

ASSOCIATION INTERNATIONALE DE GÉODÉSIE

**BUREAU GRÀVIMETRIQUE
INTERNATIONAL**

BULLETIN D'INFORMATION

N° 35

Novembre 1974

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

BUREAU GRAVIMETRIQUE
INTERNATIONAL
Paris

BULLETIN D'INFORMATION

Novembre 1974

N° 35

T A B L E d e s M A T I E R E S

1ère PartieVIIth MEETING of the INTERNATIONAL GRAVITY COMMISSION

(Paris, September 2 - 6, 1974)	p.I-3.
- List of Participants	p.I-4.
- Programme, Agenda	p.I-12.
- Séance d'ouverture	p.I-14.
- GUIDELINES for the INTERNATIONAL GRAVITY COMMISSION	p.I-18.
- TERMS of REFERENCES of the INTERNATIONAL GRAVIMETRIC BUREAU ..	p.I-21.
- RESOLUTIONS : textes anglais et français	p.I-23.
- Papers presented or distributed at the Meeting	p.I-33.

I - II - INTERNATIONAL GRAVITY COMMUNITY

I.G.C. - I.G.B.	p.I-35.
----------------------	---------

III - ABSOLUTE GRAVITY MEASUREMENTS, Sp. St. Gr. n°3.18

- Report on Absolute Measurements of Gravity A. SAKUMA, B.I.P.M., Sèvres	p.I-39.
- A new Portable Absolute Gravity Instrument J.E. FALLER & J.A. HAMMOND	p.I-43.

⌘

V - GRAVITY MEASUREMENTS at SEA, Sp. St. Gr. n°3.20

- Recent Marine Gravity Studies and Data Handling Techniques at the Woods Hole Oceanographic Institution, C. BOWIN	p.I-51.
- The Gravity Field around Iceland (5°), U. FLEISCHER	p.I-51.
- The Gravity Field of Island Arc - Trench Systems : Some new Results and their Implications, A.B. WATTS	p.I-52.
- Multiparameter Surveys of Canada's Atlantic Continental Continental Margin, R.T. HAWORTH	p.I-53.
- Members of the Sp. St. Gr. n°3.20	p.I-60.

⌘

APPENDIX

- THE INTERNATIONAL GRAVITY BUREAU Dr. S. CORON, Acting Director	p.A-1.
- PROPOSAL for the RE-ORGANIZATION of the INTERNATIONAL GRAVITY COMMISSION, Prof. C. MORELLI	p.A-33.

2ème Partie

Liste des publications reçues au B.G.I. (Octobre à Décembre 1973) concernant les questions de pesanteur	p.II-1.
--	---------

S. CORON
Acting Director B.G.I.

* Les Comptes-Rendus des autres sujets seront
publiés dans le prochain Bull. d'Inf. n° 36.

SEVENTH MEETING of the INTERNATIONAL GRAVITY COMMISSION

Paris, September 2 - 6, 1974

Chairman : C. MORELLI (Trieste)

The International Gravity Commission met for the seventh time in Paris, from September 2nd to 6th, 1974. For the first time this meeting took place at the University Paris VI, called University Pierre & Marie Curie (11, Quai Saint-Bernard, 75005 PARIS). An amphitheatre and its dependences had been kindly reserved for the Delegates by Prof. HERPIN, President of the University Pierre & Marie Curie.

The last meeting was held in 1970.

This assembly was composed of one part, the scientists officially delegated to represent their countries and, on the other part of delegates of main geodetical and geophysical Offices as well as qualified technicians specialized in various problems.

This meeting included about 98 participants, representing 26 different Nations.

The countries for which it had not been possible to send their delegates expressed their regrets to be enable to attend the sessions of the I.G.C. We will note in this case the following countries : German Democratic Republic, Ireland, Nigeria, Portugal and Republic of South Africa.

About half of the represented countries sent national reports concerning the gravimetric activity of their countries.

National Reports

Argentina (National Committee of IUGG)
Australia (P. WELLMAN)
Czechoslovakia (National Committee of Geodesy & Geophysics)
Denmark (Royal Danish Geodetic Institute)
German Democratic Republic (Cl. ELSTNER)
German Federal Republic (W. TORGE)
India (Survey of India)
Japan (T. OKUDA)
Norway (Geographical Survey)
Poland (Committee of Geodesy & Inst. of Geodesy & Cartography)
Spain (Instituto Geografico y Catastral)
Sweden (Geographical Survey Office)
Switzerland (S. MUELLER & H.G. KAHLE)
United Kingdom (Institute of Geological Sciences)
U.S.A. (W.E. STRANGE, National Geodetic Survey).

LIST of PARTICIPANTSARGENTINA

M. P. DRAGAN
Institut Géographique Militaire
Cabildo, 381
BUENOS-AIRES

Général de Brigade L.M. MIRO
Directeur de l'Institut
Géographique Militaire
Cabildo, 381
BUENOS-AIRES

Capitaine R.H. RIPANI
Institut Géographique Militaire
Cabildo, 381
BUENOS-AIRES

AUSTRALIA

Prof. R.S. MATHER
University of New South Wales
Box 1
KENSINGTON N.S.W. 2033

Dr. P. WELLMAN
Bureau of Mineral Resources
Dept. of Minerals & Energy
P.O. Box 378
CANBERRA-CITY
ACT Australia 2601

AUSTRIA

Dr. E. SENFTL
Bundesamt für Eich-und-Vermessungswesen
A - 1082 WIEN
Friedrich Schmidt Platz, 3

BELGIUM

Dr. L. BRAGARD
Université de Liège
Maître de Conférences
5, Rue Ernotte
B.500 NAMUR

M. DUCARME
Observatoire Royal de Belgique
Dept. 1
3, Avenue Circulaire
B. 1180 BRUXELLES

Ing. L. JONES
Directeur de l'Institut Géographique
Militaire, Direction de la Géodésie
13, Abbaye de la Cambre
1050 BRUXELLES

Prof. P. MELCHIOR
Secrétaire Général U.G.G.I.
Observatoire Royal de Belgique
3, Avenue Circulaire
B. 1180 BRUXELLES

M. Van RUYMBEKE
Observatoire Royal de Belgique
Dept. 1
3, Avenue Circulaire
B. 1180 BRUXELLES

M. T. SATO
Observatoire Royal de Belgique
Dept. 1
3, Avenue Circulaire
B. 1180 BRUXELLES

CANADA

M. R.K. McCONNEL
Earth Physics Branch
Dept. of Energy Mines & Resources
3, Observatory Crescent
OTTAWA, Ont. KIA OE4

Dr. R.T. HAWORTH
Atlantic Geosciences Center
Bedford Institute of Oceanography
P.O. Box 1006
DARTMOUTH, N.S.

CZECHOSLOVAKIA

Dr. V. VYSKOCIL
Institut de Géophysique
Académie Tchèqueoslovaque des Sciences
Bocni II
14131 PRAHA 4 Sporilov

DENMARK

Prof. O.B. ANDERSEN
Geodetic Institute
Rigsdagsgarden, 7
DK-1218 KOBENHAVN

M. O. REMMER
Geodetic Institute
Gamlehavn Allé 22
DK-2920 CHARLOTTENLUND

M. S. SAXOV
Laboratory of Geophysics
Finlandsgade, 6-8
DK-8200 AARHUS NI

M. C.C. TSCHERNING
Danish Geodetic Institute
Geodetic Department 1
Gamlehavn Allé 22
DK-2920 CHARLOTTENLUND

EGYPTIAN ARAB REPUBLIC

M. H.A. KAMEL
Chief Geophysist
General Petroleum Co.
8, Dr. Abu Zahra Str.
Nasr City CAIRO

FEDERAL REPUBLIC of GERMANY

Dipl. Ing. G. BOEDECKER
 Institut für Theoretische Geodäsie
 Technische Universität Hannover
 D-3, HANNOVER
 Nienburger St. 6

Dipl. Ing. W. DOERGE
 Deutsches Geodätische Institut
 Marstallplatz 8
 8 MUNCHEN 22

Dipl. Ing. H. DREWES
 Institut für Theoretische Geodäsie
 Technische Universität Hannover
 D-3, HANNOVER
 Nienburger St. 6

Dr. U. FLEISCHER
 Deutsches Hydrographisches Institut
 2, HAMBURG 4
 Bernhard-Nocht-Strasse, 78

Dr. S. GERMAN
 Physikalisch Technische Bund.
 33, BRAUNSCHWEIG
 Bundesallee 100

Prof. C. GERSTENECKER
 Technische Hochschule Darmstadt
 Experimentelle Methoden der Astro-
 nomischen & Physikalischen Geodäsie
 61, DARMSTADT
 Petersenstrasse 13

Prof. Dr. Ing. E. GROTEN
 Technische Hochschule Darmstadt
 Astronomische Geodäsie &
 Satellitengeodäsie
 61, DARMSTADT
 Petersenstrasse 13

Prof. Dr. H. LICHTHE
 Geodätisches Institut
 Universität Karlsruhe
 D.75, KARLSRUHE

Dr. S. PLAUMANN
 Niedersächsisches Landesamt
 für Bodenforschung
 3, HANNOVER 23
 Postfach 230153

Dr. Ing. B.S. SCHULZ
 Institut für Angewandte Geodäsie
 Abteilung Geodäsie
 623, FRANKFURT/Main-Sindlingen
 Weinbergstrasse 9

Prof. Dr. Ing. W. TORGE
 Institut für Theoretische Geodäsie
 Technische Universität Hannover
 D-3 HANNOVER
 Nienburger St. 6

Dipl. Ing. H.G. WENZEL
 Institut für Theoretische Geodäsie
 Technische Universität Hannover
 D-3 HANNOVER
 Nienburger St. 6

FINLAND

Prof. T. HONKASALO
 Finnish Geodetic Institute
 Pasilankatu 43 A
 SF 00240 HELSINKI

FRANCE

Ing. V. BARANOV
Compagnie Générale de Géophysique
6, Rue Galvani
91301 MASSY

Ing. CALIS
Société JAEGER
1bis, Rue Baudin
92300 LEVALLOIS PERRET

Dr. Suzanne CORON
Acting Director I.G.B.
11, Quai Saint-Bernard
75005 PARIS

Ing. H. DUFOUR
Institut Géographique National
140, Rue de Grenelle
75007 PARIS

M. E.M. FOURNIER d'ALBE
Directeur p.i.
Division des Sciences de la Terre
U.N.E.S.C.O.
7, Place de Fontenoy
75700 PARIS

Dr. Ing. A. GERARD
Bureau de Recherches Géol. & Minières
B.P. 6009
45018 ORLEANS Cedex

Prof. R. LECOLAZET
Faculté des Sciences
Institut de Physique du Globe
5, Rue René Descartes
67084 STRASBOURG Cedex

Dr. Colette QUEILLE
Laboratoire de Géophysique
Appliquée
11, Quai Saint-Bernard
75005 PARIS

Ing. STANUDIN
Bureau de Recherches Géol. & Minières
B.P. 6009
45018 ORLEANS Cedex

Dr. J. TERRIEN
Directeur du Bureau International
des Poids et Mesures
Pavillon de Breteuil
92310 SEVRES

Ing. R. BOLLO
Bureau de Recherches Géol. & Minières
B.P. 6009
45018 ORLEANS Cedex

Ing. Hydrog. A. COMOLET-TIPMAN
Ingénieur en Chef de l'Armement
Service Hydro. & Ocean. de la Marine
3, Avenue Octave Gréard
75200 PARIS-NAVAL

Mademoiselle DEBEGLIA
Bureau de Recherches Géol. & Minières
B.P. 6009
45018 ORLEANS Cedex

Ing. DUTITRE
Société JAEGER
1bis, Rue Baudin
92300 LEVALLOIS PERRET

Ing. J.A. GALLAVARDIN
60, Rue Maubeuge
75009 PARIS

Ing. P. LANDRY
3, Rue du Leman
75019 PARIS

Ing. J.J. LEVALLOIS
Secrétaire Général A.I.G.
Président de la Commission Spéciale
Permanente des Travaux Géographiques
140, Rue de Grenelle
75700 PARIS

Ing. J. RECHENMANN
O.R.S.T.O.M.
80, Route d'Aulnay
93140 BONDY

Dr. A. SAKUMA
Bureau International des
Poids et Mesures
Pavillon de Breteuil
92310 SEVRES

Ing. VILLECROSE
Institut Géographique National
140, Rue de Grenelle
75007 PARIS

HUNGARIA

Dr. A. MESKO
Geophysics Dept. of
L. Eötvös University
BUDAPEST VIII
Kun Bela, ter 2

INDIA

M. R.S. CHUGH
Director, Geodetic & Research Branch
Survey of India
Post Box n°77
DEHRA DUN 248001 (UP)

ITALIA

Prof. G. MAZZON
Istituto Idrografico della Marina
Passo Osservatorio 4
GENOVA

Prof. C. MORELLI
President of the I.G.C.
Osservatorio Geofisico Sperimentale
4, Viale R. Gessi
TRIESTE, 34123

JAPAN

Dr. C. SUGAWA
International Latitude Observatory
MIZUSAWA-SHI IWATE-KEN 023

NETHERLANDS

M. B.J. COLLETTE
Vening Meinesz Laboratory
Lucas Bolwerk 7
UTRECHT

M. G.L. STRANG Van HEES
Geodetic Institute Delft
Kanaalweg, 4
DELFT

NEW-ZEALAND

M. D.J. WOODWARD
Geophysical Division D.S.I.R.
N. Zealand Dept. of Geological Sciences
University of Durham
South Road
DURHAM, United Kingdom DH1-3LE

The Royal Society of New-Zealand
P.O. Box 12249
WELLINGTON
New-Zealand

NORWAY

M. S. BAKKELID
Senior Geodesist
Norges Geografiske Oppmåling
Box 8153 OSLO-Dep.
OSLO I

M. A. MIDTSUNDSTAD
Norges Geografiske Oppmåling
Box 8153 OSLO-Dep.
OSLO I

POLAND

Dr. Proj. J. BOKUN
Institut de Géodésie et de Cartog.
ul. Jasna 2/4
02-644 WARSZAWA

Prof. Dr. C. KAMELA
Ecole Polytechnique
ul. J. Bruna 22m.8
02-594 WARSZAWA

Prof. S. KRYNSKI
Directeur de l'Institut de Géodésie
et de Cartographie
ul. Jasna 2/4
02-655 WARSZAWA

SPAIN

Dr. Ing. F. ALONSO
Instituto Geografico y Catastral
Seccion de Gravimetria
Calle del General Ibanez Ibero
Appartado 3007
MADRID, 3

Ing. A. PEREZ BAJO
Instituto Geografico y Catastral
Seccion de Gravimetria
Calle del General Ibanez Ibero
Appartado 3007
MADRID, 3

SWEDEN

Dr. E. TENGSTROM
Geodetic Institute, Uppsala University
HÄLLBY 75590 - UPPSALA

Dr. L. PETERSSON
Rikets Allmänna Kartverk Fack
S-16210 VALLINGBY

SWITZERLAND

Prof. H.G. KAHLE
Institut für Geophysik
ETH - Honggerberg
Postfach 266
CH-8049 ZÜRICH

THAILAND

L^t C¹ S. PACHIMKUL
Royal Thai Survey Dept.
Armed Forces Supreme Command
BANGKOK 2

UNITED KINGDOM

M. G.A. DAY
Marine Geophysics Unit
13, Braefoot Terrace
EDINBURGH EH 16 6AA

Dr. D. MASSON SMITH
Applied Geophysics Unit
5, Princes Gate
LONDON SW7 1QN

M. J. WOODSIDE
Dept. Geodesy & Geophysics
Madingley Rise
Madingley Road
CAMBRIDGE CB3 0EZ

U.S.A.

M. D. ANTHONY
AFCRL-LWG
L.G. Hanscom Field
BEDFORD, MA 01730

Dr. C. BOWIN
Woods Hole Oceanographic Institution
WOODS HOLE, Mass. 02543

Prof. D.B. DeBRA
Aero. & Astro., Guidance &
Control Labo.
Stanford University
STANFORD, CA, 94305

Dr. D.H. ECKHARDT
Acting Chief, Geodesy &
Gravity Branch
AFCRL-LWG
L.G. Hanscom Field
BEDFORD, MA 01730

Dr. J.A. HAMMOND
AFCRL - LWG
L.G. Hanscom Field
BEDFORD, MA 01730

Prof. R.H. RAPP
Ohio State University
Geodetic Sciences
1958 Neil Avenue
COLUMBUS, Ohio 43210

M. W.A. HUDDY
Principal Marine Branch Six
Hydrographic Department
TAUNTON, Somerset

M. J.A. WEIGHTMAN
Principal Scientific Officer
Mapping and Charting East. R.E.
Geodetic Office
Elmwood Avenue
FELTHAM, Middlesex TW 13-7AF

Dr. L.D. BEERS
Defense Mapping Agency
Bldg. 56 U.S. Naval Observatory
WASHINGTON DC 20305

M. B. CHOVITZ
U.S. Department of Commerce
National Oceanic & Atmospheric Adm.
National Geodetic Survey C 133
ROCKVILLE, Maryland 20852

M. B.C. DOUGLAS
Wolf Res. & Dev. Corp.
6801 Kenilworth Avenue
RIVERDALE, Md. 20840

Dr. J.E. FALLER
JILA - NES
University of Colorado
BOULDER, Colorado 80302

M.R.M. PERRY
AFCRL - LWG
L.G. Hanscom Field
BEDFORD, MA 01730

Prof. U.A. UOTILA
Ohio State University
Geodetic Sciences
1958 Neil Avenue
COLUMBUS, Ohio 43210

M. P.M. SCHWIMMER
U.S. Defense Mapping Agency
Bldg. 56 U.S. Naval Observatory
WASHINGTON D.C. 20305

M.A.W. TAYLOR
Defense Mapping Agency
Liaison Office
Box 36, U.S. Embassy
Grosvenor Square
LONDON W1 - United Kingdom -

M. S. VINCENT
Wolf Res. & Dev. Corp.
6801 Kenilworth Avenue
RIVERDALE, Md. 20840

M. A.B. WATTS
Lamont-Doherty Geol. Observatory
PALISADES, N.Y. 10964

M. C.T. WHALEN
Geodetic Survey Squadron (OD)
FE WARREN AFB - Wyoming 82001

M. L.E. WILCOX
U.S. Defense Mapping Agency
Bldg 56 U.S. Naval Observatory
WASHINGTON D.C. 20305

M. O. WILLIAMS
Assistant Deputy Director, Plans,
Requirements & Technology
Defense Mapping Agency
Bldg 56 U.S. Naval Observatory
WASHINGTON D.C. 20305

Prof. G.P. WOOLLARD
University of Hawaii at Manoa
Hawaii Institute of Geophysics
2525 Correa Road
HONOLULU, Hawaii 96822

U.S.S.R.

Prof. Yu.D. BOULANGER
President I.A.G.
Academy of Sciences
Soviet Geophysical Committee
117296, Molodezhnaya 3
MOSCOW

- 4.30 to 5.15 p.m. Item V (following)
 5.20 to 5.40 Item VI : Airborne Gravity Measurements (airplane and helicopter) O. WILLIAMS
 - Progress in the apparatus
 - Recent works
- 5.40 to 6.15 Item VII : High precision Gravimetry T. HONKASALO
 - Report of Special Study Group n°3.37.

Wednesday 4th September

- 9.15 to 11.05 a.m. Item XI : Interpolation of Gravity Values in the Unsurveyed Areas U.A. UOTILA
 Item XIII : Gravity Data and Crustal Parameters G.P. WOOLLARD
- 11.15 to 12.30 Item X : Gravity Measurements on the Moon C. BOWIN
- 2.30 to 3.30 p.m. Item VIII : New Gravimetric Instrumentation (Gravity Gradiometry) } O. WILLIAMS
 The Drag-Free Satellite flight of September 1972 }
- 3.30 to 4.30 Item VIIIbis : Vertical Gravity Gradient } T. HONKASALO
 Item VII : High precision Gravimetry
 Microgravimetry }
- 4.45 to 5.15 Item XI : The Boundary Value Problem of Geodesy E. TENGSTROM
- 5.15 to 6.15 Discussion on the I.G.B.
 8.00 Dinner

Thursday 5th September

- 9.15 to 10.45 Item XII : Satellites R.H. RAPP
 - Determination of gravity anomalies from satellites observations (present and future)
 - The satellite altimetry program
- 11.15 to 12.30 Discussion on the texts of I.G.C. and I.G.B.
- Afternoon Scientific Visits : B.I.P.M. (Sèvres)
 B.R.G.M. (Orléans)
 C.N.R.S. (Paris)
 I.G.N. (Saint-Mandé)

Friday 6th September

- 9.15 to 10.45 p.m. Item IV : International Gravity Standardization Network 71 C. MORELLI
 - Up to date and extension of I.G.S.N.
 - Compilation of data
- 11.15 to 12.45 Discussion of the Resolutions - Adoption
- 1 p.m. Champagne "Farewell" at the 24th floor of the Central Tower.

SEANCE d'OUVERTURE

Le Prof. HERPIN, Président de l'Université Pierre et Marie Curie ouvre la séance en adressant au Délégués l'accueil suivant :

"En tant que Président, je suis heureux de vous accueillir dans l'Université Pierre et Marie Curie et je vous souhaite la bienvenue.

Depuis quelques années, dans la presse, on ne parle des Universités que pour faire part de leurs difficultés. On se veut d'informer le lecteur des problèmes posés par certains étudiants et on décrit d'abondance le folklore universitaire. C'est une vue partielle, partielle qui relève plus du goût d'une publicité malsaine que de l'information objective.

Il suffit de pénétrer dans les laboratoires de nos Universités pour trouver là des havres de paix. C'est un autre univers fait de travail et de calme. C'est là qu'il faut y chercher la gloire. Bien souvent des amis connaissant mes fonctions me demandent d'un air apitoyé comment s'est passée l'année, comment s'effectuera la prochaine rentrée ? A ceux là je réponds que le nombre de thèses a augmenté depuis 1968, que les publications, plus nombreuses gardent la même qualité et ceci, en dépit de difficultés matérielles considérables et de budgets en cours de récession. C'est un problème qui se pose aux plus hautes instances de notre pays : va-t-on longtemps, parce qu'on n'a pas su donner à notre jeunesse les buts qu'elle peut atteindre, miner le patrimoine national. Il serait temps que nos dirigeants séparent le bon grain de l'ivraie dans nos grands laboratoires universitaires. Mais ne soyons pas pessimistes. Puisque vous êtes là aujourd'hui c'est que l'Université n'est pas morte ! Si le Bureau Gravimétrique que dirige Melle CORON occupe des locaux dans mon Université c'est que l'on peut y travailler. Je souhaiterais qu'en dehors de vos séances de travail, vous puissiez visiter des laboratoires un peu vides actuellement à cause des congés d'été. J'aimerais que, rentrés dans vos pays respectifs, vous puissiez dire ce que vous avez vu de cette ville de recherche qu'est le centre Jussieu - Saint-Bernard et parler de l'importance de l'Université Pierre et Marie Curie.

Et du point de vue touristique, je vous invite bien cordialement à monter au sommet de la tour qui domine cet ensemble.

Je suis un vieux parisien et ne me lasse jamais de contempler de mon bureau tout le Paris historique qui s'étend à nos pieds. J'espère que le temps sera clément et que la vision sera bonne. Je vous le souhaite également pour tout votre séjour à Paris.

Encore une fois, bienvenue à tous".

Le Prof. Yu. D. BOULANGER, Président de l'Association Internationale de Géodésie remercie le Président HERPIN de l'hospitalité que l'Université a bien voulu donner à la Commission Gravimétrique Internationale.

Il remercie aussi les Délégués d'être venus aussi nombreux et souhaite que cette 7ème Réunion, de par les travaux qui en résulteront, puisse apporter, sur le plan international, à la Géodésie en général et à la Gravimétrie en particulier, de nouvelles perspectives.

Le Prof. C. MORELLI s'adresse à son tour aux Délégués :

"Mr. President of the University,
Mr. President of the I.A.G., Ladies and Gentlemen,

First of all, I think that you agree with us to address our gratitude thoughts to the Colleagues that died in the last years :

Professors TARDI (Director of the I.G.B.), BAGLIETTO, KNEISSL, PAS CLEMENTE and EWING.

Our gratitude must also be addressed to the Colleagues that retired recently after a long service in the I.G.C. :

Dr. INNES, Dr. RICE.

Then, I think we have to welcome the new Members who participate for the first time to a meeting of the I.G.C.

Last meeting of our Commission has been held in Paris in 1970 : an interval of 4 years is nowadays a long time in any science. Exceptionally, this has not been the case in Gravimetry : the good work done in the 1970 Meeting brought to excellent results at the Moscow 1971 IAG Meeting, where - I would say - the maximum of scientific benefits was reached.

The Moscow meeting indicated clearly the necessity of a radical improvement in the spirit of international cooperation and in the efficiency of the international organizations. This is in particular true for our institutions : the I.G.B., the proposed Permanent Service on Gravity, and the I.G.C. From a more or less purely academic level the necessity is felt everywhere of more dynamic and effective structures.

The problem has been preliminarily discussed by the Executive Council of I.A.G., but every proposal or conclusion has been shifted until this Commission be able to examine the problems and to express his views.

This is indeed the right forum for any discussion : potentially we have here all and the best experts, and we are sufficiently and friendly tied for any open debat : with the main goal of the advancement of our science and of the improvement of international cooperation.

Indeed, if any science is international, this is particularly true for Gravimetry. It is hardly conceivable that any of the most recent successes in Gravimetry could have been reached without an effective, also if not always officially organized or recognized, international cooperation.

But the big amount of data and of open problems require something more.

Until now, most of the scientific cooperative work and of the common projects have been performed by the Special Study Groups foreseen by the By-Laws of the I.A.G. But when big operational or computational problems have to be solved, requiring technical facilities and financial support, the participation of the existing main gravity Agencies has been a necessity and will be a necessity. This is the background of the Permanent Service adopted in Moscow, conceived as a Federation of the main Institutions actively involved in the solution of the open global gravity problems. Also this point requires discussion at this Meeting.

But the long pause of meditation after the 1971 Moscow Meeting has probably indicated to each of us possible ways for the above mentioned required re-organizations. The difficulties are great : let us hope that this Meeting will be able to solve them.

The interval has also permitted to individuate the further requirements of global gravity, between which I would like to mention :

- new absolute measurements at approximately 250 mGals interval on one Calibration Line, for a better control of the linearity (in addition to the absolute measurements of the Levallois proposal for absolute geodetic reference points) ;
- the improvement and extension of IGSN 71 to be able to fulfill the basic requirements of gravity data to be used in quadrature evaluations of the geodetic boundary value problem leading to the evaluations of the global stationary sea surface topography at the 10 cm level from satellites equipped with altimeters for ranging to the ocean surface, accordingly to the requirements that Dr. MATHER will illustrate in this meeting. This is an unique opportunity that should never be lost.

A last point must be by office duties mentioned, also if the hopes for a positive solution are small, notwithstanding our personal friendship : the delicate political point that for a large part of the World the gravity values are not available.

Finally, we have to express our gratitude :

- to the President of the University, for the kind hospitality ;
 - to Melle CORON and the staff of I.G.B. for the excellent work and the prompt cooperation to any request.
-

GUIDELINES FOR THE INTERNATIONAL GRAVITY COMMISSION (I.G.C.)

1. Purposes

- 1.1. The I.G.C. is one of the International Commissions of the International Association of Geodesy (I.A.G.), subject to compliance with its Statutes and By-laws.
- 1.2. The purpose of the I.G.C. is to promote scientific investigation of the gravity field of the Earth, its relationship with the Earth's interior and exterior, and its variations with time. Its purpose is to be achieved with the concerted action of its members, through a homogeneous gravimetric coverage of the whole world. In particular, this involves the publication of gravity anomalies computed for various hypotheses, so as to facilitate calculations dealing with problems concerning the shape of the Earth.
- 1.3. The Commission shall seek to collaborate with all international and national organizations concerned with the work of the I.G.C., particularly for the benefit of the Developing Countries.

2. Functions

The functions of the I.G.C. shall be to :

- (a) define those problems whose solution requires international co-operation in the field of scientific investigation in gravity and review the results of such investigation ;
- (b) develop, recommend, and co-ordinate international programmes for scientific investigation in gravity and related services which call for concerted action by its members and interested organizations ;
- (c) make recommendations to international organizations concerning activities of such organizations which relate to the Commission's programme ;
- (d) promote and make recommendations for the exchange of gravity data and the publication and dissemination of results of scientific investigations ;
- (e) make recommendations to strengthen education and training programmes in gravity and its technology ;
- (f) develop and make recommendations for assistance programmes in gravity and its technology ;
- (g) promote scientific investigation of gravity on behalf of the international community, taking into account special interests and rights of countries concerning scientific research in the zones under their jurisdiction.

In carrying its functions, the I.G.C. shall bear in mind the special needs and interests of developing countries, including in particular the need to further the capabilities of these countries in gravity and related technology.

3. Cooperation

The I.G.C. shall give due attention to supporting the objectives of the international organizations with which it collaborates and which may request the I.G.C. to act, as appropriate, as an instrument for discharging certain of their responsibilities in the field of gravity. On the other hand, the I.G.C. may request these organizations to take its requirements into account in planning and executing their own programmes.

4. Organization

- 4.1. The Assembly of the I.G.C. shall be its principal organ and, without prejudice to the provisions of paragraph 3 of this Article, shall make all decisions necessary to accomplish the purpose of the I.G.C.
- 4.2. In accordance with the By-laws of the I.A.G., the President of the Commission is appointed by the Council of the I.A.G. Every four years the Assembly shall elect in the course of its ordinary session two Vice-Presidents and a Secretary who, along with the President, shall constitute the Executive Board.
- 4.3. The Executive Board shall exercise the responsibilities delegated to it by the Assembly and act on its behalf in the implementation of decisions of the Assembly.

5. Working procedures

- 5.1. The Assembly shall be convened in ordinary session every four years. Extraordinary sessions may be convened at the discretion of the Executive Board or at the request of at least five National Committees.
- 5.2. Each Country represented at the Assembly shall have one vote and may send such representatives, alternates and advisers as it deems necessary to sessions of the Assembly.
- 5.3. The I.G.C. may create, for the examination and execution of specific projects, working groups or other subsidiary bodies composed of experts interested in such projects.

6. Financial support

- 6.1. The programmes endorsed and co-ordinated by the I.G.C. and recommended to its Member Countries for their concerted action shall be carried out with the aid of the resources of participating Member Countries, in accordance with the obligations that each Country is willing to assume.

- 6.2. The expenditures of the I.G.C. shall be financed from funds appropriated for this purpose by the I.A.G. as well as from such additional resources as may be made available by other organizations of the International Union of Geodesy and Geophysics and from other sources.
 - 6.3. Voluntary contributions to the Commission may be accepted and established as trust funds in accordance with the financial regulations of the I.A.G. and administered by the Director of the Central Bureau of that Association. Such funds will be allocated to programmes of the Commission in accordance with any special wishes expressed by the donor and with any relevant decisions of the Assembly or of the Executive Board.
 - 6.4. Funds so allocated shall be expended by the Secretary who will be accountable in this matter to the Central Bureau of the I.A.G.
-

TERMS OF REFERENCES OF THE INTERNATIONAL GRAVIMETRIC BUREAU (I.G.B.)

1. Purpose

The I.G.B. will function, within the framework of the Federation of Astronomical and Geophysical Permanent Services (F.A.G.S.) as the central agency of the International Gravity Commission (I.G.C.) to collect and distribute gravity data and provide advice, guidance and standards for the acquisition of these data.

2. Activities

The I.G.B. will primarily provide information to institutions and individual scientists participating in research in the geosciences, bearing in mind particularly the needs of Developing Countries, by :

- (a) keeping in contact with all scientists dealing with gravity data
 - i - to collect and compile principal data : base ties, base and harbour stations, and point values of other stations ;
 - ii - to provide these data on request ;
- (b) maintaining an index of world-wide gravity data. This would include, in addition to the data in the I.G.B. file, the location of all significant files of gravity data which are available from other data banks throughout the world. No outside agency may place restrictions on the release of data actually held by the I.G.B., but potential users of data only listed in the index should negotiate directly with the relevant data bank.
- (c) providing an advisory service for any agency wishing to undertake systematic collection of gravity data. Through this service the I.G.B. would provide information on gravity standards, establishment of reference networks, data collection specifications and data reduction procedures ;
- (d) distributing gravity values and station descriptions for the International Gravity Standardization Net (I.G.S.N.) and to co-operate with the I.G.S.N. working group by collecting new observations suitable for incorporation in future revisions of the I.G.S.N. ;
- (e) planning new projects in order to improve efficiently the present world coverage ;
- (f) compiling and producing small scale international gravity maps for scientific and other purposes ;
- (g) maintaining an index of publications relating to all aspects of scientific research in gravity and the measurement and use of gravity data ;
- (h) promoting, as directed by the I.G.C., scientific research on all topics pertinent to the activity of the I.G.B. ;
- (i) providing an administrative service for the I.G.C. and its working groups.

3. Organization

3.1. Directing Board

Policies and operational guidelines for the I.G.B. will be determined by a Directing Board made up of the President and Secretary of Section III of I.A.G. , the President of the I.G.C., the Director of the I.G.B. together with up to four other members of the International Community who are actively involved in problems of Gravimetry. These last will be nominated by the I.G.C. in consultation with the ex-officio members of the board and approved by the I.U.G.G. They will hold office for up to 8 years.

The Directing Board will also ensure that adequate financial support is available to the I.G.B.

3.2. Staffing

The I.G.B. will be operated by a Director who will be nominated by the I.G.C. in consultation with the host Country, and appointed by the I.A.G. Council. The Director will be responsible for the implementation of the Bureau's policies as determined by the Directing Board. He will be required to develop standards and procedures for world-wide gravity data collection, storage, retrieval, distribution and production of international gravity maps. He shall also be responsible for the development in consultation with the Directing Board of an effective cost recovery program to help establish the bureau on a sound financial footing. In addition, he would solely be responsible for the staffing and organization of the Bureau within the budget.

At the end of each year the Director will submit to the Executive Board of the I.G.C. a brief report of the Bureau's activities including comments of the effectiveness of any new policies implemented. At four year intervals a more comprehensive report containing a full evaluation of the Bureau's programs, a valuation on current policy and proposals on changes will be submitted by the Directing Board at the plenary session of the I.G.C. meeting.

INTERNATIONAL GRAVIMETRIC COMMISSION

September 1974

RESOLUTION N° 1

The International Gravity Commission

recognizing the generous support given then by the French Organizations in financing and operating the International Gravity Bureau, but also,

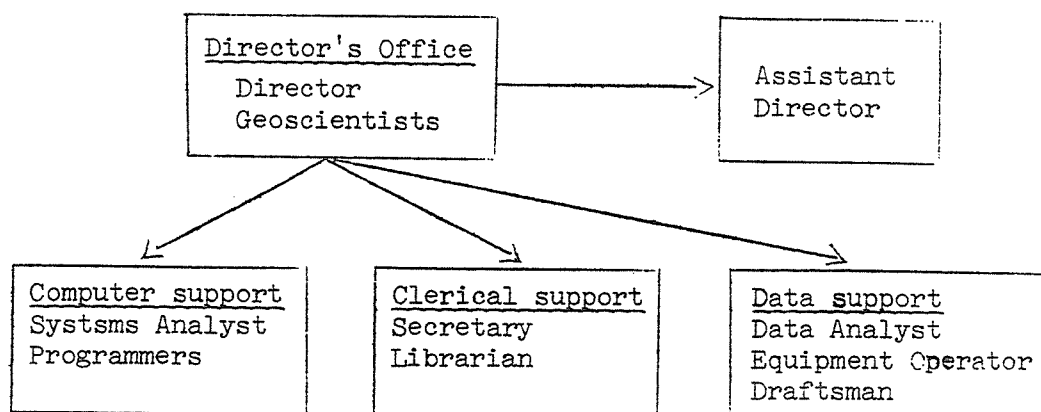
recognizing the absolute necessity of improving the services of the Bureau for the benefit of the scientific community

recommends :

- 1) That for efficient operation of the Bureau a minimum staff listed below, is required :

Director
 Assistant Director
 (2) Geoscientists
 Systems Analyst/Programmer
 (2) Programmers
 Data Processor
 Librarian
 Secretary
 Off-line equipment operator
 Draftsman/Map Compiler

- 2) That the Bureau staff should be organized along the lines shown below :



3) That the following facilities be provided as a minimum :

- a - Adequate office space
- b - Access to a computer centre having the following equipment :
 - computer with 50 k words and interactive capability
 - line printer
 - card reader
 - magnetic tape units (4)
 - disk unit
 - plotter 100 x 150 cm (approximately)
- c - In-house equipment as follows :
 - CRT/teletype computer terminal
 - digitizer 100 x 150 cm (approximately)
 - interpreting key punches (2)
 - card sorter
 - microfilm printer
 - word processing system for preparation of reports and correspondence
 - document duplicating facilities
 - magnetic tapes and disks

4) That computer software for the following purposes be acquired or developed :

- digital file maintenance and retrieval
- bibliographic file maintenance and retrieval
- plotting
 - . posting values
 - . contouring
 - . projection conversion
 - . drafting
- digitizing
 - . projection conversion
- data reduction
 - . gravity anomaly computations
 - . mean anomalies computations
 - . vertical control
 - barometric, spirit level, etc....
 - . horizontal control
 - traverse, electronic navigation, etc...
 - . terrain corrections
 - . general least squares programs to adjust old anomaly surveys to I.G.S.N.

and instructs the President of the I.G.C. :

1. to negotiate with the French National Committee of Geodesy and Geophysics to obtain agreement on a basis of support for the Bureau according to the above recommendations ;
2. to contact the National Committees of other suitable countries with a view to seeking such support elsewhere in the event that agreement with the French National Committee cannot be reached.

RESOLUTION N° 2

The International Gravity Commission

recognizing that in the near future absolute type gravity meters of microgal accuracy will be available for use at fixed sites while there will be portable instruments of ten or even one microgal accuracy, and considering that these should be used as efficiently as possible for fundamental research in the Geosciences :

- 1) Reaffirms resolution 12 of the I.A.G. at the 1971 General Assembly of the I.U.G.G. in Moscow,
- 2) Recommends that absolute gravity measurements should be made both in stable regions and in regions where secular or long period gravity variations are expected and should be repeated after sufficiently long intervals.

To this end :

a - About 10 permanent stations (or observatories) should be established where absolute gravity can be observed with microgal accuracy, to investigate possible global variations and correlations in these long term changes of g.

These stations should be sited in stable regions and well distributed across the world so that, with those observatories existing and at present under construction, there should preferably be more than one on each continent.

The maintenance of the stations should be coordinated by an international permanent service. This service should encourage cooperation between scientists working in the field with the aim of full joint publication, without undue delay of the observations and of the initial analysis of the results.

Member countries (where the stations are sited) are asked to participate in establishing and maintaining this permanent service.

b - The transportable absolute gravity meters should carry out these observations in stable regions where there is as yet no permanent station (see 3 c- below) and in unstable regions as described above.

- 3) Also recommends further uses as follows for the transportable absolute gravity meters :

a - To make observations along at least one gravity calibration line of the IGSN 71 network (such as the Euro-African Line) chosen so as to cover the full gravity range and made up of individual gravity steps of some one hundred mgls, in order to test the linearity of IGSN 71 and improve the usefulness of the calibration line.

b - To corroborate the accuracy of the permanent stations, as well as checking the accuracy of the portable devices by direct comparisons at the same place between instruments of different types.

c - To extend the number and improve the distribution of absolute stations over the world so as better to control I.G.S.N. 71 and improve its accuracy. Each such absolute station should be surrounded with a net of additional stations, measured with high precision gravimeters, to eliminate local effects.

Member Countries are strongly urged to promote and support all these activities.

RESOLUTION N° 3

The International Gravity Commission,

considering the importance to the geoscience of investigations of secular and long period gravity variations with time,

recommends the continuation of present projects and the beginning of new investigations of this type in areas of interest, using absolute and relative type gravity meters.

RESOLUTION N° 4

The International Gravity Commission,

recognizing the necessity of maintaining, extending and improving international gravity standards as defined by the International Gravity Standardization Net (I.G.S.N.),

recommends :

- 1) That the I.G.S.N. Working Group of Special Study Group 3.05
 - (a) collect, analyze and adjust new measurements for the I.G.S.N.,
 - (b) collect and update I.G.S.N. station descriptions in collaboration with the I.G.B.,
 - (c) provide, on request, advice to national agencies establishing gravity control nets,
 - (d) arrange with national agencies to make new measurements to strengthen, update or extend the I.G.S.N. in their countries,
 - (e) cooperate with agencies carrying out absolute gravity measurements by recommending sites for new measurements to improve the I.G.S.N.
- 2) That agencies who have previously supported the I.G.S.N. Working Group continue to support their activities.
- 3) That agencies concerned with gravity standardization studies contact the Working Group through the Chairman of Special Study Group 3.05 or through members of the Working Group as listed in the I.G.S.N. 71 report.

RESOLUTION N° 5

The International Gravity Commission

recognizing the great increase in activity in measuring gravity at sea, and

recognizing the importance of making these data available to geoscientists throughout the world,

recommends :

- 1) That the I.G.B. gives increased emphasis to the collection and distribution of these data and to the descriptions of the gravity bases to which sea gravity surveys are referred.
 - 2) That one member of the Directing Board of the I.G.B. have specialized background in the handling of sea gravity data.
-

COMMISSION GRAVIMETRIQUE INTERNATIONALE

Septembre 1974

RESOLUTION N° 1

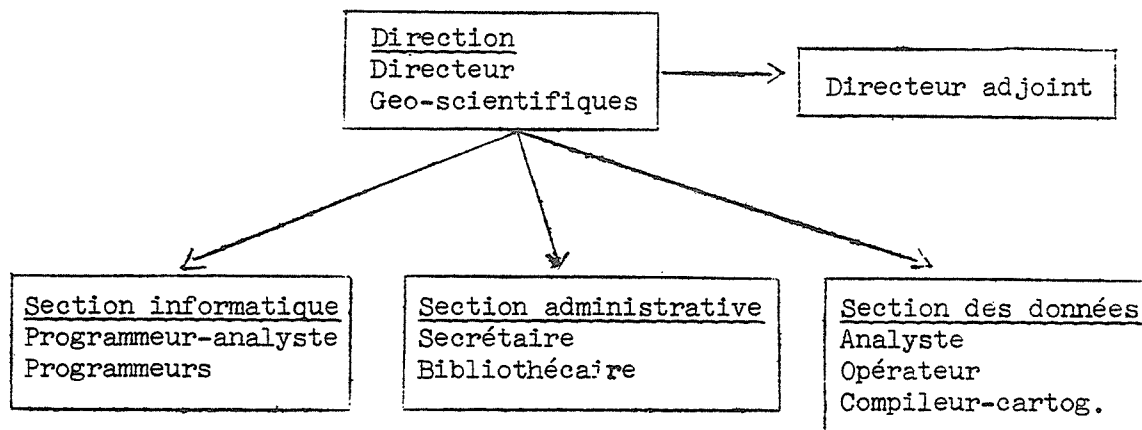
La Commission Gravimétrique Internationale

reconnaissant l'aide généreuse donnée par les Organisations Françaises permettant le financement et le fonctionnement du Bureau Gravimétrique International mais

reconnaissant aussi la nécessité absolue d'améliorer les services du Bureau au bénéfice de la communauté scientifique,

recommande :

1. Qu'en vue d'un fonctionnement efficace du Bureau, le personnel soit composé au minimum de :
 - 1 directeur
 - 1 directeur adjoint
 - 2 geo-scientifiques
 - 1 programmeur-analyste Système
 - 2 programmeurs
 - 1 opérateur pour traitement des données
 - 1 bibliothécaire
 - 1 secrétaire
 - 1 opérateur pour matériel périphérique autonome
 - 1 "compileur" de cartes/dessinateur
2. Que le personnel du Bureau soit organisé suivant le plan indiqué ci-dessous :



3. Que soient prévus au moins les moyens ci-après :

- (a) des locaux appropriés
- (b) l'accès à un centre de calcul comprenant l'équipement suivant :
 - calculateur de 50k mots et système interactif
 - imprimante
 - lecteur de cartes
 - dérouleurs de bandes magnétiques (4)
 - unité de disques
 - traceur automatique 100 x 150 cm (approximativement)
- (c) sur place l'équipement suivant :
 - terminal à télétype ou écran cathodique
 - convertisseur analogique numérique 100 x 150 cm (approximativement)
 - perforatrice-traductrice (2)
 - trieuse de cartes
 - imprimante sur micro film
 - système de traitement de mots pour préparation de rapports et correspondance
 - moyens de reproduction de documents
 - bandes magnétiques et disques

4. Que le logiciel du calculateur pour les buts ci-après soit acquis ou développé :

- maintenance et extraction des fichiers numériques
- maintenance et extraction des fichiers bibliographiques
- traçage
 - . valeurs ponctuelles
 - . courbes
 - . transformation de projection
 - . dessin
- digitalisation
 - . transformation de projection
- réduction des données
 - . calcul des anomalies de pesanteur
 - . calcul des anomalies moyennes
 - . contrôle vertical
 - barométrique, niveau à bulle ...
 - . contrôle horizontal
 - cheminement, navigation électronique ...
 - . corrections de terrain
 - . programmes généraux de moindres carrés pour ajuster les anciens réseaux d'anomalies au système IGSN ;

et charge le Président de la Commission Gravimétrique Internationale

1. de négocier avec le Comité National Français de Géodésie et Géophysique pour obtenir un accord sur une aide de base pour le Bureau en fonction des précédentes recommandations ;
2. de prendre contact avec les Comités Nationaux des autres pays possibles dans le but de rechercher un appui semblable au cas où un accord avec le Comité National Français ne pourrait se faire.

RESOLUTION N° 2

La Commission Gravimétrique Internationale

reconnaissant que, dans un futur proche, on pourra utiliser des gravimètres absolus d'une précision égale au microgal dans des endroits fixes, et des instruments portatifs d'une précision de 10 ou même 1 microgal,

et considérant que ces appareils doivent être employés le plus efficacement possible pour la recherche fondamentale dans les Sciences de la Terre :

1. Rappelle la résolution n°12 de l'A.I.G. à l'Assemblée Générale de l'U.G.G.I. à Moscou en 1971 ;
2. Recommande de faire des mesures absolues de pesanteur, aussi bien dans des régions stables que dans des régions où des variations de pesanteur séculaires ou de longue période sont prévues, et de répéter ces observations à des intervalles suffisamment longs.

Dans ce but :

- a) On établirait environ 10 stations permanentes (ou observatoires) où la valeur absolue de la pesanteur peut être observée à la précision du microgal afin de rechercher les variations globales possibles et les corrélations dans les changements de g , à long terme. Ces stations seraient localisées dans des régions stables et bien réparties à travers le monde, de sorte qu'avec les laboratoires déjà existants et ceux en cours d'installation, il y ait de préférence plus d'une station sur chaque continent. Le maintien de ces stations serait coordonné par un Service permanent. Ce service encouragerait la coopération entre les scientifiques travaillant dans ce domaine, ayant comme objectif d'établir une publication commune, sans différer trop longtemps les observations et l'analyse initiale des résultats.

On demande au pays Membres (où sont situées les stations) de participer à l'installation et au maintien de ce Service permanent.

- b) Avec les gravimètres absolus portatifs, on effectuerait des observations dans des régions stables où il n'y a pas encore de stations permanentes (voir 3c ci-dessous) et dans des régions instables comme il est indiqué précédemment.
3. et recommande d'utiliser aussi les gravimètres absolus portatifs comme suit :
 - a) pour faire des observations sur au moins une ligne d'étalonnage gravimétrique du réseau IGSN 71 (telle que la ligne Europe - Afrique) ; ces observations seraient choisies de façon à couvrir toute l'échelle de pesanteur et seraient faites à des intervalles de pesanteur de 100 milligals, de manière à vérifier la linéarité du système IGSN 71 et augmenter l'utilité de la ligne d'étalonnage ;
 - b) pour corroborer la précision des stations permanentes, ainsi que pour vérifier la précision des dispositifs portatifs, par des comparaisons directes à la même place entre des instruments de types différents ;
 - c) pour étendre le nombre et améliorer la répartition des stations absolues sur le globe de manière à mieux contrôler le système IGSN 71 et améliorer sa précision. Chacune de ces stations absolues devrait être entourée d'un réseau de stations complémentaires mesurées avec des gravimètres de haute précision, pour éliminer les effets locaux.

On demande avec insistance aux pays Membres de promouvoir et soutenir toutes ces activités.

RESOLUTION N° 3

La Commission Gravimétrique Internationale

considérant l'importance pour les Sciences de la Terre, de rechercher les variations de pesanteur séculaire et de longue période, en fonction du temps,

recommande de poursuivre les projets en cours et d'entreprendre de nouvelles recherches du même genre dans des régions particulièrement intéressantes, en utilisant des appareils de mesure absolue et relative de la pesanteur.

RESOLUTION N° 4

La Commission Gravimétrique Internationale

reconnaissant la nécessité de maintenir, d'étendre et d'améliorer les normes internationales de pesanteur comme elles ont été définies par le "Réseau Gravimétrique International Unifié" (IGSN)

recommande :

1. Que le Groupe de Travail "IGSN" du Groupe Spécial d'Etudes 3.05
 - a) collecte, analyse et compense les nouvelles mesures pour le Système IGSN,
 - b) collecte et tienne à jour les descriptions des stations du Système IGSN, en collaboration avec le Bureau Gravimétrique International,
 - c) donne des conseils aux Services Nationaux qui le demandent pour établir des réseaux gravimétriques de contrôle,
 - d) s'entende avec les Services Nationaux pour faire de nouvelles mesures afin de renforcer, tenir à jour ou étendre le Système IGSN dans leur pays,
 - e) collabore avec les services exécutant des mesures absolues de pesanteur en recommandant des emplacements pour de nouvelles mesures afin d'améliorer le Système IGSN.
2. Que les services qui ont déjà donné leur soutien au groupe de travail IGSN continuent leurs activités ;
3. Que les services intéressés par les études de standardisation concernant la pesanteur se mettent en rapport avec le Groupe de Travail en prenant contact soit avec le Président du Groupe Spécial d'Etudes 3.05, soit avec les Membres du Groupe de Travail indiqués dans le Rapport IGSN 71.

RESOLUTION N° 5

La Commission Gravimétrique Internationale

reconnaissant l'important accroissement de l'activité des opérations de mesures de pesanteur en mer et,

reconnaissant l'importance de mettre ces données à la disposition des géo-scientifiques du monde entier,

recommande :

1. Que le B.G.I. donne un accent plus important à la collecte et à la distribution de ces données, ainsi qu'aux descriptions des stations gravimétriques de base auxquelles sont rattachées les croisières gravimétriques.
 2. Qu'un Membre du Comité Directeur du B.G.I. soit un spécialiste très au courant du maniement des données gravimétriques en mer.
-

PAPERS PRESENTED or DISTRIBUTED at the MEETING

Besides the National Reports (see p.I-3), the following papers have been presented or distributed :

- 1) Yu. D. BOULANGER - "Secular variations of gravity".
Inst. Physics of the Earth, Acad. Sci. USSR, 6 p.
- 2) D.B. DeBRA & E.J. PELKA - "Study to develop gradiometer compensation techniques". AFCRL-TR-74-0114, Bedford, 65 p.
- 3) D.B. DeBRA & al. - "A satellite freed of all but gravitational forces :
"Triad I". Johns Hopkins Univ. & Stanford Univ., 32 p., 1973.
- 4) C. BOWIN - "Mascons : A two Body Solution". W.H.O.I., 1 p.
- 5) L. BRAGARD - "West-European tidal gravity profile". University of Liege, 4 p.
- 6) A.A. CERRATO - "Contributions to applied Geodesy". Inst. Geod., Graduates
School of Geodetic, Geophys. & Hydrog. Engineering, Univ. Buenos-Aires, 18 p.
- 7) S. CORON - "The International Gravity Bureau". Paris, 32 p.
- 8) G. CSAPO, K. Ya. KOZYAKOVA, M. MAJEWSKA, R.B. RUKAVISHNIKOV & L. TRÄGER
"Investigations of the dependences of the dial constants of CG-2 Sharpe
gravimeters on the effects of external factors".
Hungarian Geophys. Inst. "R. Eötvös, Budapest, 137 p.
(Translation of a russian publication, Acad. Sci. USSR, Moscow, 1974).
- 9) Cl. ELSTNER & G. HARNISCH - "Gravity connections between Potsdam, Moscow and
several stations of IGSN 71". Central Earth Physics Inst., Acad. Sci. G.D.R.
Potsdam, 26 p.
- 10) J.E. FALLER & J.A. HAMMOND - "A new portable absolute gravity instrument".
Joint Inst. Lab. Astrophys., Boulder & AFCRL, Hanscom AFB; 9 p.
- 11) U. FLEISCHER - "The gravity field around Iceland (5°)".
Deutsches Hydrog. Inst., 1 p.
- 12) C. GERSTENECKER - "Calibrational problems - Investigation of calibration
functions". Darmstadt, 9 p.
- 13) E. GROTEN - "Microgravimetry - High precision observations of small gravity
differences". Darmstadt, 16 p.
- 14) R.T. HAWORTH - "Multiparameter surveys of Canada's Atlantic continental
margin". Atlantic Geoscience Centre, Bedford Inst. Ocean. Dartmouth, 7 p.
- 15) T. HONKASALO - "Report of IAG Special Study Group n° 3.37 on Special
Techniques of Gravity Measurements". 9 p.
- 16) T. HONKASALO - "Detailed gravimetric geoid of Finland".
Geodeettinen Laitos, Helsinki, 6 p.
- 17) JAEGER - "Transportable absolute gravity meter of 2.10^{-7} n/s² (or 02 p.p.m.)
accuracy". Levallois-Perret, France, 2 p.

- 18) R.S. MATHER - "On the evaluation of stationary sea surface topography using geodetic techniques". The University of New South Wales, Sydney, 13 p.
- 19) R.S. MATHER - "Sea surface topography from satellite altimetry - Requirements for surface gravity data". The School of Surveying, The University of New South Wales, Sydney, 7 p.
- 20) R.K. McCONNELL, D.B. HEARTY & P.J. WINTER - "An evaluation of the LaCoste-Romberg model D microgravimeter". Earth Physics Branch, Ottawa, 14 p.
- 21) J.M. MONGET & C. BOWIN - "A gravity data library : organization and effective utilization". Woods Hole Oceanographic Institution, WHOI-74-33, 88 p. (1974).
- 22) C. MORELLI - "Proposal for the re-organization of the International Gravity Community. 13 p.
- 23) R.H. RAPP - "Gravity anomaly data from satellite observations - Present and future results". Ohio State Univ., Columbus, 1 p.
- 24) A. SAKUMA - "Report on absolute measurements of gravity". B.I.P.M., Sèvres, 4 p.
- 25) J. SEGAWA & C. BOWIN - "The Tokyo surface-ship gravity meter : recent developments for solving non-linear rectification error and phase lag problems". Woods Hole Oceanographic Institution, WHOI-73-89, 41 p, Dec. 1973.
- 26) H. SUZUKI - "Establishment of the gravimetric Network in Japan". Bull. Geog. Surv. Inst., v.XX, part I, 150 p, Tokyo. (1974).
- 27) W. TORGE - "Error analysis of gravity measurements carried out in 1972 with LaCoste-Romberg gravity meters along the northern part of the European Calibration Line". Inst. Theor. Geod., Tech. Univ. Hannover, 19 p.
- 28) C.C. TSCHERNING - "Application of collocation for the planning of gravity surveys". The Danish Geodetic Institute, 15 p.
- 29) E. VERMAAT & E. TENGSTROM - "The Eötvös tensor, and its importance for the detailed mapping of the gravity field near the Earth's surface, and for defining a suitable level surface for solving the external BV-problem of Geodesy as a unique Neumann-problem". Uppsala, 12 p.
- 30) V. VYSKOCIL - "Comments on the statistical analysis of gravity anomalies". Praha, 1 p.
- 31) A.B. WATTS - "The gravity field of Island Arc - Trench systems : Some new results and their implications". Lamont-Doherty Geol. Obs., Palisades, N.Y. 2 p.
- 32) P. WELLMAN, B.C. BARLOW & D.A. COUTES - "Comparison of Western Pacific and Australian calibration line gravity scales and an evaluation of secular variation". Record 1974/121, 8 p.
- 33) C.W. WILLIAMS - "Gradiometry - an assessment of the state-of-the-art". Defense Mapping Agency, Washington, 16 p.
- 34) O.W. WILLIAMS - "Summary report on airborne gravity instruments". Defense Mapping Agency, Washington, 6 p.
- 35) G.P. WOOLLARD - "Regional changes in gravity and their relation to crustal parameters". Univ. of Hawaii, Hawaii Inst. Geophys., 37 p.

I - II

INTERNATIONAL GRAVITY COMMUNITY

International Gravity CommissionInternational Gravity Bureau

Several sessions have been devoted to problems concerning the reorganization of the International Gravity Community, i.e., the International Gravity Commission and the International Gravity Bureau.

Monday, 2nd September	4.30 p.m.
Wednesday, 4th September	5.15 p.m.
Thursday, 5th September	11 a.m.
Friday, 6th September	11.30 a.m.

After the presentation of general papers, discussions and exchanges of opinions have been made and resolutions have been adopted.

During the session of Monday September 2nd, Dr. S. CORON, Acting Director of the I.G.B. presents a Report on the I.G.B. (see Appendix p.A-1).

She reminds the historical part of the I.G.B., the main resolutions adopted about it, its organization, calling attention on the activity of the I.G.B. which was directed according to the general scheme of the F.A.G.S. concerning the Permanent Services, i.e., without scientific studies (see p.A-3). She emphasizes the fact that the work guidance of the I.G.B. was mainly the resolutions (see p.A-18) adopted at the I.G.C. and I.U.G.G. meetings and that the international cooperation with the I.G.B. is in progress and is extending now to 69 Countries (Geodesy, Geophysics or Geological Services). Then, she speaks on the activity of the I.G.B. (information, advices, Bulletins, maps); she presents especially the recent world maps of mean gravity values ($5^{\circ} \times 5^{\circ}$) and 2 geoid maps obtained with the terrestrial gravity values (see p.A-30) and with satellite results.

Some remarks have been made concerning the exchange of gravity data (military secret and economical interests), about the accuracy of gravity measurements and the establishment of world gravity maps.

Prof. MORELLI, President of the I.G.C. recalls the structure of the International Association of Geodesy and the position of the I.G.C. and of the I.G.B. within the limits of the I.A.G.

Then, he states that in agreement with the Executive Council of I.A.G. met in Paris (February 25-27, 1974) he prepared a questionnaire on these problems and sent it to the National Committees and to the great gravimetric Services. He summarizes the replies (35) to this questionnaire and drew propositions in : "Proposal for the re-organization of the International Gravity Community", (Appendix p.A-33).

Some remarks are made by the Delegates, particularly :

M. LEVALLOIS explique qu'il est en faveur de conserver l'appartenance à F.A.G.S. et les subsides, même réduits, qui en sont la conséquence et de conserver, contre tout passage à un World Data Center, l'originalité du B.G.I. dans le sein de l'A.I.G.

Il propose que le groupe d'Etudes sur le rôle et les statuts du B.G.I. fasse d'abord l'inventaire des moyens nécessaires à un fonctionnement correct et adresse ensuite aux nations de l'U.G.G.I. un exposé de ces moyens à la demande éventuelle de candidature. Enfin, il insiste sur la nécessité d'un comité de direction efficace et actif.

Prof. BOULANGER thinks the Bureau has made a big work, besides, he suggests that the I.G.B. should also deal with scientific problems and that a Directing Board should be appointed.

M. FALLER simply points out the difficulty of attracting a "person who himself is highly academic" into a position (Director of the I.G.B.) in which the task of "scientific studies" is not recognized (see p.A-36) as one of the main tasks of the organization.

Dr. COLLETTE makes a remark concerning the financial problem : is France prepared to continue to pay for the I.G.B. ? Changing names would not solve the problem. It is the money that goes with it. But as everybody knows, the World Data Centers have such difficulties right now, that a solution is sought in the establishment of "Regional Centers".

In conclusion, the Delegates wish that the I.G.B. takes necessary steps for a new extension and appoints a Working Group to study these problems ; it will prepare proposals during the present Meeting and submit them to the approval of the same Meeting.

The Members of the Working Group are the following :

- C. MORELLI, President of the I.G.C. and of the Section III of I.A.G.,
- T. HONKASALO, Secretary of the Section III of I.A.G.,
- S. KRYNSKI, Member of the Finance Committee of I.U.G.G. (Poland),
- A. COMOLET-TIRMAN (France)
- R. McCONNEL (Canada)
- U. UOTILA (U.S.A.)

During the session of Wednesday afternoon and Thursday morning the Delegates examine the two papers prepared by the Working Group and distributed, concerning the I.G.C. and the I.G.B.

Some modifications have been brought to the proposed papers after some discussions to which took part Messrs : TENGSTROM, WEIGHTMAN, FALLER, LEVALLOIS, BOULANGER, CHOVITZ, TORGE, UOTILA, WOOLLARD, TAYLOR, MELCHIOR, WILLIAMS, BOWIN and DAY.

At the session of Friday morning

1°) First, after a new lecture of the proposed texts concerning the I.G.B. and the I.G.C., the definitive texts are approved as well as the Resolutions. :

- Guidelines for the International Gravity Commission (see p.I-18),
- Terms of references of the International Gravimetric Bureau (see p.I-21),
- Resolutions (see p.I-23).

2°) Then, the present Delegates appoint the following Members :

The Directing Board of the I.G.C.

- 2 Vice-Presidents { Prof. W. TORGE
 Prof. S. KRYNSKI
- Secretary Ing. Hydrog. A. COMOLET-TIRMAN

The Directing Board of the I.G.B.

- ex-officio Members { - President } of the Section III of I.A.G.
 - Secretary }
 - President of the I.G.C.
 - Director of the I.G.B.
- 4 nominated Members { - Prof. Yu.D. BOULANGER
 - Prof. R.S. MATHER
 - Dr. J.G. TANNER
 - Prof. U. UOTILA

At the end of this session, Prof. MORELLI, President of the I.G.C. recalls he has for task to negotiate with the French National Committee to obtain agreement on a basis of support for the Bureau according to the recommendation of the resolution N° 1.

When the definitive answer will be given concerning the future of the I.G.B., the nomination "of the Director of the I.G.B. will be made by the I.G.C. in consultation with the host country and appointed by the I.A.G. Council". In the meantime, Dr. CORON remains Acting Director till the next meeting of the I.U.G.G. (1975).

- III -

ABSOLUTE GRAVITY MEASUREMENTS (a)

Special Study Group n°3.18

On Tuesday morning 3rd September, as Dr. A. COOK, President of this Special Study Group was absent, Dr. A. SAKUMA agreed to preside over the session dealing with this topic. During the session two papers have been presented (A. SAKUMA, J.E. FALLER and J.A. HAMMOND):

A. SAKUMA presents a general Report which synthesized all works presently in course and the projects concerning the new instruments and the applications of absolute measurements in the field of Geophysics.

Report on Absolute Measurements of Gravity

Bureau International des Poids et Mesures, 92310 Sèvres, France

1. Introduction

The absolute measurements of gravity, carried out up to the end of the last decade, obtained accuracies of 0.1 mGal or better (Cook 1967, Sakuma 1968, Hammond 1970). These results have been adopted to establish the International Gravity Standardization Net 1971 (I.G.S.N. 71) (Marelli et al. 1974). Presently this net covers over 1800 world-wide stations where the local absolute values of gravity are believed to be accurate to at least 0.1 mGal.

In such circumstances, the activities of the absolute measurements of gravity during the three years since the last General Assembly of the I.U.G.G. can be classified into three fields :

1) Establishment and maintenance of permanent stations (Sèvres, Mizusawa) where one micro-gal accuracy may be obtained in the future (Sakuma 1973).

2) Construction of transportable absolute apparatus with $\sim 10 \mu\text{Gal}$ final accuracy (Faller - Hammond 1974, Sakuma et al. 1974, Tsubokawa et al. 1974) aimed at the maintenance and improvement of the I.G.S.N. 71 and at other applications in geophysics and metrology.

3) Achievement of absolute measurements of gravity by various methods started long before the establishment of the I.G.S.N. 71 (Schüller et al. 1971, Hytönen 1972, Bell et al. 1973). Because of their accuracies of $\sim 0.1 \text{ mGal}$ or less, these experiments have served to confirm the validity of the I.G.S.N. 71.

(a) Se reporter au C.R. antérieur : Bull. Inf. n°24, p.I-31
(C.G.I., Paris, 1970)

2. Notes on permanent stations

2.1. Bureau International des Poids et Mesures (B.I.P.M.), Sèvres

This is the first (in operation since 1967) fixed location apparatus, aimed at the study of the secular variation of gravity. A corner cube reflector forming one mirror of a Michelson interferometer is projected upwards and the four sets of white light fringes that are formed at two levels (distance 0.4 m) of the trajectory operate sub-nanosecond counters for timing the flight in vacuum ($\sim 10^{-5}$ Pa). Improvements in the accuracy of the apparatus have been continuously made in parallel with the periodical measurement of g and a final accuracy of 1 microgal may be obtained. The two principal causes of the systematic errors have recently been reduced. First, the uncertainty of the present definition of the Metre ($< 4 \times 10^{-9}$) was improved by use of a saturated molecular absorption laser of 1×10^{-10} wavelength accuracy (C.C.D.M. 1973). Second, the uncertainty in the theoretical correction of the earth-tide in the vicinity of the absolute site was reduced by installation of an earth-tide recording gravimeter using a null method (0.2 μ Gal sensitivity and + 0.7 μ Gal/day drift, Sakuma 1974). This combination of the two types of gravity apparatus, absolute and relative, gives mutual advantage to each of them; the real correction of the earth-tide now becomes available for the absolute apparatus and the absolute apparatus makes it possible to study and calibrate the long term drift and the sensitivity of the relative apparatus. A significant variation of gravity of 20 \sim 40 μ Gal was observed by the absolute apparatus, especially between the data of 1969 and those of 1972-1973. These differences in g are still unexplained. Because of modifications of the apparatus the values of g in 1974 are not yet available.

2.2. International Latitude Observatory, Mizusawa

For the purpose of the polar motion studies, an absolute apparatus is being constructed with the technical assistance of the B.I.P.M. This is a symmetrical free fall experiment very similar to that at the B.I.P.M. In order to minimize the artificial perturbations coming from neighbouring laboratories, an independent laboratory of $\sim 400 \text{ m}^2$ has been constructed for this future apparatus. In spite of the abundance of the seismic perturbations in the region of this observatory, a final accuracy of the same order as that of the B.I.P.M. is expected. Therefore, the most accurate scale ($< 1 \times 10^{-5}$) of a gravity difference of about 730 mGal will be realized between Sèvres and Mizusawa within several years.

2.3. Institute of Automation and Electrometry, Novosibirsk

This permanent station (Arnautov et al., 1974), in operation since 1972, is also destined for the detection of the secular variation of gravity, using a free fall method of a corner cube prisme associated with a fringe counting system of a stabilized laser. The particularity of the apparatus is that none of protection against the ground motions and the mechanical vibrations is employed. Therefore, the scatter of the single measurement attains about ± 2 mGal, nevertheless by taking the mean of numerous drops and assuming that the vibration effect is quite random, it is reported that an accuracy of 20 μ Gal is obtained. No secular effect greater than the accuracy of the apparatus has been detected during a one year period from May 1972 to May 1973.

3. Notes on transportable apparatus

3.1. Air Force Cambridge Research Laboratories, Bedford

This is an improved version of the first transportable apparatus (Hammond 1970) which has greatly contributed to the establishment of the I.G.S.N. 71. The method employed is that of interferometric fringe counting to measure the free fall of a corner cube prisme. The details of the apparatus and the results will be reported at this Commission.

3.2. Istituto di Metrologia "G. Colonnetti", Torino

This apparatus, constructed with the technical assistance of the B.I.P.M., also employs the principle of symmetrical free rise and fall. The instrumental details of this apparatus are very similar to those of the fixed apparatus at the B.I.P.M. Nevertheless, it is worth noting three differences which facilitate the transportation of the instrument and the calculation of g , namely :

- 1) The determination of g is made in a low vacuum of about 0.1 Pa for which the secondary vacuum pump is not required ;
- 2) Instead of the end standard of length, a stabilized laser is employed with a reversible interferometric fringe counting method ;
- 3) The vibration effect is compensated automatically by an inertial reference corner reflector which itself forms the end mirror of the horizontal beam.

This apparatus, 1.4 m high and with a 0.5 x 0.5 section, consists of two separable main parts ; a Michelson interferometer in a pressure-tight case weighting ~ 40 kg and a catapult in a vacuum cylinder weighting ~ 60 kg. This apparatus can be transported by a small truck.

A first preliminary results was recently obtained by this apparatus transported to the B.I.P.M. and installed on a pier where the value of g is already known. The mean value of 25 measurements of g (about one hour) was in agreement to within ± 0.02 mGal with the value obtained by the fixed apparatus.

A final precision of 0.01 mGal will be obtained by this transportable apparatus and its accuracy and repeatability will be checked by the fixed apparatus of the B.I.P.M.

This apparatus has been of interest to several geophysical and standard laboratories for their studies. So a project for its industrialization by a French firm is presently in progress. * This kind of apparatus will be useful not only for the creation of absolute stations and for the calibration of the gravity net, but also, by means of periodical gravity ties by the apparatus, for the study of the global evolution of the gravity field of the Earth.

3.3. Earthquake Research Laboratory, Tokyo

This prototype is originally designed for the symmetrical free rise and fall observation. But due to the difficulties of correct launching of a projectile (cat's eye), the simple free fall method is presently employed. Preliminary results show that the measured value of g is about 2 mGal lower than the expected value and this systematic error is thought to be due to the low vacuum of about 0.1 Pa in which the mirror drops.

* Société JAEGER, Division Aéronautique
2, Rue Baudin 92303 LEVALLOIS-PERRET

4. Conclusion

After long and patient efforts with various methods carried out by numerous laboratories, the principle of absolute gravimetry has been now unified into the two kinds : the free fall and the symmetrical free rise and fall. Transportable absolute apparatus of $\sim 10 \mu\text{Gal}$ accuracy will soon become commercially available. According to the proposition (Levallois 1971) and the resolutions (I.A.G. 1971), several new permanent stations will be founded within a decade in North America, in Europe and in the Far East. Thus, the modern techniques of absolute gravimetry are beginning to provide several new means for geophysical studies.

References

- COOK A.H., Phil. Trans. Roy. Soc., A.261, 211 (1967)
- SAKUMA A., Procès-Verbaux C.I.P.M., Tome 37, 58e session, 55 (1968)
- HAMMOND J.A., JILA Report N° 103, Univ. of Colorado (1970)
- MORELLI C. et al., Public. Spec. N° 4, Assoc. Int. Geod. (1974)
- SAKUMA A., Publ. Int., Symposium on Earth's Gravitational Field, Sydney (1973)
- FALLER J., J.A. HAMMOND, Report on this Commission
- SAKUMA A. et al., Publ. IMECO Meeting, Udine (May 1974)
- TSUBOKAWA I. et al., Private communication
- SCHÜLER R. et al., Veröffentlichungen des Zentralinstituts Physik der Erde, N° 10, Potsdam (1971)
- HYTONEN E., Public of the Finnish Geodetic Institute, N° 75 (1972)
- BELL G. et al., Metrologia, 9, 47 (1973)
- C.C.D.M. 1973, Rapport, 5e Comité Consultatif pour la Définition du Mètre (1973)
- SAKUMA A., Procès-Verbaux, C.I.P.M., 1974, in press
- ARNAUTOV G.P. et al., Applied Optics, vol. 13, N° 2, 310 (Feb. 1974)
- LEVALLOIS J.J., Bull. Géod., N° 99, 111 (1971)
- I.A.G. 1971, Bull. Géod., N° 102, 403 (1971).

J.E. FALLER (and J.A. HAMMOND) present a paper with many slides about the new laser-interferometer gravity instruments which offers significant improvements over the original instrument :

A new Portable Absolute Gravity Instrument

James E. FALLER
Joint Institute for Laboratory Astrophysics
Boulder, Colorado 80302
and

James A. HAMMOND
Air Force Cambridge Research Laboratories
Hanscom AFB, Massachusetts 01730

Summary

The main feature of the new design is that the freely falling reflector is enclosed in a small evacuated chamber which falls along with the reflector. These both fall in a larger vacuum chamber but since the air which comes in contact with the falling object is falling with essentially the acceleration of gravity, air resistance effects are negligible.

The electronics system will make digital time measurements between a large number (50 to 500) of interference fringes and will thus make independent measurements of g and the gravity gradient as well as detect seismic motions occurring during the fall of the object. The digital data will be processed immediately by an on-line process and control mini-computer.

The instrument will utilize a laser whose output is stabilized on an Iodine absorption line giving a contribution to the uncertainty from the wavelength of the light of only ± 0.001 mGal. The absence of magnetic materials will remove a rather large source of uncertainty which existed with the original instrument.

During the period between May 1968 and August 1969, absolute measurements were made at eight different sites : National Bureau of Standards, Gaithersburg, Maryland ; Wesleyan University, Middletown, Connecticut ; Air Force Cambridge Research Laboratories, Hanscom AFB, Bedford, Massachusetts ; Denver, Colorado ; Fairbanks, Alaska ; Bogota, Colombia ; Teddington, England ; and the Bureau International des Poids et Mesures, Sèvres, France, using the Hammond-Faller developed portable laser-interferometer system for the measurement of the acceleration of gravity. The results obtained during that period represented the first time that absolute measurements had been compared at the same site, and served to corroborate the various measurements. They further provided the first trans-Atlantic absolute transfer as well as the first series of absolute determinations along the American calibration line. These highly successful results, while fully bearing out the promise of this type of instrument, were nevertheless hard won in that the apparatus was awkward to transport because of its bulk and required a considerable effort to set up and get running because of the number of components that needed to be interconnected and because of the need to establish a high level vacuum in the system. It did, however, represent the best compromise between accuracy and transportability that we could envision at that time.

The fact that the laser interferometer method is being employed in a cooperative effort by the French and Italians (A. SAKUMA of the BIPM and G. CERUTTI of Torino) and by Soviet scientists at the Institute of Automation and Electrometry in Novosibirsk is a tribute to the fundamental correctness of the method.

Realizing the potential of this laser-interferometric technique, we have come up with a new instrument design of considerably reduced bulk and weight which, as a result of a new type of dropping chamber design, promises to provide higher mechanical reliability and markedly less set-up time at a given site. The culmination of this effort is to be a highly portable and fully computer controlled instrument capable of measuring "g" with an accuracy of 5 parts in 10^8 or better.

Figure 1 shows the relative sizes of the old and new instruments. The instrument may be considered in three parts, the mechanical system, the optics and the electronics. As in all of these types of instruments, the mechanical system presents the most challenging problems and will be discussed first.

Besides being of a smaller size the design and construction of a new dropping chamber has the aim of correcting the mechanical difficulties associated with the high-vacuum environment required in the initial instrument. These difficulties are :

- (1) a severe restriction on the materials which can be included without severe outgassing at the 10^{-6} to 10^{-7} millimeters of mercury pressure required, and
- (2) the mechanical "welding" of the parts which seemed to result after a period of operation.

Two alternatives to the use of the high vacuum requirement were examined. One of these would be to go to an up and down measurement in which the freely falling corner cube is initially launched upward with timing being done during both the up and the down parts of the motion. This would permit a less stringent vacuum requirement since on the upward part, the air drag force acts in the same direction as gravity, while during the falling part this molecular force is opposite to the force of gravity and proper handling of the data would cancel out to first order the effects of the residual air pressure on the measured value of "g". The second approach looked at was to drop not just the cube but to drop both the cube and its container so that air drag results only from the differential velocity between the cube and its container which can be kept small compared to the cube's typically 100 to 300 cm/sec velocity during the measurement portion of its fall.

The evolved concept for freeing the dropped object from its seat in the vacuum chamber (which is also falling) and doing this by a reproducible and constant (during the time of fall) distance, involves cocking the corner-cube containing vacuum system relative to an auxiliary external mass by an extended spring which on release then causes the cube containing vacuum chamber to move down a fixed amount (and hence separate from the dropped object) while the COM of the combined chamber and auxiliary mass system free falls at "g". The entirety of these two dropped systems is then enclosed in an enveloping container which is to be evacuated to a modest 10^{-30} μ vacuum. Figure 2 shows schematically the arrangement of the dropped system.

The advantages of this approach are summarized as follows :

- (1) The system should afford greater mechanical reliability.
- (2) The required vacuum interval to the falling cube bottle is only about 1μ m of Hg since the air drag results only from differences in velocity between the cube and its container—both of which will be in free fall, and
- (3) The design permits a relatively compact—less than three feet high—and light-weight system.

The actual corner cubes are of 1" diameter and better than two seconds of arc quality. Use of a beam diameter of 1/2 the cube diameter (so as to permit a mechanical blockage of the retroreflected beam from reentering the laser) results in a diffraction correction of

$$\frac{\Delta L}{L} = .06 \frac{\lambda^2}{D} \quad 1 \times 10^{-10} \quad \text{for } \lambda = 6328 \text{ \AA}, \text{ which for all}$$

practical purposes is negligible.

In the design of the new system, the major "other force" that needed to be minimized was that of electrostatics. The approach that evolved in the design uses, in addition to symmetry in the design as to what the dropped object "sees", a much closer mechanical spacing in the horizontal than in the vertical direction between parts during the period of free fall so that any electrostatic remnant forces not compensated by the symmetry of the design will be lateral rather than along the direction of gravity. This should serve adequately to remove the last vestige of electrostatic forces which could otherwise affect measurement accuracy at the parts in 10^7 to 10^8 level.

The optical system of the new instrument is straight forward and similar to that of the original instrument. A separate corner reflector is used for the reference reflector so that it may be mounted on an inertial support for isolation of external vibrations. An Iodine stabilized laser will be used for the critical gravity measurements and thus the error due to imprecise knowledge of the wavelength of the light will be about ± 0.001 mGal. This laser has been built and calibrated by the National Bureau of Standards and has proved to have adequate intensity for use in the instrument.

The electronics system to be used with the new instrument has at its heart a time digitizer which, coupled with a processing mini-computer, can acquire 1000 digital time measurements during the falling time of the object. The resolution of these time values is 0.125 nsec. The time base for the digitizer will be provided by a Rubidium frequency standard and thus the precision of the time measurement will be determined by the digital resolution of better than one part in 10^9 . The electronics system has been used to acquire data using the old mechanical system and these preliminary tests indicate that the necessary precision can be obtained.

Several schemes are being contemplated for analysing the data. A large number of simple three position measurements of "g" may be made and some sort of average taken for the value associated with that drop. A type of difference algebra could be employed if large enough intervals were used. It is also possible to try fitting a curve whose parameters involve "g" and the gravity gradient to the data. All of these will be tested to determine the best method.

It will still be necessary to make many different "drops" at a measurement site because there is a fair amount of drop-to-drop scatter that statistics on just one drop will not average out. It is possible, however, that some information on seismic noise could be obtained from the data of one drop. In particular, it should be possible to eliminate aliasing of higher frequencies into the lower frequency drop-to-drop spectrum.

The new dropping chamber is completed and tests have been made which show that the free falling object separates from the inner chamber as it should. A design has been developed for the new base which will be considerably simpler and lighter than that of the old instrument. It will be possible to use either the Iodine stabilized laser or the Lamb dip stabilized laser used in the old system. The electronics instruments are all in hand and are being tested with the original mechanical system.

The use of standards of time and length which are only one step removed from the primary standards offers a degree of confidence not present in the first laser-interferometer instrument and the advanced electronics and computing instrumentation provide a convenience and precision impossible to obtain a few years ago. These features combined with a sophisticated mechanical system promise to permit us to obtain rapid measurements with a precision at least equal to and probably exceeding that obtained in the 1968-1969 time period. The great advance with the new instrument will be in the mechanical reliability and ease of operation. The one to two weeks required with the old instrument should be reduced to two to three days and shipping weight should be reduced by a factor of two to three. The potential for this new instrument to provide a large quantity of significant gravity data during the next two years is very great and we would hope that a number of comparisons with other instruments could also be made during this time.

(See figures 1 and 2 p.I-47, I-48).

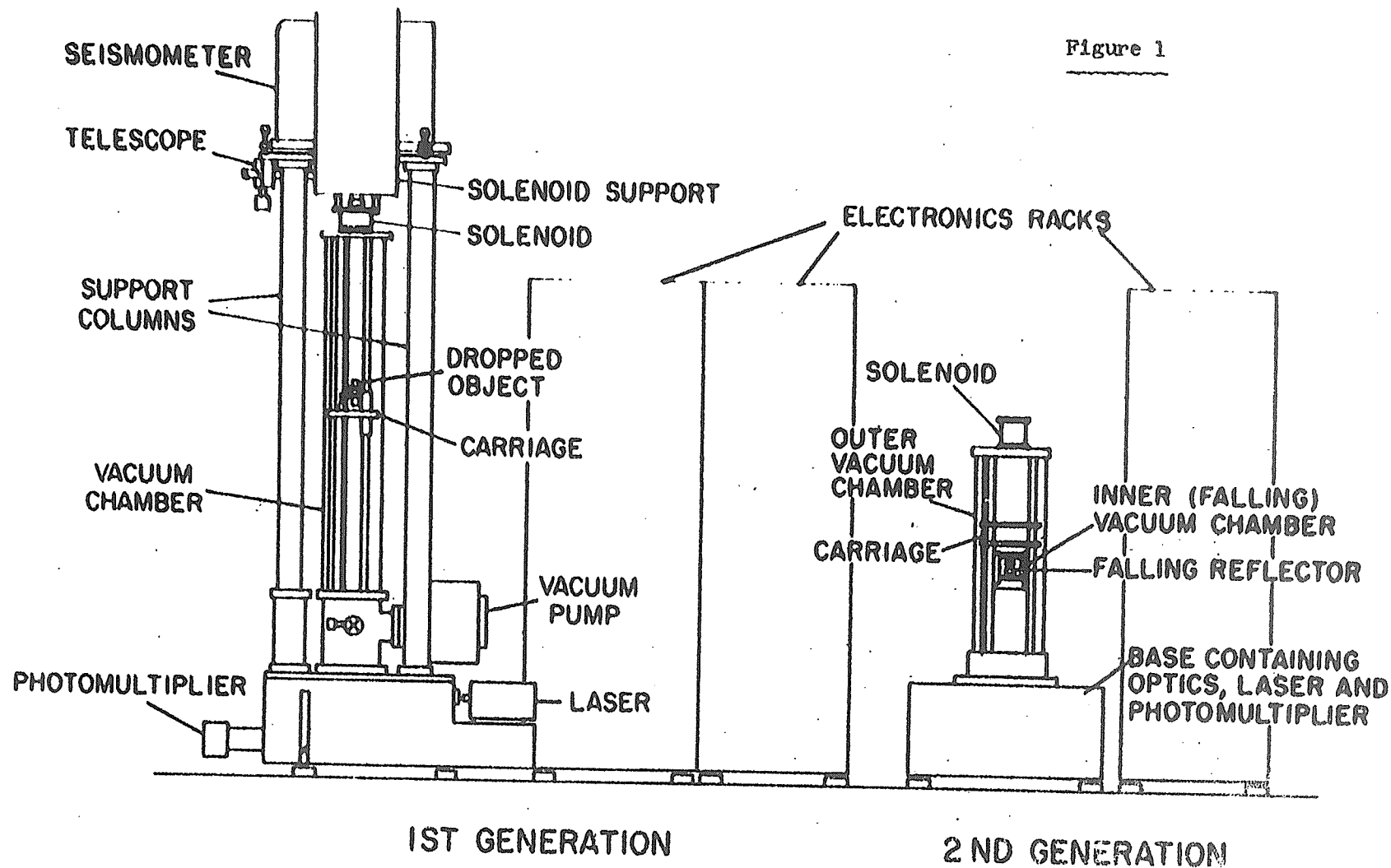
Delegates set up some questions on this new gravity instrument :

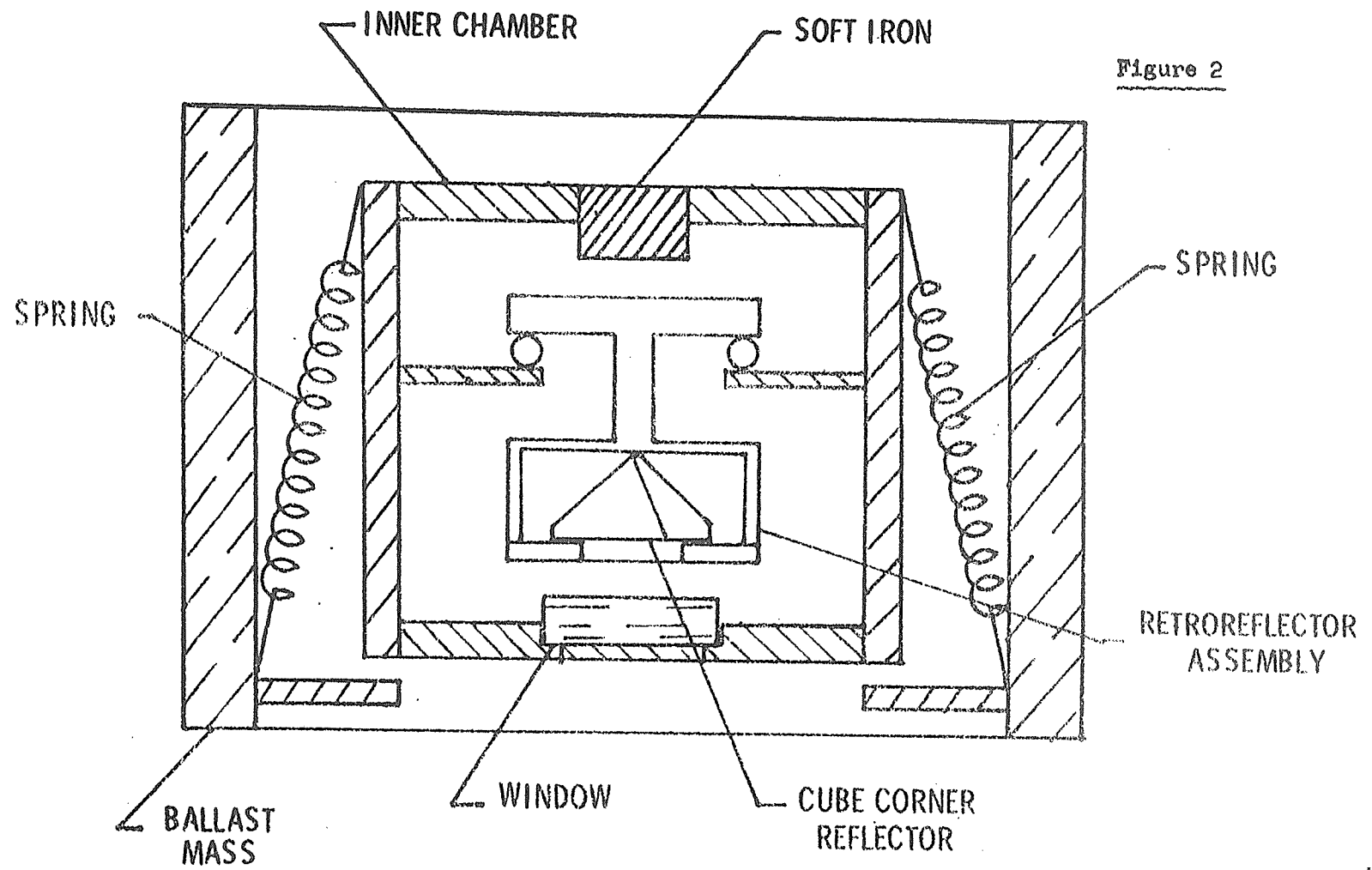
G.P. WOOLLARD asks "if the effect of power supply voltage fluctuations on results has been evaluated in addition to seismic effects ? and thinks the mGal plus variations observed at Bogota in the first measurements could have had this source".

J.E. FALLER answers : "no evaluations have been made, specifically".

A resolution concerning the programme of the absolute measurements has been adopted (Resolution n° 2, p.I-25).

LASER INTERFEROMETER ABSOLUTE GRAVITY INSTRUMENTS





FREE-FALLING UNIT IN 2ND GENERATION INSTRUMENT
(SCHEMATIC DIAGRAM)

- V -

GRAVITY MEASUREMENTS AT SEA

Special Study Group n°3.20

Since the Chairman of the Special Study Group n°3.20 Dr. J.L. WORZEL could not attend the meeting, the meeting was presided by Dr. B.J. COLLETTE. As the request to do so had reached him only a few weeks before, no time was left to prepare a report that could be presented in the meeting. Papers were presented by R.T. HAWORTH, A.B. WATTS, U. FLEISCHER and C. BOWIN. (See abstracts or text at the end of this session report).

Next a survey was made of seagoing instruments that are used at present, especially with regard to their accuracy and availability. It appears that the accelerometer used in the VSA gravimeter of the Woods Hole Oceanographic Institution is not commercially available. Dr. U. FLEISCHER reported : "As far as I know, the Askania GSS2 seagravimeter is now out of production. Production of the GSS3 is going on by Bodenseewerk-Gerätetechnik GmbH, D777 Ueberlingen, which just followed Siemens in owning Askania. This company is developing a new gyro-stabilized platform within the next three years. In the mean time, Anschütz will produce some more GSS2 platforms to be used with the GSS3. This combination worked very satisfying at several institutions". The Tokyo Surface Ship Gravity Meter (TSSG) is not commercially available. Dr. C. BOWIN reported that good results have been obtained with a newly designed processor to compensate for the non-linearity of this instrument (reference WHOI-73-89.)^{*} Dr. Yu.D. BOULANGER commented on the Russian surface ship gravimeter GAL. Accuracies of 4 - 6 mGal were reported. Near-coast accuracy is much better (0.5 - 0.6 mGal) which was attributed to better navigation.

Since the Bell gravimeter is taken out of production, the foregoing means that only the LaCoste-Romberg and the Askania GSS 3 gravity meter are on the market, the latter without a specially adapted platform. In view of this situation Dr. C. BOWIN was requested to investigate with the American authorities whether the accelerometer used in his VSA gravimeter could be made generally available to the geodetical and geophysical community.

Before the official meeting an informal discussion was held attended by : Melle J. BOUVET, C. BOWIN, B.J. COLLETTE, G.A. DAY, U. FLEISCHER, R.T. HAWORTH, S. PLAUMANN, G. STRANG van HEES, A.B. WATTS and D. WOODWARD. The following points were discussed and brought to the attention of the meeting :

^{*} See p.I-34, n°25.

- 1) Concerning the tasks of the IGB, Special Study Group n° 3.20 considers it important that at present the IGB continues to act as a world data center for the collection and distribution of :
 - a. gravity harboun base descriptions and,
 - b. gravity measurements at sea.

When discussing the future of the IGB, these tasks should be separated from other tasks, as the compilation of maps, advisory functions, etc. It is advantageous to have the gravity data and other geophysical data in a same reference system. This end can be achieved in several ways, but care should be taken that formats etc. are compatible.

It is considered of vital importance that one of the Members of the future directory board of the IGB is a specialist on data handling of gravity measurements at sea or that a special panel is nominated to advise the IGB in these matters. The meeting took over this suggestion.

- 2) It further was decided that the IGB be furnished with a list of correspondents including all institutions and people measuring gravity at sea. In this way the IGB can communicate directly with the people involved instead of being dependent on more or less haphazard information via the Members of the Special Study Group n° 3.20 and of National Committees.
- 3) Referring to a comment of Dr. CORON in her report (p.A.17) the opinion is expressed that no adjustments should be made to the raw data to be sent in to the IGB. If adjustments have been made it, of course, is important to have the adjusted values as well. However, a data bank should always have access to the primary measurements.
- 4) Furthermore, the IGB is requested to speed up publication of track charts and to keep these up-to-date (Dr. CORON's report, p.A.12). It is also considered useful to have a more complete list of projects of gravity surveys at sea (Bull. Inf. n°34, p.I-14).
- 5) The group also discussed the future of Special Study Group n° 3.20. Dr. COLLETTE reported that it was decided that in the coming year the task of Special Study Group n° 3.20 should be redefined, leaving open the possibility that the group has served its purpose and should be dissolved. He reminded the meeting of Dr. WORZEL's wish to be relieved of the chairmanship, already expressed in 1970. Since only 4 Members of the Special Study Group n° 3.20[≠] are present, viz. Prof. BOULANGER, Prof. MORELLI, Dr. PLAUMANN and Dr. COLLETTE, it was not considered appropriate to discuss this topic during this meeting of the I.G.C. Instead it was proposed that the subject should be taken up by letter with the Members of the group.

With regard to the future of Special Study Group n° 3.20, Dr. MORELLI commented that a study group could only be dissolved by the IAG. However, in view of the importance of several aspects of measuring gravity at sea he urgently requested the group to continue its work and asked Dr. COLLETTE to contact Dr. WORZEL about this, also suggesting that personal mutations might be useful. Dr. COLLETTE consented to discuss the matter with Dr. WORZEL.

[≠] See List of the Members p.I-60.

Recent Marine Gravity Studies and Data Handling Techniques
at the Woods Hole Oceanographic Institution

C. BOWIN

Woods Hole Oceanographic Institution

"Recent marine gravity studies at the Woods Hole Oceanographic Institution have been concerned with subduction zones in the Caribbean Island arc, the Indonesian Island arc, Ryukyu Island arc, New Hebrides Island arc, Philippine Trench, and Chile Trench ; spreading centers in the North and South Atlantic Ocean, and in the western Philippine Basin ; transform faults in the Caribbean region ; the Ninety East and Walvis aseismic ridges ; and the continental margins of eastern North America and western Africa. 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". *

The Gravity Field around Iceland (5°)

U. FLEISCHER

Deutsches Hydrographisches Institut

"Gravity anomalies derived from narrow-spaced geophysical surveys are presented for a continuous zone to the north, northeast and southeast of Iceland, extending to 400 km off the shore. They are supplemented by other gravity data especially over Iceland and to the southwest.

Free-air anomalies higher than the mean value of + 40 mGal occur over nearly the whole area to the north and the main parts of the Iceland-Faeroe and the Reykjanes ridges. There are extreme anomalies of + 60 to + 80 mGal along the Mid-Atlantic Ridge axis and the margins of the Iceland and Faeroe shelves. These are due to incomplete local isostatic compensation of the ridge summit and the shelf-sea transitions, respectively.

Local negative free-air anomalies, i.e. those lower than + 40 mGal are dominant in the deeper areas beside the ridges and partly parallel to the Reykjanes Ridge crest. They appear also in a tongue crossing the Iceland-Faeroe Ridge and in a steep local minimum just west of the Faeroes being explained by a sediment-filled trough and a local, possible granitic basement anomaly, respectively.

Because of the dominance of linear magnetic anomalies there are minor relations to topography and gravity. However, a good correlation between small-scale gravity and magnetic anomalies on the Iceland-Faeroe Ridge indicates intrusions during successive volcanic cycles. Further features mirrored in the gravity field point to a variable mantle plume activity".

* See p.I-34, n°21.

The Gravity Field of Island Arc - Trench Systems :

Some new Results and their Implications

A.B. WATTS

Lamont-Doherty Geological Observatory

"Studies of free-air gravity anomaly profiles across Island Arc-Trench systems show an important belt of positive anomalies landward of Island Arcs and seaward of trenches. These belts of positive anomalies are called the Inner and Outer Gravity Highs respectively. The Inner Gravity High is well developed landward of the Izu-Bonin, Mariana, Tonga and Kermadec Arcs but poorly developed landward of the Aleutian Arc. The Inner Gravity High appears to be most closely associated with those regions in which geological and geophysical evidence indicates active crustal extension occurs in island arcs. The Inner Gravity High correlates closely with the Mariana Basin, Lau Basin and La Havre Trough and may be caused, at least partly, by relatively dense material underlying these regions. The Outer Gravity High is well developed seaward of the Aleutian, Kuril, Japan, northern Izu-Bonin, northern Chile and Philippine trenches where it correlates with a regional rise in topography of a few hundred meters. The Outer Gravity High can be most satisfactorily explained by a stress system associated with convergence of lithospheric plates at island arcs. The computed gravity effect of simple models of flexure of an oceanic plate approaching an island arc generally explains both the amplitude and wavelength of the Outer Gravity High. The Outer Gravity High seaward of the central Aleutian, Central Kuril, northern Japan, northern Chile and northern Izu-Bonin trenches can be explained by a horizontal compressive stress of the order of a few kilobars applied to the oceanic plate. The Outer Gravity High seaward of the Izu-Bonin and Mariana trenches can, however, be explained in the absence of horizontal compressive stresses. These results are generally consistent with differences in the stress field at island arcs as indicated by the distribution of large shallow earthquakes and regional tectonics at island arcs bordering the Pacific. The close correlation of the Inner Gravity High with regions of active crustal extension landward of island arcs and the Outer Gravity High with regional topography seaward of trenches suggest the total gravity effect of a dense downgoing slab beneath island arcs may be small and confined in lateral extent to the region of the island arc and trench. These conclusions place important constraints on the interpretation of the regional gravity field of islands arcs and trenches and the gravity field derived from observations of satellites.

A Resolution concerning the collection and the distribution of sea gravity data has been adopted (Resolution n° 5, p.I-27).

Multiparameter Surveys of Canada'sAtlantic Continental Margin

R.T. HAWORTH

Atlantic Geoscience Centre
Bedford Institute of Oceanography

The Canadian Hydrographic Service and the Atlantic Geoscience Centre have been cooperating in systematic geophysical surveys of the Atlantic Seaboard of Canada since 1964 (Figure 1). The extent of the logistical problems faced in mounting those surveys during the early years meant that we were lagging far behind in our responsibilities to release the data in a useful form and to carry out interpretation of that data. In fact at the time of the last meeting of the International Gravity Commission in 1970 we had surveyed an area of approximately 200,000 square kilometres, but had published maps covering less than 10% of that area. During the past four years I am pleased to report that we have made significant progress in developing channels for the compilation, processing, mapping and public release of that data, and it is this which I wish to bring to your attention.

The objective of our systematic geophysical mapping program is to provide sufficient coverage of the marine areas adjacent to Canada that the continental shelf area might be meaningfully mapped at a scale of 1:250,000 and that the oceanic areas might be mapped at a scale of 1:1000000. The parameters mapped in our original operations were bathymetry, gravity and magnetic field, (although subsequently seismic profiling has been added), and maps of each of those parameters were represented in the 1:250,000 Natural Resource Map series of the Canadian Hydrographic Service. Each map covers 1° of latitude by 2° of longitude (approximately 110 km by 150 km at latitude 47°) and to provide adequate mapping at this scale, survey lines were generally spaced at 5' of latitude (approx. 9 km) or less. The hydrographers use the bathymetry information to define hazards to navigation as well as to interpret the data in the form of a geomorphic surface. The safety-of-navigation requirement was the original "raison d'etre" of the surveys. For this reason, in shallow water areas, the line spacing may be as low as 1 km.

The survey lines are generally oriented east-west because of the Eotvos correction. We have found that we can better compensate for changes in ships speed, than for changes in ships course. When lines are run in a north-south direction, the Eotvos correction varies about zero as the ship yaws. Although we position the ship every ten minutes or less, the plotted track yields Eotvos corrections which do not adequately correct for the changes in Eotvos correction apparent on the gravity record. If the lines are run east-west, although the Eotvos correction has a large positive or negative value, the variation of that value due to changes in ships speed seem to be adequately compensated for by our computed Eotvos corrections. This logistic preference for an east-west orientation of lines is generally not to the detriment of the geophysical preference for profiles perpendicular to geological features. Check lines have to be run for the validation of all types of data, and these are generally positioned so that they will assist in the definition of geophysical anomalies. For instance, on Flemish Cap a series of lines were run radiating from the centre of the feature. In the survey of the Labrador Sea which is presently underway, the lines are being run in a northeasterly direction perpendicular to the Labrador coast.

As a result of such operations we now have excellent coverage of the eastern seaboard of Canada (Figure 2). New data are being collected at the rate of approximately 30,000 km per year, and the areas of operation are progressing into the frontier areas of offshore hydrocarbon exploration. Today, therefore, there is an even higher priority for releasing data as quickly as possible. In 1972 we

decided that following basic processing of the data, we would pass the data to a Canadian geophysical company for compilation and mapping. The first such contract, which included clearing up the backlog of data held by us, was won by Computer Data Processors of Calgary. In consultation with us regarding adaptation of their existing procedures, they prepared a suite of maps of free air gravity anomaly and magnetic total field covering 45 Natural Resource Map sheets, in five areas (Figure 3). Maps of Bouguer anomaly, free air anomaly, magnetic anomaly and magnetic total field at a scale of 1:1,000,000 were also produced for the five areas. Subsequent contracts, also won by CDP (now Digitech Ltd.), have included the compilation of data to north of 51° and in those last contracts, maps of Bouguer Anomaly and magnetic anomaly have also been produced at a scale of 1:250,000. Copies of maps of all areas up to and including the 1971 data (Figure 1) have now been printed. The published maps are distributed by:

Hydrographic Chart Distribution Office,
Dept. of the Environment,
Ottawa, Ontario
Canada K1A 0E6

Maps covering the 1972 survey are in press, and maps covering the 1973 survey have been completed by the contractor and forwarded to the Hydrographic Service for colour printing.

We have at long last made some in-roads into the interpretation of the data. After considerable interest in the Orpheus Anomaly during the early years of the surveys due to the possibility of oil or gas within the sediments creating it, little interpretation was carried out because of preoccupation with survey efficiency. Recently, Watts (Marine Science Paper 10) carried out an interpretation of the middle and upper Paleozoic sediments in the southern Gulf of St. Lawrence where they produce an extensive gravity low, the Magdalen Low. Associated with this regional low is a series of localized gravity lows which Watts interpreted as salt structures. The Orpheus Anomaly and the Magdalen Low are relatively large features which we knew to exist from our shipboard compilation. However, the inter-relationship of these and similar data blocks did not become apparent until we compiled all the data for the eastern Seaboard at a uniform scale.

The compilation of Bouguer anomaly and magnetic anomaly maps at a scale of 1:1,000,000 has now been completed for the area $41\frac{1}{2}^{\circ}\text{N}$ to $50\frac{1}{2}^{\circ}\text{N}$, 43°W to 68°W and will be published this fall with a text (Haworth and MacIntyre, Marine Science Paper 16) describing the regional structures that may be inferred from the potential field data. Perhaps the most interesting feature of the maps is the way in which the structures of the Grand Banks parallel those further inland. In the Gulf of St. Lawrence the Appalachian system is involved in a large flexure shown by the gravity high that marks the Appalachian Front. The major potential field feature of the entire mapped region is a band of positive gravity and magnetic anomalies which runs from the Tail of the Banks across the Scotian Shelf bisecting Nova Scotia and trending down the west coast of the Bay of Fundy. This is more prominent on the magnetic map. Wherever sampled on land or underwater this anomaly is caused by Precambrian volcanic or metasedimentary rocks. The entire feature seems to represent a major structural discontinuity and line of weakness. Offshoots of the main feature trend into Newfoundland where again they are correlated with Precambrian (Hedrynian) volcanics. There

seems little correlation between the trends of Nova Scotia and the Grand Banks and this seems to support the proposition by Schenk that Nova Scotia was a lower Paleozoic feature of the African crustal block which welded itself to the North American block during Paleozoic continental collision.

Obviously such speculation leads to the requirement for extensive modelling of the gravity and magnetic fields, and the need for easy access to the data by means of digital data files. Digital files corresponding to each 2° by 1° map sheet have been created by our contractor. The files contain 230,000 data records, each record including all the values of each parameter as observed at intervals of approximately 0.7 km along the ship's track. The data records include both the raw data and the final adjusted data as mapped. The data files are now available under Geological Survey of Canada Open File 183 (copy attached) from:

Computer Science Centre,
Dept. of Energy, Mines and Resources,
Ottawa, Ontario
Canada K1A 0E8

Because the density of data is so great, the complete data file is of most interest to exploration companies. However, in collaboration with the Earth Physics Branch, we are preparing a regional data file which will represent the gravity field as portrayed on the Gravity Map of Canada and be available for the use of research institutions at lower preproduction cost.

In order to utilize the data most effectively we are developing a series of programs for the extraction of representative profiles in any direction across any anomaly of interest. These profiles are then used in a series of modelling programs for interpretation of those anomalies. We operate one such program on-line using a PDP-11 with graphic display. With such tools we have begun the enormous task of examining local structures throughout our 500,000 square kilometre survey area. To the present time we have merely scratched the surface by examining the structures north of the Appalachian Front in the Gulf of St. Lawrence, and by trying to determine the structural patterns north-east of Newfoundland.

However we do not consider that this data should be carefully hoarded solely for our use. That is why it is on GSC Open File. We hope that data from the surveys described here will be used extensively by the international community, therefore justifying our faith in the systematic approach to surveying. We have viewed with sorrow the demise of the U.S. Project Seamap which provided similar systematic surveys in the Pacific for ten years. We are pleased that the Canadian government has supported our eastern Canadian surveys, has initiated similar surveys on the west coast of Canada and the Arctic and may soon introduce them in Hudson Bay. With similar effort on an international scale our world geophysical data base would be invaluable.

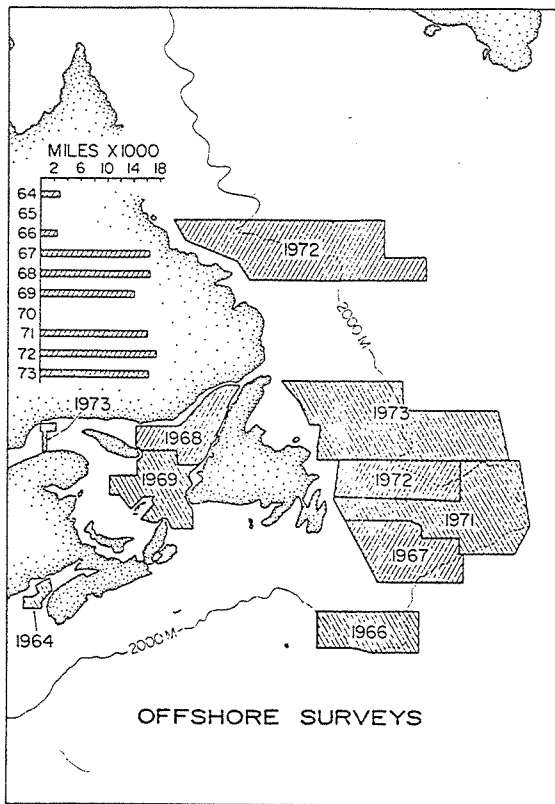


Figure 1

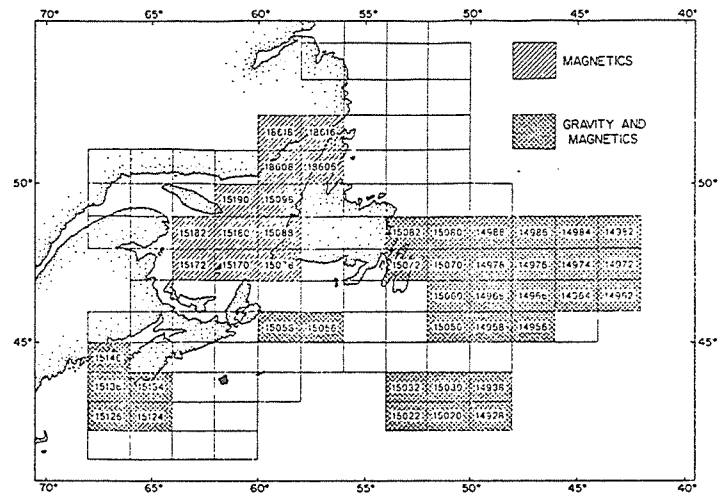


Figure 3

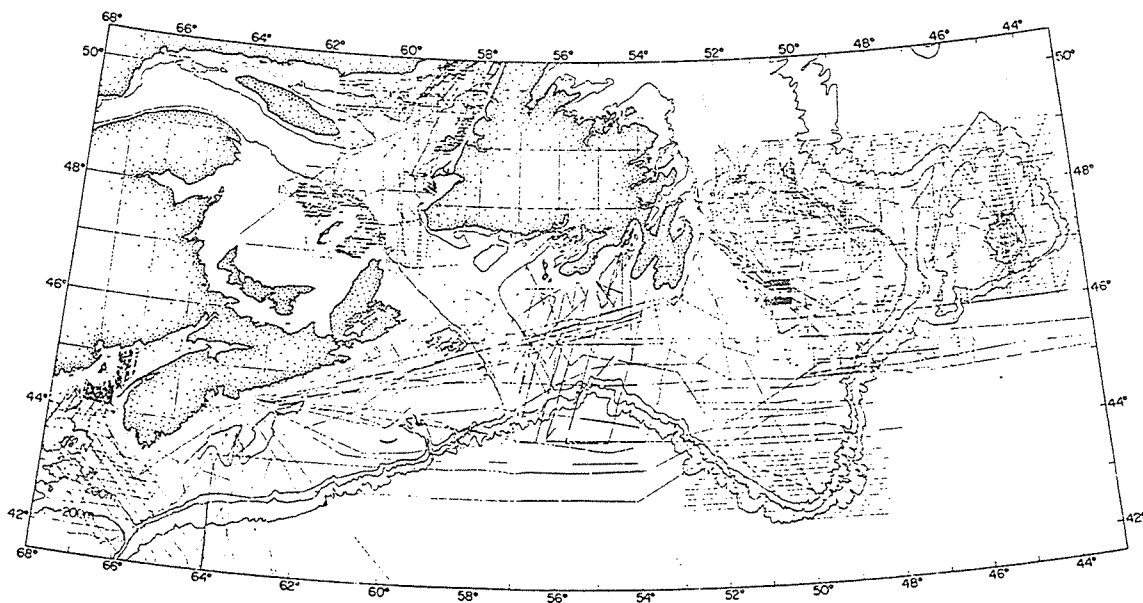


Figure 2

MARINE SCIENCE PAPER SERIES

1. King, L.H. Surficial geology of the Halifax-Sable Island map area.
1970
2. Drapeau, G. and King, L.H. Surficial geology of the Yarmouth-Browns Bank
1971 map-area.
3. MacLean, B., and King, L.H. Surficial geology of the Banquereau and Misaine
1971 Bank map-area.
4. Owens, E.H. A reconnaissance of the coastline of Chedabucto Bay, Nova Scotia.
1971.
5. Kranck, K. Surficial geology of Northumberland Strait.
1971
6. Grant, A.C. Physiography of the Labrador Shelf.
7. King, L.H., and MacLean, B. Geology of the Scotian Shelf.
1974
8. Monahan, D. Measurements of Canada's coastline.
9. Monahan, D. Three-dimensional representation of submarine relief: Continental
1971 margin of eastern North America.
10. Watts, A.B., and Haworth, R.T. Geological interpretation of gravity anomaly
1974 and magnetic anomaly maps east of the Magdalen Islands, southern Gulf
of St. Lawrence.
11. Bhattacharyya, P.J., and Ross, D.I. Mid-Atlantic Ridge near 45°N, computer
1972 interpolation and contouring of the bathymetry and magnetics.
12. Ross, D.I. Free air and simple Bouguer gravity maps of Baffin Bay and
1974 adjacent continental margins.
13. Haworth, R.T. Gravity and magnetic Natural Resource Maps (1972), offshore
1974 eastern Canada: Philosophy and technique in preparation by computer.
14. Monahan, D., and van der Linden, W.J.M., Morphology of Hamilton Bank, Labrador
Shelf.
15. Haworth, R.T., and MacIntyre, J.B. Gravity and magnetic fields of the Gulf
of St. Lawrence.
16. Haworth, R.T., and MacIntyre, J.B. Gravity and magnetic fields of Atlantic
offshore Canada.
17. Desplanque, C. Ranges and other characteristics of the tides along the
eastern Canada seaboard.
18. Monahan, D., and Tiffin, D.L. Physiography of the Pacific coast of Canada.

Available from: Hydrographic Chart Distribution Office,
Department of the Environment,
Ottawa, Ontario,
Canada K1A 0E6

Cost approximately \$3.00 each.

APPENDIX

OPEN FILE NO. 183 GRAVITY AND MAGNETIC DATA - ATLANTIC CONTINENTAL MARGIN

DIGITAL DATA FROM WHICH NATURAL RESOURCE CHARTS HAVE BEEN PREPARED

The gravity and magnetic data collected off the Atlantic coast of Canada by the Canadian Hydrographic Service and the Atlantic Geoscience Centre on all Bedford Institute of Oceanography cruises up to and including 1972 have been reduced, processed, plotted and contoured in the Natural Resource map series. The compilation work was carried out under a contract with Computer Data Processors of Calgary (now Digitech Systems Co. Ltd.) under the supervision of R.T. Haworth and R.F. Macnab of the Atlantic Geoscience Centre, Dartmouth, N.S. The maps, each covering a $2^{\circ} \times 1^{\circ}$ area, have only been created where the line density was adequate for the publication scale of 1:250,000. Maps of free air gravity anomaly and total magnetic field have been produced for all areas. Maps of Bouguer gravity anomaly and magnetic anomaly are available for eight of the areas. The maps except for those of the northern most Grand Banks will be available in 1974 from Hydrographic Chart Distribution Office, Marine Sciences Directorate, Dept. of the Environment, Ottawa, Canada K1A 0E6. Reference should be made to that office for further information regarding release dates. Maps have also been prepared at a scale of 1:1000000 depicting the Bouguer gravity anomaly and the magnetic anomaly and covering the area 42°N to 50.5°N , 43°W to 68°W . These are in production for release by the Marine Sciences Directorate and the Geological Survey in Fall 1974.

The digital data from which all maps were created will be made available at the users expense by the Computer Science Centre, Department of Energy, Mines and Resources, 588 Booth Street, Ottawa Canada K1A 0E4 on 31 January 1974. The data for each map area are stored in separate computer files con-

taining for each observation: cruise identification, day and time of observation, latitude, longitude, free air gravity anomaly, simple Bouguer gravity anomaly, total magnetic field, magnetic anomaly referred to IGRF and bathymetry. The data are available in a single file for each map area irrespective of which maps will be published for that area. All parameters are given in both their "raw" and "corrected" forms. Data files should be requested by the number of the corresponding Natural Resource map area (Fig.3). An additional "marginal file" is available for each of the five general areas of coverage. Those files contain data within approximately 20 miles of the edge of the map areas and were used to ensure the accuracy of contours to the map margins. The "marginal files" should be requested by the following numbers:

Gulf of Maine 101	Orpheus Anomaly 106
Tail of the Banks 108	Grand Banks 115 (2 files)
Gulf of St. Lawrence 131	

A total of 51 data files are therefore available. Data format information will be supplied with the completed order.

The schedule of charges by the Computer Science Centre is:

\$25.00 for each file required

plus \$50.00 basic handling charge on each complete order.

Copies of files will be supplied on new magnetic tapes (2400 ft. reels) which will be provided by Computer Science Centre.

Specify either 7 track 556 bpi
 7 track 800 bpi
 or 9 track 800 bpi

Charges include all magnetic tapes, mailing and handling. Cheques should be made payable to the Receiver General of Canada and mailed with the order to the Computer Science Centre.

1 - 5

Gravity Measurements at Sea

SPECIAL STUDY GROUP NO. 3.20

Members

Dr Yuri D. Boulanger
Bolshaya, Gruzinskaya 10
Moscow, U.S.S.R.

Dr B.J. Collette
Vening Meinesz Laboratorium voor Geofysica
en Geochemie der Rijksuniversiteit te Utrecht
Lucas Bolwerk 7
Utrecht, Netherlands

Dr Anton Graf
Liebigstrasse 4
Lochham bei München, Germany

Dr J.C. Harrison
Department of Geological Sciences
University of Colorado
Boulder, Colorado 80302

Professor Carlo Morelli, Director
Osservatorio Geofisico Sperimentale
Viale R. Gessi 4
Trieste, Italy

Dr Drummond H. Matthews
Department of Geodesy and Geophysics
Madingley Rise, Madingley Road
Cambridge, England

Mr H. Orlin
U.S. Coast and Geodetic Survey
Washington, D.C.

Dr S. Plaumann
Bundesanstalt für Bodenforschung
Alfred Bentz House: P.O. Box 54
3 Hannover-Buchholz, Germany

Professor Chuji Tsuboi
Geophysical Institute, Faculty of Science
Tokyo University, Japan

Dr J. Lamar Worzel
Lamont-Doherty Geological Observatory
Palisades, New York U.S.A. 10964

Appendix

The INTERNATIONAL GRAVITY BUREAU

(I.G.B.)

-:-:-:-:-

by

Dr Suzanne CORON

Acting Director

International Gravity Commission
Paris, 2 - 6 September 1974

TABLE

The INTERNATIONAL GRAVITY BUREAU (I.G.B.)
by Dr S.CORON, Acting Director.

I- GENERALITIES	p. 3
1) Past History	3
2) Provisional Statutes about the I.G.B.	4
3) Organization of the I.G.B.	5
a) Management	
b) Committee of Management	
c) Staff	
d) Finances	
II-ACTIVITY of the I.G.B.	7
1) International Cooperation	7
2) Collection of gravity Data	8
BOOK-LIBRARY	
MAP -LIBRARY	
SKETCH-LIBRARY	
PUNCH CARD (MAGNETIC TAPE)	
3) Publications and work of the I.G.B.	9
Bulletin d'Information	
General maps	
a) Bouguer anomaly maps I/I 000 000	
b) "Europe-Afrique", I/I0 000 000 ,Bouguer anomalies	
c) " " " " " " ,isostatic anomalies	
d) Sea gravity tracks	
e) Mean values of gravity and heights	
f) Undulations of the Geoid	
III-SCIENTIFIC BILAN of the I.G.B. since the last meeting (1970)...	I4
1) Supply of various documents and information	I4
2) Receipt of various documents and information	I5
3) Visits to the I.G.B.	I5
IV-REMARKS and SUGGESTIONS about the I.G.B. and I.G.C.	I6
1) Exchange of gravity data	
2) Computation of mean heights and mean anomalies	
3) Criticism and accuracy of sea gravity measurements	
4) World Gravity maps	
V-ANNEXES	I8
A) I-Main resolutions about the I.G.B.	I8
2-Resolutions about the mean elevations	22
B) List of "Bulletin d'Information" ,1960 - 1974	24
C) - Map of the Geoid	30
- Table :number of stations for 1°x1° square (Model)	31
- Summary Table for each degree square (Model):	
gravimetric and topographic information.	32

The INTERNATIONAL GRAVITY BUREAU (I.G.B.)

by

Dr Suzanne CORON
Acting Director

I - GENERALITIES

I) Past History

The International Gravity Bureau was created after a decision taken by the International Association of Geodesy during its General Assembly held in Brussels in 1951.

A Federation of Permanent Services of Astronomy, Geodesy, Geophysics and related sciences (F.A.G.S.) has been established within the framework of the International Council of Scientific Unions (I.C.S.U.) in 1956.

For the time being this Federation includes eleven Permanent Services ; the IGB being one of them. They are subsidized through FAGS by ICSU and UNESCO.

Consequently, the IGB activity has been directed according to the general scheme of the FAGS (which has been incorporated in the new statutes - Year Book of ICSU , 1972 , p.164) :

"For the purpose of the present Statutes, a Permanent Service shall be a scientific organization placed under the authority of one or several scientific members of ICSU and entrusted with the following tasks :

- to collect, as a continuous activity, observations, information and data relating to the sciences referred to in paragraph above;
- to analyse and synthesize them;
- to draw conclusions on request;
- to publish the results obtained.

Each Permanent Service shall be placed under the authority of a Board which shall include the Director of the Service ; the composition of each Board shall be decided by the interested Union or Unions, which shall also appoint the Director."

As far as the IGB is concerned, the IUGG is the only interested Union.

2) Provisional Statutes about the IGB

A definitive statute concerning the IGB has never been established. The following abstracts have been published in "Provisional decisions taken by the Bureau of the IAG concerning the organization of the Section IV, Gravimetry" (14-12 - 1959)

G. CASSINIS, Chairman of the IAG.
 P. TARDI, General Secretary of the IAG.
 B. C. BROWNE, Chairman of Section IV of the IAG.

As a result of the meeting in Paris of the International Gravimetric Commission (September 1959) and taking into account the resolutions adopted there, the Bureau of the International Association of Geodesy took the following decisions (in agreement with the Chairman and the Secretaries of Section IV) which will be submitted for the approval of the Executive Committee of the International Association of Geodesy at the General Assembly in Helsinki in July 1960.

A - General

Section IV (Gravimetry) has two permanent executive organizations :

- The International Gravimetric Commission ;
- The International Gravimetric Bureau.

B - The International Gravimetric Commission

The International Gravimetric Commission includes one member of each member nation. It is under the Chairmanship of the Chairman of Section IV. Its meetings take place every three years at the International Gravimetric Bureau, in principle, the year before a General Assembly of the Association. Its purpose is the achievement of a homogeneous gravimetric network covering the whole world. In particular, this involves the publication of gravity anomalies in a homogeneous form computed for various hypotheses, so as to facilitate calculations dealing with problems concerning the Shape of the Earth.

The International Gravimetric Commission appoints from among its members, a Committee of five persons (including the Chairman) as a Committee of Management of the International Gravimetric Bureau.

C- The International Gravimetric Bureau

The International Gravimetric Bureau is a Permanent Service in connexion with the Federation of Astronomical and Geophysical Permanent Services. On this account it receives from the International Council of Scientific Unions, an annual subvention in order to finance the projects it has to carry out. In principle its premises and the major part of the salaries of the staff are provided by the nation in whose country the Bureau is situated. The post of Director is honorary. The Director is elected by the General Assembly upon the proposal of the International Gravimetric Commission for two three year periods. He is eligible for re-election for successive three year periods.

The purpose of the International Gravimetric Bureau is the collection of all data concerning the homogeneous world gravity network and the compilation of cartographic documents dealing with this network. It may, in some cases, carry out reductions, computations or tabulations on behalf of any organisation of any nation. Such work, carried out in principle as supplementary work by the staff of the Bureau, may involve a special payment which will be shown in the accounts of the Bureau. In exceptional circumstances, the Bureau may take part (directly or indirectly) in making international gravity measurements.

The International Gravimetric Bureau is to publish a half-yearly, inexpensive Bulletin giving particulars of information recently received and to send it to all member nations. An important part of this Bulletin is bibliographical and is primarily concerned with experimental results (measurements and reductions) rather than with theoretical studies.

The International Gravimetric Bureau has compiled (in French and in English) a publication (x) giving the present state of the world gravity network as well as information concerning its organization, its work and its publications since it was established in 1951."

3) Organization of the IGB

a) Management

The Bureau was from the very first under the direction of Reverend Father LEJAY who had considerably contributed to its creation.

In 1958, after the death of Father LEJAY, the direction was assumed by Prof. P. TARDI, General Secretary of the IAG up to 1972.

From that time Dr. Suzanne CORON has been fulfilling this function and was appointed acting Director by the IAG Executive Committee until the next General Assembly of IUGG in August 1975.

b) Committee of Management

In 1960, it included the following members :

Prof. B.C. BROWNE	(U. K.)
Prof. G. CASSINIS	(Italy)
Prof. W. GROSSMANN	(Germany)
Prof. W. HEISKANEN	(Finland)
Dr. D. RICE	(U.S.A.)
Prof. P. TARDI	(France), Director of the Service.

(x) " Le Bureau Gravimétrique International " P.TARDI ,1960.

In September 1965, the composition of that Committee was modified as follows :

- + Prof. Y. BOULANGER (URSS)
- Prof. B. C. BROWNE (U.K.)
- Prof. W. HEISKANEN (Finland)
- + Prof. C. MORELLI (Italy)
- + Dr D. RICE (USA)
- Prof. P. TARDI (France) Director of the Service.

At the present time, there are only 3 members (+) remaining .

c) Staff

Besides the scientists working in collaboration with the IGB , four posts are especially attributed to the IGB and supported by the French Government (3 depending on the " Enseignement Supérieur " and 1 on the "Centre National de la Recherche Scientifique "). At present these posts are occupied as follows :

M H. BELZIC	:Collection of punch cards ; sketch-library ;
Melle J. BOUVET	:Map-library :gravity isanomal maps ;
Melle M.F. ESNOLT	:Computation and compilation of mean gravity anomalies;
Mme F. MAAMER	:Secretariat ;library.

d) Finances :

The funds allocated by the FAGS from UNESCO and ICSU were for the last years as follows :

I970	:	37 740 F	I973	:	I9 897,5 F
I97I	:	37 536 F	I974	:	9 6I4,5 F
I972	:	20 2I2 F			

The most important part of the expenses is taken in charge by the French Government : staff, working ...The Paris VI University has agreed to provide the IGB with rooms (2,place Jussieu ,Tour I4,first floor).

=====

II - ACTIVITY OF THE I.G.B.

1) International Cooperation

The IGB supplies the departments and individual researches with as much information as possible concerning the gravity field. Therefore it endeavours to develop its documentation as widely as possible.

- a) At present the IGB is working with 69 countries and correspondents :
 - either with National Services of Geodesy and Geophysics
 - Geophysical Institutes and Oceanographic Departments
 - Universities
 - or with prospecting Companies

The distribution of these correspondants is approximately :

- 105 geodesists
- 70 geophysicists
- 20 oceanographers
- 60 geologists.

b) The IGB is supplied with the following gravimetric data :

- list of discrete values (listing, microfilms, punched cards or magnetic tapes) ;
- gravity anomaly maps ;
- gravity profiles (and bathymetric ones) generally at sea.

In the last mentioned case, it is necessary to use a Pencil Follower (for instance D'Mac) to plot along the profiles. Computation programs permit to obtain the true gravity and bathymetric values, on punched cards.

c) The inquiries made to the IGB are particularly dealing with :

- the sites of gravity stations (IGSN 71 and other tie gravity stations ; mainly harbours, reference stations) ;
- gravity anomaly maps ;
- mean values of anomalies....

d) The work guidance of the IGB has been given :

- by the resolutions adopted at the International Gravity Commission meetings (see Annex A) :
 - . publication of a "Bulletin d'Information" ;
 - . storage of gravity values on punch cards ;
 - . publication of mean gravity anomalies ;
 - . information about sea gravity measurements.
- by the individual requests gathered on the same subject :
 - . isostatic corrections of the Mediterranean Sea areas
- by the answers to the circulars sent by the IGB :
 - . list of Bouguer anomaly maps .

2) Collection of Gravity Data

a) The BOOK-LIBRARY contains 4 500 articles dealing with Geodesy and Geophysics.

Papers are on file by author and subject under the classical card form.

It is still planned to record the papers on punched cards (or magnetic tapes) with key words.

The bibliographic references of the recent papers are generally published in the second part of each Bulletin d'Information with abstracts.

b) The MAP-LIBRARY includes : gravity maps of isanomals and maps of mean values which are filed according to the type of anomalies : free-air, Bouguer or isostatic.

About 1 500 maps are now indexed. The list of all Bouguer anomaly maps received by the IGB, was published in the Bull. Inf., n° 33, nov. 1973 (about 1000 maps).

c) The SKETCH-LIBRARY gathers sketches of gravity sites, extracted from publications or obtained directly from scientists themselves. Sketches are collected following to the IGB classification : by square of 10° x 10° and by degree of latitude and longitude. (See code p. 32 in Bull. Inf. n° 5).

The index of these sketches was published in the Bull. Inform. :
 n° 15, february 1967 n° 16, june 1967
 n° 23, june 1970

Since 1971, the IGB has a set of IGSN 71 stations (International Gravity Standard Net 1971) at the disposal of interested persons, in agreement with the Special Study Group n° 05 (C. MORELLI).

Now, we have about 8 500 sketches.

d) The PUNCH CARDS have been used to store the discrete gravity values according to the internationally adopted format (see Bul. Inf. n° 5, Dec. 1963 and n° 11, Nov. 1965).

Some amendments have been brought to the old format and a great number of gravity data have been recorded on MAGNETIC TAPES in order to facilitate the computations.

Gradually, the IGB files data for each 1 x 1° square and makes listings with tables (see annex C') which indicate the number of observations in each square degree.

The IGB plans to put all data on magnetic disks in order to facilitate the approach to recorded values, the corrections of values found to be inexact and the addition of new results.

In 1974, the distribution of punch cards (and magnetic tapes) is approximately as follows :

	<u>Index Card</u>	<u>Magnetic Tape</u>	<u>Complementary card</u>
Sea measurements	119 000	100 000	20 000
Continental measurements :			
Europe	84 000		64 000
Asia	9 000		8 000
Africa	67 000		26 000
America	21 000	10 000	20 000
Australasia	19 000		2 500
Antarctica	4 200	6 000	
	<hr/>	<hr/>	<hr/>
Total	323 200	116 000	140 000

These data cover 64 countries.

Remark : Analysis and criticism of data :

An analysis of the received data is done more or less accurately before their storage or their use for general maps and research works.

It is often necessary to ask for complementary information in order to allow for the best incorporation within the world homogeneous network (reference stations...)

As for the measurements at sea, the locations of the gravity points recorded with anomaly values, are graphically plotted with a Benson machine in order to check the position of the measurements and the agreement with those of previous cruises.

3) Publications and Work of the I.G.B.

A - Bulletin d'Information

a) In 1960 the IGB started the publication of a Bulletin d'Information according to n° 1 Resolution adopted by the Int. Grav. Com. (Paris, Sept. 1959) (see annex A).

This Bulletin of about 70 pages is published 2 or 3 times a year and is sent to the concerned Services of the IUGG.

Usually it contains 2 main parts :

The first part is devoted :

- to the most recent information on the achieved programs and the gravity projects specially at sea ;
- to reports of the gravity meetings ;

- to general views such as :
 - . maps of sea gravity tracks ;
 - . index of gravity stations (sketches IGB) ;
 - . lists of mean height maps and Bouguer anomaly maps.
- to the work of the IGB, for instance :
 - . mean free-air anomalies ;
 - . isostatic corrections of the Western Mediterranean sea ;
- to papers proposed by the authors or selected by the IGB, because of their interest or of the need for rapid circulation (sometimes after translation) ;

The second part is a Bibliography dealing with the documentation received by the IGB.

The bibliographic references are generally followed by a more or less lengthy analysis relative either to the abstract published by the author or to the results which seem to be at the time the most important to stimulate discussions or to allow quantitative comparisons.

Owing to the large number of people interested in gravity problems and of the receivers of the Bul. d'Inf., as it has been said above, the bibliographic list which formerly included only gravity papers, has been extended to some publications dealing with the Physics of the Interior of the Earth or with statistical problems connected with researches about the interpolation and extrapolation of gravity data.

b) These Bulletins are all printed by the IGB at about 280 copies with a Gestetner 466 duplicating machine. They are distributed, free of charge in exchange of publications, to about 260 persons and the additional printings are at the disposal of all those who request them. The full sending by the International Exchange Service is free; obviously this dispatch is longer than by usual mail ; the IGB apologizes for the delay to Services far from France.

Since 1960, 34 bulletins have been published (see list annex B) . Some slight amendments were made to the format in Nov. 1972 : ochre cover, size 21 x 29,7 cm.

c) Replies to the questionnaire (Feb. 1974) about the interest of this Bulletin, are as follows :

no interest : 2
interest : 63

The following items were formally asked for :

- most recent information
- mean values of anomalies (free-air, Bouguer and isostatic)
- " " " heights
- map of mean anomalies 5 x 5°
- plans for future gravity surveys particularly at sea to allow a larger coordination of efforts
- details of the sea works
- copies of Bouguer anomaly maps out of print

- reduction methods and interpretation
- results from experiments on the secular variation of g
- list of addresses of authors and Services publishing gravity maps.

B - General maps.

Owing to the amount and the diversity of the gravity networks, the IGB has begun the publication of general maps particularly for Europe :

- a) Collection of Bouguer anomaly maps at the 1/1 000 000 (Lambert conical projection secant by 36° and $52^\circ 48'$ of latitude N.)

The sheets :	Paris-Amsterdam	1959-60	are published
	Berlin-Vienna	1962-63 (Bul. Inf. n° 6)	
	Oslo-Budapest	1964-65 (Bul. Inf. n° 10)	
	Rabat-Laghout	1969-70	

Sofia	
Bordeaux-Bilbao	in preparation
Marseille	

- b) A General map of "Europe-Afrique" Bouguer anomalies at the scale of 1/10 000 000 at the equator (Mercator projection, scale 1/5 022 600 at the latitude 60° N.)

This map is covering the Western Europe, the North of Africa and the Eastern Atlantic Ocean. It is extending between the parallels 0° - 72° N and the meridians 30° W.G. - 40° E.G.

It is being continuously revised ; 3 editions have been printed (1964, 1970, 1971); the 4th edition will be available for the meeting of the IGC (Sept. 1974).

The Bouguer isanomalys were sketched for sea as well as for land. The same type of anomalies was selected for all areas without any differentiation. Actually that problem had been discussed at the IGC meeting (1965) and many delegates would have preferred distinct maps for each type of anomalies at sea as well as land (see Bul. Inf. n° 12 Feb. 1966, p. 12).

- c) General map of isostatic anomalies (Airy, 30 km) (same sheet as the Bouguer anomaly map, b).

It has been published twice (1959-1962) ; since this time it has been only partially completed.

- d) World map of sea gravity tracks :

In 1970, the IGB started the preparation of this map based on a map of the Lamont-Doherty geological Observatory as suggested by Dr. Talwani.

This world map includes 12 sheets on which are distinguished cruises of each country. Up to now, 6 sheets have been published in reduced scale :

n° 3, 4, 7	(Bul.Inf. n° 22, march 1970)
8, 11, 12	(Bul.Inf. n° 25, march 1971)

The other sheets have not been published yet.

e) Maps of mean values of gravity and heights :

- Method

- On land, one of the best method to obtain mean significant values of free-air anomalies, implies using the mean Bouguer anomalies which are continuous and correcting through the mean heights.

That is why the IGB started the computation for $1^\circ \times 1^\circ$ squares (and even $1/4 \times 1/4$ squares) of the following mean values :

{ Heights
Bouguer anomalies
Free-Air anomalies

- At sea, this method should be compared with other results because the evaluation of the mean depth may be very inaccurate. The IGB uses an empirical Code which takes into account :

- . the number of points, their distribution in the square,
- . the differences between the extreme depths of points and
- . the mean depth of the concerned square,
- . the correlation coefficient between depths and anomalies.

These various factors which are considered in the computation and the accuracy of the evaluation are indicated in the Summary Table for each degree square. An extract from the Bul. Inf. n° 31, march 1973 is given hereafter (Annex C, p.A-32).

- Published Maps

-World map of mean free-air anomalies ($5^\circ \times 5^\circ$)

old reference system	Bul.Inf., n° 29, July 1972
new reference system, new edition	July 1974

-Mean Free-Air anomaly map $1^\circ \times 1^\circ$ Bul.Inf., n° 31, march 1973

first sheet : 30° to 70° N. and -20° W.G. to 20° E.G.
old reference system

-2 maps of Antarctica (old reference system) Bul.Inf.n°34, Feb.1974

- . mean free air anomalies
- . mean Bouguer anomalies

The cutting out of integration zones has been made for each degree of latitude and for variable meridians ($\Delta\lambda = 2^\circ, 5^\circ, 10^\circ \dots$), according to the latitude.

- Maps in preparation ($1^\circ \times 1^\circ$)

- from 0 to 60° S. and -20° W.G. to 20° E.G.
- from 0 to 60° N. and -60° W.G. to -20° W.G.

f) Maps of the undulations of the Geoid

- map of the Geoid of Western Europe
(old system)

Bul.Inf. n° 19, Dec. 1968

The computation was made with mean anomalies ($1^\circ \times 1^\circ$) in the Western Europe area and with mean anomalies ($5^\circ \times 5^\circ$) in the external zone.

- World map of the Geoid obtained through the $5^\circ \times 5^\circ$ mean anomaly map (June 1974) that is to say by taking into account only the terrestrial gravity measurements. It will be presented to the meeting of the IGC and compared with map of the geoid computed only through satellite results. (see Annex C, p.A-30).

The up dating of the geoid and anomaly maps will illustrate the progress made by the addition of new gravimetric data.

III - SCIENTIFIC BILAN of the I.G.B.

since the last IGC meeting (1970)

<u>1a - Supply of various documents</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
<u>A) Regular publications</u>			
3 "Bulletins d'Information" issued each year	n°25	28	31
(see detailed list, Annex B)	n°26	29	32
	n°27	30	33
regularly distributed	600	600	630
sent on particular requests.....	30	50	60
<u>B) Various publications, reprints, communications</u>			
forwarded or given directly.....	45	50	60
<u>C) Requests for sketches of reference stations10</u>		17	19
Supply of sketches (IGSN 71 & others).....110		1980	380
lists of corresponding "g" values IGSN 71...		85	80
<u>D) General anomaly maps</u>			
a - Bouguer Europe-Africa, 3rd edition scale 1/10 000 000°			
. regularly distributed.....		180	
. sent on particular requests....		80	55
b - Other Bouguer maps, 1/1 000 000°.....	15	20	10
c - Isostatic map, 1/10 000 000°.....	3	10	4
d - Mean Free-Air anomaly maps			
1° x 1°		2	225
5° x 5°		215	5
<u>1b - Supply of scientific information</u>			
<u>A) Request of gravity data</u>	15	20	15
supply of punch cards, listings or magnetic tapes.....	25 000	40 000	30 000
<u>B) Direct requests of scientific information</u>			
(telephone, visits)	18	20	15

	1971	1972	1973
C) <u>Letters regarding scientific subjects</u>	127	150	268
- gravity anomalies and mean heights ...	30	35	45
- IGSN 71 (general information)	5	21	30
- Reference stations	25	19	20
- Various matters	15	18	68
- Requests and supplies of data	12	9	15
- Anomaly maps (comments, explanations) ..	18	24	40
- Scientific papers	22	24	50
2) <u>Receipt of scientific information and various documents</u>			
A) <u>Number of gravity data</u> (not included published data)			
on listings	15 000	10 000	13 000
on punch cards	7 000	3 000	12 000
on magnetic tapes		10 000	6 000
B) <u>Number of publications filed in library</u>	450	500	510
C) <u>Number of anomaly maps</u>	70	170	175
3) <u>Visits to the IGB</u>			
A. R. E.			1
Belgium	1		
Bulgaria	1		
Canada		1	
Finland		1	2
F. R. G.	2	2	1
Hungary			1
Israel	1		
Italy		2	1
Poland		1	
Portugal			1
Sweden		1	
U.K.		2	
URSS	1	1	4
USA	2	4	1

We thank very much all the Countries, National Services and Prospecting Companies that kindly sent gravity data to the IGB.

We hope that the countries which do not contribute to this exchange of gravity information and have not yet replied to the requests of the IGB will try to do their best to open a profitable collaboration, so that the IGB could supply the Geodesists and Geophysicists with extended and more accurate data for the progress of the worldwide studies.

IV - REMARKS AND SUGGESTIONS ABOUT THE I.G.B. AND I.G.C.

1) Exchange of gravity data

The IGB wishes to thank all departments and scientists which send spontaneously their gravity results as well as those which reply to the inquiries.

Unfortunately, the IGB meets sometimes difficulties because of military or national secret with Geographic Institutes and economical interests with prospecting departments.

As it has been said above, the copies of gravity data are sent to all those who ask for them, however the data which are still unpublished, are not supplied without the agreement of the concerned department. It should be highly profitable that those who send data should mention whether the IGB may integrally divulgate the precise results or only mean values computed through these results.

2) Computation of mean heights and mean anomalies

As it has been said above, the mean free air anomalies may be indirectly computed through the mean Bouguer anomalies and the mean heights for the same integration surface.

Several times resolutions have been adopted in order that National Departments should compute themselves the mean altitudes of their country and that the Hydrographic Departments should supply mean depths maps.

(see annex A) IGC, 1953, resolution n° XII
 IAG, 1963, resolution n° 31
 IAG, 1967, resolution n° 28

It seems necessary to adopt an effective resolution so that the Geographical, Hydrographical and Oceanographical Departments should be supported to achieve such a task. For instance the "International Hydrographic Bureau" could be appointed as the coordinator office for mean depths at sea areas.

3) Criticism and Accuracy of Sea Gravity Measurements

a) In order to improve the agreement between the gravity results at sea and the accuracy of mean values, it should be recommended :

- . either that the observers should compare themselves, their new results with those previously obtained ;
- . or that they should amend their data after the study of their rough results made by the IGB.

Whatever the adopted procedure, it is necessary that the detailed information about the cruises (such as harbour, reference station...) should be supplied as quickly as possible either by the observers themselves in a short paper or indirectly by the IGB through the "Bulletin d'Information".

b) On the other hand, it should be highly profitable that a "Panel of Experts" should meet during the present IGC session to study the best method of reduction of sea measurements and an homogeneous form for the sea results.

4) World Gravity Maps

During the session of the IGC, a "Panel of Experts" could be appointed in order to study the following items :

- usefulness and aims of the general gravity maps ;
- choice of the scale and geographic grounds (in collaboration with the "Commission for the Geological Map of the World", and eventually with some Geographical Services) ;
- data to be published (reference system, isanomals, position of gravity points) ;
- form of the maps ;
- preparation of such maps : for instance, under the IGB direction and in collaboration with National and Oceanographic Departments ;
- publishing, eventually with the UNESCO support.

ANNEX A

I) Main Resolutions about the I.G.B.

a) CREATION of an INTERNATIONAL GRAVITY COMMISSION
(Res.n°I4,IUGG,Bru ssels, 1951)

The IUGG considering

- 1)The rapid expansion of gravity measurements in many parts of the world,
- 2)The uncertainty which exists in the values of gravity on which these measurements are based,
- 3)The necessity of assuring the homogeneity of all gravity data used for geodetic purposes,
- 4)The necessity for international collaboration to ensure such homogeneity,
- 5)The advantage which would result from a central organisation,

records with satisfaction the results which have already been obtained in answer to the resolution passed at the VIIIth General Assembly at Oslo,

desires, particularly on account of the project for the calculation of the shape of the geoid a rapid development of this work of coordination,

resolves,therefore,to create an International Gravity Commission componed of one member from each country.This Commission will be in charge of the centralization of all gravity data useful for geodetic purposes, of the critical examination of this data and of making recommandations for new interconnections and surveys,

requests the Secretary General of the Association to place at the disposal of the Bureau of this Commission the necessary funds and to assist in the collection and distribution of the results assembled by each country and to try to call a meeting of the Commission between the IXth and Xth General Assemblies.

b) ESTABLISHMENT of a WORLD GRAVIMETRIC NETWORK
(Res.n°IX,IGC,Paris,1953)

The IGC considering

That the transactions of the Commission have ended in the formation of the principle governing the constitution of a World Gravimetric Network (fundamental bases, first order network, second order network) and the necessity of defining the practical method for such a network;

recommends:

- 1) that the International Gravimetric Bureau be considered as the coordinating organisation for the national works bearing on the formation of the world network;
- 2) that the different national gravimetric services should communicate to the Int.Grav.Bureau their plans for realising the requested connections for the world network,and that in due course so that the Int.Grav.Bureau well informed will be able to propose late modifications;
- 3) that the President of the International Gravimetric Commission be assisted in that task by a small body and a Vice-President.

c) INFORMATION to be furnished to the INTERNATIONAL GRAV. BUREAU
(Res.n°XIII, IGC, Paris, 1953)

The IGC recommends:

- That each country continues the use of its own system of compiling gravity data. These data should contain all information to provide the detail given on the form used by the Int. Grav. Bureau.
- That, according to the decisions at Oslo and Brussels, it should be furnished, for each 100 km² at least, data concerning one station if available, or as many stations which, according to the opinion of the reporting country, are necessary for as complete as possible a description of the gravity field. It is recommended that a report should be made as soon as the gravity value of a station appears certain to within 1 milligal.
- That observers should transmit to the Int. Grav. Bureau, details of the elements which determine the international fundamental stations, i.e. the elements for discussing the connections between the fundamental stations of first order, second order (national and other important base stations), third order (secondary base stations), furthermore the elements for discussing the calibration used (which are generally compiled but not published)..
- That the elements, which are usually duplicated by the National Institutes in limited number, intended primarily for the user of their own countries (e.g. list of the chief stations, maps of anomalies, maps of mean elevation, etc...) should be transmitted to the same Bureau.
- That the Int. Grav. Bureau should publish, at regular intervals, for instance, in the "Bulletin Géodésique" a list of the documents which it has received.
- That the Int. Assoc. of Geodesy should be requested to provide at the demand of the author and the Int. Grav. Bureau, all assistance for the reproduction and distribution of provisional documents, or for the insertion, in the "Bulletin Géodésique", of final results, concerning the works of international interest envisaged during the course of this reunion, such as international calibration bases and the primary world gravity network.

d) PUBLICATION of a PERIODICAL INFORMATION BULLETIN by the I.G.B.
(Res.n°I, IGC, Paris, 1959)

The IGC requests the I.G.B. to consider the publication of a half yearly, inexpensive "Bulletin" or "Chronicle", giving particulars of information received, with a brief analysis of these various works and with precise bibliographical references.

This information should include publications, projects completed or planned, and decisions and resolutions adopted by national or international organisations.

As the success of such a publication will depend to a great extent on information received, all organisations concerned with gravimetric work are requested to assist by co-operating closely with the I.G.B.

e) CARTOGRAPHIC MODEL on a WORLD SCALE of GRAVITY ANOMALIES
(Res.n°2, IGC, Paris, 1959)

The IGC requests the International Gravimetric Bureau to preface a detailed Report concerning:

- the various possible ways of making anomaly maps on a large scale (1/1.000.000) which could be extended to cover the whole world. Particular attention should be paid to the systems of projection and to the cartographic model to be adopted;
- the making of mean-height maps, bearing in mind the methods used for the determination of these mean heights.

This Report should be forwarded to all those concerned with gravity measurements a few months before the Helsinki Assembly so that decisions could be taken there.

f) PUNCH CARDS for COMPILING GRAVITY DATA
(Res.n°26, IUGG, Berkeley, 1963)

The IAG having considered the international format proposed by the I.G.B. for the compilation of gravity data in accordance with Resolution n°14 of the IGC at Paris in september 1962,

approves the two models proposed (index card and complementary card) with the understanding that some details of the complementary card will be decided upon later.

The IAG furthermore strongly urges the use of this format by the various gravity organizations.

g) SUPPORT for the INTERNATIONAL GRAVITY BUREAU
(Res.n°1, IGC, Paris, 1965)

The IGC recording its great appreciation of past and present activities of the "Bureau Gravimétrique International" in collecting gravity data on an international basis,

expresses the hope that the Bureau may be given support to extend these activities in the light of the great expansion in gravity information likely to result from recent advances in instruments and measuring techniques.

h) SURFACE SHIP GRAVITY MEASUREMENTS
(Res.n°8, IGC, Paris, 1965)

The IGC considering that the extension of sea gravity measurements on all the Oceans is a great necessity,

urges that all the qualified organisations continue their efforts in that field,

and recommends that all details about the gravity cruises, the areas which have been covered, the reference harbour stations etc., should be sent to the I.G.B. as soon as possible; these details would be published in the "Bulletin d'Information".

i) "BULLETIN d'INFORMATION" of the I.G.B.
(Res.n°4, IGC, Paris, 1970)

The IGC approving the important role of the I.G.B. with regard to the collecting, the analysis and the distribution of gravity data for all contributors benefit and particularly to the clarifying and maintaining of all details of F.O.W.G.N.

Wishes that the I.G.B. should actively maintain its information role by means of the Bulletins d'Information and more especially by keeping up to date the track maps of gravity measurements at sea and the state of the various maps of mean gravity anomalies.

j) INTERNATIONAL GRAVITY DEPARTMENTS
(Res.n°12, IUGG, Moscow, 1971)

The IAG recommends that a Permanent International Gravity Service, coordinated with the International Gravimetric Commission (IGC) and the International Gravimetric Bureau (IGB), be formed with the following functions;

- 1) to provide for expansion of the IGSN 71 to include areas where no stations now exist or values are not available,
- 2) the maintenance and re-observation of stations, and the replacement of any which may be destroyed,
- 3) to maintain the files in a computer-processable format and to incorporate new measurements into the existing files (one complete set of the values and descriptions to be deposited at the IGB),
- 4) to promote improvements in instrumentation, including the development of transportable absolute gravity meters, and their applicability to the standardization problem,
- 5) to establish in cooperation with the appropriate scientific institutions a net of permanent stations at which the absolute measurements of gravity, periodically repeated with an accuracy of the order of a few microgals, could be used as a geodetic reference and, in conjunction with other advanced geodetic methods, to monitor slowly varying parameters of the Earth,
- 6) to carry out computations necessary for incorporating new stations into the system,
- 7) to maintain contact with agencies active in the field of gravity measurements or using gravity data, to ensure that the IGSN 71 satisfies current needs,
- 8) to provide advice, when requested, to agencies using the IGSN 71 in local standardization problems.

The Resolutions dealing with the gravity information to be forwarded to the I.G.B. are only mentioned below:

Res.n° X , IGC , Paris ,I953
 Res.n°XI , IGC , Paris ,I953
 Res.n°20 ,IUGG , Rome ,I954
 Res.n° 5 , IGC , Paris ,I956
 Res.n° 8 , IGC , Paris ,I956
 Res.n°2I ,IUGG , Helsinki,I960
 Res.n°27 ,IUGG , Berkeley,I963

II) Resolutions about the mean elevations

a) Res.n°XII,IGC,Paris ,I953 :

The IGC recommends:

- I) That the production of charts or tables showing average elevation of "squares" of latitude and longitude be carried out.
- II) That each nation should produce such charts for their own regions.
- III) a) That the size of square should be chosen in relation to local conditions of topography and available data;
 b) That it is desirable for continuity that subdivisions of sexagesimal degrees be used;
 c) That accuracy of height should be ten meters if the topographical data allows;
- IV) That,in view of the supreme importance of bathymetric data,all nations with hydrographic departments should be strongly urged to extend bathymetric data and to produce average height charts wherever practicable;
 That the IUGG should request to ask the International Hydrographic Bureau to take necessary steps to increase the number of soundings specially in these parts of the oceans which have not been surveyed and to accelerate publication of charts.
- V) That consideration be given to the following points,prior to the Rome Assembly I954 :
 - a) What special treatment may be necessary for regions where maps are based on centesimal degrees ?
 - b) Whether all ocean depths should be multiplied by factor 0,6I5 to take account of deficiency of density, inland lakes should be considered separately ?

b) Res.n°31,IUGG,Berkeley , 1963 :

The IAG recognizing the basic significance of the mean elevations of the suitable size squares to the computation of correlation between the elevation and different reductions of the gravity anomalies in high speed computers and to these reductions ,

recommends that the member countries of IAG should estimate the mean elevations and depths of the 5' x 5' squares to the highest practicable accuracy and appreciates the activity of the countries which have done large parts of this estimation .

c) Res.n°28,IUGG,Luzern ,1967 :

The IAG noting that the need for establishing a world cover of 5' x 5' mean heights and depths, which need is reflected in the Berkeley resolution n°31, is still far from being met with,

recommends that intensified work for this purpose be done by all countries and by institutes carrying on work in open ocean areas .

ANNEX B

LISTE des BULLETINS d'INFORMATIONN° 1, Mai 1960 - 57p.

- Observations récentes et projets concernant :
 - . les mesures absolues de g, les mesures en mer,
 - . le réseau international de 1er ordre.
- Liste bibliographique classée par rubrique

N° 2, Mars 1961 - 70p.

- Voeux adoptés par l'A.I.G. à l'Assemblée d'Helsinki (1960) et informations récentes sur les principales questions relatives à la gravimétrie.
- Liste des cartes des anomalies de la pesanteur en Europe,
 - . anomalies à l'air libre, anomalies de Bouguer,
 - . anomalies de la pesanteur en mer.

N° 3, Avril 1962 - 84p.

- Informations récentes.
- Liste bibliographique classée par rubrique.

N° 4, Janvier 1963 - 135p.

- Compte-Rendu de la Commission Gravimétrique Internationale, Paris, Septembre 1962 :
 - . Compte-rendu général,
 - . Diverses annexes :
 - I) Mesures absolues (A.H. Cock, J.C. Rose)
 - II) Réseau International de 1er Ordre (C. Morelli)
 - III) Chaines d'Etalonnages Officielles (M. Kneissl et K. Marzhan, L. Solaini et G. Inghilleri, D. Rice T. Okuda).
 - IV) Mesures de pesanteur en mer (J.L. Worzel, L.B. Stichter H. Karnick).
 - V) Mesures de pesanteur en avion (L.G.D. Thompson)
 - VI) Emploi des anomalies de pesanteur en Géodésie (E. Tengstrom, W.A. Heiskanen, K. Arnold, K. Ramsayer)
 - VII) Gradient vertical de la pesanteur (H. Bodemuller)
 - VIII) Variation séculaire de la pesanteur (G. Barta)

N° 5, Décembre 1963 - 56p.

- Compte-rendu de la XIIIe Assemblée Générale de l'U.G.G.I., Berkeley 1963.
- Texte définitif relatif à l'archivage des données gravimétriques.
- Liste des Cartes d'altitudes moyennes d'Europe et d'Afrique.

N° 6, Cartes mondiales des Anomalies de Bouguer ; échelle 1/1 000 000
feuilles Berlin et Vienne - 1962-1963.N° 7, Carte des Anomalies de Bouguer "Europe-Afrique" - 1964 (1e édition)

N° 8, Février 1965 - 59p.

- Préparation de la Commission Gravimétrique, Paris, 1965.
- Bibliographie : Mesures en mer.

N° 9, Juillet 1965 - 67p.

- Informations récentes
- Translittération (ISO) des caractères cyrilliques.
- Bibliographie : Mesures absolues de la pesanteur,
 - : Problèmes d'étalonnage des gravimètres,
 - : Réseau International de Premier Ordre,
 - : Variation séculaire de la pesanteur,
 - : Mesures du gradient vertical de la pesanteur.
- Traduction d'un article russe "Etalonnage des gravimètres à quartz", première partie.

N° 10, Cartes mondiales des Anomalies de Bouguer

- Feuilles Budapest et Oslo - 1964-1965

N° 11, Novembre 1965 - 76p.

- Compte-rendu général de la Commission Gravimétrique Internationale, Paris, 13-18 Septembre 1965.
 - . B.G.I.
 - . Liste des rapports nationaux
 - . Mesure absolue de la pesanteur
 - . Lignes d'étalonnage pour gravimètres
 - . Réseau International de premier ordre
 - . Réseau européen de premier ordre.

N° 12, Février 1966 - 72p.

- Compte-rendu général de la Commission Gravimétrique Internationale (suite) :
 - . Mesures de pesanteur en mer
 - . Mesures de pesanteur en avion
 - . Variation séculaire de la pesanteur
 - . Question instrumentale
 - . Anomalies de pesanteur - isostasie.
- Traduction d'un article russe "Etalonnage des gravimètres à quartz", deuxième partie.

N° 13, Juin 1966 - 80p.

- Compte-rendu général de la Commission Gravimétrique Internationale (fin) :
 - . Emploi des anomalies de pesanteur en Géodésie
 - . Gradient vertical de pesanteur
- Liste bibliographique classée par rubrique.
 - . Détermination de la Figure de la Terre
 - . Déviation de la verticale
 - . Ellipsoïde de référence, valeurs normales de g.

N° 14 Novembre 1966 - 69p.

- Mesures absolues de g
- Mesures en Mer
 - . tableau et carte récapitulative (h.t.)
 - . Mesures (1963-1966)
 - . bibliographie
- Liste bibliographique : 20p.

N° 15, Février 1967 - 103p.

- Répertoire des stations gravimétriques
(schémathèque du B.G.I.)

N° 16, Juin 1967 - 71p.

- Informations diverses concernant l'Assemblée Générale de l'U.G.G.I., Lucerne, Septembre 1967 (section IV de l'A.I.G.)
- Gravity Measurements at sea
Additional Information to Bul. Inf. n° 14 (cruises and bibliography)
- Gravimetric terrain connections bibliography
- Premier additif au Bul. Inf. n° 15

N° 17, Décembre 1967 - 63p.

- Compte-rendu of the Section IV (Gravimetry) of I.A.G., Luzern
Sept. 25- Oct. 7, 1967.
 - . Absolute gravity measurements
 - . First Order World gravity Net, Standardization problem
 - . Gravity measurements at sea
 - . Airborne gravity measurements
 - . Resolutions.

N° 18, Mars 1968 - 61p.

- Gravity measurements at sea.
- Gravimetrical test-work.
- Liste bibliographique : 32p.

N° 19, Décembre 1968 - 76p.

- Gravity measurements at sea.
- Détails sur le géoïde (Europe Occidentale).
 - . Carte du globe
- Liste bibliographique : 43p.

N° 20, Mars 1969 - 56p.

- Recherches gravimétriques et magnétiques de la structure des Océans : A.G. GAINANOV.
- Mesures de pesanteur en mer : Etats-Unis, France, Japon.

- Travaux en Argentine.
- A superconducting gravimeter : W.A. PROTHERO, Jr & J.M. GOODKIND.
- Liste bibliographique : 32p.

N° 21, Novembre 1969 - 79p.

- Estimation des anomalies inconnues à l'aide d'un modèle stochastique : M. ALBUISSON.
- Quelques fonctions aléatoires utilisées en gravimétrie et leurs propriétés : J.M. MONGET.
- Liste bibliographique : 34p.

N° 22, Mars 1970 - 74p.

- Mesures absolues de la pesanteur.
- Mesures en Mer
 - . Carte récapitulative des trajets
 - . Cartes détaillées n° 3, 4 et 7 (Atlantique)
 - . Informations récentes - bibliographie
- Liste bibliographique : 31p.

N° 23, Juin 1970 - 123p.

- International Gravity Commission, 7 - 12 Sept., Paris.
- Stations gravimétriques :
 - . Nouvelle station gravimétrique (Rome).
 - . Répertoire des stations gravimétriques (Schémathèque B.G.I.)
 - . Stations de référence et de contrôle utilisées par chaque pays pour ses campagnes et codifiées au B.G.I.

N° 24, Novembre 1970 - 81p.

- 6e Réunion de la Commission Gravimétrique Internationale Paris, 7 - 11 Septembre 1970.
 - . Resolutions
- Absolute gravity measurements, Sp.St.Gr.n°4-18.
- Special techniques of gravity measurements, Sp.St.Gr.n°4-21.
- Vertical gravity gradient
- Liste bibliographique : 18p.

N° 25, Mars 1971 - 72p.

- Compte-rendu de la Commission Gravimétrique Internationale (suite)
- Mesures en mer - Cartes trajets n° 8, 11 et 12
- Liste bibliographique : 22p.

N° 26, Juin 1971 - 70p.

- Travaux gravimétriques effectués en U.R.S.S. en 1965-1969, C.G.I., Sept. 1970, Paris (texte français)
- Equal-area blocks, by J. LAGRULA
- Gravity base values in Tahiti, by R.T. HAWORTH
- Cartes d'altitudes moyennes (liste).
- Liste bibliographique : 36p.

N° 27, Novembre 1971 - 93 p

- XVth General Assembly of the IUGG, Moscow, 28 July - 14 August 1971
 - . New Organization of the I.A.G.
 - . Decisions concerning the section III "Gravimetry"
 - . Resolutions and recommendations
 - . Proceedings of the Meetings of Section IV of the IAG
 - . List of papers distributed at the General Assembly
 - The International Gravity Standardization Net 1971 (IGSN 71)
 - Une tendance de la variation de la pesanteur observée au B.I.P.M. à Sèvres, France.
 - Rep. of the Sp.St.Gr. n° 4.21 on Special Techniques of Gravity Measurements by T. HONKASALO.
- Tables for condensation reduction by J.C. BHATTACHARJI (54 p).

N° 28, Mars 1972 - 72 p

- Various information :
 - Int. Grav. Standard Net 1971
 - Pendulum observations : Tokyo-Christchurch
 - Gravity survey in Norway
 - Measurements at sea
 - New gravity point at Schipol-Amsterdam
- Interpretation of the Geoid Shape by G. BARTA
- On the dependency of a sharp gravimeter scale factor on the altitude of observation points by Y.D. BOULANGER and others.
- The three categories of Bouguer or isostatic anomalies by J. LAGRULA.
- Liste bibliographique : 47 p.

N° 29, Juillet 1973 - 70 p

- Meeting on the IGSN 71 and the secular variation of g.
- On the further development of the IGSN 71 and the secular variation of gravity by Y.D. BOULANGER and T. HONKASALO.
- Various information.
- Carte d'anomalies moyennes à l'air libre par 5° x 5°, B.G.I. by S. CORON.
- Equal area Blocks : a practical solution for the sphere and the ellipsoid, by J. LAGRULA and J.M. LUBART.
- Mose au point concernant les méthodes d'extrapolation statistiques des données gravimétriques, by J. LEBART.
- Liste bibliographique : 38 p.

Nouveau format du Bulletin : 21 x 29,7 et couverture ocre

N° 30, Novembre 1972 - 63 p.

- Notice nécrologique sur M.P. TARDI, directeur du B.G.I.
- Information sur IGSN 71 (station Hanover) by W. TORCE
- Traduction de 2 articles extraits de publications russes :
 - . Calcul des déviations gravimétriques ... pour la région des Alpes Occidentales par O.I. OSTACH et L.P. PELLINEN
 - . Un procédé d'interpolation des anomalies et des calculs des déviations gravimétriques de la verticale dans la région des Alpes Occidentales, par V.I. ARONOV et V.M. GORDIN.
- Liste bibliographique : 32 p.

N° 31, mars 1973 - 76 p

- Some texts concerning the organization of the I.C.B. and the I.G.C
- Scientific Bilan of the I.G.B. (1972)
- Various information on IGSN 71
 - . New Gravity Stations at the Rhein-Main-Airport, Frankfurt/Main by C. GERSTENCKER
- Sur les anomalies moyennes de la pesanteur, tests et résultats - anom. à l'air libre par 1° x 1° par S. CORON,
 - . Anomalies moyennes s'étendant de 30° à 70° N. et de 20° W.G. à 20° E.G.
 - . carte et tableaux.
- Liste bibliographique : 22 p.

N° 32, juin 1973 - 39 p

- Corrections isostatiques Airy, 20 et 30 km, pour la région de la Méditerranée Occidentale à l'Ouest du méridien de 11° E.G. Tableaux et cartes donnant les corrections pour des points à intervalles réguliers de 15 minutes sexagésimales.
- Liste bibliographique : 23 p.

N° 33, novembre 1973 - 128 p

Liste des cartes d'anomalies de Bouguer (cartothèque BGI) établie par J. BOUVET :

cartes mondiales, cartes par continents et cartes marines y compris les îles.

N° 34, février 1974 - 120 p

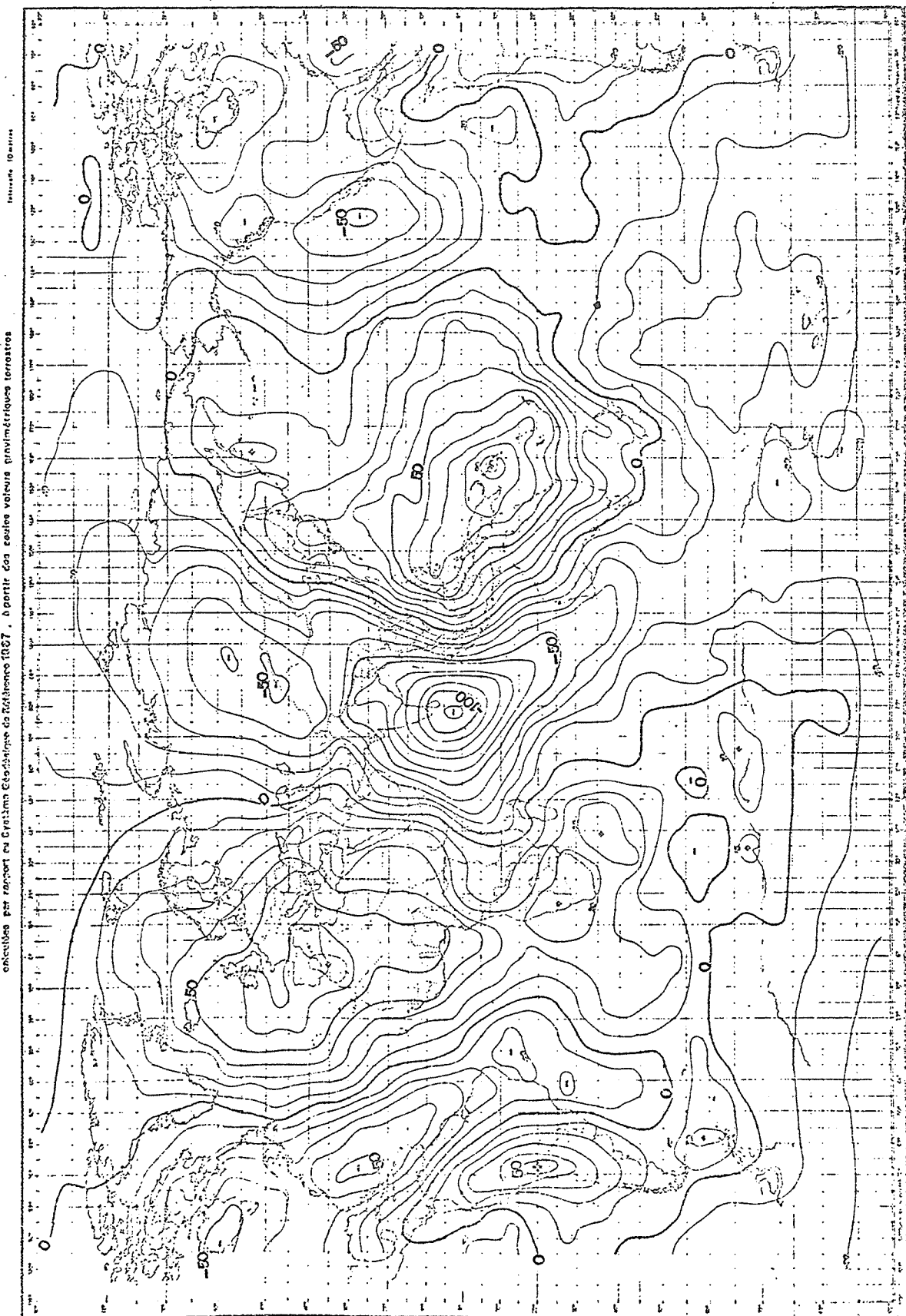
- International Gravity Commission
- IGSN 71
- List of Bouguer Anomalies maps (Complements and errata to the list published in n° 33)
- Projects of gravity Surveys at sea
- Determination of Gravitational acceleration...
 - . at Moscow, Murmansk, Odessa and Nakhodka,
 - . at Cairo
 - . at Potsdam and Tokyo
 - by Y.D. BOULANGER and others.
- Antarctique - Anomalies moyennes de la pesanteur par S.CORON et al. Tableaux et cartes.
- Liste bibliographique : 18 p.

ANNEX C

WORLD MAP of the UNDULATIONS of the GEOID

ONDULATIONS du GEOÏDE

calculées par rapport au Cylindre Ellipsoïdal de Référence 1957, à partir des seules valeurs gravimétriques terrestres



Bureau Gravimétrique International, Paris - mai 1974

à l'échelle 1:100 000 000

	-75°	-74	-73	-72	-71	-70	-69	-68	-67	-66	-65	-64	-63	-62	-61															
30°	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1															
29	1	53	1	119	1	93	1	23	1	9	1	0	1	25	1	4	1	0	1	0	1	38	1	0	1	46	1	3	1	0
28	1	143	1	101	1	54	1	42	1	13	1	8	1	24	1	50	1	0	1	0	1	3	1	27	1	15	1	35	1	0
27	1	97	1	64	1	16	1	24	1	0	1	60	1	90	1	81	1	31	1	0	1	0	1	0	1	20	1	141	1	40
26	1	33	1	49	1	9	1	25	1	13	1	90	1	74	1	76	1	20	1	0	1	0	1	0	1	0	1	102	1	105
25	1	115	1	115	1	210	1	51	1	23	1	12	1	33	1	49	1	15	1	0	1	0	1	0	1	0	1	5	1	45
24	1	171	1	476	1	121	1	49	1	7	1	18	1	39	1	44	1	10	1	0	1	0	1	0	1	0	1	54	1	14
23	1	22	1	54	1	58	1	55	1	31	1	44	1	56	1	40	1	2	1	0	1	0	1	0	1	30	1	40	1	0
22	1	33	1	12	1	118	1	84	1	7	1	0	1	17	1	76	1	0	1	0	1	0	1	23	1	26	1	38	1	0
21	1	29	1	33	1	13	1	2	1	7	1	35	1	50	1	209	1	55	1	16	1	0	1	5	1	50	1	21	1	0
20	1	19	1	113	1	74	1	83	1	61	1	12	1	2	1	65	1	24	1	170	1	0	1	40	1	44	1	35	1	0
19	1	95	1	84	1	0	1	0	1	0	1	17	1	23	1	131	1	137	1	152	1	66	1	49	1	96	1	1	1	23
18	1	56	1	27	1	0	1	0	1	0	1	0	1	34	1	58	1	162	1	217	1	130	1	18	1	65	1	27	1	50
17	1	47	1	55	1	39	1	27	1	30	1	0	1	54	1	15	1	12	1	201	1	112	1	34	1	37	1	76	1	107
16	1	56	1	51	1	56	1	35	1	20	1	0	1	37	1	0	1	29	1	145	1	65	1	81	1	69	1	85	1	136
15	1	67	1	66	1	104	1	133	1	56	1	73	1	73	1	33	1	58	1	87	1	36	1	35	1	34	1	50	1	4
	1	85	1	44	1	20	1	223	1	235	1	8	1	26	1	44	1	23	1	49	1	49	1	57	1	49	1	28	1	36

- Number of gravimetric results for 1° x 1° square -

LATITUDE 62° DEGRE										Arom. moyenne AIR. LIERE					
LONG	C	NA	NB	R	P.OBS	DP.OBS	P.BAT	DIF.P	BOUGUER	A.MOY	A.INT	AIR.B	A*X	B	BS
-14	0.93	9	9	1	-1585.	260	-1700.	-115.	132.	23.	15.	15.	0.660E-01	127.	130
-13	-0.02	18	18	4	-1108.	525	-1160.	-52.	107.	31.	31.	27.	-0.688E-03	30.	110
-12	0.03	29	29	3	-979.	267	-861.	118.	103.	36.	36.	44.	0.373E-02	39.	90
-11	0.83	134	134	4	-850.	772	-787.	63.	96.	37.	35.	42.	0.304E-01	59.	95
-10	0.58	155	155	4	-723.	562	-669.	54.	89.	40.	38.	43.	0.182E-01	50.	90
-9	0.14	236	236	4	-555.	449	-523.	32.	77.	39.	37.	41.	0.111E-01	42.	75
-8	0.26	353	353	4	-360.	484	-386.	-26.	76.	52.	42.	50.	0.251E-01	52.	78
-7	-0.26	229	229	4	-269.	751	-226.	43.	56.	37.	44.	40.	-0.350E-01	36.	55
-6	0.73	93	93	4	-510.	1322	-180.	330.	90.	55.	66.	78.	0.443E-01	74.	60
-5	0.95	18	18	3	-316.	1809	-436.	-120.	67.	45.	41.	37.	0.275E-01	53.	70

* Carreau mixte océanique et continentale (Ile Faeroes). Les calculs se rapportent seulement à la partie océanique.

Tableau 8 - RECAPITULATION PAR DEGRE CARRE DES INFORMATIONS GRAVIMETRIQUES ET TOPOGRAPHIQUES

R = nombre de 1/4 du degré carré dans lesquels sont réparties les observations S.

DP.OBS = écart entre les valeurs extrêmes des profondeurs sous les points d'observations S, en mètres.

P.OBS = moyenne des profondeurs correspondant à chaque point S.

P.BAT = profondeur moyenne relevée sur une carte bathymétrique.

International Association of Geodesy
I N T E R N A T I O N A L G R A V I T Y C O M M I S S I O N

PROPOSAL FOR THE
RE - ORGANIZATION OF THE INTERNATIONAL GRAVITY COMMUNITY

Report submitted to the I.G.C.
at its 7th Meeting (Paris, 2 - 6 Sept. 1974)

1. Forward.

The minutes of the last I.A.G.'s Executive Committee Meeting (Paris, 25 - 27 February 1974) report :

" After prof. Tardi's death, the I.G.B. has not a Director. The French Nat. Comm. has proposed to help strongly the I.G.B. but at the condition that a new Director be rapidly appointed and give more dynamism at the Bureau's activities. This proposition has not received the approval by the Members of the Executive Council, who prefer to wait for a decision from the I.G.C. I.G.C., at the Sept. 1974 meeting, will have to prepare the guideline to I.G.B.; to propose the structure and the Director. These propositions will be submitted to the ratification of I.A.G's General Assembly in Grenoble, August 1975.

With the purpose to invite the scientists interested to the I.G.B. activity to think on these problems and to propose some solutions, prof. Morelli has prepared a Questionnaire to be sent to the Nat. Committees, to the great Gravimetric Services and to the gravimetrists.

The Executive Council gives his agreement on this Questionnaire and on the procedure to be followed till to the Grenoble Assembly: sending of the Questionnaire, opening of the replies, discussions and proposals at I.G.C. 7th Meeting, and final decisions at the I.A.G. General Assembly, where the Director will be named by the Executive Committee. In the meantime, the functions of Dr. S. Coron, acting director, are prolonged till 1975. "

2. The Questionnaire.

Accordingly to the above mentioned decision, the "Questionnaire" some was sent out with a letter dated March 12, 1974, and distributed with the I.G.B. "Bull. d'Information n. 33".

Due to difficulties in the postal services, someone received the Questionnaire only in July, so that the date of July 1, 1974 for the reply could not be respected.

Up to Aug. 26, 1974, 37 replies were received, mostly in name of the National Committees or corresponding Institutions, by following scientists, whose contributions are highly appreciated:

Australia : Mather
 Belgium : Jones
 Canada : Tanner
 Finland : Honkasalo, (Kukkamäki)
 Germany : Fleischer, Grafarend, Groten, Seeger, Torge
 Germany DDR: Peschel
 Great Britain : Argent, Bullerwell, Cook, Matthews
 Hongrie : Barta, Tarczy - Hornoch
 Japan : Kumagai
 Iran : Afshar
 Italy: Cunietti, Gantar
 Netherland : Collette, van Hees
 Nigeria : Ajakaiye
 Norway : Bakkeliid ° Poland: Odlanicki-Poczobutt, Pawlowski
 Spain : Alonso, Garcia de Arangoa
 Sweden: Petterson
 USA : Daugherty, Hauer, Kaula, Powell °, Rapp, Uotila, (Williams), Woollard.

Some of the replies (indicated by °) were widening the spectrum and the essence of the "Questionnaire"; one of these is reproduced in Annex I.

Although the number of 35 could be considered statistically not very high, the quality and international distribution of the replies give them the confidence to be sufficiently representative ones.

The results are :

QUESTION

REPLIES

1. What are main tasks of the International gravity Organizations and particularly I.G.B. ?

Yes No Nothing

(a) Assistance in the form of advice to countries in the development of their national gravity programs.

26 1 10

Comments. Desirability of following the channels of IGC or IAG is indicated.

(b) Collection and distribution of gravity data (specify the form : point values, average, etc.)

34 1 1

Comments. This is considered almost unanimously the main task of IGB. The distribution is suggested mainly by point values: possibly by average values provided the have been properly computed; maybe by computer plotted anomaly maps provided that they have been properly prepared.

In any case, it is suggested that the maps should be small scale ones, possibly on a global program and coverage.

(c) Maintenance of international gravity standards (IGSN-71) : if so, specify nature of activities.

27 4 6

Comments. Involving this field observations, data processing, net adjustments and publication and distribution of the results, it is indicated the necessity of acting through special Working Group(s) of IGC, and through organisations who are equipped to do it.

(d) Scientific studies : if so, specify nature of these studies.

7 17 13

Comments...The scientific studies indicated are only related to IGB's necessities, particularly in connection with :

- a) quality evaluation;
- b) new methods of processing;
- c) satellite gravity data;
- d) global investigations (geoid);
- e) secular variations;
- f) new methods of measurement, new instruments.

	Yes	No	Nothing
(a) Maintenance of international index of gravity measurements.	<u>26</u>	1	10

(E) Other (please specify).

Comments. Between the suggestions :

- a) extension of the absolute measurements with a μ -Gal accuracy;
- b) a new volume on the actual "Modern Developments in Gravimetry" to substitute R.P. Lejay's one;
- c) suggest new topics and projects;
- d) expand the publications.

2. Being data collection and distribution one of the tasks, what form should its service to contributing countries take ?

(a) Prevision of data on punched cards magnetic tape, etc.	<u>30</u>	1	6
--	-----------	---	---

Comments. The magnetic tape is considered preferable since punched cards have a relatively short life. The format should be known to all possible users.

(b) Preparation of special maps to user specifications.	20	4	13
---	----	---	----

Comments. Only in very special cases. Indeed, this could be quite time consuming and expensive. It is proposed that it would be far better if IGB were to publish a standard gravity map series for the world at a scale that would be most useful for those engaged in regional studies. Normally, large scale, detailed gravity maps require so much data that special surveys are required. In cases such as these, IGB could best serve by furnishing available data which could be then supplemented as necessary by field surveys.

(c) Provision of all services under a system of cost recovery (if so, please specify).	19	-	18
--	----	---	----

Comments. The problem of the cost recovery must be handled carefully. It is recognized the necessity, but after a study by the Director and Directing Board.

It could be handled in part as an exchange of data by contributing members and partially by a charge for service. It is believed a charge for data services is necessary to keep certain individuals from asking for the world just because it is free.

(d) Other (please specify). Yes No Nothing

Comments. Up-dating is considered essential.
The "Information Bulletin" of IGB a valid way for reaching
all the gravimetrists in the world.

3. What should be the organization of
the IGB ?

(a) Director and staff, with director reporting to IGC every four years to seek advice and guidance on policy.	11	2	24
--	----	---	----

Comments. Also for those who replied "yes" to this question.
the 4 - years period seems too long.

(b) Director with advisory board appointed by IGC meeting at regular intervals to assist director in establishing policy.	26	3	8
---	----	---	---

Comments. The great majority is in favor of this solution
(also as combination of a and b is suggested).
Only 5 persons are proposed, selected accordingly to their
personal capacity and experience (see Annexe III) and/or
geographical distribution.

(c) Other (please specify).

Comments. The effectiveness of IGB (and IGC) will be increased if all the nations will effectively and freely participate.

4. What should be the financial structural of the IGB ?

(a) Supported partially by contributions from FAGS and partially by host country (present situation).	19	2	14
(b) Supported by FAGS and through contributions from member countries.	13	4	18

Comments. No reply to a means positive reply to b, and viceversa.

(c) Other (please specify).

5. Any other suggestion.

Preparation of a program on the tasks and future developments of IGB, also in view of the requested financial support.

3. Conclusions and proposals.

The discussions on I.G.B. have given the opportunity for a widening on many open problems in international gravimetry. Efficiency in the international co-operation must be increased, and this can be reached only through clarification and re-organization.

Following proposals are submitted to the I.G.C. 7th Meeting :

3.1. I.G.C.

To I.G.C. it is requested :

- to be more representative (all nations).;
- to be more efficient.

The By - laws of I.A.G. say :

"The structure of each Commission may be organized according to its own requirements".

It is therefore proposed :

- a) To prepare and submit to the approval of I.G.C. 7th Meeting the Statutes and by -laws for the same I.G.C.
- b) To consider in the Statutes an Executive Board (3 or 4 years between the Meeting are too long).
- c) To clarify into details the roles and tasks of I.G.C., I.G.B. and the Permanent Service whose adoption was approved by the Moscow General Assembly.

3.2. I.G.B.

It is proposed to prepare and submit to the approval of I.G.C. 7th Meeting :

- a) The Terms of Reference for the I.G.B. (draft proposal in Annexe II);
- b) The Organization of the I.G.B. (draft proposal in Annexe III).

As far as the financial structure of I.G.B. is concerned, the main change proposed in the present financial structure of the IGB relates to the implementation of a cost recovery system for data distribution. The IGB could plan to recover a nominal proportion (say 10%) of its total operating cost. The real benefit of the cost recovery system lies in the assumption that a customer-client relationship between the Bureau and its users would place a responsibility on both parties to ensure on one hand that demands for service were carefully considered and on the other that service would be provided as quickly and as flexibly as possible.

The key to the successful operation of the Bureau seems to lie in the provision of adequate financial support by the host country. The present level of service supplied by the Bureau seems to be inadequate to meet demands largely due to the size of the IGB staff. Should the present host country seem unwilling to increase the present level of financial support, it is suggested that formal approaches by the IAG to the governments of other countries be made in order to determine the potential for relocation of the IGB. Should no other country be willing to provide a greater level of support that is available from the present host country then it is proposed that the possibility of direct support by FAGS and member nations should be explored.

As far as the Director is concerned, it is suggested that should be a person who rightly accepts not only the general opinions but also even a seemingly isolated opinion of a single member, and further should be a person who himself is highly academic for the progress of the gravimetric geodesy and the geodesy in general too.

3.3. Ad - hoc Working Group.

It is proposed to give to an ad - hoc Working Group the task to prepare the above mentioned proposals during the present Meeting and to submit them to the approval of the same Meeting.

Suggested names :

Morelli, Honkasalo,, Tanner
(rapporteur).

Carl Honkasalo



NORGES GEOGRAFISKE OPPMÅLING

Sivert Bakkelid
Senior geodesist

Professor Carlo Morelli
Laboratorio Geofisico Sperimentale
I-20133 - TRIESTE
ITALY

DEKRET REF.

VÅR REF. (BES OPPGITT VED SVAR)

DATE

XI/SB/SL

9.7.1974

Dear Sir,

I and my colleagues here at the Geographical Survey of Norway (NGO) have discussed the questions in your letter of March 12 and the questionnaire has been returned to you with our replies. We appreciate the opportunity given us to voice our opinions on the objects and implementation of international gravity cooperation and especially the tasks of IGB.

The users of gravity data are mainly geologists and geodesists. The requirements of the geologists are to a local (national) distribution of gravity data, but the geodesists require both a local and a global distribution of data.

Gravity surveys are expensive so the survey of an area should at once preferably satisfy the needs of all users making it unnecessary to return to the same area for supplementary work. This ought to be fully understood and considered when planning and carrying through national gravity programs.

In Norway we have just finished a complete gravity resurvey with 10 km spacing of the regional points. We were able to draw on the experience of Defence Mapping Agency which gave us their opinions, suggestions and advice how to go about with the project.

When planning a survey at least the following questions should be answered:

- a. What should be the spacing of the points, 5 km, 10 km or what.
- b. Should the spacing be dependent on the roughness of the topography.

- c. How strictly should a grid lay-out be adhered to.
- d. What other consideration should be given to the selection of the site of a gravity point.
- e. What should be the accuracy of a point value and how achieve it.

and further:

- f. How to file the data.
- g. What data should be prepared and how should they be made available for the users.
- h. If presented as anomaly contour maps. What should be the scale and the contour intervals.

But above all:

- i. What are the arguments that will justify the expences.
- j. What is the best compromise between cost and gain.

We believe it would be a great benefit for the national gravity programs if digested experience in this field could be obtained from a central source and there would be a great international gain accruing from a standardisation of the local surveys and the national gravity files.

The users of gravity data would certainly prefer to be able to obtain the data required for a particular investigation from a single source. If this opportunity did not exist they would next look for an index which could tell them what data that are available and from where to collect them. So if it is not feasible to collect all data in a data bank there should be an international index accesible to all users with pertinent information about available data.

We believe it should be a responsibility for IGB to render such services. In order to be able to do that we believe it is necessary that IGB at intervals collect basic up to date information from users of gravity data about present and future requirements for data. The questionnaire should have such question as:

- a. Projects and investigations to be undertaken locally and globally for which gravity data is an integral requirement.
- b. How can gravity information be utilized for the different projects.
- c. What kind of gravity data are most useful for the particular purpose (point values, averages etc.)

- d. In what form should the data preferably be available (contour maps, punched cards, magnetic tape etc.)
- e. Requirements to accuracy.
- f. Areas with inadequate coverage and/or inadequate accuracy.

Further should the members of the International Gravity Commission be asked to submit status reports on the national gravity work covering the items:

- a. Coverage of land and sea areas.
- b. Point (station) density and lay out.
- c. Instrument used and accuracy obtained.
- d. Available data.
- e. Filing agency (institution, data bank).
- f. Filing medium (lists, magnetic tape etc.)
- g. Special conditions or restrictions for ordering and dispatch of data.
- h. Available EDB-programmes - Language.
- i. Other pertinent questions.

Having digested these information the policymakers of IGB (director, board or IGC) can decide or work out proposals as to:

- a. The details of the index of gravity data and EDB-programmes to maintain.
- b. What data to collect and keep available for distribution at IGB.
- c. What compilation of data to be performed at IGB.
- d. What additional theoretical and practical work to be done to make the gravity data and the collection and distribution of these data satisfactory for present and future requirements.

Please understand that I have not tried here to make a complete list of the tasks of IGB.

Sincerely yours


S. Bakkelid

Proposed Terms of Reference for the IGB

1. To keep in contact with all scientists dealing with gravity data
 - a) to collect and compile principal data : base ties, base stations, and point values of other stations;
 - b) to provide these data on request.
2. To maintain an index of world-wide gravity data. This would include, in addition to the data in the IGB file, the location of all significant files of gravity data which are available from other data banks throughout the world. In some instances release restrictions might be imposed by the proprietary agency but in any case users would negotiate directly with the file owner.
3. To provide an advisory service for any agency wishing to undertake systematic collection of gravity data. Through this service the IGB would provide information on gravity standards, establishment of reference networks, data collection specifications and data reduction procedures.
4. To distribute gravity values and station descriptions for the IGSN71 and to co-operate with the IGSN71 working group by collecting new observations suitable for incorporation in future revisions of the IGSN71.
5. To come up with standard procedures for the performance and recording of gravity measurements, which could be accepted everywhere.
6. To plan new projects in order to improve efficiently the present world coverage.
7. To produce international gravity maps.
8. To maintain an index of publications relating to all aspects of the measurement and use of gravity data.
9. To provide an administrative service for the IGC and its working groups.

Other activities

Apart from the activities outlined in the Terms of Reference above, the IAG should consider the formation of Working Groups to carry out specific projects with the co-operation and in consultation with the IGB. This approach could help alleviate the financial problem as members of the study group could use their own resources to achieve their ends. As a start it is suggested to form Working Groups to study:

- a) International Gravity Standards (Maintenance and expansion of the IGSN71).
- b) Gravity Information System (Specifications for operating an International gravity library).
- c) International Gravity Maps (Specifications and priorities for compilation and publication of global and/or large area charts of gravity and related information).

Proposed Organization of the IGB

Policies and operational guidelines for the IGB should be determined by a 5 member Directing Board made up of experts chosen from the International community who are actively involved in problems of data collection and dissemination and who have practical, managerial and scientific experience in this field. This Board would be appointed by the IGC and would operate in consultation with the Director of the IGB to determine the overall policy for the operation of the Bureau, recommend programs and ensure that adequate financial support is obtained for these programs.

The Director of the Bureau would be responsible for the execution of the Bureau's policies and programs and would be required to develop standards and procedures for :

- (a) world-wide gravity data collection, storage, retrieval and distribution;
- (b) production of international gravity maps ; and
- (c) development in consultation with the Directing Board of an effective cost recovery program to help establish the bureau on a sound financial footing. In addition he would solely be responsible for the staffing and organization of the Bureau within the budget established by the Directing Board.

At the end of each year the Director would be required to submit to the Executive of the IGC a brief report of the Bureau's activities including comments of the effectiveness of any new policies implemented. At four year intervals a more comprehensive report containing a full evaluation of the Bureau's programs, a valuation on current policy and proposals on changes should be submitted by the Director (Board) at the plenary session of the IGC meeting.

The appointment of the Directing Board would be the responsibility of the IGC. Terms could be as long as eight years with provision made for staggering appointments at four year intervals to ensure continuity.

The appointment of the Director of the IGB should be the responsibility of the host country but would be subject to ratification by the IGC Executive.

LISTE des PUBLICATIONS
reçues au
BUREAU GRAVIMETRIQUE INTERNATIONAL
(Octobre à Décembre 1973)

CONCERNANT LES QUESTIONS DE PESANTEUR

LISTE des PUBLICATIONS

196 - Bolletino di Geofisica teorica ed applicata, v.XIV, n°55, 1972.
Osser. Geof. Sper., Trieste.

- a) DEMNATI A. - "Krustenstrukture im Rif-Bereich von Nord-Marokko aus gravimetrischen und aeromagnetischen Regionalmessungen".
p.203-236.

An aeromagnetic and gravimetric survey of northern Morocco-Rif area will be presented and discussed.

A correlation between geological provinces and the gravity field was achieved by introducing quotients of mean terrain altitude to mean Bouguer values in a grid of $\Delta \varphi \times \Delta \lambda = 4' \times 5'$. The results obtained were compared with existing geological maps and proved to be satisfying.

The tectonic interpretation of the magnetic anomalies have located the NE striking Nekor Fault at its full extent which was only partly known from geological evidence, and a second one, striking EW for more than 200 km, the "Sud-Rharb" or "Kénitra" fault.

Registrations of the time variations of the magnetic field at both ends of this fault indicate the existence of conductivity anomalies caused in the upper part of the crust.

At the eastern part of the area several magnetic anomalies can be correlated with magmatic intrusions.

A strong negative gravity anomaly (~ 150 mGal) characterizes the flat western part of the area. Three crustal models crossing this anomaly show Moho depths of about 30 km and a thinning of the crust towards the Alboran Sea to about 24 km. The Peridotit massive of Beni Bouchera lies between the two structures and shows a Bouguer anomaly of $+ 70$ mGal which can be explained by upper mantle intrusions to the surface. A similar interpretation is obtained from the aeromagnetic data.

The Beni Bouchera intrusion might have resulted as a consequence of the Atlantic Ocean formation and the Nekor and Kénitra faults indicate large scale lateral movements.

- b) RECQ M. - "La structure profonde de la croûte terrestre sous le massif de l'Esterel".
p.253-268.

The results obtained from seismology in the Esterel and the surrounding areas (nuclear blast from Nevada, earthquake from Kermadec and refraction profiles) suggest the existence of a basaltic intrusion beneath the Esterel massif. This basaltic intrusion is less defined under the western part of the Maures.

The deep structure of Esterel shows a very different aspect than that we deduce for the adjoining areas.

≡ Les numéros font suite à ceux indiqués dans le Bull. Inf. n°34, Février 1974.

- 198 - FINETTI I. & C. MORELLI - "Wide scale digital seismic exploration of the Mediterranean Sea".
Osser. Geof. Sper., Boll. Geof. teor. & appl., v.XIV, n°56,
p.291-342, Trieste, 1972.

In 1969-72 the O.G.S. of Trieste conducted extensive oceanographic seismic reflection explorations in the Mediterranean employing the most advanced digital techniques.

Many of the obtained results can be considered as new, and allow a first regional delineation of the main seismic and geological characteristics of the most part of the Mediterranean except for the eastern area, which is not yet investigated.

...

- 199 - ACADEMIE des SCIENCES de l'U.R.S.S. - "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.

Liste de 6747 points avec coordonnées géographiques, profondeurs, valeurs de g observées et anomalies à l'air libre.

La croisière a été effectuée approximativement entre Gibraltar, les Canaries, Dakar, jusqu'aux Antilles.

- 200 - FINETTI I. & C. MORELLI - "Regional reflection seismic exploration of the Strait of Sicily".
Osser. Geof. Sper., Contr. n°212bis, Trieste.
Oceanography of the Strait of Sicily, Saclantcen Conf. Proc. n°7,
p.208-223, 1972.

A regional seismic reflection survey was performed by OGS in 1970 on the Sicily Channel, using multichannel digital techniques and flexotir source. Reflections up to about 5 s (two-way time) have been obtained.

The analysis of the velocity functions and the correlations with the available geological data allowed to indicate the geological attribution of the most continuous and characteristic reflectors from Miocene to Trias, and to recognize a thick sedimentary platform sequence which dominates all the Strait without solution of continuity from Northern Africa to Southern Sicily...

...

- 201 - APELL B. - "Separation between regional and local gravity anomalies by two-dimensional linear filters".
Delft Progress Rep., Ser. A/F, v.1, n°0, p.22-23, 1973.

The separation of regional from local gravity anomalies by means of application of two-dimensional linear filters is analyzed. It is found that optimization of the filter in the least square sense leads to filters that produce strong localized concentrations of the error, which may wrongly be interpreted as anomalies. For this reason the maximum value of the error is a more important criterion for the quality of the filter than the root mean square error. A relation between this maximum error and the values of the filter coefficients is established.

- 202 - GRAFAREND E. - "Three-dimensional geodesy and gravity gradients.
AFCRL-TR-73-0091, Rep. n°174, Sci. Rep. n°6, 81 p, 1972.

The report is a foundation of three-dimensional geodesy by means of Nonriemannian differential geometry. Based on the Frobenius integration theorem nonuniqueness, anholonomy of nonintegrability of geodetic measurements in their natural or astronomic reference system are proved. The characteristic Cartan object of anholonomy depends on either the gradients of the geogravity or the gradients of the standard gravity, the vertical deflections and their gradients. The necessary transition from the nonunique system to a unique, holonomic, integrable one can be performed if integrating factors exist and can be determined. It is proved that either six integrating factors in the astronomic reference system or nine integrating factors in the geodetic reference system exist. They depend on either the gradients of the geogravity and the Euclidean norm of the geogravity vector or the gradients of the standard gravity, its Euclidean vector norm and the vertical deflections, the gradients of the disturbing potential. The results show the close connection between three-dimensional geodesy and gravity gradients. With available gravity gradient data there will be a new epoch of geodesy, a revival of the original concept of three-dimensional geodesy of Antonio MARUSSI.

- 203 - MORITZ H. - "Advanced least-squares methods".
AFCRL-72-0363, Rep. n°175, Sci. Rep. n°1, 129 p, 1972.

A general least-squares method (collocation) which encompasses, as special cases, least-squares adjustment and least-squares prediction, is presented in detail and applied to various problems occurring in geodesy and photogrammetry, such as interpolation and coordinate transformation.

In particular, this method permits an optimal simultaneous determination of geodetic positions and of the terrestrial gravity field by combining different data of any kind — terrestrial angle, distance and gravity measurements as well as data from advanced satellite techniques. To provide an adequate statistical background, an alternative statistical interpretation of the anomalous gravity field in terms of covariance analysis of individual functions is given, and its relation to the usual interpretation as a stochastic process on the sphere is discussed.

- 204 - ISNER J.F. - "Determination of surface densities from a combination of gravimetry and satellite altimetry".
AFCRL-72-0743, Rep. n°186, Sci. Rep. n°5, 61 p, 1972.

The utilization of satellite altimetry by itself, and in combination with existing gravity material is considered for the determination of the gravity field of the Earth. This is done by developing equations that relate surface density values defined in discrete blocks to geoid undulations and gravity anomalies. The use of a higher order reference field defined by a set of spherical harmonics is considered and truncation errors are computed when the contribution of an area outside a spherical cap is obtained from a spherical harmonic expansion of the anomaly field.

A suggested solution to recover 5° equal area blocks is made with specific recommendations made on the ordering of these blocks so that structured sets of normal equations will result. The determination of a more local field (such as 1°) is discussed using the global 5° field as a basis.

- 205 - BEHLE A., W. EHRLSMANN, J. MAKRIK, H. MENZEL, C. MORELLI & O. ROSENBACH - "Gravimetrische Untersuchungen in den Ostalpen I (Messgebiet Mittenwald Innsbruck. Verona)".
Z. Geophys. B. 38, S.45-74, Würzburg, 1972.

Gravity measurements in the Eastern Alps have been carried out during the years from 1962 to 1964 along a profile strip.

The results of the measurements are presented as follows :

- 1) Profiles of Free-air and Bouguer anomalies along four traverses,
- 2) List of gravity stations containing topographic and gravity data.

Field technique and computational procedures are described. Special attention has been given to the terrain corrections. The measured gravity values are compared with previous measurements published by HOLOPAINEN (1947).

- 206 - BEHLE A., W. EHRLSMANN, J. MAKRIK, H. MENZEL, O. ROSENBACH & P. STEINHAUSER - "Gravimetrische Untersuchungen in den Ostalpen II (Messgebiet Salzburg, Kärnten, Tirol)".
Z. Geophys., B.38, S.221-242, Würzburg, 1972.

Gravity measurements in the Eastern Alps have been carried out in the area of the Austrian federal states Salzburg, Kärnten and Tirol during the years from 1965 to 1967.

The results of the measurements are presented as follows :

1. Profiles of Free-air and Bouguer anomalies along six traverses.
2. List of gravity stations containing topographic and gravity data.

A sketch of the methods of evaluation and of the accuracy of data is given.

- 207 - TANNER R.W. - "The estimation of plate motions by astronomical methods". From : Canadian J. Earth Sci. n°9, p.1052-1054, 1972.
Contr. Earth Physics Branch, n°403, Ottawa.

Some of the problems involved in the detection of plate motions by astronomical methods are discussed with particular reference to a Herstmonceux-Calgary cooperative program using photographic zenith tubes. Analysis of the observations obtained in 1969 and 1970 shows that several decades of continued observation may suffice with present techniques to demonstrate and measure the relative motion of the North American-Eurasian plates.

- 208 - CHOJNICKI T. - "Calculs des marées terrestres théoriques et leur précision". Inst. Geof. Polskiej Akad., Materialy i Prace 55, p.3-42, Warszawa, 1972.

Pour éviter la propagation des erreurs systématiques à l'élaboration des observations propres aux différentes méthodes de détermination des marées théoriques, cet article présente une nouvelle méthode de calcul de ces marées visant à l'unification des méthodes employées jusqu'à présent...

- 209 - WEICHERT D.H. - "Anomalous azimuths of P : evidence for lateral variations in the deep mantle".
from : Earth & Planetary Sci. Letters n°17, p.181-188, 1972.
Earth Phys. Branch, Contr. n°434, Ottawa.

Certain anomalies of $dT/d\Delta$ and azimuth of P-waves arriving at the Yellowknife seismic array have long defied explanation by near-array structure. Similarly, the anomalies are not easily explained by source structure. A study of 43 Aleutian events now leads to a satisfactory explanation in terms of lateral variations of velocities near the vertex of the ray path near 800 km depth, which can readily be accommodated within the constraints of the known mantle structure.

- 210 - DENCE M.R. - "The nature and significance of terrestrial impact structures". 24th IGC, Section 15, p.77-89, 1972.
Earth Physics Branch, Contr. n°393, Ottawa.

Topographic, structural and petrographic characteristics, geophysical properties and styles of deformation distinguish terrestrial impact structures from volcanic and tectonic phenomena...

Comparisons of data from terrestrial and also lunar impact events with those obtained from cratering and equation-of-state experiments are leading to refinements of the classification and theory of cratering phenomena and to a better understanding of the response of crustal materials to large-scale shock events.

- 212 - RIDDIHOUGH R.P., G.V. HAINES & W. HANNAFORD - "Regional magnetic anomalies of the Canadian Arctic".
from : Can. J. Earth Sci., v.10, n°2, p.157-163, 1973.
Earth Physics Branch, Contr. n°412, Ottawa.

A contoured residual map of the vertical magnetic field, observed at an altitude of 3,5 km above sea level, provides a broad view of major tectonic patterns and relations between the Canadian Shield, the Innuitian Region, and the oceanic ridges of the Arctic Basin.

- 213 - ROBERTSON W.A. - "Pole position from thermally cleaned Sibley Group sediments and its relevance to proterozoic magnetic stratigraphy".
from : Can. J. Earth Sci., v.10, n°2, p.180-193, 1973.
Earth Physics Branch, Contr. n°413, Ottawa.

Thermal cleaning of paleomagnetic samples of the Sibley Group shows that 3 directions of magnetization are present ... This suggests that there is a bend in the North American polar wander curve between 1200 and 1400 m.y. ago. The curve is compared with the polar wandering curve derived from rocks of comparable age from southern Africa.

- 214 - WOOLSEY E.G. - "Gravitational effects on the vertical observed by the Ottawa PZT".
from : Can. J. Earth Physics, v.10, n°3, p.379-383, 1973.
Earth Physics Branch, Contr. n°433, Ottawa.

The deflection of the vertical due to the combined gravitational attraction of both the sun and moon appears in the observations made with the Ottawa PZT during the years 1962-1970. The values are very small, but the 95 % confidence level shows they are real. The Love number $(1 + k - 1)$ was determined as 1.3 ± 0.9 from latitude readings, and 0.9 ± 0.8 from longitude, where the uncertainties quoted in both cases are the 95 % confidence limits. The coefficient of correlation between observed and calculated residuals is 0.7 for longitude and for latitude readings.

- 215 - LAVRITZEN S.L. - "The probabilistic background of some statistical methods in physical geodesy".
Geod. Inst., Med. n°48, 96 p, Copenhagen, 1973.

- 216 - WILCOX L.E. - "Geological and geophysical methods for interpolation of gravity anomalies".
DoD Gravity Services Branch, AFIC, 5 p, St-Louis

Two methods are being developed for interpolation of gravity anomalies. In Analytical Geological Gravity Interpolation, short wave local effects are computed analytically from a geological "model" of the area being worked, and regional elevation effects are determined empirically. These factors are removed from the terrain corrected Bouguer anomaly field to obtain a regional field characterized by only long period variations. Gravity values are interpolated by adding regional and local effects at intermediate points; In Empirical Correlation Gravity Interpolation, formulas given by Woollard are modified to enable derivation of a crustal parameter from the observed Bouguer anomaly. This parameter is empirically correlated with measured geological and geophysical data at gravity station locations. The empirical correlation is used to interpolate gravity values at intermediate points. Analytical Geological Gravity Interpolation may enable interpolation of gravity data in the West Alp Study Area.

- 217 - IVANOVA M.V. & B.P. PERTSEV - "Evaluation de marées et nutation semi-mensuelle de la Terre d'après les résultats des observations de cinq services de l'heure".
Marées Terrestres, Bull. Inf. n°65, p.3481-3492, Bruxelles, 1973.

- 218 - Marées Terrestres, Bull. Inf. n°66, p.3560-3672, Bruxelles, 1973.

CENTRE NATIONAL pour l'EXPLOITATION des OCEANS, PARIS

- 219 - Bull. Inf. n°52, 23 p, Avril 1973.
- 220 - Rapport annuel 1972, 80 p, Paris, 1973.
- 221 - Bull. Inf. n°53, 15 p, Mai 1973.
- 222 - Bull. Inf. n°54, 12 p, Juin 1973.
- 223 - GERARD A. & P. GRIVEAU - "Carte gravimétrique de la France, 1/320.000, feuille de Paris, notice explicative".
B.R.G.M., 27 p, Orléans, 1971.
- 224 - DEBEGLIA N. - "Carte gravimétrique de la France, 1/320.000, feuille de Bourges, notice explicative".
B.R.G.M., 65 p, Orléans, 1972.
- 225 - BUREAU de RECHERCHES GEOLOGIQUES et MINIERES - Carte gravimétrique de la France : LA ROCHELLE, feuille 21, échelle 1/320.000, Paris.
Isanomales de Bouguer tracées sur fond géologique.
- 226 - BOWIN C. - "Puerto Rico trench negative gravity anomaly belt".
The Geol. Soc. America, Memoir 132, p.339-350, 1972.

The Puerto Rico trench negative free-air anomaly belt extends from south of Barbados, around the Antillean arc, to eastern Cuba. The free-air minimum east of the Lesser Antilles is related to underthrusting of the Caribbean plate by the Atlantic Ocean plate. Here the axis of the free-air minimum lies very close to the eastern border of a zone of epicenters which apparently marks the commencement of crustal faulting along the underthrust. The line of trend of historic volcanoes of the Lesser Antillean arc is equidistant (160 km) from the axis of minimum free-air anomaly. It is postulated that differential shifts between the Caribbean plate and the underthrust Atlantic plate have occurred at least twice, once in late Eocene to early Oligocene, during which the outer island chain of the northern Lesser Antillean arc was formed, and again sometime since the late Miocene, when the Barbados ridge and associated uplifted topography were formed. This latter deformation caused the disappearance of a trench opposite the southern Lesser Antillean arc and a displacement of the Puerto Rico trench axis oceanward away from the axis of the negative free-air anomaly belt near the northeast corner of the Caribbean plate.

- 227 - CORNWELL J.D. - "A gravity survey of the Isle of Man".
Proc. of the Yorkshire Geol. Soc., v.39, part 1, n°6, p.93-106, 1972.

The Bouguer anomaly map of the Isle of Man is dominated by two gravity lows, elongated in a north-east to south-west direction across the island, and by a rapid decrease of values at the Point of Ayre. The two anomalies are thought to be due to granite bodies,

intruded into the Manx Group, and these granites are interpreted as having broad, flat tops and steep sides, those of the South Barrule Granite reaching a depth of ten kilometres...

The cause of a gravity high near Jurby in the northern plain is unclear, but a rock-unit of high density underlying the Manx Group may be responsible.

- 228 - STEPHENS L.E. & R.V. COOPER - "Results of underwater gravity surveys over the southern Nova Scotia Continental shelf with map n°149 - Yarmouth-Burgeo".

Earth Physics Branch, Gravity map series, 10 p, Ottawa, 1973.

Underwater gravity surveys completed during 1971 on the southern Nova Scotia continental shelf are an extension of surveys carried out in 1970 by the Earth Physics Branch of the Department of Energy, Mines and Resources.

The major gravity anomalies trend more or less parallel to the strike of the southern Nova Scotian shelf. A series of gravity highs on the southern Scotian shelf may be related to ridges developed within the basement during an early Mesozoic continental rupture. A steep gravity gradient associated with the continental margin delineates the transition from continental to oceanic crust, in common with other continental margins throughout the world. A broad gravity low northwest of Sable Island, suggests the presence of an extensive Devonian granite batholith while other weaker negative gravity anomalies on the shelf are probably related to Mesozoic and Tertiary sedimentary basins some of which contain Jurassic salt.

- 229 - INSTITUT ROYAL METEOROLOGIQUE de BELGIQUE - Annuaire des Marées Terrestres 1970.

84 p, Bruxelles, 1973.

- 230 - BALLARIN S., B. PALLA & C. TROMBETTI - "The construction of the gravimetric map of Italy".

Pub. Com. Geod. Italiana, Memoria n°19, 31 p, Firenze, 1972.

List of maps :

- . n°1 : location of the gravimetric stations,
- . n°2, 3 and 4 : gridded map of the mean elevations of Italy and neighbouring countries and of the mean depths of the surrounding seas,
- . n°5 : lines of equal mean elevation..(zone 11),
- . n°6 and 7 : Bouguer isoanomals, constant density (2,67) and variable density,
- . n°8 : lines of equal Bowie reduction of the indirect effect,
- . n°9 and 10 : isoanomals in the Airy Heiskanen hypothesis (30km) and in the Vening Meinesz hypothesis (30 km - R = 174,3 km).

- 231 - Chronique de l'U.G.G.I., n°91, 64 p, Mai 1973.

- . Information on the Central Bureau for Satellite Geodesy, p.6.
- . C.R. des Bull. Inf. du B.G.I. n°27, 28, 29 et 30, p.63-64.

- 232 - CHOJNICKI T. - "Determination of long-period Earth-tides".
Polska Akad. Nauk, Kom. Geod.
from : Geod. i. Kart., t.XXII, Z.2, p.91-103, Warszawa, 1973.

The article concerns the determination of long-period tidal waves parameters by means of the zero point method applied to the determination of instrumental drift. This method consists in calculation of moments in which the value of theoretical tide equals zero and the observed value equals the value of drift. A sketch of program construction for numerical realization of this method on a computer is also presented. Finally a series of examples of calculation results obtained by the above mentioned method is presented.

- 233 - GUMERT W.R. & G.E. COBB - "Sistema de Medicion de la Gravedad desde Helicopteros (SMGH)".
Inst. Geog. Militar, Revista Cartog., Ano XXI, n°22, p.15-40,
Buenos-Aires, 1972.

El SMGH consiste en un gravimetro LaCoste y Romberg de plataforma estable, un altimetro Laser Spectra Physics, un calibrador portable de presión Rosemont, una cámara de 35 mm o barredor Bendix infrarrojo, un sistema de navegación Hiram, una computadora digital Laser y el conjunto de control y archivo.

Este sistema fue instalado en noviembre de 1968 en un helicóptero CJ3E de ma Fuerza Aérea de los Estados Unidos. La instalación fue realizada por la corporación del Servicio Aéreo bajo la dirección del U.S. Army Topographic Command (TOPOCOM). Este vehículo voló sobre una zona de prueba en donde se contaba con una diferencia conocida de gravedad. Dicha zona de prueba se encuentra en Maryland, Virginia, llamada área Delaware, limitada aproximadamente entre los 67° y 70° de longitud W y 37° y 39° de latitud Norte. En esta area, la gravedad presenta diferencias significativas siendo la topografia irregular con datos que se hallan en mar y tierra. Dichos datos han sido controlados a fines de satisfacer los propósitos de evaluación buscados. Sobre un periodo de dos meses y medio se ejecutaron aproximadamente 100 horas de vuelo. Se concentró la atención sobre tres bloques de datos : uno en terreno ondulado, otro en area continental costera y un tercero en una región abrupta de los Appalacheans, alrededor de las cavernas Luray. Los resultados de estas pruebas indican que por este medio pueden efectuarse mediciones de gravedad de precision, teniendo cuidado de no utilizar procedimientos adecuados en la obtención y manejo de datos. Con este sistema es posible obtener en forma rutinaria, valores de gravedad suficientemente precisos como para ser utilizados con fines geodésicos.

- 237 - WORLD DATA CENTER A - Catalogue of data received by WDC A during the period 1 July 1957 - 31 Dec. 1972 : Gravity, Tsunami, Seismology, Longitude and Latitude, Metecrology".
42 p, Washington, 1973.

ACADEMIE des SCIENCES U.R.S.S. - Références bibliographiques :
Géophysique.

242 - N°2, 242 p, Moscou, 1973 (texte russe).

243 - N°3, 255 p, Moscou, 1973 (texte russe).

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

244 - N°3, 43 p, Moscou, 1973 (texte russe).

245 - N°4, 54 p, Moscou, 1973 (texte russe).

246 - MATHER R.S. - "The geocentric orientation vector from limited astro-geodetic data".
Goddard Space Flight Center, Reprint X-553-72-378, 12 p, Greenbelt, 1972.

The establishment of a world geodetic system from gravity data available at the present time, can be based on the corrections necessary to convert the separation vectors, as determined from astro-geodetic information, to equivalent values which could be directly compared with those determined from an imperfect knowledge of the Earth's gravitational field.

Test computations using the comprehensive sets of both astro-geodetic and gravimetric data available for the region covered by the Australian Geodetic Datum indicate that the accuracy of the geocentric orientation vector so determined from incomplete representations of the Earth's gravitational field, is dependent on the overall extent of the datum over which the comparisons are made.

The lack of an astro-geodetic determination of the "geoid" due to an inadequate density of astro-geodetic stations over certain parts of the datum does not materially affect these determinations. The effect is only marginal if the station density of the area referred to does not markedly differ from the average for the region. These tests indicate that sufficient astro-geodetic data exists for the connection of the North American Datum to a world geodetic system assembled from gravimetric considerations and referred to the geocenter with an accuracy of 0.2 or its linear equivalent in each component of the geocentric orientation vector.

247 - MATHER R.S. - "A solution of the geodetic boundary value problem to order e^3 ".
Goddard Space Flight Center, Reprint X-592-73-11, 128 p, Greenbelt, 1973.

A solution is obtained for the geodetic boundary value problem which defines height anomalies to ± 5 cm, if the Earth were rigid. The solution takes into account the existence of the Earth's topography, together with its ellipsoidal shape and atmosphere.

A relation is also established between the commonly used solution of Stokes and a development correct to order e^3 . The data requirements call for a complete definition of gravity anomalies at the surface of the Earth and a knowledge of elevation characteristics at all points exterior to the geoid. In addition, spherical harmonic representations must be based on geocentric rather than geodetic latitudes.

No unique solution is possible in theory at the present time due to the nature of the Earth's atmosphere and the limited knowledge of its structure. Practical solutions which are only marginally in error with respect to the estimates of accuracy given above, are possible if an adequate model were adopted for the atmosphere.

A quick-look analysis based on statistical considerations of the Earth's gravity field, indicates that a definition which would meet the requirements given above for studies of sea surface topography, is afforded by a global grid with a 10 km spacing in non-mountainous and undisturbed regions, provided such information were :

- a) controlled by a global gravity standardization network of $\pm 50 \mu\text{Gal}$ accuracy, and
- b) elevations were based on a correlation of all the major continental datums with errors kept below $\pm 15 \text{ cm}$.

Any predictions that are necessary must be based only on the height correlation characteristics over limited distances.

248 - Bulletin Géodésique de l'A.I.G., n°108, Paris, Juin 1973.

- a) OBENSON G. - "Error analysis of deflections of the vertical and undulations from the accuracies of gravity anomalies". p.141-156.

Equations, suitable for machine evaluation, are derived for computing the coefficients to be multiplied by each mean gravity anomaly, world-wide, to obtain the deflections of the vertical and undulations at any given point. These coefficients together with the accuracies of the anomalies are used to compute the standard of the deflections and undulations. Sample computations done with some assumed data gave average world-wide standard errors of 0".6 for the meridian and prime vertical deflections and 4.5 m for the undulations.

- b) MATHER R.S. - "Four dimensional studies in Earth space". p.187-210.

A system of reference is proposed. The requisite data is used to define both global control network and also polar wandering. The determination of variations of the Earth's gravitational field with time also forms part of such a system. Techniques are outlined for the unique definition of the motion of the geocenter, and the changes in the location of the axis of rotation of an instantaneous Earth model, in relation to values at some epoch of reference. The instantaneous system referred to is directly related to a fundamental equation in geodynamics. The reference system defined would provide an unambiguous frame for long period studies in Earth space, provided the scale of the space were specified.

249 - GUJA N.H. - "Detecting the movement of the Caribbean plate using paleomagnetic data".

Inst. Geophys. Tehran Univ., J. Earth & Space Physics, v.1, n°3, p.11-36, 1972.

Paleomagnetic data were the first geophysical data to provide evidence supporting the hypothesis of continental drift, originally proposed by WEGENER (1924). On the basis of such data it was suggested that North America and Europe have drifted apart as a result of the break-up in the early Paleozoic of the pre-existent Laurasia.

- 250 - STACEY R.A. - "Gravity anomalies, crustal structure and plate tectonics in the Canadian Cordillera".
from : Can. J. Earth Sci., n°10, p.615-628, 1973.
Earth Physics Branch, Contr. n°452, Ottawa.

Bouguer values are presented for a strip across the southern part of the Canadian Cordillera (49°N to 51°N and from 112°W to 132°W). The Bouguer anomalies outline density variations in the surface rocks, but where there are regional changes in the topography, these anomalies are distorted by the relationship between Bouguer values and elevation. A Bouguer anomaly profile at 50°N has been interpreted in terms of Woollard's average crustal model which assumes Airy-type compensation for the topography. Residual anomalies are related to lateral density variations in first the crust and then the upper mantle. Comparison between these models and other geophysical data suggests there is a decrease in the density of the crust and of the upper mantle west of the Rocky Mountains ; the transition is related to the western edge of the Precambrian basement. The large residual anomalies in the vicinity of Vancouver Island are attributed to either very dense crustal material or low density mantle material. It is concluded that the anomalous density distribution below Vancouver Island is due to the presence of a remnant plate of oceanic lithosphere below the island which extends eastwards below the central part of the Cordillera. The suggested northern limit of this plate is 51°N and arguments are presented for the plate being relic of late Cenozoic convergence between the Juan de Fuca and American plates.

- 251 - BOWER D.R. - "A sensitive water-level tiltmeter".
from : Phil. Trans. R. Soc. Land.A, n°274, p.223-226, 1973.
Earth Physics Branch, Contr. n°440, Ottawa.

A sensitivity approximately equal to that of a horizontal pendulum is obtained in a 50 m long water-level tiltmeter. A crapaudine-type calibrating device is described.

- 252 - VALLIANT H.D. - "A technique for the precise calibration of continuously recording gravimeters".
from : Phil. Trans. R. Soc. Land.A, n°274, p.227-230, 1973.
Earth Physics Branch, Contr. n°439, Ottawa.

A prototype device to calibrate recording Earth tide meters of the TRG-1 variety has been constructed and demonstrated to operate satisfactorily. The calibration is effected by subjecting the gravimeter to an external sinusoidal acceleration of approximately $3 \mu\text{m/s}^2$. The magnitude of the applied acceleration which is determined from a record of the gravimeter's displacement, is compared directly with the gravimeter's response. The prototype was limited to a driving frequency of 0.01 Hz. The reconstruction of the calibrator to permit operation at frequencies down to 0.001 Hz is discussed. A calibration precision of 0.1 % was achieved with the prototype.

- 254 - IELGEMANN D. - "Spherical approximation and the combination of gravimetric and satellite data".
Typewritten text, 8 p. Submitted to the 5th Symposium on Mathematical Geodesy, Firenze, Italy, October - 25 - 26, 1972.

- 255 - TORGE W., G.L. STRANG van HEES & H. DREWES - "Verbindung des niederländischen Schwerenetzes mit dem "International Gravity Standardization Net 1971". (IGSN 71).
D.G.K., Reihe B : Angew. Geod., H. n°195, 22 S, München, 1973.

In November 1971, a gravity connection between the IGSN 71 stations Hamburg, Hannover, Bad Harzburg, Torfhaus and five stations of the Dutch gravity net, including Amsterdam, has been performed. As the result of these measurements carried out with LaCoste-Romberg gravity meters, the gravity values of the Dutch stations are given in the IGSN 71 with an accuracy of $\pm 0,01 \dots 0,02$ mGal, referring to the station Hannover. We advise to use in future as gravity basepoint in the Netherlands AMSTERDAM 21625L (at the new Airport) with gravity $g = 981.273,43 \pm 0,01$ mGal.

(This sketch was published in the Bull. Inf. n°29, p.I-9).

- 256 - GOODACRE A.K. - "Some comments on the calculation of the gravitational and magnetic attraction of a homogeneous rectangular prism".
from : Geophys. Prospecting, v.XXI, n°1, p.66-69, 1973.
Earth Physics Branch, Contr. n°442, Ottawa.

The use of arctangents rather than arcsines in the expression for the gravitational attraction of a homogeneous rectangular prism reduces computational difficulties. Once a subroutine is available to compute one component of attraction in a Cartesian coordinate system, the other components may be obtained by cyclic permutation of the field point and body coordinate parameters. This technique also readily provides derivatives of the gravitational attraction and hence forms a compact method for the calculation of a magnetic anomaly due to a homogeneous rectangular magnetic prism.

- 257 - BROWN D.C. & J.E. TROTTER - "Extensions to SAGA (Short Arc Geodetic Adjustment) for the geodetic reduction of Doppler operations".
AFCRL-TR-73-0177, Final Report July 1971 - January 1973, 66 p, 1973.

Several significant extensions to the AFCRL program SAGA (Short Arc Geodetic Adjustment) have been implemented and tested.

- 258 - CALLIGARIS D., C. MORELLI & M. PISANI - "Rilievo gravimetrico e magnetico".
from : La Ricerca Scientifica, n°83, p.72-81, 1972.
Osser. Geof. Sper., Contr. n°220b, Trieste.

Relevé géophysique dans le Golfe de Pozzuoli et au large, jusqu'à 50 km environ. Interprétation de l'anomalie.

259 - Bolletino di Geofisica teorica ed applicata, v.XV, n°57, 1973.
Osser. Geof. Sper., Trieste.

- a) CARRARA E., F. IACOBUCCI, E. PINNA & A. RAPOLLA - "Gravity and magnetic survey of the Campanian Volcanic area, S. Italy".
p.39-51.

Detailed gravity and magnetic profiles were carried out along the Campanian volcanic area, S. Italy. Computer assisted interpretation of gravity data let a detailed model of the structural patterns of the carbonate basement to be put forward. Interpretation of magnetic profiles shows the presence at moderate depth of magmatic bodies intruded along the main fracture lines.

On the basis of these results the relationship between tectonic and volcanic activity of this area is discussed.

- b) CARROZZO M.T., G. de VISINTINI, F. GIORGETTI & E. IACCARINO - "General catalogue of Italian earthquakes".
p.95-99.

260 - Bolletino di Geofisica teorica ed applicata, v.XV, n°58, 1973.
Osser. Geof. Sper., Trieste.

- a) HAGIWARA Y. - "Best-fitting polynomial for derivatives of Stoke's function in the truncated Vening Meinesz integration".
p.115-122.

Molodenskii et al. (1962) treated a polynomial S_N (degree $n \leq N$) as an approximation of Stoke's function S in an interval $\psi \leq \psi \leq \pi$ (ψ : spherical distance). They also applied $dS_N/d\psi$ to the deflection of the vertical in the Vening Meinesz integration over the same interval. However, $dS_N/d\psi$ is not a polynomial which best fits $dS/d\psi$. The author investigates the best-fitting polynomial for $dS/d\psi$ in the present paper. The limiting errors due to the difference between $dS_N/d\psi$ and the best-fitting polynomial are evaluated.

- b) RECQ M. - "Contribution à l'étude de la structure profonde de la croûte terrestre dans la région de Nice".
p.161-180.

La structure de la croûte terrestre déduite d'expériences réalisées à terre et en mer dans la région niçoise est caractérisée par un rapide amincissement d'Ouest en Est et par un double réseau de failles parallèles et perpendiculaires au littoral. L'amincissement de la croûte terrestre ne devrait pas se poursuivre au-delà de San Remo, on constate un changement de nature de la structure profonde de la croûte, conséquence de l'extension vers le Sud-Est de la zone d'Ivrea.
