Distribution: limited

IOC-IHO/GEBCO Guiding Committee XX
English only
26 August, 2004

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

INTERNATIONAL HYDROGRAPHIC ORGANIZATION

General Bathymetric Chart of the Oceans (GEBCO)

Twentieth Meeting of the GEBCO Guiding Committee

1-6 April, 2004

at

The Fortezza, Palmaria Island, Porto Venere, La Spezia, Italy

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1. OPENING OF THE MEETING

1 The Twentieth Meeting of the Guiding Committee of the joint IOC-IHO General Bathymetric Chart of the Oceans was held in the Fortezza on the island of Palmaria, Porto Venere, Italy from 1st-6th April 2004.

2 The Chairman, Mr Dave Monahan, opened the meeting at 0940 on 1st April. Those present were the Chairman, Robert Anderson, Etienne Cailliau, Ray Cramer, Mike Carron, Norman Cherkis, Robin Falconer, Chris Fox, Jose Frias, Andrew Goodwillie, Hugo Gorziglia, John Hall, Michel Huet, Peter Hunter, Mike Loughridge, Ron Macnab, George Newton, Bill Rankin, Hans-Werner Schenke, Steve Shipman, Walter Smith, Dmitri Travin, John von Rosenberg, Pauline Weatherall and the Permanent Secretary. The Chairman also welcomed local visitors Flora Lichtman (SACLANT) and Cdr. Maurizio Demarte and Cdr. Poalo Lusiani (Italian Hydrographic Office). Apologies for absence had been received from Sir Anthony Laughton and Alexis Hadjiantoniou.

2. INTRODUCTION AND CONDUCT OF THE MEETING

3 Dr Carron, as local host welcomed the GEBCO visitors and introduced Ing. Orlando Pandolfi, President of the Fondazione Marenostrum which is responsible for the maintenance and operation of the Fortezza. Ing. Pandolfi explained that his organisation has as its aims the protection of the environment and of the historical, artistic, archaeological and natural and monumental heritage in Italy and abroad.

4 The Chairman began by introducing the Agenda (Annex 1) and noting that the previous meeting of the Guiding Committee had taken place at an important moment of transition for GEBCO. GEBCO now faced a new future.

5 Capt. Gorziglia informed the committee that the IHB was devoting more resources in support of GEBCO. Although Michel Huet would continue as the Secretary of SCUFN Steve Shipman would in future be the link person between the Guiding Committee and the IHB. Tony Pharaoh remained in charge of digital mapping.

6 Dr Smith tabled a report called ‘Bathymetry from Space’ which reported a workshop meeting held at Scripps Institution of Oceanography, California in October 2002 and is available from http://www.igpp.ucsd.edu/bathymetry_workshop/.

3. REPORTS COVERING THE PERIOD 2003-2004

3.1 Conference Organising Committee

7 Dr Loughridge referred to the Conference Organising Committee which he had chaired. He said that for months after the Centenary Conference in Monaco he had received favourable comments, particularly on the quality of the papers presented, and he wanted to acknowledge the contributions of the authors and their contribution to the success of the Conference. He reminded members of the CD recording of the contributions which had been produced by Dr Wells and copies of which could be obtained from Ing. en Chef Huet.

8 The Chairman added his own thanks to Dr Loughridge for carrying out this unenviable task

3.2 Sub-Committee on Digital Bathymetry

9 No report was presented because the Sub-Committee had not met during the year. It was noted that the Sub-Committee also currently lacked a Chairman.

3.3 Sub-Committee on Undersea Feature Names

10 Dr. Ing. Hans-Werner Schenke reported that the Sub-Committee had not met since April 2003. He said it planned to meet in St Petersburg from 8-11 June 2004 and that the Minutes of the last meeting could be obtained from the IHB (as well as from the GEBCO web site). He explained that over 120 new feature names had been added to the Gazetteer. Dr Ing Schenke reported that new IHB Gazetteer software had been developed, at the expense of IHB, to search the Gazetteer and that preliminary tests had been carried out. He said that Lisa Taylor had demonstrated the software at a workshop at WHOI and it had been found to be very useful.

11 Dr. Ing. Schenke thanked the IHB for the software which it was planned to add to the GEBCO web site via a link from the IHO site. He noted that the Sub-Committee now had nine members.

12 Ing. en Chef Huet invited members to submit any suggestions for feature names to him as soon as possible because a new edition of the Gazetteer with software on a CD was planned to be published in 2004 [Action All].

13 Capt. Gorziglia announced that he would circulate guidelines for naming features to IHO Member States. He stated that the prospective SCUFN member from Colombia has declined the invitation and that the IHB was seeking a replacement.

14 Dr. Ing. Schenke noted that the procedure for naming new features had been discussed; it was cumbersome and complicated. He said that new software is being prepared at AWI to enable new names to be proposed over the internet. Mr Cherkis interjected that ACUF had already come to the same conclusion and Lisa Taylor had been asked to prepare an internet method for ACUF.

15 The Secretary requested that the new Gazetteer should contain locations in digital degrees, to aid automatic searching, and not in degrees, minutes and seconds as hitherto.

16 The Chairman ended by thanking Dr. Ing. Schenke and Ing. en Chef Huet for their work in providing the Gazetteer.

3.4 Finance Working Group

17 The Secretary circulated the report of the Finance Working Group on behalf of its Chairman who had been unable to attend (Annex 2). The report considered the status of the three accounts currently available to support GEBCO. It showed that the University of Southampton GEBCO Fund had received a substantial donation from Dr Hall and his family during 2003 as well as some income from the sales of the GDA. On the other hand, it noted that there had been considerable expenditure on the Centenary Conference and on supporting the setting up of the Nippon Foundation/GEBCO Training Project. The report noted that the Nippon Foundation Fund at the University of Southampton had received the first tranche of funds from the Nippon Foundation and these were currently held in an interest-bearing account until they were required. Finally, it was reported that the IHB GEBCO Centenary Fund, administered by the IHB in Monaco, is a Euro account in which a small residue of expenditure from the Centenary Conference is held. Even neglecting the Nippon Foundation funds, which are available only for the specific purposes of the Training Project, the report indicated that GEBCO currently has financial reserves that should give it flexibility to meet unexpected expenditure and to seek out new sources of financial support.

18 Dr Smith queried whether the ca. £10,000 received from the sale of the GDA was really worth the trouble of collecting it. He wondered whether the GDA should be free of charge (or at cost). The Chairman said that this point should be deferred for later discussion (Item 3.12).

19 Mr Cherkis asked if there were any copies of 'The History of GEBCO' book left unsold because he had been asked to write a review which might lead to further sales. Ing. en Chef Huet replied that several hundred remained and none had been sold in the past year.

20 Capt. Gorziglia commented that some of the IHB GEBCO Centenary Fund had been spent on assisting two people to participate in the present meeting.

21 Dr Hall commented that he and the Margaret Blodgett Trustees were very pleased at the leverage their support had provided and at the success of the Nippon Foundation proposal. He said that he thought that it might be possible to find other sources of funds, perhaps with fewer strings attached.

22 Mr Macnab commented that he thought that in future GEBCO was likely to be able to depend less on voluntary efforts. He considered that selling value-added products over the Internet was the way to generate funds to enable GEBCO to meet its objectives. Dr Smith responded that selling the GDA is not at present generating substantial funds and that charging for the GDA was in fact hindering its distribution.

3.5 Data Assimilation and Acquisition Working Group (The National Geophysical Data Center)

23 Dr Fox tabled a report (Annex 3) on the activities of the National Geophysical Data Center. He stated that he had been in post for only 16 months and was keen to get back to the NGDC's basic function which was to archive data. He said he planned to make as much digital data freely available on-line as possible and NGDC had loaded up more data in the last 6-8 months. He said that he did not have the resources to handle multichannel seismic data which was too voluminous; it was more important to include sidescan and bathymetric data. He added that he wished to actively seek out new cruise data and plans to advertise for it. Finally, he reported that NGDC was starting a new service which delivered web-based interactive maps.

24 Dr Fox continued that NOAA had access to data from 20-30 multibeam systems which generated 44 Terabytes per annum. Although relatively large, this was tiny (about one three-thousandth) compared to the 140 Petabytes/p.a. which satellite observations were expected to produce in the next decade.

25 Dr Fox concluded by saying that he wanted to build a global framework for bathymetry involving an incompletely populated grid. Dr Carron concurred that it was a sensible objective to populate a world-wide grid at different levels. He said that there would be problems of both information technology and quality control. In response to a question from M. Cailliau, Dr Fox replied that the quality of navigational data was improving. He said that the problems lay in making use of opportunistic, non-survey data sets. Although he did not have the manpower to handle such data at present he did not want to turn data away. Dr Hall responded that UNH were looking into the problem. He said it took 20 minutes to clean up 24 hours of data.

3.6 Educational Working Group

26 In the absence of a report from the Chairman of the Working Group, Dr Fox reported that as far as he was aware the only activity during the year had been to produce an icosahedron (20-faceted) globe from the GEBCO 5-minute elevation grid with the standard GEBCO colour scheme which is freely downloadable from the NGDC site.

3.7 Integration of Geoscientific Data Working Group

27 The Chairman, Dr Walter Smith, reported that he had not managed to stay in touch with all the Working Group in the past year; therefore the WGIGD Report (Annex 4) should be construed as reflecting the general sense of the Working Group and not a unanimous recommendation. He said

that he regarded the job of the Working Group was how to integrate ancillary information, such as altimetry, into GEBCO's products and to understand how the products are being used. He reported that Karen Marks (NGDC) had set up a web site which could model what altimetry should 'see'. He said that some problems of offset grids had been recognised between DBDB2, ETOPO2 and the GEBCO grid; it had been discovered that different bathymetric grids performed differently and that roughness was important at certain scales. He said that the GEBCO 1 arc-minute grid is smoother than others and that several publications 'in press' were critical of the GEBCO grid. Dr Carron agreed that there are problems with the GEBCO grid in the South Pacific but he said he would be very concerned if there were problems elsewhere. Dr Smith responded by saying that his comments were preliminary but even so there appeared to be systematic differences everywhere, in slopes and computed topography, even when the new GEBCO areas were investigated. He speculated that the 500 m contours on the GDA-CE may limit the maximum slope. Dr Carron wondered whether terracing might be a problem and Dr Smith replied that it might be. Dr Smith added that he had compared GEBCO and other gridded datasets and he agreed that they could be very different. He said that ETOPO2 possessed more features than GEBCO. He said that the 'dimples' in the bathymetry were partly due to random errors in the satellite data but they also partly correlated with the abyssal hill texture seen in multibeam data, a result he had published with Dr. John A. Goff in Geophysical Research Letters **30** (24), 2003. Dr Smith concluded that although he had used 'clean' multibeam and single beam data it turned out that the data were not so clean after all.

3.8 Report of the GEBCO Bathymetric Editor (Annex 5)

28 Mr Hunter presented his reports for 2002-2003 and 2003-2004. In 2002 he said that he had principally been concerned with generating contours for the North Atlantic and assisting with the production of graphics for 'The History of GEBCO' book. Mr Hunter said that in 2003 he had helped to generate the new GEBCO flyer, he had loaded some sample charts from the GDA-CE on the Challenger Division, SOC web site and he had worked on detailed bathymetry of the Azores, Irish Sea, Porcupine Abyssal Plain (where problems of calibrating the depth of the towed fish had to be overcome) and Faeroe-Shetland Channel. In the Azores area, he said he had obtained a 300m gridded dataset; this, when compared with a multibeam survey, revealed how smooth is the GEBCO grid derived from contours. He said that he had examined a similar grid in the Irish Sea and come to the same conclusion. He stated that there is a real problem in managing a contour-based grid alongside a soundings-based grid.

29 Mr Hunter reported that he had also cleaned up bathymetric data from 28 NERC cruises in 2003 but a backlog of 100 cruises remained. The latest NERC cruise data that had been submitted to GEODAS were collected in 1995. Another project had been to generate bathymetry in the southern Red Sea as part of a project to investigate how 'man walked out of Africa'. He said he had used gridded hydrographic data and effectively 'lowered' sea-level to reveal shallow water pathways.

30 Finally, Mr Hunter presented his plans for the coming year. He noted that his line management continued to allow him to work on GEBCO matters but that he was also expected to spend some time on Challenger Division work. Dr Falconer asked what would happen if GEBCO asked him to change his work areas. Mr Hunter replied that this would not be a problem; his line management was 'reasonably helpful'.

31 Dr Hall asked if Mr Hunter had made any effort to acquire Irish multibeam data from the Irish Sea. Mr Hunter replied that these were not accessible until Ireland had submitted its UNCLOS claim. Dr Hall asked why he had not been asked for data that he held from the southern Red Sea. Mr Hunter replied that it had been a matter of timescale; he had had to respond rapidly.

32 Ing. en Chef Huet asked Mr Hunter when he expected to complete Sheets 4 and 5 of the IBCEA. Capt. Gorziglia enquired whether Mr Hunter's activities formed part of the GEBCO Work

Programme or were simply following the needs of the Challenger Division. Mr Hunter replied that he was available to service the needs of GEBCO.

3.9 Report of the GEBCO Digital Atlas Manager (see Annex 6)

33 Ms Weatherall described the work she had done, mainly in support of the preparation of data sets, publication and documentation of the GDA-CE and, more recently, to provide sales and back-up support to GDA users and to provide tiles of the GEBCO One Minute Grid over the internet (see Section 3.12).

34 Finally, Ms Weatherall presented her plans for the future. She said that she could control the work she does for GEBCO but that she is also called on to carry out work for BODC as well. For example, she is currently spending 20% of her time in helping to re-design the BODC web site. She said that she hoped to combine any additional IBCCA and IBCEA datasets into the GDA in the next 12 months if they become available.

35 Dr Loughridge asked what percentage of her time was spent on GEBCO matters. The answer was more than 90% in the last 12 months. She said that the work had involved transferring data and answering enquiries. Dr Loughridge then asked to what degree she was supported by NERC funds. The answer was 100%.

36 Dr Smith asked how much data has been requested in the form of the 20° x 20° tiles. Ms Weatherall replied that there had been 649 requests (combined grid, grid and image or just image).

37 Dr Falconer asked Dr Cramer how he managed to work on GEBCO matters. Dr Cramer replied that he had done 3-4 months work in the last 2 years, partly in his own time, and that he wished to continue.

38 Finally, Dr Carron noted that the BODC group had been asked to carry out a lot of work on GEBCO's behalf towards the GDA-CE and he said that he wished to thank the whole team, including Dr Jones, for all their efforts.

3.10 Sales of the GDA Centenary Edition

39 Annex 7 records how the proceeds of sales of the GDA-CE were agreed to be divided between BODC and GEBCO. It also records the distribution and sales by sector and by country of the GDA-CE in 2003-2004.

3.11 The GEBCO web site

40 Dr Goodwillie introduced the discussion. He said that 18 months ago the web site had been unsuited to marketing GEBCO. In the Autumn of 2002 he had proposed, and been funded by GEBCO, to improve the content of gridded data on the site. He noted that this had been done in the run-up to the Fall AGU meeting in 2002 and in the following months the appearance and functionality of the site had been changed. Very recently, he said, he had added text that explained the concepts behind the gridding of the GDA-CE. He finished by saying that the project had been completed and he would like to formally thank Ms Carla Moore of NGDC for her help.

41 Finally, he said that he thought that the 'Personality List' should be called 'GEBCO People'. He reminded the Committee that he had suggested in May 2002 that CVs should be linked to those named in the List; so far, only three people had supplied a CV.

42 Dr Loughridge raised the question of using a more concise and memorable URL than http://www.ngdc.noaa.gov/mgg/gebco/gebco.html. He stated that he had contacted gebco.org but the commercial owners were unwilling to give up the site and move to gebco.com. He said that he had investigated gebco.int and gebco.edu but the rules about .int and .edu sites prevented GEBCO from using them. He continued that an alternative URL, which was being pursued, might be

the_gebco.org or the-gebco.org (Dr Goodwillie also suggested gebco-bathymetry.org). He said that in principle the most appropriate extensions for GEBCO were .org or .net. He stated that there were new rules about sites hosted by NOAA but GEBCO was tied to NOAA through its IOC/IHO parentage and the rules were unlikely to be a problem. Dr Fox concurred that NGDC was still happy to help with hosting the GEBCO site.

43 The Chairman concluded by saying that the Guiding Committee should review the situation [Action Guiding Committee].

3.12 Release of the GDA over the Internet

44 Ms Weatherall described the system that had been set up to allow users to access tiles of the GEBCO One Minute Grid over the internet. She explained that users have to log in (so that their details are recorded by BODC in a database) and can download data for one tile, i.e. grid file, image file or both grid and image file, per session. Since 17 February 2004, there had been 649 downloads from the site by 73 users. The users came from 19 different countries and included commercial and educational backgrounds. Only three, educational, users had downloaded a large number of GDA gridded dataset tiles.

45 This presentation prompted a discussion over whether GEBCO products should be free or sold at cost. Mr Macnab began by stating that as Chairman of IBCAO he had always had to battle for funds. He said that he thought that GEBCO needed a marketing strategy. In his opinion some things should be free, such as the IBCAO grid, but others should be charged for, such as print-on-demand charts. GEBCO needed funds to support young researchers. Dr Smith concurred with many of these comments. He said that he believed that there were different categories of potential user. Scientific users could use a raw product, such as a grid, and use it directly; other users needed a straightforward product and yet again others might be prepared to pay. He thought that if the second category of user was willing to pay for the CD this might discourage the first type of user. Dr Smith queried whether income from sales of the GDA-CE, which had reached £10,000 in the first year, would be maintained in later years. He asked whether the GDA grid, without the associated display software, should be free. Mr Macnab responded that the IBCAO grid had been free since 2000. Dr Loughridge noted that if sales tailed off over some period the long tail might cost more to service than it might provide as income.

46 Dr Loughridge voiced his opinion that it was difficult to convince funding agencies that a lab, such as BODC, was doing something ‘useful’ without the statistics of sales to back up this contention. He said that he thought that at least some users should pay for products in order to convince NERC to continue to support GEBCO

47 Dr Smith returned to his suggestion that the GDA-CE should be sold but that the grid alone should be free. He stressed that other bathymetric grids were already free.

48 Dr Cramer pointed out that BODC regarded the software on the GDA as free but that the gridded data was being paid for. Dr Smith responded by saying that the data itself is not for sale because it had been donated. Dr Carron pointed out that some of the donated data had been in the form of a grid. Dr Cramer replied that personally he agreed but it all depended on whether one wished to obtain a financial return.

49 Dr Fox rejoined that NGDC’s view was that payments should be used only to recover marginal costs. He thought that charges would discourage graduate students, for example, but that teachers would be prepared to pay only the marginal costs. He supported the idea of providing free internet access to the grid and was willing to host a site for this purpose (while recognising that many users with only dial-up access would prefer to be given a CD).

50 Capt. Gorziglia noted the policy of IHO/IOC towards publications. He said that both organisations wish to allow free access to their publications on web sites because they think that this pays off in the long term.

51 The Chairman voiced the opinion that GEBCO really needed a Marketing Working Group to look into which users could, and could not, pay. He proposed that a decision about free access to the grid was deferred. He said that there was a need to consider two matters 1) whether the GDA grid should be free and 2) how available the GDA-CE was to users in different situations.

4. NEW ACTIVITIES IN THE PERIOD 2003-2004

4.1 The Nippon Foundation/GEBCO Training Project

52 The Permanent Secretary, Prof. Whitmarsh, introduced the newly funded Nippon Foundation/GEBCO Training Project. He began by describing how, following a suggestion from Mr Tani, the project had arisen from a simple proposal for a postdoctoral research fellowship, submitted by Sir Anthony Laughton in Summer 2003, to a major million dollar proposal submitted by himself in November 2003 which had been approved in December. He noted that funding amounted to almost US$3 million spread over 5 years and that the first tranche of funds for April 2004 until March 2005 had already been paid into a GEBCO account in Southampton University. He described how the project would be split into three complementary parts, a Postgraduate Certificate in Ocean Bathymetry, Project Fellowships and Work Packages. He continued that it had already been decided, through competitive tenders, that the PCOB would be taught at the University of New Hampshire in the USA and that seven students were being sought, primarily from developing countries, for the first intake due to start in September 2004. He said that advertisements had been placed for a Project Manager and interviews for this position were planned within the next two weeks; the first Project Fellows and Work Packages would start work in 2005 and 2006, respectively. The Secretary also noted that an *ad hoc* Project Management Group consisting of Mr Anderson, Dr Falconer (Chairman), Dr Jakobsson, Dr Loughridge, Mr Monahan, Dr. Ing. Schenke, and himself had already been set up; the PMG had already met once in January 2004. The Secretary finished by saying that the Nippon Foundation award promised to change GEBCO dramatically and to address the important objective of bringing a new generation of bathymetrists into the GEBCO community.

53 M Cailliau asked whether funds for succeeding years, after March 2005, were assured. The Secretary replied that he had been assured by the Nippon Foundation that funding would be awarded on a yearly basis but it was a bureaucratic formality to re-apply for funds each year.

54 Dr Falconer expanded on the situation regarding the Project Manager appointment. He said that 31 applications had been received by the deadline in March. He noted that a selection Panel had been agreed consisting of the Secretary, Chris Andreasen, himself, Hans-Werner Schenke and Jean-Claude Sibuet (Ifremer, France); a panel of three would conduct the interviews on 15 April. He said that it was planned that the Project Manager would report to the PMG acting on behalf of the Guiding Committee. The position of the Project Manager was discussed; Dr Falconer explained that the post might initially be part-time, it could, depending on the final choice of candidate, overlap with the post of Director of Studies within the PCOB course; the PM would also be responsible for the disbursement of the Nippon Foundation funds. Dr Loughridge noted that the PM position was not something that the Permanent Secretary could also take on in addition to his other duties.

55 Dr Falconer described the selection of students. He stressed that this had to be done in a very short time frame. Mr Anderson said that he had been asked by the PMG to solicit GEBCO members for the names of contacts, particularly in developing countries, but he had had very little feedback. The Secretary offered to send him the address of a URL of all geoscience departments

world-wide. Dr Cramer added that BODC could supply the addresses of people in developing countries who had bought the GDA-CE. His contacts in universities in the USA had suggested that applicants should have a single point of contact which could be the GEBCO web site. A view was expressed that the best or better graduate students would have already made their plans for the 2004/2005 academic year and that, even now, it was too late to seek students for 2004.

56 Dr Falconer noted that the IHB had offered to help in finding candidates for the PCOB. Capt. Gorziglia explained that at the time of the meeting between himself and the Chairman and Secretary of GEBCO in Monaco in January the IHO Member States did not know about the Nippon Foundation project. Therefore he had issued a Circular Letter asking them to provide names of candidates by 7 April. He said that he was very concerned at the speed with which the PCOB course was being set up and that GEBCO was making mistakes. He said he wanted to be sure that the Nippon Foundation funds were well spent and that the PCOB students will stay in the GEBCO community after their training. Dr Falconer responded that the selection process had been carefully planned. He noted that it was intended that interviews should be conducted in regions by a Panel consisting of representatives from the Nippon Foundation, GEBCO, the University of New Hampshire and an expert from each region.

57 Mr Macnab thanked Capt. Gorziglia for raising the issue. He did not want to sound too negative but he too was taken aback by the speed of events. He said that he thought GEBCO was in danger of putting the cart before the horse and that first GEBCO needed to decide what it wanted to do. He was concerned that students returning to developing countries might get promoted above the level at which they might contribute to GEBCO. He asked whether students already in developing countries could be funded immediately by GEBCO. Dr Falconer responded that GEBCO was constrained by the guiding objective of the Nippon Foundation to promote human development. He recalled that there had already been problems persuading the NF to include Project Fellowships in the proposal.

58 The Chairman explained that the timing was not of GEBCO's choosing; it had been hoped to begin the PCOB course in 2005 but GEBCO had been asked by the NF to start in 2004. He continued that Dr Falconer was correct to stress the need for human resource development, it had been difficult to persuade the NF to include the Project Fellowships, for example. Dr Carron agreed that it may be getting too late to seek students for 2004 but Dr Falconer countered that GEBCO was not necessarily seeking the highest calibre postdoctoral students. He said that some candidates might already be in employment; GEBCO was not seeking only fresh graduates. M. Cailliau enquired what would happen if insufficient good students would be available by September. Dr Falconer replied that he was confident that 7 students would be found. Dr Smith concluded that it was pointless to argue now about setting up the PCOB another way. He said he was more concerned about whether the PCOB students would find relevant jobs afterwards and about the time required for them to obtain visas to enter the USA.

59 Mr Travin noted an example of the experience of IOC in this field. Five years ago 15 people had been trained, with funds from the German government, but only one of these people still works in a related position in government today. Dr Loughridge noted that it was not important that a student remained in government employment. Mr Travin noted that many of the trainees had even left their home countries.

60 Capt. Gorziglia asked why the Work Packages would last for 2 years and not, say, 18 months. Dr Falconer replied that GEBCO had had to make a substantive proposal; the problem now was for GEBCO Working Groups to find suitable projects. Capt. Gorziglia said he though that the Guiding Committee should define the Work Packages. The Chairman concurred and noted that this item was on the Agenda. Dr Loughridge said that he though that a good example was how to get a developing country to move into the digital domain in its data handling. Capt. Gorziglia thought that better information and communication was required. Dr Smith concluded by saying that the first priority was the choice of PCOB students, the Work Package problem could be

addressed later. He pointed out that to some extent the students could be chosen according to the areas of the world in which GEBCO wanted to work.

61 The Secretary continued the discussion by describing the Project Fellowship scheme. In answer to various questions it was noted that the Fellowships did not have to be based in a university, that the results of any research will have to be put in the public domain, that there was no guarantee that Fellows would remain in the GEBCO community and that Fellows would not have to come from developing countries.

62 Capt. Gorziglia again announced his misgivings. He felt that there was a lack of information about the Teaching Organisation and about the details of the PCOB course. He noted that TEFL examinations happened only 2-3 times a year and that prospective students might not have time to take such a course before applying.

63 Dr Falconer concluded the discussion of the Nippon Foundation/GEBCO Training Project by reiterating that the GEBCO community could help by providing contact addresses of potential students, and by suggesting projects for Work Packages and Project Fellowships. [Action All]

5. PROPOSALS THAT COULD IMPACT GEBCO IN THE FUTURE

5.1 Proposal from IHB and IOC

64 Capt. Gorziglia presented a proposal from the IHB and the IOC Secretariat for a reorganisation of Ocean Mapping (Annex 8). The stated objective was ‘to improve things’. He began by describing the mission and membership (74 member states) within the IHO. He then showed how GEBCO fitted within the work programme of the IHO and noted the Memorandum of Understanding between IHO and IOC which specifically mentions GEBCO. He then presented an organogram of ocean mapping which included a new Ocean Mapping Directing Board whose job would be to co-ordinate the efforts of GEBCO and the Regional Mapping Programme. Capt. Gorziglia sought feedback from GEBCO by October 2004. Meanwhile, he stated, a resolution would be put to the IOC Executive Council in June 2004 and an IHO Circular Letter would be sent to member states to seek their approval of the change. Finally, he said, a resolution would be put before the IOC General Assembly in 2005.

65 Capt. Gorziglia continued that this proposal stemmed from the IHB’s frustration at the lack of communication between GEBCO and the IOC/IHO. For example, he alleged that the GEBCO Work Programme, developed in Durham, New Hampshire in 2002, had not been sent to either IHB or IOC. Further, he had asked the Guiding Committee at its meeting in 2003 for a clear Work Programme so that the IHB would know what funds were needed to underpin it. Mr Macnab replied that, speaking as the Editor of the IBCAO (an IOC Regional Mapping programme using GEBCO data), he found the document from the IHB a worthwhile attempt to find an administrative solution to the co-ordination problem. He said that, of course, integration was needed at a technical level; it was nonsensical to produce two series of overlapping charts. However, he stated that in his view the document was an administrative instrument that put the cart before the horse. He considered that it was better to decide first what needed to be done and then to devise an administrative structure to accomplish it.

66 Dr Falconer responded by saying that he was not very familiar with the IBCs projects and asked those present to explain how they worked.

67 Dr Hall give a brief history of the IBCM which he had joined in 1981. The project had evolved, although there had been no grand plan, to producing geophysical charts as well as charts of bathymetry. However, he continued, no geophysical data had been contributed by the hydrographic community. In fact, he said, the Hydrographic Offices had objected to a decrease in the gridding interval and a request for gridded bathymetry, that was held in Italy, had been met with a response asking for funds and manpower. Dr Hall continued that today most data was

being collected by French and Spanish scientists. In summary, he said that Hydrographic Offices contributed very little data and the IBCM was going ahead without them. He concluded that, in his experience people, from Hydrographic Offices had only raised difficulties in the last 20 years. On the other hand there had never been any problem in collaborating with the GEBCO community.

68 Dr Frias described his experience of the IBCCA which had been set up in 1986 by an IOC resolution. Initially, he said, 1:250,000 plotting sheets had been used later superseded by sheets at 1;500,000 scale; at least 6 countries were involved. Training courses had been set up for people from countries without Hydrographic Offices which had also helped to identify sources of data. He noted that there had been a lot of support from the NGDC. He said that the Editorial Board had met 8 times but there had been a lot of restrictions on its work; even so, 12 sheets had been published but other sheets were stalled by the lack of participation from countries such as France. A meeting had taken place in Guadeloupe in November 2003 to consider adding geological and geophysical overlays to the sheets. In answer to questions Dr Frias confirmed that all the sheets existed in digital form; the sheets were updated as digital contours. Dr Carron noted that grids, generated by GEBCO from the IBCCA, were used in the GDA-CE (contours from the first 4 sheets had been digitised and gridded but only the contours had been digitised in the next 5 sheets). The Chairman noted that he saw this example as a sign of good co-operation. Dr Carron concurred; he said that IBCM, IBCAO and IBCCA had all contributed extensively to the GDA.

69 Mr Macnab offered his experience with the IBCAO which had taken a different approach to that heard so far. The IBCAO, he said, had been motivated by countries' needs pertaining to Article 76 of the Law of the Sea; the IBCAO had worked through a series of workshops to bring in a number of countries including Russia and this led to the inauguration of the IBCAO in 1997. He continued that the IBCAO members worked with original soundings (contour input was not regarded as essential) and Martin Jakobsson had played an important part in assembling the data. After 2 years, he said, by late 1999, all the data had been assembled and this led to publication of the chart in EOS the following year. He stressed that the IBCAO grid was free and that contours could be generated on charts (printed by the US Government Printing Office) or simply as digital files. Mr Macnab concluded by saying that he had had good support from IHO and IOC.

70 Dr Loughridge summarised the discussion. He said he sensed that there was a lot of international co-operation at the working level but that there were negative comments about intergovernmental co-operation. He wondered to what extent the intergovernmental bodies were involved. Mr Travin responded by saying that IOC had helped to declassify data using intergovernmental co-operation. Dr Falconer asked for an explanation of how intergovernmental co-operation worked. Mr Macnab said that, as far as the IBCAO was concerned, it had helped to have three endorsing bodies which were IOC, IHO and the International Arctic Science Committee.

71 The Chairman returned to the point at issue by asking whether the proposed reorganisation would make any difference. Mr Macnab said he could not say.

72 Mr Hunter reported his own experience of the IBCs. He said that GEBCO had provided a lot of contours for the IBCEA which had been handled by SHOM but there had been delays because their resources were limited. Regarding the IBCWIO, he continued, there had been good co-operation between Hydrographic Offices in Russia, South Africa and Germany and it had introduced emerging nations to ocean mapping. Mr Travin added that the Editorial Board meets every 2-3 years depending on the finances available from IOC. He said that the Board had revised work from recent year and approved the printing of colour proofs. It planned to print only sheets.

73 Dr Loughridge asked about the state of co-operation involving the IOC and IHO in the West Pacific. Mr Travin responded that it was a huge area with a lot of political problems. He said that the important factor was that intergovernmental organisations existed there which were trying to work through the IOC. He noted that the next meeting would be held in China in two weeks time.

74 Dr Loughridge asked again whether the proposal would help the situation. Capt. Gorziglia replied that it was important because of the bathymetric data that came from Hydrographic Offices, a statement that did not receive consensus from those present. He asked who, in that case, would run the ships that gather multibeam data and was reminded that such data do not come from the Hydrographic Offices. Dr Carron reminded Capt. Gorziglia that the IHB's recent circular letter asking for data from shallow water had elicited very little response and even a nil response from some continents. Capt. Gorziglia insisted that the Guiding Committee should give guidance to the IHO and that the proposal would get rid of shortcomings in the present situation.

75 The Chairman concluded that most IBC projects do work well with GEBCO and asked again what specific problems would be solved by the proposal. Capt. Gorziglia said that people needed to know what data were being collected for. For example, the IBCSEP Board should meet with GEBCO people. Dr Falconer asked what was happening in the SE Pacific area. Capt. Gorziglia stated that a Hydrographic Commission representing countries such as Colombia, Peru and others had agreed on a work programme to collect survey data each year. Dr Carron concurred that a reasonable plan had been set up in which deep-water bathymetry derived from satellite altimetry would be combined with shallow-water bathymetric data. The Chairman re-iterated that it seemed to him that a lot of collaboration was going on between GEBCO and the IBCs already.

76 Dr Fox continued the discussion by saying that any new structure needed to support the missions of both GEBCO and the regional mapping programme. GEBCO, he said, should consider how it makes use of the latest technology, define where it needs to update its charts and ensure that it moves into the 21st century. Dr Smith reiterated that the proposal tries to address the lack of communication but, so far, the IHB has asked for and received no answers. At last year's meeting there was insufficient time to discuss the problem but even so there had been a lot of discussion within GEBCO already. For example, he noted that the SCDB was not meeting formally this year, yet people were still working together, however this had not been communicated formally to IOC and the IHB. He continued that GEBCO was in a time of transition and there were many difficulties due to conflicts between the old and the new ways of working. The Chairman responded by saying that in a time of transition documents do not necessarily capture the sense of change. He sensed that GEBCO was making a transition internally, technology was changing and that the IBC communities were becoming more productive. He wondered whether the parent organisations only read the GEBCO Minutes and not the publications that related to ocean bathymetry. Nevertheless, he concurred that GEBCO should continue to look at its internal organisation.

77 Dr Ing Schenke noted that the setting up of the new IBCSO had been driven by the success of the IBCAO. He reminded the Committee that the idea for the IBCSO had come from scientists during the meeting in Durham, New Hampshire (2002) which had led to an *ad hoc* meeting to develop a plan in late 2002. He said that SCAR had been involved, the IOC Secretariat had been informed and an initial meeting (Bremen, Germany 2004) had been approved by the Chairman of CGOM. CGOM had accepted the idea at its meeting in 2003. However, he stressed that the principle idea had arisen from within GEBCO.

78 Cdr Shipman noted that the proposal contains draft Terms of Reference. The Sub-Committee of Digital Bathymetry, the Sub-Committee on Undersea Feature Names and the GEBCO Working Groups remain part of the proposal but any organisation can suggest changes or make alternative proposals. Capt. Gorziglia concluded that IHB did not want to destroy GEBCO or ocean mapping. He recognised that GEBCO and the IBCs are separate. The new feature was the proposal for an Ocean Mapping Directing Board. He hoped to raise ocean mapping activity.

79 Mr Newton said that he agreed that times had changed but he remained convinced that GEBCO was a bottom-up, collegiate organisation that really works. He said he had read the IHB/IOC proposal and suggested that it should be accepted for consideration by a small GEBCO group

which should respond by a fixed date. Capt. Gorziglia said that IHB expects comments soon preferably by October 2004 but he was prepared to consider any comments now which could be incorporated into the document. Mr Newton asked whether the proposal would go to IOC and IHO for consideration regardless of the GEBCO reaction. Capt. Gorziglia replied that the proposal would go to the Executive Council of IOC in June 2004 as a draft resolution. The optimum solution would be for the proposal to be passed to CGOM, the Guiding Committee and the IHO/IOC Member States for consideration. The Chairman concluded the discussion by saying that GEBCO should set up a Working Group that should report within one month [see para. 101].

5.2 The POBACE Proposal

80 Dr. Ing. Schenke introduced the Polar Ocean BAthymetry Co-ordination Effort proposal. He described how the proposal started life at a meeting in Potsdam when Chris Rapley and Robin Bell proposed an International Polar Year in 2007/2008, to include Earth sciences, at both poles (following earlier IPYs in 1883 and 1932-33 and the IGY in 1957-58). He noted that the proposal was intended to be for multidisciplinary research into global processes, especially climate studies, and for research that needed to be conducted with the collaboration of several countries (Annex 9). Dr. Ing. Schenke explained that he and Martin Klenke had also proposed bathymetric studies that would impact on many activities (fishing, safety, transport, pollution etc.). He said that the POBACE proposal would experience problems of data archiving, co-ordinating expeditions, planning tracks and post-cruise processing but that there would also be many benefits; links with the IBCSO had already been established. So far, he continued, world-wide distribution of the proposal had elicited many positive comments. In answer to a question Dr. Ing. Schenke stated that he hoped that the environmental concerns of acquiring multibeam data in the Antarctic would ease within a few years.

81 Capt. Gorziglia remarked that the IMO and IHO were concerned about the safety of navigation in remote areas such as the Antarctic Ocean and that IATO (International Association of Antarctic Tour Operators) was similarly concerned and had proposed that one person should be embarked on each cruise ship, some of which have deep-water systems, as a means of acquiring bathymetric data. In fact , he continued, an Antarctic Treaty Consultative meeting had already discussed the IPY and the use of multibeam systems in such areas. Dr Falconer responded by asking whether the IHO/IOC had had any contacts with the fishing industry; in the case of New Zealand, for example, vessels routinely run deep-water echo-sounders in the Ross Sea. Capt. Gorziglia replied that they were not getting the benefit of data acquired by fishermen because their work areas were kept secret.

5.3 German contact

82 Dr. Ing. Schenke explained that he had got to know a popular science journalist in Germany who was also a good teacher. This person, Bernhardt Macovia, was very interested, he had already been to sea and had written about the GEBCO Centenary; he had promised to prepare a document about an Educational GDA in time for the Guiding Committee meeting but he had run out of time due to illness. Dr. Ing. Schenke undertook to maintain contact with Mr Macovia [Action Dr-Ing Schenke].

5.4 A proposed new altimeter mission

83 Dr Smith referred to the document 'Bathymetry from Space' which he had circulated earlier. He said that the next issue of *Oceanography*, the journal of the Oceanography Society in the USA, would be devoted to the topic. He noted that in the GDA the bathymetric texture depended on the style of the contouring and that the track coverage was often poor (comparable to the spacing of Interstate routes in the conterminous USA!). He added that profiles from the South Pacific differed depending on whether they were derived from satellites or ships and on the navigation used by the ships. This had important consequences, he said, because tsunami height depends on

seamount orientation and height above the surrounding seafloor. PDF files of the articles in Oceanography are available from http://www.tos.org/oceanography/issues/archive.html.

84 Dr Smith noted that his proposal, first made a few years ago to NASA, to put an altimeter on the International Space Station had not been funded in spite of receiving good reviews and it now appeared uncertain that the ISS would be completed. He continued that a NOAA-funded design study had shown how to accomplish the same goals at a similar cost by carrying the instrument on a dedicated, small spacecraft rather than the ISS. He said he would continue to propose such a project to NASA and other agencies as opportunities arose; other states had also expressed interest in participating in such a mission.

5.5 Draft letter from the President of SCOR to Data Centres

85 The Secretary presented the draft of a letter from the President of SCOR to Data Centres which he had been sent for comment. Dr Fox noted that the draft was factually incorrect in places concerning the distribution and availability of certain products. He added that a lot of freeware already existed and that the problem was to make it more easy to use. Mr Macnab noted that the letter appeared to be based on the SCOR107 Working Group Report the recommendations of which had been made 5 years ago and some may no longer be relevant. Dr Smith, also a member of the SCOR107 Working Group, thought that the letter presented an incomplete and possibly biased view of the Working Group's recommendations. The Committee agreed that the letter needed to be brought up to date. The Committee was asked to send their comments to the Secretary by mid-May [Action All].

5.6 Co-operation with the International Steering Committee for Global Mapping

86 The Chairman informed the Committee that he was in contact with Professor Fraser Taylor, the Chairman of the International Steering Committee for Global Mapping, and hoped to meet him in Ottawa [Action Chairman]. The function of the ISCGM and its relation to the International Cartographic Association was unclear. Dr Hall noted that the ICA meets every two years and that it might be useful to send them a copy of the GDA-CE. Mr Macnab said he thought that Dr. Ing. Schenke already had contacts with the ISCGM. Capt. Gorziglia clarified the situation by informing the Committee that the ISCGM and the ICA were unrelated. He said that the ISCGM maintained world topography on a web site. The IHB had been approached by both the Chairman and Secretary of the ICGM asking whether they could combine IHB's bathymetry with the topographic data. Capt. Gorziglia opined that the approach from the ISCGM should be treated with caution.

5.7 GEBCO's requirements in shallow water

87 The Chairman introduced the topic of GEBCO's approach to the inclusion of shallow water bathymetry. Mr Macnab sought clarification because he recalled that in the past it had been stated in some circles that there was 'no place for GEBCO on the continental shelves'. Dr Loughridge replied that when the IHO/DCDB had been set up the Terms of Reference had included the acquisition of data from <200 m in order to encourage the submission of continental shelf bathymetry. Dr Smith pointed out that the GDA-CE already contained some shallow-water data although elsewhere the coastline needed better definition. Dr Goodwillie concurred that the shallow-water bathymetry needed to be improved. He recalled that in 2003 Mr Pharaoh had offered to look into obtaining data from ENCs. Mr Hunter recalled that Mr Pharaoh had only said that data might be available. Mr Hunter said that he had obtained a sample of ENC data from the UK HO and had been able to create a grid from it. The Chairman requested Mr Hunter to write up what he had done [Action Mr Hunter]. The Chairman recalled that Mr Pharaoh had said that he would only use soundings published on existing paper charts; he suggested that the Committee should look at what Mr Hunter had done before making a decision.

88 Dr Hall confirmed that Mediterranean HOs had been asked to provide data from the shelf. Capt. Gorziglia noted that, although more ENCs were being produced all the time, 10 m and 100 m contours and grids were not routinely available.

89 The Chairman noted that soundings represented a very small fraction of the total data in shallow water. Dr Smith suggested that in the short-term a 1' grid might be sufficient; the soundings could even be averaged over a 1' grid. He thought that some countries might be reluctant to donate all their data but might be willing to provide relatively low resolution data sets.

90 Dr Carron informed the Committee that all the negative comments he had received since the publication of the GDA-CE had pertained to areas where the depths were <100 m e.g. Gulf of Carpentaria, Great Barrier Reef. He said that oceanographic modellers in these areas needed 1' or even 0.1'grids.

91 Dr Falconer noted that currently, at least in New Zealand, interest in bathymetry was focused more on its application to defining the 'legal continental shelf' (UNCLOS needs) than to shallow-water areas.

5.8 Proposal for floating buoys

92 Mr Anderson updated the Committee on his SSPARR project to build a series of free-floating bathymetric buoys (Annex 10). He reminded the Committee of the scarcity of soundings in the Southern Ocean, Arctic Ocean and South Pacific Ocean. He continued that development of the buoys had begun in September 2003 following funding by the NSF and stated that the aim was to move to a pilot production stage after 3 years and to buy a few thousand buoys. He expected the cost to be $2-3k per buoy. Those involved, he said, were himself, two engineers, someone from Lamont-Doherty Earth Observatory and Larry Mayer. They planned the first deployment from the USCGC *Healy* in October 2004. Navigation by GPS, he said, was preferred to the use of Argos fixes. Mr Anderson offered to submit a cruise report to the Permanent Secretary [Action Mr Anderson]. Dr Hall added that he calculated that 100 buoys deployed in the Arctic might collect 500,000 soundings over 5 years.

5.9 Submarine tracks in the Arctic Ocean

93 Mr Newton reminded the Committee that he had convinced the US Navy in 1997 to release depth measurements acquired by submarines outside EEZs. Mr Anderson had had some similar success. He continued that the US Navy had now agreed to declassify all bathymetric data after 5 years (previously the limit had been 10 years). He said that he was also trying to obtain data from Denmark even from inside the EEZ. He offered to pass a CD containing such data to Mr Macnab and Dr Fox.

94 Mr Cherkis added that in 2002 the University of Washington, Seattle, USA had obtained 972,000 data points from submarine tracks which, after quality control, had been reduced to 630,000 points (Annex 11).

5.10 World vector shoreline

95 RADM Andreasen reported that his office is collecting a new World Vector Shoreline which he plans to make public; the shoreline in the current version of the GDA is from the WVS at 1:250,000 scale. RADM Andreasen said that his office had contracted to collect a new WVS shoreline at 1:50,000 scale from north of Antarctica to something like 82° or 84°N; this will be a satellite-derived shoreline which approximates the High Water Line not the Low Water Line desired for boundary work. He said he also plans to put this shoreline into continual maintenance such that it is improved over time. The U.S. Department of State has asked that he begins to include marine boundary information and he will begin doing this on a resource available basis.

He continued that the new WVS should start to become available later this year. He reported that he is also collecting the coral reef areas of the Caribbean Sea area to support NOAA coral reef work and to update some of his large scale products. The intention was to make the WVS freely available on 28 CD-ROMs and a single DVD.

96 In answer to questions RADM Andreasen stated that there was no documentation available yet, that no lower resolution product would be immediately available and that there would be no hard copy version of the WVS. In answer to a further question he confirmed that the Antarctic shoreline would be included eventually.

6. RESPONSES TO THE IHO/IOC PROPOSAL

97 Mr Macnab offered his personal views. He considered that the primary objectives of GEBCO should be to include the creation of a digital model of global bathymetry from original observations and to promote international co-operation and co-ordination in the design and execution of ocean mapping. He noted that the IBCs involved ~130 sheets and GEBCO ~30 sheets. He continued that the work involved was very time consuming, there was geographical overlap between the IBCs and GEBCO and some charts areas were somewhat arbitrary. In his experience, he said, it was hard to co-ordinate activities although he favoured a joint approach by both groups. He thought that the bathymetric charting community would lose credibility if the IBC and GEBCO products differed (because they were based on different data sets). Consequently, he proposed that, in future, bathymetric charting should be organised by oceanic areas to rationalise the organisational issues and enable the merging of the IBCs and GEBCO. He stated that he saw the advantages of such an approach as fewer project areas, natural geographically integrated areas, a reduction in project overheads, far less duplication (all the data would reside in a single database) and the possible better and more efficient use of funds. Finally, Mr Macnab presented his scheme for a new organisational structure (Annex 12).

98 Dr Loughridge presented feedback on behalf of the Guiding Committee encapsulated in another organogram (Annex 13). He said that the Guiding Committee's view was that the proposed re-organisation was unnecessarily complicated and biased towards the rather bureaucratic mode of operation characteristic of the IHO and IOC. He added that the proposal also added an extra layer to the committee organogram. While agreeing with the IHB and IOC stated goal of more efficiency, the Guiding Committee considered that the new proposal did not help to achieve this. Dr Loughridge concluded that if ocean mapping needed a new name it should be called the GEBCO Ocean Mapping Project.

99 The Chairman responded by saying that two very powerful responses had been made and asked whether this was sufficient response for the IHB to act on. Capt. Gorziglia answered that he thought the two responses were not very different from the IHB proposal; it was not his intention to reduce the influence of either GEBCO or the IBCs. He added that the views of CGOM should also be sought and that the final outcome would depend on what the Guiding Committee and CGOM submitted to the IOC Executive Council.

100 Dr Loughridge thanked Capt. Gorziglia for his positive response. He affirmed that it was better to create a framework that allows for future development rather than one that is too prescriptive. Dr Smith remarked that of the IHB and Guiding Committee diagrams he preferred the Guiding Committee one because it allows more direct communication between the IBCs and GEBCO's Sub-Committee on Digital Bathymetry (or its successor). Dr Fox concurred. He said that the Guiding Committee organogram was an improvement but he noted that it omitted the IBC enabling committees that appeared in Mr Macnab's plan. Dr Loughridge replied that the new Guiding Committee for Ocean Mapping would include the task of an enabling committee. Mr Newton disagreed and said that he thought that the enabling committee should have a separate identity. RADM Andreasen said that he liked the Guiding Committee plan as it stood; it

eliminated a layer in the IHB plan which would avoid an increase in the cost and complexity of meetings.

101 Capt. Gorziglia repeated that he considered the Macnab and Guiding Committee diagrams were no different from the IHB diagram except that the Guiding Committee would become the GEBCO Global Project Committee. He said that he did not want to close down the Guiding Committee. He stated that he realised that the GEBCO Global Project Committee was superfluous and that he would be happy to delete it from any revised scheme. He concluded that it was necessary to think about the terms of reference of the constituent bodies of the new scheme by October 2004. RADM Andreasen asked about the timescale of formal ratification of any new scheme. Capt. Gorziglia responded that the proposal would be put to the IOC Executive Council in June 2004 and that IOC Member States would consider the issue at the IOC General Assembly in late June 2005. Finally Dr Falconer suggested that GEBCO should establish a small Working Group to re-work its response; membership of this group was agreed to be the Chairman and Drs. Frias, Loughridge and Macnab [Action Chairman, Dr Frias, Dr Loughridge, Mr Macnab]

7. PRESENTATION OF WORKING GROUP REPORTS

7.1 Marketing Working Group

102 Mr Macnab, as *ad hoc* Chairman, summarised the results of a meeting of an *ad hoc* Marketing Group that had met on Saturday afternoon 3rd April. He stated that the group had come to the following conclusions (see Annex 14).

103 7.1.1 the basic GEBCO grid should be provided over the internet

104 7.1.2 more copies of the GDA-CE would be sold if the price was lower

105 7.1.3 GEBCO could sell other value-added products but this would involve a lot of effort

106 7.1.4 GEBCO should seek out more foundations and other bodies that could support it financially

107 7.1.5 GEBCO should be more pro-active in reaching out to the general public and its users; for example, it needed a distinctive logo.

108 Mr Newton added that in his experience with Foundations they would wish to know what sort of organisation GEBCO wanted to become. He agreed that the use of a distinctive logo was one way to engender greater visibility. He also recommended that,

109 7.1.6 GEBCO should acquire a new and easy-to-remember URL for its web site

110 7.1.7 the flyer should be improved by stressing that GEBCO was not-for-profit and it should include more photos

111 7.1.8 when new sponsors are approached it is made clear what the money will be used for

112 7.1.9 GEBCO should work out what it was not doing that it should be doing

113 Capt. Gorziglia noted that the IHO needed to be sent a clear Work Programme so that he could fight for funds for GEBCO within the IHO.

7.2 Data Integration Working Group

114 Dr Smith listed the main objectives that he saw for the Working Group.

115 7.2.1 maintain and update the existing 1’ grid on the GDA and expand it into near shore areas

116 7.2.2 continue to explore new technologies and data sources

117 7.2.3 correct errors in the data

118 7.2.4 develop an alternative 1’ grid assimilating all relevant data and using all available technologies

119 7.2.5 ingest new data from the IBCs

120 7.2.6 build a quality-estimate grid

121 7.2.7 request help from the IHO and the IOC to access new sources of data

122 7.2.8 explore the best blend of soundings, contours, altimetry and existing grids

123 7.2.9 expand the use of metadata

124 Mr Macnab added to the list by saying that a new grid should be built from existing soundings and not from digital contours. RADM Andreasen noted that any alternative grid should include multibeam data but it will also need new organisational structures such as the editorial review of added data.

8. DEVELOPMENT OF A WORK PLAN FOR 2004-2005 (see Annex 15)

125 Discussions of Tasks 1 to 3 inclusive proved to be inconclusive. The main discussions started with Task 4, Review roles, responsibilities and memberships. Many points raised in discussion were used to update the Work Plan, the current issue of which is shown in Annex 15. The principal discussion points were as follows,

126 Task 4.5 (Improve diversity). Improve the diversity of the GEBCO community. Dr Goodwillie reported that he had made a start. He thought that providing free access to the GDA grid via the internet would help and that producing an educational version of the GDA on CD will increase interest in GEBCO and lead to more contributions as well. Dr Carron and others praised the virtues of taking on summer students.

127 Task 6.1 (Paper edition). Mr Macnab and Dr. Ing. Schenke both reported that they were investigating print-on-demand by companies in their home areas. Dr Goodwillie noted that he had found there was still a demand for paper copies by people he had talked to at the AGU and EGS meetings. Dr Cramer reported that he wanted to add images of chart areas to the BODC web site. Dr Smith agreed that GEBCO could easily create plot files of the standard chart areas; he asked whether there was a technical problem with this or whether it was a matter of principle. Mr Hunter said he already offered image files of fixed areas on the SOC web site. Capt. Gorziglia wanted to know whether a paper 6th Edition was going to be published; he noted that it was mentioned in Terms of Reference of the GC. The Chairman pointed out that this had been discussed for the last two years; GEBCO was now in the digital era and it was unlikely to happen. Dr Carron responded by proposing that images of GEBCO sheets should be created with named features and labelled contours. Capt. Gorziglia suggested that it would help if the GC asked the IHO to establish whether there was a need for a 6th Edition.

128 Task 6.2 (Displays at conferences). Capt. Gorziglia offered to assist with display at the ICA meeting in Madrid (summer 2004) where there will be a display of nautical charts. Dr Goodwillie said he would discuss this with Ing. en Chef Huet [Action Dr Goodwillie].

129 Task 6.5.7 (Multiple web sites). Discussion centred around there being two sites to access information about GEBCO (at NGDC and BODC); there were goods reasons to keep both sites. However it was remarked that GEBCO's URL is long, cumbersome and hard to remember. Dr Falconer volunteered to find a new and more memorable URL [Action Dr Falconer].

130 Task 6.5.8 (Compile a contact database). Dr Falconer stressed that GEBCO needed easy access to a list of relevant university departments, GDA buyers, Nippon Foundation/GEBCO students etc. It was agreed that everyone should send suggestions and email addresses to Pauline Weatherall [Action All].

131 Task 9 (Finance). Dr Loughridge suggested that, before approaching potential funders, GEBCO quantify the in-kind support that it received from various quarters such as NGDC, BODC and even the GEBCO community itself. Dr Fox offered to calculate the contribution from NGDC [Action Dr Fox]. Dr Hall mentioned the possibility of using a professional fund raiser to target sources of special or major gifts. He said that such fund raisers should have experience in the field of ocean science. He offered to contact US oceanographic and other institutions that had availed themselves of such fund raisers to obtain names and recommendations [Action Dr Hall]. Dr Falconer offered to contact the Robin Hood Foundation in New Zealand which matches not-for-

profit organisations with industrial organisations that have common interests [Action Dr Falconer].

9. COMPOSITION OF THE GUIDING COMMITTEE AND ITS SUB-COMMITTEES

9.1 Guiding Committee

132 Dr Goodwillie began the discussion by noting his disappointment at the non-attending, non-participating members of the Guiding Committee. Dr Falconer responded by saying that the Guiding Committee were well aware of the situation and had already discussed it in closed session. He said that the problem was that IOC and IHO were formal intergovernmental organisations and it was not possible for GEBCO to reject GC members or to end their membership but even so there were other means which might be adopted to improve the situation. He noted that one positive aspect of the proposed restructuring might be that the GC Terms of Reference could be re-written. He added that the GC had also considered the appointment of a Vice-Chairman; it had been thought that the appointment had to alternate between the IOC and IHO but this did not seem to be correct. He said that the decision had been put on hold.

9.2 Sub-Committee on Digital Bathymetry

133 The Chairman began by stating that GEBCO needed a strong SCDB and by noting that the Committee lacked a Chairman. Dr Fox proposed, and Dr Carron seconded, that Dr Smith be appointed Chairman. Dr Smith responded to say that he accepted the task. He considered that there were many time-consuming and challenging tasks to address that might well lead to the formation of several Working Groups. He added that he hoped Dr Carron would help him as Chairman to which Dr Carron replied that he was willing to become Secretary of the Sub-Committee to improve communications within the SCDB and with the GC. Dr Falconer asked Dr Smith whether he had any views about the scope of the work to be carried out by the working groups. Dr Smith replied that personally he had an interest in educational outreach but he considered that it was up to the GC to decide on the scope of the SCDB, which currently was wide. Dr Loughridge noted that he saw an opportunity, at this time of transition, for the SCDB to propose revisions to its Terms of Reference to the GC.

9.3 Sub-Committee on Undersea Feature Names

134 Dr. Ing. Schenke introduced the work of SCUFN. The Sub-Committee planned to meet from 8-11 June 2004. He said that he wanted to see a global distribution of members so a number of new members had been recruited, up to a current total of nine. In addition observers attended from ACUF and Indonesia. He informed the Committee that he had been approached by the US Board of Geographical Names, with a request for closer collaboration, by SCAR, who maintain a gazetteer of Antarctic names, and by others.

9.4 Strategy Planning Committee

135 Dr Loughridge noted that the Strategy Planning Committee had first met in Japan in 2001. He said he was disappointed that the Strategic Plan had not been embraced but maybe the reorganisation would present a new opportunity to do so. Dr Fox, as a newcomer, expressed the view that he saw an organisation experiencing rapid change and in that case strategic planning was critical. Several of those present then offered to assist the Strategy Planning Committee. Dr Carron proposed that the Strategy Planning Committee should be dissolved and re-formed. Dr Falconer proposed, and Dr Loughridge seconded, that the Strategy Planning Committee should be disbanded. Dr Falconer proposed, and Dr Loughridge seconded him, that an *ad hoc* Committee should replace the Strategy Planning Committee. RADM Andreasen offered, with Dr Fox and the Chairmen of the SCDB and SCUFN, to draft a new outline of the strategy.

9.5 Review of the Working Groups

136 Dr Smith began by asking whether the Working Groups reported to the Sub-Committees or to the Guiding Committee. Dr Falconer responded that, given the proposed reorganisation, Working Groups might be well served by having a parent sub-committee.

137 The Chairman stated that he was hearing a lot of support for regionally based committees. Dr Falconer suggested that a Regional Issues Working Group should be set up to study regional problems. He proposed that Mr Macnab, who readily agreed, should lead such a WG.

138 Dr Smith reported that the Data Integration Working Group had been tasked with two jobs, first, to ingest satellite altimetry and second, to look at new applications of bathymetry to improve GEBCO's products. There were other problems too, such as how to incorporate multibeam bathymetry. He considered that these were technical questions to be addressed by the SCDB and asked what his Working Group should do now. Dr Loughridge responded by suggesting that the SCDB should subsume all three WGs and let the GC establish new WGs as required.

139 The Chairman summarised the above discussion by confirming that the Integration of Geoscientific Data WG had been disbanded and that its remaining tasks had been transferred to the SCDB. He also confirmed that the Data Assimilation and Acquisition WG had also been disbanded and subsumed into a Regional Issues WG chaired by Mr Macnab. However he affirmed that the Finance WG, which reports to the GC, should remain.

140 The discussion moved on to consider the Educational WG and recognised that this WG needed to be revitalised.

141 Finally the Chairman summarised that each major task in the GEBCO Work Plan had a corresponding Committee or WG responsible for it as follows,

Task No.	Title of Task	Sub-Committee or Working Group
1	Production of products	SCDB initially but transferring to regional groups eventually
2	Geoscience Data Integration	SCDB
3	Data Assimilation and Acquisition	Regional Issues WG
4	Review Roles, Responsibilities and Memberships	Guiding Committee
5	Updating	SCDB initially
6	Outreach	Outreach WG
7	Features	SCUFN
8	Educational Products	Education WG
9	Finance	Finance WG
10	Nippon Foundation/GEBCO Training Project	Nippon Foundation/GEBCO Training Project Management Group

142 The membership of the Outreach WG, to include marketing and outreach, was proposed to be Dr Falconer, Dr Fox, Dr Goodwillie and some of the NERC employees.

10. DATES AND PLACES OF NEXT MEETINGS

143 Dr Frias confirmed that he was very happy to host the 2005 meeting in Mexico either in Mexico City or in his home town of Aguascalientes. The consensus was that the Committee preferred to meet in Aguascalientes. June was said to be a good month to visit Mexico but various constraints

(IHO conference in early April, IOC General Assembly in late June) also had to be taken into account.

144 No firm offer was made to host the 2006 meetings.

11. CLOSURE OF THE MEETING

145 The Chairman thanked Dr Carron for hosting the meeting and Prof. Whitmarsh for keeping a record of the discussions. He closed the meeting at 15.30.

ANNEX 1

Twentieth Meeting of the GEBCO Guiding Committee

09.00 Thursday 1st April, 09.00 Friday 2nd April, 09.00 Monday 5th April, and 09.00 Tuesday 6th April, 2004

Porto Venere, Italy

AGENDA

The primary focus is on the future, which is what the Guiding Committee is guiding GEBCO towards.

Thursday Morning

Administration

1. OPENING OF THE MEETING

2. CONDUCT OF THE MEETING
2.1 Documentation; Administrative Arrangements, etc.

PART ONE
Before we can deal with the future, have to make sure we know where we are. First, recount what have we done over the last year. Relate this to Work Plan and reports of WGs and SCs. Include unforeseen activities (i.e. not in work plan).

3. REPORTS COVERING THE 2003- 2004 PERIOD

(Note ; some of these groups will not have met since the April 2003 meeting and will be meeting on Saturday 3rd April and Sunday 4th April. In that case, they can simply report that fact.)

3.1 Sub-Committee on Digital Bathymetry
3.2 Sub-Committee on Undersea Feature Names
3.3 Finance: GEBCO funds at Southampton University, UK and IHB, MONACO
3.4 Educational WG (Sharman)
3.5 Integration of Geoscientific Data WG (Smith)
3.6 Report of the GEBCO Bathymetric Editor (Hunter)
3.7 Report of the GEBCO Digital Atlas Manager (Weatherall)
3.8 GDA Centenary Edition – sales (tabled paper from BODC)
3.9 Release of the GDA-CE over the internet (Weatherall)
3.10 The GEBCO web site, a new URL and biographies (Goodwillie/Loughridge)

3.11 Review work plan for any unreported actions

End Thursday Morning

Thursday Afternoon

4. NEW ACTIVITIES IN THE 2003- 2004 PERIOD

4.1 Nippon Foundation/GEBCO training project
- 4.1.1 Background to the proposal
- 4.1.2 Current status of the proposal
- 4.1.3 Establish the NF/G Project Management Group formally, appoint Chair
- 4.1.4 Approve the process of selecting the Teaching Organisation
- 4.1.5 Update on contractual arrangements with the Teaching Organisation
- 4.1.6 Terms of Reference of the Project Manager
- 4.1.7 Interview criteria and choice of Project Manager
- 4.1.8 Approve process of advertising for, and selecting, students

End Thursday Afternoon

Friday Morning

PART TWO

Next, determine what else is happening that could impact our future. Actions by parent organisations and by other organisations.

5. PROPOSALS THAT COULD IMPACT GEBCO IN THE FUTURE

5.1 Proposal for a new organisational structure for the ocean mapping programme activities within IHO and IOC. See attached document. Presentation by IHO.
5.1.1 Discussion of aims and objectives of proposal.
5.1.2 Discussion and evaluation of other ways of achieving these aims.
GEBCO members who are also involved with individual International Bathymetric Charts will be asked to comment from both the GEBCO and IBC perspectives.

End Friday Morning

Friday Afternoon

5. Continued

5.2 The Polar Ocean Bathymetry Co-ordination Effort (POBACE) proposal (Macnab)
5.3 A promising new contact re the Educational CD (Schenke)
5.4 A proposed new altimeter mission (Walter Smith)
5.5 Draft Letter from President of SCOR to Data Centres (Secretary)

5.6 Co-operation with the International Committee for Global Mapping ICA (Chair)

5.7 Shallow water requirements (Chair)

ORGANIZATION AND SCHEDULING OF MEETINGS FOR SATURDAY AND SUNDAY

It is planned that the following will meet over Saturday and Sunday. The SCDB, Educational WG, Finance WG, Integration WG, Data Assimilation WG, Nippon Foundation Project Management Group and an *ad hoc* Group of Gridders. Since some attendees have multiple memberships, schedules will be developed on site.

Business for sub-committees and WGs must include, in addition to their scheduled items, the following -

1. Carry over business from past year
2. Discussion of the possible impact of the IHO/IOC organisational proposal on SC/WG. Recommendations to Guiding Committee re the proposal.
3. Possible interaction between the SC/WG and the Nippon Foundation/GEBCO Training Project, in particular Work Programs and Project Fellows – is there work the SC/WG wants done that would fit a Work Program? is there research the SC/WG wants done that could be done by a Project Fellow?
4. Plan for next year – to be included in Work Plan.

End Friday afternoon

Saturday and Sunday. Meetings of Working Groups and Sub-Committees

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PART THREE

Decide what we will do in the next year based on what we have got done in the past year and any reactions we need to take in response to actions by others. Decide who will do it and determine if we are organised properly to do what needs to be done.

Monday Morning

6. CONSIDERATION OF IHO IOC PROPOSAL

Monday Afternoon

7. REPORTS OF ALL SC AND WG ON PLANS FOR NEXT YEAR AND DEVELOPMENT OF A WORK PLAN FOR 2004-2005

7.1 Presentation of reports
7.2 Draft list of PDOB student projects, Fellowship and Work Package projects

Tuesday Morning

7 continued

Tuesday Afternoon

8. COMPOSITION OF THE GUIDING COMMITTEE AND ITS SUB-COMMITTEES
8.1 Guiding Committee and appointment of Vice-Chairman
8.2 Sub-Committee on Digital Bathymetry (SCDB) and appointment of Chairman
8.3 Sub-Committee on Undersea Feature Names (SCUFN)
8.4 Strategy Planning Committee
8.5 Review of GEBCO Working Groups (Educational WG, Finance WG, Integration of Geoscientific Data WG, Data Assimilation and Acquisition WG)
8.6 General Review of the GEBCO Personality List

9. DATES AND PLACES FOR THE NEXT MEETINGS
9.1 Year 2005
9.2 Year 2006

10. ANY OTHER BUSINESS

11. CLOSURE OF THE MEETING

ANNEX 2

Report of the GEBCO Finance Working Group to the GEBCO Guiding Committee
1st April 2004

by Anthony Laughton

Chairman GEBCO Finance Working Group

The Guiding Committee will remember that at the last meeting in Monaco in 2003, GEBCO held funds in two separate accounts, one in Southampton University and the other in the IHB. As a result of the negotiations with the Nippon Foundation, a new account at Southampton has now been opened to handle the grant from the NF, pending decisions about where the major expenditure on the Diplomas, Work Packages, Fellowships and Project Manager's salary is spent.

1. Southampton GEBCO Fund

administered by Southampton University (Project HK997700)

The major income to this fund in recent years has been from the initial contribution by GMS of £11,650, from the generous donations from the MKB Foundation from John Hall of $50,000 and from sales of the GDA from BODC of £29,248.

Further income of £10,222 is expected from a half share of the sales of the GDA in Calendar year 2003.

I have not been able to extract the second and third tranches of the grant from GMS but will attempt once more in April, in the belief that the initial grant constituted a contract.

Expenditure from the account consists largely of a contribution to the Centenary expenses (£10,674), the cost of the Centenary book (£9,031) and travelling and incidental expenses. The Fund spent about £2,200 on costs related to the negotiations with the Nippon Foundation in London, including air fares for the Chairman and for the *ad hoc* Project Management Group to meet at Southampton Oceanography Centre, and advertising.

2. The Nippon Foundation Fund

administered by Southampton University (Project HK997702)

The Nippon Foundation approved, in principle, the total sum of $2,919,885 for the six year period of the training project. The first year's funding of $533,000 has been paid into the NF GEBCO training Fund at Southampton. It is in a US dollar account, which attracts a small amount of interest.

The location of this fund over the whole period of the project is likely to depend on the eventual location of the Project Manager. The initial location at Southampton enables the project to get started.

3. The IHB GEBCO Centenary Fund
administered by the IHB

The Fund has a current balance of 3826 €, but is due to receive another 4677 € (US$5000) from the IOC, making a total of 8503 €.

The final balance sheet differed from the budget in several ways. The fee income from attendees was considerably down since the total number of 138 was lower than expected and about 100 of these were speakers and VIPs. There was a higher expenditure on supplementary hours worked, on other staff overtime, on a wide variety of costs that were met by the item on contingency costs, and on removal costs.

The use of the Fund is at the discretion of the IHB for GEBCO purposes according to the minutes of the 19th meeting of the Guiding Committee.

During last summer I pursued my discussions with David Rockefeller, meeting him in Maine. There are two avenues that I could pursue for funds from this source. One is the Pew Oceans Fund and the other the Rockefeller Brothers Fund. The latter is more likely to be sympathetic to a global oceans project. I have not yet followed this up, however, because of the successful negotiations with the Nippon Foundation, which have fully stretched the resources of our Permanent Secretary.

Summary (including expected income)

Southampton GEBCO Fund	(as at 29/2/04)	£46,064 equiv to at £1 = $1.85	US$ 85,218
IHB GEBCO Centenary Fund	(as at 29/4/04)	8503 € equiv to at 1 € = $1.24	US$ 10,560
		Total	**US$ 95,778**
Nippon Foundation Fund (as at 5/3/04)			US$ 533,000

ANNEX 3

National Geophysical Data Center Report to GEBCO

April 2004

Porto Venere, Italy

I. REPORT OF THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION DATA CENTER FOR DIGITAL BATHYMETRY (IHO DCDB)

I-A. Bathymetric Data Holdings and Global Database Management

Since the April 2003 Meeting of the GEBCO Sub-Committee on Digital Bathymetry, the National Geophysical Data Center (NGDC) has responded to 200 international requests for digital marine geology and geophysics data or information from 37 countries of which 28 are IHO Member States. This contrasts with over 867 sales requests within this category from the U.S. over the same time. NOAA's customer tracking management system no longer tracks requests that do not result in a data sale. Overall numbers of requests is expected to decrease slowly due to NGDC placing more data online for free download.

Version 4.1.18 of the global Marine Trackline Geophysics data set became available in March 2004 on a single DVD-ROM, which may be ordered online at http://www.ngdc.noaa.gov/mgg/fliers/03mgg02.html. The new release contains an additional 1.2 million nautical miles of bathymetry, magnetics and gravity from 356 surveys, added since Version 4.0. (The Version 4.1 CD-ROM set of three disks is also still available, but contains somewhat less new data). DVD and CD sets are available as a complete set or as an upgrade, which brings previously purchased sets up to date to include newly assimilated data. Also provided on the DVD/CD is GEODAS search and retrieval software, which runs under MS Windows®, UNIX Xwindows, and now Macintosh OS-X. NGDC's global Marine Trackline Geophysics database continues to grow and now includes 43 million soundings from over 4500 cruises. During this reporting period, 1.7 million soundings were assimilated, originating from 106 cruises covering over 264,000 nautical miles.

NGDC continues to archive digital sidescan sonar data and imagery collected as part of National Ocean Service (NOS) hydrographic survey operations. These data contain digital files of trackline sidescan sonar that can be mosaiced to produce seafloor imagery. NGDC is working to establish archive and access procedures for these data, as well as potential future products derived from these data. Since August 2002, over 3.3 terabytes of data have been archived. The shear volume of the data is providing IT challenges in the areas of data archive, access, and product generation.

NGDC's multibeam database also continues to grow. During the past year, 29 multibeam surveys were delivered from the Monterey Bay Aquarium Research Institute, three from the Woods Hole Oceanographic Institution, and one from France's IFREMER for an addition of 66 gigabytes of data. LIDAR data from the United States Geological Survey was also received for the Hawaiian Islands. These data include tracklines from the U.S. West Coast, the Hawaiian Islands, and the Antarctic. NGDC has placed this data into its tape library archiving system using Tivoli software. Additionally, NGDC is expanding its multibeam data inventory with the recent inclusion of high-resolution shallow-water multibeam data from the NOS. Since December 2003, 91.6 gigabytes of shallow-water multibeam data have been archived at NGDC. The flow of these data into NGDC is expected to increase as more survey platforms are equipped with multibeam technology and the ability to process and store these data is enhanced. These surveys typically cover coastal areas and a small number of selected offshore shoals.

NGDC has begun to develop online access to its multibeam bathymetric data holdings using an interactive mapping tool with query capabilities. The queries can be conducted using several parameters including ship, source (institution), and survey name. In addition, NGDC will be providing an interactive website, which will allow the user to generate colour relief maps (with contours, if desired) and grids of the data using NOAA/PMEL's AutoChart, Generic Mapping Tools (GMT), and MBSystem software. The maps and grids will be provided in Postscript and GMT formats, respectively, and users will also have the option to download the source data.

I-B. GEODAS Software Development

NGDC continues to enhance the GEODAS software management system. Originally developed to manage marine geophysical trackline data, GEODAS has evolved into a universal software management tool, which can handle a variety of data formats and types including single-beam/multibeam, trackline/survey, and gridded bathymetric/topographic data. The software serves users both as a desktop application on various NGDC CD and DVD products, and as an online search, display and retrieval system. New developments include automated creation and viewing of online data plots in PDF Format, and free automated download of marine trackline and hydrographic survey data with software and coastlines included. Also, the GEODAS GRD98 format for gridded data has been incorporated into GMT as a standard format.

GEODAS Software runs under Microsoft® Windows™ for PCs, Xwindows for UNIX™ and now Mac OS-X for Macintosh platforms. The window driven interfaces simplify data searches, guide users with a context-sensitive help system, and support colour postscript and screen plotting capabilities.

II. REPORT OF THE WDC FOR MARINE GEOLOGY & GEOPHYSICS, BOULDER

NGDC, in its capacity as the World Data Center for Marine Geology and Geophysics (WDC MGG), Boulder, promotes excellence in archiving, managing, and exchanging data obtained from measurements of the seafloor, and works with national and international groups on many projects outside the scope of the IHO DCDB, GEBCO, and the IOC Regional Mapping Projects.

Although the WDC MGG, Boulder manages all types of data from the ocean floor including descriptions and analyses of seafloor samples, deep drilling data, underway geophysical measurements, and derived gridded data sets, only those areas dealing with bathymetry will be mentioned in this report.

II-A. U. S. – Canada Cupertino on New Bathymetry for the Great Lakes

New bathymetry for the Great Lakes has resulted from a long-term international co-operative effort between NOAA/ NGDC, NOAA/ Great Lakes Environmental Research Laboratory (GLERL), and the Canadian Hydrographic Service. Bathymetry is complete for Lakes Erie, St. Clair, Michigan, and Ontario, and is progressing steadily toward completion for Lakes Superior and Huron.

NGDC maintains web pages for Great Lakes bathymetry at http://www.ngdc.noaa.gov/mgg/greatlakes/greatlakes.html. These pages provide direct links to the web of related external organisations including NOAA/GLERL, the Canadian Hydrographic Survey, and the Great Lakes Information Network. During the period from April 2003 to February 2004, an average of 27,471 hits per month was recorded for the Great Lakes web pages at NGDC.

II-B. U. S. – Japan Co-operative Program in Natural Resources (UJNR)

Dr. George F. Sharman participated in the 32nd Annual UJNR Sea-Bottom Surveys Panel Meeting of the U.S.-Japan Co-operative Program in Natural Resources, held in Tokyo, Japan in February 2004. This panel continues as one of the principal mechanisms by which Japan and NGDC exchange technologies and marine geophysical data, including bathymetry. Discussions have included the latest capabilities of NGDC's GEODAS software, such as the variable resolution coastline applications, and the availability of digital data and map products for download over the internet.

II-C. WDC MGG, Boulder, On-Line Activities

The web pages of the WDC MGG, Boulder, collocated with those of the NGDC's Marine Geology and Geophysics Division, averaged 2,840,968 hits per month during the period from April 2003 through February 2004, compared with 1,536,721 hits per month over the last reporting period. Over this reporting period, users downloaded an average of 96 gigabytes of data from the MGG website each month, compared with 46 gigabytes per month during 2002. NGDC's web software no longer reports unique users or countries at the Marine Geology and Geophysics Divisional level, as identified in some previous reports. The WDC MGG website can be found at http://www.ngdc.noaa.gov/mgg/aboutmgg/aboutwdcmgg.html.

II-D. ETOPO2

In September 2001, NGDC published a high-resolution global topography and bathymetry database, ETOPO2. The database was a 2 arc-minute latitude-longitude grid of elevations and depths, compiled from a variety of sources, primarily the work of Smith and Sandwell's measured and estimated ocean depths between the 72° parallels, north and south, the GLOBE elevations for the land masses, and the IBCAO bathymetry and Greenland topography. After several years of exposure, a number of discrepancies have been detected by users. NGDC is currently working with colleagues to revise the database, correcting those and other discrepancies uncovered during quality assessment investigations. The GLOBE data will be resampled to eliminate a one-cell westward positional bias, the Smith and Sandwell database will be resampled to remove some small north-south errors and will be correctly positioned in the east-west direction, and the revised database will have its new and consistent protocol documented.

II-E. New Educational Visualizations of Global Relief

Three new cut-and-fold globes, with 6, 12, and 20 facets, have been produced from the ETOPO2 relief data. The 6-facet (Origami Cube) and 12-facet (Dodecahedron) versions also include an overlay of city lights and are available only as online PDF downloads from the NGDC website at http://www.ngdc.noaa.gov/mgg/image/images/origamiearth.pdf and http://www.ngdc.noaa.gov/mgg/image/images/dodecahedron.pdf, respectively. The Icosahedron (20-facet) globe is being printed for distribution and is available in downloadable PDF form at http://www.ngdc.noaa.gov/mgg/image/images/etopo2icosahedron.pdf. An additional Icosahedron has been prepared from the GEBCO 5-minute elevation grid and standard GEBCO color scheme.

II-F. NOS Bathymetric Fishing Maps

As part of NGDC's transfer to new web servers, the historic, home-grown interface for ordering scanned NOS Bathymetric and Fishing Maps was translated to a new ArcIMS interactive map interface. NGDC's interactive map service provides a visual display of one or more data layers, with links to preview the map images. Layers include state boundaries, shaded relief, all maps or

map types individually as bathymetry, fishing, preliminary, and topo/bathy. The existing TIFF and MrSid images on the CD-ROM set were converted to PDF form and placed online. The black and white preliminary maps are at their full resolution in PDF form, and directly downloadable to meet customer needs. Colour bathymetry and colour fishing maps were slightly degraded in resolution to speed up image loading times. Customer orders remain popular for paper copies of the maps and the scanned images on CD-ROM. For more information and a link to the ArcIMS map interface, please see: http://www.ngdc.noaa.gov/mgg/bathymetry/maps/nos_intro.html

III. REPORT OF NGDC ACTIVITIES IN SUPPORT OF IOC / GEBCO

III-A. IOC Regional Mapping Projects

In addition to participation in GEBCO, NGDC staff continues to take an active role in the IOC regional bathymetric mapping projects. Dr. Troy Holcombe serves on the Editorial Board of IBCCA, IBCEA, and IBCWIO; Dr. George Sharman continues as an active member of the Editorial Board of the IBCWP; and Dr. David Divins serves on the Editorial Board of the IBCAO and as a technical advisor to the IBCSEP.

1. Gulf of Mexico and Caribbean (IBCCA)

A CD-ROM containing vector contours and DEM data with color imagery for the completed areas was released at the IOC General Assembly by the Instituto Nacionale de Estadistica, Geografia, y Informatica (INEGI) from Mexico. Additional data in the series is planned for later release. The next IBCCA Editorial Board Meeting is scheduled for 2005, and will be hosted by the Venezuelan Hydrographic Office in Isla Margarita, Venezuela.

2. Mediterranean Sea (IBCM)

There was no reportable NGDC activity during the past year.

3. Arctic Ocean (IBCAO)

NGDC will be publishing a poster for the International Bathymetric Chart of the Arctic Ocean (IBCAO) in 2004 as part of its Research Publication series. The colour shaded relief poster portrays the bathymetry and topography of the Arctic region in a Polar Stereographic projection at a scale of 1:6,000,000 at 75° North. The poster is designed to replace GEBCO Sheet 5-17.

4. Western Indian Ocean (IBCWIO)

The next Editorial Board Meeting of the IBCWIO has not been scheduled.

5. Eastern Atlantic (IBCEA)

There was no reportable NGDC activity during the past year.

6. Eastern South Pacific (IBCSEP)

Dr. David Divins attended the second meeting of the Editorial Board for the International Bathymetric Chart of the South East Pacific (IBCSEP) in Lima Peru, 29-30 October 2003. Dr. Divins attended the meeting as a technical representative for the IOC. Resulting from the meeting, NGDC will host a web site for the IBCSEP and provide technical training to representatives from Peru and Ecuador in 2004. The training will focus on data management, corrections and adjustments to bathymetric data, use of satellite altimetry data, GIS applications, tectonics implications for bathymetry, preparation of compilation sheets, and digitizing of hydrographic soundings and contour information.

7. Western Pacific (IBCWP)

Dr. David Divins has been invited to attend the fourth meeting of the Editorial Board of the Western Pacific (IBCWP) in Hang Chou, China from 19 to 23 April 2004. The last meeting of the IBCWP was in Tianjin, China in 2000.

8. Southern Ocean (IBCSO), (Proposed)

There will be a meeting in Bremen, Germany, hosted by Hans Werner Schenke and scheduled in July 2004, concerning the bathymetry of the Southern Ocean. An invitation is open to present scientific and/or technical ideas and source data supporting enhanced Southern Ocean bathymetry. At this meeting, the IBCSO is expected to become a GEBCO regional mapping project.

III-B. GEBCO Reviewers Report:

1. North-East Pacific Ocean

While there are no major mapping programs in the Northeast Pacific, there are numerous small-scale studies and a host of ship activity. All of the major Universities and NOAA have ship's working in the north-east Pacific, including Lamont Doherty Earth Observatory's *MAURICE EWING*, NOAA's *KA'IMIMOANA* and *RONALD H. BROWN*, the University of Washington's *THOMAS G. THOMPSON*, Woods Hole Oceanographic Institution's *ATLANTIS*, Scripps's *MELVILLE* and *ROGER REVELLE*, and Oregon State University's *WECOMA*.

During 2003, the R/V *Revelle* conducted an acoustic geodesy study of the Juan de Fuca ridge under co-PI's Dave Chadwell and Dave Sandwell. Later that year, the ship made a multibeam and seismic transit from San Diego to Manta, Columbia, passing down the coastal Eastern Pacific, under the direction of Peter Lonsdale. In July of 2003, Gail Christeson, University of Texas Institute of Geophysics studied the correlation of seismic structure with observed outcrop geology at the Hess Deep and the Blanco Transform at 2°N, 101°W.

Small-scale, regional mapping is being done primarily at Scripps. Coastal Baja California is being mapped along with regions of the central eastern Pacific on a piecemeal basis. The R/V *Revelle* conducted deep-tow and magnetotelluric studies of the EPR at 9°30' N. in February and March of this year. Lonsdale, aboard the *Revelle*, is slated to conduct multibeam mapping of the Gulf of California, along with seismic profiling and dredging during March and April of this year. There are a number of Alvin Dives scheduled for the East Pacific Rise during April and May and then off California and Oregon later in the year. The *Maurice Ewing* will be conducting Multi-Channel Seismic (MCS) surveys of the Blanco Fracture Zone in August 2004. As these data become available, they will serve to reinforce a well-populated database of bathymetry for the north-eastern Pacific basin.

2. Caribbean Sea and Gulf of Mexico

While there are no major mapping programs in the Caribbean, there is significant ship activity. U.S. institutions, Universities, and NOAA all have vessels that periodically work in the area, and as this data becomes available, it may be incorporated into the bathymetric databases of the region.

III-C. Related Activities Supporting IOC / GEBCO Programs and Projects:

1. GEBCO On-Line Activities

1A. GEBCO Web Pages

The GEBCO web pages continue to be updated on a regular basis, especially the contacts lists. Links to the new GEBCO centenary CD-ROM were added during 2003, as well as a new page citing reviews of the GEBCO History book. Access to the GEBCO webpages at http://www.ngdc.noaa.gov/mgg/gebco/gebco.html has quadrupled over the last year, averaging 16,954 hits per month.

1B. IBCWIO Web Pages

There have been no new updates of the IBCWIO web pages during the last year. Only seven of the eleven months during the reporting period recorded hits above NGDC's accounting software threshold. For these seven months, the average hits per month were less than 2000. This average would be lower if the totals for all months could be identified.

1C. IBCAO Web Pages, and IBCAO Announcements List Server

There have been no new updates to the IBCAO web site during the year, other than new meeting reports posted. The average number of IBCAO hits per month from April 2003 through February 2004 was 20,981, an increase of over 5,000 hits per month over the 2003 GEBCO Report.

1D. IBCM Web Pages

There have been no new updates to the IBCM web site during the year. Only eight of the eleven months during the reporting period recorded hits above NGDC's accounting software threshold. For these eight months, the average hits per month totalled less than 2000. This average would be lower if the totals for all months could be identified.

1E. IBCCA Web pages

The IBCCA website is now being presented in Spanish as well as English. Since the last GEBCO meeting, the site averaged 11539 hits per month, roughly the same as reported in 2003.

1F. IBCEA Web Pages

There have been no significant updates to the IBCEA web site during the year. The IBCEA site received an average of 5624 during this reporting period, roughly doubling the number of hits reported at the 2003 GEBCO Meeting.

1G. GEBCO Gridders List Server

During the past year, there has been virtually no traffic on the gebco_gridders list server operated by NGDC. NGDC welcomes comments from the GEBCO community on how we can improve or enhance these services.

1H. GEBCO Folk List Server

NGDC continues to maintain the GEBCO Folk List Server to facilitate communication between members of the GEBCO personality list.

2. Coastal Relief Model Development

The Coastal Relief Model (CRM) is complete for the contiguous United States. The next areas to be completed are the coastal regions of Hawaii and Puerto Rico, followed by Alaska. The CRM includes topographic data from the USGS, NOS sounding data, and NOS multibeam bathymetry. Although addition of the high-resolution multibeam data makes the coverage appear uneven, the increase in resolution offered by the multibeam is well worthwhile. The CRM is an ideal base layer for all sorts of scientific and coastal zone management activities, fishing and fisheries work, and hazard modelling. All NOS data were converted to a common horizontal datum, NAD83, while the vertical datum for individual surveys was retained. The CRM is now available on a single DVD-ROM, or eight CD-ROM volumes, at http://www.ngdc.noaa.gov/mgg/coastal/coastal.html.

Supplement I

Sources of bathymetric data contributed to the NGDC during this reporting period:

Brazil - Centro de Hidrografia da Marinha
France - IFREMER
Monterey Bay Aquarium Research Institute (MBARI)
National Oceanic and Atmospheric Administration
Ocean Drilling Program
Scripps Institution of Oceanography
U.S. Army Corps of Engineers
Woods Hole Oceanographic Institution

Supplement II

Number of NGDC Marine Geology and Geophysics digital data products distributed by country between April 1, 2003 and March 2, 2004.

Products	Country
15	Australia
1	Austria
4	Belgium
2	Brazil
43	Canada
1	Chile
1	China
2	Denmark
1	Fiji
14	France
9	Germany
3	Great Britain
2	Hong Kong
1	Iceland
3	Indonesia
1	Israel
7	Italy
20	Japan
2	Latvia
2	Malaysia
2	Mexico
1	Netherlands
4	New Zealand
4	Norway
1	Papua New Guinea
2	Peru
1	Poland
1	Portugal
1	Republic of Korea

1	Reunion Island
2	Russia
2	South Africa
6	Spain
2	Sweden
1	Switzerland
4	Taiwan
31	United Kingdom

Supplement III

Number of cruises with bathymetry added to the Marine Trackline Geophysics database, this reporting period:

USA	91
Germany	12
Russia	3
Grand Total	106

Number of cruises with bathymetry received during this reporting period:

USA	85
Brazil	15
France	1
Grand Total	101

ANNEX 4

Report of the GEBCO Working Group on the Integration of Geoscience Data

by Walter H. F. Smith (Chairman)

Bathymetry in global hydrodynamic studies

In the deep ocean basins, depth variations on the order of 100 meters or less vertically over horizontal distances of 100 km and less are hydrodynamically important in the steering of flows [Metzger and Hurlburt, 2001; Gille et al., 2004], the dissipation of eddy [Gille et al., 2000] and tidal energy [Egbert and Ray, 2001; Jayne and St. Laurent, 2001] and resulting mixing of the ocean [Kunze and Llewellyn Smith, 2004], the heat transport of the ocean [Jayne et al., 2004], and the scattering of tsunamis [Mofjeld et al., 2001; 2004]. Because of the importance of deep-ocean bottom texture on 100 km and shorter scales, most recent research has used the Smith and Sandwell seafloor topography, or products based on it, such as ETOPO2, DBDB2, or OCCAM. The GEBCO grid has been out for only a year, and it is just beginning to be studied by ocean modellers. Arbic et al. [in press] compare the GEBCO and the OCCAM grids to see which one gives a better model of the global deep-ocean tides; the GEBCO product is significantly worse.

Comparison of global grids

Karen Marks has begun a study of various global bathymetric grids (Smith and Sandwell, ETOPO2, DBDB2, and GEBCO) in the Woodlark Basin and adjacent Coral Sea region, where local and regional grids are also available for comparison. She finds that DBDB2 and ETOPO2 have incurred a significant loss of fine-scale amplitude in moving the S&S data from its original "pixel registration" to a "grid registration" (that is, from the 1, 3, 5, … minute meridians to the 2, 4, 6, … meridians). In addition, other registration shifts are apparent in ETOPO2. She is preparing a paper for the GEBCO special issue of *Marine Geophysical Researches*.

"Bathymetry from Space"

A workshop on improved global bathymetry was held at Scripps in October of 2002, and a summary report "Bathymetry from Space: Oceanography, Geophysics, and Climate" appeared in June of 2003 [Sandwell et al., 2003]. The Oceanography Society then dedicated the March 2004 issue of their *Oceanography* magazine to the subject of "Bathymetry from Space". The Guiding Committee Chairman contributed an article [Monahan, 2004], and there is an overview of conventional bathymetry, bathymetry from space, and satellite altimetry [Smith and Sandwell, 2004], as well as other articles cited elsewhere in this report.

The background texture in satellite altimetry maps

Some GEBCO personalities have observed that the "orange peel" texture in the background of satellite altimeter gravity and bathymetry maps is inconsistent with the smooth ocean floor classically portrayed by GEBCO. This texture can cause contours of altimetric data to have many small zig-zags. Two new studies [Goff and Smith, 2003;

Goff et al., 2004] find that changes in the amplitude and lineation of the bumpy texture can be correlated with known changes in the size and orientation of abyssal hills on the ocean floor, where the latter have been mapped with multibeam bathymetry. These studies were aided by a compilation of multibeam data and comparisons with altimetry by Karen Marks. See http://ibis.grdl.noaa.gov/SAT/Bathy.intro.html

Goff et al. [2004] also find that changes in the amplitude of the altimetry bumps can be correlated with changes in spreading rate. It appears that the bumpy texture is a mixture of "noise" plus the signal due to abyssal hills. Currently available altimeter data can resolve the orientation and texture parameterisation of abyssal hills where those hills are very large; where hills are smaller, the texture in the altimetry maps is essentially random and dominated by noise. Forward modelling suggests that a new satellite altimeter mission would have a low-enough noise level to allow mapping of abyssal hill orientations for hills of all sizes typically found on the ocean floor. Until such a mission is a reality, we can use the available data and studies of the noise texture to perhaps improve the estimation of bathymetry from existing data.

Provisional Recommendations for study/discussion

[The following two recommendations were tabled by the WGIGD Chair and are being partially implemented in the work plan of the SCDB.]

1. GEBCO should become truly independent of its traditional scales
The transition to digital topography in principle allows GEBCO to become scale-independent. GEBCO practice, however, has not realised this opportunity. By holding to a standard contour of 500 m and by leaving most of the ocean mapped at only 1:10M scale, many of the hydrodynamically important features are missed. For example, if 500 m contours cannot appear closer than 3 mm apart on a 1:10M scale map, then bathymetric slopes exceeding 0.016 will never be portrayed; yet the "critical slope" for tidal dissipation may be of order 0.1 [St. Laurent and Garrett, 2002]. The global mean square slope of the GEBCO grid is a factor of 2 smaller than that of Smith and Sandwell.

2. A grid intended to facilitate hydrodynamic and other global studies should strive for global uniformity of resolution, by ingesting altimetry as necessary. A 1-arc-minute global grid product blending the altimetric estimates with the existing GEBCO GDA 2003 grid should be delivered within a year. Rapid and widespread dissemination of grid updates should be possible, ideally at zero cost to users. Historically, GEBCO has ingested local and regional contributions from diverse sources. Consequently, the global grid shows changes in bottom texture and roughness that reflect changes in the contouring style or the scale of the ingested material, and not real changes such as those caused by variations in seafloor spreading rate or abyssal hill texture. The only feasible way to reflect real texture at present is to ingest information from altimetry. The details of how best to do this blending may need some experimentation by an ad hoc group.

Disclaimer
The views, opinions, and findings contained in this report are those of the authors and should not be construed as an official National Oceanic and Atmospheric Administration or U. S. Government position, policy, or decision.

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ANNEX 5

GEBCO Bathymetric Editor - List of Activities for 2002 to 2004

by Peter Hunter, SOC, UK

GEBCO Digital Atlas, Centenary Edition

The main task during this period was providing bathymetry for the next version of the GEBCO Digital Atlas, Centenary Edition. During 2002-2003, contours were completed for the North Atlantic region and supplied to the GDA Manager for digitising. Following various corrections and additions, these digital contours and additional information, such as individual soundings, digital grids and extra contours in flatter regions, were used to prepare the North Atlantic region of the GEBCO Global Grid. This required several iterations to achieve an acceptable product.

When required towards its final stages of production, the GBE occasionally assisted the GEBCO Manager with other aspects of the Centenary Edition of the GEBCO Digital Atlas.

Other GEBCO Products

The GBE was responsible for preparing all the figures for the 'History of GEBCO' book (GEBCO Centenary volume) which was distributed at the Centenary Conference.

At the request of the GEBCO Permanent Secretary, the GBE prepared several versions of an A4-sized flyer describing GEBCO, the GDA and other GEBCO products.

The GBE prepared several maps, mainly of the Atlantic region. These maps were created from the GEBCO Global Grid. Images in JPG format have been placed on the following web-page for use by researchers at SOC.

http://www.soc.soton.ac.uk/CHD/Crustal_Processes/gebco/gebco_maps.html

Updating North Atlantic Bathymetry

During the last year information was supplied by Dr Goodwillie about the availability of bathymetric data from various sources that he learned of whilst exhibiting the GEBCO during conferences. The GBE followed up these leads and in one case has assimilated one of these, a grid in the region of the Azores (Map Area 1, Fig.1), into the North Atlantic region grid. Also, from another source, a gridded bathymetry of the Irish Sea created by CEFAS, UK (Map Area 2) was supplied to update the existing grid.

NERC Cruise Data

Since 1995 no NERC cruise data has been supplied to NGDC for inclusion in the GEODAS dataset. This has been due to the lack of additional help. The GBE has prepared a total of 26 cruises by NERC ships (RRS *Discovery* and RRS *Charles Darwin*). There are still 80 more cruises to process. The main checking procedure is a comparison of the cruise bathymetric profile against one created from the GEBCO global grid over the same track.

EFCHED

During the last year, the GBE has worked on a NERC funded project called, EFCHED - *Environmental Factors in the Chronology of Human Evolution and Dispersal*. This project required the compilation of high resolution bathymetry in regions of possible routes of hominids from Africa into Europe and Asia. Two areas were initially chosen, the southern Red Sea and the Strait of Gibraltar. This application of bathymetry, creating and manipulating digital bathymetric grids, has provided archaeologists with an insight that until now had not been possible with paper maps.

Other Bathymetric Projects

In addition to the bathymetric work mentioned above, two other projects are in preparation. The first is located in the Porcupine Abyssal Plain (Map Area 3), where SOC scientists have collected a large amount of data in a small area of the plain and need a better bathymetry than is available. Unfortunately the data which was collected over a number of cruises is inconsistent. The echo-sounder depth has not been corrected between cruises and when towing at different speeds.

The other area is located on the edge of the continental shelf to the north-west of the United Kingdom (Map Area 4).

Additional Work

The GBE has also attended a week-long course on CARIS LOTS software, to support UNCLOS activities at SOC.

Every year the GBE lectures and gives practical courses in support of MSc and MRes course units. The subjects involved are:

(i) Seafloor Exploration and Surveying (Bathymetric Mapping)
(ii) Computational geophysics (Projections, Digitising and GMT)

This presents the opportunity to acquaint students with bathymetric mapping and with GEBCO in particular. It also tells them about the advantages of submitting cruise data to a data centre.

The GBE is always available for requests about bathymetry, this usually peaks just after one of the above courses and he acts as local support for all bathymetric, cartographic and digitising matters.

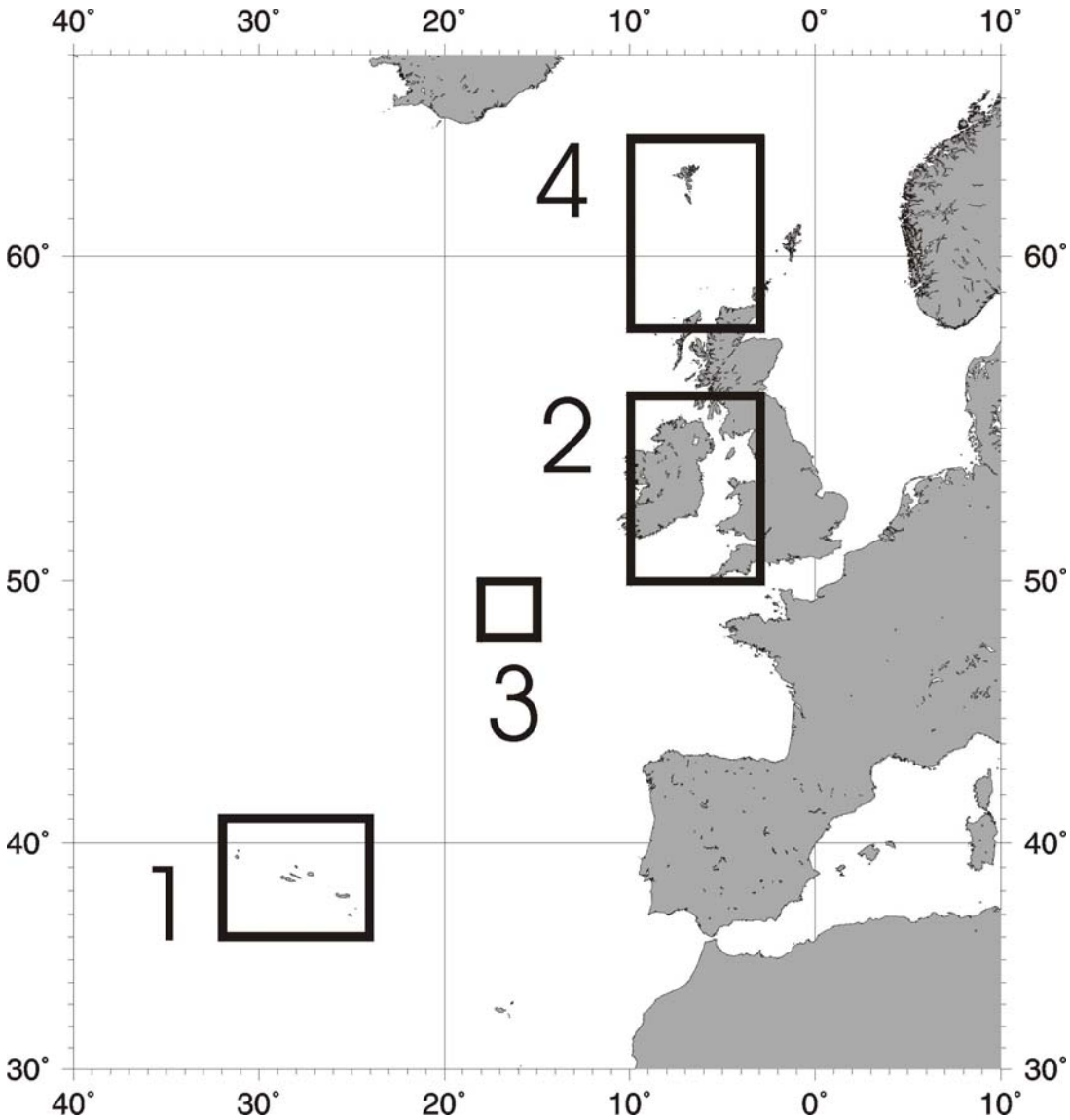


Figure 1. Map Areas worked by the GEBCO Bathymetric Editor, 2002-2004 (see text).

ANNEX 6

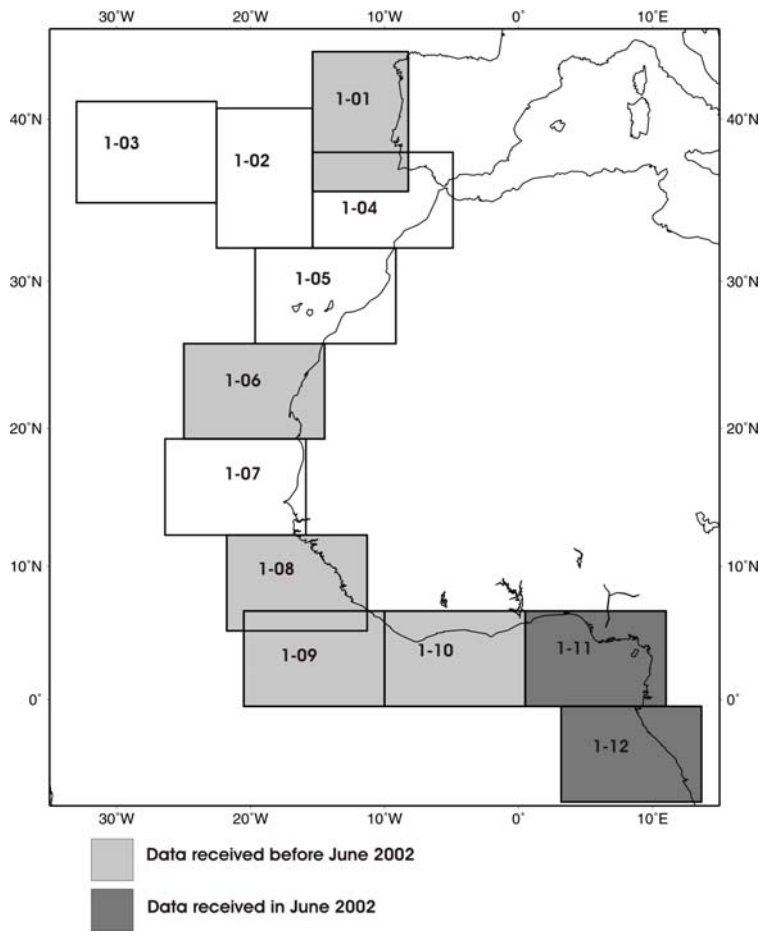
Report of the GEBCO Digital Atlas Manager May 2002 – April 2004

by Pauline Weatherall, BODC, UK

May 2002 – April 2003

Finalisation of the digital bathymetric contour and trackline control data sets for inclusion in the Centenary Edition of the GEBCO Digital Atlas (GDA)

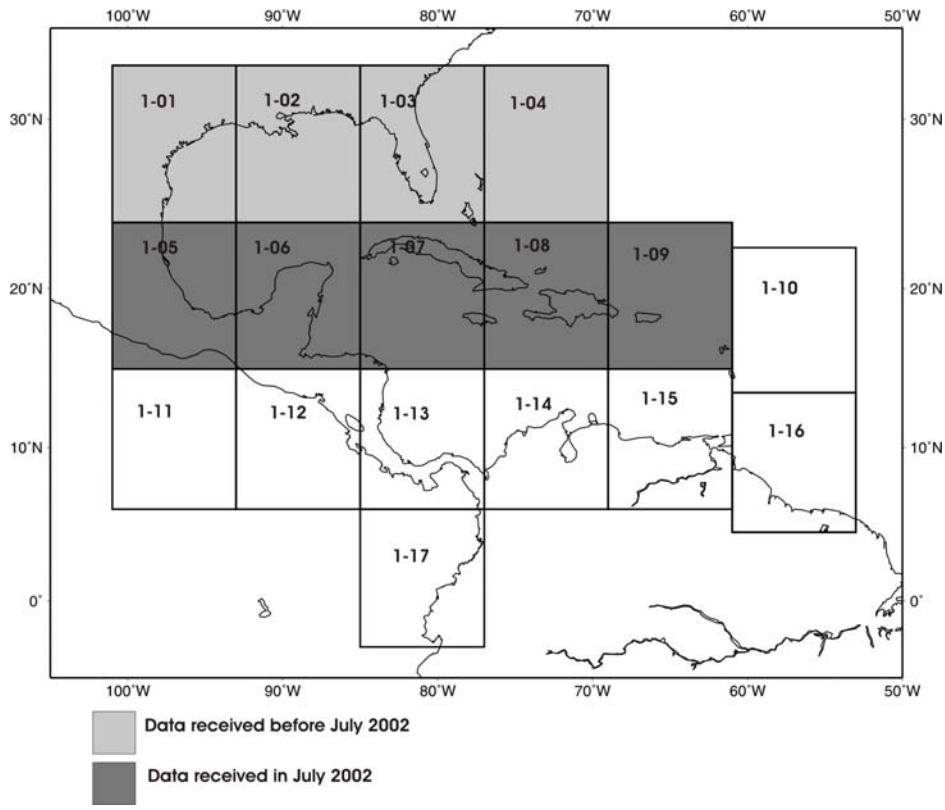
My report to the GEBCO meetings held in New Hampshire (May 2002) detailed the bathymetric contour and trackline control data sets that had been received up to that date for inclusion in the GDA. This included data for the Indian Ocean area; Weddell Sea area, waters around New Zealand, Arctic Ocean (IBCAO project); Northeast Atlantic (including data from the IBCEA project) and the Caribbean Sea and Gulf of Mexico (IBCCA project).



Geographic coverage of the sheet areas for the International Bathymetric Chart of the Central Eastern Atlantic

In addition to the above we received digital bathymetric contour and trackline control data sets from SHOM for the IBCEA, sheets 1.11 and 1.12 in June 2002.

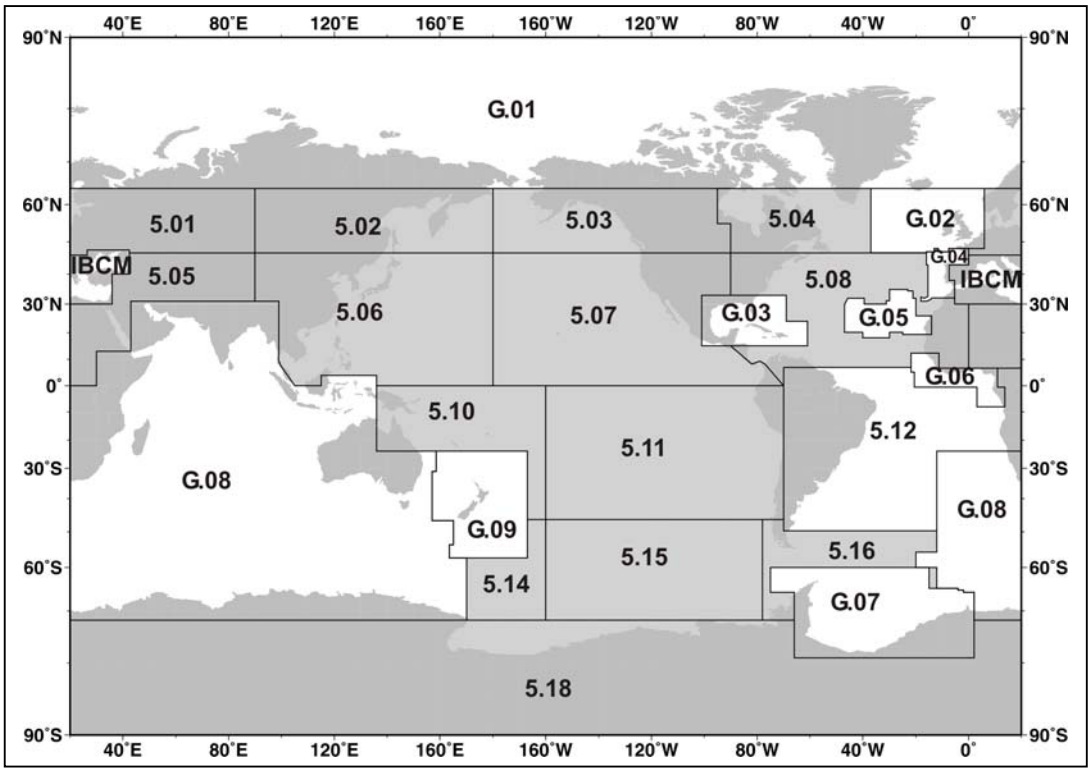
In July 2002 we received digital bathymetric contour, coastline and trackline control data sets from Jose Luis Frias Salazar for the IBCCA, sheets 1.05, 1.06, 1.07, 1.08 and 1.09.



Geographic coverage of the sheet areas for the International Bathymetric Chart of the Caribbean Sea and Gulf of Mexico

These new data sets from the IBCEA and IBCCA projects were quality controlled and edge-matched in to the existing data set. The bathymetric contour data were supplied to the gridding group for the development of the GEBCO One Minute Grid.

Further work was done on finalising all the digital bathymetric contour, coastline and trackline control data sets to be included in the GDA. The following diagram shows the coverage of bathymetric contour data sets included in the Centenary Edition of the GDA.



Geographic coverage of sheet areas digitised to form the Centenary Edition of the GEBCO Digital Atlas. The new data sets included in this release are numbered G.01 – G.09

The GEBCO One Minute Grid

The GEBCO One Minute Grid was supplied in the form of 30 degree by 30 degree tiles on behalf of the GEBCO Gridding Group by William Rankin and Michael Carron in December 2002. The data set was then assembled into a global file at BODC. Quality control checks were carried out on the data and any necessary changes to the data set were made by Bill, Mike and other members of the gridding team. Any amended data tiles were then re-supplied.

Walter Smith was asked to generate a 5 minute interval version of the GEBCO One Minute Grid to be included on the GDA CD-ROM set. This data set was provided at the beginning of March 2003.

Assembling the additional data sets to be included on the GDA CD-ROM

A copy of the latest version of the GEODAS (Geophysical Data System) data set was supplied by Dan Metzger of the U.S. NGDC. A trackline inventory comprising of a simplified navigation file for each cruise leg with enough points to replicate the coverage of the echo-sounding data logged in the database was extracted. This was then included on the GEBCO Centenary Edition CD-ROM.

Michel Huet and colleagues at the International Hydrographic Bureau provided a copy of the latest release of the IHO/IOC Gazetteer of Geographic Names of Undersea Features, including all names approved by SCUFN up to September 2002. Quality control checks

were then carried out on the data. The data were reformatted and additional points were added to the list for extensive features such as the Mid-Atlantic Ridge to help to define the feature when plotted on screen.

Development of the GDA Software Interface

As with previous releases of the GDA, the Centenary Edition comes with a software interface. It provides the functionality to allow users to plot their chosen data sets on screen with a variety of colours, line styles and projections and includes for the first time the facility to plot data using a Polar Stereographic projection. It allows the user to export the data in a number of formats, plain ASCII, DXF or ESRI Shapefile format for use in Geographic Information Systems. The GEBCO One Minute Grid can be accessed either directly from the CD-ROM in NetCDF or through the software interface and exported in either NetCDF or ASCII format. The development of this software was carried out at BODC by Ray Cramer.

Compilation of Documentation to Accompany the GDA

I worked on the development of a 'Help file' to describe the functionality of the GDA software interface. This was produced with help from Peter Hunter of SOC.

I also worked on assembling the text for the survey boxes included in the GDA trackline control data set.

Miscellaneous Tasks

The GDA web pages hosted at BODC were updated to advertise the content and features of the Centenary Edition of the GDA and its software interface.

A new database was set up at BODC to store information about orders received for the Centenary Edition of the GDA CD-ROM.

April 2003 – April 2004

Dealing with orders for the GDA and answering enquiries

Once the Centenary Edition of the GDA had been released work began on processing orders and sending out the CD-ROM sets. Since its release in April 2003, over 480 copies of the CD-ROM have been distributed. The orders for the GDA are dealt with at BODC by Mairi Marshall.

We have dealt with a large number of enquiries concerning the GDA. These range from general enquiries about the data sets and software to copyright and attribution issues.

Updating Computer Software and Hardware Systems used for GEBCO Project work at BODC

For a number of years, the GEBCO project work had been carried out at BODC using data capture and quality control software produced by Laser-Scan Ltd. run on VAX

workstations. It was decided to change the software and hardware systems once the Centenary Edition of the GDA was published and before our relocation to new offices in Liverpool. We now use ESRI ArcINFO/ArcGIS software run in a Microsoft Windows environment. All the GEBCO project data files were migrated from the VAX workstations to the new environment. I have also undertaken an introductory training course on the use of the ESRI ArcGIS software and I am currently taking a training course on the use of ESRI ArcIMS software.

Development of New GEBCO Project Web Pages at BODC

A 'Hints, Bugs and Fixes' web page has been set up to provide information about software fixes and problems within the GDA data sets.

A page displaying sample images from the GDA has been created to illustrate some of the features of the GDA software interface and to display some of the data sets available within the GDA.

Development of a means of accessing the GEBCO One Minute Grid via the internet

Work was also done at BODC on the development of a means of accessing the GEBCO One Minute Grid via the internet in a limited and controlled way. The global grid file was split into 20 degree by 20 degree tiles and shaded relief images of the tiles were produced. I helped in defining the specification for the site and I worked on the production of the images. Work on the technical development of the site was carried out by Siva Kondapali at BODC. Help and advice on the text used in the web pages was provided by GEBCO colleagues, especially by Andrew Goodwillie and Meirion Jones.

Updates To the GEBCO Digital Atlas Software Interface

There have been two software bugs reported.

1. Missing links to web sites through the help menu
2. Error message displayed when a comma is used as a decimal separator instead of a full stop

There is 'work around' information on these bugs on the 'Hints, Bugs and Fixes' web page. Both bugs have now been fixed.

Further development work on the GDA software interface has been carried out by Ray Cramer at BODC. Upgrades include:

1. Title screen – on fast computers the title screen becomes a brief blur before it disappears; to counter this, the screen now fades in and out over a few seconds.

2. Magnify window – this function has been added to enable the viewer to look at areas under the 'magnifier' in greater detail. The user can select the size, magnification and shape (round or square) of the magnifier window. The viewed area is not printable.

3. Plotting information from the Gazetteer of Undersea Feature Names - the user can choose to plot features defined on type, e.g. all seamounts, all ridges etc.

4. Map window image export - the map window can be saved in JPEG format.

Promotion of the Centenary Edition of the GDA

I have produced a leaflet about the GDA which was distributed at the Oceanology International Exhibition, London, March 2004.

ANNEX 7

GEBCO DIGITAL ATLAS - Payment of Sales Royalties to GEBCO for 2003

by Meirion T Jones

1. In March 2002, it was agreed between Director BODC, Director POL and the Chairman of the IHO/IOC GEBCO Guiding Committee that the net income received from sales of the GDA should be shared equally between BODC and GEBCO from 1 January 2002 onwards. A special agreement was entered into for sales prior to 1 January 2002.

2. Income from sales of GDA-97 from 1 January to 31 March 2003

£1,840	8 full price copies at £230
£495	5 discounted copies at £99
£0	1 free copy
£2,335	14 copies distributed

3. Income from sales of GDA (Centenary Edition) from 1 April to 31 December 2003

£12,880	56 full price copies at £230
£12,177	123 discounted copies at £99
£375	3 discounted copies at £125
£700	14 discounted copies at £50
£0	260 free copies
£26,132	456 copies distributed

4. Gross income for 2003 = £28,467

5. External costs for publication, promotion & distribution in 2003

£3,002	CD-ROM Mastering & Duplication (2000 copies Centenary Edition)
£1,258	CD-ROM Jewel Case Inserts (3000 copies Centenary Edition)
£2,500	External Consultancy Costs for preparing Centenary Edition
£712	Bank charges at 2.5%
£551	Postage and package for distribution of 277 copies
£8,023	Total external costs

6. Net income for 2003 = £28,467 - £8,023 = £20,444

7. Royalties owed to GEBCO for 2003 = £10,222

DISTRIBUTION/SALES OF THE CENTENARY EDITION OF THE GEBCO DIGITAL ATLAS
(March 2003 – 26 March 2004)

Country	SECTOR Gov	Univ	Comm	Other	Total	(sold)
Argentina	3	1	-	-	4	(1)
Australia	8	6	4	2	20	(17)
Austria	-	1	-	-	1	(1)
Belgium	3	1	-	2	6	(2)
Benin	1	-	-	-	1	(0)
Brazil	1	-	-	-	1	(1)
Cameroon	1	-	-	1	2	(0)
Canada	8	5	4	-	17	(8)
Chile	6	-	-	-	6	(0)
China	3	1	-	2	6	(0)
Colombia	2	-	-	-	2	(0)
Comoros	1	-	-	-	1	(0)
Cote d'Ivoire	1	-	-	-	1	(0)
Croatia	1	-	-	-	1	(0)
Denmark	2	1	-	-	3	(2)
Dominica	1	-	-	-	1	(0)
Ecuador	1	-	-	-	1	(0)
Estonia	4	-	-	-	4	(0)
Faeroes	1	-	1	-	2	(0)
Finland	2	-	1	-	3	(1)
France	20	2	4	2	28	(13)
Germany	15	10	2	5	32	(25)
Ghana	1	-	-	2	3	(0)
Greece	-	-	-	1	1	(1)
Guinea	1	-	-	-	1	(0)
Iceland	1	-	-	-	1	(0)
India	4	-	-	-	4	(1)
Indonesia	-	-	1	2	3	(1)
Ireland	1	2	-	3	6	(5)
Israel	1	-	-	-	1	(0)
Italy	11	2	-	1	14	(3)
Jamaica	1	-	-	-	1	(0)
Japan	7	4	2	-	13	(7)
Kenya	1	-	-	1	2	(0)
Korea	2	1	-	-	3	(3)
Madagascar	1	-	-	-	1	(0)
Mauritania	1	-	-	-	1	(0)
Mauritius	3	-	-	-	3	(0)
Mexico	5	-	-	-	5	(0)
Monaco	4	-	-	2	6	(0)
Morocco	1	-	-	-	1	(1)
Mozambique	2	-	-	-	2	(0)
Namibia	1	-	-	-	1	(1)
Netherlands	3	2	4	2	11	(5)
New Zealand	2	-	1	-	3	(1)
Nigeria	1	-	-	-	1	(0)
Norway	5	2	4	1	12	(7)
Oman	-	1	-	-	1	(1)
Pakistan	1	-	-	-	1	(0)
Panama	1	-	-	-	1	(0)
Peru	5	-	-	-	5	(0)
Philippines	-	1	-	2	3	(1)
Poland	4	-	-	-	4	(0)
Portugal	7	1	-	-	8	(2)
Russia	6	1	-	1	8	(1)
Senegal	1	-	-	-	1	(0)
Seychelles	3	-	-	-	3	(1)
South Africa	2	-	-	2	4	(1)
Spain	8	7	2	3	20	(18)
Sweden	2	-	-	-	2	(0)
Tanzania	1	-	-	-	1	(0)
Togo	2	-	-	-	2	(0)
Tunisia	1	-	-	-	1	(0)
Ukraine	2	-	-	-	2	(0)
UK	28	25	26	16	95	(46)
USA	24	29	23	15	91	(55)
Vietnam	-	-	-	2	2	(0)
TOTAL	243	106	79	70	498	(233)

Figures above refer to total number of copies sold or distributed up to 26 March 2004. GOV = Government/Public funded organisation; UNIV = University; COMM = Commercial organisation. Number in parenthesis refers to total number of copies sold as opposed to complimentary copies.

DISTRIBUTION/SALES OF GEBCO DIGITAL ATLAS – SUMMARY STATISTICS (up to 26 March 2004)

a) Total number sold/distributed = 498 copies
Total number sold = 233 copies
Number of complimentary copies = 265 copies

b) Copies sold/distributed to 67 countries

c) Breakdown of copies sold/distributed by sector:

Government bodies	243	copies
University groups	106	copies
Commercial bodies	79	copies
Other organisations	70	copies

d) Distribution of 265 complimentary copies:

GEBCO Centenary Conference:	104 copies
Distributed by IHB on request from IHO member states:	24 copies
Distributed to UNCLOS Commissioners on request:	10 copies
Customers purchasing GEBCO-97 from 1 January 2002:	21 copies
International and UK national exchange:	106 copies

e) Sales/distribution by month:

	Sold	Gratis	Total
2003			
Mar	-	4	4
Apr	24	114	138
May	44	46	90
Jun	34	9	43
Jul	23	28	51
Aug	14	1	15
Sep	22	38	60
Oct	14	18	32
Nov	10	1	11
Dec	11	1	12
Total	196	260	456

	Sold	Gratis	Total
2004			
Jan	20	1	21
Feb	11	2	13
Mar	6	2	8
Total	37	5	42

ANNEX 8

PROPOSAL FOR A NEW ORGANIZATIONAL STRUCTURE FOR THE OCEAN MAPPING PROGRAMME ACTIVITIES WITHIN IHO AND IOC

by Hugo Gorziglia, IHB, Monaco

1.- INTRODUCTION

The Intergovernmental Oceanographic Commission (IOC) and the International Hydrographic Organization (IHO), being aware of the growing need for close-co-operation in activities of common interest to both Organisations and their Member States, agree among other topics, on the following:

To continue to co-operate in the development of the IOC/IHO General Bathymetric Chart of the Oceans (GEBCO), and in the development of International Bathymetric Charts (IBC) in accordance with the decisions of the International Hydrographic Conference and the IOC Assembly, and, in particular, to promote the free exchange of processed data between the two Organisations both for the production of future editions of GEBCO and IBC, and for use as a base for the preparation of various kinds of geological/geophysical, physical, chemical and biological overprint/overlay sheets;

Co-operate in the formulation of proposals for, and the execution of, technical co-operation projects having components which fall within the competence and the expertise of the respective Organisations, including advance exchange of relevant information and the formulation of other measures required to implement the projects;

To promote training, education and capacity building in all spheres of surveys mapping and charting of mutual interests by enhancing the awareness of the Member States of both Organisations to the importance of co-operation in the use of training facilities, research institutions, vessels, data, and the expertise and experience of personnel, especially to the benefit of developing States;

2.- RELEVANT OCEAN MAPPING PROGRAMME'S ORGANIZATIONS

2.1 THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO)

The International Hydrographic Organization (IHO) is an intergovernmental organization of a consultative and technical nature comprising over 70 Member States represented by their respective national Hydrographic Offices. IHO objectives include the coordination of the activities of national hydrographic offices; the greatest possible uniformity in

nautical charts and documents; the adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys and the development of the sciences in the field of hydrography and the techniques employed in descriptive oceanography, all aiming at contributing to safety of life at sea, safety of navigation and the protection of the marine environment."

2.2 INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)

The Intergovernmental Oceanographic Commission is a body with functional autonomy within the United Nations Educational, Scientific and Cultural Organization (UNESCO).
The purpose of the Commission is to promote international cooperation and to coordinate programmes in research, services and capacity-building, in order to learn more about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States. The Commission will collaborate with international organizations concerned with the work of the Commission
Among others, the functions of the Commission shall be to recommend, promote, plan and coordinate international ocean and coastal area programmes in research and observations and the dissemination and use of their results.

2.3 IHO DATA CENTRE for DIGITAL BATHYMETRY (IHO-DCDB)

The US National Geophysical Data Center (NGDC) on behalf of the IHO operates the IHO Data Centre for Digital Bathymetry and has agreed to provide the services indicated in **Annex A.**

3.- JOINT IOC-IHO OCEAN MAPPING DIRECTING BOARD (OMDB)

The Joint IOC-IHO Ocean Mapping Directing Board (OMDB) has the overall responsibility for fostering the GEBCO Global Project and the International Bathymetric Chart Regional Projects in conformity with resolutions adopted by IHO and IOC, proposing to its two parent organisations the policy and strategy for the preparation and dissemination of the world and regional series of contoured charts of the ocean floor and the "GEBCO Digital Atlas" (GDA). Its Terms of Reference are provided in **Annex B**.

A Structural Diagram illustrating the components of OMGC is given in the last page.

3.1 JOINT IOC-IHO GEBCO GLOBAL PROJECT

3.1.1 Background Information:

The preparation of the first world series of oceanic bathymetric charts was started in 1903, and was published one year later as the GEBCO, under the auspices of Prince Albert 1st of Monaco.

As additional data became available over the years, new editions were compiled, first by the Prince's scientific committee and later, after the Prince's death, by the International Hydrographic Bureau. The last sheet of the 4th Edition, which was printed by the Institut Géographique National (IGN) of France, was published in 1973.

With the increasing knowledge of the morphology and of the geological processes on the ocean bed in the 1950s and 1960s, a scientific input into the preparation of the contours was introduced into GEBCO by linking the Intergovernmental Oceanographic Commission (IOC), of UNESCO, with the IHO as joint sponsors of the project.

Under the new Joint IOC/IHO Guiding Committee for the GEBCO, a 5th Edition was prepared and completed in 1982. This edition differed in many ways from its predecessors. There were new sheet boundaries, new specifications, sounding control was shown by track lines and dots, and an extensive scientific review process was carried out prior to publication.

The contours of the 5th Edition have been digitised, together with the tracks, sounding control and the names, to form the basis for the "GEBCO Digital Atlas" (GDA) which were initially available on magnetic tape, and now on CD-ROM.

The database of the GDA is updated as new contour data are acquired and blocks of older data are replaced. Users can extract from the database the areas they need on any suitable scale.

At an appropriate time it is planned to produce a 6th Edition of printed sheets from the GDA database.

3.1.2 The Organization and Components of the GEBCO Global Project

3.1.2.1 The Joint IOC-IHO GEBCO Global Project Committee (GGPC).

The GEBCO Global Project will have a Committee formed by 3 representatives of the IHO, 3 representatives of the IOC and the Chairmen of the Sub Committees of the GEBCO Global Project Permanent Secretary. The Terms of Reference of this Committee are provided **in Annex C**

3.1.2.2 The GEBCO Global Project Sub Committees.

The following two Sub Committees will provide the required technical support for the GEBCO Global and the IBC Regional Projects:

- The Sub-Committee on Geographical Names and Nomenclature of Ocean Bottom Features (SCUFN) that recommends to the Ocean Mapping Directing Board names to be included in the global and regional charts as well as in the GDA. Its Terms of Reference are provided in **Annex D.**
- The Sub-Committee on Digital Bathymetry that advises the Ocean Mapping Directing Board on procedures to achieve a fully digital version of the

GEBCO Global Projects as well as IBC Regional Projects and to prepare the "GEBCO Digital Atlas" (GDA). Its Terms of Reference are provided in **Annex E.**

3.2. JOINT IOC-IHO INTERNATIONAL BATHYMETRIC CHARTS REGIONAL PROJECTS

3.2.1 Background Information:

IOC activities in international ocean mapping began in 1969 after the endorsement by the UN General Assembly of the Long-Term and Expanded Programme of the Ocean. The first activity was the compilation of the Geological and Geophysical Atlas of the Indian Ocean taking advantage of the data collected through the International Indian Ocean Expedition (IIOE). This atlas was published in 1975 by
the Academy of Sciences and the Main Administration of Geodesy and Cartography of the former USSR.

The International Geological-Geophysical Atlases of the Atlantic and Pacific Oceans (GAPA) is another endeavour of IOC in Ocean Mapping. The Atlantic Ocean Atlas was published in 1991 and the Pacific Ocean Atlas was published in 2003, thus completed the GAPA project.

3.2.2 The Organization and Components of the IBC Regional Projects

3.2.2.1. The IBC Regional Projects

There are 8 established IBC regional projects:

- IBC Southern Ocean, covering the Antarctic (IBCSO)
- IBC Arctic Ocean (IBCAO)
- IBC Caribbean Sea and Gulf of Mexico (IBCCA)
- IBC Central East Atlantic (IBCEA)
- IBC Mediterranean (IBCM)
- IBC South East Pacific (IBCSEP)
- IBC West Indian Ocean (IBCWIO)
- IBC Western Pacific (IBCWP)

Additional IBC projects may be established as necessary.

3.2.2.2 The Joint IOC-IHO IBC Regional Projects Committee (IRPC).

The IBC Regional Project Committee will comprise the Chairman of each of the IBC Projects listed above. The Terms of Reference of this Committee are provided in **Annex F**.

ANNEXES

ANNEX A Services provided by IHO Data Centre for Digital Bathymetry (DCDB)
ANNEX B Terms of Reference of the Joint IOC-IHO Ocean Mapping Directing Board (OMDB)
ANNEX C Terms of Reference of the Joint IOC-IHO GEBCO Global Project Committee (GGPC)
ANNEX D Terms of Reference of the GEBCO Global Project Sub-Committee on Undersea Feature Names (SCUFN) .
ANNEX E Terms of Reference of the GEBCO Global Project Sub-Committee on Digital Bathymetry (SCDB).
ANNEX F Terms of Reference of the Joint IOC-IHO IBC Regional Projects Committee (IRPC)

ANNEX A

Services provided by IHO Data Centre for Digital Bathymetry (DCDB)

Oceanic soundings are acquired by hydrographic and oceanographic ships during surveys and on passage between survey areas and ports. In addition many warships, fisheries and others vessels also collect oceanic soundings.

These data are submitted to the IHO Data Centre for Digital Bathymetry (DCDB) at Boulder, Colorado (USA), in digital or hard copy (collector tracing) format. The DCDB carries out the following functions:

(1) Operation of the data centre with a focus of activity on oceanic regions with depths greater than 100 meters.

(2) Provision free of charge to the IHO and IOC for use by its Member States, of the data needed for their national or international projects. The IHO and IOC Member States will submit their requests for data through directly to the IHO-DCDB. IHO Member States' Hydrographic Offices (HOs) will provide the center with the digital bathymetric data collected by their nation's institutions in oceanic regions, such as the national oceanographic commissions.

(3) Maintenance of a quality control facility whereby data provided to the center are at least subjected to simple checks for violation of physical principles (instantaneous changes in position, impossibly high ship speeds, etc.) and completeness of labeling, referring detected obvious errors back to suppliers of data for possible corrections. Member States' Hydrographic Offices may be requested to assist in resolving matters of quality control concerning data originated by their nation's organizations.

(4) Maintenance of inventories in digital form of all digital bathymetric data including digital contour data and the production of an annually updated catalogue of recently acquired bathymetric data. The center will provide this catalogue to the IHB in a form analogous to the IHO publication B-4.

(5) Maintenance of trackline catalogues of newly collected data for further studies.

(6) Collaboration with various international organizations in the development of exchange formats and standards to expedite bathymetric data exchange, including digital bathymetric contours.

(7) The operational procedures, systems and formats supporting the Banking of Bathymetric data at the IHO DCDB are given in APPENDIX 1 TO Annex A.

Appendix 1 to ANNEX A

OPERATIONAL PROCEDURE, SYSTEMS AND FORMATS SUPPORTING THE BANKING OF BATHYMETRIC DATA AT THE IHO DATA CENTRE FOR DIGITAL BATHYMETRY (DCDB)

The IHO DCDB operates on the basis that the prime responsibility for quality control of the data rests with the collector or custodian of the raw data. DCDB receives data from IHO Member States' Hydrographic Offices or other national Institutions or Agencies in oceanic regions on any specially agreed-upon transfer media. Contributors are responsible for providing digital cruise data and headers (which list general information about the cruise and data acquired during the cruise) preferably in MGD77 format. The MGD77 format is described in a separate document available from DCDB. Data provided in other formats are accepted when accompanied with concise documentation. If data are provided to DCDB in an alternate format, written headers on MGD77 coding forms are accepted.

As soon as the data package arrives, DCDB reviews the accompanying written enclosures, checks the physical condition of the data storage media and assigns the data a project number used as a permanent identifier. Documentation which should be provided as enclosures with the data by each contributor is listed in Appendix 1. If data are not provided in MGD77 format, a concise description of the format used and completed MGD77 header coding forms should be included. DCDB provides enclosure forms and header coding forms to contributors on request. If the data and headers are in MGD77 format, or if the data are in a well documented alternate format with completed MGD77 header coding forms, data processing begins. Acknowledgement via mail or electronic mail is sent to the contributor within one week of receipt of the data. If necessary the acknowledgement includes a request for any information needed by DCDB to begin processing.

Within 3 weeks of the arrival of the data to DCDB they are copied for archival protection reasons and are scanned electronically using a digital scanning routine to determine whether the format matches that described in the written documentation. A manual check of the printout of the scanning routine is completed to determine if the data are entered in the proper record fields. After this scanning review is completed, a follow-up letter or electronic mail notice is sent to the contributor explaining the results and describing the expected date of completion of assimilation. This notice will also include a request for further documentation on any received format not familiar to DCDB staff.

The first step of assimilation occurs when the data are electronically transferred to a computer to begin error checking. Validation software is employed to routinely check several parameters. Latitude and longitude are checked to determine whether they fall within the normal ranges of 90E to –90E and 180E and –180E respectively. Each depth value, 2-way travel time, magnetic value, and gravity value is checked against physically possible values. Any value not physically possible (see Appendix 2) is flagged by the software. Navigation is also checked by comparing the time and navigation points for accelerations and/or course changes physically possible on an oceanic vessel. If there are errors discovered in the navigation check, plots of the navigation are reviewed. If there is

a discrepancy, a staff person further reviews the situation and communicates with the contributor as necessary.

There are two checks done by DCDB staff at this point in the assimilation process. First the header record is reviewed for possible data entry errors. Second, randomly selected depths of the survey are compared to GEBCO chart depths as a check for two possible errors – mismatched units of depth such as fathoms instead of meters or the misplacement of a decimal point in the depth record.

The staff at DCDB reviews any errors discovered and flagged by the validation software or during the two checks discussed above. If there are relatively few errors, the processing continues. But if there are a significant number of flagged errors, the contributor is notified and asked to correct and resubmit the data or provide enough information so the errors can be corrected by DCDB staff.

Next, an inventory file is created, which is a compacted version of each cruise. Normally the inventory file includes just enough data to define the trackline of the original cruise, usually about 2 percent of the total. The inventory file includes a list of the total number of data records for each parameter in the data set and a complete header for each cruise. The trackline of the inventory is displayed on a computer screen, where it is reviewed for obvious errors such as ship travel across a land mass, gaps in the cruise track or unusual navigational deviations. Quality Control processing is now complete.

The final assimilation steps are data management and archival functions. All assimilated cruises are added to the master inventory which is available for IHO Member States' hydrographic offices and other appropriate Agencies as described in documentation establishing the IHO DCDB. A copy of the master data file for each cruise is archived on-site and another off-site for added security. The inventory file, which is used by DCDB as part of the data request system, is also duplicated and stored in two locations. After the data are archived, the results of the DCDB validation software checks are offered to the contributor of the data along with a copy of the assimilated data set.

Sub - Appendix 1 to Annex A

Documentation to be Provided with Data

ITEM	EXAMPLES
Contributor	Royal Australian Navy
Project Name	1986 Offshore Cruises
Contact	John Smith
Address	self explanatory
Telephone number	self explanatory

Facsimile number	self explanatory
Electronic mail address	(if applicable)
Digital Data Format	Internal J.O.D.C. (provide complete documentation)
Cruises Names	OFF8601, OFF8602
Storage Media	CD-Rom
Character Code	ASCII or EBCDIC (only)
Record Size	120 bytes
Block Size	1920 bytes
Other Media Specific Information	(if applicable)
Cruise Information	MGD77 Header Coding Forms
Comments	Anything that will assist DCDB staff in the data processing.

Sub - Appendix 2 to Annex A

Data Range limits

DATA PARAMETER	ALLOWABLE RANGE
Latitude	90E to –90E
Longitude	180E to –180E
2-way Travel Time	greater than 0 less than 15 seconds
Corrected Depth	0 to 11,000 meters
Magnetic Total Field	20,000 to 72,000 nanoteslas
Gravity	977,000 to 985,000 mgals.

ANNEX B

JOINT IOC-IHO OCEAN MAPPING DIRECTING BOARD (OMDB)

Terms of Reference

Considering the need to promote and co-ordinate the development of their ocean mapping projects, the Intergovernmental Oceanographic Commission (IOC), of UNESCO, and the International Hydrographic Organization (IHO) establish a joint Ocean Mapping Directing Board (OMDB) with the following Objectives and Rules of Procedure:

1. Objectives

The objectives are to:

1.1 Foster the achievement of, and keep under continuous review, all ocean mapping activities agreed by the two parent organisations. Provide annual reports on the jointly sponsored programs, to both Parent Organisations.

1.2 Guide the ocean mapping programme, for implementation by its two subsidiary committees, i.e. the GEBCO Global Project Committee (GGPC) and the IBC Regional Projects Committee (IRPC), and make recommendations to the two parent organisations on policy and strategy issues to be followed for the preparation and dissemination of all products from the global and regional projects.

1.3 Develop a costed four-year work programme, identifying tasks, products, responsibilities, resources and target dates. This programme shall be updated and submitted by the Board to the Parent Organisations annually.

1.4 Taking into account technological development and data availability, identify new applications for bathymetric data and/or define new bathymetric products. Draft specifications for these products, as appropriate.

1.5 Explore the potential, for the better interpretation of oceanic bathymetry, of techniques such as acoustic imagery and satellite observations.

1.6 Provide a technical link between the groups supervising each ocean mapping project, so as to ensure that common specifications are used for all resulting products.

1.7 Encourage subsidiary regional bodies to identify their requirements for the development of bathymetric chart series, as well as overlay series showing other scientific parameters, including marine resources.

1.8 Advise the IHO (in its capacity as the World Data Centre for Bathymetry),on matters connected with the collection and exchange of bathymetric data, including

the development of automatic data assimilation, archival, retrieval and distribution methods, soliciting the advice and assistance of the IOC Committee on International Oceanographic Data and Information Exchange (IODE), and others as necessary.

1.9 Stimulate the flow of data relevant to the Ocean Mapping programme by actively identifying sources of new data and encouraging release of data to appropriate data banks, with the object of ensuring that maximum available data are provided to the World Data Centre for Bathymetry and its IHO Data Centre for Digital Bathymetry.

1.10 Provide advice on ocean mapping, as requested by intergovernmental and non-governmental organisations.

1.11 Develop and promote training opportunities in ocean mapping.

1.12 Recommend and develop measures for optimum publicity, distribution and sales of copies of Ocean Mapping Projects and other bathymetric products produced under the aegis of the Committees.

2. Rules of Procedures

2.1 Membership of the Ocean Mapping Directing Board is covered by the following guidelines:

(1) The Board will consist of 12 members, plus a Permanent Secretary. Five members will be nominated by the IHO and five by the IOC. The other two members will be the Chairpersons of the GEBCO Global Project Committee (GGPC) and the IBC Regional Projects Committee (IRPC).

(2) In close consultation, the Parent Organizations will ensure that nominated members of the Directing Board will be appointed from as wide a geographical area as possible.

(3) Members of the Board are experts acting in their personal capacity and shall not represent their governments[1].

2.2 The Chairperson and Vice-Chairperson are elected by the Board and endorsed by the Parent Organisations. The Chairperson, or in his/her absence the Vice-Chairperson, will conduct the business of the Committee. The Chairperson and Vice-Chairperson should come from different Parent Organisations.

2.3 The Chairperson is elected for a four-year period and will normally be succeeded by the Vice-Chairperson. The Chairperson may be re-elected for one additional four-year period

[1] So far as IOC is concerned, the Directing Board is classed as a Joint Group of Experts under the IOC guidelines for subsidiary bodies.

2.4 Meetings of the Board will normally be held every 2 years. The venue and date will be discussed at Board Meetings and confirmed twelve months in advance. In the intervening period the Board will conduct its business by correspondence (usually electronic).

2.5 The Chairperson, at the request of Members of the Board, may invite interested scientists and hydrographers to attend meetings as observers. IHB and the IOC Secretariat will have *ex-officio* representation at meetings.

2.6 Meetings of the Board will be held in conjunction with those of the GEBCO Global Project Committee (GGPC) and of the IBC Regional Projects Committee (IRPC). GGPC and IRPC meetings will be conducted in parallel, typically over two days, and will immediately be followed, by an OMDB meeting, at same venue, normally for two days.

2.7 The Board, under the Chairperson's guidance, will appoint a Permanent Secretary to the Board. He will be primarily tasked, on the occasion of meetings of the Board, to make the necessary arrangements, send invitations, prepare the documentation (including an agenda), act as rapporteur and write a report of discussions and conclusions.

2.8 The Board should strive to make decisions by consensus. If a vote is necessary, the quorum required is 7 members, the majority required for acceptance is to be a simple majority.

2.9 Any nominated member of the Board [see 2.1 (1)] absent from two consecutive OMDB meetings will loose its position. A replacement will then be nominated by IHO or IOC as appropriate.

2.10 A yearly report on the progress and status of all ocean mapping projects (see 1.1) is to be submitted by the Chairperson through IHB and the IOC Secretariat to the Parent Organisations. It should include all recommendations of the Board (see 1.2), an updated work programme (see 1.3) and any other relevant information.

ANNEX C

JOINT IOC–IHO GEBCO Global Project Committee (GGPC)

Terms of Reference

1. Objectives:

The objectives are to:

1.1 Guide the GEBCO project and make recommendations to the Ocean Mapping Directing Board (OMDB) on the policy to be followed for the preparation and dissemination of that world series of contoured charts of the ocean floor and of the "GEBCO Digital Atlas".

1.2 Identify the needs of the various users of the bathymetry of the world's oceans; study the ways and means whereby these needs can be met, and implement actions found feasible, which meet these needs.

1.3 Stimulate the flow of data relevant to the GEBCO Project by actively identifying sources of new data and encouraging the release of data to appropriate data banks, with the object of ensuring that maximum available data are provided to the World Data Centre for Bathymetry and the IHO Data Centre for Digital Bathymetry.

1.4 Supervise the means of maintaining, further developing and routinely updating the "GEBCO Digital Atlas" (GDA). Activities to include but not restricted to:

(1) Organising procedures for new compilations of bathymetry;

(2) Advising on standards and methodology;

(3) Generating and developing a supplementary file containing ship tracks, for the purpose of providing graphic presentation for quality assurance related to interpreted bathymetric information;

(4) Producing a worldwide gridded data set of bathymetric data, at the best resolution compatible with the compiled bathymetry available, in order to support various marine applications, e.g. geosciences, law of the sea, offshore exploration.

(5) Integrate, in an appropriate way the geographical names of undersea features; and

(6) Consider the best medium and software for the effective use of the GDA by all users.

1.5 Investigate and develop new extra-budgetary logistic and financial arrangements necessary for the furtherance of the GEBCO Project.

1.6 Prepare and maintain, in association with national and international bodies, an authoritative Gazetteer on Geographical Names of Undersea Features.

1.7 Maintain, as necessary, advisory Sub-Committees on: Undersea Feature Names and Digital Bathymetry. Form Working Groups to investigate and report on specific topics as required.

1.8 Advise regional IBC projects, through the IBC Regional Projects Committee (IRPC), of the specifications for, and collaborate in the preparation of, bathymetric charts at scales suitable for regional projects, to help ensure their compatibility with, and later inclusion in, the GDA.

2. Rules of Procedure

2.1 Membership of the GEBCO Global project Committee is covered by the following guidelines:

(1) The Committee will consist of 8 members, 3 members will be appointed by IHO and 3 by IOC. The additional two members will be the Chairpersons of the Sub-Committee on Undersea Feature Names (SCUFN) and the Sub-Committee on Digital Bathymetry (SCDB).

(2) Members of the Board are experts acting in their personal capacity and shall not represent their governments[2].

2.2 The Chairperson and Vice-Chairperson will be elected by the Committee and endorsed by the OMDB. They should come from different Parent Organisations.

2.3 The Chairperson is elected for a four-year period and will normally be succeeded by the Vice-Chairperson. The Chairperson may be re-elected for one additional four-year period.

2.4 The Chairperson, or in his/her absence the Vice-Chairperson, will conduct the business of the Committee. Meetings will usually be held every 2 years, in parallel with a meeting of the IBC Regional Projects Committee (IRPC) and will normally last 2 days. The GGPC and IRPC meetings will precede that of the OMDB, which will be held at the same location. In the intervening period the Committee will conduct its business by correspondence (usually electronic).

2.5 The Committee should strive to decide by consensus. If a vote is required, the quorum required is 5 delegates, the majority required for acceptance is to be a simple majority.

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[2] So far as IOC is concerned, the Project Committee is classed as a Joint Group of Experts under the IOC guidelines for subsidiary bodies.

2.6 The Chairperson is to submit an annual report to the OMDB.

2.7 The Chairperson is to provide a costed business plan for approval at the biennial meeting of the OMDB.

ANNEX D

GEBCO Sub-Committee on Undersea Feature Names (SCUFN)

Terms of Reference.

1. Objectives:

1.1 The Sub-Committee on Undersea Feature Names reports to the Joint IOC-IHO GEBCO Global Project Committee (GGPC) as its designated authority for all matters concerning undersea feature names.

1.2 It is the function of the Sub-Committee to select those names appropriate for use on GEBCO graphical and digital products, on the IHO small-scale international chart series, and on the regional IBC series.

1.3 The Sub-Committee shall:

(i) Select undersea feature names on the basis of:

a) undersea feature names provided by national and international organisations concerned with nomenclature;
b) names submitted to the Sub-Committee by individuals, agencies and organisations involved in marine research, hydrography, etc.;
c) names appearing in scientific journals or on appropriate charts and maps, with valid supporting evidence.
d) Names submitted to the Sub-Committee by the Chairpersons or Chief Editors of IBC projects, in relation to the work on these projects.

Such names will be reviewed before they are inputted into the Gazetteer.

(ii) Define when appropriate the extent of named features;
(iii) Provide advice to individuals and appropriate authorities on the selection of undersea feature names in international waters and, on request, in waters under national jurisdiction;
(iv) encourage the establishment of national boards of geographical names and undersea features, and when such a board does not exist for a given coastal state, co-operate in the naming of seafloor features related to those national waters;
(v) prepare and maintain an international and world-wide gazetteer of undersea feature names;
(vi) encourage the use of undersea feature names included in the Gazetteer, on any maps, charts, scientific publications, and documents by promulgating them widely;
(vii) prepare and maintain internationally agreed guidelines for the standardisation of undersea feature names and encourage their use;

(viii) review and address the need for revised or additional terms and definitions for submarine topographic features.

(ix) maintain close liaison with the UN Group of Experts on Geographical Names, the focal point of which shall be invited to attend meetings of the Sub Committee, and international or national authorities concerned with the naming of undersea features.

2. Rules of Procedure

2.1 Membership of the Sub-Committee on Undersea Feature Names is covered by the following guidelines:

(1) The Sub Committee will consist of 10 members, 5 members will be appointed by IHO and 5 by IOC.

(2) Members of the Sub Committee are experts acting in their personal capacity and shall not represent their governments[3].

2.2 The Chairperson and Vice-Chairperson will be elected by the Sub Committee and endorsed by the Joint IOC-IHO GEBCO Global Project Committee (GGPC). They should come from different Parent Organisations.

2.3 The Chairperson is elected for a four-year period and will normally be succeeded by the Vice-Chairperson. The Chairperson may be re-elected for one additional four-year period.

2.4 The Chairperson, or in his/her absence the Vice-Chairperson, will conduct the business of the Sub Committee. Meetings will usually be held every 2 years, ideally before the GGPC meeting. In the intervening period the Sub Committee will conduct its business by correspondence (usually electronic).

2.5 The Sub Committee should strive to decide by consensus. If a vote is necessary, the quorum required is 6 delegates, the majority required for acceptance is to be a simple majority.

2.6 The Chairperson is to submit an annual report to the GGPC.

2.7 The Chairperson is to provide a costed business plan for approval at the biennial meeting of the GGPC.

[3] So far as IOC is concerned, the SCUFN Sub Committee is classed as a Joint Group of Experts under the IOC guidelines for subsidiary bodies.

ANNEX E

GEBCO Sub-Committee on Digital Bathymetry (SCDB)

Terms of Reference

2. Objectives:

1.1 The Sub-Committee on Digital Bathymetry reports to the Joint IOC-IHO GEBCO Global Project Committee (GGPC) as its designated authority for all matters concerning digital bathymetry.

1.2 It is the function of the Sub Committee to maintain a watching brief on developments in deep sea bathymetric mapping and related activities, and on the evolving technologies used to support such work.

1.4 The Sub-Committee shall:

(i) Keep under review, and provide advice on, standards and procedures for ensuring the continued and effective management, availability and depiction of digital bathymetric data.

(ii) Maintain, routinely update and further improve the GEBCO Digital Atlas (GDA) by:

a) developing procedures for incorporating new compilations of bathymetry;

b) advising on standards and methodology;

c) generating and developing a supplementary file containing shiptracks, for the purpose of providing graphic presentation for quality assurance related to interpreted bathymetric information;

d) integrating in an appropriate way the geographical names of undersea features; and

e) investigating the best medium and software for the effective use of the GDA by all users.

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

(iv) Provide advise on matters connected with the collection and exchange of bathymetric data.

(v) Interact with the relevant committees and working groups, to bring about, to the extent possible, uniformity and compatibility with IODE

developments and also with IHO Classification Criteria for Deep Sea Soundings (IHO Special Publication No. 44, Annex A).

2. Rules of Procedure

2.1 Membership of the Sub-Committee on Digital Bathymetry is covered by the following guidelines:

(1) The Sub Committee will consist of 10 members, 5 members will be appointed by IHO and 5 by IOC.

(2) Members of the Sub Committee are experts acting in their personal capacity and shall not represent their governments[4].

2.2 The Chairperson and Vice-Chairperson will be elected by the Sub Committee and endorsed by the Joint IOC-IHO GEBCO Global Project Committee (GGPC). They should come from different Parent Organisations.

2.3 The Chairperson is elected for a four-year period and will normally be succeeded by the Vice-Chairperson. The Chairperson may be re-elected for one additional four-year period.

2.4 The Chairperson, or in his/her absence the Vice-Chairperson, will conduct the business of the Sub Committee. Meetings will usually be held every 2 years, ideally before the GGPC meeting. In the intervening period the Sub Committee will conduct its business by correspondence (usually electronic).

2.5 The Sub Committee should strive to decide by consensus. If a vote is necessary, the quorum required is 6 delegates, the majority required for acceptance is to be a simple majority.

2.6 The Chairperson is to submit an annual report to the GGPC.

2.7 The Chairperson is to provide a costed business plan for approval at the biennial meeting of the GGPC.

[4] So far as IOC is concerned, the SCDB Sub Committee is classed as a Joint Group of Experts under the IOC guidelines for subsidiary bodies.

ANNEX F

JOINT IOC–IHO IBC REGIONAL PROJECTS COMMITTEE (IRPC)

Terms of Reference

1. Objectives:

The objectives are to:

1.1 Keep under continuous review all regional ocean mapping activities of the Committee, reporting to the Ocean Mapping Directing Board (OMDB) on the progress made with each International Bathymetric Chart (IBC) project sponsored by the Board.

1.2 Facilitate the exchange of expertise and experience between the groups supervising each regional IBC project.

1.3 Provide a technical link between the IBC projects, so as to ensure that a standard form of presentation is used for all ocean mapping products published by, or on behalf of the International Oceanographic Commission (IOC) and the International Hydrographic Organization IHO)**.**

1.4 Encourage regional IBC projects to identify the requirements for bathymetric chart series and overlay (overprint) series showing other scientific parameters, including marine resources

2. Rules of Procedure

2.1 Membership of the IBC Regional Projects Committee is covered by the following guidelines:

(1) The Committee will consist of the Chairpersons of each IBC Regional Project.

(2) Members of the Board are experts acting in their personal capacity and shall not represent their governments[5].

[5] So far as IOC is concerned, the Project Committee is classed as a Joint Group of Experts under the IOC guidelines for subsidiary bodies.

2.2 The Chairperson and Vice-Chairperson will be elected by the Committee and endorsed by the OMDB.

2.3 The Chairperson is elected for a four-year period and will normally be succeeded by the Vice-Chairperson. The Chairperson may be re-elected for one additional four-year period.

2.4 The Chairperson, or in his/her absence the Vice-Chairperson, will conduct the business of the Committee. Meetings will usually be held every 2 years, in parallel with a meeting of the GEBCO Global Project Committee (GGPC) and will normally last 2 days. The IRPC and GGPC meetings will precede that of the OMDB, which will be held at the same location. In the intervening period the Committee will conduct its business by correspondence (usually electronic).

2.5 The Committee should strive to decide by consensus. If a vote is required, the quorum required is half the IRPC membership, plus one delegate, the majority for acceptance is to be a simple majority.

2.6 The Chairperson is to submit an annual report to the OMDB.

2.7 The Chairperson is to provide a costed business plan for approval at the biennial meeting of the OMDB.

ANNEX 9

Polar Ocean BAthymetry Co-ordination Effort (POBACE)

A suggestion for an International Polar Year (IPY) initiative

by Martin Klenke & Hans Werner Schenke
Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Sea floor topography is a pivotal basic data for many marine scientific disciplines. Fields of application include, but are not limited to oceanographic modelling at all scales in order to predict regional and global ocean circulation and its impact on climate, geological modelling of ocean basin evolution, sample regionalisation and calculation of areal particle fluxes and budgets, evaluation of fisheries resources and habitats, assessing the impact of coastal sediment transport and pollution, etc.

Nevertheless, our bathymetric knowledge in general is poor and fragmentary. In fact, most of the relief of Moon and Mars is known in better spatial resolution than the bottom topography of the world's oceans. Globally, the biggest uncertainties remain in the remote and partly ice-covered regions of the Arctic and Antarctic waters. On the other hand, we learned that particularly the Polar seas have a critical impact on the global climate, e.g. through bottom water formation controlling the global thermohaline circulation.

Recognising this, two international projects are currently working on the improvement of our bathymetric knowledge in the Arctic and Antarctic oceans: The well established "International Bathymetric Chart of the Arctic Ocean" (IBCAO) and the "International Bathymetric Chart of the Southern Ocean" (IBCSO) which is currently about to start. Both projects are carried out under the auspices of the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Hydrographic Organization (IHO). Scientific reference is given by the International Arctic Science Committee (IASC) and the Scientific Committee on Antarctic Research (SCAR).

The Arctic Ocean mapping project IBCAO already provides a detailed inventory of existing bathymetric data sets in Arctic waters. The IBCSO project will lead to such an inventory for the Southern Ocean by the end of 2004. Both enquiries in return supply us with an explicit image of the distribution of the "bathymetric white spots".

During the envisaged IPY many vessels will travel the polar oceans fulfilling research and logistic missions. Almost all ships will be equipped with sonar systems, at least a single beam aperture. The Polar Ocean Bathymetry Co-ordination Effort (POBACE) is targeting on the collection of respective sonar data and the co-ordination of ship tracks in order to enhance our bathymetric source data stock. The initiative will raise new data sets as easy and cheap by-products of other missions. Up to now, sonar data from many vessels does not find its way to international data bases. Moreover, vessels, particularly when concerned with logistic tasks, tend to sail the same track lines over the years. In many cases, even minimal track shifts could raise exciting new data sets.

Hence, deliverables of the POBACE initiative will include:

- Setting up a communication infrastructure between possible data providers and scientists interested in bathymetric information, preferably using existing IASC and SCAR channels.
- Definition and rating of areas of interest to be mapped on the basis of the IBCAO and IBCSO data inventories and the manifold Arctic and Antarctic scientific programs and tasks.

- Collection of the ship tracks planned in the polar oceans during the IPY and respective metadata in a central facility allowing scientists an easy track query and visualisation via internet.
- Checking of the tracks planned against the potential mapping areas identified and, where necessary, desired and applicable, track adjustments in close co-operation with the originators.
- Organization of data collection and data processing following the cruises.
- Publication of the data products and integration in the IBCAO and IBCSO data bases.

If successful, POBACE will lead to an ongoing international effort to communicate and better co-ordinate ship movements in the Polar oceans in order to increase our bathymetric knowledge, and therewith raise synergistic potentials and enhance the cost effectiveness of Arctic and Antarctic research.

ANNEX 10

The SSPARR Project

by Robert M Anderson, SIAC, Seattle, USA

Collaborative Research: Seafloor Sounding in Polar and Remote Regions (SSPARR) ***[text extracted from the funded NSF Proposal]***

This is a collaborative proposal between the Hawaii Mapping Research Group of the University of Hawaii (HMRG), the Lamont-Doherty Earth Observatory of Columbia University (LDEO), and the Center for Coastal and Ocean Mapping of the University of New Hampshire (CCOM).

We propose to develop a system for acquiring seafloor depth soundings in regions of the world for which there is currently only very sparse bathymetric coverage; areas which are seldom or never visited by ships. In particular, this system is targeted for use in the Arctic Ocean and Southern Ocean. This proposal is for the accomplishment of the first phase of the system development, beginning summer 2003 through summer 2004.

Scientific Background and Rationale

Accurate and detailed knowledge of global bathymetry is a prerequisite for progress in numerous scientific disciplines related to earth systems. Among these are modeling of ocean circulation and its relation to climate; modeling of tides and tsunamis; describing tectonic plate structure and dynamics; understanding the formation, modification and ultimate destruction of Earth's crust; sediment transport, distribution, and thickness; paleoceanography; etc. Detailed understanding of seafloor shape is also necessary to select sites and routes for undersea communication cables. Understanding of the energy and mineral resource potential of the seas requires detailed knowledge of bathymetry.

Working Group 107 was established by the Scientific Committee on Oceanic Research (SCOR) of the Intergovernmental Oceanographic Commission to: (i) address the scientific need for improved knowledge of ocean depths; (ii) specify the accuracy and resolution requirements needed in different geographical and research areas; and (iii) recommend actions and priorities. In its final report, WG107 provides extensive examples of scientific fields that require detailed bathymetric information [SCOR Working Group, 2001]. In two specific areas of the world oceans – the Arctic Ocean and the Southern Ocean – the existing database of bathymetry is too sparse to meet most science needs.

The General Bathymetric Chart of the Oceans (GEBCO) fifth-edition Sheet 5.17, depicting the seafloor north of 64°N, has been considered the authoritative bathymetric portrayal of the Arctic Ocean for over two decades. While this contour map provided a general description of major features of the seabed, evidence was accreting to indicate that many of the smaller and scientifically significant features were poorly or wrongly defined. For example, during the "Arctic Ocean 96" expedition, Swedish icebreaker *Oden* was heading towards the crest of the Lomonosov Ridge, measuring a depth of 607 m where Sheet 5.17 indicated a depth greater than 3000 m. The more recent map published by Naval Research Laboratory (NRL) indicated a depth ranging between 1000 and 1500 m at this location. The discrepancies between published maps and the data collected aboard *Oden* highlighted the need for a complete recompilation of the bathymetry of the *Arctic Ocean 96* survey area (85°20'-87°40'N, 135°-155°E).

The importance of the Arctic Ocean bathymetry lead to the initiation of the "The International Bathymetric Chart of the Arctic Ocean" (IBCAO); a co-operative effort between the International Arctic Scientific Committee (IASC), the International Hydrographic Commission (IHO), and the

Intergovernmental Oceanographic Commission (IOC). The first outcome of the project was a beta version of a digital grid comprising the bathymetry and topography of the entire Arctic region. Despite that IBCAO made use of recently declassified U.S. Submarine data acquired between 1958 and 1988 as well as all the single beam data gathered during the SCICEX submarine cruises, the data base is remarkably sparse over vast areas of the Arctic Ocean. Given the sparseness of existing data is very likely that will be many more examples of bathymetric changes on the order of that needed for the Lomonosov Ridge.

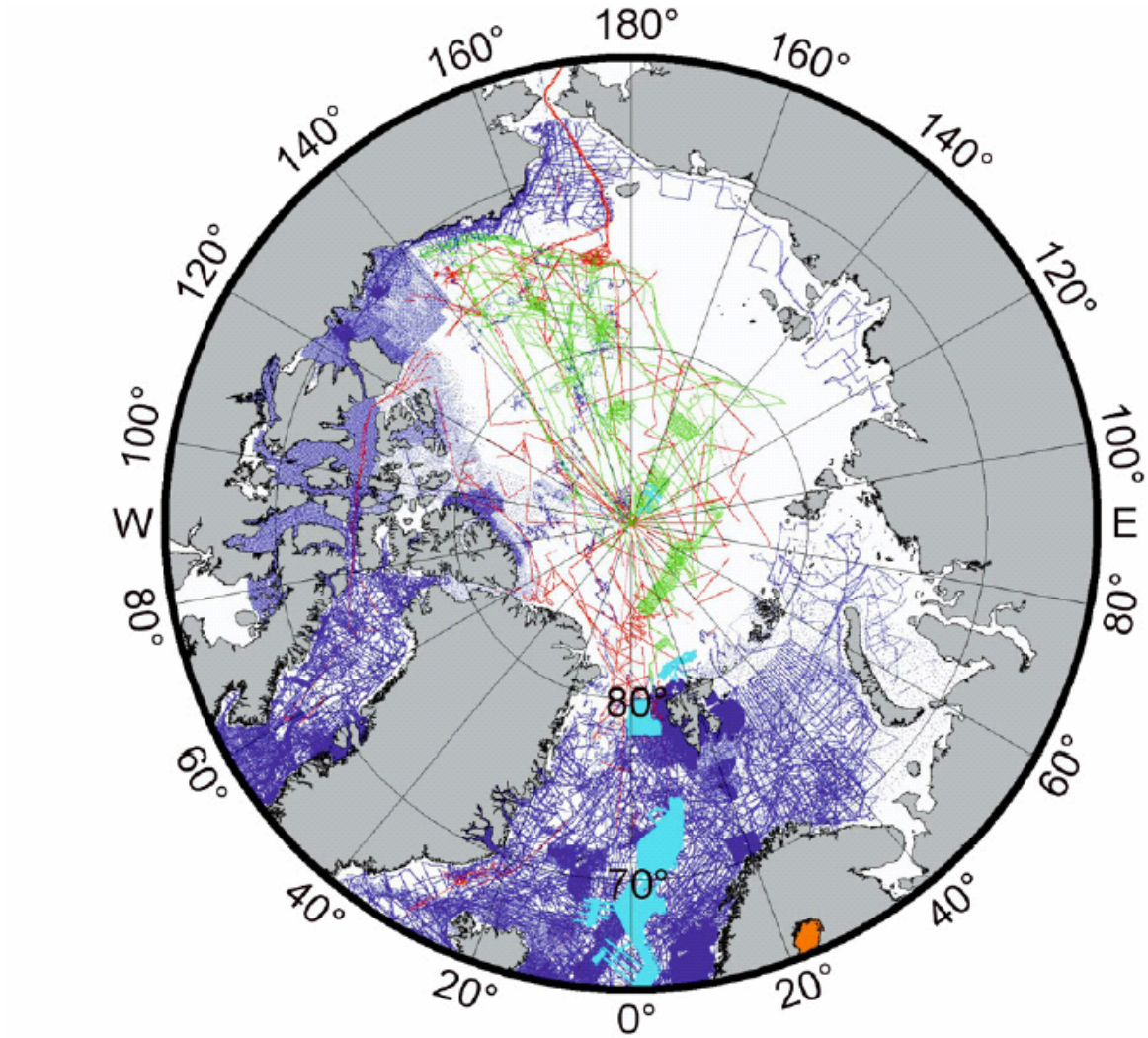

Figure 1. Depth sounding observation distribution for the Arctic Ocean. Red tracks are U.S. and U.K. submarine data; green are SCICEX data; blue are other sources including NGDC. Light blue is a multibeam survey area; orange is a grid model over the Gulf of Bothnia. (Prepared by M. Jakobsson, University of New Hampshire)

While IBCAO is a considerable improvement over previous portrayals of the Arctic Ocean floor, the sparseness of the data base that underlies it is readily apparent from data distribution maps. Figure 1 portrays the distribution of all bathymetric data, except for digitised contours from compilation maps, used for the IBCAO compilation.. Note that in the southernmost areas of Baffin Bay and the Norwegian Sea (areas which are ice-free) the data density is so great that there are essentially no data gaps (at the resolution of this figure). Conversely, in the regions nearer the North Pole, there are only sparsely scattered track lines from U.S. and British submarine cruises, and a few icebreaker tracks; and some discrete spot sounding which were obtained by coring

through ice. In vast regions of the East Siberian Sea, and the Canada and Makarov Basins, there are no observations at all.

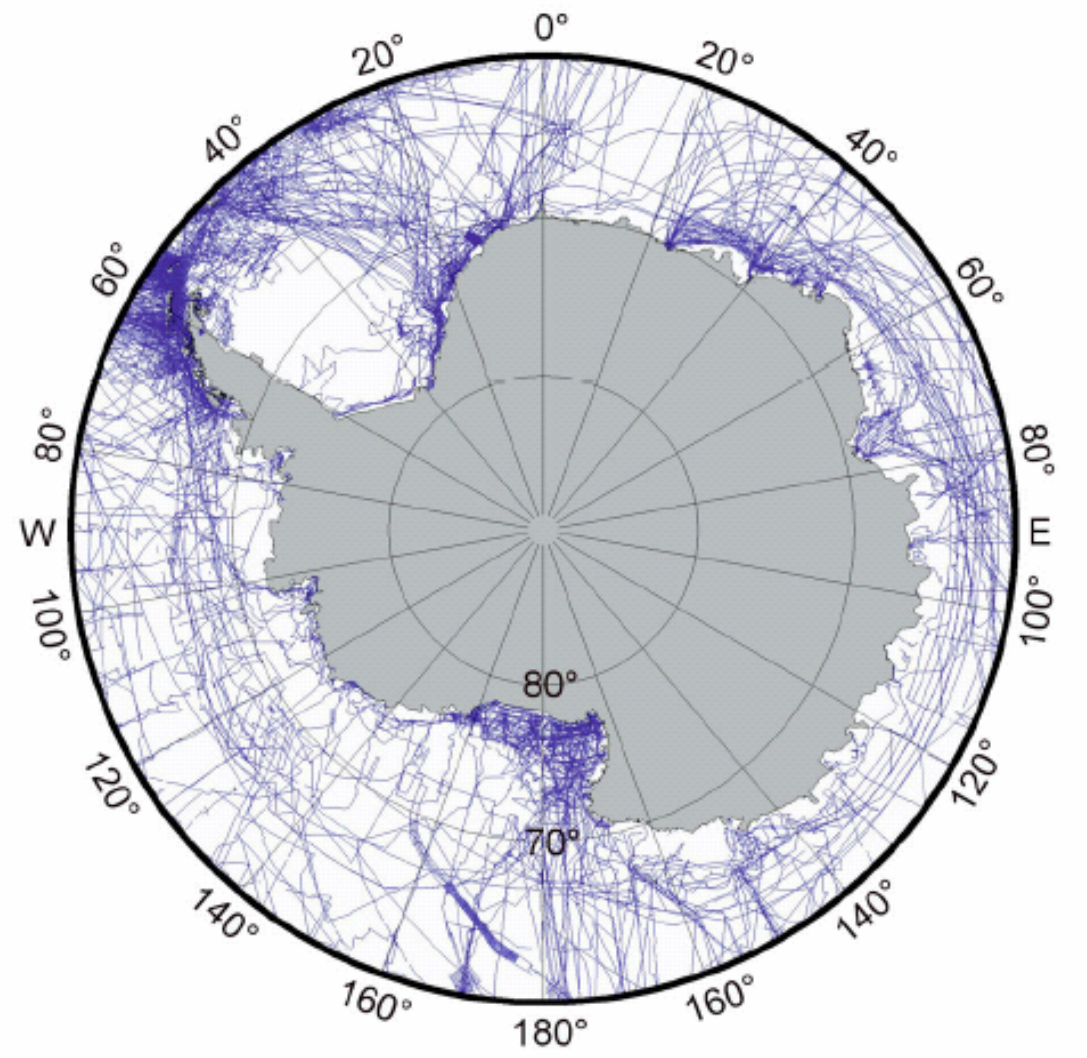

Fig. 2. Depth sounding observation distribution for the Southern Ocean, based upon NGDC holdings (prepared by M. Jakobsson, University of New Hampshire)

And while the dedicated submarine SCICEX cruises in the 1990's added significant new bathymetry data to IBCAO, the Navy representatives at the SCICEX 2000 Workshop painted a bleak picture for further SCICEX cruise opportunities in the foreseeable future [SCICEX 2000 Workshop Report, 1999]. The SSPARR system will provides a means for improving upon the bathymetric coverage depicted in Figure 1, without reliance on costly dedicated ship time.

In the Antarctic, the situation is similar. Figure 2 shows the track lines of existing sounding records for the Southern Ocean, held by NGDC.. Smith and Sandwell [1997] provided predicted bathymetry from satellite altimetry in this area, however the altimeter-derived maps should only be used as a guide to bathymetry; actual soundings are needed in order to correctly interpret the predicted bathymetry, and to portray features at scales smaller than 25 km [SCOR Working Group, 2001; W.H. Smith, personal communication]. In the presently available bathymetry data base for the Southern Ocean, and along the southern margins of the Pacific, Atlantic, and Indian oceans there are gaps as great as 500 km between sounding lines.

Of course, the reason for the sparseness of depth sounding observations in the polar regions is that ships seldom visit the areas; areas where there are no sounding observations have likely never been visited by ships. In the Arctic Ocean, permanent sea ice cover precludes operations by ships other than submarines or icebreakers. In the Southern Ocean, most depth sounding observations have been made from ships transiting to Antarctic to re-supply science stations; few bathymetry surveys have been conducted. Sea ice inhibits ship operations in the Southern Ocean as well, from permanent ice covering the Ross Sea and Weddell Sea to seasonal ice further to the north. We propose to fill in the bathymetry data gaps in both polar regions by the development and deployment of unmanned, drifting depth sounders with satellite telemetry.

The proposed Seafloor Sounding in Polar and Remote Regions (SSPARR) system will comprise a network of expendable drifting buoys (the SSPARR buoys) and a shore infrastructure which monitors the position and controls the functions of the buoys, archives the depth sounding information, makes the sounding data freely available over the Internet, and regularly transfers sounding data to public domain data bases such as the National Geophysical Data Center, the International Bathymetric Chart of the Arctic Ocean, the International Bathymetric Chart of the Southern Ocean, and the General Bathymetric Chart of the Ocean.

We plan the development of the SSPARR system in three phases: In 2004, we will develop prototypes of the instruments the SSPARR buoy will comprise; validate by laboratory and sea testing the required sonar parameters, power consumption, and robustness of the satellite communication modem. Simultaneously, we will develop communication protocols and assemble a prototype land site for communication with the prototype buoy. For 2005, we expect to propose in-house production of a number of engineering development models (EDM's, physically and functionally equivalent to commercially produced devices) of the SSPARR buoys, simultaneously developing specifications adequate for later procurement of buoys commercially. These EDM's will be fully functioning buoys, which we will deploy in ocean areas that have already been well surveyed, in order to compare SSPARR-derived depth soundings with "ground truth". We will further develop the shore site from which the buoy network will be controlled and polled for position and depth sounding data. For 2006, we plan to evaluate the producibility of the SSPARR buoys commercially, by contracting with one or two manufacturers for buoys, using the specification developed in the prior year.

During the development of SSPARR, we will pursue options for long-term funding for procurement, deployment, and monitoring of SSPARR buoys, and for the establishment of a permanent site for the shore facility. We anticipate that there will be a requirement for dedicated SSPARR buoys for use in specific surveys, however we also anticipate incorporation of the SSPARR depth sounder design into existing buoys, leveraging on existing infrastructure for buoy deployment and monitoring. There are existing buoys programs for both the Arctic and the Antarctic, but no buoys presently incorporate depth sounding. We have had promising dialog with personnel in NOAA about SSPARR as a part of the NOAA Ocean Exploration project. Additional discussions have been held with the Data Buoy Co-operation Panel of the WMO and IOC, who have invited our participation in their activities, should the SSPARR project come to fruition. We are also in contact with scientists at the British Antarctic Survey, who have a long history of buoy deployments in the Southern Ocean and who have agreed to provide us recommendations and/or assistance.

In addition to acquiring depth soundings autonomously, it is envisioned that the buoys developed under this project may be usable as precision aids to navigation to vehicles operating submerged, by transmitting timing signals and their own GPS positions via acoustic modems to the submerged vehicles. This function could support, for example, surveys conducted by unmanned underwater vehicles beneath the sea ice. (Some areas, such as the Lincoln Sea in the Arctic, or the Ross Sea in the Antarctic, are not amenable to survey by drifting buoys because of heavy, stationary ice cover; the auxiliary function of SSPARR buoys as precision navigation aids will

provide accurate positioning, not currently available, to vehicles surveying beneath the ice in such regions.

System Description

Please note that in the following discussions we describe the dedicated SSPARR buoys concept. In the event that the SSPARR sounder is incorporated into an existing buoy design, we would expect that the satellite telemetry and navigation functions already exist, and therefore only the depth sounder and associated functions would be added.

SSPARR BUOYS:
Each SSPARR buoy will incorporate a single-beam depth sounder capable of reliably measuring ocean depths up to 5000 meters (with slightly degraded performance in deeper water); a GPS receiver for geographic position determination; and a bi-directional satellite communication link for telemetering the data to a shore site and for receiving commands from the shore site. A buoy control processor will receive and implement commands from the shore site; sample and archive GPS position data; initiate the depth sounding function and archive resultant data; monitor status of various buoy sensors (power monitor, leak detector, etc); and respond to polling requests from the shore site by telemetering requested data. The buoy will be battery powered, with sufficient power to operate for several years (although in the harsh polar environments damage from sea ice may shorten the buoy lifetime). The intention is to position the battery and electronics in the buoy so that they are below water level, in order that their temperature is kept relatively warm for efficient battery function, and acceptable operating temperatures for the electronics.

The operating frequency of the SSPARR depth sounder will be in the region of 8 to 15 kHz. Operation at higher frequencies would result in higher source levels, and consequent better performance in shallow water; however, the absorption of sound in seawater at higher frequencies would preclude acquisition of soundings in deep water. Operation at frequencies near the 12 kHz frequency typical of depth sounders will provide the desired capability in deep water, and should be suitable for sounding in water as shallow as tens of meters. We are also somewhat influenced by the availability of transducers that have been developed for other expendable active sonar systems, such as sonobuoys. There are a number of active sonobuoys which operate in the 8 to 15 kHz range of frequencies, which assures us a supply of affordable transducers, without the non-recurring engineering expense normally associated with development of a new transducer. (In fact, in preparation for this proposal, we have already procured transducers, at the single-unit cost of under $500, to assure ourselves that we can obtain suitable transducers at an affordable cost.)

The source level of the SSPARR sounder will be cavitation limited, and is expected to be from 194 to 200 dB relative to 1 micro Pascal at 1 meter. The transducer will be a ceramic cylinder with an essentially hemispheric directivity pattern with a directivity index of 3 dB; so the expected source levels correspond to transmitted acoustic power of around 100 to 400 watts. While this seems to be a significant amount of power for a device which is to be battery-operated, it must be kept in mind that the duty cycle of the SSPARR buoy depth sounder will be extremely low, and hence the energy consumption from the batteries will be low. If we assume that a reliable estimate of depth might require as many as ten transmissions, and that a typical ocean current might dictate a requirement to obtain four depth estimates per day, we estimate that a sonar transmitter (50% efficient) will consume about 32 watt-hours of energy per year. To put this into perspective, a common alkaline D-cell battery, at low discharge rates, provides between 10 and 15 watt-hours of energy. So the depth sounder function of the SSPARR buoy may be expected to use the energy of three or four D-cells, per year of operation.

The beam pattern of the SSPARR projector will be very broad, nearly omnidirectional in the downward direction. If we use the same transducer for sound reception, the sounder will be susceptible to detection of first returns from directions other than nadir (in areas of significant

slope or large features on the seafloor.) We will therefore investigate the feasibility of incorporating a larger, more directive hydrophone in order to reduce the acoustic footprint of the sounder.

One of the greatest technical challenges to the development of the SSPARR buoy will be the automatic detection of the first echo from the seafloor, without a human operator in the loop. Some single beam depth sounders in common use employ several kilowatts of transmitted power, and display echoes graphically for human interpretation. We will have neither the luxury of high power transmission, nor a human to interpret the echoes. We cannot transmit kilowatts of power because of the cavitation limit and the size of our transducer. However, the self-noise of a buoy-borne sonar instrument will be considerably lower than a ship-borne instrument. We expect our principal noise source to be the ambient noise level of the ocean. In a typical deep-water environment of 5000 meters water depth, and assuming a simple band pass filter/envelope detection receiver, we expect a received signal to noise level of about 20 dB, which should be adequate for automatic detection of the first echo from the seafloor. However, identification of this first echo could be complicated by echoes from other objects (seamounts, rocks, etc.) in the vicinity, or by heavy seas, which could disorient the buoy. Testing of a prototype sounder during the first phase of this development will validate whether the echo level is sufficient for automatic detection in deep water. If necessary, the sounder design will be modified to incorporate a matched filter to enhance the echo level, perhaps the Echo-Echo Correlation method developed by Dale Green when he was with Scripps [Green, 1980]. (In some active sonar applications, such as submarine detection, addition of matched filtering is complicated by the presence of target Doppler shift. In the case of seafloor detection, there is no target Doppler and so the matched filter only has to compensate, if necessary, for vertical motion of the sounder itself.) We anticipate difficulty in single-ping detection and identification of the first return from the seafloor, and so plan to develop a robust multi-ping scheme for bottom identification.

For the GPS navigation and satellite communications functions of the SSPARR buoy, a number of off-the-shelf solutions are available. Communication modems are currently available for Iridium, Orbcomm, and Service Argos. Within the next few years, other options are likely to become available. GPS receiver technology has progressed to the point where there are GPS receivers incorporated into some cellular telephones (a certainty to drive the price down). There are, at present, commercially available products that already integrate a GPS receiver and a satellite communication modem. During the engineering development of the SSPARR buoy, we will select, on the bases of cost and capability, the most appropriate device for our application.

To keep engineering development costs to a minimum, we plan to utilise proven sonar components that have already been developed and tested for other applications (DSL-120, IMI-12, IMI-30) in our depth sounder design. Designs are available for both the transmitter (signal generator, power amplifier, power supply) and receiver (monolithic preamplifiers, digitizers, DSP code). Adapting these designs for use in SSPARR is considered low risk.

We are aware of other programs that deploy drifting buoys in the Southern Ocean and the Arctic. A reasonable long-term strategy for deployment and operation of the SSPARR sounder might be its incorporation as another instrument into these existing buoys. During SSPARR development, we will establish liaison with, for example, the International Arctic Buoy Program and the International Program for Antarctic Buoys, to investigate how SSPARR sounders might be incorporated into these buoys.

In a stand-alone configuration, the physical form of the SSPARR buoy will be an elongated cylinder (mostly submerged), to provide a measure of stability in ocean currents and waves [Severance, 1972]. In ice-free ocean areas, the buoy will be manually deployable over the side of a ship. We will also investigate the feasibility of air deployment, for example out of a helicopter

or Hercules aircraft. Buoys will be strategically placed in areas of predictable ocean currents so as to obtain wide area coverage.

We anticipate that the buoys will be stored without the battery power supply. The batteries will be installed, and the initial operating mode selected, at the time of deployment. The buoy will not initiate communication with the shore site, but will instead respond to data requests or mode commands from the shore site. Mode commands may include modification of sonar parameters such as transmitted pulse length, waveform, and receiver filter characteristics; specification of sampling methodology (periodic in time or space); invocation of the navigation aid function; and, depending on circumstances, orders to self-scuttle. Data transfers, initiated by polling from the shore site, will include GPS position history for determination of ocean currents; depth soundings; buoy health indicators (power supply status, leak detectors); and outputs of other sensors, which might be incorporated into the SSPARR, buoys. We plan on establishment of the communication link by the shore site. While the details of the communication protocol have not yet been established, in general we will plan for the communication to employ measures such as packet transmission to ensure reliability of data; and encryption to provide security against malicious tampering.

When employed as aids to navigation, the SSPARR buoy will change its function from a depth sounder to a beacon which transmits timing pulses and GPS positions to submerged vehicles. The GPS receiver on the buoy will derive latitude, longitude, and precise time from the GPS satellite constellation. Timing pulses may be transmitted into the water synchronously (on a prearranged schedule) or asynchronously. In either event, the telemetry following the timing signal will include geographic position as well as time of transmission. The underwater vehicle will record the acoustic signals transmitted by SSPARR for accurate track reconstruction.

Testing of prototype system components during the first year of SSPARR development is planned in laboratory facilities, and in near-shore areas on ships of opportunity. No ship time is therefore requested for this development phase. For laboratory testing, we will have available the JACOE test facility at UNH. The JACOE engineering tank is a deep-water testing basin. The 60 x 40 x 20 foot tank is used for a variety of experiments where simulating unobstructed, open water environments, is required. A newly developed X-Y platform allows precise positioning of large equipment anywhere in the tank and a new rotary table allows computer-controlled rotation of transducers or other devices with a resolution of .01 degree. Calibrated hydrophones and software are available tank-side are for systematic transducer calibration. For testing and acquisition of bottom sounding data at sea in deep water areas, we plan using ships of opportunity in areas near Hawaii, where access to deep water is within a few hours of shore.

BUOY DEPLOYMENT STRATEGIES

The environments being targeted for data acquisition by the SSPARR system are the polar regions – the Southern Ocean, the Arctic Ocean, and other peripheral seas in which present data bases have sparse bathymetric coverage. Fortunately, the ocean surface currents in these regions are well known. By utilising predicted currents, strategic emplacement of buoys can achieve a reasonable sampling of an ocean area. Existing buoy programs, such as the International Program for Antarctic Buoys, routinely deploy large numbers of GPS and satellite telemetry-equipped buoys for monitoring ocean currents. Such buoys would be ideal candidates for incorporation of the SSPARR depth sounder, and acquiring depth soundings over large areas. Deployment of dedicated SSPARR buoys could accomplish higher density sampling of seafloor depths in specific areas.

In the Southern Ocean the prevailing currents are circumpolar (east to west near shore; west to east further north, with gyres between). Figure 3 provides a map of typical buoy drift tracks, circum-Antarctic, from buoys deployed 1995-2000 by the International Program for Antarctic Buoys.

If a ship transiting to an Antarctic station were to deploy buoys along its track, the network of buoys would tend to drift orthogonal to the ship's track and thereby obtain soundings over a predictable area. We would plan for deployment of SSPARR buoys from icebreakers (U.S. or other nations') transiting the Southern Ocean. In addition, we have been assured by Robin Falconer of the New Zealand Institute for Geological and Nuclear Sciences that he can arrange for buoy deployment from ships of the New Zealand fishing fleet, at no cost (bathymetry data from the Southern Ocean is very important to the New Zealand fishing fleet, and they would be willing to deploy the buoys in exchange for receiving the data later.)

In ice-covered seas, a buoy may be deployed by implanting it in an ice floe. Within the Arctic Ocean itself, buoys may be strategically deployed to selectively sample the basin via the trans-polar drift stream or the Beaufort Gyre (for example). As in the Southern Ocean, icebreakers operating in the region might deploy buoys. In addition, the U.S. Navy has a long history of providing the service of implanting arctic buoys for other agencies, at no cost, from submarines, which periodically operate beneath the ice. The Arctic Submarine Laboratory could be provided with a number of buoys, and a prioritised list of deployment sites. For security reasons they cannot tell us in advance, specifically, when and where they are deploying a buoy. However, after the fact we would be advised of the buoy deployment, at which point communication with the buoy could be established and data acquisition initiated.

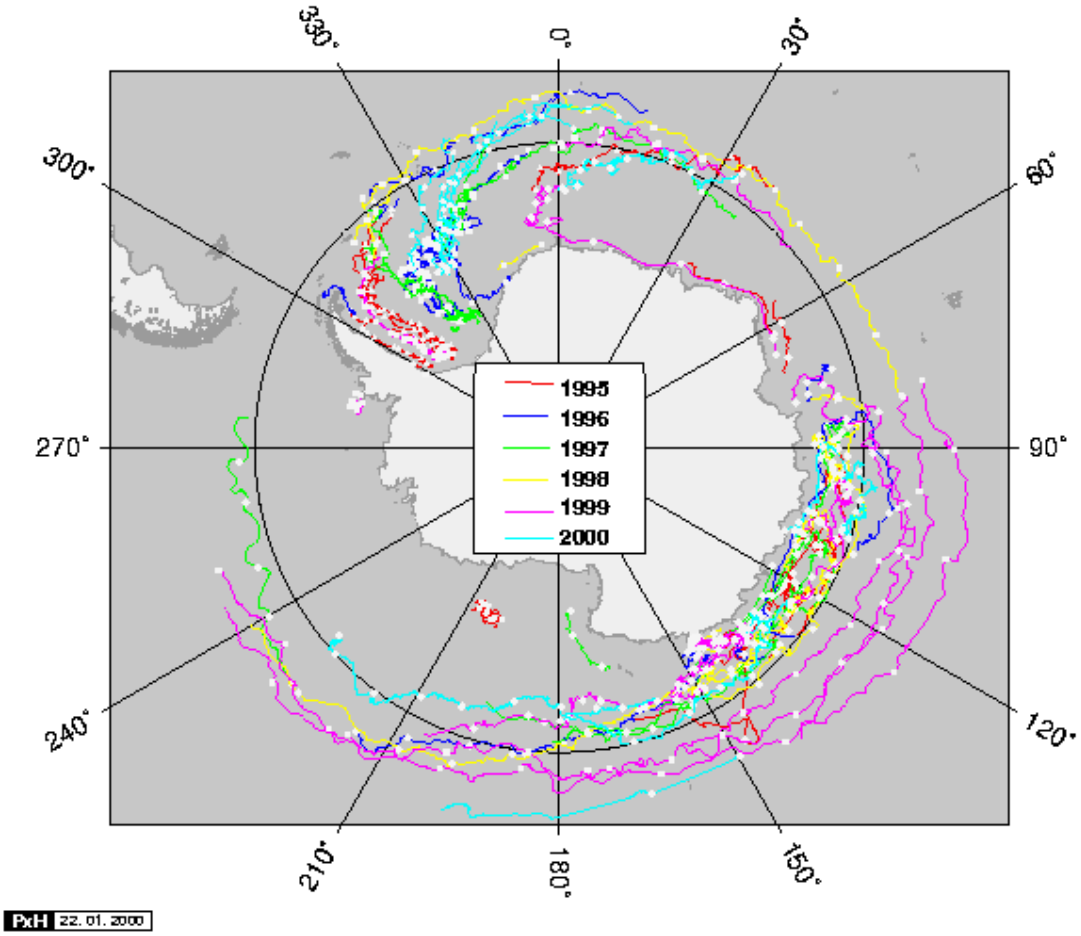

Figure 3. Typical Antarctic buoy tracks, 1995-2000. From the International Program for Antarctic Buoys, posted to the University of Tasmania web site at: *http://www.antcrc.utas.edu.au/antcrc/special/buoys/buoys.html*

Because the SSPARR buoy will contain a GPS receiver, it may be programmed to achieve a fixed spatial sampling density by sampling at a rate proportional to its drift velocity. Alternatively, it could be programmed to sample at a fixed rate temporally, in which case the spatial sampling density would be inversely proportional to the drift velocity. The bi-directional satellite link will enable downloading of firmware to the buoy control processor, by which means the functional control of the buoy can be selected, or various sonar parameters changed to optimise data quality according to the environment. The navigation aid function will also be selectable by the satellite communication link.

We envision a buoy lifetime of three years, after which time the buoy will self-scuttle by galvanic action. Consideration will be given to including the capability to scuttle upon command. The commanded scuttle feature would be used to save satellite communication costs, in the event that a buoy's sounder system fails; or to disable a buoy in the even that it drifts into an area in which bathymetric data collection is unneeded or inappropriate.

The first step in the development of the SSPARR buoy, which is the subject of this proposal, is assessment and demonstration of the technology: a low power depth sounder capable of reliably and autonomously determining seafloor depth in up to 5000 meter depths, integrated with a combined data acquisition, navigation, control, and telemetry system. Initial development of components of the shore site, including communication protocols, will also be accomplished in the first stage of SSPARR development.

Proposed Work

Objectives

The overarching goal of the SSPARR project is to develop a network of drifting buoys to acquire bathymetric observations in ocean areas seldom or never visited by ships; specifically, the Southern Ocean, the Arctic Ocean, and circumpolar peripheral seas. Specific goals of the initial phase of development of SSPARR, proposed to be accomplished during the first year, are:

1. To evaluate available technologies for the various components of the SSPARR system.
2. Demonstrate the viability of the SSPARR system concept through development and testing of prototype sounder, control system, and telemetry.
3. Establish design parameters for a SSPARR buoy including sonar parameters, power supply, control system, telemetry, antenna design, and physical configuration.
4. Establish functional characteristics necessary for the SSPARR buoy to be used as an aid to navigation, including timing and telemetry protocols and estimates of usable range.

Methodology

1. Perform parametric studies to select optimum power and frequency of operation for the SSPARR depth sounder, consistent with the size and battery capacity limitations. (HMRG lead, others contribute)
2. Conduct modeling studies to evaluate the effect on bathymetric resolution of using omnidirectional source and receiver, utilising archived bathymetric data bases. (CCOM).
3. Evaluate and adapt existing sonar transmitter and receiver designs (from IMI-30, IMI-12, and DSL-120) for use in the SSPARR sounder. (HMRG)
4. Evaluate existing acoustic telemetry systems for adaptation to the SSPARR sounder navigation aid function. Identify requirements for reception of telemetry by underwater vehicles using the SSPARR navigation aid function. (LDEO)
5. Devise a candidate algorithm, which will automatically detect the first echo from the seafloor, in water depths from 100 meters to 5000 meters or more, and with variable bottom reflectivity. (HMRG lead, others contribute).

6. Conduct a market survey of available GPS receivers and portable satellite telemetry transmitters suitable for incorporation into an expendable buoy, conduct trade off of acquisition and operational costs to select suitable devices. (LDEO)
7. Establish communication protocols for data and control signals between the SSPARR sounder and the control subsystem. Assemble and test communication between a prototype shore communication facility and the SSPARR telemetry system. (LDEO).
8. Select suitable off-the-shelf controller for incorporation into the SSPARR buoy, and develop controller firmware to accomplish tasks of depth sounder control, navigation, data acquisition and archiving, and telemetry. (LDEO lead, HMRG contribute)
9. Construct a prototype SSPARR sounder and control system, and integrate into a configuration suitable for field-testing in the laboratory and aboard ship. (All)
10. Conduct tests of SSPARR sounder at UNH's JACOE facility (CCOM lead, others contribute)
11. Test SSPARR system components aboard ships of opportunity in ocean areas near Hawaii. Evaluate capability to automatically detect first returns from seafloor in a variety of water depths, and modify designs as necessary to achieve required performance. (HMRG lead, others contribute)
12. Develop algorithms and protocols for incorporation of incoming buoy sounding data into regional bathymetric compilations IBCAO and IBCSO. (CCOM)

Cost Sharing

Cost sharing from a number of different sources will support the technology demonstration of SSPARR proposed herein:

John Hall of the Geological Survey of Israel has donated funding to support the early acquisition of suitable electroacoustic transducers to be used in development of prototype hardware for the SSPARR technology demonstration. Existing, tested sonar electronics (power amplifiers, receivers and signal processors) developed under prior research projects (CEROS Synthetic Aperture Sonar, DSL-120 Sonar, IMI-30 Sonar) will be utilised as appropriate in the prototype system.

Deliverables

A comprehensive summary report will be provided, which includes the engineering design details of the prototype SSPARR buoy, test results, and recommendations for a follow-on program for development and deployment of buoys suitable for sea deployment in remote ocean areas.

Personnel Responsibilities

Robert Anderson, acoustician with HMRG, has extensive experience in development of sonar systems for arctic applications. While with the Navy's Arctic Submarine Laboratory, he was involved with development of and improvements to the Digital Ice Profiler System (DIPS), which automatically detects ice canopy echoes. Anderson will have responsibility for overall system design of the SSPARR buoy, for parametric sonar design studies, and for co-ordination of the work of other team members. He will work with Rognstad to apply technology developed on prior NSF projects to the SSPARR sounder, and will be the principal liaison with collaborators from LDEO. He will have primary responsibility for producing the summary report of the project, and presenting the results at appropriate meetings.

Mark Rognstad has extensive experience in all prior engineering developments at HMRG, and will apply proven hardware and signal processing elements from such prior NSF-sponsored developments as the IMI-30 sonar and DSL-120 upgrade to the design of the SSPARR sounder.

Dale Chayes of LDEO has extensive recent experience in development of data acquisition, control and telemetry systems. Chayes will have responsibility for the system control and telemetry portions of the buoy, which will include data archiving capability, a GPS receiver, and overall control system firmware.

Larry Mayer is Director of UNH's Center for Coastal and Ocean Mapping. He has many years of experience with a range of seafloor mapping problems including the development of algorithms for robust bottom detection and the early development of chirp sonars for sub-bottom profiling applications. He will provide the facilities for sonar calibration and work with all P.I.'s on pre-design modeling and post-deployment interpretation.

Martin Jakobsson has been the principle researcher responsible for the compilation and production of the new IBCAO maps of Arctic bathymetry. He is an expert on data base structures, data manipulation and visualisation and will be responsible for the verification of the data and its integration into appropriate data bases. Martin will also work on pre-design modeling of sonar performance.

Anticipated Benefits

This project will demonstrate the feasibility and operational characteristics of a buoy that will provide mapping capability in remote regions. It is anticipated that following this first phase, of technology demonstration, Engineering Development Models (EDM's) of deployable buoys will be developed in-house and tested extensively to validate all aspects of the SSPARR concept – extended autonomous operation, accurate depth sounding, correct control system operation, and telemetry. The final stage of system development will be the procurement from commercial sources, and testing in actual polar environments, of SSPARR buoys; during this final stage the operating procedures for a shore facility will be refined, and membership established with the Data Buoy Co-operation Panel of IOC. The concept of a network of SSPARR buoys, deployed in the Arctic and Antarctic, has been discussed with the High Latitude Program manager at ONR, who has indicated in interest in sponsoring a DURIP project to fabricate a large quantity of these buoys, once the full capability has been demonstrated. Interest has also been expressed by NOAA personnel in SSPARR as a possible component of the Ocean Exploration Program. It is envisioned that the SSPARR buoy may ultimately become a component of a larger ocean-observing program such as NOAA OE, leveraging the infrastructure and intergovernmental agreements, which have already been established to govern deployment of ocean observing systems.

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ANNEX 11

US Nuclear Submarine-Collected Under-Ice Bathymetry (1985-1992)

by Norman Z. Cherkis, Marine Geologist, Five Oceans Consultants (fiveoceanscon@yahoo.com)

The enclosed 12 bathymetry files were declassified and released by the United States Navy, Deep-Submergence Division. The data were collected on US Navy nuclear submarines between 1985 and 1992.They were processed and databased at the National Geospatial-Intelligence Agency (NGA-formerly the National Imagery and Mapping Agency [NIMA]).

All information identifying the collecting vessels has been removed. **The individual trackline data do not show times or dates, however, the positions are themselves, sequential for each individual dataset.** There are breaks in the data, indicating that no soundings were collected (during non-science, i.e., operational periods). All of the data are within the deep Arctic basin, not less than 200 nm from the shores of any national state other than the United States of America.

The data were recorded during ICEX programs. They were collected by hull-mounted, single-beam echo-sounders at various intervals, calibrated to 800 FATHOMS (4800 FEET) per second and converted by to a metric equivalent with a nominal sound speed of.1500 METERS per second. However, the supplied data **HAVE NOT BEEN CORRECTED FOR THE SPEED OF SOUND IN SEAWATER,** i.e., by Carter's Tables or any other algorithm.

Navigation was by inertial navigation, periodically updated by Transit satellite and Global Positioning System (GPS) transmissions when available.

The data are listed in three columns:

Latitude, Longitude, Depth.

Latitudes and longitudes are given in degrees and decimal degrees. Depths are given in meters and tenths of meters.

DISCLAIMER: Attempts were made to eliminate spurious data points within the data sets, however this effort was by visual examination and therefore the data sets may contain some missed erroneous points. The user is therefore advised to use *some caution* when combining the data with other datasets.

If further information regarding the data is sought, the user is asked to contact the author.

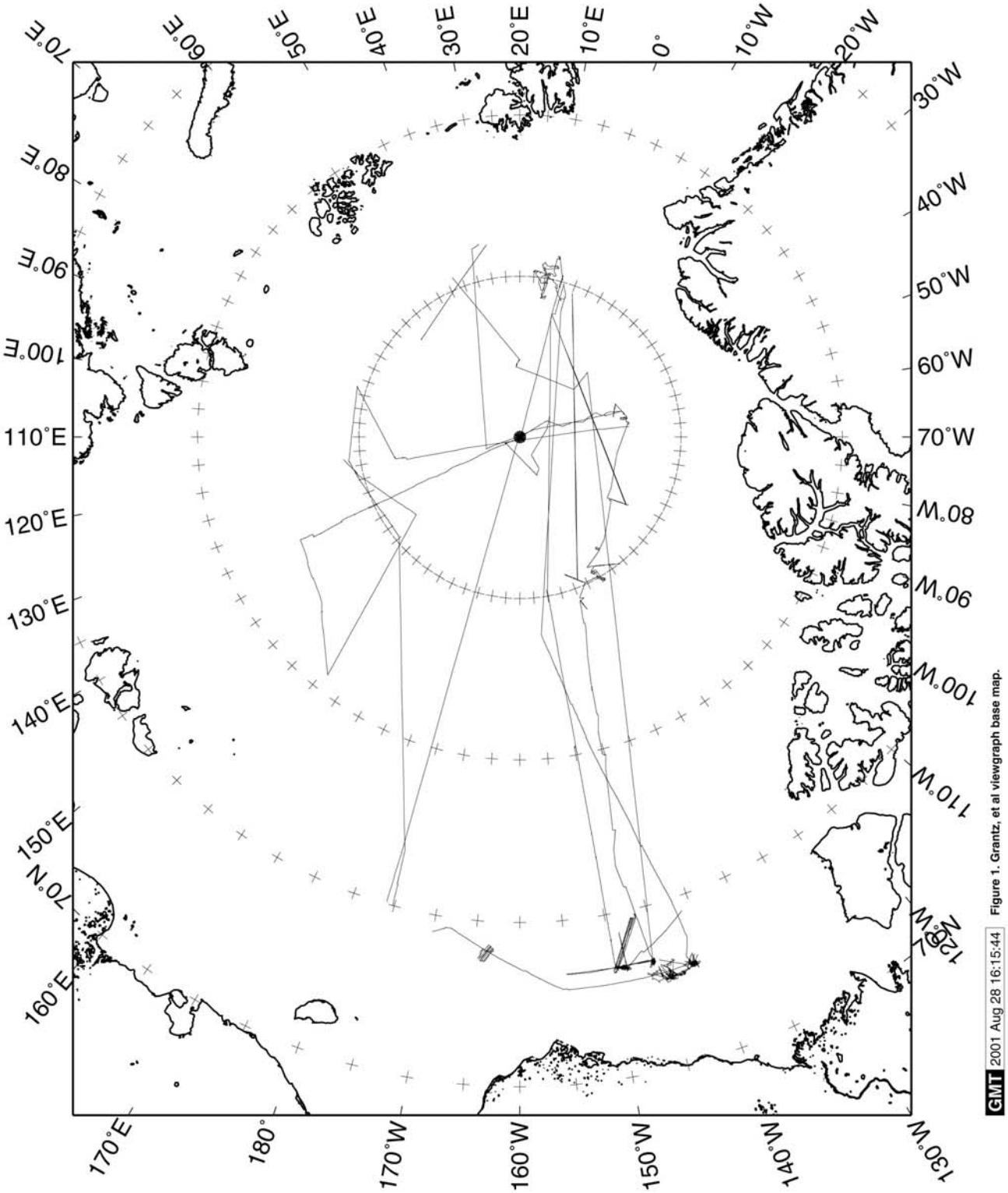


Figure 1. Grantz, et al viewgraph base map.

ANNEX 12

REINVENTING GEBCO:
A PROPOSED MANIFESTO FOR THE TWENTY-FIRST CENTURY

A discussion paper submitted to the Twentieth Meeting of the GEBCO Guiding Committee

by Ron Macnab, Geological Survey of Canada (Retired)

1 GEBCO's Mission

Before attempting any administrative or technical re-organisation, it is essential to have a clear idea of what a renewed GEBCO can and should do. The following are suggested as key elements in choosing a direction for the future:

1. To construct an accurate and up to date digital model of global bathymetry from original observations.

2. To promote international co-operation and co-ordination in the design and execution of ocean mapping programs.

3. To sanction the naming of undersea features.

2 Current project layouts in the GEBCO and IBC undertakings

GEBCO's traditional chart scheme comprises seventeen sheets, complemented in recent years by nine 'update sheets'. The IBC project scheme consists of eight separate project areas, divided into nearly 130 sheets. Thus we are faced with the necessity of assembling and manipulating information in nearly 160 separate map/project areas, and of managing the overall process so that seamless outputs are generated on time and according to specifications.

There are several disadvantages to this approach:

(a) it is difficult to monitor progress over so many fronts in order to identify problems and to resolve them in a timely fashion;

(b) project areas are divided arbitrarily, fostering the fragmentation of data sets that should otherwise remain intact;

(c) there is a significant cost in production and communication overhead, given the necessity of matching the contents of adjoining sheets, and of sharing information among numerous project teams;

(d) there is a strong potential for duplication of effort when work is pursued independently in overlapping areas;

(e) there are prospects of incompatible products arising from the use of different data sets.

3 A simplified project scheme for building a digital model of global bathymetry

The Ocean is large, but Life is short. To achieve meaningful results within the careers and lifetimes of participants, the job must be broken into manageable segments. It is recommended

that GEBCO define eight Ocean Project areas, each one corresponding to a major oceanic area and its marginal seas:

Arctic Ocean
Indian Ocean
Mediterranean and Black Seas
North Atlantic Ocean
South Atlantic Ocean
North Pacific Ocean
South Pacific Ocean (perhaps further sub-divided into SE and SW components)
Southern (circum-Antarctic) Ocean

A suggested administrative and technical structure that would support this arrangement is illustrated in the Figure.

There are several advantages to this approach:

(a) fewer project areas result in a simpler, leaner management structure;

(b) project areas are naturally and geographically integrated, so major features may be defined with coherent data sets;

(c) reduced production and communication overheads (no edge matching!);

(d) less scope for overlaps and duplication of effort between project areas;

(e) common databases to ensure compatibility of output products;

(f) better value from limited funds?

(g) easier to create and apply uniform specifications.

4 Ocean Projects: what they would do

The Ocean Project for any given area would seek to accomplish the following:

(a) assemble all available acoustic observations in analogue and digital form;

(b) digitise selected analogue observations;

(c) as an interim measure, fill blank areas with information from alternative sources, e.g. altimetry;

(d) combine and rationalise all assembled observations;

(e) preserve the rationalised observations for future re-use and updates

(f) build a seamless grid for the project area;

(g) create standard derivative products, e.g. isobaths and shaded relief images from the grid;

(h) post seamless grid and standard derivative products on the Web for public distribution;

(i) prepare thorough documentation for all data sets and procedures;

(j) (optional) design and prepare more advanced derivative products;

(k) (optional) prepare scientific papers addressing the contents of the grid and derivative products.

5 Ocean Project Working Groups: composition and tasks

Each Ocean Project would be the responsibility of an Ocean Project Working Group (OPWG). It is hardly necessary to state that the leadership and membership of each OPWG would have to consist of competent and well-qualified individuals who had the required enthusiasm and willingness to commit to their undertaking. OPWGs should be quasi-autonomous bodies with the freedom to establish their own operating procedures, however they would have to agree to certain conditions and specifications in order to qualify for the support and endorsement of IOC/IHO.

Ideally, an OPWG should be based in its project area, and housed in a recognised institution with adequate facilities. To achieve regional buy-in and credibility, it would be essential to draw upon local talent wherever possible, but members from elsewhere should be invited to join in order to capitalise on their specialised skills and knowledge, and to help promote communication with external parties.

6 SCUFN

No change is anticipated in the mandate or the operation of this sub-committee.

7 DCDB

The role of the DCDB would remain essentially unchanged, except for the addition of a new function: to act as a closed archive for the refined data sets that were used to produce grids within each project area. These data sets would be homogenised into one coherent global data base. It is strongly recommended that this archive remain inaccessible to the public, for several reasons:

(a) it may contain proprietary or classified data sets that were contributed to the initiative under a non-disclosure agreement;

(b) representing a significant investment of human, financial, and other resources, its future use should be reserved for GEBCO purposes, e.g. scientific research, updating with new data sets, building custom products, etc;

(c) it prevents misuse of the data base by casual or opportunistic operators, which might reflect badly upon GEBCO.

8 A commentary on synthetic bathymetry derived from observations of satellite altimetry

Pros:

- Near-global coverage
- Reasonably uniform coverage
- Free – collected for other purposes
- Useful for tectonic investigations
- Useful reconnaissance tool for large unmapped features

Cons:

- Wide 8-12 km footprint limits the resolution of seabed features
- Depth accuracy limited to several hundred metres
- Also reflects the effect of sediment layers beneath the seabed
- Creates illusion that global seabed already fully mapped

9 The necessity for revenue generation

Much has been said about the voluntary nature of GEBCO, however this approach has drawbacks because it restricts the participation of individuals who might not have access to the funding necessary for salaries and/or expenses. It also curtails the scope of certain project activities because money is not available to pay for selected services.

Two possible approaches have been suggested for dealing with this situation:

(a) implement a business plan that would permit GEBCO to generate revenue through the sale of value-added products; these products could be sold directly to the public, or indirectly through licensing and partnership arrangements whereby the products were embedded in selected commercial packages;

(b) approach funding organisations that might be prepared to support GEBCO's objectives through the outright provision of operating grants.

10 An expanded role for GEBCO

GEBCO could do other things in addition to producing a model of global bathymetry. Some suggestions:

(a) advocate the furtherance of global ocean mapping, particularly in areas that remain poorly mapped;

(b) persuade major data holders to contribute the contents of their archives to centralised data centres;

(c) monitor the state of ocean mapping world-wide;

(d) support the development of advanced techniques for manipulating and visualising bathymetry;

(e) devise innovative means of disseminating bathymetric information.

Appendix: Proposed GEBCO-IBC Re-Organization

The accompanying figure illustrates an organisational structure that would support a fully-integrated IBC/GEBCO operation. It would consist of several elements:

(a) a Directing Committee that combined the functions of the IBC Consulting Group for Ocean Mapping (CGOM) and the GEBCO Guiding Committee. The DC would report to IOC and IHO through an Executive Committee that included a Chairman, a Vice-Chairman, and a Permanent Secretary;

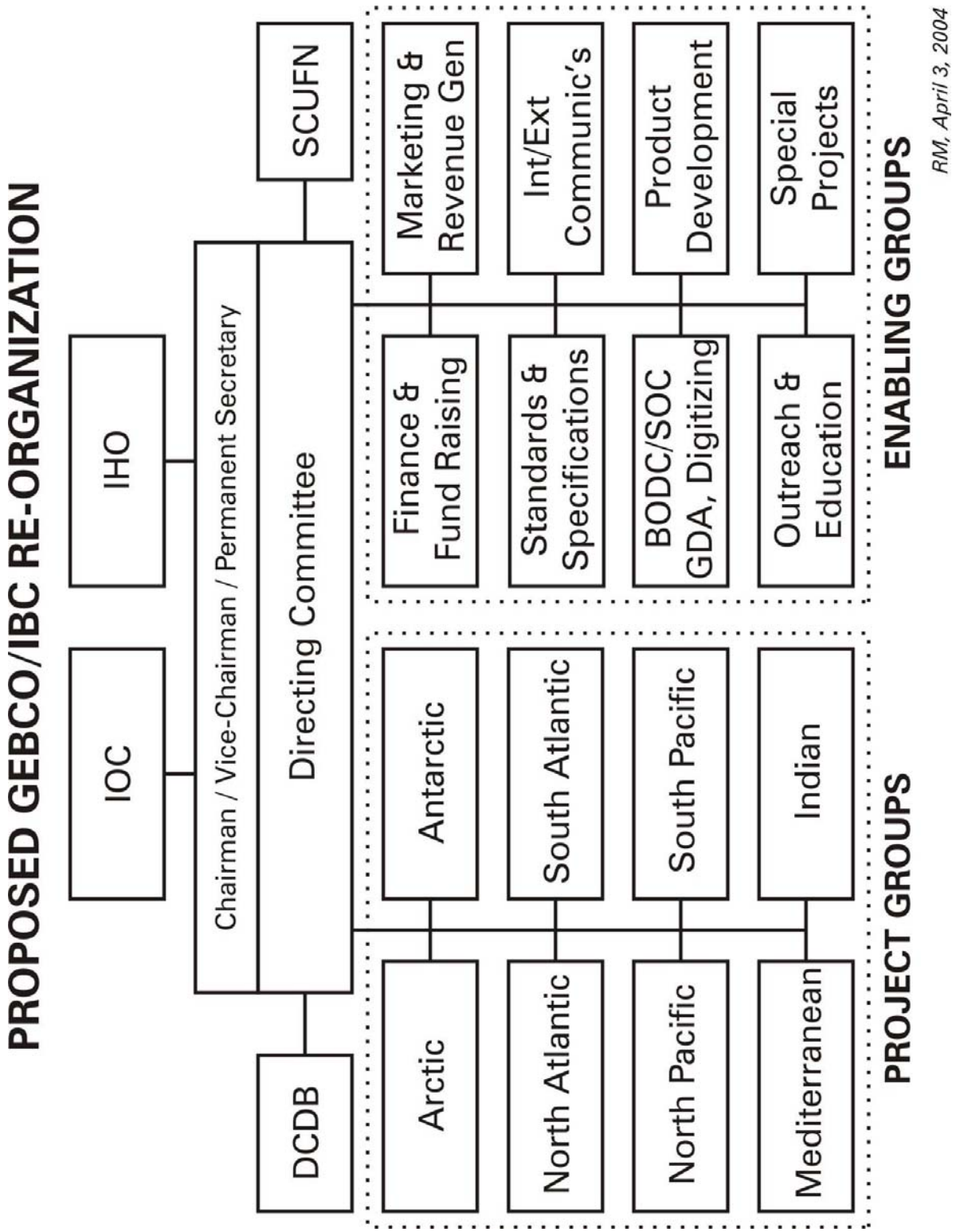
(b) the DCDB, whose function would remain largely unchanged;

(c) SCUFN, whose function would remain largely unchanged;

(d) eight Project Groups charged with constructing digital bathymetric models in their assigned areas;

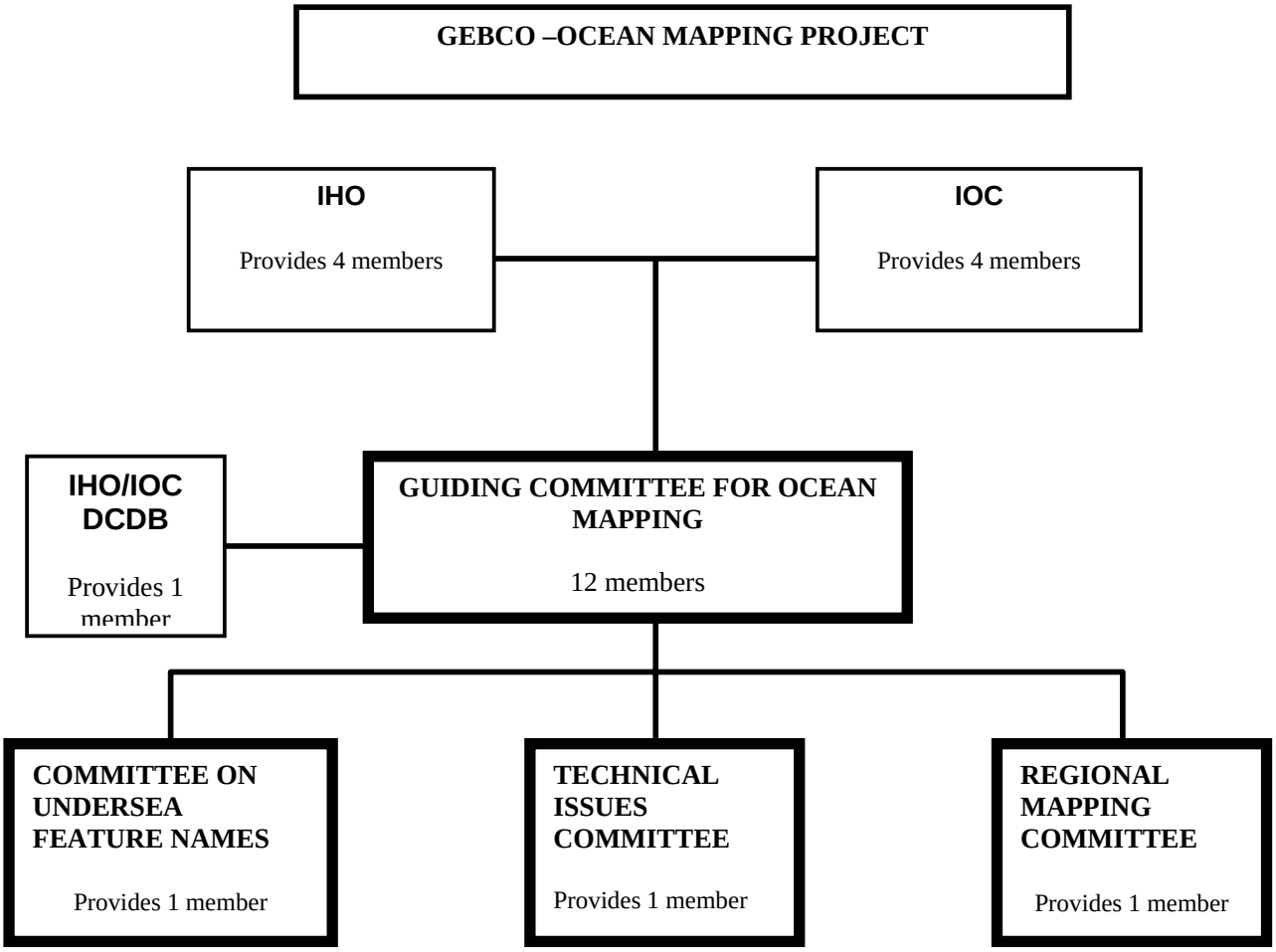
(e) eight or so Enabling Groups that provided the necessary technical and administrative infrastructure for the Project Groups.

Membership in the DC would include representatives of IOC and IHO, the heads of DCDB and SCUFN, the heads of the Project and Enabling Groups, and others invited to join as appropriate.


PROPOSED GEBCO/IBC RE-ORGANIZATION
IOC
IHO
Chairman / Vice-Chairman / Permanent Secretary
Directing Committee
SCUFN
DCDB
Arctic
North Atlantic
North Pacific
Mediterranean
Antarctic
South Atlantic
South Pacific
Indian
PROJECT GROUPS
Finance & Fund Raising
Marketing & Revenue Gen
Standards & Specifications
Int/Ext Communic's
BODC/SOC GDA, Digitizing
Product Development
Outreach & Education
Special Projects
ENABLING GROUPS
RM, April 3, 2004

ANNEX 13

NEW OCEAN MAPPING COMMITTEE STRUCTURE PROPOSED BY GEBCO (PROVISIONAL)



ANNEX 14

NOTES FROM A MEETING OF THE AD-HOC GEBCO 'MARKETING' SUB-GROUP

by Ron Macnab, Canada
(Discussion moderator)

The meeting lasted about an hour and a quarter, and was attended by 10-12 people. Mr Macnab offered to serve as group moderator, with Prof. Whitmarsh volunteering to record the discussion.

Mr Macnab began by saying that he though that GEBCO needed to move beyond depending solely on voluntary efforts and should aim to become more self-sufficient. He thought GEBCO had access to datasets which, with added value, could be sold.

Dr Goodwillie concurred. He thought that the GDA would have wide appeal to teachers. He noted that SIO graduate students had formed the impression that GEBCO was a closed society which was one of the reasons he had wanted to man booths at the Fall AGU (2002) and EGS (2003) meetings. So, in answer to a question from Dr Loughridge, this amounted to marketing both GEBCO and its products. In the above instance, he continued, GEBCO had achieved sales of about £20k from an outlay of a few thousand US dollars.

Dr Fox noted that NGDC did not expect to obtain sufficient income to pay for the datasets it distributed, which cost about $25 per CD to create, when these datasets had already been paid for by the US tax payer. He said that he preferred to make GEBCO data easy to obtain. He stressed that he was happy to continue to host the GEBCO web site.

Mr Macnab said that in his opinion the data itself should be free and that a charge should be made only for any added value.

RADM Andreasen noted that there might be copyright problems with releasing some of the data used by GEBCO.

Mr Macnab enquired whether GEBCO should conclude agreements with commercial organisations. Ms Weatherall replied that GEBCO already did so. She explained license agreements already existed but that no royalties were involved. She added that commercial organisations also paid a higher rate for GDA. Dr Cramer added that the license agreements were designed to project the datasets.

Mr Newton opined that the logical place to start was to enquire how GEBCO was to continue as an entity. Presently GEBCO had a single product and to develop further it needed more resources. Whatever was decided would determine the future marketing strategy. For example, he continued, perspective views could be added to the GDA and the GDA could be used to teach geography. The web site could be used more.

In response to a comment from Mr Cherkis regarding greater publicity Dr Goodwillie suggested that articles could be written for EOS, Physics Today and Science and even for specialist newspapers read by the teaching profession.

Dr Loughridge opined that if the GDA price was very low GEBCO would sell thousands of copies. Dr Hall pointed out that this was not always so. When a DTM of Israel was printed on laminated sheets rolled into tubes unexpected costs arose which deterred teachers who expected

free copies. When the National Geographic magazine, with a distribution of 13 million, published an article and map of the Holy Land in which he had been involved it generated only 12 enquiries!

Dr Falconer said that he thought that GEBCO should get better known even if in doing so it was able only to cover its costs.

Mr Macnab commented that he saw the discussion blurring two different activities which were outreach and selling. He thought that GEBCO should concentrate its efforts on good sources of funds such as charitable foundations. Mr Newton concurred. He said that Foundations, in the USA, needed to dispense funds at certain times of the year to avoid paying tax.

Dr Fox concluded, to general agreement, that selling the GDA on CDs was not profitable and that Foundations should be pursued to generate new funds.

Dr Loughridge asked whether GEBCO should distribute the GDA grid for free via the internet and this elicited comments that GEBCO needed both an easier to memorise URL and a logo, to which he replied that these were tasks which should both be added to the GEBCO Work Plan. RADM Andreasen replied that he would like to see the grid being available over the internet but there was a need for legal safeguards and to charge licensing fees.

Mr Macnab concluded the meeting by summarising the main points on which participants achieved some level of consensus:

1. While there may be a market for certain value-added products and services, basic information such as the global bathymetric grid should be freely available. The sale of value-added products such as the GDA might be significantly enhanced if the price were reduced appropriately.

2. The sale of value-added products and services may not generate sufficient revenue to justify the effort.

3. GEBCO might realise greater returns by investing time and effort in identifying and approaching funding sources that appreciated the organisation's objectives, and which could be persuaded to provide significant support to realise the achievement of those objectives.

4. A concerted outreach program was perceived as essential to raising GEBCO's profile in a variety of general and specialised contexts, in order to acquaint audiences with the aims and accomplishments of the organisations. This in turn was expected to make funders more receptive to applications for support.

ANNEX 15

GEBCO Work Plan Version 2004.1
(2004-2005)

Revised / reviewed by attendees at Porto Venere, Italy, 5-6 April, 2004

List of agreed tasks

TASK 1 PRODUCTION OF PRODUCTS
TASK 2 GEOSCIENCE DATA INTEGRATION
TASK 3 DATA ASSIMILATION AND ACQUISITION
TASK 4 REVIEW ROLES, RESPONSIBILITIES AND MEMBERSHIPS
TASK 5 UPDATING
TASK 6 OUTREACH
TASK 7 FEATURES
TASK 8 EDUCATIONAL PRODUCTS
TASK 9 FINANCE
TASK 10 NIPPON FOUNDATION/GEBCO TRAINING PROJECT

Key employed in the following pages:

*	potential subject of a Project Fellowship in the Nippon Foundation/GEBCO Training Project
**	potential subject of a Work Programme in the Nippon Foundation/GEBCO Training Project
	New elements or elements changed from the previous version

Details of Tasks

TASK 1 PRODUCTION OF PRODUCTS

OBJECTIVE – To complete production of products and disseminate them

	Task	Those in charge	Task timelines	Current status
1.1	**GDA new edition**	Jones		
1.1.1	GDA on web	Jones		
1.1.2	Pricing of GDA			
1.1.3	Topology / ESRI formats	Weatherall		
1.1.4	GDA to handle other grids	Cramer		
1.1.5	Platform independence via HTML	Jones/ Sharman	Start 2003	later
1.2	**Further Development of Grid**	Carron		
1.2.3	Uncertainty estimates*	Carron/Hall/Tani	During 2003	Development
1.2.4	Variable resolution grid*	Carron/ Sharman	During 2004	later
1.2.5	Continual Updated Grid from new data	Carron		Ongoing Intense discussion and agreement to support
1.2.6	Quality assessment	Carron/Tani/Weatherall		Development
1.2.7	Develop new grid at 1 minute resolution	Carron, Smith	Start 2004	Work programs**
1.2.8	Shallow water requirements			
1.2.8.1	ENC soundings	Hunter, Weatherall		Work programs**
1.2.8.2	Analogue chart soundings	Hunter, Weatherall		Work programs**
1.2.9	Multiple siting of grid site			
1.2.10	Data source metadata	Weatherall		
1.3	**Internet Availability**	Sharman		
1.3.2	Updated grid on web (free)	Sharman		Weatherall has done this for 20 degree squares GC to decide Monday/Tuesday to apply this to entire grid
1.3.3	Licensing / Agreement			

TASK 2 GEOSCIENCE DATA INTEGRATION

OBJECTIVE – To include all types of geoscience data to improve and update GEBCO products

	Task	Those in charge	Task timelines	Current status
2.1	**Altimetry**	Smith		
2.1.1	Calibrate with Japanese database	Smith/Tani	Start Jun 2002	Ongoing
2.1.2	Liaison with ABYSS	Smith		Ongoing
2.2	**Multibeam Integration with single beam***	Monahan, Schenke, Tani		Ongoing Schenke leading contouring software development
2.2.1	Multibeam data base proposal Scripps	? Schenke ? Monahan		Find out more

TASK 3 DATA ASSIMILATION AND AQUISITION

OBJECTIVE – To increase the amount and type of data available for inclusion in the DCDB and in GEBCO products

	Task	Those in charge	Task timelines	Current status
3.1	**Establish Working Group**	Divins, Tani, Sharman, Hunter, Hall, Cherkis, Huet, Frias	Get it started	Later
3.1.1	Regional contacts	See 3.1		Later
3.1.2	IHO and VHO process	See 3.1		Later
3.2	**Filling Gaps**			
3.2.2	Bathymetry from Buoys	Anderson, Hall		Ongoing Progress reported to 2004 meeting
3.2.3	*Healy* not turning on MBES. Others too!!!!!!!	Mayer	It is now!	Healy Fixed
3.2.4	RIDGE multibeam to GEBCO	Hunter		
3.2.5	NERC Cruises	Hunter		
3.3	**Shallow water data**			
3.4	**Polar Ocean Bathymetry Co-ordination Effort (POBACE)**	Schenke		
3.5	**Letter from President of SCOR to Data Centres**	Whitmarsh		
3.6	**Released USN submarine tracks**	Newton		

TASK 4 REVIEW ROLES, RESPONSIBILITIES AND MEMBERSHIPS

OBJECTIVE – To ensure that organisational structure continues to fulfil requirements

	Task	Those in charge	Task timelines	Current status
4.1	**Review personality list**	GC	ongoing	
4.1.1	Succession Planning	GC	ongoing	
4.1.2	Emeritus Members	GC	Next meeting	
4.2	**Review sub-committees**	GC	Done May 2002	
4.3	**Establish new groups**			
4.5	**Improve diversity**	Smith/Goodwillie	Get started	Later
4.5.1	Recruit new skills			
4.7	**New organisational structure for the ocean mapping**			
4.7.1	Establish Working Group			

TASK 5 UPDATING

OBJECTIVE – To ensure that GEBCO products include the latest data and incorporate current thinking.

	Task	Those in charge	Task timelines	Current status
5.1	**Southern Ocean (Antarctic)**	Schenke		Active
5.2	**Southeast Pacific**			
5.2.1	Investigate update with geoscience data. Work programs**	Carron	Late 2002	Ongoing
5.2.2	Data discovery	Divins	By next meeting	Ongoing
5.2.3	Relationship with IBC			

TASK 6 OUTREACH

OBJECTIVE – To make GEBCO more accessible to the entire marine community.

	Task	Those in charge	Task timelines	Current status
6.1	**Paper Edition**			
6.1.2	Print on demand	Jones/Cramer		Later
6.2	**Displays at conferences**			
6.5	**Website and Contacts**			
6.5.2	Submission of additional experts	Members	ongoing	
6.5.3	Displays for web	Jones/ Sharman	Dec 2002	
6.5.4	Maintenance of list servers	Sharman/Weatherall	ongoing	
6.5.5	Biographies on web	All		ASAP
6.5.6	Authorisation of material for website			
6.5.7	Multiple web sites ?			
6.5.8	Contact data base	Weatherall		
6.6	**General articles to journals**	all	ongoing	
	Special edition of MGR	Hall		
	Hydro International	Monahan		
6.7	**World map**	Jacobson, Mayer		Monahan
6.8	**One-pager**	Laughton	done	
6.9	**Develop GEBCO logo**	Hunter		
6.10	**Proposal re Outreach**	Schenke	Hunter	
6.11	**Co-operation with the International Committee for Global Mapping**	Monahan		Investigate asap

TASK 7 FEATURES

OBJECTIVE – To standardise and enhance the verbal description of the sea floor

	Task	Those in charge	Task timelines	Current status
7.1	**SCUFN**			
7.1.1	Gazetteer	Schenke, Huet		1. will meet 8-11 June St Petersburg, Russia make new names proposal digital via net
7.2	**GIS version of S23 Limits**	Divins/ IHB	Jan 2003	Hold due to politics
7.3	**Feature Rules and Prototyping**			
7.3.1	SW Pacific	Falconer		
7.3.2	Mediterranean	Hall/Carron		
7.4	**Automatic Name Placing**	Schenke/Cramer		Investigate
7.5	**Land/ Water Mask**	Carron		?

TASK 8 EDUCATIONAL PRODUCTS

OBJECTIVE – To bring the sea floor to the next generation

	Task	Those in charge	Task timelines	Current status
8.1	**Education Working Group**	Sharman		
8.1.1	Icosohedral globe	Sharman		done
8.1.2	Educational version of GDA	Goodwillie, Hunter		

TASK 9 FINANCE

OBJECTIVE – To continuously examine and enhance the financial basis for GEBCO

	Task	Those in charge	Task timelines	Current status
9.1	**Existing funds**			
9.2	**Future funds**	Laughton, Hall, Cherkis		
9.2.1	Seek future sources	Laughton		Nippon
9.2.2	Seek partnerships	Laughton		Nippon
9.2.3	Travel funds			

TASK 10 NIPPON FOUNDATION/GEBCO TRAINING PROJECT

OBJECTIVE – To train a new generation of scientists and hydrographers in ocean bathymetry, mostly from less developed countries.

	Task	Those in charge	Task timelines	Current status
10.1	**Nippon Foundation/GEBCO training project**			
10.1.1	Establish the NF/G Project Management Group			
10.1.2	Appoint Project Manager			
10.1.3	Finalise contract with Teaching Organization			
10.1.4	Put training program in place			
10.1.5	Begin defining Fellowship projects			
10.1.6	Information to IHB re student advertising			
10.1.7	Seek students			

ANNEX 16

LIST OF ACRONYMS

ACUF	Advisory Committee on Undersea Features (of BGN)
AGU	American Geophysical Union
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung (Bremerhaven, Germany)
BODC	British Oceanographic Data Centre
CD	Compact Disk
CGOM	IOC Consultative Group on Ocean Mapping
CV	Curriculum Vitae
DBDB2	Digital Bathymetry Data Base on a 2 arc-minute grid
DCDB	Data Centre for Digital Bathymetry (IHO - at NGDC, Boulder, Colorado, USA)
EEZ	Exclusive Economic Zone
ENC	Electronic Navigation Chart
ETOPO2	A 2 arc-minute grid of global topography
GC	Guiding Committee
GDA	GEBCO Digital Atlas
GDA-CE	GEBCO Digital Atlas – Centenary Edition
GEBCO	General Bathymetric Chart of the Oceans (IOC/IHO)
GEODAS	GEOphysical DAta System (NGDC database)
HO	Hydrographic Office
IATO	International Association of Antarctic Tour Operators
IBC	International Bathymetric Chart
IBCAO	International Bathymetric Chart of the Arctic Ocean (IOC/IASC/IHO)
IBCCA	International Bathymetric Chart of the Caribbean and Gulf of Mexico (IOC)
IBCEA	International Bathymetric Chart of the Central Atlantic Ocean (IOC)
IBCM	International Bathymetric Chart of the Mediterranean (IOC)
IBCSEP	International Bathymetric Chart of the SE Pacific (IOC)
IBCSO	International Bathymetric Chart of the Southern Ocean (IOC)
IBCWIO	International Bathymetric Chart of the Western Indian Ocean (IOC)
ICA	International Cartographic Association
IHB	International Hydrographic Bureau (Secretariat of IHO)
IHO	International Hydrographic Organization
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IPY	International Polar Year
ISCGM	International Steering Committee for Global Mapping
NASA	National Aeronautical and Space Administration
NERC	Natural Environment Research Council (UK)
NF	National Science Foundation (USA)
NGDC	National Geophysical Data Center (Boulder, Colorado, USA)
NOAA	National Oceanographic and Atmospheric Administration (USA)
NSF	National Science Foundation (of USA)
PCOB	Postgraduate Certificate in Ocean Bathymetry

PM	Project Manager
PMG	Project Management Group
POBACE	Polar Ocean Bathymetry Co-ordination Effort
SACLANT	Supreme Allied Commander Atlantic, Undersea Research Centre, La Spezia, Italy
SCAR	Scientific Committee on Antarctic Research (ICSU)
SCDB	Sub-Committee on Digital Bathymetry (GEBCO)
SCOR	Scientific Committee on Oceanic Research (ICSU)
SCUFN	Sub-Committee on Undersea Feature Names (GEBCO)
SHOM	Service Hydrographique et Océanographique de la Marine (France)
SOC	Southampton Oceanography Centre (UK)
SSPARR	Seafloor Sounding in Polar and Remote Regions
TEFL	Teaching English as a Foreign Language
UNCLOS	United Nations Convention on the Law of the Sea
UNH	University of New Hampshire (USA)
URL	Uniform Resource Location (Internet address)
WG	Working Group
WHOI	Woods Hole Oceanographic Institution
WVS	World Vector Shoreline

ANNEX 17

GEBCO PERSONALITY LIST

(Last Revised: 26 July, 2004)

JOINT IOC-IHO GUIDING COMMITTEE FOR GEBCO

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Dr Meirion Jones	Mr David Monahan (Chairman)
Lic. José Luis FRIAS Salazar	vacant
Dr-Ing. Hans-Werner Schenke	Dr Michael S. Loughridge
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Dr Michael Carron

Mr Norman Z. Cherkis

Dr Andrew Goodwillie

Mr Alexis E. Hadjiantoniou

Dr John K. Hall

Mr Peter Hunter

Dr Meirion T. Jones

Dr Michael S. Loughridge

Mr Ron Macnab

Capt. Andrey Popov

Mr William Rankin

Dr -Ing. Hans-Werner Schenke

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Prof. Bob Whitmarsh (Secretary)

FINANCE WORKING GROUP

Sir Anthony Laughton (Chairman)

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Dr Falconer

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