

ASSOCIATION INTERNATIONALE DE GÉODÉSIE

---

**BUREAU GRAVIMETRIQUE  
INTERNATIONAL**

---

**BULLETIN D'INFORMATION**

**N° 38**

**Mai 1976**

**UNIVERSITÉ PARIS VI**

11, Quai Saint-Bernard - Tour 14  
75005 PARIS (FRANCE)

BUREAU GRAVIMETRIQUE  
INTERNATIONAL

Paris

-----

BULLETIN D'INFORMATION

Mai 1976

N° 38

Publié pour le Conseil International des Unions  
Scientifiques avec l'aide financière de l'UNESCO

Subvention UNESCO 1976 DG/2.1/414/42

## T A B L E    d e s M A T I E R E S

1ère Partie

- NOTICE NECROLOGIQUE
  - Prof. Julio Manuel MARTINS ..... p. I - 2.
- VARIOUS INFORMATION
  - A) Changes in the Gravity Reference System  
of Great-Britain ..... p. I - 3.
  - B) Recent publication : Geological-Geophysical Atlas  
of the Indian Ocean (Acad. Sci. USSR) ..... p. I - 3.
- INTERNATIONAL GRAVITY BUREAU
  - Compte-Rendu of the Joint Meeting of the IGB Directing  
Board and IGB Working Groups I, II and III,  
Feb. 23 - 25, 1976 ..... p. I - 5.
- INFORMATION ABOUT GRAVITY MEASUREMENTS AT SEA,  
1970 - 1975 (J. Bouvet) ..... p. I - 14.

2ème Partie

- Liste des publications reçues au B.G.I.  
(Avril à Novembre 1975)  
concernant les questions de pesanteur ..... p. II - 1.

-----

NOTICE NECROLOGIQUE

---

Nous venons seulement d'apprendre le décès du  
Professeur Júlio Manuel MARTINS malheureusement survenu en Mai 1975  
à Lisbonne après 3 mois de retraite.

La Communauté Gravimétrique Internationale a la grande tristesse  
de vous en faire part.

Né le 29 Juillet 1913 à Évora, J.M. MARTINS a fait ses études  
supérieures à l'Université de Lisbonne où il a obtenu une licence ès  
sciences mathématiques et le grade d'Ingénieur Géographe en 1937.

La même année, il a été nommé Professeur Agrégé et il a enseigné  
plusieurs matières notamment la Géodésie, l'Astronomie et la Topographie.  
Grâce à ses qualités et compétence, il a toujours eu le respect et l'amitié  
de ses élèves.

Cependant, c'est à l'Instituto Geográfico e Cadastral qu'il a  
passé la majeure partie de sa carrière professionnelle, débutant aux  
Services Géodésiques ; il en devint le chef en 1956.

Son oeuvre a l'empreinte de son profond intérêt et de ses con-  
naissances des problèmes de Géodésie : il s'est particulièrement occupé  
du réseau gravimétrique et a fait publier les premières cartes d'iso-  
anomaies du Portugal.

En 1961 M. J.M. MARTINS a été nommé Directeur de l'Instituto  
Geográfico e Cadastral.

M. J.M. MARTINS a participé à beaucoup de réunions scientifiques  
internationales et appartenait à plusieurs comités scientifiques :

- Secrétaire de la Direction de la Section Portugaise de l'UGGI ;
- Membre du Comité Permanent pour la Compensation d'Ensemble des  
Triangulations Européennes (RETrig) ;
- Président de l'Association Portugaise de Photogrammétrie ;
- Membre du Comité Permanent pour les Etudes de l'Espace Extérieur ;
- Président de la Délégation Portugaise à l'Assemblée Générale de  
l'UGGI (Lausanne, 1967) ;
- Président de la Délégation Portugaise à la Conférence pour la  
Standardization des Noms Géographiques (ONU Genève, 1957) ;
- Président de la Délégation Portugaise au XII Congrès des  
Surveyors (Londres, 1968) ;
- Président de la Délégation Portugaise au XII Congrès de la  
Société Internationale de Photogrammétrie (Ottawa, 1972) ;
- Invité d'honneur à la VII Conférence de l'Association Cartogra-  
phique Internationale (Madrid).

Décédé le 27 Mai 1975 à Lisbonne.

---

## V A R I O U S     I N F O R M A T I O N

---

### A) CHANGES IN THE GRAVITY REFERENCE SYSTEM OF GREAT BRITAIN

The reference points in this system are Fundamental Bench Marks (FBM). Gravity values at the reference points are given in Table 7 of "The National Gravity Reference Net (NGRN73)", Ordnance Survey, Professional Paper N° 26 (New Series), Ordnance Survey, Southampton, England. Two of the FBM have recently been demolished and re-erected at different sites for which gravity values have now been obtained.

The new values are :

FBM Name	National Grid Reference	Gravity (mGal)	Standard Error (mGal)
Glen Moriston	NH 4192 1658	981 668.846	0.042
Haverford West	SM 9673 1574	981 251.119	0.080

from : Lt Col M.R. RICHARDS RE, Assistant Director  
Geodetic Services, ORDNANCE SURVEY,  
Southampton - United Kingdom -

09.01.1976

### B) RECENT PUBLICATION

#### "GEOLOGICAL-GEOPHYSICAL ATLAS OF THE INDIAN OCEAN"

Academy of Sciences of the USSR, Main Administration of Geodesy and Cartography, under the Council of Ministers of the USSR, 151 p, Moscow, 1975. (Format : 37 x 65 cm).

Published in accordance with a decision of the Intergovernmental Oceanographic Commission UNESCO.

The International Indian Ocean Expedition (IIOE) was conceived in 1957 and carried out between 1959 and 1965.

For the purpose of the IIOE the Indian Ocean was taken to include the Red Sea, Persian Gulf, and the seas adjacent to the Sunda Arc, and to extend southwards to the Antarctic continent. The southwest and southeast limits were taken to be the longitudes of the southern points of Africa and Australasia (about 20°E and 147°E, respectively). During the course of the IIOE, 13 countries and at least 46 ships took part, some returning several times to the region. Initially the scientific programmes were co-ordinated, sometimes more and sometimes less, by a working group set up in 1960 by the Special (now Scientific) Committee on Oceanic Research (SCOR).

Numerous publications greatly adding to the body of scientific knowledge on the region have resulted from the expedition.

The Geological-Geophysical Atlas of the Indian Ocean has been under preparation since 1966, under the overall guidance of an International editorial board of scientists from a wide range of disciplines in the Earth sciences.



## PRESENTATION of DATA in the ATLAS

The geological and geophysical data are presented in nine sections under the titles of :

- I. Status of knowledge
- II. Bottom topography
- III. Photographs of the bottom
- IV. Magnetic anomalies
- V. Gravity
- VI. Heat flow
- VII. Seismicity and active volcanoes. Deep structure of the ocean floor
- VIII. Sedimentary cover and exposures of igneous rocks
- IX. Bottom sediments and suspended matter.

Each section is introduced by explanatory notes describing the nature of the data presented and some details of the charts and diagrams in the section.

Especially Section V - GRAVITY -

### Text

- Submarine pendulum observations
- Surface-ship gravimeter observations
  - 1. Errors in surface-ship gravity measurements
  - 2. Estimate of the accuracy of individual cruises and corresponding adjustments
  - 3. Method of construction of the map

### Charts

- Tracks of gravity survey
  - Free-air gravity anomalies of the Indian Ocean, sheets 1, 2, 3, 4, 5 and 6, 1 : 5.000.000.
  - Averaged Bouguer gravity anomaly map, 1 : 40.000.000,  $d = 2,67 \text{ g/cm}^3$ .
  - Position of gravity base stations and profiles, 1 : 40.000.000.
  - Schematic sections of the Earth's crust on the basis of gravimetric studies.
    - . Profile of free-air gravity field of the Arabian Sea
    - . Profile of free-air gravity field of the Carlsberg Ridge
  - Profiles of the continental slopes
  - Plans of gravity base stations
  - Bottom topography of the northwest Australian Shelf, Davis Sea, Antarctica
  - Davis Sea, 1 : 2.500.000.
  - Free-air gravity anomalies of the Indian Ocean, Indonesia, 1 : 5.000.000.
  - Free-air gravity anomalies of the Gulf of Aden, 1 : 2.000.000.
-

I N T E R N A T I O N A L   G R A V I T Y   B U R E A U

Joint Meeting of the I.G.B. Directing Board  
and I.G.B. Working Groups I, II, and III

February 24, 1976

Attendees

D.B. : C. MORELLI, Chairman	W.G. : S. CORON	Inv.: S. KRYNSKI
Y. BOULANGER	K. McCONNELL	J. LEPRETRE
J. LEVALLOIS	R. RAPP	J. LUBART
R. MATHER	W. TORGE	A. SAKUMA
J. TANNER	L. WILCOX	G. STANISLAS
U. UOTILA		

The group observed a moment of silence to honor Prof. HONKASALO, the late President of IAG Section III.

The purpose of the meeting was to summarize the work completed to date by the three IGB Working Groups and enable interchange of ideas between Members of the IGB Directing Board and Members of the Working Groups.

Members of the Working Groups are as follows :

Working Group I : Data Processing and Evaluation

J. TANNER (Canada), Convenor  
B. BARLOW (Australia)  
A. GERARD (France)  
L. WILCOX (U.S.A.)  
K. McCONNELL (Canada)  
W. STRANGE (U.S.A.)

Working Group II : Gravity Standards

U. UOTILA (U.S.A.), Convenor  
B. BARLOW (Australia)  
K. McCONNELL (Canada)  
W. TORGE (German Federal Republic)  
L. WILCOX (U.S.A.)

Working Group III : Presentation of Gravity Data

Y. BOULANGER (USSR), Convenor  
H. KAUTZLEBEN (German Democratic Republic)  
R. MATHER (Australia)  
R. RAPP (U.S.A.)  
O. WILLIAMS (U.S.A.)

C. MORELLI, J. LEVALLOIS and S. CORON are ex-officio Members of all three Working Groups.

J. TANNER presented the report of IGB Working Group I.<sup>(\*)</sup> He welcomed the enthusiastic data processing support being provided to IGB by BRGM, and there was general agreement that many thanks are due to BRGM from the international gravimetric community.

J. LEVALLOIS announced that one of the tasks of the IGB will be to adjust their gravity data holdings into agreement with the IGSN 71. The BRGM will not be expected to do any of these adjustments, their function is that of data processing.

The IGB has already completed adjustment of ORSTOM's data in Africa to the IGSN 71. The results of this work were published by IGB in January 1976.

J. TANNER requested that other agencies experienced in adjustment of heterogeneous gravity data to a common system provide data adjustment support to the IGB. L. WILCOX indicated that DMAAC may be able to provide some support in this area if requested to do so.

R. MATHER pointed out the need to identify the specific datum used for elevations at gravity stations for use in very precise geodetic studies. S. CORON suggested that the datum of horizontal positions be recorded also. J. LEVALLOIS confirmed the need for horizontal datum information in that, for example; discrepancies of up to one minute of arc in position are common between different map series in Africa. J. TANNER stated that horizontal and vertical datum can be added later on after the system becomes operational.

U. UOTILA presented the report of IGB Working Group II.

J. LEVALLOIS announced that the IGB needs assistance in acquiring all gravity data as well as IGSN 71 station data.

J. TANNER pointed out that the IGB data bank being set up by BRGM will establish a record of all base station information in addition to IGSN 71 sites. He recommended establishment of a consistent numbering system for base stations data and requested assistance from Working Group II in achieving transformation of all base station data to the IGSN 71 system.

U. UOTILA confirmed that Working Group II will assist in managing all base stations information, and requested that the Group be made aware of all new base stations ties. Other organizations which have done work in this area may be requested to assist.

(\*) See some details p.I-13.



U. UOTILA announced that the Working Group II has plans to follow up on the IGSN 71 questionnaire being sent to all national agencies. If necessary, these agencies will be recontacted to obtain names of individuals and agencies which can provide additional information about IGSN 71 sites.

K. McCONNELL indicated that EPB will notify IGB of all new and revised IGSN 71 material received as a result of replies to the Working Groups questionnaire.

Y. BOULANGER requested Working Group II to prepare a program for new absolute gravity measurements using the new more accurate absolute measurement apparatus now operational or soon to become operational. In the ensuing discussion it was agreed that the most logical priority for new absolute measurements is :

- 1) Comparison between the different absolute measurement systems to check the consistency of the different systems and determine whether or not any are subject to systematic error.
- 2) Observations along calibration lines over large gravity differences to check for linearity in IGSN 71.
- 3) Establishment of additional national base stations.

This sequence of priorities will be recommended to the IAG. Although the recommendation is in general agreement with a resolution adopted by the IAG in August 1975, the order of priorities is revised in the group's recommendation. Working Group II will establish plans for new absolute measurements within the context of this recommendation.

It was agreed that IGSN 71 must be the accepted absolute standard until the IAG recommends its replacement by a better standard. In the meantime, Working Group II can plan for future IGSN adjustments.

Y. BOULANGER presented the report of IGB Working Group III.

In the ensuing discussion it was generally agreed that the report of Working Group III establishes a set of priorities for the activities of the IGB which is compatible with the staffing limitation of the Bureau.

First in importance is the acquisition of gravity data and the transformation of this material to the IGSN 71 - GRS 67 system. The Bureau will release to users only data which is compatible with this system.

The second priority will be to compile and publish  $1^{\circ} \times 1^{\circ}$  and  $5^{\circ} \times 5^{\circ}$  equal area mean anomalies for areas where sufficient gravity data is available to support accurate estimates of the mean values.

Acquisition of sea gravity measurements has third priority.

Preparation of iso-anomaly maps will be done only as resources are available.

Other activities to be continued on a time available basis include publication of the IGB Bulletin of Information and satisfying miscellaneous requests from users.

The Directing Board of the IGB plans to discuss these priorities and the activities of the IGB, in general, in more detail.

L. WILCOX offered the support of DMAAC in providing mean elevations data to the IGB as requested. DMAAC also publishes and periodically updates mean anomaly values and their accuracies and will provide this material to the IGB. It may also be possible to provide published information on methods of mean anomaly determination. Consideration will be given to converting the continental gravity anomaly maps published by DMAAC into the format recommended by the Working Group.

A. SAKUMA presented a report on the results of absolute measurements made by the Istituto di Metrologia "G. Colonnetti" of Torino during 1975 in Italy using the new Italian apparatus. Five absolute stations were established between Catania and Torino. The standard error of measurement is 10 micro-gals. The work was done with financial support from the Italian Geodetic Commission to test the absolute apparatus and to unify the IGSN 71 stations in Italy.

Differences between the absolute measurements and IGSN 71 value ranged from + 0.13 mGal at Napoli, to + 0.12 mGal at Rome, and + 0.04 mGal at Torino. A. SAKUMA proposed that these differences, amounting to an error of about  $3 \times 10^{-4}$  the total gravity interval, might be caused by the influence of pendulum measurements in the IGSN 71 adjustment, secular changes in gravity due to tectonic movement, or an error in IGSN 71.

K. McCONNELL stated that the differences were most likely not due to pendulum influences in IGSN 71 since these measurements carried were small weight.

U. UOTILA and W. TORGE indicated that the differences are more likely due to a second order error in the adjustment of IGSN 71 rather than a systematic error.

C. MORELLI indicated that the Catania results were deleted due to mal-functioning of the apparatus and that the Italian absolute apparatus will make additional measurements in Italy this year which may confirm A. SAKUMA's initial results.

A general discussion of absolute gravity measurements, A. SAKUMA's results and its importance to Working Group II activities followed.

L.E. WILCOX

Meeting of the Directing Board and the Executive Committee,  
International Gravity Commission - 25 Feb. 1976.

---

Present :	Yu.D. BOULANGER	C. MORELLI (Chairman)
	S. CORON	J.G. TANNER
	S. KRYNSKY	W. TORGE
	J.J. LEVALLOIS	U.A. UOTILA
	R.S. MATHER	

C. MORELLI opened the meeting by raising the question of publishing the reports of the 3 Working Groups. It was decided that a summary of the joint meeting of the Working Groups held on the afternoon of 24 February should be published in preference to the individual WG reports.

J. LEVALLOIS reported on the activities of the IGB since the Grenoble General Assembly. Present efforts were largely concentrated on data in Africa which was currently being adjusted. It was felt that there was a reasonable probability that the order of priorities laid down in the WG 3 report could be met with the existing resources. Work was nearing completion on the preparation of a map of ocean gravity survey tracks.

C. MORELLI then requested reports from the WG Chairmen in the form of their expectations from the Bureau. The Chairman of WG 1 (J. TANNER) summarized his WG's requirements as follows :

- a) The primary requirement was that of providing scientific guidance to BRGM which has as its primary concern the preparation and maintenance of a storage and retrieval system.
- b) The second requirement was the publicizing of the BRGM system to both potential sources of input data as well as users.

After some discussion it was decided that such scientific guidance to the BRGM could only come from a source in France itself rather than from afar. While Canada might be able to release one person on a "once off" basis for about a month to train IGB personnel, J. TANNER felt it would be preferable if one of the scientific cadre of IGB (e.g., S. CORON) could spend some time in Canada to obtain a feel for the basis of providing scientific input to BRGM in the maintenance of the gravity data file.

As regards the requirement b), what was required was the publication of an article(s) in the appropriate scientific periodical(s) in about one or two years, describing the storage/retrieval system established for the information of contributors and users. A second stage would call for the National Committees and/or agencies to be contacted by the Executive Committee of the IGC seeking contributions for inclusion in the data bank and also calling attention to the facilities it offers for users.

The Chairman of WG 2 U.UOTILA stated his WG's requirements as follows :

- a) National Agencies should be contacted for descriptions of stations in IGSN 71 and their revision in order that an up-to-date file of station descriptions could be maintained.
- b) Information on new ties should be sent direct to EPB in Ottawa for appropriate action.

After some discussion it was decided that the required information could be sent in any reasonable format so long as there were no omissions. This would include station descriptions as well as values obtained for the ties. This aspect of the work at IGB would be supervised by S. CORON. The EPB, Ottawa, has provided a tape containing all information on IGSN 71 stations to IGB.

J. TANNER pointed out the importance of maintaining such information for all appropriate secondary stations which were not in IGSN 71 but which had been adequately connected to the former, along with details of such connections.

The Chairman of Working Group 3 Y. BOULANGER summarized his group's requirements from IGB as follows :

- a) All gravity data released should be made compatible with IGSN 71 and GRS 67.
- b) The preparation of one degree equiangular free-air anomaly area means and five degree equal area free-air anomaly means in regions where the quality of data warranted such effort as detailed in the WG 3 report.
- c) The compilation of ocean gravity survey tracks on a quadrennial basis.
- d) If resources were available, it was desirable to prepare a 1:15,000,000 series of Bouguer anomaly maps compatible with the International Geotectonic Map of the World Series.

It was felt that the requirement at b) could only be achieved after the BRGM storage/retrieval system was set up in about a year's time. It might be necessary to prepare the mean anomalies region by region as resources and the available data permitted. On d), Y. BOULANGER stressed the importance of the task, despite the inability of IGB to tackle it with its inadequate resources. He felt that the accuracy requirements of the data was less exacting than that for geodetic purposes and that such a task could be pursued without waiting for the final adjustment of data.

R. MATHER drew the attention of the meeting to the offer of the Soviet Geophysical Committee to actively participate in such a task and to the fact that DMAAC was shortly to release a Bouguer anomaly map of South America. In addition, Bouguer anomaly maps were available for Canada, USA, Australia and other regions ... The problem is that they did not constitute a uniform series, that met the requirement at d).

After some discussion, it was decided that the Executive Committee of the IGC consider the matter of setting up a Working Group to look into the matter. This was unanimously approved by the EC IGC and Y. BOULANGER was elected unopposed as Chairman of the Working Group on the International Bouguer Anomaly Map Series. The Working Group would seek the co-operation of member nations of the IGC in contributing data to such a project and/or preparing maps in the series if such assistance could be given.

C. MORELLI then asked the meeting to discuss the work priorities of the IGB. J. LEVALLOIS recommended that first priority be given to the adjustment of data in Africa. It was also considered of high priority to write to all member nations to publicise the IGB and call for contributions to the data bank. It was also decided to request each National Committee to appoint a National Correspondent who would keep the IGB informed through the National Committee, of all gravimetric work and publication in his country.

S. CORON will take care to publish in the "Bulletin d'Information" the gravimetric Bibliography.

On the finances of the IGB, J. LEVALLOIS stated that \$ 3,000,00 was received from FAGS in 1975 and it was expected that an equivalent sum would be received in 1976. This should become known in April. In addition, a special subvention is being sought from ICSU for the African adjustment.

C. MORELLI reminded that after the IUGG Meeting, he asked FAGS an additional subvention 1975 (about : \$ 3,500) for the work of IGB concerning the gravity storage in the data bank and the publication of the chart : Sea gravity tracks. In his answer, G. GARLAND reported on the possibility that a "substantial part" of this grant could be approved and voted by the Council of FAGS.

J. TANNER would raise the matter of FAGS support for the IGB personally with J. GARLAND.

It was also decided to charge all users of IGB for services beyond the usual servicing operation. While costs would be charged at the discretion of the Director, it was generally agreed that a charge of "cost plus 75 %" should normally levied, with "cost" being defined as expenses over and above recurrent expenditure.

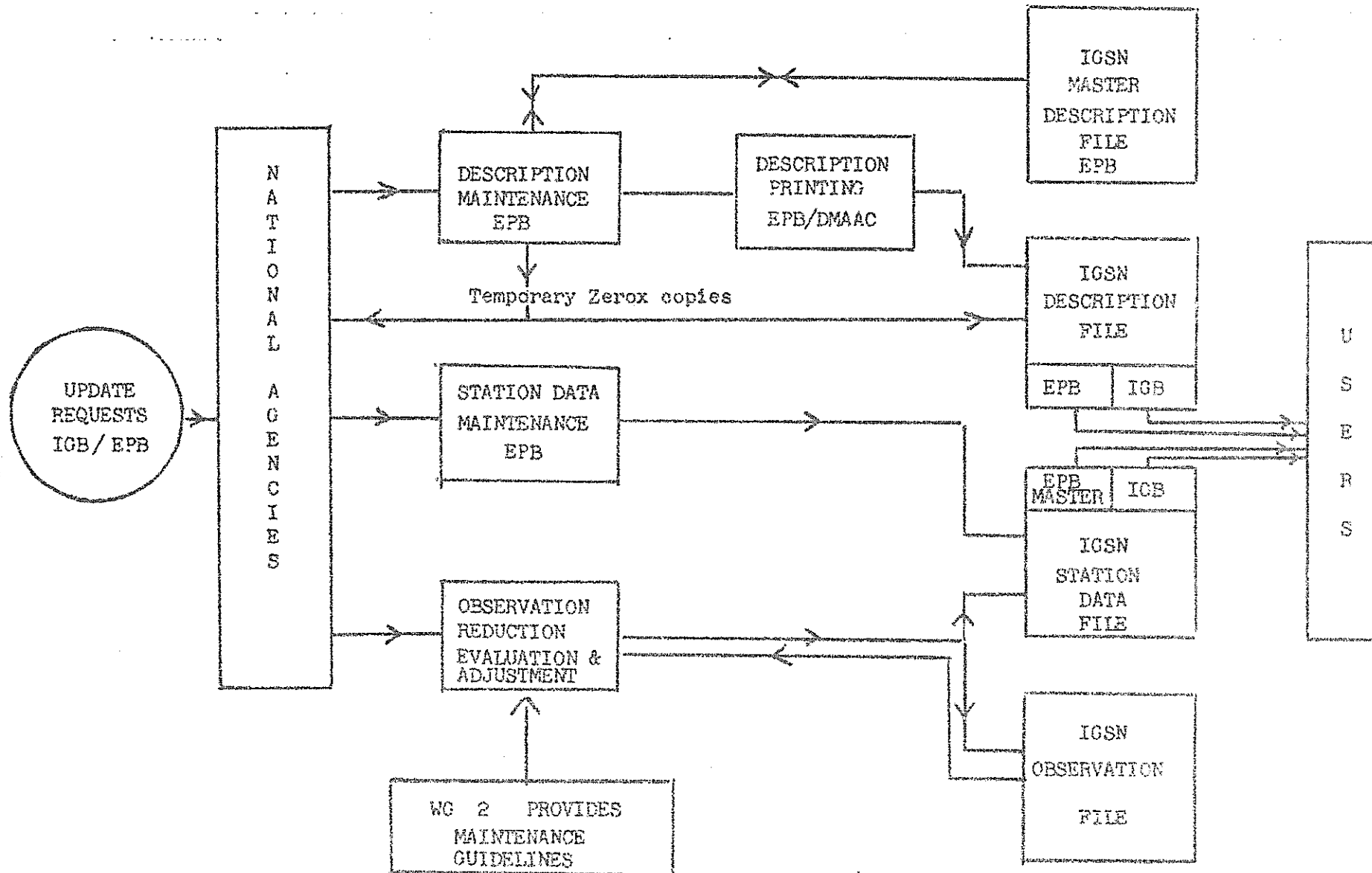
J. LEVALLOIS expressed reservations on the ability of IGB to make such charges under French law. It would be necessary to issue such invoices under the aegis of either the IAG or ICSU. J. TANNER was requested to bring up the subject at the IAG Executive Meeting to be held on 26-27 Feb., and request Executive Committee permission for such action.

C. MORELLI raised the question of the continuation of the "Bulletin d'Information". All agree that it must be continued.

The next meeting of the Directing Board was tentatively scheduled for February 1977.

R.S. MATHER

# I G S N    M A I N T E N A N C E    S Y S T E M





Extract from the Compte-Rendu of the Working Group N° 1.

...

The Working Group then turned to a consideration of the format in which data will be made available to users. A sub-committee consisting of L. WILCOX, A. GERARD and R. RAPP (representing Working Group 3) was appointed to develop a recommendation in this respect. After discussion this sub-committee suggested a "select" file containing the following :

- (a) latitude
- (b) longitude
- (c) elevation
- (d) type of elevation
- (e) supplementary elevation (indicates presents of water depths,  
ice thickness etc ...)
- (f) gravity value
- (g) reference station
- (h) free-air anomaly (compute on retrieval)
- (i) Bouguer anomaly (compute on retrieval)
- (j) indicator of availability of other anomalies
- (k) terrain correction
- (l) source code or reference to original data.

Associated with each retrieval will be a source code list and a reference stations list. The source code list will indicate the origin of the data by country and project (including reference to publications if appropriate). This source code is a unique reference to the data, location, type, and accuracy of the survey. The reference stations list will contain the principal facts for control station.

Copies of the report prepared by BRGM<sup>✱</sup> are available through S. CORON of the IGB. This report described in detail the IGB format upon which the select format is based. Users should note that data will normally be made available on the select format and only by special request will they be made available on the longer more format IGB format adopted in 1963. All gravity values will be transformed to the IGSN 71 system and all anomalies calculated using Geodetic Reference System 67.

In a second session, the Working Group considered its future activity. After discussion it was agreed that L. WILCOX will prepare documents outlining standard techniques for reducing and processing land and marine observations given with the original observations or the reduced data in the form of gravity values or anomalies. It is estimated that these reports will take about a year to prepare.

They will be published in the Bulletin d'Information of the IGB in the hope that they will provide a basic reference for the reduction and presentation of gravity data.

The Working Group is very pleased to note the good work of BRGM. An excellent start has been made on the development of the retrieval system and this augurs well for the future.

J.G. TANNER

✱ "Progress report for the creation of a worldwide gravimetric data bank", J.P. LEPRETRE.

## INFORMATION ABOUT GRAVITY MEASUREMENTS AT SEA

1970 - 1975

At the Meeting of the IUGG (Grenoble, August 1975), the Members of the Section III - Gravity - wished to update a map of gravity tracks at sea.

Two editions of this map have already been published in the Bulletins d'Information of BGI (1966 and 1970).

- Index sheet : Sea Gravity Measurements
  - . 1st edition : Bull. Inf. BGI N° 14, November 1966,
  - . 3rd edition : Bull. Inf. BGI N° 22, March 1970.
- Detailed sheets concerning the highly explored sea areas :
 

. North Atlantic : N° 3-4	}	Bull. Inf. BGI N° 22, March 1970
. Center Atlantic : N° 7		
. South Atlantic : N° 11		
. Mediterranean sea : N° 8	}	Bull. Inf. BGI N° 25, March 1971
. Indian Ocean : N° 8-12		

95°W	5°E	105°E	
3	4		80°N
7	8		55°N
11	12		11°S
			65°S

A circular sent on September 26, 1975 requested to the interested Services to mention the works performed since 1970 or the works not yet published in the previous editions. From the replies received at the BGI it has been possible to present, here-after, a general view on the recent works at sea.

The BGI thanks very much the Organizations for their collaboration.

The following pages are dealing with the items :

- A - General presentation of the map
- B - Tables of sea gravity tracks
- C - Information on the works of each country and Services.

A - General presentation of the map

On the complementary map (1970-1975) presented at the end of this Bulletin are reported :

- the tracks omitted or amended in the previous editions,
- the new tracks (1970-75) received at the BGI in due time to be inserted in this Bulletin.

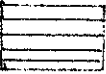



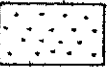

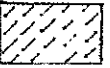
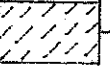
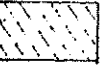
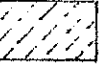
As for the previous editions, the tracks have been distinguished according to the Nation which carried out the surveys (see legend). In the case where groups of several countries participated in the operations the distinguishing mark of the most concerned country was preserved, but the participation of other Services is indicated in the text.


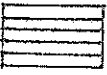
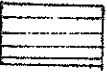
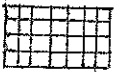
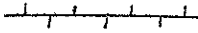
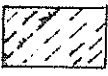
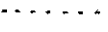
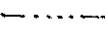
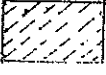

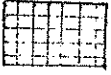

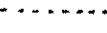

The recapitulative tables (B) permit the identification of gravity tracks, the Country and the Organization which performed the tracks.

## B - TABLES of SEA GRAVITY TRACKS and SURVEYS

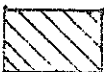






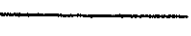
(for each ocean, from North to South approximately)

ATLANTIC, ARCTIC and ANTARCTIC OCEANS

Region of gravity traverse	Country	Reference
Lincoln Sea Beaufort Sea Baffin Bay Davis Strait	 Canada	Dept. En. Min. Res.
Arctic Oc. - Norw. Sea North Atlantic	..... France	CNEXO
Norw. Sea - North Atl.	 France	Serv. Hydrog. Mar.
Iceland - Faroe Ridge and Jan Mayen Ridge	 G.F.R.	D. Hydrog. Inst.
Iceland Coast	 Iceland	Nat. En. Aut.
Interior Danish Sea	 Denmark	Geod. Inst.
Coastal Baltic Sea	 Poland, USSR	Inst. Geod. Cartog. Acad. Sci. USSR
Western Baltic Sea	 G.F.R.	N.L.f.B.
East Greenland Margin	----- U.K.	Univ. Durham
N.E. Atl. - Norw. Sea	 G.F.R.	N.L.f.B.
Atlantic Ocean	----- U.S.A.	Lamont D. Geol.Obs.
Norw. Seashore	 Norway	Norges Geogr. Opp.
Northern North Sea	 G.F.R.	N.L.f.B.

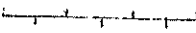

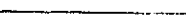
Mid Atl. Ridge		U.K.	Univ. Cambridge
Gulf of St Lawrence Coast of Labrador North West Atlantic		Canada	Dept. En. Min. Res.
Bay of Fundy		Canada	Oc. Lab. Bedford
Around British Isles King Trough		U.K.	Hydrog. Dept.
Spanish Coast, Africa Carribean Sea		USSR	Acad. Sci. USSR
Portugal Coast		France G.F.R.	CNEXO N.L.f.B.
Azores - Gibraltar		France	CNEXO
Around Azores Isl.		G.F.R.	D.H.I.
Morocco Coast		G.F.R.	N.L.f.B.
Around Canary Isl.		G.F.R.	N.L.f.B.
E. and W. approaches to Santa Lucia - West Indies Aves Ridge to Windward Isl.		U.K.	Hydrog. Dept. Univ. Durham
American and African Coasts		U.S.A.	Lamont D. Geol.Obs.
S.W. and S.E. Atlantic		France	CNEXO
Around S. Georgia and Falkland Isl. Scotia Sea Weddell Sea		U.K.	Univ. Birmingham

PACIFIC OCEAN

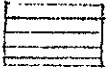
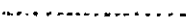
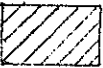
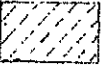
Region of gravity traverse	Country	Reference
N. Pacific Ocean W. Pacific Oc. (Japan)	 U.S.A.	Univ. Hawaii Lamont D. Geol.Obs.
Around Japan	 Japan	Hydrog. Dept.
Suiko Seamount	 Japan	Oc. Res. Inst.
Okhotsk Sea Japan Sea	 U.S.S.R.	Acad. Sci.
Owen Shoal <sup>⊠</sup> 8°30'N ; 11°E.G.	U.K.	Hydrog. Dept.
W. and Center Pacific	 U.S.S.R.	Acad. Sci.
Eastern Pacific Alaska... Chile	 U.S.A.	Oregon St. Univ.
Bougainville Strait <sup>⊠</sup> 6°30'S ; 155°30'E.G.	U.K.	Hydrog. Dept.
Solomon Islands <sup>⊠</sup> 7°S ; 157°30'E.G.	U.K.	Hydrog. Dept.
Around Australia	 Australia	Bur. Min. Res.
S. Pacific Ocean	 U.S.A.	Lamont D. Geol.Obs.

<sup>⊠</sup> Small surveys not indicated on the map.

INDIAN OCEAN

Region of gravity traverse	Country	Reference
N. part Indian Ocean Center Indian Ocean	 U.S.S.R.	Acad. Sci.
Indian Ocean	 U.S.A.	Lamont D. Geol.Obs.
Male and Fadifollu Atolls <sup>*</sup> 4°30'N ; 74°E.G.	U.K.	Hydrog. Dept.
Ninety East Ridge 89°E - 3°S	 U.S.A.	WHOI 1971
Aldabra Island <sup>*</sup> 9°30S ; 46°E.G.	U.K.	Hydrog. Dept.

CONTINENTAL SEAS and LAKES

Erie Lake	 Canada	Dept. En.Min.Res.
Mediterranean Sea Alboran Sea	 France	C.N.E.X.O.
East Mediterranean	 Italy	O.G.S., I.M.G.A.
Southern Red Sea	 G.F.R.	N.L.f.B.

<sup>\*</sup> Small surveys not indicated on the map.



C - Information on the work of each Country and  
Services mentioned in the tables.

AUSTRALIA

Bureau of Mineral Resources, Geology and Geophysics

A marine geophysical survey was carried out between September 1970 and January 1973 for the B.M.R. to determine the extent of the Australian continental margins, and to obtain regional information on the geological structure. The survey covered the continental slope and marginal plateaux around Australia and Papua New Guinea, parts of the continental shelf, and some oceanic areas in the Tasman and Bismarck Seas. A total of 176 000 km was traversed in water between about 50 m and 5000 m deep, at a line spacing which varied from 18 km in some areas of New Guinea to 63 km off the west coast of Australia.

Primary position fixes were obtained at approximately two-hourly intervals by satellite Doppler. Intermediate positions between the satellite fixes were obtained by sonar Doppler backed by Chernikeeff electromagnetic log, pressure log and gyrocompass records.

A LaCoste & Romberg marine gravity meter (n° S.24) mounted on a gyro-stabilized platform near the centre of the ship, provided gravity data which was recorded on digital tape together with navigational data, water depth and the total magnetic field. An analogue magnetic tape recorded the results of a 120 kilojoule sparker used for sub-bottom seismic profiling.

The drift of the gravity meter varied between 0.1-1.1 mGal/month throughout the survey. The presence of about seven major tares, or unrecorded gravity meter adjustments, result in a contribution to the uncertainty in the gravity values of about one milligal. However, the largest errors in gravity mapping are those caused by errors in position. An estimate of the accuracy of the free-air anomalies is given by the discrepancy of the gravity values at the line intersections ; these have a standard deviation of 6 mGal. The quality of the data gathered during this survey is described in the field progress reports of the contractor, Compagnie Générale de Géophysique. Final reports are in preparation by BMR.

L.C. NOAKES

2.2.76

## CANADA

Department of Energy, Mines and Resources

We mention, hereafter, the maps and some publications concerning the sea gravity results.

Maps : Canadian Hydrographic Service, Ottawa, published charts with gravity anomalies in the Atlantic Ocean, Canadian seaboard.

- Free-air anomaly maps (n° 14976, 14978, 15070, 14982, 14984, 14986, 14988, 15080),
- Bouguer anomaly maps (n° 14978, 15070, 14988, 15080).

Published maps may be ordered from : Hydrographic Chart Distribution Office, Department of the Environment, OTTAWA, Ont., Canada K1A 0E6.

PublicationsLincoln Sea (62°W - 83°N) :

SOBCZAK L.W., L.E. STEPHENS - The gravity field of Northeastern Ellesmere Island, part of Northern Greenland and Lincoln Sea with map n° 114 - Lincoln Sea. Gravity Map Ser., Earth Physics Branch, Ottawa, 1974. (Abstract n°442, Bull. Inf. BGI n° 37, p.II-20).

Coast of Labrador

VALLIANT H.D., R.F. MACNAB, L.E. STEPHENS, S.T. GRANT & R.V. COOPER - Results of underwater and surface regional gravity surveys off the Coast of Labrador, 1972 with maps : 156 - Hamilton Inlet (Bouguer and Free-air). Dept. En. Mines & Res., Ottawa, 1974. Gravity Map Ser., Earth Physics Branch, S = 1/1.000.000°

Queen Elisabeth Islands and Polar Continental margin :

SOBCZAK L.W., R.J. WEBER - Gravity measurements over the Queen Elisabeth Islands and polar continental margin with maps : n° 115 - Queen Elisabeth Islands (East), n° 116 - Queen Elisabeth Islands (West). Gravity Map Ser., Earth Physics Branch, Dept. En. Mines & Res., Ottawa, 1970. (Abstract n°268, Bull. Inf. BGI n°26, 1971, p.II-29).

Gulf of St LawrenceErie Lake

Surveys are now complete (information 1970).

Bedford Institute of Oceanography, Dartmouth, N.S.

"The Canadian Hydrographic Service and the Atlantic Geoscience Center, Bedford have been cooperating in systematic geophysical surveys of the Atlantic Seaboard of Canada since 1964".

HAWORTH R.T. - Multiparameter surveys of Canada's Atlantic Continental margin. See Bull. Inf. BGI n°35, p.I-53 to I-59, 1974.

HAWORTH R.T., L.F. BARRETT & J.B. MACINTYRE - Bathymetry gravity and magnetic data cruise Bl 72-009 Dawson. Data Ser. Bl-D-72-14/ Sept. 1972.

"The survey performed aboard CSS DAWSON during cruise BI 72-009 from April 17 to May 19, 1972 covered portions of the Grand Banks south and southeast of Newfoundland, the Laurentian Channel and transit lines across the Scotian Shelf. Although the majority of the survey was carried out on the continental shelf, several lines were extended across the continental slope

"An omission of the Bay of Fundy survey area and of 3 survey lines completed during 1970" have been added on this new edition."

HUDSON	19 - 64	Bay of Fundy
HUDSON	050 - 69	Atlantic Ocean
BAFFIN	02 - 70	

DENMARK

Geodaetisk Institut, ChalottenlundInterior Danish Waters (10°E - 57°N) from 1970-75

"are not published yet but ... will be published by the Geodaetisk Institute in the near future".

Publications concerning sea gravity tracks already mentioned on the detailed map 3. (Bull. Inf. BGI n°22, 1970) :

ANDERSEN O.B. - Surface-ship gravity measurements in the Davis Strait, Western Greenland 1965. Geodaetisk Inst., Sk. 3 Raekke, Bind 39, Copenhagen, 1973.

ANDERSEN O.B. - Surface-ship gravity measurements in the North Atlantic Ocean 1965.- 1968. Geodaetisk Inst., Sk. 3 Raekke, Bind 41, Copenhagen, 1975.

O.B. ANDERSEN

30.09.75

## FINLAND

Geodetic Institute, Helsinki

"Since 1956 we have measured 1176 new stations on the Islands near to the coastline, in the Gulf of Finland, in the Aland Archipelago and in the Gulf of Botnia. We consider these stations as land stations though this net goes up to the outermost rocks in the sea and so comes near to our stations in the sea bottom".

T. HONKASALO  
3.10.75

## FRANCE

Centre National pour l'Exploitation des Océans

Cartes des trajets communiquées par J.C. SIBUET (Centre Océanologique de Bretagne) le 2/12/1975.

Ces croisières se répartissent dans les zones suivantes :

Mer de Norvège - Océan Arctique : Campagne "Nestlante II".

du 19/8 au 31/10/1970, (Bull. n°21, CNEXO, Sept. 1970).

Zone située approximativement entre 60° .. 80°N et 30°E .. - 10°W.G.

Mer de Norvège : Campagne "Norge".

du 9/9 au 15/10/1974, N.O. Jean CHARCOT <sup>⌘</sup>

Zone située approximativement entre 50° .. 60°N et 0° .. 5°E.G.

et entre 60° .. 70°N et 15°E .. - 25°W.G.

Atlantique Nord : Campagne "Rift"

du 19/9 au 10/10/1973, N.O. Jean CHARCOT. CNEXO, Rapport annuel 1973.

Zone située approximativement entre 15° .. 47°N et - 10° .. - 35°W.G.

Atlantique Nord : Campagne "Midlante A et Midlante B".

du 21/4 au 13/6/1974, N.O. Jean CHARCOT <sup>⌘</sup>

Zone située approximativement entre 15° .. 30°N et - 15° .. - 30° W.G.

et entre 30° .. 60°N et 0° .. - 60°W.G.

Côte du Portugal : Campagne "Cineca 74

Zone située approximativement entre 35° .. 45°N et - 10° .. - 15°W.G.

Mer d'Alboran : Campagne "Albatlante".

du 5/11 au 16/12/1974, N.O. Jean CHARCOT <sup>⌘</sup>

Zone située approximativement entre 34° .. 47°N et - 5° .. - 15°W.G.

<sup>⌘</sup> CNEXO, Rapport annuel 1974.

de Gibraltar aux Açores : Campagne "Gibraco",

du 9/8 au 5/9 1972, N.O. Jean CHARCOT, CNEXO, Rapport annuel 1972.  
Zone située approximativement entre  $33^{\circ}$  ..  $39^{\circ}$ N et  $- 5^{\circ}$  ..  $- 30^{\circ}$ W.G.

Mer Méditerranée Occidentale : Campagne "Polymède I"

du 10/5 au 3/7/1970, près du seuil de Gibraltar. Les résultats sont publiés dans le cinquième des rapports de la série "Résultats des campagnes à la mer". Chaque chapitre contient : la liste des points de la navigation, les cartes de navigation, de la bathymétrie, de la gravimétrie, du magnétisme ...

En vente au prix de 100 FF, Service de l'Information du CNEXO, B.P. 107, 75783 PARIS Cedex 16. Bull. Inf. CNEXO n°52, Avril 1973.  
Zone située approximativement entre  $35^{\circ}$  ..  $47^{\circ}$ N et  $10^{\circ}$ E.G. ..  $- 10^{\circ}$ W.G.

Mer Méditerranée Occidentale et Orientale : Campagne "Polymède II".

du 23/3 au 27/5/1972, N.O. Jean CHARCOT, CNEXO, Rapport annuel 1972.  
Zone située approximativement entre  $35^{\circ}$  ..  $44^{\circ}$ N et  $26^{\circ}$ E.G. ..  $- 5^{\circ}$ W.G.

Atlantique Sud-Ouest : Campagne "Géobrésil"

du 2/10 au 23/12/1973, N.O. Jean CHARCOT. CNEXO, Rapport annuel 1973.  
Zone située approximativement entre  $- 30^{\circ}$ S ..  $40^{\circ}$ N et  $- 10^{\circ}$  ..  $- 45^{\circ}$ W.G.

Atlantique Sud-Est, région comprise entre l'Angola et le Nigéria :

Campagne "Walda", du 24/5 au 24/8/1971, N.O. Jean CHARCOT, CNEXO, Rapport annuel 1971.  
Zone située approximativement entre  $- 25^{\circ}$ S ..  $5^{\circ}$ N et  $15^{\circ}$ E.G. ..  $- 5^{\circ}$ W.G.

Service Hydrographique de la Marine

Mer de Norvège : Levés antérieurs non reportés sur la Carte

générale 1970, (Bull. Inf. BGI, n°22, Mars 1970), mais signalée dans le Bull. Inf. BGI n°23, Juin 1970.

GERMAN FEDERAL REPUBLIC
-------------------------

Deutsches Hydrographisches Institut, HamburgNorth Atlantic, around Iceland

"Within the framework of the North Atlantic programme of the D.H.I., the following detailed gravimetric surveys have been undertaken in the years from 1970 to 1975 :

<u>Year</u>	<u>Ship</u>	<u>Area</u>	<u>Track Dist.</u>	<u>Track Direction</u>	<u>Other disciplines</u> <sup>*</sup>		
1970	METEOR	Iceland Faroe R. Northwestern part	4 n.m.	45/225°	M	B	
1971	KOMET	Iceland-Jan Mayen R. (Kolbeinsey R.)	6 n.m.	90/270°	M	B	
1972	METEOR	East of Iceland (South of Jan Mayen R.)	6 n.m.	90/270°	M	B	S
1975	KOMET	South of Iceland	7.5 n.m.	97/277°	M	B	S

Free-air and simple Bouguer anomalies have been published in the papers by :

MEYER O., D. VOPPEL, U. FLEISCHER, H. CLOSS & K. GERKE, 1972, Results of bathymetric, magnetic and gravimetric measurements between Iceland and 70°N, Dt. Hydr. Z., 25, 193-201. Abstract n°178, Bull. Inf. BGI, n°34, p.II-14.

FLEISCHER U., F. HOLZKAMM & D. VOPPEL, 1974. - Die Struktur des Island-Farøer-Rückens aus geophysikalischen Messungen, Dt. Hydr. Z., 27, 97-113. Abstract n°500, Bull. Inf. BGI, n°37, p.II-28.

(D. VOPEL) for U. FLEISCHER

16.10.75

<sup>\*</sup> M = Magnetics (total intensity)  
B = Bathymetry  
S = Reflexion Seismics



Niedersächsisches Landesamt für Bodenforschung (NLfB)  
and Bundesamtalt für Bodenforschung (BfB), Hannover.

"... The areas with tracks of the sea gravity surveys which have been carried through by the BfB and the NLfB have been added".

Portugal coast, "gravity measurements during METEOR cruise N° 8 1967".  
 Zone approximately situated at 39°N and 11°W.G.

Gravity survey of Small and Great METEOR Seamount in 1967 with R.V. METEOR.  
 Zone approximately situated at 30°N and 28°W.G.

S. PLAUMANN : "Zur gravimetrischen Bestimmung der Dichte von Seamounts mit Anwendung auf die Kleine und Grosse Meteor-Kuppe". Geologisches Jahrbuch, Reihe E, n°2, S.99-110, Hannover, 1974.

A gravity survey in the Norwegian Sea with R.V. PLANET in 1969.  
 Zone approximately situated at 64° .. 68°N and - 7°W.G. .. 10°E.G.

H.A. ROESER, S. PLAUMANN, E. FORSTNER-BALLHEIM : "The crustal structure of the Norwegian continental margin and the Norwegian Basin according to magnetic and gravimetric measurements". Meteor-Forschungsergebnisse, Reihe C, n°21, Berlin, Stuttgart, 1975.

A detailed gravity survey of the Southern Red Sea, performed in 1971 aboard R.V. VALDIVIA.  
 Zone situated between 14°N and 19°N.

H.A. ROESER & B. STORK : "Gravimetrische und magnetische Messungen im Roten Meer zwischen 14° und 19°N. In : VALDIVIA VA 01/03, Rotes Meer - Golf von Aden. Wiss. Erg. I, Bundesanst. Bodenforsch., Hannover.

S. PLAUMANN : "Some results of a detailed gravimetric survey of the Southern Red Sea". Geologisches Jahrbuch, Reihe D, n°13, Hannover, 1975.

Gravity measurements in the Western Baltic Sea with R.V. PLANET in 1973.  
 Zone approximately situated at 54°30'N and 10° ... 13° E.G.

Gravity survey in the Northern North Sea aboard R.V. FRIEDRICH HEINCKE in 1974.  
 Zone approximately situated at 60°.. 62°N and 0° .. 7° E.G.

S. PLAUMANN  
 27.10.75

Note : One track starting from Canary Islands (30°N - 17°W to 28°W) had not been reported on the previous chart (detailed map n°8, Bull. Inf. BGI n°25, March 1971).  
The results of the gravity survey in this area with R.V. METEOR (1967) were published :

ROESER H.A., K. HINZ & S. PLAUMANN - Continental margin structure in the Canaries". In : The Geology of the East Atlantic Continental Margin. Edited by F.M. Delany. Inst. Geol. Sci., Rep. n°70/16, p.27-36, Cambridge, 1971.

# ICELAND

Orkustofnun, Reykjavik

Atlantic Ocean, around Iceland

gravity tracks of :

NEA - DMATC, 1972  
NEA - DMATC, 1973  
US NAVOCEANO, 1967-69

National Energy Authority (NEA), Reykjavik  
Defence Mapping Agency Topographic Center (DMATC), Washington  
US Naval Oceanographic Office (US NAVOCEANO), Washington.

G. PALMASSON  
31.07.74

# ITALY

Istituto di Miniere e Geofisica Applicata, Fac. Ing. Univ. Trieste.  
Osservatorio Geofisico Sperimentale, Trieste.

Recent publications concerning the Mediterranean Sea :

MORELLI C., C. GANTAR & M. PISANI - Bathymetry, gravity and magnetism in the Strait of Sicily and in the Ionian Sea. Boll. Geof. teor. appl., v.XVII, n°65, Marzo 1975.

. Strait of Sicily	32° - 38°30'N ; 10°30' - 16°E.G.
. Ionian Sea North	36°30' - 41°N ; 15° - 22°30'E.G.
. Ionian Sea South	30°20' - 37°N ; 16° - 21°E.G.

MORELLI C., C. GANTAR & M. PISANI - Geophysical studies in the Aegean Sea and in the Eastern Mediterranean. Boll. Geof. teor. appl., v.XVII, n°66, Giugno 1975.

. Aegean Sea	35°30' - 41°N ; 22°30' - 27°30'E.G.
. South Crete	31°30' - 37°N ; 21° - 26°30'E.G.

MORELLI C., M. PISANI & C. GANTAR - Geophysical anomalies in the Western Mediterranean. Boll. Geof. teor. appl., v.XVII, n°67, Set. 1975.

. Alboran Sea	35° - 39°20'N ; 4°20'W - 2°40'E.G.
. Gulf of Lions to Corsica	40°30' - 44°30'N ; 2°30' - 11°E.G.
. Balearic I. to Sardinia	36°30' - 40°40'N ; 2°30' - 11°E.G.

JAPAN

Hydrographic Department, Maritime Safety Agency, Tokyo

Hydrog. Dept. is conducting gravity measurement on sea surface to prepare the Basic Map of the Sea in Continental Shelf Areas. Each set of the Basic Map consists of 4 sheets : bathymetric chart, submarine structural chart, total magnetic intensity chart and gravity anomaly chart at 1/200.000 scale ; the last one shows 10 mGal contours of free-air anomaly. Surveyings are made by using two surveying ships : the Shoyo and the Meiyo, each of which is equipped with Tokyo Surface Ship Gravity-Meter (T.S.S.G.). Spacing of surveying lines is 2 n.miles in general. Raw data of gravity measurement are published in the Data Report of Hydrographic Observations, Series of Astronomy and Geodesy annually. Surveyings for this project have been made since 1968 and are expected to be completed in 1976 to cover the whole areas of continental shelf around Japan by 80 sets of the Basic Map. It is planned that, after finishing the present project, similar surveyings will be made in the deeper waters of the Northwest Pacific to publish another series of the Basic Map of the Sea at 1/500.000 scale.

For calibration of surface values, the department is making gravity measurement on sea bottom by an underwater research vessel Sinkai by installing LaCoste or Worden gravimeter. Measurement has been made at 14 spots at the depths of 65 to 150 metres off Sikoku.

A new type gravimeter has been developed at the department. It is one of static types and oscillation of its spring is damped by high viscous silicon-oil. Tests on board suggest its measuring accuracy of about  $\pm 1$  mGal on sea surface and  $\pm 0.1$  mGal on land.

D. SHOJI  
28.11.75

Note : Practically the limits of the surveyed area around Japan has been taken from :

Report on the Geodetic Works in Japan for the period from Jan. 1971 to Dec. 1974. XVIth General Assembly of IUGG, Grenoble, France, 1975. Nat. Com. for Geod. & Geophys., fig. 4.

The Ocean Research Institute of the University of Tokyo

has surveyed mainly over the Western Pacific Ocean by the Hakuho maru equipped with a TSSG. The total mileages (8 cruises) amount to about 54,000 miles during the period of 1971-74.\* TOMODA (1972-73) compiled gravity anomalies in the Pacific Ocean and published maps of free-air and Bouguer anomalies in and around the Japan (TOMODA 1973) from : Report on the Geodetic Works in Japan 1971 - 1974.

Suiko Seamount

"Observations made on board the Hakuho maru (cruise KH 68-3) (sec. 1-5) ; this seamount is located in the Emperor Ridge in the North Pacific Ocean (170°E.G., 45°N) from J. SEGAWA (1970), see abstract in Bull. Inf. BGI n°28, p.II-4.

## NETHERLANDS

Technische Hogeschool, Delft

"No measurements were made during the years 1970 - 75. This is caused by the fact that our ship was too bad and is taken out of duty.

At the moment a new oceanographic ship is built and will be ready about in 1978. After that time new seagravity measurements will probably be done".

G.L. STRANG van HEES

3.10.75

## NORWAY

Norges Geografiske Oppmåling, Oslo. (Th. SØMOD & S. BAKKELID  
24.10.75)

Norwegian Coastal area

"The survey extends from near the shoreline to 40 nautical miles seaward, was carried out in 1970-71 as a cooperative effort between the U.S. Defence Mapping Agency Topographic Center and the Norges Geografiske Oppmåling.

The 1970 survey was accomplished between 59°N and 63°N and comprises a total of 1468 stations from 124 open ocean tracks (areas 3 to 6)... Gravity base stations were established at all docking sites prior to the initiation of the survey.

The 1971 survey covers the areas south of 59°N and north of 63°N... comprises a total of 9135 stations from 403 tracks (areas 1, 2 and 7 to 17). The LaCoste and Romberg Air/Sea gravimeter n°S 32 and n°41 were respectively used in each cruise.

\* Not yet received at the BGI.

All data reduction was performed by DMATC using a UNIVAC 1108 and the program MARINE".

U.S. Defence Mapping Agency Topographic Center (USDMATC) :

"Norwegian Marine Gravity Survey - 1970. Report n° 72,"  
3 Bouguer anomaly maps. Unpublished.

"Marine Gravity Survey Norway Coast - 1971. Areas 9 through 17.  
Report n° 100, 8 Bouguer anomaly maps. 1973. Unpublished.

"Marine Gravity Survey Norway Coast - 1971. Areas 1, 2, 7 and 8,  
Report n° 108, 3 Bouguer anomaly maps. Unpublished.

Report on Gravity Measurements in Norway 1970-74. Presented at the I.G.C., Paris, September 1974.

POLAND

Institut de Géodésie et de Cartographie

Au cours des années 1970 - 1972, on a effectué des mesures gravimétriques sur la Mer Baltique, tout le long de la côte maritime polonaise. \* Ces mesures ont été faites par l'Institut de Géodésie et de Cartographie avec lequel coopérait l'Institut de Physique du Globe AN U.R.S.S.

Le levé gravimétrique consiste en des profils parallèles et transversaux à la côte. La longueur générale des profils de mesure s'élève à : 6.000 miles marins. Le terrain soumis aux mesures gravimétriques s'étend jusqu'à 50 miles marins de la côte maritime.

De plus, on a effectué des mesures gravimétriques détaillées sur une étendue de 20 km sur 50 dans les terrains maritimes au Sud de la Mer Baltique.

"Rapport sur les travaux géodésiques exécutés en Pologne de 1971 à 1975". Acad. Pol. Sci. Varsovie, UGGI, Grenoble, Août 1975.

\* Zone approximativement située entre 54°N et 56°N ; 14°E et 19°30'E.

## UNITED KINGDOM

## References :

- IGS Progress Report to the Commission Gravimétrique Internationale, Paris, Sept. 1974. United Kingdom Gravity Measurements 1 January 1971 - 31 May 1974.
- Letters from :
  - W.A. HUDDY (Marine Sciences Branch 6, Hydrographic Department) 3.10.75.
  - G.A. DAY (Int. Geol. Sci.) 24.11.75
  - P. SIMPSON (The University of Birmingham) 9.10.75
  - S.A. WILLIAMS for Dr. MATTHEWS (University of Cambridge) 10.03.76.

CONTINENTAL SHELF AROUND THE BRITISH ISLES

(Compilation map 1/2.500.000° was sent by IGS).

Department of Geology, University College, Aberystwyth

In March 1971 surveys were made in the South Irish Sea area on RRS John Murray using a LaCoste & Romberg sea gravity meter. The results have been compiled into Bouguer anomaly contour maps and discussed qualitatively (ROBSON, EVANS and WHITTINGTON, 1973).

The same ship and equipment were used for a survey of an area North West of Bloody Foreland, County Donegal, Republic of Ireland, to examine possible submarine extensions of the Thorra and Fanad plutons (EVANS and WHITTINGTON, 1974).

Department of Geological Sciences, University of Durham

During 1971 summer, surveys were made in the region west of the Hebrides and Shetlands from MV Researcher (BOTT and WATTS, 1971 ; WATTS, 1971).

Hydrographic Department, Royal Navy

Gravity surveys have been carried out on Hydrographic Department ships as set out below, using Graf surface ship gravity meters, 1 January 1971 - 31 December 1974.

<u>Survey Ref. N°</u>	<u>Ship</u>	<u>Title</u>
K6173	Hecate	Outer Hebrides
K6296	Hecate	Western Approaches to the Minches
K6456	Hecate	Scilly Isles to Hurd Deep
K6546	Hecate	Scilly Isles to Hurd Deep
K6564	Hecla	Western Approaches to Stanton Banks
K6627	Hecla	Porcupine Bank
K6783	Hecate	Scilly Isles to the Lizard
K6546/11-12	Hecate	Scilly Isles to Hurd Deep
K6897/1	Hecla	Inner Sound of Raasay.



Marine Geophysics Unit, Institute of Geological Sciences

The Marine Geophysics Unit of IGS has carried out gravity surveys from a number of chartered vessels. The areas worked have been in the Bristol Channel, the Celtic Sea, the Western Approaches to the English Channel and in the UK sector of the North Sea between 55°30'N and 58°N. In each area a grid of lines was surveyed with spacing between 5 and 10 km depending on local geology.

Marine Science Laboratories, University College of North Wales

Approximately 2850 km of gravity profile have been recorded on the continental margin west of Ireland in the general area 50°30'N - 53°40'N ; 10°00'W - 16°00'W. (BUCKLEY and BAILEY, 1974).

Department of Geology, University College, Swansea

A shipborne gravity meter survey of the Bristol Channel east of longitude 4°15'W has been completed.

SEA MEASUREMENTS IN OTHER AREAS

Department of Geophysics, University of Birmingham.

The programmes in collaboration with the British Antarctic Survey have continued. The main effort has been in the Scotia Sea area with some measurements on passage from and to the U.K.

- a) 1969-1970 (HMS Endurance) : tracks in the Scotia Sea (60°S from 15°W.G. to 60°W.G.) not mentioned in the previous edition (1970).
- b) November 1971 - March 1972 (RRS Shackleton) : ships tracks were concentrated over North Scotia Ridge, around South Georgia, Falkland Islands, across the eastern Scotia Sea between South Georgia and the South Orkney Islands and across Drake Passage.
- c) February - March 1973 (HMS Endurance) : gravity measurements around the Falkland Islands formed part of a geophysical survey of the Falkland Island Shelf (52°S - 60°W.G.).
- d) October 1973 - March 1974 (RRS Shackleton) : data were collected on a line 15°N to 3°S in mid Atlantic on passage to Montevideo for Dr JONES of University College. Southern ocean lines were well spread out over the whole of the Scotia Sea with two crossings of the South Sandwich Arc. Rough weather and a gyro failure in the Weddell Sea meant that only a small amount of data was collected south of 68°S.

Project : "We are soon to join the RRS Shackleton for another Antarctic cruise from November 1975 until March 1976. During the time there will be one track across the South Atlantic from Cape Town to north of South Georgia, whilst the major part of the cruise will be spent in the eastern half of the Scotia Sea, especially around South Georgia, North Scotia Ridge, and South Scotia Ridge between the South Orkney Islands and the South Sandwich Islands". (P. SIMPSON, 9.10.75).

Department of Geodesy and Geophysics, University of Cambridge

Excellent results were obtained with GSS2-21 borrowed from the Admiralty, during a survey of the Horseshoe Seamount group and on the Mid-Atlantic Ridge at 45°N, May - July 1972 (Shackleton cruise 1 and 2/72).

Department of Geological Sciences, University of Durham

During 1971 geophysicists of the department joined HMS Hecla during a cruise in the Caribbean (14°N - 63°W.G.) when a series of east-west profiles were recorded in areas both eastwards and westwards of St. Lucia and St. Vincent. In 1972 the surveys from HMS Hecla were extended to cover the Aves Ridge area (KEARY 1974 ; WESTBROOK, BOTT and PEACOCK 1973).

During 1973 the LaCoste & Romberg surface ship gravity meter was used again in RRS Shackleton to survey the region north-west of the Hebrides and extending to the East Greenland margin. (See Bull. Inf. BGI n°34, p.I-18).

Hydrographic Department, Royal Navy

Gravity surveys have been made in the Atlantic, Caribbean, Indian Ocean, South China Sea and south-west Pacific as set out below : (1 January 1974 to 31 December 1974).

<u>Survey Ref. N°</u>	<u>Ship</u>	<u>Title</u>
K6077	Hecla	Atlantic - Kings Trough
K6091	Hydra	South China Sea - Owen Shoal
K6268	Hecla	Eastern Approaches to St Lucia
K6269	Hecla	Western Approaches to St Lucia
K6311	Hydra	SW Indian Ocean - Shoal investigations
K6396	Hydra	Indian Ocean - Aldabra Island
K6587	Hydra	Solomon Islands - Bougainville Strait
K6595	Hecla	West Indies - Kick-em-Jenny Volcano
K6596	Hecla	Aves Ridge to Windward Islands
K6686	Hydra	Solomon Islands - Choiseul Island - South Coast
K6687	Hydra	Solomon Islands - New Georgia Sound
K6907/3	Hydra	Male and Fadifollu Atolls

UNITED STATES
---------------

A large number of marine gravity surveys were carried out by universities and governmental agencies.

The University of Hawaii carried out gravity surveys in the Panama Basin-Nazca Plate area, west of South America, as well as in the North Pacific area.

Oregon State University obtained surface ship measurements along tracklines in the eastern Pacific Ocean extending from Alaska to Chile. Their principle areas of study included the Cocos Plate, the Nazca Plate, the Panama Basin and the continental margin areas of southern Alaska, Mexico, Central America, Ecuador, Peru and Chile. Free-air gravity maps have been prepared for the Riviera Fracture Zone and the continental margin of Peru. Measurements were obtained with a LaCoste-Romberg gravity meter on a stable platform with satellite navigation for positioning and are considered accurate to  $\pm 3.5$  mGal.

Since 1972, the Marine Sciences Institute of the University of Connecticut, has used a LaCoste-Romberg gravimeter aboard Coast Guard ice breakers to obtain gravity measurements in the southern Beauford Sea (of the Arctic Ocean) between Barrow, Alaska, and the Canadian border. More than 2,000 free-air gravity anomalies with an estimated accuracy of 1 mGal were obtained and a free-air anomaly map constructed.

In the period 1970 through 1974, the Woods Hole Oceanographic Institution has conducted gravity measurements aboard R/V CHAIN and R/V ATLANTIS II on cruises in the North and South Atlantic Ocean, Indian and Pacific Oceans. These cruises total approximately 242,000 km of track and about 196,000 gravity measurements. Reports on the gravity field of these and other regions are listed in the accompanying bibliography. These gravity measurements were made with a vibrating string accelerometer (VSA) mounted upon a Sperry Mark 19 Mod 3c gyrocompass. This gravity system and its computerized control and data logging system has been described by BOWIN et al. (1972). This system has continued to perform very well, usually providing continuous gravity measurements during cruises of six to eighteen months with down time of only a few hours per month. WHOI participated in conducting gravity observations aboard the Hakuho-Maru of the Institute of Ocean Research, University of Tokyo, cruises KH-72-1 and KH-72-2. These observations were made using LaCoste & Romberg sea gravity meter S-32 on loan from the U.S. Army Topographic Command. WHOI also conducted gravity measurements aboard the R/V THOMAS WASHINGTON of Scripps Institution of Oceanography from October 1973 through February 1974, during the Tasaday Cruise. These measurements were made with a new sea gravity meter system built at WHOI, consisting of a VSA sensor mounted on a modified Aeroflex ART-57 two-axis stabilized platform. This system is easily portable by air freight. Improved data processing and handling techniques for the rapid access display, editing, and processing of large digital data files have been developed. These techniques allow an efficient and cost-effective method for retrieving and displaying gravity data for any selected part of the globe.

In the Period 1970-1974, the Lamont-Doherty Geological Observatory has obtained nearly continuous gravity measurements (approximately 10 months a year) on R/V VEMA and R/V ROBERT D. CONRAD and until December 1973 on USNS ELTANIN. Lamont-Doherty presently holds gravity measurements from over a million miles of ship's tracks in each of the world's oceans. These measurements have been made with Graf-Askania Gss-2 gravity meters mounted on various stable platforms : Anschutz gyrotable, Aeroflex stable platform, and a platform built at Lamont utilizing U.S. Navy's Mark IV Mod O stable element. The Aeroflex stable platform has been tested and found to be well suited for use with Graf-Askania meters. Analog cross-coupling systems are used on each ship in which the cross-coupling error is computed in real time and subtracted from the gravity trace. In regions of large data density free-air gravity anomaly maps have been prepared or are being compiled (usually at an interval of about 25 mGal). The areas of compilation are mainly (a) North Atlantic, (b) Equatorial Atlantic, (c) Indian Ocean and (d) the north-western Pacific. The maps of the western North Atlantic and Indian Ocean have been used to compute gravimetric geoids and in a number of geological studies.

During this report period, marine gravity surveys were carried out by several components of NOAA including the National Ocean Survey (NOS), the Atlantic Oceanographic and Meteorological Laboratories (AOML) and the Pacific Oceanographic Laboratories (POL). NOS work included a shipboard survey in Bristol Bay, Alaska, a detailed bottom gravity meter survey along the west coast of the United States from San Francisco, north to the Juan de Fuca Straits and extending out to the 100 fathom line, and bottom gravimeter work off the east coast of the United States between Cape Hatteras, North Carolina, and Cape May, New Jersey. Also, during this period, final adjustments were made to the Seamap gravity data in conjunction with the University of Connecticut and final maps of a substantial area between Hawaii and Alaska published. POL carried out a number of gravity surveys throughout the north Pacific area. AOML undertook gravity observations in the North Atlantic. In particular, as a part of the IDOE, an extensive survey was made in the area east of the Caribbean bounded by 14° to 18° north latitude and 43° and 62° west longitude.

I.G.C. Meeting of September 1974, "Gravimetric activities of the United States 1970-74".

U.S.S.R.

Academy of Sciences of the USSR, Soviet Geophysical Committee

"The map shows all the routes made by us and the list of all our expeditions which took place from 1970 till 1973" with gravity measurements.

Gravity tracks of the measurements carried out by the USSR  
Academy of Sciences :

3rd	cruise of NIS Dimitri Mendeleev,	Atl. Ocean	1970	(a)
5th	" " " "	Pacif. Ocean,	1971	(b)
6th	" " " "	Pacif. Ocean,	1971	(d)
7th	" " " "	Indian Ocean,	1971/72	
9th	" " " "	Pacif. Ocean,	1973	(e)
10th	" " " "	Indian Ocean,	1973	(f)
49th	cruise of NIS Vitiaz	Pacif. Ocean,	1970/71	
51th	" " " "	Pacif. Ocean,	1972	(c)
53th	" " " "	Pacif. & Mer d'Okhotsk,	1972	

Yu. D. BOULANGER  
6.11.1975

Publications :

- (a) "Catalogue des mesures de pesanteur effectuées dans l'Océan Atlantique en 1970 au cours de la 3ème croisière du navire "Dimitri MENDELEEV". Inst. Phys. Globe O.Y. SCHMIDT, 125 p, Moscou, 1972.
- (b) "Expédition gravimétrique en mer sur les bateaux de l'Académie des Sciences de l'URSS - Catalogue des observations gravimétriques : 5ème voyage du bateau NIS Dimitri MENDELEEV, équipe n°9, Océans Atlantique et Pacifique, 1971". Inst. Phys. Globe O.Y. SCHMIDT, 186 p, Moscou, 1972.
- (c) "Expédition gravimétrique en mer sur les bateaux de l'Académie des Sciences de l'URSS - Catalogue des observations gravimétriques : 51ème voyage du bateau NIS VITIAZ : Partie Equatoriale de l'Océan Pacifique, 1972. Inst. Phys. Globe, O.Y. SCHMIDT, 190 p, Moscou, 1973.
- (d) "Catalogue des mesures gravimétriques, 6ème croisière du NIS Dimitri MENDELEEV, équipe n°10, Océan Pacifique, 1971". Inst. Lénine Phys. Globe O.Y. SCHMIDT, Moscou, 1974.
- (e) "Catalogue des mesures gravimétriques, 9ème croisière du NIS Dimitri MENDELEEV, équipe n°12, Océan Pacifique 1973". Inst. Lénine Phys. Globe O.Y. SCHMIDT, Moscou, 1974.
- (f) "Catalogue des mesures gravimétriques, 10ème croisière du NIS Dimitri MENDELEEV, équipe n°12A, Océan Indien, Mers du Sud de la Chine et de Chine Orientale". Inst. Lénine Phys. Globe O.Y. SCHMIDT, Moscou, 1975.

Baltic Sea (17°E - 55°N)

In collaboration with Poland (see p.I-29).

BUREAU GRAVIMETRIQUE INTERNATIONAL  
J. BOUVET

LISTE des PUBLICATIONS  
reçues au  
BUREAU GRAVIMETRIQUE INTERNATIONAL  
(Avril à Novembre 1975)  
-----  
CONCERNANT LES QUESTIONS DE PESANTEUR  
-----

LISTE des PUBLICATIONS

≡

- 605 - JUBINSKI P. - "Design specifications for a long-range swath-mapping sonar".  
Hawaii Inst. Geophys., Univ. Hawaii, HIG-72-12, 31 p, 1972.

Design specifications are presented for a transducer array operating at 3.5 kHz and capable of bathymetric mapping over a swath of at least 25 nautical miles across the ship's track. Beam shaping was determined solely by transducer placement. Specifications are given for the beam transmission patterns and comparisons are made to a hypothetical array which would illuminate the ocean bottom uniformly. Signal-flow and processing designs are provided for application of the array to the detection of large-scale bathymetric features above the mean ocean depth. The entire system will provide a coverage of  $250 \text{ (n.miles)}^2/\text{hour}$  from a 10-knot research vessel.

- 606 - BOWMAN B.R. - "Density variations of the upper atmosphere below 200 km, from analyses of high eccentricity satellite orbit decays".  
Hawaii Inst. Geophys., Univ. Hawaii, HIG-73-17, 123 p, 1973.

Upper atmospheric density variations in the 100 - to 200 - km altitude region are determined from two satellite geodetic analyses of the decay of high eccentricity orbits with low perigee heights. Variations at the 200 - km height are examined for a continuous two-year period using the orbit of satellite 1967-31A, while those in the 120 - to 150 - km region are examined for a period of more than eight months using the orbit of the 4th Molniya 1 upper stage rocket body, 1966-92 D. Correlations are very good between density increases and solar flare activity measured by the geomagnetic index ...

- 607 - WOOLLARD G.P., H.C. MARSH & R.L. LONGFIELD - "A comparison of observed and predicted Earth tide observations between Alaska and Mexico and across the zone of crustal transition between Nebraska and Utah".  
Hawaii Inst. Geophys., Univ. Hawaii, HIG-73-20, 34 p, 1973.

- 608 - "Reliability of satellite determined positions of latitude and longitude".  
Hawaii Inst. Geophys., Univ. Hawaii, HIG-74,1, 1974

- a) Part 1 - DAUGHERTY K.I. - "Geodetic (?) positioning of some Islands in the Pacific using the transit shipboard navigation system".  
p.1-30.

As a result of oceanographic research cruises in the Pacific by vessels of the University of Hawaii, the coordinates of nine docking sites have been determined through the operation of the Shipboard Doppler Satellite Navigation System. Positions in the Doppler Satellite Coordinate System with a precision of from

≡

Les numéros font suite à ceux indiqués dans le Bull. Inf. N° 37, Nov. 1975.

$\pm 4$  to  $\pm 30$  meters (standard deviation of the mean) were obtained using the MX:702/hp Satellite Navigation System and the standard navigation program. The relatively precise mean positions were achieved despite rather wide variations of individual satellite fixes and in at least one case statistically inhomogeneous means obtained by considering multiple pass data from each satellite in separate solutions. Differences between charted positions of the docking sites and the results of this paper ranged up to 11".6 in latitude and 32"5 in longitude.

- b) Part II - WOOLLARD G.P. & N.J. THOMPSON - "Problems in the use of a magnavox 706 marine-type satellite navigator for land station position control".  
p.32-56.

Through the cooperation of the Ocean Science and Technology Division of the Office of Naval Research and the Magnavox Company, a Magnavox 706 marine-type satellite navigator was used to determine the position of the Colombia geodetic datum at Bogota and seven land recording shooting sites occupied on the Project "Narino" seismic refraction study of crustal structure between the Pacific coast of Colombia and the crest of the Andes.

- 609 - PICK M. & I. JAKUBCOVA - "Artificial models for checking different methods of determining the figure of the Earth".  
Studia Geophys. & Geod., t.17, n°3, p.245-252, Praha, 1973.

A new type of mathematical model has been proposed and computed for the advantages of natural and artificial test areas to be combined.

- 610 - PICK M. - "Recent movements of the Earth's crust".  
Studia Geophys. & Geod., t.17, n°3, p.253-254, Praha, 1973.

It has been shown that it is necessary to combine several methods to be able to describe and explain recent movements of the Earth's crust.

- 611 - ROCHOLL W. & H. WOLF - "Periodizitäten in den berechneten Amplitudenquotienten aus gravimetrischen Erdzeitenbeobachtungen".  
Mit. Inst. Theor. Geod. Univ. Bonn, n°30, 31 S, Bonn, 1974.

5 years of gravimetric Earth tides registrations as performed by Prof. BONATZ at the Bonn station, have been analysed month by month with respect to the amplitude ratio & of O1 and M2. These values obviously show a period of 24 months which seem to be superposed by a secondary oscillation of a 31 months period, as far as can be recognized. Questions as to their nature have been posed. Encouragements are given as to perform similar computations with other instruments and at other places, if the registration-time intervall is of comparably equal duration (5 years).



- 612 - SCHWECHHEIMER G. & H. WOLF - "Korrelative Zusammenhänge zwischen magnetischen Missweisungen und Schwereanomalien".  
Mit. Inst. Theor. Geod., Univ. Bonn, n°31, 40 S, Bonn, 1975.

Two regions with different geophysical structure are compared : The first one ("Kottenforst") with irregular or weakly systematic behaviour of the anomalies ; the second one ("Rodderberg"), however, with obviously systematic features, due to buried masses of volcanic origin. A detailed gravity survey and an area-covering measurement of the declinations have been performed in both regions. At first autocorrelations are computed and subsequently cross-covariances between both phenomena. Two functions  $B_1$  and  $B_2$  from the cross-covariances are proposed to measure the correlative interrelation between these phenomena, considering the "zero-area" (with the weak anomalies) as reference. At the "Rodderberg" the field of the anomalies deviates obviously from isotropy.

- 614 - GOTTSCHALK H.J. - "I - Ein Rechnerprogramm zur Auswahl und Glättung von kartographischen Linien".  
"II - Ein Rechnerprogramm zur Berechnung von Flächen aus flächenartig strukturierten Punktmengen mit Hilfe der Verarbeitung von Binärbildern".  
D.G.K., Reihe B : Angew. Geod. H. n°205, 45 S, Frankfurt, 1974.

- 615 - RODDE A. - "Simultanbestimmungen der Lotabweichungskomponenten  $\xi$  und  $\eta$  mit dem Prismenastrolabium - X - Beobachtungen auf den Hauptdreieckspunkten Amrum, Battenhausen, Beckum, Brillit, Friedrichskoog, Gross Reken, Helgoland, Hinsbeck, Kampen, Much, Niederreifenberg, Nottuln, Oer-Erkenschwick, Radevormwald, Remscheid, Sievern, Westerheversand, Wingst und Xanten in den Jahren 1968 und 1970".  
D.G.K., Reihe B : Angew. Geod., H.n°197, 108 S, Frankfurt, 1974.

Author reports on the astronomical determinations of longitudes and latitudes simultaneously performed on 18 first-order triangulation stations pertaining to the West German part of the European Triangulation Net. The components  $\xi$  and  $\eta$  of the deviation of the vertical have been computed.

- 616 - RODDE A. - "Simultanbestimmungen der Lotabweichungskomponenten  $\xi$  und  $\eta$  mit dem Prismenastrolabium - Va - Beobachtungen im 48 Breitengrad und auf dem Hauptdreieckspunkt Seebach, Hornisgrinde im Jahre 1971".  
D.G.K., Reihe B : Angew. Geod. H. n°198, 92 S, Frankfurt, 1974.

Author reports on his astronomic determinations of longitudes and latitudes performed simultaneously on 16 stations and on the first-order triangulation station of Seebach, Hornisgrinde, on the profile of the geoid at 48° of latitude, as well as on the calculation of the components  $\xi$  and  $\eta$  of the deviation of the vertical.

- 617 - LELGEMANN D. - "Zur gravimetrischen Berechnung des Geoids der Bundesrepublik Deutschland".  
D.G.K., Reihe A : Höhere Geod. H. n°77, 32 S, Frankfurt, 1974.

- 618 - EHLERT D. - "EDV-Programme zur Auflösung grosser Gleichungssysteme mit symmetrischen Koeffizientenmatrizen".  
D.G.K., Reihe A : Höhere Geod., H. n°78, 59 S, Frankfurt, 1974.

Author gives EDP programmes for the determinate and indeterminate solution of great linear equation systems with complete, symmetrical, positive definite matrices of coefficients. He uses the Gaussian algorithm applied to submatrices. The inverse matrices of coefficients are constructed step by step according to the Hansen method.

- 619 - REIGBER C. - "Lagrangesche Störungsgleichungen bezüglich nichtinertialer Bezugssysteme".  
D.G.K., Reihe A : Höhere Geod., H. n°79, 35 S, München, 1974.

- 620 - RAMSAYER K. - "Untersuchungen eines geschlossenen Raumpolygonzugs".  
D.G.K., Reihe A : Höhere Geod., H. n°80, 49 S, München, 1974.

To get an idea of the errors which are to expect in a spatial traverse a closed traverse with a length of 83 km was measured. This traverse was observed both as "normal traverse" (NT) with simultaneous measurements of the vertical angles from both sides and as traverse with observations in the middle of each line (MT). The observations were rigorously adjusted in an ellipsoidal reference system in different variations as closed and free traverse, with and without astronomical observations.

The most important results are the following : the closing error in height is extremely small (~~26~~ 26 mm), if the vertical angles are measured in 4 sets, each set at another day. If only one set is measured, the closing error increases to 13 cm (NT) resp. 18 cm (MT). Both methods give the heights with the same accuracy. If the astronomical observations are neglected the heights change up to 36 cm. These changes correspond with high accuracy to the result of pure astronomic levelling.

The closing error in position varies between 26 cm and 59 cm. It is supposed that this relatively large error is mainly caused by errors of the azimuths and longitudes in the Laplace points. If all astronomical observations are neglected the closing error in position increases up to 120 cm. If only the Laplace azimuths are taken into consideration, we get approximately the same positions of the traverse points as with all astronomical observations. This underlines the well known importance of Laplace points.

- 621 - ZIELINSKI J.B. - "Vertical sounding of the Earth's gravity field".  
D.G.K., Reihe A : Theor. Geod., H. n°81, 37 S, München, 1974.

The vertical sounding concept consists on the measuring of the vertical component of the gravity vector by observing the free-fall motion along the trajectory near to the plumb line direction.

Two possible applications of this method are considered : determination of the GM constant and the local improvement of the gravity field. With the present accuracy of the geopotential the GM can be determined from the motion above 7000 km, without harmful influence of unknown gravity forces.

Local improvement of the gravity field is reduced to the downward continuation problem, which is solved by collocation method. It is proved that gravity anomalies on the Earth surface can be determined from gravity disturbances measured in space with transformation error below 1 mGal, assuming that the covariance function is known.

- 622 - BRENNER J. & U. HEINEKE - "Erfahrungen mit der Ungarischen Drehwaage E-54".  
Wissens. Arb. Lehr. Geod. Photog. & Kartog. Tech. Univ. Hannover, N° 57, 27 S, Hannover, 1975.

Die Erläuterung der Anwendung, Handhabung und Fehlereinflüsse dienen dem Zweck, die Einsatzmöglichkeiten dieses Instrumentes aufzuzeigen.

Laboruntersuchungen hinsichtlich der inneren Genauigkeit erbrachten Werte, die in derselben Größenordnung wie die von MUELLER (1960) angegebenen Ergebnisse ( $\pm 0,25$  E für  $W_{xz}$  und  $W_{yz}$  bzw.  $\pm 0,7$  E für  $W_{\Delta}$  und  $W_{xy}$ ) liegen. Sie zeigen die gute Qualität des verwendeten Instrumentes.

Inwieweit es gelingt, den Geländeeinfluss richtig zu erfassen und so die Messwerte für geodätische Zwecke nutzbar zu machen, sollen weitere Untersuchungen zeigen.

- 623 - BOEDECKER G. - "Bestimmung der Gravimetrischen Lotabweichung für die station Wulften, Recke".  
Wissens. Arb. Lehr. Geod. Photog. & Kartog. Tech. Univ. Hannover, N° 59, 23 S, Hannover, 1975.

For the station Wulften (Recke, TP 4327/2, F.2.0) in the "Testnetz Westharz" components of the gravimetric deflection of the vertical (accuracy  $\pm 0".3$ ) and a preliminary value for the geoidal undulation were computed. The gravimetric densification in the neighbourhood of the station consists of 154 points. Performing the computation, an inner Zone with  $\psi < 10$  m is neglected, in the nearer zones  $10 \text{ m} \leq \psi \leq 20 \dots 35$  km a station-centered template is applicated. In the outer zones blocks of different size are used, bounded by geographical coordinates. An improvement of accuracy depends mainly on the improvement of gravity data in the zones 1000 ... 2000 km, but also 2000 ... 5000 km.

- 624 - Studia Geophysica et Geodaetica, t.19, n°1, Cesk. Akad. Ved, Praha, 1975.

- a) KUBACKOVA L. - "Probability model for studying the spectral composition of anomalous geophysical fields".  
p.1-7.

The paper is a contribution to the stochastic analysis of geophysical fields. Using Mercer's theorem, the theorem of the resolution of Hilbert's random field  $\xi(X)$ , continuous with respect to the quadratic mean, into a general Fourier series which converges uniformly with respect to the quadratic mean to  $\xi(x)$ , is proved.

- b) BURDA M. - "Properties of the characteristics of linear transformation of geophysical fields".  
p.8-13.

Proof is given of the theorem which determines the relation between the characteristics of a random function prior to and after linear integral transformation. Moreover, only a single realization of the random function is available in a limited set and statistical homogeneity is not assumed. The characteristics are defined in Section 2 and they correspond to the actual estimates of the statistical characteristics.

- c) NEDOMA J. - "Solution of boundary value problems of the gravity potential using finite difference methods".  
p.85-88.

The possibility is shown of studying the gravity field outside local disturbing masses by applying the methods of numerical analysis, in particular the finite difference method.

- d) TOBYAS V. & K. DIVIS - "Seismic noise at some points of the gravimetric latitude base Hrensko - Dolni Dv oriste (CSSR)".  
p.89-94.

The vertical component of seismic noise, due to road and rail traffic, was observed at 11 gravity points. The magnitude of the maximum amplitudes of displacement, which were mostly in the frequency range of 2-20 Hz and between 0.1  $\mu\text{m}$  and 1.1  $\mu\text{m}$ , are markedly affected by local geological conditions. At some points the ground vibrations may disturb accurate gravity observations.

625 - Studia Geophysica et Geodaetica, t.19, n°2, Cesk. Akad. Ved, Praha, 1975.

- a) BURSA M. - "The potential and gravitation of a homogeneous layer bounded by equipotential surfaces of the geopotential".  
p.105-114.

The potential of a homogeneous layer, bounded by equipotential surfaces of the geopotential, defined by a development into a series of spherical harmonics, is derived. Terms of the order of  $10^{-6}$  are retained.

- b) ZATOPEK A. & B. BERANEK - "Geophysical synthesis and crustal structure in Central Europe".  
p.121-133.

After a structural description of the shape of the Mohorovicic discontinuity as obtained in Central Europe by DSS, a geophysical synthesis is given for the territory of Czechoslovakia under the use of gravimetric, seismologic, geomagnetic, magnetotelluric, geothermic and geodetic data. Particular attention is paid to the contact zone between the Bohemian Massif and the Carpathians.

626 - Travaux de l'Institut Géophysique de l'Académie Tchécoslovaque des Sciences, N° 397-415, v.XXI (1973), Praha, 1975.

- a) BURSA M. - "The Gaussian and mean curvatures of the equipotential surface from satellite data".  
N° 397, p.9-76.

Numerical results are given of the anomalies of the Gaussian and mean curvatures of the external equipotential surface, as well as of the anomalies of the radii of curvature, determined from satellite data.

- b) BURSA M. - "The curvature of the external equipotential surface determined from the deflections of the vertical on the territory of Czechoslovakia".  
N° 398, p.77-110.

The discrete values of the components of the deflections of the vertical on the territory of Czechoslovakia, distributed homogeneously, were used to compute their derivatives and these, in turn, to determine the anomalies  $\Delta J$  of the mean curvature of the equipotential surface and the anomalies  $\Delta(\partial g / \partial n)$  of the vertical gradient of gravity. The results have been represented graphically by the isolines  $\Delta J = \text{const.}$  and  $\Delta(\partial g / \partial n) = \text{const.}$

- c) PICHA J., L. SKALSKY & Z. SIMON - "The problem of tidal corrections of very accurate measurements of the acceleration of gravity".  
N° 399, p.111-136.

The problem of tidal corrections of very accurate measurements of the acceleration of gravity is discussed. The necessary formulae and constants for computing the tidal corrections with an accuracy of upto  $\pm 0.1 \mu\text{gal}$  are given. The necessity of unifying tidal stations (methods of observation and processing) and of comparing the instruments used is pointed out. A project of a network of tidal stations for the socialist countries is presented. Table 4 is used to show that at present it is not possible to prove a marked geographic dependence of the gravimetric factors of the main tidal waves, derived from the present tidal measurements, at European stations. For this reason it is proposed that certain representative values, suitably selected from European stations, be used for preliminary calculations of the tidal corrections.

- d) SKALSKY L., J. PICHA & V. SKOCH - "Tidal measurements with the Gs11 Gravimeter in Pribram".  
N° 400, p.137-212.

The results of the analyses of the observational data from the tidal station Pribram, covering the years 1969 - 1970, are slightly anomalous as compared to the results, obtained at most European stations. This cannot be ascribed to errors in the programme, or the method of analysis used. Nor can it be explained by instrumental errors or by errors due to the preparation of the observational data for the analysis. The analysis of the pattern of the relative frequencies of the corrections, obtained by the CHOJNICKI method indicates the existence of systematic disturbances of the tidal records, probably caused by temperature effects.

- e) GARGALOVIC L., Z. SIMON & L. TRAGER - "Influence de la température sur le gravimètre SHARP". (texte russe).  
N° 401, p.213-217.

Im gravimetrischen Laboratorium auf den Geodätischen Observatorium Pecny wurden Einflüsse von Temperaturstößen auf die Gravimeter Sharpe N° 280 G und N°226 G geprüft. Die Stösse waren der Temperaturgrösse von - 15°C und je 15 Minuten-Dauer, die Stösse derselben Temperatur, jedoch zu je 30 Minuten, die Stösse von - 25°C und 30 Minuten-Dauer. Die Durchschnittswerte der durch die Temperaturstösse verursachten Störungen enthält.

627 - Materialy i Prace 71 - Publications of the Institute of Geophysics Polish Academy of Sciences - Marées Terrestres, Warszawa, 1973.

- a) CHOJNICKI T. - "Détermination de la dérive dans les mesures des marées au moyen de la méthode des points neutres".  
p.3-74.

On a présenté le moyen de déterminer la dérive à partir du régistrogramme des observations des marées, en se basant sur la connaissance des moments où la valeur des marées théoriques est égale à zéro. L'avantage essentiel de cette méthode est la possibilité de déterminer les ondes de longue période des marées. On a présenté et décrit un programme, en langage Fortran IV, permettant la réalisation numérique de cette méthode sur ordinateur. A la fin de ce travail, on trouvera une suite d'exemples illustrant les calculs.

- b) CHOJNICKI T. & W. ZARNOWIECKI - "Résultats des mesures gravimétriques des marées, exécutées au cours des années 1971-72 à la station Varsovie".  
p.75-116.

On présente les résultats obtenus à partir des observations des marées, exécutées à l'aide du gravimètre Askania Gs-11 n° 110 à la station des marées à Varsovie. Les calculs ont été élaborés au moyen de la méthode de CHOJNICKI en plusieurs versions.

- c) CHOJNICKI T. & J. ORZECOWSKI - "Modification du programme de l'analyse des observations des marées".  
p.117-178.

On décrit la construction de la nouvelle version du programme de l'analyse des observations des marées sur la base du principe des moindres carrés ; cette nouvelle construction constitue une modification de l'ensemble des programmes de transformation des données de marée qui a été incluse dans le numéro 55 (1972) de notre édition.

628 - Proceedings of the Institute of Geodesy & Cartography, T.XXI, Z.2(49),  
PLISSN 0032-6224, 69 p, Warszawa, 1974.

- 629 - BARLIK M. - "Some aspects of study of real vertical deflections in the mountain areas".  
Geod. i Kartog., t.XXIII, Z.4, Polska Akad. Nauk., Kom. Geod., p.269-280, Warszawa, 1974.

In the article some author's notices on the subject of calculation of vertical deflections without use any gravity reduction to the surface of the geoid are given. Author put to test Molodenskij's method of determination of vertical deflections on the surface of the Earth. This course of action was also apply to the calculation of the vertical deflection in the test network in the Polish Tatra Mountains. Results of analysis and calculations point out that the integration of anomaly over rugged telluroid's surface falsifies the vertical deflections in mountain conditions.

- 630 - Geodezja i Kartografia, t.XXIV, Z.1, Polska Akad. Nauk., Kom. Geod., 90 p, Warszawa, 1975.

- 631 - Instituto Panamericano de Geografia e Historia - Revista Cartografia N° 24 - 25, 147 p, Enero - Dic. 1973, Mexico, 1974.

- 632 - GROTEN E. & St. THYSSEN-BORNEMISZA - "Approaches in dG/G-Determinations" from : Pure & Applied Geophys., v.99, n°VII, p.5-11, 1972.

Whereas observations of planets and solar satellites are more promising for detecting possible variations of Newtonian gravitational constant, G, with time the application of additional methods which are substantially different might be useful. It is discussed to what extent the tidal problems can be solved in connection with lunar orbit tracking for detecting G; further a relative G-experiment at the Earth surface is outlined.

- 633 - GROTEN E. & R. RUMMEL - "Interrelations between secular sea level variations and subsidence of coastal areas in the North Sea".  
from : Pure & Applied Geophys., v.99, n°VII, p.12-16, 1972.

The effect of secular sea level variations on coastal levelling nets was considered for some parts of the North West European Lowlands levelling. On neglecting local geological influences a simplified global model was used for treating the following problems :

- Magnitude of secular tilt effects in NWELL due to possible sea level variations ;
- Levelling errors due to sea tide loadings.

- 634 - THYSSEN-BORNEMISZA S. - "Testing inertial mass variation".  
from : Transactions of the New York Acad. Sci., Ser. II, v.34, n°8, p.687-690, 1972.

In Einstein's theory of relativity some controversial issues such as Mach's principle including the Mach-Einstein doctrine remain unsolved. Involved is a possible inertial mass variation as a function of its surrounding. The briefly discussed but very feasible experimental test could provide valuable new insight into the mechanism of creating inertia, of which so little is understood.

- 635 - GROTEN E. - "The problem of gravitational absorption".  
Geophys. J. R. Astr. Soc., n°27, p.447-448, 1972.

- 636 - GROTEN E. & S. THYSSEN-BORNEMISZA - "Time varying gravitational satellite".  
Geophys. J. R. Astr. Soc., n°29, p.237-239, 1972.

Tracking data from a high flying laser-reflector-satellite can be useful to measure temporal changes of the gravitational constant G. In view of presenting speculation about time-varying G this approach could provide experimental evidence.

- 637 - GROTEN E. - "Some numerical aspects of least squares autoregression prediction".  
Presented at the 5th Symposium on Mathematical Geodesy, Florence, 25-26 Oct. 1972.  
Boll. Geod. Sci. Affini, Anno XXXII, n°4, p.201-227, 1973.

Effects due to non-uniform distribution of data, incomplete elimination of trends, anisotropy, non-stationarity etc... for two different models of stochastic fields are investigated, corresponding influences on linear regression prediction are discussed.

- 638 - PALLA B. - "La riduzione di Bowie per l'effetto indiretto in Italia : carta delle linee di eguale riduzione".  
Inst. Geod. e Topog., Pub. n°58, Pisa, 1964.

The criterias has been shown in the following, reffering the treatment of calculation, to obtain the values of Bowie's reduction for the indirect effect which concerns the national territory and the circumstant seas, as for the construction of the relative maps for equal reduction lines.

- 639 - NANCE R.L. - "Gravity : first measurement on the lunar surface".  
Science, v.166, p.384-385, 1969.

The gravity at the landing site of the first lunar-landing mission has been determined to be 162,821.680 milligals from data telemetered to earth by the lunar module on the lunar surface. The gravity was measured with a pulsed integrating pendulous accelerometer. These measurements were used to compute the gravity anomaly and radius at the landing site.

- 640 - BOOKER J.R., R.L. KOVACH & L. LU - "Mascons and lunar gravity".  
J. Geophys. Res., v.75, n°32, p.6558-6564, 1970.

The mascon in a lunar ringed mare is approximately proportional to the area of the mare material in the basin. This relationship is consistent with the hypothesis that the lunar mascons are produced by dense plugs in the maria, and it means that the maximum thickness of the uncompensated rock is the same for all maria.



The relationship also predicts the presence of mascons in other ringed lunar structures which are consistent with satellite Doppler data. The relative masses of the known and predicted mascons accurately predict the moon's dynamical asymmetry without any large mascons on the lunar farside. However, reconciliation of the absolute differences between the lunar moments of inertia with satellite accelerations directly above the maria requires mascons buried deeper than 250 km. Such deeply buried mascons seem unlikely.

It therefore also seems unlikely that the differences in the lunar moments of inertia are completely due to the mascons. However, a converse relationship cannot be ruled out. Examination of the degree variances of harmonic analyses of lunar gravity reveals a gentle peak near degree 10. This peak is predicted by the spacing of the two largest mascons, Imbrium and Serenitatis.

- 641 - RIKETS ALLMÄNNNA KARTVERK - "The second high precision levelling of Sweden 1951 - 1967".  
Med., n°A.40, 91 p, Stockholm, 1974.
- 642 - ANDERSEN O.B., E. KEJLSØ & O. REMMER - "Secular movements within Jutland as determined from repeated precise levellings 1885 - 94 and 1943 - 53".  
Mémoires de l'Institut Géodésique de Danemark, 3ème série, 40ème tome, 70 p, Copenhagen, 1974.
- 643 - KAARIAINEN J. - "Beobachtungsergebnisse der Finnischen Winkelmessungen in den Jahren 1969 - 1970".  
Pub. Finnish Geod. Inst., n°77, 40 p, Helsinki, 1974.
- 644 - Bulletin of the Geographical Survey Institute, v.XX, Part 1, 186 p, Tokyo, 1974.
- a) FUJII Y., Y. HASEGAWA & M. MOTTAMED - "Gravity change and crustal deformation accompanied with the Matsushiro Swarm Earthquakes".  
p.151-174.

The Geographical Survey Institute has been observing gravity in order to detect possible gravity change that may be accompanied with various geophysical phenomena such as earthquake, volcanic activities and so on. During the active period of the Matsushiro Swarm Earthquakes, gravity observations had been carried out several times by the Geographical Survey Institute to detect change of gravity.

In January 1974, additional gravity observations were made in the same area as a part of Group Training Course for Surveying and Mapping under the Colombo Plan. Summarizing all the observational results, it is elucidated that the Swarm Earthquakes are accompanied with change of gravity around Mt Minakami. For the explanation of these observed gravity change during the active period, it is necessary to assume that some masses, perhaps underground water, intruded into the seismic region not only for land upheaval but also for the succeeding land subsidence period.

Throughout the whole period, density decreased. Except around Mt. Minakami, no remarkable gravity change was detected in spite of abnormal crustal deformation during the Swarm Earthquakes. From these facts, we can presume that the Swarm Earthquake activities are closely related to the intrusion of under-ground water into the seismic region and the resultant gravity change as well as land upheaval.

- b) TADA T. - "Crustal movement and fault motion associated with 1973 Nemuro-Oki Earthquake".  
p.175-186.

Crustal movements in the eastern part of Hokkaido associated with the 1973 Nemuro-Oki earthquake were detected by means of levelling survey and tidal gauge records. The detected crustal movements were found to be a subsidence and the maximum subsidence was about 7 cm at Attoko.

...

The direction of fault motion is similar to the other earthquakes which occurred along the inner margin of Kuril Trench. It is, therefore, interpreted that this earthquake was caused by the low-angle reverse faulting which occurred due to underthrusting of the Pacific plate against the Continental plate.

It is obvious by the careful study of the mareographic records that the anelastic crustal deformation occurred immediately after the earthquake. When the continental plate which thrust up to the oceanic plate was dragged down by the gravity force along the fault plane, the anelastic crustal deformation occurred taking a relaxation time of about two weeks. This anelastic deformation suggests that the fault plane has the visco-elastic properties. Using this relaxation time, the viscosity and the thickness of the fault plane are estimated as  $1 \times 10^{17}$  poise and 50 - 100 cm respectively.

- 645 - RIDDIHOUGH R.P. - "A magnetic map of the continental margin West of Ireland including part of the Rockall Trough and the Faeroe Plateau".  
Com. Dublin Inst. for Advanced Studies, Ser. D, Geophys.,  
Bull. n°33, 1 p + map, 1975.

- 646 - SOCIÉTÉ HELVÉTIQUE des SCIENCES NATURELLES - Procès-verbal de la 120ème séance de la Commission Géodésique Suisse tenue à l'Université de Berne le 22 Juin 1974".  
14 p, Berne, 1975.

- 647 - DENHAM D. - "Seismicity of the New Guinea, Solomon Islands region, 1968".  
B.M.R., Geol. & Geophys., Rep. n°169, 61 p, Canberra, 1974.

Basic earthquake statistics for 1968 in the New Guinea/Solomon Islands region are presented. 463 earthquakes were large enough to be located accurately by computer methods and 802 reports of felt earthquakes have been catalogued. Although similar numbers of events were listed for 1967, the level of seismic activity in 1968 was considerably higher, as 8 earthquakes gave a body-wave magnitude of 6 or more, and considerable damage was caused by two important earthquake series...

- 648 - PALMASON G. & K. SOEMUNDSSON - "Iceland in relation to the Mid-Atlantic ridge".  
Annual review of Earth & Planetary Sci., v.2, p.25-50, Reykjavik, 1974.

The central question to be answered concerning Iceland and its relationship to the Mid-Atlantic Ridge is whether Iceland fits into the framework of ocean-floor spreading or not. The presently available evidence favors a process of drift. This process, however, appears to be more complicated than is usually envisaged for the submarine parts of the Mid-Atlantic Ridge.

...

The hypothesis of ocean-floor spreading provides a good working hypothesis for interpreting data of Icelandic geology, geophysics, and geochemistry. Most of the available evidence appears consistent with it. Various arguments which have been presented as contradicting drift in Iceland do not appear to be valid in the light of what has been discussed in this paper.

- 649 - KONO M. - "Gravity anomalies in East Nepal and their implications to the crustal structure of the Himalayas".  
Geophys. J. R. Astr. Soc., v.39, n°283-299, 1974.

Gravity measurements were carried out at 145 points in eastern Nepal as a part of the scientific programme of the Japanese Mount Everest Expedition 1970. As the position and elevation of the gravity stations were determined by maps with the aid of an aneroid altimeter, they have standard errors of about 400 m and 33 m, respectively. Correspondingly, the gravity anomalies presented in this paper have errors of 5-15 mGal. Free-air, Bouguer, Pratt-Hayford and Airy-Heiskanen anomalies were obtained from these data. A terrain correction of Hayford zones F-O was applied in the calculation of the latter three anomalies. The terrain correction amounts to more than 40 mGal at many stations. The gravity data were divided into three groups according to geological-morphological zones of east Nepal :

a) Higher Himalayas, (b) Lower Himalayas, and (c) Foothills.

Different anomaly-elevation relations were indicated by free-air and Bouguer anomalies of different zones. Especially, Bouguer anomalies in individual zones show almost no correlation with the heights, suggesting that isostasy does not prevail in the wavelength of less than 100 km. Pratt-Hayford and Airy-Heiskanen isostatic anomalies show a weak positive correlation with the elevation. In this case the trend is not significantly different among the subdivided zones. It was observed that Bouguer anomalies projected on a line perpendicular to the structural trend of the Himalayas in this region show a remarkable linear relation with the distance measured along this line. Although the topography in this area is quite rugged because of the erosion due to the north-south running rivers, the surface of the substratum seems to be quite smooth and Bouguer anomalies are caused by almost two-dimensional structure of the Himalayas. The crust under the Himalayas is much thinner than that expected from isostatic equilibrium. Thus the Himalayas seem to be isostatically not in equilibrium in longer as well as shorter wave lengths. The lack of isostatic equilibrium and the existence of very smooth, inclined substratum suggest that the Himalayas are currently under the influence of large scale tectonic forces, probably due to collision of the Indian plate against the Asian plate.

- 650 - REMMER O. - "Levelling errors in statu nascendi".  
Geod. Inst., Med. n°51, 44 p, Copenhagen, 1975.

- 651 - OZAWA I. - "Pattern of tidal deformation on the Earth".  
from : Contr. Geophys. Inst., Kyoto Univ., n°14, p.29-38, 1974.

The tidal deformation on the Earth is classified into three types. The first type is formulated by a product of tidal numbers and the potential of the tide generating force like the tidal change of the gravity acceleration. The second type is formulated by a product of tidal numbers and the tidal displacement like the tidal tilting. The third type is formulated by a combination of the tidal potential, tidal numbers and the trigonometrical function of the latitude like the tidal strain.

The patterns of the latitudinal and the azimuthal distributions are calculated. And the possibility to obtain the ratio  $1/h$  is shown by means of the observations of these patterns of tidal changes.

- 652 - CHOUKROUNE P., X. LE PICHON, M. SEURET & J.C. SIBUET - "Bay of Biscay and Pyrénées".  
Earth & Planetary Sci. Letters 18, p. 109-118, 1973.

The different hypotheses proposed for the creation of the Bay of Biscay are reviewed. New geological and geophysical data collected in the last two years in the Bay and in the Pyrenean domain give new insight into the tectogenesis of the Pyrenees. Geological data of the Pyrenean area provide tight constraints on the hypothesis of formation of the Bay. The most probable hypothesis is an opening by rotation of the Iberian Peninsula around a pole of rotation situated near Paris, which resulted in strike-slip motion along the North Pyrenean fault during the Upper Mesozoic. A progressive westward migration of the pole initiated in the late Cretaceous blocked the motion along the fault and led to the main Eocene tectogenetic Pyrenean phase.

- 653 - BOTT M.H.P. - "The geological interpretation of a gravity survey of the English Lake District and the Vale of Eden".  
from : J. Geol. Soc., v.130, p.309-331, 1974.  
Dept. Geol. Sci., Univ. Durham, Pub. n°483.

The Lake District is dominated by an east-west belt of relatively low Bouguer anomaly which attains individual minima over the exposed Eskdale, Shap and Skiddaw granites. The negative anomaly is attributed to a composite granite batholith which underlies the central and northern parts of the Lake District, connecting the exposed granites at depth. Interpreting on the basis of surface density measurements, the granites appear to extend to a depth of about 7 to 10 km and the contacts with the country rocks generally slope outwards. There are substantial variations in density within the composite granite body. The roof region of the granite includes a series of shallow granite "ridges", one of these connecting the Eskdale and Shap granites, and another connecting the Ennerdale, St. John's, Threlkeld and Skiddaw granites. The Shap granite is probably connected to the Weardale granite by a deep granite ridge.

Present and past uplift of the Lake District may be attributed to the granite mass deficiency, which is estimated to be  $1.1 \times 10^{18}$  g and is approximately equal to the present elevation of the Lake District above a 270 ft (82 m) datum.

The low gravity values along the Vale of Eden suggest that the Permo-Triassic rocks reach a maximum thickness of at least 1 km northeast of Penrith, and that these rocks formed during contemporaneous subsidence. The detailed gravity interpretation of the structure of the Vale of Eden allows a new assessment to be made of the structural history of the Pennine line which reconciles the Hercynian structures with the occurrence of Whin Sill or dyke pebbles in the Upper Brockram.

- 656 - ROSE J.C. & R.W. TRACY - "Gravity results in the Solomon Islands region, aboard H.M.S. Dampier in 1965".  
Hawaii Inst. Geophys., Univ. Hawaii, HIG-71-2, Data Rep. n°17, 102 p, 1971.

The gravity results of the cruise are presented in three forms :

- 1) Appendix 1. Profiles of water depth, and free-air and Bouguer anomalies. The horizontal dimensions is the distance of ship travel corresponding to 15 minutes of time. Sometimes there is a hiatus in the time.
- 2) Appendix 2. Listing of principal facts. Gravity anomalies are calculated using the International gravity formula (1930). Bouguer anomalies assume an infinite flat slab and crustal density 2.67 g/cc. Water depths have been corrected for sound velocity as discussed in Rose, Woollard, and Malahoff (1968).
- 3) Nine free-air anomaly charts. Figure 1 is an index to the nine charts. The charts have a scale of 4 inches = 1 degree of longitude, the same scale as have the HO-3000 series plotting charts. Not all the stations given in Appendix 2 appear on the charts in those instance where the stations are too closely spaced.

An ozalid copy of individual charts to scale is available at a cost of \$ 1.00 per chart. Send request and check, made payable to the University of Hawaii.

- 657 - TRACY R.W. - "Gravity results obtained between Hawaii and California aboard the R/V Mahi in 1969".  
Hawaii Inst. Geophys., Univ. Hawaii, HIG-71-3, Data Rep. n°18, 28 p, 1971.

Presented are profiles, listings, and charts of principal gravity facts and free-air and simple Bouguer gravity anomalies obtained between Hawaii and California aboard the R/V MAHI in 1969. An index to the charts is given, and it is possible to obtain on ozalid copy of individual charts to scale at a cost of \$ 1.00 per chart.

- 658 - MATHER R.S. - "The Australian Geodetic Datum and the Geocentre".  
Search, v.3, n°3, p.80-85, Sydney, 1972.

This paper reviews recent advances in gravimetric geodesy with special reference to progress made in Australia over the past five years. There appears to be no published record of previous determinations in other countries which have aimed for and achieved the precision attained in the work which is the subject of this review. This is chiefly due to the quality of the data available for the Australian study which called for the use of methods which are more sophisticated than those applied previously. The resulting techniques, are judged to be of adequate accuracy to warrant the extension of the concepts used, after suitable modification, to other continental areas of the Earth. A world geodetic system established in this manner will be of significance in global geophysics.

- 659 - BOULANGER Yu. D. - "Secular variations in gravity".  
Proc. Symposium on Earth's gravitational field & secular variations in position, p.202-212, 1973.  
See also Bull. Inf. B.G.I. n°36, p.I-62-68, Mars 1975.

- 660 - SAKUMA A. - "A permanent station for the absolute determination of gravity approaching one micro-Gal accuracy".  
Proc. Symposium on Earth's gravitational field & secular variations in position, p.674-684, 1973.

This paper describes the first permanent station for the absolute determination of gravity at the International Bureau of Weights and Measures. The station presently consists of an absolute apparatus of a few micro-Gal accuracy based on a symmetrical free rise and fall observation of a corner reflector in vacuum. Periodic determinations of  $g$  by the apparatus permits one to monitor the small variations of  $g$  arising from the Earth tide and various geophysical causes including the secular effects. The principal sources of errors in the apparatus are discussed and it is predicted that a final accuracy of  $1 \mu\text{Gal}$  can be obtained by the symmetric free rise and fall principle, provided that the local Earth tide and the vertical gradient of  $g$  are measured with sufficient accuracy. A tendency of the secular variation of  $g$  of the order of  $10 \mu\text{Gal}$  per year is reported. An Earth tide recording gravimeter and a transportable absolute gravity apparatus, both of which have recently been completed at this station, are also described.

- 661 - WILLIAMS O.W. - "Gradiometry an assessment of the state-of-the art".  
Defense Mapping Agency, Paper presented at the VIIth I.G.C., Sept. 74, 16 p, 1974.  
See also Bull. Inf. B.G.I. n°36, p.I-48-60, Mars 1975.

- 662 - MATHER R.S. - "The 1971 geoid for Australia and its significance in global geodesy".  
J. Geol. Soc. Australia, v.19, part 1, p.21-29, Sydney, 1972.

A review is presented of all solutions for the geoid in the Australian region, culminating in the 1971 determination, based on a combination of astro-geodetic and gravimetric techniques. It is shown how the principles underlying this combined solution can be used to establish a World Geodetic System which would provide an alternate method for studying the secular variations in position, of points at the surface of the Earth.

- 663 - MATHER R.S. - "Position from gravity".  
Proc. Symposium on Earth's gravitational field & secular variations in position, p.117-153, Sydney, 1973.

Procedures for obtaining position from surface gravity observations and reviewed and their relevance assessed in the context of the application of modern geodetic techniques to programs of Earth and ocean physics. Solutions based on the use of surface layer techniques, the discrete value approach, and the development from Green's third identity are stated in summary, the latter being extended to order  $e^3$  in the height anomaly.

The representation of the surface gravity field which is required in order that this accuracy may be achieved is discussed. Interim techniques which could be used in the absence of such a representation are also outlined.

The role which can be played by the determination of changes in observed gravity to a few microgal, in the definition of geodetic reference systems for long period studies in Earth physics, is discussed and the consequences of changes of zero degree summarized. The possible use of these techniques in future geodetic practice is also assessed.

- 664 - MATHER R.S. - "The influence of stationary sea surface topography on geodetic consideration".  
Proc. Symposium on Earth's gravitational field & secular variations in position, p.585-599, Sydney, 1973.

The comparison of the results of geodetic levelling with the mean level of the sea as defined by tide gauge readings, has indicated the apparent existence of widespread departures of sea level from an equipotential surface of the Earth's gravitational field.

While the evidence available at present for the existence of this quasi-stationary sea surface topography is confined to coastal regions, there should be repercussions of fundamental significance in high precision geodesy if this phenomenon were to prevail over the global oceans with amplitudes and wavelengths which are not negligible. This arises primarily through the widespread adoption of "mean sea level" as a datum for elevations, and affects global determinations of the highest resolution in both physical geodesy and vertical crustal motion studies.

These problems are summarized and desirable goals indicated for satellite altimetry and laser ranging techniques which would not only eliminate the errors arising from the assumption outlined above, but also confirm the global characteristics of stationary sea surface topography in non-coastal areas.

- 665 - MATHER R.S. - "Sea-surface topography from satellite altimetry - Requirements for surface gravity data".  
The School of Surveying, Univ. of New South Wales, Paper presented at the I.G.C. Paris, Sept. 1974, Sydney, 1974.  
See also Bull. Inf. n°36, p.I-86-92, Mars 1975.

National Aeronautics & Space Administration (NASA) plans to launch a series of spacecraft equipped with altimeters for ranging to the ocean surface, as part of its Earth and Ocean Physics Applications Program (EOPAP). The first of these spacecraft is due for launch at the end of 1974. One of the goals of this program is the resolution of quasi-stationary sea surface topography.

It would appear that the separation of effects other than non-tidal Newtonian gravitation acting on the ocean surface using solutions of the geodetic boundary value problem, cannot be achieved without the use of gravity measurements of adequate accuracy on land and on the continental margins. This gravity data will have to satisfy certain stringent requirements on a global basis if unacceptable levels of systematic error in the computed values are to be avoided.

The dominant requirements to be met by the gravity control networks are the following :

- 1) The spacing of stations comprising the global gravity standardization network should be approximately  $10^3$  km in continental areas, the gravity values having been established with a resolution approaching  $\pm 100 \mu\text{Gal}$  and exhibiting no error correlation of significance between values at adjacent stations.
- 2) Regional gravity control networks should be established using techniques which will not introduce correlated errors at levels significantly above those given at 1) above, though larger magnitudes of purely accidental error are tolerable.

Free-air anomalies as conventionally used, are inadequate for the task outlined above. The gravity anomaly required for this purpose should be computed from geopotential differences with respect to the datum for geodetic levelling. As the latter are not necessarily coincident with the geoid (the equipotential surface of the Earth's gravity field corresponding to the mean value of mean sea level for the epoch of determination), it is essential that computer files of gravity data to be used for this purpose, should contain reference to the sea level datum to which the levelling data is linked.

It will be difficult to determine the quasi-stationary sea surface topography with any degree of confidence unless all national organizations and/or global gravity data banks providing gravity information for geodetic purposes, were to correctly identify and describe the levelling datum when providing suitably "clean" gravity data.

- 667 - RAPP R.H. - "Procedures and results related to the direct determination of gravity anomalies from satellite and terrestrial gravity data".  
Ohio State Univ., Dept. Geod. Sci., Rep. n°211, 51 p, Columbus, 1974.

The equations needed for the incorporation of gravity anomalies as unknown parameters in an orbit determination program are described.



These equations were implemented in the Geodyn computer program which was then used to process optical satellite observations. Besides the arc dependent parameters unknowns, we consider 184  $15^\circ$  unknown anomalies and coordinates of 7 tracking stations. Up to 39 arcs (5 - 7 day) involving 10 different satellites, were processed. An anomaly solution just from the satellite data and a combination solution with  $15^\circ$  terrestrial anomalies was made. The results with the somewhat limited data sample indicate that the method works. The report gives the  $15^\circ$  anomalies from various solutions and the potential coefficients implied by the different solutions.

- 667 - HAJELA D.P. - "Direct recovery of mean gravity anomalies from satellite to satellite tracking".  
Ohio State Univ., Dept. Geod. Sci., Rep. n°218, 125 p, Columbus, 1974.

This study investigates the direct recovery of mean gravity anomalies from summed range rate ( $\dot{R}_S$ ) observations, the signal path being ground station to a geosynchronous relay satellite to a close satellite significantly perturbed by the short wave features of the Earth's gravitational field. To ensure realistic observations, these were simulated with the nominal orbital elements for the relay satellite corresponding to ATS-6, and for two different close satellites one at about 250 km height, and the other at about 900 km height corresponding to the nominal values for Geos-C. The Earth's gravitational field was represented by a reference set of potential coefficients up to degree and order 12, considered as known values, and by residual gravity anomalies obtained by subtracting the anomalies, implied by the potential coefficients, from their terrestrial estimates. The Geodyn orbit generation and parameter estimation program was used after modifying it to accept gravity anomalies as parameters. The standard deviation (std. devn.) of  $\dot{R}_S$  observations was assumed as 0.08 cm/sec. based on an integration interval of 10 seconds.

The recovery of mean gravity anomalies over  $10^\circ$  and  $5^\circ$  equal area blocks from  $\dot{R}_S$  observations to close satellites at heights of about 900 and 250 km respectively were classified as recovery from strong signal. The recovery of  $5^\circ$  and  $2^\circ 5'$  equal area mean anomalies using the same close satellites were classified as recovery from weak signal. The anomaly recovery was considered over local or regional areas. The satellite state vectors could not be recovered from short individual arcs of 4 to 20 minutes duration, and were held fixed in this study to a-priori known values.

It was found that gravity anomalies could be recovered from strong signal without using any a-priori terrestrial information, i.e, considering their initial values as zero and also assigning them a zero weight matrix. However, while recovering them from weak signal, it was necessary to use the a-priori estimate of the std. devn. of the anomalies to form their a-priori diagonal weight matrix. Without this a-priori information, the solutions from weak signal were unstable and not meaningful.

...

The criteria for examining the "goodness" of anomaly recovery have been described. The std. devn. of recovered anomalies from strong signal was found to be about 2 mGals for  $10^\circ$  and about 6 mGals for  $5^\circ$  equal area mean anomalies. These results have been compared with those obtained by Schwarz in 1970.

- 668 - MATHER R.S. - "The gravity field and the definition of stationary sea surface topography".

Proc. 2nd Symposium Geodesy & Physics of the Earth, Potsdam  
7 - 11 May 1973, p.381-414, 1973.

Veröff. Zentralinst. Physik der Erde n°30(4), 1974.

The proposal to place an altimeter in the Earth orbit affords a means for evaluating the instantaneous geocentric position of the sea surface. If the measurements were of adequate precision, it would be possible to obtain those features of the sea surface which were of a stationary nature, on filtering out the periodic gravitational effects based on luni-solar tidal theory, along with meteorological corrections and salinity effects. The "free" sea surface so obtained should be an equipotential surface of the Earth's gravitational field. Observations made along coastlines indicate the existence of deviations between these surfaces on more than one continent. These deviations have been reported to be as large as 2 m. The resolution of the surface gravity field which is required for the definition of the geoid over ocean areas with an accuracy of  $\pm 10$  cm is estimated from the known statistical characteristics of the terrestrial samples available, and is based on an adequate solution of the boundary value problem. The effect of systematic errors on these results is also estimated and the requirements for an appropriate global gravity standardization network discussed. The significance of a unified world-wide elevation datum is investigated and possible techniques for unification at the  $\pm 15$  cm level are outlined.

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

- 669 - n°73, 24 p, Paris, Janvier 1975.

Supplément au n°73 : Catalogue des Publications, n°2, Janvier 1975.

- 670 - n°76, 19 p, Paris, Avril 1975.

- 670bis - n°77, 20 p, Paris, Mai 1975.

- 671 - GOPALAPILLAI S. - "Non-global recovery of gravity anomalies from a combination of terrestrial and satellite altimetry data".

AFCRL-TR-74-0333, Rep. of the Dept. Geod. Sci. n°210, Sci. Rep. n°16, 98 p, 1974.

Two methods for recovery of gravity anomalies are described. Of those, the indirect method, based on the use of the Stokes' formula is chosen for its flexibility in combining any a priori information available on the anomalies and in filtering out any systematic error that may be inherent in the observations.

A truncation theory developed for the Molodenskii (Inverse of Stokes') formula forms the basis for implementing the indirect method in a non-global solution. This method is tested with simulated data for the recovery of  $2^\circ \times 2^\circ$  and  $1^\circ \times 1^\circ$  anomalies. Weighted constraints for parameters are necessary for any realistic results. The anomalies appear to be recoverable with an accuracy of about 8 mGals for  $2^\circ \times 2^\circ$  and of 19 mGals for  $1^\circ \times 1^\circ$  blocks from altimetry data with 1 m accuracy. The minimum requirement for the density of observations is shown to be one per block.

The performance of this procedure, to an extent, depends on the cap sizes chosen for both the Stokes' and Molodenskii formulas. The magnitude of the remote zone contributions for both these formulas have been evaluated for various cap sizes and highest degree of the potential coefficients used and graphs to aid in cap selection are plotted.

The minimal effect of an observation in one block on the determination of the anomalies in the neighboring blocks suggests that the cap size for the Molodenskii integral need not be more than 1 or 2 degrees for the accuracies obtainable in this procedure.

- 672 - TSCHERNING C.C. - "A Fortran IV program for the determination of the anomalous potential using stepwise least squares collocation". AFCRL-TR-74-0391, Rep. of the Dept. Geod. Sci. n°212, Sci. Rep. n°17, 125 p, 1974.

The theory of sequential least squares collocation, as applied to the determination of an approximation  $\hat{T}$  to the anomalous potential of the Earth  $T$ , and to the prediction and filtering of quantities related in a linear manner to  $T$ , is developed.

The practical implementation of the theory in the form of a FORTRAN IV program is presented and detailed instructions for the use of this program are given. The program requires the specifications of :

- 1) a covariance function of the gravity anomalies and,
- 2) a set of observed quantities with known standard deviations). ...

- 673 - TSCHERNING C.C. - "Some simple methods for the unique assignment of a density distribution to a harmonic function". AFCRL-TR-74-0506, Rep. of the Dept. Geod. Sci. n°213, Sci. Rep. n°19, 17 p, 1974.

One to one relationships are established between functions harmonic outside a sphere and density functions :

- 1) with support equal to the sphere and,
- 2) having the property that the density functions  $\rho$ , multiplied by a positive function of the distance from the center of the sphere, are harmonic, i.e.,

$$(\times) \quad \Delta(f(r) \cdot \rho) = 0, \quad f(r) > 0 \text{ for } 0 \leq r \leq R.$$

The relationship is established by specifying the relation for each external solid spherical harmonic  $V_{nm}^e$  of degree  $n$  and order  $m$ . The Poisson equation is first used to obtain a density function, equal to a distribution with support in the center of the sphere. This density is then spread out inside the whole sphere. As spreading operators are used the identity operators on Hilbert spaces of density functions fulfilling  $(\times)$ .

The derived relations may be used to assign a density distribution to the harmonic part of the potential of the Earth, and a covariance function of a density anomaly distribution to the covariance function of the anomalous potential of the Earth.

- 664 - SMITH G.N. - "Mean gravity anomaly prediction from terrestrial gravity data and satellite altimeter data".  
AFCRL-TR-74-0451, Rep. of the Dept. Geod. Sci., n°214, Sci. Rep. n°18, 139 p, 1974.

This report examines the prediction of mean gravity anomalies from terrestrial gravity material and/or simulated satellite altimeter data. The first part of the report deals with the prediction of 1° and 5° equal area anomalies using equations following from those of Moritz where the accuracy of the terrestrial data is considered. The prediction of 1° blocks from 1° anomaly data gave a standard error of prediction of approximately  $\pm 19$  mGal while the prediction of 5° anomalies from 1° data led to prediction accuracies from  $\pm 1$  to  $\pm 19$  mGals. The correlation between adjacent predicted blocks when overlapping data sets were used was found to be low. The Least Error Integral prediction method of Moritz was derived in matrix form but was found to be not applicable to non-uniform real world data. Collocation prediction methods were used in the second part of the report to carry out 1° and 5° anomaly predictions from gravity anomaly and simulated altimetry data. Using only altimeter data a 1° anomaly could be predicted to an accuracy of about  $\pm 17$  mGals for sparse data distributions and  $\pm 12$  mGals for dense data distributions.

- 675 - HAJELA D.P. - "Adjustment of mean Earth ellipsoid parameters".  
AFCRL-TR-74-0509, Rep. of the Dept. Geod. Sci. n°215, Sci. Rep. n°20, 20 p, 1974.

The report describes the details of an adjustment techniques used to find parameters of a mean Earth ellipsoid. The parameters considered include : the equatorial radius, geocentric gravitational constant, the flattening, equatorial gravity, and the geoid potential. Various adjustment models are described. The linearized observation equations are formed and the specific adjustment procedure is given. The procedure used incorporates apriori estimates of quantities determined from satellite and gravimetric data. Results, as originally reported by RAPP (1974), are given.

- 676 - SCHWARZ K.P. - "Tesseral harmonic coefficients and station coordinates from satellite observations by collocation".  
AFCRL-TR-74-0641, Rep. of the Dept. Geod. Sci. n°217, Sci. Rep. n°22, 42 p, 1974.

The usual formulation of the least squares collocation method requires the inversion of matrices with dimensions equal to the number of observations. Such a procedure poses difficult numerical problems when large numbers of observations are involved. It is shown in this report how this difficulty can be overcome. The size of the matrices to be inverted can be reduced to the number of unknown quantities, i.e. the amount of numerical work will be the same as for the corresponding adjustment problem.

A comparison between the adjustment and the collocation solution shows that the basic structure of the two approaches is very similar and that existing algorithms for the adjustment solution can easily be implemented to include the collocation solution. Furthermore,

the results of the adjustment solution can be used to compute the collocation solution without additional matrix inversions by a Neumann series expansion. If a further reduction of matrix dimensions is necessary a method similar to matrix partitioning can be used to determine tesseral harmonic coefficients and station coordinates separately. A similar partitioning into two groups of unknowns is achieved with an iterative procedure. It is shown that the iteration converges to a solution which is identical to that obtained by the direct approach.

Numerical questions as the treatment of orbital parameters, the determination of the speed of convergence, the stability of different solutions, and the choice of a covariance function are discussed. The determination of tesseral harmonic coefficients from a combination of satellite and gravimetric data is treated in some detail and the results are related to previous work.

- 677 - MORITZ H. - "Precise gravimetric geodesy".  
AFCRL-TR-74-0640, Rep. of the Dept. Geod. Sci. n°219, Sci. Rep. n°21,  
75 p, 1974.

The report discusses the refinement of computational formulas and the gravity data necessary to obtain geoidal heights to  $\pm 10$  cm accuracy. Methods of taking into account the effects of the atmosphere, of the topography, and of the ellipticity of the reference surface are given. Emphasis is on appropriate refinements of Stokes' formula, using gravity anomalies, and of least-squares collocation, using data of different types. The determination of the sea surface topography from gravity disturbances is also investigated. Finally, requirements on absolute and relative gravity data and on their distribution are outlined.

- 678 - RAPP R.H. - "Gravity anomaly recovery from satellite altimetry data using least squares collocation techniques".  
AFCRL-TR-74-0642, Rep. of the Dept. Geod. Sci. n°220, Sci. Rep. n°23,  
25 p, 1974.

The prediction of mean gravity anomalies from other anomalies and satellite altimeter data is described using the technique of least squares collocation. The equations derived are then used in simulation studies, using altimeter data alone, to estimate the accuracy to which we can determine mean gravity anomalies with respect to an ellipsoidal reference field and a degree 12 reference field. In these studies we found that for the ellipsoidal reference model it was necessary to include altimeter data out to  $8^\circ$  from the center of the anomaly block while such data was needed only out to  $4^\circ$  when using the  $N = 12$  reference field. We also saw that along track and cross track spacings of  $1^\circ$  were adequate for anomaly recovery purposes. In fact the increase of the cross track spacing led to only small accuracy degradation. In addition we found that as the altimeter accuracy varied from  $\pm 0.5$  to 2 m only a small change in the accuracy of the predicted anomaly was found. Assuming a uniform  $1^\circ \times 1^\circ$  grid of altimeter data, of 1 m accuracy, within  $8^\circ$  of the block center we found the following prediction accuracies with respect to the ellipsoidal reference field :  $5^\circ$ ,  $\pm 4.2$  mGals ;  $2^\circ.5$ ,  $\pm 4.9$  mGals ;  $1^\circ$ ,  $\pm 10.0$  mGals.

- 679 - DeBRA D.B. & E.J. PELKA - "Study to develop gradiometer compensation techniques".

AFCRL-TR-74-0114, Final Rep. 1 Feb. 1973 - 31 Jan. 1974, 65 p, 1974.

The primary goal of the gravity gradiometer (GG) research effort at Stanford University has been to establish the feasibility of operation of a GG in a closed loop mode. A parameter estimation techniques will allow for online modification (compensation) of the sensor output signal as well as for trimming of pertinent sensor physical properties so as to improve instrument performance. Gravity gradiometers are required to operate with an accuracy of 1 E.U. This is so demanding that closed loop mode operation may be essential. Although attention has been focused exclusively upon the Hughes rotating Gravity gradiometer (RGG), the parameter estimation method developed is applicable, in principle, to any instrument subject to dynamically induced errors.

- 680 - LOUIS M. - Bulletin Géodésique de l'Association Internationale de Géodésie. N° 116, Paris 1er Juin 1975.

- a) PAUL M.K. - "Satellite Doppler solutions in terms of a single parameter".  
p.131-142.

By an appropriate combination of the integrated doppler counts for a motionless ground station over two consecutive arcs of a satellite path, it is possible to obtain a linear mathematical model relating the coordinates of the ground station to the observations. In this mathematical model, the involvement of the fourth unknown of the problem - the frequency off - set parameter, is, however, not linear. By application of the least squares technique, the solutions for the coordinates are obtained as analytical functions of the frequency off - set parameter only. These, in turn, reduce the basic formula for the doppler count to be an implicit function of the same single variable. The value of the variable which provides the best fit of this function with the observed doppler counts, minimizing the sum of squares of the deviations for all involved pairs of satellite positions is the best value for the unknown frequency off-set parameter and an iterative technique is devised to compute this value. The desired values for the coordinates of the ground station can then be obtained by substitution of the best value of the frequency off - set parameter into the corresponding formula and correcting for reducing the effects of the random noise in the observed doppler data.

- b) DUFOUR H.M. - "Note au sujet de l'article "Satellite Doppler solution in terms of a single parameters".  
p.143-148.

From the article of M. PAUL, a geometric illustration of the result is presented here, with the agreement of the Author.

It is possible to find out a linear relation when the intersection is found for 2 conics (or quadrics) of same focus.

The method may be interesting for the acquisition of the approached coordinates, or for testing regularity of observations.

- c) BHATTACHARJI J.C. - "Establishment of precise gravity network of airport stations in India".  
p.167-176.

A precise gravity network of 35 stations based on the first order gravity station at Palam airport, New Delhi (979.13433 gals, University of Wisconsin 1969 value) was established during April - June 1971, covering the entire country, in order to use them as reference bases for any future gravity surveys in India with a repeatability of  $\pm 0.05$  mGal or less. The instrument, a LaCoste-Romberg geodetic gravimeter n° G-84, was transported by air over the network of airport stations embracing Trivandrum in the south, Srinagar in the north, Bombay in the west and Mohanbari in the east. The 4 airport stations in New Delhi, Calcutta, Madras and Bombay which were more precisely established by a large number of repeat observations were utilized as base stations for facilitating easy occupation of the remaining 31 stations within their respective zones.

The observations were reduced by procedure which permits automatic removal of instrumental drift from the observed readings. According to the depicted drift curve, the instrumental drift though comparatively small, is found not exactly linear due to the possible tare effect observed at the initial stage and also the resulting creep drift that might have been developed during transportation of the gravimeter by air. The final results along with their probable errors of the order of  $\pm 0.01$  mGal for base stations and  $\pm 0.03$  mGal for other stations relative to the adopted value at Palam airport, are given in Table 1.

14 of the sites occupied are reoccupations of stations already established by the University of Wisconsin in 1963, and the results of the old and the new measurements as given in Table 2, are in remarkable agreement, which ensures the correctness of the calibration factors of the present instrument relative to that of the Woollard's LaCoste-Romberg gravimeter n° G-1-A actually employed in the 1963 measurements.

- d) KIVINIEMI A. - "A method for studying global gravity variations".  
p.177-182.

Global variations in gravity caused by the general variation in the mass distribution of the Earth can be investigated by measuring gravity differences around the Earth. When the gravity differences to be measured are small and special arrangements are applied, the gravity differences can be measured with an accuracy of some microgals. Measurement of this kind needs effective and extensive international cooperation.

- e) TSCHERNING C.C. - "Application of collocation for the planning of gravity surveys".  
p.183-198.

Least squares collocation can be used to determine the density of a gravity survey, when the object of the survey is :

- 1) To produce a (free-air) gravity anomaly map, so that point gravity anomaly values can be interpolated with a standard error of  $\pm X_1$  mGal.

- 2) To interpolate deflections of the vertical with a standard error of  $\pm X_2$  arc sec. between astronomical stations Z km apart.
- 3) To compute an upward continuation of a point gravity anomaly to a height of Z meters with a standard error of  $\pm X_3$  mGal.
- 4) To compute mean gravity anomalies of block size Z degrees with a standard error of  $\pm X_4$  mGal.
- 5) To obtain a (local) gravimetric geoid with a standard error of  $X_5$  meters.
- 6) To compute density anomalies at a depth of Z km with a standard error of  $\pm X_6$  g/cm<sup>3</sup>.

f) PAVONI N. - Fifth International Symposium on Recent Crustal Movements (August 26 - 31, 1974, Zurich, Switzerland).  
p.205-208.

Resolutions.

681 - INSTITUT ROYAL METEOROLOGIQUE de BELGIQUE - Annuaire - Marées terrestres 1973.  
84 p, Bruxelles, 1975.

682 - DJUROVIC D. & P. MELCHIOR - "Recherches des termes de marée dans les variations de la vitesse de rotation de la Terre".  
Obs. Royal Belgique, Comm. Sér. B, n°79, Sér. Géophys., n°115.  
from : Bull. Cl. Sci. Acad. Royale Belgique 5ème Sér. t.LVIII,  
p.1248-1257, 1972.

The effect of tides on the rotation speed of the Earth has been investigated from the astronomical observations of time. In a mean time system recalculated for 1967-1971, the authors have identified seven tidal components.

683 - MELCHIOR P. - "Some problems of tilt and strain measurements".  
Obs. Royal Belgique, Comm. Sér. A, n°22, Sér. Géophys., n°116,  
from : Phil. Trans. R. Soc. London, n°A.274, p.203-208, 1973.

The importance of calibration method is emphasized. It is considered that the numerical results obtained for the tidal diurnal tesseral waves provide a quality test for the instruments.

684 - DEJAIFFE R. - "Constantes astronomiques et systèmes fondamentaux".  
Obs. Royal Belgique, Comm. Sér. B, n°80, Sér. Géophys., n°117,  
from : Ciel et Terre, v.89, n°3, 35 p, 1973.

This general review paper contents a presentation of the 1964 IAU system of astronomical constants with related explanations, a discussion on the fundamental systems adopted until now in astronomy with prospective considerations about the future FK5, and remarks on some specific reference systems as SAO and MD including an original comparison between these two systems.



- 685 - PAQUET P. - "L'observation radioélectrique des satellites artificiels et son rôle en astronomie fondamentale".  
Obs. Royal Belgique, Comm. Sér. B, n°82, Sér. Géophys. n°118,  
from : Ciel et Terre, v.89, n°4, 27 p, 1973.
- 686 - DJUROVIC D. - "Sur un terme harmonique de 122 jours dans la rotation de la Terre et dans le mouvement du pôle".  
Obs. Royal Belgique, Comm. Sér. B, n°84, Sér. Géophys., n°119,  
from : Ciel et Terre, v.90, n°1, 16 p, 1974.
- 689 - MELCHIOR P., B. DUCARME, J.M. Van GILS, J. FLICK & C. DENIS -  
"Preliminary results obtained with a vertical strainmeter at the  
Underground Laboratory of Geodynamics at Walferdange (Grand-Duchy  
of Luxembourg)".  
Obs. Royal Belgique, Comm. Sér. A, n°30, Sér. Géophys., n°122  
from : Physics of the Earth and Planetary Interiors, v.9, n°2,  
p.97-100, 1974.

A new vertical strainmeter is described. An harmonic analysis of Earth tides measured with that instrument has been performed. It yields a numerical estimation of the first Love number derivative which seems to be compatible with the Poisson coefficient of the local rocks of approximately 0.4.

- 690 - MELCHIOR P. - "Earth-tides".  
Obs. Royal Belgique, Comm. Sér. B, n°90, Sér. Géophys., n°123,  
from : Geophys. Surveys, v.1, p.275-303, 1974.

The main geometrical characteristics and mechanical properties of bodily tides are described, using the convenient elastic parameters of Love. The problem of the Earth's deformation is a problem of spherical elasticity of the sixth order. The importance of Earth tides in astronomy and geophysics is emphasized by their relation to the precession-nutation and tesseral tidal problems, the secular retardation of the Earth's speed of rotation due to the dissipation of energy in sectorial tides, the periodic variations of the speed of rotation due to zonal tides, the satellite orbit perturbations due to the Earth's potential variation, and the radial deformations in laser distance measurements.

The possibility that dynamical effects would be produced in the Earth's liquid core was pointed out by Poincaré and developed by Jeffreys, Vicente, and Molodensky. An experimental confirmation is presented here. The role of the Earth tide phenomenon in gravimetry and oceanography is also described, as are the perturbing effects due to regional tectonic features. Instrumental developments are critical in the acquisition of precise data ; the calibration problem is fundamental for a correct comparison with Earth models.

- 691 - DUCARME B. - La base gravimétrique du Lion de Waterloo".  
Obs. Royal Belgique, Comm. Sér. B, n°91, Sér. Géophys., n°124,  
from : Ciel et Terre, v.90, n°6, 22 p, 1974.

Résultats des mesures effectuées de 1967 à 1974 avec divers gravimètres, entre le pied et le sommet de la butte, environ 42 m. La variation de 11 mGal est utilisée pour étalonner les gravimètres.

- 692 - DITCHKO I.A. & P.S. KORBA - "Résultats de l'étalonnage des gravimètres "Askania" par la méthode de l'inclinaison".  
Marées Terrestres, Bull. d'Inf. N° 70, Obs. Royal Belgique,  
p. 3976-3980, Bruxelles, 15 Fév. 1975.

- 693 - FINETTI I. & C. MORELLI - "Esplorazione geofisica dell'area Mediterranea circostante il Blocco Sardo-Corso".  
from : Paleogeografia del Terziario Sardo nell'ambito del Mediterraneo Occidentale suppl. ai "Rendiconti del Seminario della Facoltà di Scienze dell'Università di Cagliari".  
p.213-237, Bologna, 1974.

On the basis of a vast geophysical exploration, and in particular of digital seismic reflection, it has been conducted a study on the main regional geological conditions of the Mediterranean sea around the Sardinia-Corsica area. The interpretation of the seismic lines allows to establish the existence of thick sedimentary basins on the western Mediterranean and thinner basins on the Tyrrhenian sea. The most evident characters of these basins have been described.

Particular attention has been devoted to the study of the Upper Miocene evaporitic interval which constitutes a thick sequence on the Western Mediterranean (up to 2800 m) with salt-dome structures of different dimension. On the Tyrrhenian Sea the evaporitic is in general less consistent (0-800 m) and only rarely creates sizeable diapire features SE to Sardinia, where locally we have thicker basins. ...

- 694 - MORELLI C. - "La gravimetria dell'area Italiana".  
Accad. Naz dei Lincei, Anno CCCLXX, n°183, p.297-313.  
Problemi Attuali di Scienza e di Cultura - Moderne Vedute sulla Geologia dell'Appennino.  
Osser. Geof. Sper., Contr. n°206bis, Trieste, 1973.

Briefly illustrated are the criteria followed for the preparation, measurements and reduction of the gravity values performed for the gravity map of Italy, on land from 1952 to 1961, on all the continental shelf with remotely controlled gravity-meters from 1953 to 1961, and on surface ships on all the seas around Italy from 1965 to 1972.

Indicated the meaning of the Faye anomalies in the Alps, Apennines and Tyrrhenian Sea as an index of the isostatic equilibrium, the Bouguer anomalies are discussed, from which informations are deduced on the structure of the upper Crust (in particular, thick sedimentary basins in the external peri-apenninic arc, to the East of Corsica and around the Tyrrhenian ; sial missing in the central parts of the Ligurian and Tyrrhenian Seas) and of the lower Crust (in particular,

deep Moho roots below the Alps, weak ones below the external appenninic margin ; near surface Moho antiroots in the central parts of the Tyrrhenian and Ligurian Seas...)

Results are also discussed in the light of the recent and actual Geodynamics.

- 695 - GIESE P., C. MORELLI & L. STEINMETZ - "Main features of crustal structure in Western and Southern Europe based on data of explosion seismology".  
from : Tectonophysics, n°20, p.367-379, 1973.

During the past two decades deep seismic sounding measurements have been carried out in western and southern Europe, mainly using the refraction method. These investigations were performed partly on a national basis but as well within international cooperative programs under the sponsorship of the European Seismological Commission.

In France, a systematic study has been executed to determine the main feature of deep structures under the Central Massif and the Paris Basin. In the Forez and Margeride regions, the sub-crustal velocity is lower (7,2 km/sec) than the normal value (8.0 km/sec.) observed in the adjacent areas.

The central and southern part of Western Germany is covered by an extensive network of refraction profiles. The crustal thickness varies, similarly to France, from 25 to 35 km. A great amount of deep reflection data was obtained by commercial and special reflection work. The crust beneath the Rhine-graben area shows the typical "rift system" structure with a low subcrustal velocity (7,4 - 7,7 km/sec.).

Very intensive refraction work has been carried out in the Alpine area. The maximum crustal thickness found near the axis of the negative gravity anomaly is about 55-60 km. Furthermore, a clear low-velocity layer at a depth between 10 and 30 km has been detected. A key position with regard to the geotectonic structure of the Alps is held by the zone of Ivrea characterized by a pronounced gravity high. From the refraction work it may be concluded that there material of the lower crust and the upper mantle (7.2 - 7.5 km/sec.) is overlying a layer of extremely low velocity (5.0 km/sec.) which is interpreted as sialic crust.

Three years ago, a systematic study of crustal structure of the Italian peninsula has been started. Reversed profiles were observed on Sicily, in Calabria, and in Puglia. On Sicily, the structure is very complicated ; the crust of the western part looks like a transition between a continental and oceanic structure whereas the eastern side shows a continental-type crust. In Calabria and Puglia, the crustal thickness has been determined to be about 25 - 35 km.

- 696 - GIESE P. & C. MORELLI - "La struttura della crosta terrestre in Italia".  
Accad. Naz dei Lincei, Anno CCCLXX, Quad., n°183, p.317-362.  
Problemi Attuali di Scienza e di Cultura - Moderne vedute sulla Geologia dell'Appennino.  
Osser. Geof. Sper., Contr. n°207b, Trieste, 1973.

The present report shows a synthesis of the DSS (Deep Seismic Soundings) profiles carried out in Italy from 1956 to the end of 1971 and the results of their interpretation. The practice used for working out the records and setting forth a suitable Earth's Crust model in agreement with both seismic and gravity data is briefly outlined.

Some details are given on other models previously proposed in comparison with the present one. Finally, region by region the structural aspects of the Earth's Crust and the Crust-Mantle boundaries in Italy are outlined.

- 697 - MORELLI C. & P. GIESE - "Crustal structure of Italy - Some general features from explosion seismology".  
Osser. Geof. Sper., Contr. n°230b, p.94-98, Trieste, 1973.

- 698 - CORRADO G., F. IACOBUCCI, E. PINNA & A. RAPOLLA - "Anomalie gravimetriche e magnetiche e strutture crostali nell'Italia Centro Meridionale".  
Boll. Geof. Teor. Appl., v.XVI, n°64, p.271-291, Dec. 1974.

This paper reports the analysis and interpretation of the gravity and magnetic data in middle-southern Italy. The study was preceded by a land magnetic survey (F, H, Z). Available gravity and magnetic data over the Tyrrhenian and Adriatic Seas were taken into account in the analysis procedure

Analysis and residuation of both fields was performed by multidimensional filtering procedures on the basis of previous spectral analysis. Gravity anomalies were interpreted by bidimensional models of arbitrary shape.

Results show the presence along the Adriatic side of the surveyed area of several intense high-frequency and low-frequency magnetic anomalies interpreted as due to basic magmatic intrusions within the upper crust and sedimentary layers.

Interpretation of gravity anomalies let define the following discontinuity surfaces : carbonatic basement-light sediments ; top of the crystalline layer ; "Moho".

Higher than normal densities were inferred for the crustal layers whose morphologies are characterized by structural highs in the Gargano area. Such structural highs are interpreted as possibly due to a crustal shortening at a plate margin caused by compressive actions, while the mentioned intense magmatic intrusions would have occurred during a previous distensive phase.

- 699 - EARTH PHYSICS BRANCH, Gravity Division - Index of publications : 1948 - 1973.  
Dept. En. Min. & Res., 22 p, Ottawa, 1974.

- 700 - EARTH PHYSICS BRANCH - Index of Geophysical Publications, Series and Contributions to December 1974.  
Dept. En. Min. & Res., 92 p, Ottawa, 1975.

- 701 - PHILLIPS R.J., R.S. SAUNDERS & J.E. CONEL - "Mars : Crustal structure inferred from Bouguer gravity anomalies".  
from : J. Geophys. Res., v.73, n°23, p.4815-4820, 1973.

Bouguer gravity has been computed for the equatorial region of Mars by differencing free-air gravity and the gravity predicted from topographic variations. The free-air gravity was generated from an eighth-order set of spherical harmonic coefficients. The gravity from topographic variations was generated by integrating a two-dimensional Green's function over each contour level. The Bouguer gravity indicates crustal inhomogeneities on Mars that we postulate are variations in crustal thickness. The Tharsis ridge is a region of thick continental type crust. The gravity data, structural patterns, topography, and surface geology of this region lead to the interpretation of the Tharsis topographic high as a broad crustal upwarp possibly associated with local formation of lower-density crustal material and subsequent rise of a thicker crust. The Amazonis region is one of several basins of relatively thin crust, analogous to terrestrial ocean basins. The Libya and Hellas basins, which are probable impact features, are also underlain by thin crust and are possible regions of mantle upwelling like those proposed by Wise and Yates (1970) for mascon basins on the moon".

- 702 - GUPTA J.C. - "Lunar ionospheric and oceanic dynamo variations".  
Gerl. Beitr. Geophys., n°83/1, S.1-15, Leipzig, 1974.

Lunar harmonic coefficients obtained from the analysis of long series of geomagnetic data from a few stations are used to study the daily variation, according to several geophysical variables, of the lunar ionospheric ( $L_1$ ) and oceanic ( $L_0$ ) dynamo parts of  $L_2$ . It is found that :

1. the changes in calendar months in  $L_1$  are similar to those found in  $L_2$  tide and are compatible at nearby stations. On the other hand, month-to-month variations in  $L_0$  are not only complex but change significantly even at stations only a few km apart, and depend upon the proximity of the station to the ocean.
2. The seasonal variations in the phase and amplitude of the daily variation of  $L_1$  are very large ; on an average the amplitude is larger in summer than winter by a factor of about 4.  $L_0$  shows little or no variation with season.
3. Both  $L_1$  and  $L_0$  show variations with the lunar distance, and the changes seem to conform to those predicted by the gravitational equilibrium tide theory.
4. Neither of the dynamos shows much variation in intensity with either sunspot numbers or magnetic activity.

- 703 - BERRY M.J. - "Structure of the crust and upper mantle in Canada".  
from : Tectonophysics, v.20, p.183-201, 1973.  
Earth Physics Branch, Contr. n°461, Ottawa.

The seismic probing of the crust and upper mantle in Canada started in 1938 and since then has involved many government and university groups using a wide variety of techniques.

- 701 - PHILLIPS R.J., R.S. SAUNDERS & J.E. CONEL - "Mars : Crustal structure inferred from Bouguer gravity anomalies".  
from : J. Geophys. Res., v.73, n°23, p.4815-4820, 1973.

Bouguer gravity has been computed for the equatorial region of Mars by differencing free-air gravity and the gravity predicted from topographic variations. The free-air gravity was generated from an eighth-order set of spherical harmonic coefficients. The gravity from topographic variations was generated by integrating a two-dimensional Green's function over each contour level. The Bouguer gravity indicates crustal inhomogeneities on Mars that we postulate are variations in crustal thickness. The Tharsis ridge is a region of thick continental type crust. The gravity data, structural patterns, topography, and surface geology of this region lead to the interpretation of the Tharsis topographic high as a broad crustal upwarp possibly associated with local formation of lower-density crustal material and subsequent rise of a thicker crust. The Amazonis region is one of several basins of relatively thin crust, analogous to terrestrial ocean basins. The Libya and Hellas basins, which are probable impact features, are also underlain by thin crust and are possible regions of mantle upwelling like those proposed by Wise and Yates (1970) for mascon basins on the moon".

- 702 - GUPTA J.C. - "Lunar ionospheric and oceanic dynamo variations".  
Gerl. Beitr. Geophys., n°83/1, S.1-15, Leipzig, 1974.

Lunar harmonic coefficients obtained from the analysis of long series of geomagnetic data from a few stations are used to study the daily variation, according to several geophysical variables, of the lunar ionospheric ( $L_1$ ) and oceanic ( $L_0$ ) dynamo parts of  $L_2$ . It is found that :

1. the changes in calendar months in  $L_1$  are similar to those found in  $L_2$  tide and are compatible at nearby stations. On the other hand, month-to-month variations in  $L_0$  are not only complex but change significantly even at stations only a few km apart, and depend upon the proximity of the station to the ocean.
2. The seasonal variations in the phase and amplitude of the daily variation of  $L_1$  are very large ; on an average the amplitude is larger in summer than winter by a factor of about 4.  $L_0$  shows little or no variation with season.
3. Both  $L_1$  and  $L_0$  show variations with the lunar distance, and the changes seem to conform to those predicted by the gravitational equilibrium tide theory.
4. Neither of the dynamos shows much variation in intensity with either sunspot numbers or magnetic activity.

- 703 - BERRY M.J. - "Structure of the crust and upper mantle in Canada".  
from : Tectonophysics, v.20, p.183-201, 1973.  
Earth Physics Branch, Contr. n°461, Ottawa.

The seismic probing of the crust and upper mantle in Canada started in 1938 and since then has involved many government and university groups using a wide variety of techniques.

These have included simple profiling with both wide and narrow station spacing, areal time-term surveys, detailed deep reflection experiments, very long-range refraction studies and the analysis of surface wave dispersion between stations of the Canadian Standard Network.

A review of the published interpretation leads to the general conclusion that :

- 1)  $P_n$  velocities vary from a value possibly as low as 7.7 km/sec. under Vancouver Island to 8.6 km/sec. and higher in the extreme eastern part of the shield and some parts of the Atlantic coast.
- 2) Large areas of Canada have a crustal thickness of 30-40 km, with Vancouver Island, the southwestern Prairies, the Lake Superior basin and parts of the eastern shield of Quebec being thicker. No continental area in Canada is known to have a crust thinner than 29 km.
- 3) The Riel discontinuity - a deep intra-crustal reflector and sometime refractor, is widely reported in the Prairies and Manitoba. It is not seen to the north in the vicinity of Great Slave Lake, nor in the Hudson Bay, Lake Superior and Maritime regions, nor in the interior of British Columbia. It may be present in some areas of the eastern shield.
- 4) As experiments have become more detailed, crustal structures of greater complexity have been revealed. The concept that crustal structure becomes simpler with increasing depth is apparently unfounded.

Long-range refraction studies suggest that the Gutenberg P-wave velocity channel is poorly developed under the Canadian Shield. The analysis of the dispersion of surface waves, however, suggests that the channel is better developed for S-waves, and is present throughout the country. The lid of the channel is deepest under the central shield and shallowest under the Cordillera.

- 704 - DENCE M.R. - "Meteorite impact craters and the structure of the Sudbury Basin".  
from : The Geol. Assoc. of Canada, Sp. Paper n°10, p.7-18, 1972.  
Earth Physics Branch, Contr. n°402, Ottawa.

The structure of hypervelocity impact craters such as Clearwater Lake, Charlevoix and Vredefort when compared with that of the Sudbury Basin shows important similarities and some differences . . . .

- 705 - DENCE M.R. & J. POPELAR - "Evidence for an impact origin for Lake Wanapitei, Ontario".  
from : The Geol. Assoc. of Canada, Sp. Paper n°10, p.117-124, 1972.  
Earth Physics Branch, Contr. n°398, Ottawa.

Lake Wanapitei (lat. 46°44.7'N, long. 80°44.6'W) is 40 km northeast of Sudbury, Ontario on the eastern margin of the Sudbury Basin. The lake has a strongly indented outline but in its north-central part contains an island-free area 8.6 km in diameter. Topographic, geophysical and petrographic data indicating this circular depression has formed by hypervelocity impact include :

- (i) water depths averaging 50 m and in places exceeding 100 m,
- (ii) a circular Bouguer gravity anomaly of - 15 mGal coinciding with the circular part of the lake,
- (iii) absence of any significant local disturbance of the magnetic field and,
- (iv) evidence from glacial drift collected around the southern margin of the lake, that the lake bottom is underlain by friable red sandstone, coarse mixed breccia, fresh glass and vesicular igneous rocks. ...

Certainly the crater is younger than and unrelated to other events in the Sudbury area. Its relationship to the Sudbury Basin is compared to that between the lunar craters Theophilus and Theophilus B.

- 706 - WRIGHT C. - "Observations of multiple core reflections of the PnKP and SnKP type and regional variations at the base of the mantle".  
from : Earth & Planetary Sci. Letters n°19, p.453-460, 1973.  
Earth Physics Branch, Contr. n°462, Ottawa.

Seismological results interpreted as evidence for large inhomogeneities near the base of the Earth's mantle below Hawaii have recently been published. It is possible to place constraints on the magnitude of such heterogeneities by identifying seismic phases multiply reflected within the Earth's core. ...

- 707 - WRIGHT C. - "Array studies of P phases and the structure of the D" region of the mantle".  
from : J. Geophys. Res., v.78, n°23, p.4965-4982, 1973.  
Earth Physics Branch, Contr. n°446, Ottawa.

Slowness ( $dT/d\Delta$ ) and azimuth measurements for P and pP phases have been derived for 57 earthquakes at distances between  $82^\circ$  and  $115^\circ$  recorded at the Yellowknife array to determine whether such data are capable of elucidating the structure of the lowest 300 km of the mantle. To show that systematic errors in the azimuths of arrival and slight differences in  $dT/d\Delta$  values from those associated with the "Seismological Tables for P Phases" (1968) are unlikely to be produced in the source region, the data have been supplemented by slowness and azimuth measurements of PcP, ScP, PKP, P2KP, P3KP, and P4KP phases from 28 events at distances where the expected  $dT/d\Delta$  values are greater than 40 sec/deg. Evidence for regional variations in structure at depths greater than 2500 km is presented, together with one velocity model that will explain an offset in the  $dT/d\Delta$  curve near  $90^\circ$  for rays that have penetrated to the base of the mantle below the Caribbean Sea and surrounding regions. The occurrence of large-scale anomalies in  $dT/d\Delta$  and azimuth for some azimuth ranges has been demonstrated ; such anomalies in  $dT/d\Delta$  are produced by lateral variations in structure or irregularities within the crust and upper mantle beneath the array, but comparable anomalies in azimuth may accumulate over the whole of the ray path or may be caused by structure below the array.



- 708 - BERRY M.J. & K. FUCHS - "Crustal structure of the Superior and Grenville Provinces of the Northeastern Canadian Shield".  
from : Bull. of the Seism. Soc. of America, v.63, n°4,  
p.1393-1432, 1973.

A large scale seismic refraction experiment was mounted in the Superior and Grenville provinces of the NE Canadian Shield during the summer of 1968. The purpose was to investigate possible differences in their crustal structure and to study the nature of the large gravity anomaly which is centered along the boundary or front between them.

We tentatively interpret the confusing  $P_n$  data as indicating a weak anisotropic velocity behavior in the material at the top of the upper mantle, coupled with considerable topographic relief on the Mohorovicic transition and a complex crustal structure above. The preferred upper mantle velocity is  $8.06 \pm 0.06$  km/sec with a maximum deviation caused by the anisotropy of 0.17 km/sec. We are not able to discern a marked difference in the upper mantle velocities beneath the two provinces, but we cannot be definite on this point.

The average velocity of the crust is  $6.57 \pm 0.03$  km/sec and appears to be the same over the whole region. Crustal thickness varies from 48 to 29 km over the survey area with the average thickness in the Superior being 34 km compared to 39 km in the Grenville to the south. The crust is thickest along the Grenville Front and has an average value of 45 km along our profile.

We have made extensive use of synthetic seismograms to interpret the later events on our three seismic profiles. Our preferred models each show a family resemblance. The upper crust has a sharp velocity gradient at the surface with velocities increasing from 5.0 to approximately 6.2 km/sec. From a depth of 1 or 2 km down to the Conrad discontinuity the upper crust is essentially homogeneous except for a low-velocity channel, the depth of whose bottom varies from 6 to 15 km. The channel is thickest, about 5 km, and deepest at the east end of the central profile along the Grenville Front and the center of the gravity anomaly. The channel appears to rise and to become thinner to the north and south.

The Conrad discontinuity lies at a depth of approximately 14 km in the Superior, 21 km in the Grenville and 24 km along the Front. The material below the Conrad has a velocity from 6.5 to 6.8 km/sec and a small velocity gradient of roughly  $0.02 \text{ sec}^{-1}$ . Approximately 12 km above the Mohorovicic boundary, some of the profiles indicate another low-velocity channel, but in any case, at this depth or below the channel, all of the profiles require a model with a strong velocity gradient down to the crust-upper mantle transition. Here, the velocity rises sharply but more or less continuously and, if there is a discontinuity at all, it is probably a jump of less than 0.02 km/sec.

The thickening of the low-velocity channel and the thickening of the upper crust along the Front together are able to explain much of the strong local negative Bouguer anomaly there. The strong trend across the area is not simply explained by our models.

- 710 - HASHIZUME M. - "Two earthquakes on Baffin Island and their tectonic implications".  
 from : J. Geophys. Res., v.78, n°26, p.6069-6081, 1973.  
 Earth Physics Branch, Contr. n°471, Ottawa.

The source parameters of two earthquakes that occurred under Baffin Island, Canada, were determined from surface wave spectrum analysis. By selecting records for which the travel paths were essentially continental, it was possible to determine precisely both the focal mechanism and focal depth. The utilization of the phase spectrum complemented the information obtained from the amplitude spectrum studies. It is proposed that the stress pattern of these very shallow (4-6 km) earthquakes is a dilatational stress acting normal to the general trend of Baffin Island. Short-period surface wave attenuation for less than 20-sec. periods was found to be very low under the Canadian Shield.

- 711 - RIDDIHOUGH R.P. & G.V. HAINES - "Magnetic measurements over Darnley Bay, N.W.T.".   
 from : Canadian J. Earth Sci., v.9, n°8, p.972-978, 1972.  
 Earth Physics Branch, Contr. n°396, Ottawa.

Five high level, 3-component, magnetic profiles outline a large magnetic anomaly approximately coincident with the previously observed, 130 mGal, positive gravity anomaly. Three-dimensional interpretations of the magnetic data establish the major dimensions of the source body but do not distinguish between a normal and inverted conical shape. Directions of magnetization derived from the interpretations suggest that the body is geologically related to the Precambrian Franklin Diabases.

- 712 - IRVING E., F.K. NORTH & R. COUILLARD - "Oil, climate, and tectonics".  
 from : Canadian J. Earth Sci., v.11, n°1, p.1-17, 1974.  
 Earth Physics Branch, Contr. n°472, Ottawa.

We identify four sets of factors governing oil occurrence - climate (especially temperature), mineral nutrients, tectonic factors controlling initial basin formation, and tectonic factors controlling preservation of the oil. We argue that all factors are themselves subject to the framework imposed by plate tectonics. If we are to consider all Phanerozoic oil deposits, the only factor capable of quantitative comparison for all the periods is the first one, in that it is partly a function of latitude.

A paleolatitude analysis has been made for both reservoir rocks and preferred source rocks for all petroliferous basins, with results weighted according to total reserves. No statistically satisfactory relationship was found between oil and paleolatitude that would embrace all Phanerozoic deposits. Most Paleozoic oil was formed in rocks deposited in low latitudes, but this may be an accident of preservation. The much larger Mesozoic deposits were similarly related to low paleolatitudes, but this result is heavily biased by the huge reserves of the Persian Gulf. If these are excluded, Mesozoic oil occurs with equal probability in high and in low paleolatitudes. Cenozoic oil is uniformly distributed with respect to paleolatitude.

The distribution of oil with time reveals that 72 % of all known oil was probably formed in the late Mesozoic, most of it (60%) in the mid-Cretaceous. The first requirement in any general theory of oil occurrence, therefore, is to understand why so much oil was formed near the present Persian Gulf, and to a lesser extent in Middle America, during such a short interval of geological time. We attempt to show that all four controlling factors were optimized in these two places for this brief time-span. In the timetable of plate tectonics, two large marine embayments opened astride the equator in the late Mesozoic, and these may or may not have been connected through the western Mediterranean. One embayment contained the Persian Gulf, and the other, Middle America. The renewal of mantle convection of about - 100 m.y. activated these embayments, abruptly increased the rate of sea-floor spreading and enlarged the oceanic ridges, causing maximum development of warm, shallow seas and releasing, through igneous activity, greatly increased quantities of mineral nutrients.

The geometry of subsequent plate activity was such that the Persian Gulf was tectonically protected by the rapid northward movement of the Indian plate (which absorbed most of the impact with the Eurasian plate), and the Gulf of Mexico was protected by the northeastward movement of the Antillean arc.

714 - RAMPTON V.N. & R.I. WALCOTT - "Gravity profiles across ice-cored topography".

from : Canadian J. Earth Sci., v.11, n°1, p.110-122, 1974.  
Earth Physics Branch, n°483; Ottawa.

Gravity profiling at five different sites in an area of ice-cored topography indicates the usefulness of the technique as a method for the detection of ground ice and for estimating the thickness of the excess ice. Bouguer anomaly profiles using a density of  $2.0 \text{ Mg m}^{-3}$  provide a quick method of assessing the relative amount of ice along a profile, the thickness of ice and the elevation being inversely proportional to the Bouguer anomaly value along each profile. The average amount of excess ice in the topography along the profiles is obtained by removing linear trends, obtaining the Bouguer density of the topography and calculating the proportion of frozen saturated sediment and ice required to produce this density. Variations in the thickness of the body are obtained from significant gravity residuals. Finally, models are given to show the distribution of the excess ice with the aid of supplementary information. The above technique is unable to detect changes in the amount of excess ice that have a linear trend over the complete profile or a uniform slab of ice underlying the complete profile. A model for a pingo is constructed using stacked concentric cylinders. Geologic data from the region indicate that all models give reliable estimates of the amount of excess ice and probable thermokarst subsidence if the area were thawed.

- 717 - FORSYTH D.A., M.J. BERRY & R.M. ELLIS - "A refraction survey across the Canadian Cordillera at 54° N".  
 from : Canadian J. Earth Sci., v.11, n°4, p.533-548, 1974.  
 Earth Physics Branch, Contr. n°489, Ottawa.

Record sections from partially reversed refraction lines in northern British Columbia show that the amplitudes of upper mantle vary smoothly with distance, while the pattern of crustal arrival amplitudes is not smooth. Normalization of the seismograms to remove the effects of varying shot size and instrument response show that  $P_n$  amplitudes are largely site-independent.

Models derived from ray theory indicate a crust which thins from about 40 km in the Omineca Crystalline Belt to about 25 km in the Insular Trough. The average  $P_n$  velocity is 8.06 km s<sup>-1</sup>, and the average crustal velocity is 6.4 km s<sup>-1</sup>. The secondary energy indicates that the models are greatly simplified.

A time-term profile between the Omineca Crystalline Belt and the Coast Mountains suggests a Mohorovicic transition which is characterized by two significant topographic wavelengths. The shorter (200 km) wavelength correlates roughly with the Cordilleran structural elements of Wheeler and Gabrielse (1972). The larger (800 km) wavelength may have tectonic significance.

- 720 - CLEE T.E., K.G. BARR & M.J. BERRY - "Fine structure of the crust near Yellowknife".  
 from : Canadian J. Earth Sci., v.11, n°11, p.1534-1549, 1974.  
 Earth Physics Branch, Contr. n°517, Ottawa.

A detailed reflection-refraction experiment was conducted near Yellowknife, Northwest Territories, in 1969. Over 3000 seismograms were recorded along two profiles with a geophone separation of 250 m. The high quality, quantity and unexpectedly high frequency content of the data has revealed a crustal structure which correlates well with the local geology and Bouguer gravity. Extensive use has been made of a ray-tracing program which includes an estimate of the amplitudes based on first-order seismic theory.

The model includes a belt of greenstones to the east of the Yellowknife Fault, surrounded by granitic rocks. The velocities are, respectively, 6.17 and 6.0 km/s at depths of 1 km and greater, but the granites are overlain by a transition zone with the velocity at the surface being 5.5 km/sec. In the granites at a depth of 8-10 km lies a low velocity layer ( $V_p = 5.8$  km/s). The bottom of the greenstones corresponds roughly to the bottom of the LVL and both are underlain by a zone in which  $V_p = 6.2 - 6.4$  km/s.

The highly complex nature of the Mohorovicic reflection coda suggests that the M transition is characterized by strong lateral variations of velocity over 20 km or less which give rise to sideways reflections and interference patterns at the surface,  $t^2$ ,  $x^2$ , calculations using some of the M reflections suggest a crustal thickness of about 30 km and an average crustal velocity of 6.22 km/s. Both values are considered low for a stable shield region.

- 721 - JESSOP A.M. - "The distribution of glacial perturbation of heat flow in Canada".  
 from : Canadian J. Earth Sci., v.8, p.162-166, 1971.  
 Earth Physics Branch, Contr. n°328, Ottawa.

A contour map has been constructed of the perturbation of heat flow caused by the Wisconsin and earlier glaciations of the Pleistocene period. Under extreme conditions perturbation can be as high as one-third of the world average heat flow, but in most areas the disturbance is of the order of 10 % or less of the average heat flow.

- 723 - WALCOTT R.I. - "Structure of the Earth from glacio-isostatic Rebound".  
 Earth Physics Branch, Contr. n°426, p.15-37, Ottawa, 1973.

- 724 - WEICHERT D.H. - "An attempt to detect gravitational waves with the Yellowknife seismic Array".  
 from : Geophys. J. R. Astr. Soc., v.35, p.337-342, 1973.  
 Earth Physics Branch, Contr. n°444, Ottawa.

The Yellowknife array of 19 vertical short-period seismometers was used to search for small coherent signals in the frequency range from about 1 to 8 Hz. Beamforming and autocorrelation of several hours of digital seismic recording lowers the background noise level of about 10-11 ms<sup>-1</sup>. Consistent peaks are observed at several frequencies, but terrestrial or instrumental origins have been identified for most components. None of the observed components shows correlation with sidereal time. There is, therefore, no evidence that gravitational waves have been detected.

- 725 - LAMBERT A. - "Earth tide analysis and prediction by the response method".  
 from : J. Geophys. Res., v.79, n°32, p.4952-4960, 1974.

The response method of ocean tide analysis developed by Munk and Cartwright can be applied to the analysis of tidal gravity and tilt data by a suitable transformation of the response weights. Response admittances derived from the weights take the form of the familiar gravimetric or diminishing factors as functions of frequency. A method is developed for calculating confidence limits for the admittances from an estimate of the variance of the extraneous noise. Analyses of simulated data are used to demonstrate the effect of extraneous noise on the response weights and admittances. A small number of response weights describe the Earth tide accurately and concisely in a region of complex ocean tide perturbations and provide the improved predictions now required in precise gravity surveys. The Earth tide admittances are shown to contain potentially useful information on the admittances of the ocean tide.

- 728 - THOMAS M.D. - "The correlation of gravity and geology in Southeastern Quebec and Southern Labrador with maps :

N° 64 - Mingan-Cape Whittle	N° 96 - Battla Harbour-Cartwright
N° 65 - Clarke City-Mingan	N° 97 - Hamilton-Hopedale
N° 66 - Northwest River	N° 98 - Naskaupi".
N° 67 - Ashuanipi	

Earth Physics Branch, Gravity Map Series, 49 p, Ottawa, 1974.

The results of over 3,000 gravity observations in southeastern Quebec and southern Labrador over mainly the Grenville Structural Province and portions of the adjacent Superior, Churchill and Nain provinces are presented in the form of 1:500,000 contoured Bouguer anomaly maps. The results of almost 1,500 density measurements on rock samples from the area are also given.

The gravity field over the Grenville is characterized by prominent regional and local anomalies, while that over an adjacent area of the Superior is devoid of such anomalies. There is also a significant difference in the background levels of the Bouguer anomalies over the two provinces ; the level of the Grenville is about 15 mGal higher than that of the Superior. The latter difference is attributed to a denser Grenville crust...

Prominent gravity highs in the region are interpreted as gabbroic masses, and two-dimensional models having approximately saucer- or funnel funnel-shapes are presented for several of these. All models have upper surfaces coinciding with sea level and extend to depths varying between 6 to 14 km.

- 729 - GIBB R.A. & D.W. HALLIDAY - "Gravity measurements in Southern district of Keewatin and Southeastern district of Mackenzie N.W.T. with maps :

N° 124 - Fort Smith-Nonacho	N° 128 - Eskimo Point
N° 125 - Wholdaia Lake	N° 129 - Chesterfield Inlet
N° 126 - Kazan River	N° 130 - Dubawnt Lake
N° 127 - Nueltin Lake	N° 131 - Aberdeen Lake

Earth Physics Branch, Gravity Map Series, 36 p, Ottawa, 1974.

A total of 3,464 gravity stations was used to compile 8 Bouguer anomaly maps (1:500,000) which cover part of the Western Churchill Province of the Canadian Shield in southern District of Keewatin and southeastern District of Mackenzie, Northwest Territories. Major negative anomalies in zones of high-level crust, characterized by abundant greenstones and greenschists to amphibolite facies metamorphism, are related to epizonal granitic plutons of Archean and Aphebian age. A prominent north-northwesterly trending broad regional gravity low which cuts across the dominant northeasterly trends of the Province, contains a belt of "Nueltin Lake" type post-orogenic granite of late Hudsonian age. Gravity highs are related to basic volcanic and intrusive rocks and to areas of deep-level crust, characterized by granulite or retrograded granulite facies metamorphism, roots of batholiths and an absence of greenstones.

The major feature of the gravity field, the Central Belt anomalies, crosses the area from southwest to northeast. In this belt dominant gravity, magnetic, and geological trends are northeasterly and linear in sharp contrast to marginal zones on either side in which trends appear to "wrap around" the older Slave and Superior provinces of the Shield to the northwest and southeast. These differences in trend, along with differences in crustal level, metamorphism, plutonism and tectonic style may be related to a complex origin for Western Churchill Province by ancient plate interaction during Aphebian (Lower Proterozoic) time.

- 730 - VALLIANT H.D., R.F. MACNAB, L.E. STEPHENS, S.T. GRANT & R.V. COOPER - "Results of underwater and surface regional gravity surveys off the coast of Labrador, 1972 with maps :  
 N° 156 - Hamilton Inlet (Bouguer)  
 N° 156 - Hamilton Inlet (Free-air)".  
 Earth Physics Branch, Grav. Map Ser., 18 p, Ottawa, 1974.

A geophysical survey was completed in the Labrador Sea off Hamilton Inlet in 1972 using two surface gravimeters and one underwater gravimeter. The two surface meters were operated simultaneously aboard CSS Hudson. The underwater meter was operated from CFAV Sackville in an area which overlapped the surface meter measurements. The observations from the three gravimeters were adjusted by the method of least squares and the composite data were completed in the form of free-air and Bouguer anomaly maps at a scale of : 1/1.000.000. The accuracy of the computed anomalies was estimated at between one and two mGal (  $\pm 1 \sigma$  ) depending on the number of instruments which were observed at the point.

- BUREAU of MINERAL RESOURCES, GEOLOGY & GEOPHYSICS, Australia - "Bouguer Anomalies", 48 maps of Western Australia, 1974, and 10 maps reedited in 1974.  
 - Scale : 1/500.000  
 - Gravity contour interval : 1 to 5 mGal
-



# RECENT SEA GRAVITY TRACKS AND SURVEYS

1970 - 1975

B.G.I. 1975

