 200 γ and in the form of elongate bipoles striking perpendicular to the observed structural trends. Depth estimations suggest a three-layer crust, and computed susceptibility contrasts suggest that the magnetic anomalies are associated with intrusive basalts or andesites.

- 406 - MAZAC O. - "Reconnaissance gravity survey of Zambia".
Geol. Survey Dept. Tech. Rep. N° 76, 40 p, Lusaka, 1974.

Gravity measurements have been made by the Geological Survey, the University of Zambia and Strojexport at stations established at about 15 km intervals along passable roads in Zambia. Free-air and Bouguer anomalies have been calculated and the map enclosed shows the locations of the stations and Bouguer anomalies for a density of 2.67 g cm^{-3} .

Table of 1698 stations - 1 gravity map of Zambia.

- 407 - WOODSIDE J.M. & S.A. WILLIAMS - "Geophysical data report of the Eastern Mediterranean Sea". (RRS Shackleton cruises 3/72, 5/72, 1/74). Cambridge Univ., Dept. Geod. & Geophys., 225 p, 1977.

This report contains data obtained during Cambridge University marine geophysical surveys carried out during 1972 and 1974 on R.R.S. Shackleton in the eastern Mediterranean Sea and the Aegean Sea. All the original seismic reflection profiles are included as well as the gravity, magnetic and bathymetric data collected in the region east of 27°E.

The data are presented both as profiles and as maps with values posted along ship's tracks. The maps are scaled at 1:1M at 46°N (except where noted) and plotted in conformal Mercator projection. The profiles (excluding the seismic profiles) are also plotted with a horizontal scale of 1:1M.

- 420 - DARRACOTT B.W., J.D. FAIRHEAD & R.W. GIRDLER - "Gravity and magnetic surveys in Northern Tanzania and Southern Kenya". from : Tectonophysics, v. 15, N° 1-2, p. 131-141. in East African Rifts, 1972.

The main results of gravity survey carried out in 1968 and 1969 are presented with occasional reference to magnetic surveys carried out at the same time. The long wavelength negative Bouguer anomaly associated with the northern part of the rift zone is found to terminate at about 4°S and the shorter wavelength positive anomaly over the Gregory Rift floor dies out at about 2°S. The negative anomaly is thought to be due to a low density asthenolith and the positive anomaly to be an intrusive zone penetrating the upper crust suggesting extreme thinning of the lithosphere beneath the eastern rift north of 2°S. The negative Bouguer anomaly over the Speke Gulf region is interpreted in terms of a simple rift ; reasons are given for considering this to be a Precambrian structure which is presently being rejuvenated. The negative Bouguer anomalies found over the west-east volcanic chain which includes Meru and Kilimanjaro are considered to be due to low density lava piles.

- 421 - SHEPPARD T. - "The Joint Services West East Sahara Expedition, 1975". from : The Geogr. J., v. 142, Part 2, p. 201-215, 1976.

The Joint Services West East Sahara Expedition, comprising eight men and four 1 tonne Land Rovers, completed the first crossing of the Sahara from the Atlantic to the Red Sea through the Mauritanian "Empty Quarter" between 25 January and 3 May 1975. The distance was 12054 kilometres (7494 miles) and the time taken 100 days. A complete gravity measurements traverse was carried out, a number of other scientific projects pursued, and new refinements to methods of navigation were tried. Appendices give details of fuel consumption and planning, and of the scientific programme.

- 422 - COWAN I.M. & H.N. POLLACK - "Gravity in Zambia".
from : Nature, v. 266, p. 615-617, 1977.
- 423 - HASTINGS D.A. - "Gravity mapping and interpretation in Ghana".
from : Ghana Geol. Survey, p. 333-337, 1976.
- 424 - REEVES C.V. & D.G. HUTCHINS - "The National Gravity Survey of Botswana, 1972-73".
Geol. Survey Dept., Bull. N° 5, 162 p, Lobatse, 1976.

In 1972 and 1973 field work was carried out to establish the first nation-wide gravity survey coverage of Botswana. The gravity determinations were controlled by a new network of gravity reference points connected to IGSN 71 datum points in neighbouring countries.

Heighting of stations was achieved by altimetry controlled by trigonometrical heights and the new precise levelling network in Botswana. Station positions were determined with reference to accurate survey points using vehicle-mounted navigation equipment. Access to the most-remote areas was achieved by helicopter, using satellite imagery and photographic print laydowns as navigation aids. The field procedure and the reduction of the data is described ; a Bouguer anomaly map of Botswana at the scale of 1:1,000,000 is presented and supported by a catalogue of parameters for 2131 data points distributed over the whole country.

- 425 - INSTITUTO PANAMERICANO DE GEOGRAFIA E HISTORIA - Revista Cartografica, N° Esp. 28 (Reunion Panamericana de Catastro), 278 p, Mexico, 1975.
- 426 - INSTITUTO PANAMERICANO DE GEOGRAFIA E HISTORIA - Revista Geofisica N° Esp. 5, 326 p, Mexico, 1976.
- 427 - BERG E. - "The double pass method for more precise determinations of longitude and geoidal height using the transit system of navigational satellites".
HIG-75-11, Univ. of Hawaii, 76 p, 1975.
for Office of Naval Research.

Using the Stansell (1970) elevation correction for navigational satellites together with the double pass method of Anderle (1971) and Greely (1971) but for individual navigational satellites on two consecutive passes, it is shown that uncertainties in longitude position can be reduced to the order of 10 to 18 m for land stations with just a few observations, and less than 4 m for dock-side ship stations taken over a period of a week. It is also shown that the method allows identification of satellites not giving reliable data and permits conclusions to be

reached as to the cause of an apparent error dependence on surface elevation noted above 1000 m in the Andean region of Colombia, South America, reported by Woollard and Thompson (1974). An additional advantage of the double pass method brought out is that it allows geoidal heights to be determined for remote islands with the same degree of reliability as their position and comparable to the best, continental determinations of geoidal height using standard geodetic measurements.

- 428 - RUMMEL R., D.P. HAJELA & R.H. RAPP - "Recovery of mean gravity anomalies from satellite - satellite range rate data using least squares collocation". AFGL-TR-76-0291, The Ohio State Univ., Sci. Rep. N° 7, 61 p, 1976.

Range rate data between two satellites can be used to determine acceleration along the connecting line between two satellites by numerically differentiating an analytic representation of this data. Using a reference potential field this acceleration can be interpreted to be a derivative of the disturbing potential along the line of the satellites. Using geometric techniques, the radial component of the disturbing potential can be estimated. This component can then be incorporated in the determination of mean gravity anomalies at the surface of the earth using least squares collocation and theoretical covariance functions. This paper discusses the theoretical basis of the above procedures and describes two simulation studies performed.

In the first, postulated data surrounding a 5° equal area block and a $2^\circ \times 2^\circ$ block was used to estimate the accuracy in which the anomaly could be recovered. For example, with acceleration data having an accuracy of ± 1 mGal, a 5° anomaly could be determined with an accuracy of ± 4 mGals with the low satellite at 250 km, and ± 8 mGals with the low satellite at 850 km. A comprehensive simulation experiment was then performed to check the actual recovery of postulated anomalies determined from defined sets of potential coefficients. Assuming known orbits the recovery of the unknown anomalies was accomplished to about ± 2 mGals. When orbits errors were introduced the errors increased but could properly be controlled through assignment of data accuracies.

The promising results of this study indicate that least squares collocation techniques can be advantageously applied to this type of anomaly recovery avoiding the instability of the downward continuation problem that exists in other methods of anomaly recovery from this data type.

- 429 - ASSOCIATION INTERNATIONALE DE GEODESIE - Bulletin Géodésique, v. 51, N° 1, Paris, 1977.

- a) BRENNECKE J. & E. GROTEN - "The deviations of the sea surface from the geoid and their effect on geoid computation". p. 47-51.

The effects of the deviations of sea surface topography from the geoid are estimated for terrestrial geoid computations as obtained from Stokes' formula. The results are based on an equal-area expansion of Lisitzin's sea surface topography data in a spherical harmonic series. It is realized that those data affect mainly the harmonics of degree $n \leq 10$. Consequently, in geoids obtained from combination solutions (where low harmonics are dominated by harmonics as obtained from differential orbit improvement) the sea surface topography effects are relatively small.

- b) PETROVSKAYA M.S. - "Generalisation of Laplace's expansion to the Earth's surface".
p. 53-62.

The external expansion of the Earth's potential V in spherical harmonics is generalized to the Earth's surface. Some additional expansions are also proposed which represent the potential of a finite body practically in the whole space. The series developed can be used for the combined evaluation of the Earth's potential from both satellite and gravimetric measurements.

- c) RUMMEL R. & R.H. RAPP - "Undulation and anomaly estimation using Geos-3 altimeter data without precise satellite orbits".
p. 73-88.

The paper describes results obtained from the processing of 53 Geos - 3 arcs of altimeter data obtained during the first weeks after the launch of the satellite in April, 1975. The measurement from the satellite to the ocean surface was used to obtain an approximate geoid undulation which was contaminated by long wavelength errors caused primarily by altimeter bias and orbit error. This long wavelength error was reduced by fitting with a low degree polynomial the raw undulation data to the undulations implied by the GEM 7 potential coefficients, in an adjustment process that included conditions on tracks that cross. The root mean square crossover discrepancy before this adjustment was ± 12.4 meters while after the adjustment it was ± 0.9 m. These adjusted undulations were used to construct a geoid map in the Geos - 3 calibration area using a least squares filter to remove remaining noise in the undulations. Comparing these undulations to ones computed from potential coefficients and terrestrial gravity data indicates a mean difference of 0.25 m and a root mean square difference of ± 1.92 m.

The adjusted undulations were also used to estimate several 5° , 2° , and 1° anomalies using the method of least squares collocation. The resulting predictions agreed well with known values although the $1^\circ \times 1^\circ$ anomalies could not be considered as reliably determined.

- 430 - ASSOCIATION INTERNATIONALE DE GEODESIE - Bulletin Géodésique, v.51, N° 2, Paris, 1977.

- a) ARGENTIERO P. & B. LOWREY - "On estimating gravity anomalies - A comparison of least square collocation with conventional least squares techniques". p.119-126.

The least squares collocation algorithm for estimating gravity anomalies from geodetic data is shown to be an application of the well known regression equations which provide the mean and covariance of a random vector (gravity anomalies) given a realization of a correlated random vector (geodetic data). It is also shown that the collocation

solution for gravity anomalies is equivalent to the conventional least-squares Stokes' function solution when the conventional solution utilizes properly weighted zero a priori estimates. The mathematical and physical assumptions underlying the least squares collocation estimator are described.

- b) TSCHERNING C.C. - "A note on the choice of norm when using collocation for the computation of approximations to the anomalous potential".
p. 137-147.

In order to use the method of (least squares) collocation for the computation of an approximation to the anomalous potential of the Earth (T) it is necessary to specify a reproducing kernel Hilbert space the dual of which contain the (linear) functionals associated with the observations.

The specification includes the prescription of an inner product or an equivalent norm. It is demonstrated, that this is equivalent to the prescription of a specific reproducing kernel when an orthogonal (but not necessarily orthonormal), countable basis is known.

When T is an element of the Hilbert space, it is proved, that absolute error bounds may be computed, provided the norm of T is known. Also the convergence of a sequence of approximations obtained using observations increasing in a regular fashion is secured in this case as proved by MORITZ.

In Geodetic practice the empirical covariance function of the anomalous potential has been used as a reproducing kernel and has in connection with the set of solid spherical harmonics specified a norm. It is proved, that a Hilbert space (of infinite dimension) equipped with this norm does not contain the anomalous potential.

- c) BELLAIRE R.G. - "Correlation functions on the upper half space".
p. 149-161.

The boundary condition and solution of a Dirichlet problem on the upper half space are treated as random processes. It is shown that the first - and second - order statistics of the solution to this problem are completely determined by the corresponding statistics of the boundary condition. The mean of the solution is the mean of the process on the boundary. The correlation function of the solution above the boundary is related to its value on the boundary by a Poisson integral formula.

- 431 - DERMANIS A. - "Probabilistic and deterministic aspects of linear estimation in Geodesy".
The Ohio State Univ., Dept. Geod. Sci. Rep. N° 244, 167 p, Columbus, 1976, for NASA, Washington.

The objective of this work has been twofold : First, to clarify the mathematical and probabilistic background of standard linear estimation techniques used in geodesy and to reveal their interrelationship Secondly, to address what we considered to be the two most important estimation problems in geodesy : the norm choice problem in gravimetric collocation, and the adaptive determination of the stochastic models for not directly observable physical processes. ...

- 432 - AGAJELU S.I. - "The influence of the short wavelength features of the Earth's gravity field on low orbiting satellites". The Ohio State Univ., Dept. Geod. Sci. Rep. N° 246, 60 p, Columbus, 1976. for NASA, Goddard Space Flight Center, Greenbelt.

The influences of short wavelength features of the Earth's gravity field (equivalent to 5° blocks) on satellite to satellite summed range rate data, have been studied using simulated data.

It is found that the influence of a 5 mGal 5° anomaly is highly detectable at the Apollo/Soyuz altitude but barely detectable at Geos-3 altitude. It is not possible to determine the expected magnitude of the influence comparable to observation because of the present limitation of the Geodyn program used in the study ; but it is known that (for Rev. 8 of Apollo/Soyuz satellite), the r.m.s. influence of the higher degree (19 to 30) coefficients is larger than the corresponding influence of lower degree (12 to 18) coefficients.

In the practical evaluation of the influences, it is found that they are very sensitive to the changes in the initial orbital elements. Since these initial elements are at present not known to the accuracy of being held fixed, it is concluded that contrary to the view expressed in Hajela (1974), it is not feasible to recover gravity anomalies from satellite to satellite range rate observables while holding the initial orbital elements fixed at some apriori values.

A feasible method must be capable of removing the contaminating influence of the initial orbital elements on the ultimate observables that will be used in anomaly recovery. One such method is to apply the least squares collocation to a set of quantities derived from filtered satellite to satellite range rates.

- 433 - CHRISTODOULIDIS D.C. - "On the realization of a 10 cm relative oceanic geoid". The Ohio State Univ., Dept. Geod. Sci. Rep. N° 247; 96 p, Columbus, 1976, for NASA, Goddard Space Flight Center, Greenbelt.

An investigation into the theoretical and numerical problems associated with the computation of a 10 cm oceanic geoid was carried out. Based on a model which requires potential coefficients and gravity anomaly information for the computation of geoidal undulations, an error analysis was developed through which the necessary data requirements for the realization of such a high accuracy geoid were derived.

In order to ensure the validity of the Stokes integral to the required level of accuracy, seasonal and latitude dependent atmospheric corrections to the gravity and height anomalies were developed. From these corrections it was deduced that when the combined latitudinal/seasonal dependence is neglected, the maximum error introduced is of the order of 40 uGals for the gravity corrections and 0.7 cm for the height anomaly corrections.

While attempting the error analysis in a more or less rigorous manner, the numerical difficulties associated with such an approach were brought to light. An approximate error model in the frequency domain was then developed through which an idea was obtained as to the nature, quality and quantity of the desired data requirements. Various data sets could result in a 10 cm relative oceanic geoid. One such set, indicative of the strictness of these requirements, involves gravity profile spacings of approximately 3 km with observational noise not exceeding 0.5 mGals inside detailed data caps of 30° , and potential coefficients available to degree and order 70.

- 434 - MORITZ H.- "Least-squares collocation as a gravitational inverse problem".
AFGL-TR-76-0278, The Ohio State Univ., Sci. Rep. N° 6, 28 p, 1976.

The report compares least-squares collocation methods for determining the Earth's gravitational field with geophysical inversion techniques. Both are underdetermined problems with strong structural similarities. Collocation is also considered from the point of view of representing the external gravitational field by means of analytic functions. Finally, the conceptual basis of least-squares collocation is briefly discussed.

- 435 - SANCHEZ B.V. - "Seismic effects on the rotational dynamics of the Earth and its gravitational field".
Goddard Space Flight Center, X-921-77-9, 35 p, Greenbelt, 1976.

- 436 - MARSH B.D. & J.G. MARSH - "On global gravity anomalies and two-scale mantle convection".
from : J. Geophys. Res., v. 81, N°29, p. 5267-5280, 1976.

RICHTER and PARSONS (1975) in their two-scale model of mantle convection predict that if the depth of the convective layer is about 600 km, then for a plate moving at 10 cm yr^{-1} , longitudinal convective rolls will be produced in about 50 m.y., and the strike of these rolls indicates the direction of motion of the plate relative to the upper mantle. In the case of the Pacific plate there should then exist a series of longitudinal convective rolls probably striking WNW. These predictive features of two-scale mantle convection are tested by examining a new global free-air gravity model which is complete to the thirtieth degree and order. To isolate only those anomalies with wavelengths of probable interest, the low degree and order field (degree of the field $n = 12$) is subtracted from a field complete to the twenty-second degree and order. The resulting free-air gravity map shows a series of linear positive and negative anomalies spanning the Pacific Ocean. Anomalies of this type are found only in the Pacific Ocean area. These anomalies cross the east Pacific rise and strike parallel to the Hawaiian seamounts. Their traverse wavelength is about 2000 km. Visual correlations between residual depth anomalies and free-air gravity in the central Pacific are fair. We suggest that the long linear pattern of free-air gravity anomalies may indicate the presence of longitudinal convective rolls beneath the Pacific plates. In order for these rolls to have been developed in the course of 43 m.y., the age of the bend in the Hawaiian Emperor seamount chain, for an absolute plate velocity of about 10 cm yr^{-1} the convective depth must be about 600 km or less. These results tend to support the predictions of the two-scale model of RICHTER and PARSONS.

- 437 - BREIN R., C. GERSTENECKER, A. KIVINIEMI & L. PETTERSSON - "Report on high precision gravimetry".
Lantmäteriet, Nat. Land Survey, Profes. Papers 1977/1, 26 p, Gävle, 1977.