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INTERGOVERNMENTAL OCEANOGRAPHIC
COMMISSION
(of Unesco)

INTERNATIONAL HYDROGRAPHIC
ORGANIZATION

Ninth Meeting of the GEBCO Sub-Committee on Digital Bathymetry

British Oceanographic Data Centre, Bidston

8 - 10 April 1992

SUMMARY REPORT

It is regretted that a Summary Report was not produced for the Eighth Meeting of the Sub-Committee held in St. Petersburg in June 1991. However, all matters discussed at that meeting may be considered to have been covered by the present report of the Ninth Meeting.

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ANNEXES

1. OPENING OF THE MEETING

1 The Chairman, Dr. Meirion T. Jones, opened the meeting at 10.00 on Wednesday, 8th April 1992 and welcomed participants to the British Oceanographic Data Centre and its host institute the Proudman Oceanographic Laboratory.

2 A List of Participants is given in Annex II. Apologies for absence were received from Dr. Andrey Popov, Mr. Shin Tani, Mr. David Monahan, Dr. Robin Falconer, and Cdr. Jose M. Fernandez de la Puente.

2. CONDUCT OF THE MEETING

2.1 ADOPTION OF THE AGENDA

3 The Agenda was adopted without alteration (see Annex I)

2.2 ADMINISTRATIVE ARRANGEMENTS AND DOCUMENTATION

4 The following documents were tabled for the consideration of the meeting:

* Proposal to the International Arctic Science Committee for a Working Group for Geophysical Compilation and Mapping
* Report on work carried out by the GEBCO Digital Atlas Manager (June'91 to April'92)
* BODC Information Note 92/2 - "The GEBCO Digital Atlas"
* Operational Procedure, Systems and Formats supporting the Banking of Bathymetric Data at the IHO Data Centre for Digital Bathymetry
* 1991 Annual Report of the IHO Data Centre for Digital Bathymetry
* IHO Transfer Standard for Digital Hydrographic Data - IHO SP-57
* Information Note on NOS Multibeam Survey Maps
* Supporting Documentation for NOS 'Gridded EEZ Bathymetric Data' discs
* 'Bathymetry and Sea Floor Mapping at the AWI' from Geodetical Info Magazine
* Information Note on the Circum-Atlantic Project (CAP)
* Report (Minutes) of the IHO Meeting on Hydrographic Cooperation in the Antarctic, 9-10 October 1991, Bonn, Germany, and associated documents
* BP-0007 Guidelines for the GEBCO - Part 2B (Third Draft)
* BP-0007 Guidelines for the GEBCO - Final versions of Parts 3 and 5
* Second Draft Report of the IHO Working Group on Oceanic Plotting Sheets
* NRL Bathymetric Chart of the Barents and Kara Seas
* Plots of the digitized tracklines of GEBCO Sheets 5.16 and 5.18
* Plots of the digitized contours of the draft version of revised GEBCO Sheet 5.12
* CAP Demonstration Plot of the Sea-Floor Topography of the Atlantic Basin

3. REVIEW OF RELATED ACTIVITIES OF OTHER INTERNATIONAL AND NATIONAL GROUPS

3.1 IHO COMMITTEE ON EXCHANGE OF DIGITAL DATA (CEDD)

5 Mr. Don Pryor, on behalf of Rear Admiral A. Yeager, CEDD Chairman, reported on the activities of CEDD and, in particular, on the preparation of the IHO Special Publication SP-57 "IHO Transfer Standard for Digital Hydrographic Data" which represented the culmination of many years of work by the Committee. It was anticipated that the standard would be formally adopted at the forthcoming 1992 International Hydrographic Conference for use in the exchange of digital hydrographic data between national Hydrographic Offices and for their distribution to manufacturers, mariners and other data users, for example for electronic chart purposes. Future changes to the Standard would be coordinated by a Change Control Procedure Working Group of the IHO.

6 Mr. Pryor explained how the standard was described in three parts within the printed volume and accompanied by an appendix on floppy disc containing a worked example of a section of a chart and associated data encoded according to the standard:

7 **Part A - 'The Object Catalogue'** - provided a description of the feature coding schema to be used, i.e. the means for describing 'real world' objects, their attributes and relationships. Included within this section were codes for object classes, for attributes and for cartographic symbols.

8 **Part B - 'DX-90'** - specified the format (known as DX90) for information transfer including the semantics (meaning) and the syntax (structure) of the files used to facilitate such transfer. The DX90 format was based on the ISO 8211 international standard ('Specification for a data descriptive file for information exchange') which provides media independence and the means for data exchange between computers, independent of their make.

9 **Part C - 'Digitizing (Transfer) Conventions'** - contained a description of the conventions to be observed when converting analogue source data into machine readable form.

10 It was noted that the format was fairly sophisticated and not readily digested by typical users solely interested in bathymetric data. Mr. Pryor pointed out that a commercially available software package 'ISO 8211 Implementation Software' could be obtained under licence through the IHB and this provided the means for simplifying the task of converting data between the user's own formats and fully-conforming ISO 8211 files. The meeting recognized that the DX90 format was targeted primarily at multithematic chart data and at present was not well suited for the exchange of data within the GEBCO community.

3.2 IOC REGIONAL OCEAN MAPPING PROJECTS

11 The IOC representatives, Mr. Vladimir Sekachev and Dr. Alexei Suzyumov, informed the meeting of progress on the various IOC Regional Ocean Mapping Projects as follows:

3.2.1 International Bathymetric Chart of the Mediterranean and its Geological-Geophysical Series (IBCM)

12 It was reported that the Seismicity Series had been published and was ready for distribution. The Plio-Quaternary/Messinian Structure Series had reached the colour proof stage and was awaiting the approval of the Editorial Board at its meeting in Trieste, October 1992. The IOC had received two compiled sheets for the Magnetic Anomaly series from Professor Jannis Makris, Hamburg, and these had been sent to St. Petersburg for further processing. These charts were in addition to the bathymetric chart published in 1982 and the gravity series of 1989.

13 It was understood that Dr. John Hall would be preparing material for a Second Edition of the IBCM to be published in 1994 and that he was particularly interested in revising the bathymetry of the eastern part of the Mediterranean incorporating much of the Russian data collected there in recent years. It was further understood that he was proposing to build up the revised bathymetry by digital methods centred

around a Digital Terrain Model. The meeting was particularly interested in this approach and wished to be kept informed of developments.

14 Mr. Sekachev reported that, due to lack of funds, the Russian Federation was unable to continue to support the post of IBCM Secretary at Monaco recently occupied by Mr. Dmitry Travine and it was suggested that future enquiries about the project should be directed through Dr. Andrey Popov in St. Petersburg.

3.2.2 International Bathymetric Chart of the Caribbean Sea and Gulf of Mexico (IBCCA)

15 The Editorial Board of IBCCA met at the Cuban Hydrographic Institute, 24-26 March 1992. For practical reasons the EB had decided to compile the sheets at a scale of 1:500,000 and only use 1:250,000 when the density of data justified it. Reported progress with the various sheets was as follows: Venezuela hoped to have compilation material for sheets 1.14 and 1.15 completed in 1993. Although the work had started using traditional techniques it was now being transferred to the digital domain. Cuba had started using automated systems in January 1992 and had virtually completed the compilation of data for sheet 1.07 while it was hoped to complete the compilation material for 1.08 in August 1992. Mexico hoped to begin the publication of sheet 1.06 in August 1992 while the USA had concluded work on sheet 1.04 and was about to start on sheet 1.03. A proof version of sheet 1.09 compiled by the USA was currently being reviewed and was likely to be sent for final printing shortly.

16 The meeting was informed that the Cuban Hydrographic Institute was proposing to create a Regional Data Bank for the IBCCA Project and was prepared to develop the necessary software and to digitize cartographic material drafted by manual methods. It was understood that the Cuban proposal would be formally submitted to the Editorial Board for fuller consideration.

17 While welcoming the work being undertaken in the IBCCA project, the meeting expressed much concern that the GEBCO Bathymetric Editor had not been informed about the meeting in Cuba or involved in any way in its deliberations. It was felt that he was an essential technical link between the bathymetric mapping activities of GEBCO and those of the IOC Regional Ocean Mapping Projects. Concern was also expressed that it appeared that the Cuban proposal for a Regional Digital Atlas was being considered without reference to the GEBCO Digital Atlas.

3.2.3 International Bathymetric Chart of the Western Pacific (IBCWP)

18 The meeting noted that the First Session of the Editorial Board for the IBCWP would be held in Beijing, China, 16-18 June 1992 (this meeting was later postponed until 1993).

3.3 IUGS CIRCUM-ATLANTIC PROJECT (CAP)

19 Dr. Loughridge presented a report from Dr. Terence Edgar of USGS outlining the current status of the CAP. Although the Project continued to have funding difficulties, a number of pilot projects had been established and a meeting would be held in April 1992 with the Directors of the major institutions involved in geoscience investigations in the Atlantic region with a view to obtaining a commitment from each to participate in CAP. This meeting would be held on the 150th anniversary of the Geological Survey of Canada.

20 Mr. Cherkis stated that he was working closely with CAP and was taking the lead in preparing maps of the Barents Sea as a pilot project. Other projects included collaboration with IBCM involving geophysical charts of the Mediterranean, and the preparation of digitized maps of onshore and offshore Atlantic-margin geology of the United States and Brazil. These pilot projects would be used as demonstration material for seeking funding, and as samples for developing the GIS and digital database techniques that would underpin CAP. One of the major aims of CAP would be to establish a digital database from which other products could be prepared.

21 It was noted that CAP had accepted the GEBCO (5th Edition) bathymetry to serve as the topographic base for the Atlantic Basin and the Chairman reported that he had provided Dr. Edgar with the digitized

contours for Arctic Sheet 5.17, Atlantic Sheets 5.04, 5.01, 5.08, Southern Ocean Sheets 5.15, 5.16, 5.13 and 5.18, Pacific Sheets 5.07, 5.11 and Indian Ocean Sheet 5.09. The meeting was shown a preliminary map plotted out from these data by USGS at a scale of 1:17 million on Lambert Azimuthal Equal Area Projection covering the area between the poles from 100° W to 40° E. It was understood that CAP would be using this map as the base for overlays of other parameters. A notable omission from the map was the bathymetry of the South Atlantic and it was agreed that BODC should send Dr. Edgar the digitized contours for Sheet 5.12 as soon as they became available.

3.4 INTERNATIONAL ARCTIC SCIENCE COMMITTEE (IASC)

22 The Chairman informed the meeting of a proposal being submitted to IASC by Ron Macnab and Jacob Verhoef of the Geological Survey of Canada for the creation of a Working Group for Geophysical Compilation and Mapping of the Arctic. The proposal was aimed at fostering international cooperation in the development of high quality data bases for Arctic investigations and had suggested that attention should first be paid to databases of bathymetry, geomagnetics, gravity, and seismic reflection/refraction. The Chairman reported that he had been in contact with Dr. Macnab who had expressed interest in collaborating with GEBCO. Realising that the Arctic was poorly mapped in the GEBCO (5th Edition), the meeting welcomed any initiative that would lead to an improved bathymetry of the region and requested the Chairman to bring the proposal to the attention of the GEBCO Officers. Mr. Cherkis stated that he was already in touch with Dr. Macnab concerning bathymetric mapping in the Arctic and would keep the Sub-Committee informed on developments.

3.5 IHO WORKING GROUP ON 'HYDROGRAPHIC COOPERATION IN THE ANTARCTIC'

23 Dr. Hans Schenke informed participants of the meeting of the IHO Working Group on "Hydrographic Cooperation in the Antarctic" held in Bonn (9-10 October 1991) and which he attended on behalf of GEBCO. He explained how, following a number of shipping accidents, concern had been expressed about the lack of adequate charts and associated hydrographic information in Antarctic waters and how the IHO Working Group had been established. At the meeting, the newly produced IHO publication, SP-55, Appendix 1 - "Status of Hydrographic Surveying and Nautical Charting in Antarctica" was tabled. A report of the Bonn meeting was submitted by the IHO to the Consultative Meeting of the Antarctic Treaty. The report highlighted the need to foster the gathering of bathymetry and the production of bathymetric maps of Antarctic waters (i.e. south of 60°S). It asked the Antarctic Treaty Partners to request that "all ships visiting Antarctica carefully record bathymetric data in the course of their voyages, taking care that the parameters governing the quality of the data be recorded and the data be sent to their national Hydrographic Offices at the conclusion of their voyages". It was being proposed that the IHO Working Group should become a Permanent Working Group with one of its Terms of Reference being to "establish and maintain liaison with the IHO/IOC GEBCO organization concerning Antarctic bathymetric data collection and mapping". The meeting welcomed any initiative that would improve the content of the GEBCO Digital Atlas in Antarctic waters and requested Dr. Schenke to keep them informed on developments.

3.6 COMMISSION OF THE EUROPEAN COMMUNITIES (CEC)

24 The Chairman recalled the long standing need for a high quality, gridded, digital bathymetry of the North West European continental shelf, particularly for the North Sea, which could be used for example as a standard data set for modelling the waters of the shelf seas. He was pleased to report that, as pump priming for the creation of such a data set, the CEC Marine Science and Technology Programme had issued contracts to BODC and BSH to produce gridded bathymetry for the UK and German sectors respectively. The data set would be produced on a spheroidal grid with a mesh size of 1' by 1.5' (latitude by longitude). Dr. Jones reported that BODC's contribution would be based on the extensive bathymetric data set collected by the British Geological Survey during its surveying of the UK sector. However, the data set had not been tidally corrected and the work had been held up awaiting the development of an appropriate algorithm for retrospectively computing the tidal correction. Such an algorithm had recently been produced by the Proudman Oceanographic Laboratory.

3.7 ICA WORKING GROUP ON MARINE CARTOGRAPHY

25 The Chairman reported that he had been informed by the new Chairman of the ICA Working Group on Marine Cartography, Mr. Ronald A. Furness (Australian Institute of Cartographers), of the new objectives set for the Working Group by the ICA Conference in Bournemouth, UK, in October 1991. These included:

* examine the economic value of bathymetric and (in conjunction with the IHO) navigational charting and their underlying data sets to nations and draw conclusions on a global basis

* establish the role of (marine) cartographers by identifying issues and considering background, education, tasking and trends, draw conclusions on the way ahead

* suggest appropriate working relationships with the IHO and the IMO; seek observer status at various meetings of their electronic chart working groups; offer assistance from the resources and expertise of ICA in the development of electronic charting

* consider and make recommendations concerning the unique problem inherent in merging large data sets of the marine environment into homogeneous data bases; examine the potential of graphic presentations and techniques as aids to human comprehension of large volume data sets and their use by oceanographers, scientists, navigators and environmentalists

26 The meeting clearly recognised the relevance of the problems being addressed by the ICA Working Group and the immensity of its tasks. The Chairman was requested to inform Mr. Furness of the work of the Sub-Committee.

3.8 SOUTH PACIFIC APPLIED GEOSCIENCE COMMISSION (SOPAC)

27 Mr. James Eade described the activities of SOPAC (South Pacific Applied Geoscience Commission) and stated that the Commission was very keen to collaborate with GEBCO both in the compilation of bathymetric charts and in the exchange of data. Much of the mapping activity of SOPAC tended to concentrate on inshore areas although the Technical Secretariat in Suva maintained an extensive database covering some 700 cruises across the region - about 10% of these data were of a proprietary nature and the Secretariat was actively involved in searching out new data not yet submitted to the IHO DCDB. The database would soon be transferred to a SUN Workstation using GMT as the main graphics package. At Mr. Eade's request, the Chairman agreed to send the Secretariat a copy of the relevant digitized GEBCO Sheets for the region and a copy of the World Vector Shoreline. In return the Secretariat would carry out an evaluation of the quality of the WVS for the islands of the region. (For a more extensive account of SOPAC activities see Annex IV).

3.9 GEBCO BATHYMETRIC EDITOR'S TOUR OF WEST PACIFIC REGION

28 Mr. Peter Hunter explained how, as part of his role as the GEBCO Bathymetric Editor, he was responsible for developing contacts with those academic and agency geoscientists and hydrographic services demonstrably interested in and actively researching the geomorphology of the world's oceans, as well as the technical groups involved in the forefront of processing and manipulation of such data. This involved both investigating what bathymetric work was ongoing and planned, and liaising with appropriate specialists with a view to soliciting their collaboration in the work of GEBCO. An integral part of this responsibility was to undertake personal visits to the relevant organisations and to discuss their work at first hand.

29 Mr. Hunter reported on a mission he had recently undertaken (5th to 28th February 1992) to the Western Pacific region with visits to:

Japan: Ocean Research Institute, University of Tokyo
Hydrographic Department, Maritime Safety Agency
Japan Oceanographic Data Center

Australia:	Hydrographic Service, Royal Australian Navy Bureau of Mineral Resources, Geology & Geophysics James Cook University of North Queensland Australian Institute of Marine Science
New Zealand:	GeoResearch Associates Geology & Geophysics Division of DSIR New Zealand Oceanographic Institute Defence Scientific Establishment Hydrographic Office, Royal New Zealand Navy
Fiji:	South Pacific Applied Geoscience Commission
Hawaii:	Pacific Mapping Program Seafloor Surveys International, Inc. University of Hawaii

30 Mr. Hunter informed the meeting of the many bathymetric data collecting and mapping activities being carried out in the region and of the advances being made in the introduction of digital techniques for handling these data. He noted a general willingness of many organisations to collaborate with GEBCO and had identified a number of mapping activities of relevance to the updating of the GEBCO Digital Atlas.

31 The meeting felt that the information gleaned on such visits was of great value to the future work of GEBCO and that some way should be found to make it available to the GEBCO Community. After some discussion it was agreed that, as the Sub-Committee always undertook a review of ongoing national and international activities at each of its meetings, it would be appropriate that the GEBCO Bathymetric Editor's Visit Reports should be included as an annex to the Summary Report of such meetings. (The report on his mission to the Western Pacific region is therefore presented in Annex IV).

3.10 ALFRED-WEGENER-INSTITUT (AWI), BREMERHAVEN

32 Dr. Hans Schenke outlined AWI's bathymetric surveying activities from RV POLARSTERN and their continued primary interest in the Fram Strait, the Romanche Fracture Zone and in Antarctic waters between 70°W and 40°E, particularly the Weddell Sea region. In recent years RV POLARSTERN had performed boxed multibeam bathymetric surveys in the areas of:

North Atlantic:	"Fram Strait", Vesteris Seamount
Central Atlantic:	Ampere Seamount, Meteor Seamount, "Little Meteor Bank", Romanche Fracture Zone
South Atlantic:	"Weddell Fracture Zone"
Antarctic:	Wegener Canyon, "Explora Escarpment", sediment fans off the Filchner-Ronne Ice Shelf, Hero Fracture Zone

33 During 1991, RV POLARSTERN cruises yielded multibeam data as follows:

Arctic:	several profiles in the central part, touching the Gakkel and Knipovich Ridges
North Atlantic:	boxed surveys of central "Fram Strait" (now covering about 220 by 140 sq.km) boxed survey (60 by 80 sq.km) of Ampere Seamount
Central Atlantic:	part of Romanche Fracture Zone (now covering about 100 by 300 sq.km)
South Atlantic:	several profiles in the northern and eastern part of the Weddell Sea, Maud Rise and Astrid Ridge

34 During January-March 1994 RV POLARSTERN would be working in the Bellingshausen (71°S, 84°W) and Amundsen (72°S, 115°W) Seas.

35 Dr. Schenke stated that, because the gyro compass performed badly at high latitudes, the navigation system on RV POLARSTERN was now driven by three GPS receivers for the positioning and orientation of the vessel.

36 Dr. Schenke reported that the AWI planned to produce two large scale chart series of bathymetric maps: "Fram Strait Bathymetric Atlas" and "Bathymetric Charts of the Weddell Sea". Detailed maps would also be produced for smaller features such as seamounts. (Further information on AWI charting activities may be found under agenda item 6.1).

37 Dr. Schenke reported that AWI had completed the digitization of the tracklines printed on GEBCO Sheets 5.16 and 5.18. Stable base transparencies of the sheets had been raster scanned and the final data set had been produced in vector form on magnetic tape. The meeting expressed its grateful appreciation to Dr. Schenke for carrying out this work and a copy of the magnetic tape was handed to BODC for incorporation into the GEBCO Digital Atlas.

3.11 BUNDESAMT FÜR SEESCHIFFAHRT UND HYDROGRAPHIE (BSH), HAMBURG

38 Dr. Hans Schenke reported that a small group had been set up by the BSH at its branch-office in Rostock to operate as the German national centre for bathymetric data. The group started work in 1991 and would be responsible for managing both single beam and multibeam data collected by German ships. At present, effort was concentrating on developing appropriate digital systems for supporting the processing and banking of data, and on visiting the laboratories responsible for collecting the data. The group would support the main surveying activities of BSH in the North Sea and the Baltic, particularly for data collected by ATAIR, WEGA, GAUSS etc., as well as archiving bathymetric data collected on scientific cruises of METEOR, POLARSTERN, SONNE etc. The group would also act as a focus for the supply of German data to the IHO DCDB. The meeting welcomed this BSH initiative and wished the new centre a successful future.

3.12 UK HYDROGRAPHIC OFFICE (HO), TAUNTON

39 Mr. Brian Harper was pleased to report on the good progress being made at the HO in the changeover to digital techniques for handling bathymetric data. The Office had ceased maintaining their hard copy Oceanic Plotting Sheets and made use of two digitizing tables for manually converting incoming analogue data into digital form. He stated that 25 cruises of 1991 data had been dispatched on magnetic tape (in MGD77 format) to the IHO DCDB in March 1992. It was planned that all incoming data would be handled in digital form and that non-classified navy data, particularly passage tracks, would be worked up for submission to the IHO DCDB. In parallel with the ongoing digital capture of incoming data, the HO had begun the first phase of a project to capture historical data working back from 1990 to 1980. To date 10% of the cruises from 1990 had been captured in digital form working in this retrospective mode. In April 1992 it was planned to introduce a new database for recording/indexing digital ocean sounding data in the HO.

3.13 NATIONAL OCEAN SERVICE (NOS), WASHINGTON

40 Mr. Don Pryor reported on progress at NOS in the bathymetric mapping of the US Exclusive Economic Zone and presented an information brochure outlining the maps and data sets currently available. He explained how the Service was actively surveying the EEZ, using fully overlapping multibeam echosounding in offshore areas of depths greater than 100 metres, and producing bathymetric maps by automated techniques. To date the work had been concentrated in the Gulf of Mexico, the Gulf of Alaska, and off Hawaii, California, Washington, Oregon and Virginia. More than 50 maps had been produced, each covering an area of half degree latitude by one degree longitude. Printed maps were produced on UTM projection at a scale of 1:100,000 with depth contours at 20m intervals. As each map was published a digital version of the map was also made available on a single floppy disc readable by a PC or PC clone using PC-DOS or MS-DOS. Each disc contained two grids for the map area: a) a 250m UTM grid (as used for drawing the contours on the published map); and b) a less dense geographic grid derived from the UTM grid with depth values at every 15 seconds of latitude and longitude.

3.14 NAVAL RESEARCH LABORATORY (NRL), WASHINGTON

41 Mr. Norman Cherkis reviewed the various activities at NRL relevant to the updating of GEBCO. A new chart, "Bathymetry of the Barents and Kara Seas" was published in November 1991 on Mercator projection at a scale of 1:2,313,000. The chart had been raster scanned and the data was being processed and edited at USGS as part of a CAP pilot project. Mr. Cherkis offered to make this digital data set available to GEBCO once it had been completed.

42 In 1990 NRL completed a large survey of Aegir Ridge with multibeam (Atlas Hydrosweep) echosounding and SeaMARC II and the results were being finalised for publication. The contours would be produced from a gridded data set and should be available to GEBCO in 1994 (or possibly earlier).

43 Work was continuing in the compilation of a revision of the NRL Chart of "Bathymetry of Norwegian, Greenland and Western Barents Seas". The new chart would be enlarged to include all of the Barents and Kara Seas and the entire coast of East Greenland, and would be produced on polar stereographic projection. Collaborators in the chart were multinational and data had already been supplied by UK, Germany, France, Norway, Canada, Denmark, Iceland and Russia. Further data were being sought particularly in sparsely sounded areas.

44 Mr. Cherkis further reported that NRL had acquired the contours of Zemlya Frantsa Iosifa from Murmansk Marine Biological Institute, prepared by Gennady Matishov. NRL planned to edit and add data to the chart before submitting it to the Geological Society of America for publication.

45 Finally, Mr. Cherkis drew attention to a proposed geophysical atlas of the Northern Nordic Seas. A planning meeting for the project was held at the AGU in December 1991 and Kathleen Crane (LDGO) and Peter Vogt (NRL) were acting as primary conveners. The atlas would include sedimentary history, heat flow, transects, seismic stratigraphy, magnetics, SeaMARC II images, tectonics, structure and possibly gravity. It was planned that NRL would compile the bathymetry for the atlas and other contributions were anticipated from scientists in Norway, Germany, France, UK, Canada and USA. Possible Russian collaborators were being approached.

3.15 US NAVAL OCEANOGRAPHIC OFFICE (USNOO), BAY ST. LOUIS

46 Mr. Frank Marchant reported that there were no immediate plans at USNOO for updating the DBDB5 data set although preliminary investigations have been carried out to ascertain the problems that might be encountered in producing a gridded data set at two minute intervals rather than the present five minutes. A small sample area had been evaluated but doubts were cast as to whether two minute gridding was useful as many areas were not supported by adequate source data.

4. DIGITIZATION OF THE GEBCO (5TH EDITION)

47 The GEBCO Digital Atlas (GDA) Manager, Miss Pauline Weatherall, presented a report on her activities at BODC since the last meeting of the Sub-Committee. The main emphasis of this work had been in completing the digitization of the contours of the GEBCO (5th Edition) and in preparing for the revised version of Sheet 5.12. As of June 1991 all GEBCO (5th Edition) sheets had been digitized with the exception of Sheets 5.06, 5.10 and 5.12.

4.1 DIGITIZATION OF THE BATHYMETRY AND COASTLINES OF THE 5TH EDITION

48 Miss Weatherall reported that the bathymetric contours and coastlines for Sheet 5.10 had been digitized by Dr. Gary Robinson at the NERC Unit of Thematic Information Systems at Reading University and had been delivered to BODC on tape in early August 1991. No great difficulties had been encountered at BODC in checking the data out and assimilating them into the GDA.

49 As the printed version of Sheet 5.06 had been compiled by Dr. Iwabuchi at the Hydrographic Department of Japan and subsequently updated in a digital form at JODC, it had been decided to use the JODC data

set as the basis for input to the GDA. This data set was supplied to BODC on magnetic tape in September 1991 in two sections:

a) area 0° to 48°N; 120° to 180°E occupying 40 megabytes - these data originated from JODC's 1:1 million atlas of the area published in 1984 and a copy of the paper atlas was also supplied to BODC for checking the digitized data;

b) area 0° to 30°N; 100° to 120°E occupying 24 megabytes - these data originated from 1:1 million charts available at JODC but no accompanying hard copy charts were supplied to BODC for data checking.

50 Due to the size of these data files it was decided to reduce the volume of data by applying the Douglas-Peuker generalization algorithm with a lateral tolerance factor of 0.08 chart millimetres. This had the effect of reducing the data volume by 89% with minimal loss of information.

51 In checking through these data it was noted that the contours had not been edgematched across the individual 1:1 million sheets, i.e. discontinuities were apparent at intervals of 6° latitude and 10° longitude. Extra work was therefore entailed in edgematching the sheets paying close attention to the trackline control on the printed sheets.

52 The remaining area of Sheet 5.06 (i.e. 0° to 46°40'N; 90° to 100°E) was digitized at BODC following raster scanning by an external bureau of a stable base transparency of the published sheet. The contours were vectorized, labelled and edited using the Laser-Scan VTRAK software installed at BODC on a VAX workstation.

53 Miss Weatherall reported that, having completed the assimilation of the digitized contours for all the GEBCO Sheets (except 5.12 - see below) and in order to produce a seamless bathymetry for the world's oceans, she had undertaken a detailed edgematch between the digital data of all adjacent sheets. Where necessary the contours were adjusted so as to produce an edgematch and, in so doing, close attention was paid to the underlying track control on the published sheets. Only at the edgematch to Sheet 5.06 did any difficulties occur - due mainly to the fact that the contours were not digitized from the original 5th Edition sheet. Finally, in assembling the GDA, documentation was prepared to accompany the data for each sheet detailing the compiler of the sheet, the limits of the sheet, the contour depths digitized and any problems encountered in digitizing the sheet. At this stage areas of overlap between the published sheets were removed - in general the most up to date version of the bathymetry in each overlap area was retained.

54 The meeting recognized the great effort that had gone into the digitization of the contours of the 5th Edition Sheets and was pleased to note the high quality product that had been achieved. Grateful appreciation was extended to BGI, HDNO, NUTIS, JODC and BODC for the major roles that they had played in this work. The full data set (excepting Sheet 5.12) could now be obtained from BODC on magnetic tape (or floppy disc for single sheets) and a BODC Information Note was available describing the data set (see Annex V).

4.2 PROGRESS ON REVISING SHEET 5.12

55 Miss Weatherall reported on progress in digitizing the revised contours of Sheet 5.12 in preparation for the republication of the sheet by the Canadian Hydrographic Service. The revised contours were being compiled under the editorship of Peter Hunter - the bulk of the chart being based on the uncorrected depth contours from the chart (3° to 40°S; 70°W to 20°E) of 'Bathymetry of the South Atlantic' compiled by Norman Cherkis et al and published by the Geological Society of America in 1989. These contours were interpolated at 500m intervals of corrected depth by Robin Falconer and Jane Handley. Other contributions to the revised sheet were compiled by Norman Cherkis (0° to 3°S; 70°W to 20°E), Carl Brenner (40° to 50°S; 70°W to 20°E) and Gleb Udintsev (0° to 7°N; 70° to 20°W). For the remaining area (0° to 7°N; 20°W to 20°E) the contours would be taken from the digital version of Sheet 5.08 while the digital coastline would be taken from the World Vector Shoreline.

56 In February 1992 BODC began work on digitizing the contours from the hand drawn material prepared by the various contributors and Miss Weatherall was pleased to report that, except for the sections (0° to 3°S; 70°W to 20°E) and (40° to 50°S; 0° to 25°W), the bathymetric contours for revised Sheet 5.12 had been digitized. However, these data still had to be finally checked for labelling and registration errors and work was required to perform an edgematching between the component sections of the sheet. Once this had been completed, work would then start on digitizing the underlying tracklines before the full data set was plotted out for approval by the Sheet Reviewers. It would then be submitted to the Canadian Hydrographic Service for publication.

4.3 PREPARATION OF A GEBCO CD-ROM

57 With the imminent completion of the digitization of the 5th Edition contours and the production of a seamless digital data set covering the world's oceans, the meeting set about discussing how the data set might be best made available to the user community. The Chairman stated that, as an interim measure, the data set would be distributed by BODC on a single 6250bpi magnetic tape in GF3 format, although individual sheets could be distributed on floppy disc. However, it was generally recognized that the most effective form of distribution would be through the production of a CD-ROM with supporting software for use on personal computers. It was agreed that the package should serve not only as a mechanism for delivering the digital data to users but also be complemented by display software to enable the user to view the data as a live atlas with facilities to zoom into areas of interest.

58 In order to stimulate discussion on how the CD-ROM package might be configured, the meeting was given demonstrations of three PC-based Atlas products:

59 a) Mr. Pryor demonstrated a prototype version of the Digital Chart of the World being produced on behalf of the Defense Mapping Agency. The product was due to be released in the second half of 1992 and would contain global coverage of 17 thematic layers digitized from the 1:1 million ONC Charts (1:2 million for the Arctic). The data set would comprise 1.7 Gbytes of data stored on 4 CD-ROMs and formatted in the Vector Product Format, with the software interface being written in Turbo-C for use under DOS. Mr. Pryor demonstrated how the package would be used for zooming into selected geographic areas and viewing selected themes.

60 b) Dr. Andy Tabor of BODC demonstrated the Second Edition of the UK Digital Marine Atlas which had just been completed and would shortly be available on general release. It contained some 462 charts of the seas around the British Isles covering a wide range of maritime themes including resources and uses, conservation areas and protected sites, marine geology and biology, physical and chemical oceanography, meteorology, fisheries information, chart indexes and data catalogues. Topics ranged from sightings of the killer whale to the location of earthquakes; from cable routes and protected wrecks to tidal currents and storm surges; from seabird sightings and plankton distributions to fishing ports and herring catches; and from bottom deposits and iceberg plough marks to marine conservation areas and lifeboat stations.

61 c) Dr. Loughridge demonstrated a 'provocative draft' version of a GEBCO CD-ROM that had been developed at NGDC over the past 6 weeks from a magnetic tape of the GEBCO (5th Edition) contours supplied by BODC. The CD-ROM disc had been produced on NGDC's in-house equipment and a software interface had been put together using various elements of software already developed at NGDC. The package enabled individual GEBCO 5th Edition sheets to be selected and for the user to zoom into selected geographic areas displaying selected bathymetric contours colour coded according to the users specification. The meeting congratulated Dr. Loughridge on the speed with which the CD-ROM and its software had been prepared and recognized that it provided an excellent demonstration of how modern technology could be used to the benefit of GEBCO.

62 Following these demonstrations a wide ranging discussion ensued and, on the basis of this discussion, Dr. Tabor was invited to work during the meeting with a small group of participants to draft a system specification for the CD-ROM and its supporting software. The resultant draft is to be found in Annex VI. It was agreed that following his experience in developing UKDMAP, Dr. Tabor should be requested to undertake the development of the CD-ROM with the view to having a basic product available for

review at the next meeting of the Sub-Committee. Dr. Loughridge kindly offered the services of NGDC to assist Dr. Tabor in his task.

63 It was agreed that the first release of the CD-ROM should include:

a) The digitized GEBCO (5th Edition) bathymetric contours and coastlines;
b) Digitized tracklines from the GEBCO (5th Edition) sheets;
c) The names of undersea features (i.e. those named on the 5th Edition sheets) and their geographic coordinates;
d) Textual information crediting the sources of the data.

4.4 DIGITIZATION OF THE 5TH EDITION TRACKLINES

64 With the digitization of the contours and coastlines of the 5th Edition nearly complete, the next priority for BODC would be to digitize the tracklines from the published sheets. Only once this had been accomplished could one consider that the GEBCO Digital Atlas had become fully operational.

65 It was recalled that the tracklines for Sheets 5.01, 5.02 and 5.04 had already been digitized by the Head Department of Navigation and Oceanography at St. Petersburg and that a magnetic tape of these data had been submitted to BODC.

66 Dr. Schenke reported that his group at AWI had digitized the tracklines for Sheets 5.16 and 5.18 and he presented BODC with a magnetic tape containing these data. Miss Weatherall stated that BODC would digitize the tracklines on the remaining sheets by raster scanning stable base transparencies to be provided by the Canadian Hydrographic Service and then vectorizing the scanner output using the Laser-Scan VTRAK system at Bidston. It was recognized that this would be a major task.

4.5 GEBCO GAZETTEER

67 Ing. en Chef Michel Huet reported that the names of all undersea features appearing on the GEBCO (5th Edition) sheets were listed in IHO Publication BP-0008 together with single point coordinates of their geographic position - linear features were often described by a pair of positions at their extremities. He further reported that this information was now maintained at IHB on a DBASE-III database, copies of which could be made available on floppy disc. At the request of the meeting he kindly agreed to send a copy of the database to BODC for use with the GEBCO CD-ROM.

68 Ing. en Chef Huet explained that the database also contained the names of features on the IHO Small-scale International Chart Series as listed in the BP-0008 publication and additional names were added as and when they were approved by the GEBCO Sub-Committee on Geographical Names and Nomenclature of Ocean Bottom Features. Also included were the names from IBCCA Sheet 9 but the names from the IBCM charts had not yet been digitized due to their sheer volume.

69 The meeting recognized that as bathymetric charting moved towards compilations at larger scales the numbers of feature names would rise dramatically. This was obviously a problem that the Sub-Committee on Geographic Names and Nomenclature of Ocean Bottom Features would have to grapple with. However, once the GEBCO Digital Atlas started to be updated at scales no longer constrained by the 1:10 million scale of the published 5th Edition charts, special techniques would need to be developed for the electronic display of feature names depending on the map scale on which the features were registered. Problems were also anticipated in the positioning of feature names and in linking names to the geographic extent of the features. Dr. Robinson agreed to look into these problems. It was also suggested that the ICA Working Group on Marine Cartography might be able to provide useful insight into this matter.

5. DIGITAL WORLD COASTLINE

70 In looking forward towards the updating of the GEBCO Digital Atlas, the Sub-Committee had agreed at its earlier meetings that it was important to adopt a standard digital global coastline and had decided

upon the Defense Mapping Agency's World Vector Shoreline (WVS). The Chairman was pleased to recall that GEBCO had been given permission to use this data set in its products and that his initial evaluations of a prototype version of WVS had shown it to be a high quality product. It had been developed to the specification that 90% of all shoreline features be located within 500 metres (2mm at 1:250,000) of their true geographic position with respect to the WGS-84 datum.

71 The Chairman was pleased to report that he had recently received a set of 10 magnetic tapes containing the 2nd Edition of WVS - this superseded provisional versions received earlier. He was pleased to note that future updates of the data set would be clearly labelled with new edition numbers, thereby enabling GEBCO to be aware of which version of the data set was held.

72 Mr. Don Pryor informed the meeting that DMA intended to release a CD-ROM version of WVS in 1992 which, in addition to the full data set, would also include generalized versions at smaller scales (probably 1:1 million; 1:3 million and 1:12 million).

73 Dr. Robinson reported that he was currently evaluating digital coastlines around the British Isles - an initial comparison of WVS with the Ordnance Survey 1:50,000 sheet of the Isle of Wight had shown acceptable agreement, bearing in mind the differences in scale.

74 Concern was expressed that the accuracy specification for WVS only covered 90% of the globe and that no indication was given of the accuracy for the remaining 10% or where these areas occurred. It was agreed that members of the GEBCO community should be invited to evaluate the data set in their own geographic areas of interest so as to build up user confidence in the product and to identify any potential uncertainties. The Chairman agreed to coordinate this evaluation and to keep DMA fully informed of its outcome.

75 Dr. Schenke reported that there were major uncertainties in the coastline of Antarctica, which were reflected in WVS, and that AWI, in collaboration with the Institute for Applied Geodesy in Frankfurt, was engaged in preparing a revised Antarctic coastline from 0° to 70°W using LANDSAT images (the section 0° to 50°W had already been completed). It was understood that the US and Australia were engaged in similar work in other areas of the Antarctic.

6. FUTURE DEVELOPMENT OF THE GEBCO DIGITAL ATLAS

6.1 REVISION OF THE BATHYMETRY OF THE WEDDELL SEA AT AWI

76 Dr. Heinrich Hinze reported on developments at AWI that would eventually lead to a revision of GEBCO Sheet 5.16 and the adjacent area of Sheet 5.18. Work was already underway preparing 'Bathymetric Charts of the Weddell Sea' and a set of 1:1 million charts would be produced on Mercator projection in three latitudinal bands between 60°S and 78°S, coincident with the standard IHO Oceanic Plotting Sheets (as shown in Annex VII). Once these had been completed a composite chart would be produced covering the entire Weddell Sea on stereographic projection at a scale of 1:3 million. Dr. Hinze anticipated that the charts would be produced in 1994 and that they would be submitted to BODC in digital form for incorporation in the GEBCO Digital Atlas. In several areas covered by multibeam boxed surveys detailed charts at 1:100,000 would be produced, e.g. Wegener Canyon and its vicinity and other parts of the eastern Weddell Sea area.

77 Dr. Hinze explained the digital techniques that were being developed at AWI to assist in the mapping programme. These were based essentially on Digital Terrain Modelling onto uniform grids coupled with a certain amount of predictive modelling in areas of sparse sounding coverage. One of the major problems in mapping the Weddell Sea was the inhomogeneity of data coverage, often of different type, source and quality. Testing of the modelling techniques was being carried out in three areas with different topographic characteristics:

a) Maud Rise where a wide range of swath, track and spot sounding data were available with good data coverage;

b) abyssal plain areas of the Weddell Sea, where data coverage varied from boxed swath sonar surveys in some areas to other areas where no data were available within a radius of some 100km;

c) continental margin of Antarctica often showing very rough and unpredictable topography within its slope region between shallow and deeper waters.

78 One of the problems with topographic modelling was in dealing with navigation errors in the data, and techniques were being developed for shifting tracks so as to minimize estimated errors at the grid points. Programs had been developed for the processing of multibeam measurements for automatic blunder checking and to identify rogue data points.

79 Mapping of the western part of the Weddell Sea was proving to be problematical due to variable ice coverage and the sparsity of data. Alternative techniques were being considered for this area including the possible use of radar altimetry and magnetic data for trend determinations, coupled with spot values from hand held depth recorders. Dr. Hinze reported that he had noted some correlation between magnetic patterns, Free-Air gravity anomalies and marine morphological structures.

80 Dr. Schenke informed the meeting that the seafloor in the region of the South Atlantic between 70°S, 8°W to 55°S, 6°E had recently been mapped using the Hydrosweep swath system under the subtrack of a ERS-1 three day orbit. He was optimistic that the analysis and comparison of the bathymetry, gravity and altimeter data would provide information on the correlation of these data and assist in the prediction of the bathymetry in the remoter areas of the southern oceans.

81 Dr. Schenke stressed that the computer techniques being developed at AWI were simply tools to assist the mapping process and that in the final analysis it was the intuitive instinct of the bathymetrist that controlled the nature of the final product. The meeting congratulated Drs. Schenke and Hinze on the progress being achieved at AWI and looked forward to the completion of the Weddell Sea charts. Concern was expressed that, as yet, not all of the data collected in the area were available to them and participants were requested to assist in searching out missing data.

6.2 RESEARCH INVESTIGATIONS AT NUTIS

82 Dr. Robinson introduced this item by explaining that the NERC Unit of Thematic Information Systems had a long history in the field of geographic modelling and had an interest in undertaking novel research in this area. To date most of this work had been focused on land based applications and they welcomed the opportunity of experimenting in the marine field. For GEBCO purposes they were keen to develop automated techniques that could assist in bathymetric mapping and had identified the problem of assimilating trackline data, with its inherent data errors, into terrain models as an appropriate topic for research. Mr. Paul Pan had been taken on as a research assistant to investigate this problem.

83 Mr. Pan outlined the nature of the system he was attempting to develop involving the assimilation of data into digital terrain models, the estimation of error fields, the automatic updating and refining of the DTM with new data and the automatic production of mapping products. He was beginning his studies by developing a system to handle trackline data with its inherent problems relating to positional errors, it being recognized that although errors in modern data were greatly reduced by the use of GPS positioning, much of the global coverage of sounding data depended on older data.

84 As a first step he had developed a workstation system providing facilities for visualising trackline data at a variety of viewing angles, for examining crossover errors and for adjusting tracks to minimize such errors. The system, comprising some 12,000 lines of code, was written in X and Motif on a VAX workstation but had been designed to be portable across UNIX systems. Mr. Pan gave a demonstration of his system which aroused considerable interest. It was suggested that with further development the system might be of considerable value for examining and quality controlling data being submitted to the IHO DCDB, for example, by the VHOs.

85 Mr. Pan explained that he would be further developing the system so as to enable tracks to be compared with other data sets such as GEBCO contours or DBDB5. Further statistical tools would be added to the system and universal kriging techniques would be introduced for the computation of DTMs and

automatic contouring. At all stages, error analysis facilities would be available to examine the quality of the data and its derived products. The meeting encouraged Mr. Pan to continue his interesting work and looked forward to being kept informed of developments.

7. IHO DATA CENTRE FOR DIGITAL BATHYMETRY (DCDB)

86 Dr. Mike Loughridge reported that, since being officially established on 1st June 1990, the DCDB had made substantial progress towards establishing itself as the focal point for digital bathymetric services for the IHO Member States. In many respects this complemented and paralleled the existing activities of the co-located World Data Centre 'A' for Marine Geology and Geophysics and the US National Geophysical Data Center (NGDC). In November 1991, Lt. Cmdr. Maureen R. Kenny was recruited to DCDB to monitor and facilitate data exchanges and to oversee the operation under Dr. Loughridge. In June 1991, Dr. George F. Sharman was recruited to NGDC to oversee the development of the bathymetric processing systems and databases, particularly for extending the existing operation to accommodate multibeam and swath data.

87 Dr. Loughridge further reported that, over the period 1 June 1990 to 1 April 1992, a total of 266 cruise/legs of data had been assimilated into the Underway Geophysics Data Bank, including over 3 million digital soundings collected over some 792,000 nautical miles of track. In addition to accessions of data from US laboratories he was pleased to report data submissions from 6 other countries. A statistical breakdown of the total holding, and of data archived since 1 June 1990, may be found in Annex VIII.

88 The DCDB was actively conducting programmes to digitize bathymetric data from paper or hard copy plotting sheets and had established internal standards for this work. In addition to their contribution to GEBCO, NGDC staff were actively involved in exchanging bathymetric data with the IBCCA, IBCEA, IBCWIO and IBCWP projects, and in collaborating in the compilation of charts for IBCCA.

89 Dr. Loughridge announced that NGDC would be publishing the complete MGD77 marine geophysics database on two CD-ROM discs in late 1992, including bathymetry, magnetics and gravity data as well as a navigation inventory. These discs would be supported by software to enable users to search the inventory for specific data, to view tracklines on the screen and to retrieve selected data into ASCII MGD77 format data files.

90 In May 1991 in order to facilitate an active international exchange of multibeam bathymetric data, NGDC began developing a comprehensive inventory of multibeam cruises worldwide. Requests were made to numerous institutions and IHO Member States with multibeam systems for cruise information, and a substantial amount of material had already been submitted. NGDC intended to continue to update this inventory as new systems were brought on-line. Work had already started in discussing optimum structures for the exchange of swath bathymetry and digital side scan sonar imagery, and close attention was being paid to the systems in use at NOS, University of Rhode Island and the Scripps Institution of Oceanography. In particular NGDC was looking to provide a secondary archive for the large volumes of NOS multibeam data.

91 Finally Dr. Loughridge reviewed current computing trends at NGDC. The Center was making increasing use of the Internet network for the transmission of data files up to 10-12 Mbytes in size, and in particular for servicing customer requests. For larger data volumes NGDC now had facilities for generating customer tailored CD-ROMs internally - this was proving to be more cost effective than preparing data on magnetic tape. However, fearing that the technology for optical storage was not stable, the Center had supplemented the use of optical discs as a medium for the safe long term archiving of data with the use of 3480 tape cassettes. At present the Center was engaged in migrating all of its 30-40,000 nine track magnetic tapes to 3480 tapes. The representatives of both AWI and BODC stated that they were also moving to 3480 tapes for data archiving, although optical discs were recognized as providing an excellent working media for data.

8. REVISION OF THE 'GUIDELINES OF THE GEBCO'

92 Mr. Brian Harper reported on the intersessional activities of the IHO Working Group on Oceanic Plotting Sheets which was due to submit its findings to the forthcoming 1992 International Hydrographic Conference. From a GEBCO viewpoint the main conclusion of the Working Group had been that the present system of maintaining hard copy 'collected soundings sheets' should be phased out in favour of a digitally based system centered around the activities of the IHO Data Centre for Digital Bathymetry. The VHOs would continue to play a major role in searching out and quality controlling sounding data in their own geographic area of interest and in ensuring its submission in digital form to the IHO DCDB where the global database of soundings would be maintained. VHOs and HOs would also be expected to give active encouragement to other national data collectors to send their data to IHO DCDB or through them for coordination and validation purposes.

93 The Working Group had recognized that VHOs, or regional groups of VHOs, might wish to maintain their own geographic area databases. Indeed, this was to be encouraged as a means of effecting efficient quality control on new data and obtaining regional coherence. However, in such cases, it was recommended that the administrators of such databases should liaise closely with the IHO DCDB and ensure that copies of their data were also sent to the IHO DCDB. A similar relationship with IHO DCDB was also envisaged for those coordinators engaged in projects for the production of IOC's Regional Bathymetric Chart series.

94 Mr. Harper tabled for discussion a second draft of Part 2B of the BP-0007 'Guidelines for the GEBCO' which dealt with the implementation of the findings of the Working Group concerning the handling of digital bathymetric data by the VHOs and HOs. The draft included sections on: a) the role of the IHO Volunteering Hydrographic Offices; b) the role of the IHO Member State Hydrographic Offices; c) IHO Bathymetric Publication BP-0004; and d) the important issue of converting existing Oceanic Plotting Sheets to digital form. The meeting reviewed the document line by line and suggested a number of alterations for Mr. Harper's consideration. It was generally agreed that, if the findings of the Working Group were put into practice, this would provide a strong foundation for ensuring an effective management of digital bathymetric data on a global basis and Mr. Harper and his Working Group were congratulated on an excellent piece of work. It was recognized that, at some future date, consideration should also be given to the handling of multibeam data and that the IHO DCDB had already made a start on this issue.

95 The Chairman tabled, for the approval of the meeting, final versions of Part 3 (Digital Bathymetric Data from Single-Beam Echo Sounders) and Part 5 (Underway Geophysics Data) of BP-0007. It was recalled that earlier drafts of these sections had been discussed in detail by previous meetings of the Sub-Committee. The Chairman stated that the IHB had circulated the documents to the Member States of the IHO for comments, and that he and the IHB had been able to address the comments received by making minor changes which had been incorporated into the final versions of the documents. These documents were then approved by the meeting.

9. ANY OTHER BUSINESS

96 The meeting decided that it would be appropriate to review the Terms of Reference of the Sub-Committee which were first formulated back in 1984 at the time of its first meeting at Bay St. Louis. It was generally agreed that considerable progress had been achieved in the meantime and that, with the successful a) digitization of the GEBCO (5th Edition) bathymetry, b) establishment of the IHO Data Centre for Digital Bathymetry, and c) updating of the GEBCO Guidelines to reflect a new digital framework for managing sounding data, the Sub-Committee had virtually completed its work on items 1, 2, 4 and 5 (see Annex III), at least to the extent that these items needed updating. Furthermore, the meeting felt that the Sub-Committee had established itself as an effective forum for reviewing worldwide activity in the field of bathymetric mapping and data management, and for formulating technical solutions to support these activities. The Sub-Committee also had a key role to play in supporting the work of the IHO DCDB and the GEBCO Digital Atlas. It was agreed that the Chairman should be tasked with drafting updated Terms of Reference for consideration at the next meeting of the Sub-Committee.

10. CLOSURE OF THE MEETING

97 In closing the meeting the Chairman thanked participants for their active and positive contributions, and in particular for the enthusiastic manner in which they were cooperating in the work of GEBCO. It was agreed that, in order to maintain the momentum of the Sub-Committee's work, a further meeting should be held in a year's time.

98 The meeting closed at 17.00 on Friday, 10 April 1992.

Meirion T. Jones
Chairman

ANNEX I

AGENDA

1. Opening of the Meeting

2. Conduct of the Meeting

3. Review of Related Activities of Other International and National Groups

4. Digitization of the GEBCO (5th Edition)

5. Digital World Coastline

6. Future Development of the GEBCO Digital Atlas

7. IHO Data Centre for Digital Bathymetry

8. Revision of the GEBCO Guidelines

9. Any Other Business

10. Closure of the Meeting

ANNEX II

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ANNEX III

TERMS OF REFERENCE

GEBCO Sub-Committee on Digital Bathymetry (SCDB)

The Sub-Committee on Digital Bathymetry shall:

1. Maintain a watching brief on those agencies or institutes which are or may be intending to digitize the GEBCO (5th Edition) contours, or input therefrom, to ascertain:

   a) the method being used;
   b) the format of the digitized material; and
   c) the availability of the completed digitized record.

2. Interact with the IHO Committee on Exchange of Digital Data (CEDD) to bring about, to the extent possible, uniformity and compatibility with International Oceanographic Data Exchange (IODE) (*) developments and also with IHO Classification Criteria for Deep Sea Soundings (IHO Special Publication No. 44).

3. Investigate and recommend ways and means by which digital methods may be used to expedite production of the GEBCO (6th Edition).

4. Study and report on the ways and means of achieving an international system of storage and retrieval by an automatic digital system of the data at present stored by the IHO (as the World Data Centre for Bathymetry) on 1:1 million and 1:250,000 plotting sheets, and any further data to be collected in the future.

5. Provide advice for the International Hydrographic Organization (in its capacity as the World Data Centre for Bathymetry) on matters connected with the collection and exchange of high-quality bathymetric data, in particular on the development of automatic data generating, archiving and retrieval, soliciting the advice and assistance of the IOC Working Committee on International Oceanographic Data Exchange (IODE) (*), as necessary.

6. Identify new sources of data, in particular those stored in digital form, with the object of ensuring that maximum available data are submitted to the World Data Centre for Bathymetry.

(*) Now "International Oceanographic Data and Information Exchange"

ANNEX IV

REPORT ON THE GEBCO BATHYMETRIC EDITOR'S VISIT TO THE WEST PACIFIC REGION - 5 TO 28 FEBRUARY 1992

Note: This report contains the informal notes taken by Mr. Peter Hunter on his visits - the information has not been checked for accuracy by the organisations visited.

JAPAN

ORI - Ocean Research Institute, University of Tokyo. (Marine Geology and Geophysics)

Address:	Ocean Research Institute, University of Tokyo (Marine Geology and Geophysics), 15-1, 1-chome, Minamidai, Nakano-ku, TOKYO 164, Japan.
Tel:	(+81) 3 3376 1251
Fax:	(+81) 3 3375 6716
Director:	ASAI, Dr. Tomio
Main contact:	NAKANISHI, Dr. Masao (Ocean Floor Geotectonics)
Other contacts:	KOBAYASHI, Professor Kazuo (Head, Ocean Floor Geotectonics) TAIRA, Professor Asahiko (Head, Submarine Sedimentation) TOKUYAMA, Dr. Hidekazu (Submarine Sedimentation) KLAUS, Dr. Adam (Submarine Sedimentation)

Notes on visit of 05/02/92:

ORI have two research vessels; "Tansei-Maru" and "Hakuho-Maru". The "Hakuho-Maru" has Seabeam installed. The geology and geophysics groups at ORI use this ship for about 50 days per year. Most of their activities have been in Japanese waters. During Summer 1992 they will be working in the Kuril Trench. A cruise to the Indian Ocean Triple Junction is planned for 1993, TAMAKI will be the PSO. Their intention is to deposit all their data with Boulder eventually, of particular interest would be cruise 89-2 which circum-navigated the World.

Magnetic anomalies in the northwest Pacific are also studied here.

The Submarine Sedimentation group uses the IZANAGI which was built by SSI Inc. (See later SSI report). Studies have concentrated on the Izu-Ogasawara Arc area. The IZANAGI is producing a great deal of good quality bathymetry which finds its way to the JODC.

Documents collected on visit:

a) Ocean Research Institute, University of Tokyo, Catalogue 1990, 53pp.

b) Klaus, A. & Taylor, B., (1991). "Submarine canyon development in the Izu-Bonin forearc: a SeaMARC II and seismic survey of Aoga Shima Canyon". Marine Geophysical Researches, 13(2), 131-152.

c) Taylor, B., Klaus, A., Brown, G.L., Moore, G.F., Okamura, Y. & Murakami, F., (1991). "Structural development of Sumisu Rift, Izu-Bonin Arc". Journal of Geophysical Research, 96(B10), 16113-16129.

d) Nakanishi, M., Tamaki, K. & Kobayashi, K., (1989). "Mesozoic magnetic anomaly lineations and seafloor spreading history of the northwestern Pacific". Journal of Geophysical Research, 94(B11), 15437-15462.

e) Kobayashi, K. (Ed.), (1991). "Preliminary report of the 'Hakuho Maru' Cruise KH 90-1, June 25-July 28, 1990: geological and geophysical investigation of Japan Trench and Izu-Ogasawara region". Tokyo: University of Tokyo, Ocean Research Institute. 174pp. Includes 3 bathymetric maps [scale: 1/300,000 @ 35°N, contour interval 50 metres] and 3-D view of the Japan Trench, based on Sea Beam survey 37°45' to 39°45'N x 143°30' to 145°E.

f) An example of sidescan sonar record from a survey by the IZANAGI instrument.

HD MSA - Hydrographic Department, Maritime Safety Agency

Address: Hydrographic Department,
Maritime Safety Agency (Kaijohoan-Cho Suiro-Bu),
3-1, Tsukiji 5-chome,
Chuo-ku,
TOKYO 104,
Japan.

Tel: (+81) 3 3541 3811

Fax: (+81) 3 3545 2885

Director: IWABUCHI, Dr. Yoshio (Chief Hydrographer)

Main contact: YASHIMA, Dr. Kunio (Head of Marine Research Laboratory)

Other contacts: KASUGA, Mr. Shigeru (Continental Shelf Surveys Office)

Notes on visit of 06/02/92:

In addition to their standard nautical charts, the Hydrographic Department of Japan also publish Basic Maps of the Sea. Bathymetry and submarine structure are available for coastal water areas at scales of 1:10,000 and 1:50,000, and these plus total magnetic intensity and gravity anomalies are available for the continental shelf areas at a scale of 1:200,000 (a 1:500,000 scale is planned for the near future).

The contouring of bathymetry by computer was demonstrated: Seabeam mapping provides a substantial part of the input to the database, on the shelf survey lines at 5 n.miles spacing are available (the requirement for these has been driven by EEZ and mining needs). In-house software grids and contours the data at a scale of 1:500,000, corrections are made by hand. The final contours are used at various scales. For GEBCO, the 500 metre contours are extracted and digitised. Cross checking of the contouring is carried out by others outside HD (such as KOBAYASHI at GSJ). A new bathymetric map of "The Southern Seas of Nippon" was given to the GBE, the contours depicted are a later version than those in the GEBCO Digital Atlas.

Documents collected on visit:

a) The Hydrographic Department of Japan Brochure [in Japanese and English].

b) JODC Bathymetry Integrated Random Dataset (JBIRD), 1990#3, pp161.

c) Japanese Chart Index (Nippon & Adjacent Seas) Mar. 1991. [in Japanese and English]

d) Japanese Chart Products leaflet [in Japanese].

e) Hedo Misaki. "Bathymetric Chart 6507, 1/50,000, Lambert Conformal Projection". MSA, Tokyo, 1989.

f) Hedo Misaki. 1. Submarine Structural Chart, 2. Report of Survey. Basic Map of the Sea in Coastal Waters (1:50,000), No.6507 2-s. Maritime Safety Agency, Tokyo, Japan, 1989.

g) Asada, A., (1988). "Contour Processing and 3-D Image Processing of Sea Beam Bathymetric Data". International Hydrographic Review, Monaco, LXV (1), p 65-80.

h) Tani, S., (1989). "Detailed Topographic Study of the Daiichi-Kashima Seamount". Palaeogeography, Palaeoclimatology, Palaeoecology, 71, p 31-47.

i) The East of Boso Hanto. 1/200,000, Lambert Conformal Projection. 6366S Submarine Structural Chart. MSA, Tokyo, Jan. 1979. 6366M Total Magnetic Intensity Chart. MSA, Tokyo, May 1982. 6366G Gravity Anomaly Chart. MSA, Tokyo, Nov. 1982. 6366 Bathymetric Chart. MSA, Tokyo, Jan. 1988.

j) The Southern Seas of Nippon. Bathymetric Chart, 1/2,500,000, Lambert Conformal Projection. Hydrographic Department, MSA, Tokyo, 1991.

k) GEBCO Ocean Sounding Chart G1405, 1/1 million @ 35°N, MSA, Tokyo 1974. [An example of the old methods].

l) GEBCO Ocean Sounding Chart G1405, 1/1 million @ 35°N, MSA, Tokyo 1986. [An example of the new methods].

m) An example of Present Bathymetric Mapping Methods at the HD MSA; A series of 3 charts showing the progression from Sea Beam surveys, through computer contouring to the final hand-adjusted contoured chart. Scale: 1/500,000, Lambert Conformal Projection. [27°-30°N x 140°-142°30'E].

JODC - Japan Oceanographic Data Center, Hydrographic Department

Address: Japan Oceanographic Data Center,
Hydrographic Department,
3-1, Tsukiji 5-chome,
Chuo-ku,
TOKYO 104,
Japan.

Tel: (+81) 3 3541 3811

Fax: (+81) 3 3545 2885

Director: YAMADA, Dr. Osamu

Main contact: TANI, Dr. Shin

Other contacts: SHIMAKAWA, Ms. Yasue

Notes on visit of 06/02/92:

Most of the bathymetric data held at JODC is in digital form, there are still some remaining data still to be digitised. All the original "raw" data is still held. The version of bathymetric contours represented in the GEBCO Digital Atlas is not the latest available, more recent contouring is held, but it needs to be digitized, also it does not contain recent work by the groups at ORI, GSJ and elsewhere.

Shin TANI demonstrated a rudimentary Digital Atlas that he is writing software for. It is based on an optical disc that contains a copy of the JODC bathymetric contours in the northwest Pacific, at present it has very limited facilities, such as; colour coding of contours, selecting a window and zoom. He is hoping to develop it further and distribute it on a CD-ROM.

Documents collected on visit: See list under HD MSA.

AUSTRALIA

RAN HS - Royal Australian Navy, Hydrographic Service

Address: Royal Australian Navy,
Hydrographic Service,
161 Walker Street,
NORTH SYDNEY,
NSW 2060,
Australia.

Tel: (+61) 2 925 4800

Fax: (+61) 2 925 4835

Director: LEECH, Capt. John W. (Hydrographer)

Main contact: BOLGER, Lt. Cdr. Mark

Other contacts: BURROWS Mr. Kenneth G. (Director, Coordination & Development)
HALLS, Mr. Ian W. (Project Development Officer)
DOYLE, Mr. Joe
SEARLE, Mr. Ben J. (AODC)

Notes on visit of 10/02/92:

The Hydrographic Service is very close to having full digital capabilities. A Hydrographic Information System (HIS) has been developed to meet the needs of the Hydrographic Service; to handle raw survey data, survey planning and management and chart information management. It handles all types of hydrographic data and also accepts those from external data sources. Geographic Nomenclature and the requirements for GEBCO are included in the HIS. One database covers both Hydrographic Charting and GEBCO Mapping, so long as the input data is properly edited and its integrity is maintained. The Hydrographic Data Base is intended as an integrated repository of hydrographic digital data from all sources, this includes data that was previously designated as GEBCO, but data in the HDB is not be confined to soundings alone. It is organised along the lines of a multi-level pyramid, the base contains all the survey data, regardless of provenance, age or if surveys overlap other sets. The second level contains selected sounding data that is suitable for hydrographic charting and has been quality controlled and hydrographically approved. This is the GISMO (General Integrated Survey Model of the Oceans); it is a single contiguous model of the World. On top of the GISMO are summary levels which contain generalised data for use at smaller scales (ie. GEBCO). The section responsible for GEBCO is controlled by Mark BOLGER. The manuscript GEBCO sounding sheets are no longer up-dated because of the imminent availability of the HIS. The copies of original data plots are well maintained.

There is a flourishing nomenclature section under Joe DOYLE; he has methodically entered all the names for Australian Undersea Features into an Excel database on an Apple Mac computer. He regularly submits the new names to IHB.

Documents collected on visit: None.

BMR GG - Bureau of Mineral Resources, Geology & Geophysics

Address: Bureau of Mineral Resources,
Geology & Geophysics,
GPO Box 378,
CANBERRA,
A.C.T. 2601,
Australia

Tel: (+61) 62 499353

Fax: (+61) 62 576041

Director: JOHNSTON, Mr. Chris

Main contact: JONGSMA, Dr. Derk (ORMS)

Other contacts: MOFFAT, Mr. Martyn
JAENSCH, Ms. Angela

Notes on visit of 11/02/92:

BMR,GG, in conjunction with the Bureau of Rural Resources and the Australian Hydrographic Service, is compiling and publishing a series of 32 bathymetric maps of the Australian continental margin at a scale of 1:1,000,000. The project is known as the ORMS (Offshore Resource Map Series). These maps are based on the National Bathymetric Map Series (NBMS) (1976-90) at 1:250,000 scale, marine geophysical and

geological surveys carried out by BMR over the last 20 years (digital data, providing approximately 50% of the deep-water information) and GEBCO. Non-digital data, including the contours from the 1:250,000 NBMS maps, are digitized. An initial run grids and contours the BMR data, using Petroseis software on a PC, editing takes place and additional data are added for further runs, the resultant contours are then manipulated and edited by an expert geologist (Derk JONGSMA); at this stage non-depth information is used to improve the depicted shape of the sea-floor. The changes are digitized back into the digital map using Intergraph software and the final maps are published through Map Publisher software. Checking of the final contours is carried out by other people who cross-check with original bathymetric profiles. With the necessary authority, these maps in their digital form would make ideal material for including in the GEBCO Digital Atlas.

Documents collected on visit:

a) Johnston, C.R., Jongsma, D., Falvey, D.A. & Jernakoff, P., (1990). "Bathymetric Mapping of the Australian Continental Margin: A Possible Model for the IOC WESTPAC Region?" Bureau of Mineral Resources, Geology & Geophysics, BMR Record 1990/56, 23pp.

b) Jongsma, D., Johnston, C.R., Davies, H.L., & Jernakoff, P., (1991). "CEDUNA (1:1,000,000 scale Offshore Resource Map)". Bureau of Mineral Resources, Geology & Geophysics, Canberra, Australia.

c) Copy of the layout of the 1:250,000 & 1:1,000,000 scale sheets used in the ORMS Project.

d) Onslow Bathymetric Survey. Sheet SF 50-5, Edition 1, National Bathymetric Map Series, scale 1:250,000. NATMAP, Australia, 1983.

JCU James Cook University of North Queensland, Department of Geology

Address:	James Cook University of North Queensland, Department of Geology, TOWNSVILLE, QUEENSLAND 4811, Australia.
Tel:	(+61) 77 81 4536
Fax:	(+61) 77 25 1501
Director:	
Main contact:	JOHNSON, Dr. David (Marine Geoscience Research Group)
Other contacts:	HOPLEY, Prof. David (Biology) BODE, Dr. Lance (Civil Systems) MASON, Mr. Luciano

Notes on visit of 12/02/92:

In the Department of Geology, Dave JOHNSON is working on the interpretation of some of the recent GLORIA survey. In particular they are interested in the region of the Coral Sea. Any bathymetric data that they collect is forwarded to the RAN HS.

In another group, David HOPLEY is interested in having access to good contoured bathymetry, although in the past any bathymetric measurements made were dust-binned after cruise, because they were only positioned with a dhan-buoy. Bathymetry will now be positioned with GPS and so will have value; these data will be handed on to the RAN HS.

Lance BODE and others are working on gridded bathymetry. At present they are using ETOPO5 for the oceanic areas, but are having problems with it, they are very keen to replace it with GECBO bathymetry. They have created their own dataset for the Great Barrier Reef region, the size of this is 32 Mbytes. They have their own gridding algorithms and are making use of variable grid sizes, 100 metres (0.5') to 15' grid cells. The grids are kept separately.

Documents collected on visit: None

AIMS - Australian Institute of Marine Science

Address:	Australian Institute of Marine Science, Private Mail Bag 3, TOWNSVILLE, QUEENSLAND 4810, Australia.
Tel:	(+61) 77 78 9211
Fax:	(+61) 77 72 5852
Director:	BAKER, Dr. Joe T.
Main contact:	PARKER, Mr. Bruce (Reef Biology)
Other contacts:	BURRAGE, Dr. Derek (Physical Oceanography) ISDALE, Dr. Peter

Notes on visit of 13/02/92:

AIMS is principally associated with the understanding of coastal and reef processes and resources in tropical seas and the living communities of tropical Australia, Southeast Asia and the Pacific and Indian Oceans. Peter ISDALE specialises in coral chronologies/ palaeoenvironments, he and Bruce PARKER used "SURFER" software to generate vertically enhanced 3-D images from raw bathymetric data on a PC computer.

The data were obtained from AUSLIG (Australian Surveying and Land Information Group). The 3-D images enabled submarine relief details not visible by other means to become evident, providing novel information on reef platform evolution and current geomorphological processes.

Derek BURRAGE specialises in the dynamics of Australian tropical seas. He uses DTMs derived from ETOPO5. He is interested in the effects of the bathymetry on the current patterns.

Documents collected on visit:

a) Projected Research and Development Activities 1991/1996. Australian Institute of Marine Science.

b) Isdale, P., (1991). "Three-dimensional representation of coral reefs: generation of submarine terrain images on personal computers". Marine Geology 96, p.145-150.

NEW ZEALAND

GRA - GeoResearch Associates

Address: GeoResearch Associates,
P O Box 137,
WAIKANAE,
New Zealand.

Tel: (+64) 4 293 4659

Fax: (+64) 4 293 4659

Director: FALCONER, Dr. Robin K. H.

Main contact: FALCONER, Dr. Robin K. H.

Other contacts: HANDLEY, Mrs. L. Jane

Notes on visit of 17/02/92:

Robin FALCONER and Jane HANDLEY handled the interpolation of the 500 metre interval contours for the replacement GEBCO South Atlantic sheet 5.12. Their main work is geological consultancy for a variety of clients. A great deal of data handling is carried out on a PC with the GIS package pcArc/Info. This produces very presentable maps and is used to pass files to the clients to use on their own systems.

Documents collected on visit: None

DSIR G&G - Department of Scientific & Industrial Research, Geology & Geophysics

Address: Department of Scientific & Industrial Research,
Geology & Geophysics,
32 Salamanca Road,
Kelburn,
PO Box 1320,
WELLINGTON CENTRAL,
New Zealand.

Tel: (+64) 4 4738 208

Fax: (+64) 4 4710 977

Director:

Main contact: DAVY, Dr. Bryan

Other contacts: WOOD, Dr. Ray

Notes on visit of 18/02/92:

The Geology & Geophysics Division of DSIR has recently changed its name to the 'Institute of Geological and Nuclear Sciences'. Their main thrust is geophysical surveys, but they collect some bathymetric data which is handed on to NZOI for their bathymetric mapping programme compilations. They would prefer to sell their data to GEBCO and others because of the costs and efforts involved in gathering it.

They are currently involved in setting up an Arc/Info GIS on a SUN computer.

Documents collected on visit: None

NZOI - New Zealand Oceanographic Institute

Address: New Zealand Oceanographic Institute,
National Institute of Water & Atmospheric Research Ltd. (NIWAR),
Evans Bay Parade,
Greta Point,
P.O. Box 14-901,
Kilbirnie,
WELLINGTON 3,
New Zealand.

Tel: (+64) 4 386 1189

Fax: (+64) 4 386 2153

Director:

Main contact: CARTER, Dr. Lionel

Other contacts: LEWIS, Dr. Keith
WRIGHT, Dr. Ian

Notes on visit of 19/02/92:

NZOI produce an excellent series of bathymetric maps at scales of 1:200,000 and 1:1,000,000. The later sheets exist as digital contours, which may be available to GEBCO. They use all available data. Bathymetric maps are produced frequently as data permits. Since the beginning, ~266 charts have been published by NZOI, the present day external costs (printing etc.) are about NZ$20,000 (US$11,000). Their main purpose is to be used as 'roadmaps' of the seafloor. Commercial data lodged at NZOI are available after 5 years.

Documents collected on visit:

a) Thompson, R.M., (1991). "Gazetteer of Seafloor Features in the New Zealand region". Miscellaneous Publication 104, New Zealand Oceanographic Institute, DSIR Marine and Freshwater, Wellington. 64pp. [Note: This document was passed on to M. Michel HUET, IHB]

b) Thompson, R.M.C., (1989). "Division of Water Sciences, New Zealand Oceanographic Institute List of Charts". NZOI, DWS, DSIR, Wellington. 24pp.

c) van der Linden, W.J.M., (1968). "Three Kings Bathymetry". N.Z. Oceanogr. Inst. Chart, Oceanic Series, 1:1,000,000.

d) Krause, D.C. & Cullen, D.J., (1970). "Bounty Bathymetry". N.Z. Oceanogr. Inst. Chart, Oceanic Series, 1:1,000,000.

e) Baldwin, R.P. & Lewis, K.B., (1991). "Cook Bathymetry". N.Z. Oceanogr. Inst. Chart, Oceanic Series, 1:1,000,000.

f) Mitchell, J.S., (1988). "Campbell Bathymetry". (2nd Edition). N.Z. Oceanogr. Inst. Chart, Coastal Series, 1:200,000.

g) Carter, L. & Herzer, R.H., (1986). "Pegasus Sediments". (2nd Edition). N.Z. Oceanogr. Inst. Chart, Coastal Series, 1:200,000.

h) Mitchell, J.S., (1989). "Lake Otamangakau Bathymetry". N.Z. Oceanogr. Inst. Chart, Lake Series, 1:40,000.

i) Pyne, A.R., Ward, B.L., Macpherson, A.J. & Barrett, P.J., (1985). "McMurdo Sound Bathymetry". N.Z. Oceanogr. Inst. Chart No.62, Miscellaneous Series, 1:250,000.

j) Mitchell, J.S., Carter, L. & McDougall, J.C., (1989). "New Zealand Region Sediments". N.Z. Oceanogr. Inst. Chart No.67, Miscellaneous Series, 1:6,000,000.

k) Wright, I.C., (1990). "Bay of Plenty - Southern Havre Trough Physiography". N.Z. Oceanogr. Inst. Chart No.68, Miscellaneous Series, 1:400,000.

DSE - Defence Scientific Establishment

Address:	Defence Scientific Establishment, Defence Department, Auckland Naval Base, AUCKLAND, New Zealand.
Tel:	(+64) 9 445 5902
Fax:	(+64) 9 445 5890
Director:	BUCKINGHAM, Dr. John H.
Main contact:	HALL, Dr. Lindsay H.
Other contacts:	CROOK, Mr. F. George CRAIG, Lt. Cdr. Gordon (Commanding Officer RNZNS "Tui")

Notes on visit of 21/02/92:

DSE does a great deal of work on development of passive sonar arrays. The New Zealand quiet ocean environment is particularly suited to passive sonar operations. Detection of both submarines and surface ships is possible at significant ranges. However, this poses a challenge since target localisation at long ranges requires good bearing accuracy. Interactions of the seafloor with the signals cause their modification, particularly features such as seamounts and ridges. Knowledge of the locations of these features could allow a target's position to be deduced. DSE are using DBDB5 to provide a reference gridded bathymetry to coordinate the equipment.

Documents collected on visit:

a) Defence Scientific Establishment 1989/90 Review. DSE Misc. 91/1, NR 1275. Auckland, New Zealand 1991.

b) Defence Scientific Establishment Brochure.

RNZN HO - Royal New Zealand Navy

Address:	Hydrographic Office, Royal New Zealand Navy, Burns Avenue, PO Box 33-341, TAKAPUNA 9, New Zealand.
Tel:	(+64) 9 486 3560
Fax:	(+64) 9 486 7895
Director:	FRISKEN, Cmdr. William D. (New Zealand Hydrographer)
Main contact:	FRISKEN, Cmdr. William D.

Other contacts: ATKINS, Mr. Alan
WALLEN, Lt. Bruce

Notes on visit of 21/02/92:

The HO are not able yet to handle digital data for GEBCO, in about 12 months time, they intend setting up a similar system to the RAN scheme with GEBCO data sharing the same database as other hydrographic data. The particular problem they are experiencing at the moment is obtaining data from vessels that worked in New Zealand waters, especially foreign scientific expeditions and also, surprisingly, from their own national institutes.

Documents collected on visit: None

FIJI

SOPAC - South Pacific Applied Geoscience Commission

Address: South Pacific Applied Geoscience Commission,
SOPAC Technical Secretariat,
Private Mail Bag,
SUVA,
Fiji.

Tel: (+679) 381139

Fax: (+679) 370040

Director:

Main contact: EADE, Dr. James V. (Deputy Director)

Other contacts: TIFFIN, Dr. Don L. (Offshore Co)
WOODWARD, Mr. Philip (Ch Carto)

Notes on visit of 25/02/92:

The South Pacific Applied Geoscience Commission (SOPAC) is an inter-governmental, regional organisation established by several Pacific nations. Amongst other duties they:

* coordinate marine geological and geophysical research being carried out in the region.

* curate and distribute marine geological and geophysical data from the South Pacific.

SOPAC is funded by a combination of statutory and voluntary contributions by its member countries and grants from donor governments and international agencies. An annual budget of nearly F$10 million supports the implementation of the technical Work Programme and the overall operation of the Technical Secretariat.

The Offshore Programme (Don TIFFIN) coordinates the activities of foreign research vessels and ensures that member countries are kept fully informed on the activities, data collected and results of cruises in their waters. SOPAC also interprets seabed and bathymetric data and produces reconnaissance-scale maps of selected areas. A major mapping exercise will be set up to follow on from the GLORIA surveys that took place in 1989.

Within the Technical Support Programme are Data Management & Technical Information.

Yann MOREL from France is the Data Manager. The objectives of Data Management include:

* locating all data collected in the SOPAC region that is relevant to the Work Programme and establishing the type and quality of those data.

* acquiring copies of data that are not readily accessible or data that are required for reassessment by Techsec.

* digitizing data held at Techsec and storing on computer.

The database is held on a microVAX computer, although it will be soon transferred to a SUN using GMT as the main graphics package. The policy is to search actively for data - this Yann MOREL has carried out with great success. There are some 700 cruises on the database of which about 10% are not held at Boulder. This 10% includes cruises made by the Mining Agency of Japan (around the Cook Is.) and other commercial data. Japanese multibeam surveys on seamounts, looking for Mg nodules, should be available in about 5 years time. In the meantime this data is protected on disk at SOPAC.

Priority has been given to obtaining new offshore data not available from WDC-A, particularly from Japan, Germany, Australia and New Zealand. The database has been extended northwards to 18°N (now that Guam and Micronesia are in SOPAC). There is a long term agreement for Data Management to receive continued assistance from ORSTOM in Noumea, particularly for developing computer applications for offshore data. One of the principal packages that will be used in the future will be the Arc/Info on the SUN computer.

Philip WOODWARD is the chief draughtsman; he and one other are responsible for compiling and preparing maps.

He also provides training for member country nationals.

Documents collected on visit:

a) SOPAC Video: The Organization and its Work Programme. SOPAC 1991. (PAL format, running time 14 minutes).

b) SOPAC leaflet.

c) SOPAC News. Vol.8, No.3, p.17-26, December 1991.

d) SOPAC Projects. No.2, 8pp, July 1991.

e) SOPAC Annual Report 1990, 36pp.

f) List of SOPAC published Reports (April 1975 - September 1991). SOPAC Miscellaneous Report 15, September 1991.

g) Flow Diagram showing the Data Collection & Management System employed by SOPAC.

HAWAII

PMP - Pacific Mapping Program

Address: Pacific Mapping Program,
Department of Civil Engineering,
University of Hawaii,
Holmes Hall 383,
2540 Dole Street,
HONOLULU,
HAWAII 96822,
U.S.A.

Tel: (+1) 808 956 7338

Fax: (+1) 808 956 5014

Director: SAXENA, Professor Narenda, K.

Main contact: SAXENA, Professor Narenda, K.

Other contacts: LI, Dr. Rongxing
PAI, Ms. Sunyeen

Notes on visit of 27/02/92:

The Pacific Mapping Program is funded by the USGS, NOAA and University of Hawaii, with initial support from the DMA and the Oceanographer of the U.S. Navy, to act as a central repository for information and data on the Pacific EEZ of the U.S.. The mapping information will be made available to government agencies and private interests capable of undertaking EEZ resource development to facilitate exploration and development of the zone. PMP do not wish to be seen as duplicating the work of NGDC in Boulder, but rather as providing a centre to integrate all the different datasets.

There is a variety of computer hardware; a VaxStation with the USGS MIPS software running on it, and SUNs and PCs.

There are 6 positions in mapping research, one of these is occupied by Dr. Rongxing LI, a photogrammetrist.

Documents collected on visit:

a) Pacific Mapping Program flyer.

b) Pacific Mapping Program prospectus.

c) Saxena, Narenda K. Pacific Mapping Program. Abstract only.

d) PACON International flyer.

e) PACON International Newsletter. Vol.8, No.1, Jan.1992.

f) Li, Rongxing & Pai, Sunny, (19??). "Improvement of bathymetric data bases by shape from shading technique using side-scan sonar images". Pacific Mapping Program, University of Hawaii. 5pp.

g) Li, Rongxing, (19??). "Generation of object representations of 3D objects in CAD/CAM by digital photogrammetry". ISPRS Commission V. Pacific Mapping Center, University of Hawaii. 8pp.

h) Li, Rongxing, (1990). Erfassung unstetiger Oberflachen aus digitalen Bilddaten durch Flachen- und Kantenzuordnung. Vom Fachbereich 07 Bauingenieur- und Vermessungswesen der Technischen Universitat Berlin genehmigte Dissertation. Deutsche Geodatische Kommission bei der Bayerischen Akademie der Wissenschaften. Reihe C, Dissertationen, Hefte Nr.364. (Title page only).

SSI - Seafloor Surveys International, Inc.

Address: Seafloor Surveys International, Inc.,
1221 Kapiolani Blvd.,
PH-40,
HONOLULU,
HAWAII 96814,
U.S.A.

Tel: (+1) 808 537 9561

Fax: (+1) 808 523 5958

Director:

Main contact: CAMPBELL, Dr. J. Frisbee (Vice President)

Other contacts:

Notes on visit of 28/02/92:

SSI is a multidisciplinary marine surveying consultancy which offers state-of-the-art ocean bottom mapping services throughout the world. Included amongst their wide range of services are hydrographic, geological & geophysical surveys and interpretation.

They use exclusive side-scan sonar technology to provide high-resolution geometrically precise hydrographic maps and clear seafloor images. Examples of the systems developed by SSI are; SeaMARC/S (150kHz high-resolution side-scan mapping system with bathymetric processing capability) and IZANAGI (12kHz deep ocean swath mapping system, providing swath bathymetry and side-scan images up to 20 km wide in any water depth). Clients from the U.S., Canada, Japan and Australia are amongst their customer base. They are interested in small scale bathymetry for planning purposes. They have access to bathymetry that was collected for their customers, that data could be made available to GEBCO.

Documents collected on visit:

a) Seafloor Surveys International, Inc. brochure.

SOEST HIG - School of Ocean & Earth Science & Technology, University of Hawaii

Address:	School of Ocean & Earth Science & Technology, University of Hawaii, 2525 Correa Road, HONOLULU, HAWAII 96822. U.S.A.
Tel:	(+1) 808 956 6649
Fax:	(+1) 808 956 2538
Director:	RALEIGH, Professor Barry
Main contact:	HEY, Dr. Richard (Dick)
Other contacts:	TAYLOR, Professor Brian KROENKE, Dr. Loren

Notes on visit of 28/02/92:

SOEST have various sets of contoured bathymetry available through scientific publications. Of particular note is the bathymetry of the whole region of the Easter Island microplate and a recently published Atlas of SeaMARC surveys in the South Pacific by Taylor et al.. SeaMARC data would be available in the course of time; there are a number of passages that contain data that have never been published.

Documents collected on visit:

a) Article on GMT system.

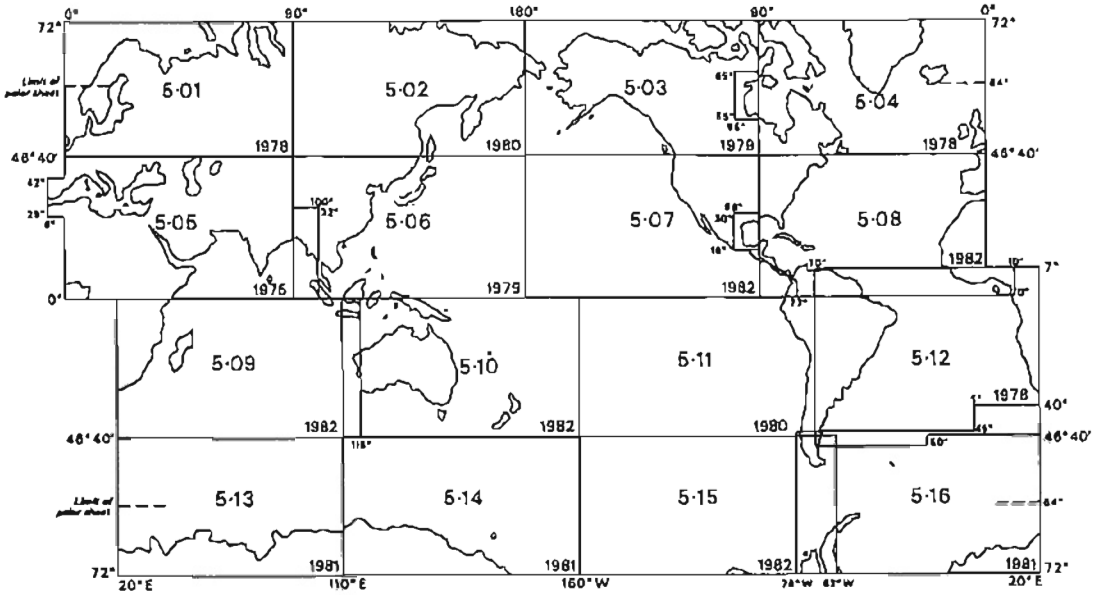
ANNEX V

BODC Information Note 92/2 *6 April 1992*

BODC

BRITISH OCEANOGRAPHIC DATA CENTRE

IHO-IOC
GENERAL BATHYMETRIC CHART OF THE OCEANS
GEBCO DIGITAL ATLAS



THE GENERAL BATHYMETRIC CHART OF THE OCEANS
(GEBCO)

Series established in 1903 by
H.S.H. Prince Albert I of Monaco

The FIFTH EDITION OF GEBCO was published between 1978 and 1982 by the Canadian Hydrographic Service, Ottawa, Canada, under the joint authority of the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

The Fifth Edition consists of 19 charts:

- 16 sheets on Mercator Projection covering the world from 72°N to 72°S, on a scale of 1:10 million at the equator
- 2 sheets on Polar Stereographic Projection from the poles to 64°N and 64°S respectively, on a scale of 1:6 million at 75° latitude.
- 1 world sheet with global coverage at a scale of 1:35 million.

Each large scale sheet depicts contoured bathymetry (in corrected metres) at standard depths of 200m, 500m, 1000m and at 500m intervals thereafter, although the actual contours displayed vary slightly as some sheets also include contours at depths intermediate to the standard levels. Sounding control is printed on the face of each sheet showing the position of the echosounding tracks and detailed surveys used in the compilation of the contours.

The land topography and coastlines for the Fifth Edition were taken from the Carte Generale du Monde, by permission of the Institut Geographique National, Paris, France. The Antarctic continent was taken from maps supplied by the Scott Polar Research Institute in Cambridge, UK. All sheets are based on the International 1924 (Hayford) Ellipsoid.

All the bathymetric contours and coastlines depicted on the Fifth Edition sheets have recently been digitized as part of an international venture involving laboratories in France, Japan, UK and USSR, collaborating under the guidance of the GEBCO Sub-Committee on Digital Bathymetry.

Copies of the digital data set are now obtainable directly from BODC - prices available on request.

Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, UK
Telephone: (051) 653 - 8633 Telex: 628591 OCEANB G Telefax: (051) 652 - 3950

PRODUCTION OF THE FIFTH EDITION

Production of the Fifth Edition was supervised by a Joint IOC-IHO Guiding Committee composed of five members nominated by the IHO and five by the IOC. The IHO experts were selected from Volunteering Hydrographic Offices in their Member States. The IOC experts were marine geologists/geophysicists specialised in morphological charting of the sea-floor, who were nominated in consultation with the Scientific Committee on Oceanic Research (SCOR); the International Association for the Physical Sciences of the Ocean (IAPSO); and the Commission for Marine Geology (CMG).

The IHO was responsible, in conjunction with 19 Volunteering Hydrographic Offices in its Member States, for maintenance of 655 base master sounding sheets on a scale of 1:1 million, and for cartographic advice on, and supervision over, the final product. On the other hand, the IOC took responsibility for all scientific input into the project, including contouring of the bathymetric data. For each sheet, one or more marine geoscientists were appointed as Scientific Co-ordinator(s) to co-ordinate and compile the contours employing the best available geological and geophysical knowledge of the ocean floor.

Cartographic production of the Fifth Edition was undertaken by the Canadian Hydrographic Service in Ottawa. Copies of the published sheets can be obtained throughout the world through agents for the sale of Canadian Nautical Charts, or direct from:

Hydrographic Chart Distribution Office,
Department of Fisheries and Oceans,
1676 Russell Road, P.O. Box 8080,
Ottawa, Ontario, Canada K1G 3H6

They may also be obtained *via* the International Hydrographic Bureau, Monaco, or the Intergovernmental Oceanographic Commission, Paris.

DIGITIZATION OF THE FIFTH EDITION

The digitization of the bathymetric contours and coastlines of the Fifth Edition was carried out, on a sheet by sheet basis, by the following laboratories:

* Bureau Gravimetrique International (BGI), Toulouse, France, in collaboration with the Institut Geographique National (IGN), Paris - 11 sheets
* NERC Unit for Thematic Information Systems (NUTIS), Reading, UK - 4 sheets
* Head Department of Navigation and Oceanography (HDNO), Leningrad, USSR - 1 sheet
* British Oceanographic Data Centre, Bidston, UK - 1 sheet

Quality control, final editing and reformatting of these data into a uniform data set was carried out by BODC.

Stable base transparencies of the master, bathymetric contour plates of the published sheets were used as the source material for digitizing. These transparencies were provided by the Canadian Hydrographic Service at the same scale and projection as the published sheets. At each of the participating laboratories the transparencies were raster scanned using laser scanning equipment. The raster output, typically on a 20 dot/mm. binary matrix, was converted by software into unlabelled contour vector streams, which were then exhaustively checked and edited using an interactive graphics display terminal. Gaps in the contours, caused by the contour labels on the published charts, were filled in digitally from the terminal. Each digitized contour stream was then manually assigned an appropriate bathymetric depth by cross reference to the contours on the published chart.

On occasions where it was difficult to identify contour values without ambiguity, reference was made back to either the Scientific Co-ordinator(s) for the sheet, the GEBCO Bathymetric Plotting Sheets or the digital sounding data at the National Geophysical Data Center, Boulder, USA.

Prior to their final release, the digitized contours for each sheet were reviewed in detail at BODC. This review involved plotting out the contour vectors on the same scale and projection as the published sheet and checking out in detail the registration and labelling of each contour. Edited and checked contours and appropriate covering documentation were then compiled into the final data set. BODC checks on the digitized sheets confirmed that the techniques adopted at the participating laboratories were able to reproduce the Fifth Edition contours to an accuracy comparable with the line thickness of the contours on the published sheets.

The digitization was carried out on a sheet by sheet basis. Where the published sheets overlap in geographic coverage, only one version of the overlapping area was digitized - usually the most recently compiled version. Edge matching was carried out across the sheets to ensure the digitized data provide a seamless bathymetry across the globe.

The two polar sheets (5.17 and 5.18) were only digitized to 72°N and 72°S respectively i.e. they were not digitized where they overlapped adjacent Mercator sheets.

It should be noted that the Mediterranean Sea and Black Sea on sheet 5.05 were not digitized - a higher resolution digital data set at a scale of 1:1 million is available from BODC for these areas derived from the International Bathymetric Chart of the Mediterranean (IBCM).

For sheet 5.06 in the Western Pacific the digital contours for the area from 100° to 180°E were taken directly from a digital data base maintained by the Japan Oceanographic Data Center, Tokyo, rather than from the printed sheet.

The bathymetry for sheet 5.12 in the South Atlantic is currently being revised and the sheet is to be republished from a digitized version of the revised contours which is likely to become available early in 1992.

At present the digitized data set does not include land contours (except for coastlines) or sounding control information. Users of the digitized contours are advised to consult the published sheets for information on the distribution of the data used to compile the contours.

FORMAT OF DIGITAL DATA SET

The data set is available from BODC on unlabelled, 9-track, half-inch magnetic tape in GF3 format (IOC standard data exchange format) with a fixed length blocksize of 1920 bytes and a choice of ASCII or EBCDIC code - tape density either 1600 bpi or 6250 bpi.

Where data volumes allow, individual sheets are also available on MS-DOS compatible floppy disks.

File sizes for the digitized sheets are as follows:

Sheet No.	No. of points (thousands)	File size (Mbytes)
5.01	43	0.78
5.02	37	0.67
5.03	156	2.73
5.04	202	3.61
5.05	47	0.85
5.06	341	6.30
5.07	299	5.31
5.08	309	5.51
5.09	273	4.85
5.10	303	5.35
5.11	238	4.26
5.12	?	?
5.13	32	0.56
5.14	66	1.17
5.15	34	0.62
5.16	131	2.31
5.17	91	1.60
5.18	31	0.55

The full data set will occupy 2 tapes at 600 bpi or 1 tape at 6250 bpi. The IBCAM data set occupies 35 megabytes and is available on a separate tape.

Each digitized Fifth Edition sheet is stored in a separate GF3 data file - the file header record and succeeding plain language record(s) identify the sheet and its scientific coordinator(s), and contain information on the geographic area digitized, notes on any special problems encountered in digitizing the sheet and a list of the contour depths included in the file.

Contours are arranged in each file in ascending order of contour depth starting with all 0m contours i.e. the coastlines.

Individual contours are stored as a labelled stream of paired geographic latitude and longitude coordinates. Each coordinate is expressed in units of 0.001 degrees - north and east are positive, south and west are negative. Longitude values fall in the range -180 to +180 degrees.

Each contour is broken down into 80 character segments, each labelled with the contour depth and containing up to 5 pairs of latitude/longitude values - the actual number of coordinate pairs is stored in a count field in the segment. Also included is a one-character flag field to indicate whether the segment represents the start of a new contour, or the continuation of a contour from the previous segment. A fresh segment is created at the start of each new contour stream.

The contours are labelled with the corrected bathymetric depth in whole metres - for the coastline this value is set to zero. For the rare occasions where the contour value cannot be identified the depth is set to -9999.

A full description of the GF3 system may be found in IOC Manuals and Guides No. 17 available either from the IOC Secretariat, UNESCO, 7 Place de Fontenoy, 75700 Paris, France, or from the British Oceanographic Data Centre.

FUTURE PLANS

Once the digitization of sheet 5.12 has been completed it is planned to digitize the tracklines and survey boxes shown on the printed sheets so that the sounding control can be displayed with the digital contours. A digital Gazetteer will also be available covering the geographic names of the undersea features named on the printed sheets.

The digitized Fifth Edition forms the basis for creating the GEBCO Digital Atlas which is being developed as an active data base regularly updated with improved bathymetry at scales no longer constrained by the limits of the printed chart. It is envisaged that in some areas the bathymetry will be updated at scales of 1:1 million or better. The digital nature of the Atlas will provide new opportunities for presenting and disseminating bathymetric information. In entering this new era the Digital Atlas will continue the traditional close collaboration between IOC and IHO in providing the best available bathymetry of the world's oceans.

CREDITS FOR THE GEBCO (FIFTH EDITION) SHEETS

Sheet No.	Digitized by	Publication Date	Sheet Authors
5.01	BGI/IGN	1978	J. Ulrich, Institut fur Meereskunde an der Universitat Kiel, Germany
5.02	HDNO	1980	G.B. Udintsev, Institute of Physics of the Earth, Moscow, USSR
5.03	NUTIS	1979	G.L. Johnson, Office of Naval Research, Arlington, USA, and D. Monahan, Canadian Hydrographic Service, Ottawa, Canada
5.04	BGI/IGN	1978	A.S. Laughton, Institute of Oceanographic Sciences, Wormley, UK, and D. Monahan, Canadian Hydrographic Service, Ottawa, Canada
5.05	BGI/IGN	1975	A.S. Laughton, Institute of Oceanographic Sciences, Wormley, UK
5.06	JODC	1979	Y. Iwabuchi, Hydrographic Department MSA, Tokyo, Japan
5.07	NUTIS	1982	J. Mammerickx & S.M. Smith, Scripps Institution of Oceanography, La Jolla, USA
5.08	BGI/IGN	1982	R.C. Searle, Institute of Oceanographic Sciences, Wormley, UK, D. Monahan, Canadian Hydrographic Service, Ottawa, Canada, and G.L. Johnson, Office of Naval Research, Arlington, USA
5.09	BGI/IGN	1982	R.L. Fisher, Scripps Institution of Oceanography, La Jolla, USA
5.10	NUTIS	1982	D. Monahan, Canadian Hydrographic Service, Ottawa, Canada, R.K.H. Falconer, Bedford Institute of Oceanography, Dartmouth, Canada & the New Zealand Oceanographic Institute, Wellington, New Zealand, and M. Tharp, Lamont-Doherty Geological Observatory, New York, USA
5.11	NUTIS	1980	J. Mammerickx & S.M. Smith, Scripps Institution of Oceanography, La Jolla, USA
5.12	BODC	1992	Sheet currently being revised in preparation for republication
5.13	BGI/IGN	1981	D.E. Hayes & M. Vogel, Lamont-Doherty Geological Observatory, New York, USA
5.14	BGI/IGN	1981	R.K.H. Falconer, Bedford Institute of Oceanography, Dartmouth, Canada & the New Zealand Oceanographic Institute, Wellington, New Zealand, and M. Tharp, Lamont-Doherty Geological Observatory, New York, USA
5.15	BGI/IGN	1982	J. Mammerickx & I. L. Taylor, Scripps Institution of Oceanography, La Jolla, USA, and S. Cande, Lamont-Doherty Geological Observatory, New York, USA
5.16	BGI/IGN	1981	J. LaBrecque, P.D. Rabinowitz & C. Brenner, Lamont-Doherty Geological Observatory, New York, USA
5.17	BGI/IGN	1979	G.L. Johnson, Office of Naval Research, Arlington, USA, D. Monahan, Canadian Hydrographic Service, Ottawa, Canada, G. Gronlie, University of Oslo, Norway, and L.W. Sobczak, Department of Energy, Mines and Resources, Ottawa, Canada
5.18	BGI/IGN	1980	G.L. Johnson, Office of Naval Research, Arlington, USA, and J-R Vanney, Universite Pierre et Marie Curie, Paris, France

Digitized by the Bureau Gravimetrique International/Institut Geographique National, France (BGI/IGN); NERC Unit for Thematic Information Systems, UK (NUTIS); Head Department of Navigation and Oceanography, USSR (HDNO) and the Japan Oceanographic Data Center (JODC). Final quality control and assembly of the digital data set by the British Oceanographic Data Centre.

ANNEX VI

GEBCO DIGITAL ATLAS CD-ROM

Draft System Specification - V2.0

Users and Uses

The Atlas will appeal to a wide variety of users in Government, science, industry and education, each with his or her own requirements. Basically, however, there will be three major requirements:

1) To view sections of the Atlas data quickly and clearly on the PC screen.

2) To generate a hardcopy (*via* printer or plotter) of selected data directly from the Atlas.

3) To 'export' a subset of the Atlas data to the PC's hard disk in a format which permits it to be used in other software products, or to access the CDROM directly for the same purpose.

Platform

The Apple Macintosh and the IBM PC are the two possible platforms. CD-ROM technology is well established for both types of machine, and both have a very wide user base.

One possibility is to develop two Atlas software systems, one for each machine, but this would be very resource intensive unless a suitable program 'shell' could be identified which would permit a single program to run on both machines (in which case the porting of the software to Unix workstations is also a possibility). The alternative is to target only one of the machines. If the latter option is chosen, then the fact that the Macintosh can emulate an IBM PC (up to EGA display standard at least) whilst the IBM PC cannot emulate the more complex Macintosh system may dictate that the target machine should be the IBM PC.

Data Content

The CD-ROM should contain:

1) The digitized 5th Edition GEBCO contours and coastline.

2) Digitized tracklines from the 5th Edition GEBCO charts.

3) Feature names.

4) Textual information crediting the sources of the data.

Future editions of the CD-ROM could also contain:

1) Trackline inventories of IHO Data Centre bathymetric data.

2) Gridded bathymetric data sets and either pre-generated perspective views or the software to generate these from the gridded data.

3) Textual information of an educational nature; possibly a global overview plus separate text for each of the major oceans/seas.

Data Storage Structure

Data storage structures must be chosen to satisfy two different (and conflicting) requirements. A simple ASCII text file storage structure (similar to that used on the demonstration CD-ROM) will be required to permit users to access data directly from the CD-ROM from within their own software. A more complex storage structure, preferably binary numeric and heavily indexed, is required to permit the Atlas selection/display software to perform swiftly and efficiently.

For the interim, it is convenient to hold the data in ASCII text 'sheet' files, each of which holds the data for a single printed GEBCO sheet. This format may also be the most convenient for the user accessing the CD-ROM directly. It also has the advantages that:

a) Long sections of a single depth contour will be stored as a contiguous string of points, rather than being split at latitude/longitude boundaries for indexing purposes.

b) Since the area covered by each GEBCO sheet has already been chosen to be as 'functional' as possible, there is maximal chance that the data required by a user accessing the CD-ROM directly will be contained within a single file.

For the Atlas selection/display software, however, the concept of printed chart sheets is an irrelevance. Data storage should be truly generalised on a purely latitude/longitude basis so that the user may select and view data from any geographic area with equal ease, and without artificial constraints.

The ASCII text files of the demonstration CD-ROM occupy approximately 50Mb. In packed binary format it should be possible to reduce the size of the dataset to approximately 17Mb. Indexing 10° squares would require 2.6kb per depth or depth group indexed, 5° squares would require 10.4kb, and 1° squares would require 260kb. At worst case, indexing each of 61 depth levels by 1° square would require approximately 16Mb.

In order to maximise access and display speeds, a 'double indexation' by file and by offset index within file is probably the most effective. If each data file contained data for a square of 10° of latitude by 10° of longitude, then the full index to data within that file would occupy approximately 30kb, thus permitting the entire index to be held in the memory of the PC simultaneously.

In order to optimise speed of display when viewing large geographic areas, it would probably be desirable also to include generalised copies of the 1:10,000,000 data (e.g. to approximately 1:30,000,000 and 1:100,000,000 scales). The display software could then select the dataset most appropriate to the current screen resolution and geographic area to be plotted; this would minimise the amount of time that the software spends accessing and plotting data at a level of detail that the VDU is incapable of resolving.

A complete set of ASCII text data files plus their binary equivalent and a full 1° square index would therefore occupy approximately 82Mb (or 120Mb if indexed generalised copies of the binary data are included). With each CD-ROM capable of bearing 0.5Gb, it should therefore be possible to have the best of both worlds on a single platter.

The volume of data involved in the trackline and feature names datasets is presently unknown, but should be substantially within the limits of a CD-ROM.

Projection

In order to maximise display speed, the default projection should be linear within each 1° square, with the N-S:E-W ratio determined *via* a lookup table which will approximate to a Mercator projection.

An accurate Mercator or other computed projections might be offered as alternatives, but these would necessarily have considerable impact on the display speed.

The polar regions will need to be treated as a special case, and a suitable polar projection will be required in order to display them satisfactorily. Zooming in on such a projection would necessarily be limited to a circular zoom window concentric with the pole.

As an alternative to computing projections 'on the fly', pre-processed datasets could be generated and included on the CD-ROM (an estimated 35Mb per dataset). Although this method has attractions in terms of speed of display, the projection and back-transformation calculations would still be required for grid overlay, cursor positioning, feature name placement or query etc.; 'on the fly' computation is therefore the preferred method for the sake of internal consistency within the software.

Software Functionality

Assuming for the moment that the software will be written for IBM compatible PCs, it should be capable of running on a standard 640kb RAM machine with a hard disk and EGA (or better) colour graphics display. The software should be capable of being driven by keyboard alone, but should take advantage of a mouse if one is available. Similarly, the software should not require the presence of a numeric co-processor, but it would be desirable if it could use a co-processor if one is present. The EGA graphics standard should be regarded as a minimum requirement; the software should be capable of using VGA display, and the design should include (or at least not preclude) support for higher resolution graphics standards such as 8514 or XGA.

Essentially, the software should permit the user to display contour data at default or user-specified depth levels for any specified geographic area with the option also to display tracklines and/or feature names. The user should have the facility to 'customise' the display in terms of the colours or styles used for different contour levels, tracklines and feature name text. Ideally, the software should support output to standard vector devices such as HPGL compatible plotters and Postscript printers, and should permit the user to transfer selected data to his/her hard disk in a standard ASCII text file format. A screen dump/capture facility should also be considered.

A user-friendly system controlled by pull-down (or pop-up) menus is required, with context-sensitive help available at all times. Wherever possible, control of the software should be by mouse, with 'click boxes' for option selection (but controllable by keyboard alone if no mouse is available).

In view of the time taken to produce complex plots, the software should never initiate a plot without being told to do so by the user. This will enable the user to select the geographic area, contour levels, display colours etc. first, and then have the plot displayed. For the same reason, the software should permit a plot to be aborted in a controlled manner by the user at any time without throwing control back to the start of the program. With suitable data indexing and display software, the user should always be presented with a 'busy' screen upon which plotting is obviously taking place; at times when this is not the case (e.g. during search operations), then a 'busy' icon should be displayed, plus a message indicating what action the software is presently taking.

Three alternative methods of geographic area selection should offered as a minimum:

1) By means of a 'zoom box' positioned and sized on the current display (initially a small-scale chart of the world) by the user.

2) By specifying a GEBCO chart number.

3) By entering the desired geographic limits *via* the keyboard.

The facility to reposition or resize the selected area without returning to the initial screen is highly desirable, as is a 'backtrack' facility to permit the user to 'undo' one or more zoom operations.

The option should be provided for the user to save to disk details of frequently used area, contour level and colour selection settings, and to use these to restore the system to the same state at a later date.

The ability to superimpose, and subsequently remove, a geographic grid (at default or user-specified grid intervals) should be included. Additionally, the software should provide the facility to switch on/off a display of the geographic coordinates to which the mouse cursor currently points.

The facility to 'query' a contour line to determine its depth value is highly desirable in view of the number of contour levels which may be displayed simultaneously (which will necessarily mean that very similar colours must be used for some of them).

The superimposition of feature names on the display may be desirable in some circumstances, but will inevitably obscure underlying information. The software should offer the alternative option of indicating, by means of a symbol, locations for which feature names are available, and then permitting the user to 'query' individual symbols to determine the associated name.

The software should permit the user to measure great circle distances between two or more points on the display.

Advanced features / Future enhancements

The facility to compute the area contained within a user-specified border is desirable, but may be difficult to implement such that the software actually answers the question that the user intended. For example, a straight border line drawn on a projected map would not necessarily adequately define the desired border once converted to a great circle line for area computation; this can, of course, be overcome, but only at the expense of the user who actually requires a great circle border line! To cater for both cases adds to the complexity of the software and user interface.

The possibility of providing the capability for the user to 'import' his/her own data into the system for display in conjunction with the GEBCO dataset should be considered, but this should be regarded as secondary to the main objective of disseminating the digital 5th Edition GEBCO widely in a timely manner.

Similarly, the provision of a 'flood fill' facility to infill between contour lines in an appropriate colour is seen as a desirable feature, but the necessary pre-processing of the data to make such an option possible would be a source of delay in releasing the digital data set.

The facility for the user to perform simple 'drawing' tasks on the displayed chart in order to annotate it with, for example, lines, circles, symbols or text would be useful in some cases. This apparently simple facility is, however, surprisingly complex to implement with adequate flexibility (particularly the facility to change or 'undo' a drawing operation that the user made in error). Many excellent drawing packages are available on the market, and the user will probably already possess one that he/she is familiar with; rather than 're-invent the wheel', it is probably more sensible to concentrate upon providing adequate screen capture facilities in standard formats so that the display may be post-processed with the drawing software of the user's preference.

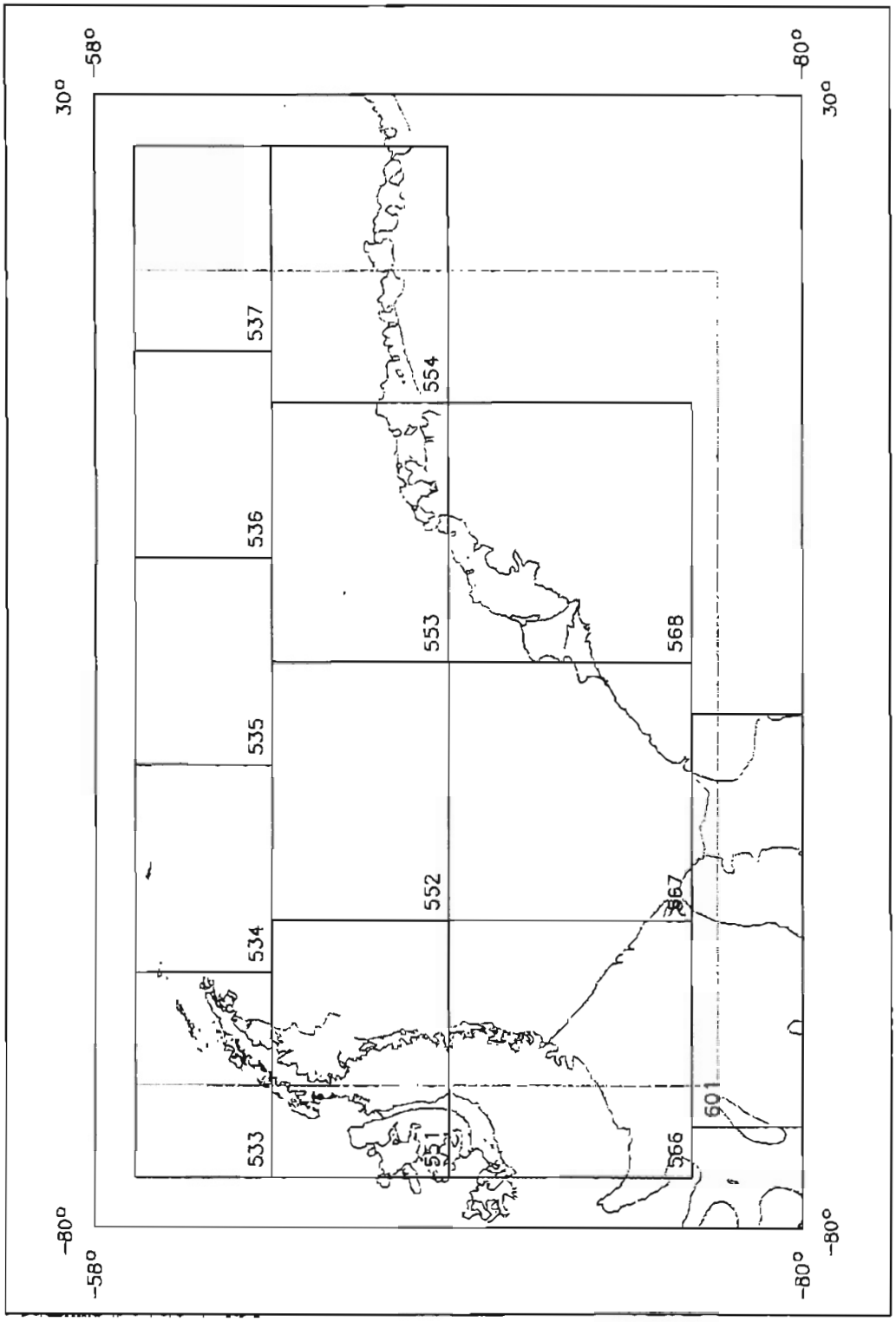
The facility to construct and display depth profiles along a user-specified track is desirable. In simple form, this could be implemented by analysis of the raster image of the displayed chart. Alternatively, a more accurate profile could be generated directly from the contour data, but this would necessarily take considerably longer since each segment of contour within range of the track must be analysed for possible intersection points.

Pre-indexing of the data on additional criteria could be performed in order to offer the user additional data access routes. For example, indexes corresponding to established series of (non bathymetric) charts might be generated. Additionally, access by standard area units such as WMO or Marsden square, or by IHB Sea Area name might be considered.

The feature name information included on the CD-ROM might also be used as an 'index' to the data, such that the appropriate geographic area might be displayed when the user selects a feature name from an alphabetically sequenced list. An adequate area around the feature would also need to be displayed in order to permit the user subsequently to refine the area selection.

ANNEX VII

INDEX TO 'BATHYMETRIC CHARTS OF WEDDELL SEA BEING PRODUCED BY THE ALFRED WEGENER INSTITUTE



ANNEX VIII

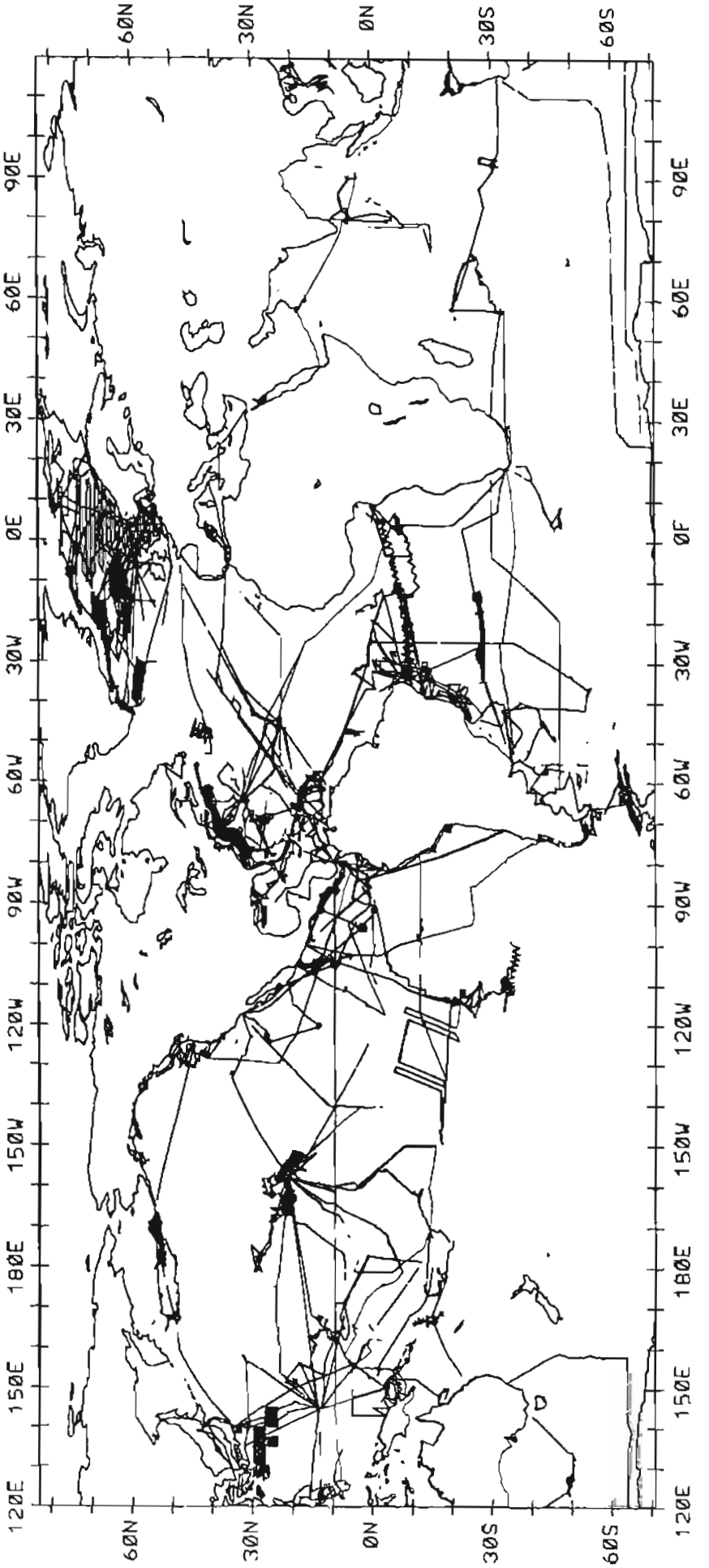
SUMMARY OF DIGITAL BATHYMETRIC DATA HELD IN THE GLOBAL MARINE GEOPHYSICAL DATA BASE (GEODAS) AT THE US NATIONAL GEOPHYSICAL DATA CENTER AND THE IHO DATA CENTRE FOR DIGITAL BATHYMETRY

TOTAL HOLDINGS

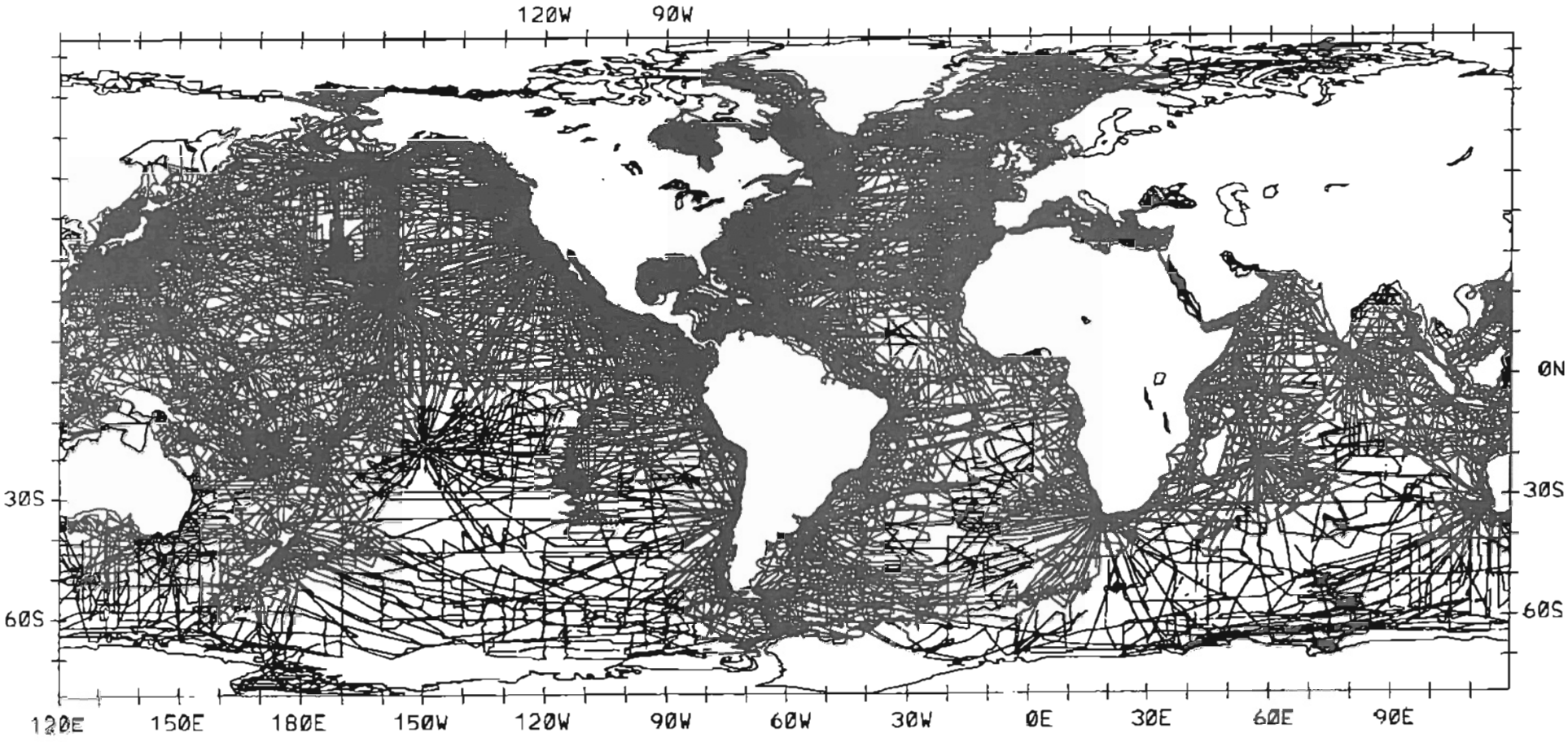
SOURCE	NO. OF CRUISES /LEGS	TRACKLINE IN NAUTICAL MILES				NO. OF BATHYMETRIC SOUNDINGS
		TOTAL	BATHYMETRY	MAGNETICS	GRAVITY	
Lamont (LDGO)	583	2438464	2347265	2030217	1807008	4305042
Woods Hole O.I.	146	532912	516718	340151	302323	925223
NOAA	84	591143	584658	548205	341546	651581
US Geol. Survey	187	360659	269845	167761	164629	1869760
Oregon St. Univ.	70	175633	166122	125891	115555	250973
Hawaii Inst. Geo.	194	694688	663224	398510	422259	1646330
US Navy	199	899452	869094	363513	35023	2882018
Univ. of Texas	49	84584	73497	53611	0	139955
Rice Univ.	2	7681	7681	0	0	3557
Univ. of Conn.	4	4522	3884	0	4522	2175
Scripps Inst. Oc.	516	2009684	1843867	1397564	115138	3589850
U Rhode Island	25	62402	61298	7164	0	385876
U Washington	9	12868	12868	0	0	34316
Texas A & M Univ.	40	98949	69999	61131	0	122807
Defense Map. Ag.	84	358808	357687	0	0	678526
Min. Manag. Serv.	7	42957	42784	0	0	399693
NEW ZEALAND	15	27389	26345	21257	17306	20218
CANADA	150	636575	619574	18490	1173	609799
CHINA	4	23986	23851	0	23982	10107
UNITED KINGDOM	41	136806	127415	91291	91353	279056
AUSTRALIA	3	29902	21263	26749	9243	150826
USSR	20	197450	168114	0	190893	67124
JAPAN	155	777722	743616	459410	537501	573334
NETHERLANDS	5	23246	20969	5777	9754	113080
FRANCE	154	359969	324236	223679	136202	1793668
SOUTH AFRICA	18	52990	45907	49951	0	56432
BRAZIL	7	32194	32194	0	0	131415
BGI (TOULOUSE)	9	59789	59020	0	59778	29699
GERMANY	27	84523	84523	0	0	49487
ORSTOM NEW CAL.	22	65025	63007	51001	28449	89752
GRAND TOTAL	2829	10882970	10250530	6441326	4413640	21861679

DATA BANKED BETWEEN 01/06/90 AND 30/03/92

SOURCE	NO. OF CRUISES /LEGS	TRACKLINE IN NAUTICAL MILES				NO. OF BATHYMETRIC SOUNDINGS
		TOTAL	BATHYMETRY	MAGNETICS	GRAVITY	
Lamont (LDGO)	61	225570	211174	148278	142959	984541
Woods Hole O.I.	4	12736	12231	2869	4642	17181
US Geol. Survey	41	69389	56057	32039	25661	449826
Hawaii Inst. Geo.	32	120943	117569	72343	86314	500600
US Navy	2	2494	2494	0	0	8876
Univ. of Texas	15	35428	30945	24482	0	59047
Scripps Inst. Oc.	23	94820	82912	29089	22110	388703
U Rhode Island	18	43127	42913	4347	0	287065
Texas A & M Univ.	11	24558	23208	17319	0	47544
USSR	4	15322	13411	0	8765	3595
JAPAN	18	65368	65039	42649	54913	35850
NETHERLANDS	3	13492	11215	5777	0	67795
BRAZIL	7	32194	32194	0	0	131415
BGI (TOULOUSE)	1	13434	13423	0	13423	6627
GERMANY	26	76960	76960	0	0	45853
GRAND TOTAL	266	845837	791747	379193	358788	3034518



Trackline plot of bathymetric data assimilated into the NGDC Global
Marine Geophysical Data Base (GEODAS) from June 1, 1990, to March 30, 1992



Trackline plot of total holdings of digital bathymetric data in the
NGDC Global Marine Geophysical Data Base (GEODAS) - March 30, 1992