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1. OPENING OF THE MEETING

- 1 The Twentieth Meeting of the joint IOC-IHO General Bathymetric Chart of the Oceans Sub-Committee on Digital Bathymetry (SCDB XX) was held at the International Hydrographic Bureau, Monaco on 12th April 2003.
- 2 The Chairman, Dr Meirion Jones, opened the meeting at 0900. Those present, in addition to the Chairman, were Robert Anderson, Mike Carron, Norman Cherkis, Ray Cramer, Andrew Goodwillie, John Hall, Peter Hunter, Martin Jakobsson, Mike Loughridge, David Monahan, Peter Morris, George Newton, Bill Rankin, Walter Smith, Shin Tani, Pauline Weatherall, and the Secretary, Bob Whitmarsh. The meeting was later joined, sometimes temporally, by David Divins, Sir Anthony Laughton, Tony Pharaoh, Hans-Werner Schenke and Lisa Taylor.
- 3 Members were welcomed to IHB by Admiral Gorziglia. He said that IHB was very happy to welcome three separate mapping groups to IHB at the same time. The Directing Committee of IHB regard GEBCO as very important. He said that he had known Patricio Bernal, the Executive Secretary of IOC, for many years and had been in recent contact. The present meetings were a good opportunity for GEBCO to consider the future including what would happen to the regional bathymetric charts. The Directing Committee of IHB would like GEBCO to consider this although the Committee has no solution to propose itself.
- 4 The Chairman responded by thanking Admiral Gorziglia. He reflected on the history of the Sub-Committee and warned that sadly some of the former strong networking within the bathymetry community had been lost in recent years. No longer was all data being collated by GEBCO. Maybe the IHO and the Hydrographic Offices could help to remedy this situation? There had been a tendency for the International Bathymetric Charts (IBCs) to go their own way somewhat although admittedly a considerable amount of IBC data had been incorporated into the GDA-CE in the last year. Nevertheless he felt that some improvement was needed.
- 5 The Chairman returned to the business of the meeting. He noted that he had started as Chairman of the SCDB in 1983 and felt it was now time for him to retire. In the last 20 years he had seen the publication of the Fifth Edition (1983), its digitisation to generate the first GDA (1994) and now the publication of the Centenary Edition of the GDA with a 1-minute grid and new bathymetry for a third of the world ocean. GEBCO had reached the end of an era and it was time for him to stand down.

2. CONDUCT OF THE MEETING

- 6 The Chairman presented a revised Agenda which was adopted (Annex 1).

3. THE CENTENARY EDITION OF THE GEBCO DIGITAL ATLAS

- 7 The Chairman presented the new GDA-CE to the Sub-Committee. The GDA would be released on 14th April and be on sale from the British Oceanographic Data Centre from 1st May 2003. The educational/academic price would be £99. For commercial users it would be £230. The CDs would be free to members of the GEBCO community.
- 8 The presentation was followed by some discussion of the desirability of there being access to the Gazetteer of Undersea Feature Names via the internet. It was established that the Sub-Committee on Undersea Feature Names was well aware of this requirement.
- 9 Dr Carron added that he thought the GDA access software was very good. The GDA had been much harder to put together than he had anticipated. Great credit was due to many individuals including those at BODC and NIWA and the IBCAO team. A lot of thought was needed on how to update the GDA particularly if this was to be done much faster than previously. GEBCO should seek feedback about the new GDA from users.

4. UPDATE ON BATHYMETRIC ACTIVITIES WORLDWIDE

4.1 Data Integration Working Group

- 10 The Chairman of the Working Group, Dr Smith, reported on the activities of the group. He stated that some useful images had been put on a web site (see <http://ibis.grdl.noaa.gov/SAT/Bathy.intro.html>). Detailed charts were available of a number of areas. There was a link to a Geophysical Analysis section, created by Karen Marks. This section can be used to compare multibeam bathymetry, satellite altimetry, satellite gravity etc. displayed on different charts. A password, obtainable from Dr Marks (Karen.Marks@noaa.gov), is required to download full-resolution swath bathymetry in those areas where the data were obtained from proprietary sources. A major problem was how to characterise the quality of the altimetry and how and when to ingest it into GEBCO. Dr Smith noted that multibeam datasets covering larger areas would furnish a better test. He suggested that the Japanese grid in the NW Pacific would be the best such data set for this purpose and he undertook to discuss with Mr Tani how to obtain these data. This approach would be useful to make progress in deciding how to correlate satellite gravity with swath bathymetry and thereby to develop a global formula that would allow the integration of computed depths from satellite gravity into GEBCO.
- 11 In answer to a question from the Chair Dr Smith said that the future plans of the group included talking to non-typical users of bathymetry such as those in the fishing industry and ocean modellers. Dr Hall asked about the recent article in EOS about a new higher resolution satellite altimetry system (ABYSS). Dr Smith responded that a proposal to mount this altimeter on the International Space Station had been put to NASA in 2001 but had not been funded. It turns out that it is actually cheaper (only \$60m) to build a purpose-built satellite. Dr Smith said that sponsors such the US Department of Defense and other (even overseas) government agencies were being approached. The new altimeter would increase resolution by factors of 2-3 linearly and by 5 in vertical precision. This is important because at present the abyssal hill fabric, important for modellers wanting to estimate bottom roughness, is obscured by noise.
- 12 In answer to a question from Dr Loughridge, Dr Smith confirmed that non-polar orbits were preferred and that ideally the satellite tracks should form two orthogonal sets. There were alternatives to a purpose-built satellite as well. He noted that the new ESA CryoSat satellite, which operates in a polar orbit, will try out the Doppler mode of operation which will be used by ABYSS. He concluded by stating that most of the technology for ABYSS already existed.
- 13 Dr Goodwillie reported that while he was manning the GEBCO Booth in Nice visitors to the booth had informed him of new datasets from the south coast of France, north of Australia, Barbados to Trinidad, 35-45N; 23-38W, the mid-Atlantic Ridge, the Azores (2 areas) and a large part of the Indian-Pacific Ocean (Annex 2).
- 14 Dr Carron added that he knew of a lot of new RIDGE multibeam data. The RIDGE web site had not been updated in recent years because of data release problems. Dr Smith explained that three years ago the US RIDGE Program had adopted a new 10-year plan (RIDGE-2000) for its research program which had a narrower geographic focus mostly in areas where bathymetry had already been collected. Thus, he did not expect to see much new bathymetry being collected by RIDGE-2000. Dr Divins reported that even data acquired with NSF funds was not always sent to NGDC after the requisite two years had elapsed. Dr Loughridge elaborated by saying that enforcement of NSF regulations had depended previously on individual NSF Program Managers but they were getting firmer in applying the rules.

4.2 The International Bathymetric Chart of the Arctic (IBCAO)

- 15 Mr Newton reported activities related to the Arctic Ocean. He reminded the Committee that the Director of Naval Intelligence and Chief of Naval Operations had agreed to the release of Arctic data acquired between 1988-1992. This corresponded to 14 'deployments' that had followed over 107,700 n.m. of under-ice track. The Royal Navy may add data from a further three deployments; he was awaiting a letter on the subject. All this data will need to be digitised. He advised the

adoption of a non-threatening stance when dealing with US bureaucracy and to keep strictly to the rules.

- 16 He also reported recent developments in the Arctic related to Article 76 of UNCLOS. The US Navy is to be asked to map parts of the Arctic using submarines. The Secretary of State is committed to asking the President of the US for two submarine deployments. After a written request had been submitted to the State Department the Danish government had formally requested that a joint survey be carried out north of Greenland. He added that Mr Monahan was working similarly with the Canadian government. Mr Monahan confirmed this and reported that he had been involved recently in trying to get permission for a US submarine to survey in Canadian Arctic waters. Mr Newton should expect to receive a letter from the Canadian Department of Foreign Affairs. He added that Canada was likely to ratify the UN Convention on the Law of the Sea. He expected UNCLOS surveys to significantly impact GEBCO in the next 10 years. GEBCO must consider how it will handle these data assuming they enter the public domain after coastal states have made their UNCLOS submissions.

4.3 Use of data from shallow water areas

- 17 Dr. Smith noted that UNCLOS-related activities might stimulate interest in the GDA-CE, and since GEBCO had traditionally stayed out of coastal waters, he wondered whether a relative lack of coastal information in the GDA-CE might be seen to be to GEBCO's discredit. Mr Monahan feared this was the case but getting permission to use coastal bathymetry usually required political decisions. Dr Divins thought that the IBCs were mapping a lot of continental shelf areas; GEBCO needed to let IOC know that these data were required by GEBCO. Mr Pharaoh responded that IHB had tried several times to get the VHOs to contribute their data. The data were often non-digital so it was impossible to submit sub-sets of the data. On the other hand many Hydrographic Offices held (digital) electronic navigational charts in S57 format which included soundings, contours etc. He asked why GEBCO didn't request these data for incorporation into its database. He had just finished working with the WEND Working Group which produced a series of charts showing where such ENC data existed (see <http://www.iho.shom.fr/>).
- 18 The Chairman recalled that IBC standard practice was to include a 200 m contour; 20, 50 and 100 contours were added only if necessary. Should such detail be added to the GEBCO database? Dr Divins responded that that exact point was on the Agenda of CGOM (which was meeting concurrently in Monaco). Dr Divins and Sir Anthony Laughton stressed that it was important to get this point across to CGOM immediately, particularly regarding the SE Pacific Ocean which it had not even begun to map. Dr Divins added that there was political sensitivity about supplying gridded data for shallow water (continental shelf) areas. Dr Smith commented that obviously the more data the better but we should not 'set the bar too high'. GEBCO should encourage the submission of more data, particularly from less than 200 m. The Chairman considered that 20, 50 and 100 m contours provided fairly coarse resolution. Dr Goodwillie interposed that the new Indian Ocean bathymetry did in fact contain shallow water contours from offshore South Africa and Australia but it had taken years to enter by hand. At the EGS/AGU/EUG 2003 Joint Assembly in Nice many tidal modellers had expressed a need for shallow water bathymetry. The Chairman concluded that there was a strong scientific case for more and better shallow water bathymetry.
- 19 Dr Carron requested clarification on what action the Sub-Committee intended to take. Dr Loughridge advised that to get a motion passed at an IOC General Assembly GEBCO needed to demonstrate that the motion would benefit member countries. Dr Smith thought that the SCOR WG 107 report could be used to go even further than just to recommend a course of action and that if the Sub-Committee approached CGOM it would need to demonstrate how GEBCO can benefit CGOM. Dr Hall recalled that when the IBCM had changed from a 0.25' to a 0.1' grid it had taken 8 years to get IOC to pass a recommendation that the Volunteering Hydrographic Offices should help the IBCM. Dr Pharaoh repeated that a display of the areas covered by shallow water surveys could be viewed on the IHB web site (see <http://www.iho.shom.fr/>). Most surveys were non-digital. A lot were commercially available but permission to use them could be obtained through IHB. Mr Tani was sceptical about being able to override commercial interests. He thought that it would be easier to obtain gridded data than contours in S57 format.

4.4 National Geophysical Data Center.

- 20 A report from the National Geophysical Data Center is presented in Annex 3.

4.5 Database of multibeam systems.

- 21 A spreadsheet of World-wide Seafloor Swath-mapping Systems (dated 8 April 2003) is presented in Annex 4.

5. FUTURE PERSPECTIVES

5.1 Proposed changes to the GEBCO Guidelines B-7 – the role of the IBCs

- 22 A discussion ensued about whether IBCs should be digital and include gridded data. Dr Loughridge stated that the IBCs existed to supply data to GEBCO although IBC people might have other ideas. Dr Taylor stated that the original goal of the IBCs was to produce paper charts but now all data were submitted in digital form. There should be no problem in adding near shore (shallow) soundings to the charts where IBCs already had 10 m contours. She noted that some IBCs omitted the sounding control; she urged that soundings, particularly digital, were needed as well as contours to enable edge matching.
- 23 Many changes were suggested and Sir Anthony Laughton cautioned that to make a lot of changes would cause problems. He reminded the Sub-Committee that the IBCs also had an educational role e.g. to train and inform people in coastal states. Dr Loughridge commented that it was not possible to impose the procedures used by IBCM or IBCAO on the other IBCs.
- 24 The Chairman noted that the document said nothing about the IBCs submitting data to the IHO DCDB.
- 25 Mr Monahan drew the discussion to a close and noted that it was imperative that GEBCO and the IBCs interact. He concluded that the IBCs were already discussing the use of digital data but GEBCO cannot easily influence the IBCs.

5.2 USA and UNCLOS Surveys

- 26 Dr Jakobsson reported that the University of New Hampshire had been commissioned by US government agencies to carry out a desk top study entitled *The Compilation and Analysis of Data Relevant to a U.S. Claim Under United Nations Law of the Sea Article 76*. The report is available on the UNH web site (<http://www.ccom.unh.edu/unclos/index.htm>). They had discovered that there was a lot of data that had not been submitted to the NGDC e.g. data held by the US Minerals Management Service and NIMA. These data were now being pooled and sent to NGDC. The point was that GEBCO would have to go through a similar exercise before any new product was developed. The desk top study had revealed that a lot more data needed to be acquired in the Arctic to evaluate the US UNCLOS case and consequently two multibeam surveys were planned there in summer 2003. UNH had made a world-wide compilation of metadata that included raw (not quality assured) data.

5.3 The future of the Sub-Committee on Digital Bathymetry and appointment of new Chairman

- 27 A discussion occurred about how the new Chairman of the SCDB was to be appointed. Sir Anthony Laughton affirmed that either the Guiding Committee or the Sub-Committee itself could appoint the chairman. Mr Monahan noted that any new Chairman, if in employment, should have the support of his employer for this voluntary but time-consuming GEBCO role. The Chairman noted that even the future of the Sub-Committee itself was in doubt and that it was essential first to

agree the new GEBCO Strategy document. The question about the future of the SCDB and the appointment of a Chairman was referred to the Guiding Committee for a decision.

5.4 The future of GEBCO

- 28 Dr Loughridge started the discussion by pointing out that any future plan had to engage people's interest and excitement. Mr Monahan admitted that there needed to be a discussion of where GEBCO was going. For his part he wanted to map the whole Earth surface. Mr Anderson stressed the importance of high resolution bathymetry; people in his lab typically worked at a much higher resolution than 1'. Today geologists wanted to see back-scatter images as well as bathymetry. Dr Jakobsson stressed the importance of multibeam data. GEBCO should move beyond the 1' grid and consider how to incorporate variable grid sizes and how to include other features than just bathymetry. GEBCO must also work to break down the boundaries between itself and the IBCs. Lastly, there was a need to bridge the gap between paper charts and displays derived from the Centenary Edition CD; '6th Edition' paper charts should somehow be available. Dr Goodwillie concurred. At the AGU and EGS GEBCO booths, a number of booth visitors had expressed their interest to him for a print-on-demand facility. These tended to be teachers or others who do not have access to a large-format plotter. there was a need for 'print on demand' charts. Mr Rankin demurred about the need to bridge the gap. He thought that ideas of a '6th Edition' was 'old thinking'. GEBCO should aim for constant updating of its database and the incorporation of a variable grid size. In response to the Chairman's comment that quality assurance of the data was essential Mr Rankin stated that these days data can be reviewed very fast electronically. Different levels of review could be applied to data from different sources depending on the reputation of the source.
- 29 Sir Anthony Laughton said that updating the bathymetry of the Pacific Ocean, the weakest part of the new GDA, should be one of GEBCO's next main priorities. Dr Carron concurred that a lot of the bathymetry in the SE Pacific was poor. A group needed to be formed to complement the IBCSEP chaired by Capt. Mingram but the IBCSEP might not deliver the goods any faster than the other IBCs. Someone must start work soon to keep up the momentum. Sir Anthony Laughton wanted to find an individual, supported either by their employer or by part-time funding, or else a group of committed people. He hoped that funding could be leveraged from another organisation.
- 30 Dr Goodwillie responded that the new GDA was largely finished by individuals who operated by by-passing the SCDB, for example, the Indian Ocean grid had been generated by Bob Fisher and himself. GEBCO should look into adding data directly into existing datasets without recompiling them. Dr Jakobsson agreed. That was exactly how the IBCAO group had treated their Arctic database; it had taken just two days to add in all the new data.
- 31 Dr Goodwillie continued that in his opinion GEBCO entailed too much voluntary work. Sir Anthony Laughton responded by asking how GEBCO would spend if it received, for example, 500,000 US dollars or pounds. He would like to see the creation of a GEBCO Geoscience Unit, a suggestion that had been mooted in 1973 when the IHO and the IOC had come together to support GEBCO. Perhaps this idea should be re-visited?
- 32 The Chairman expressed the view that ensuring the flow of data into the IHO DCDB was critical. This was one of the improvements to GEBCO that he had proposed in his chapter in the 'History of GEBCO' book. For example, he had published Figures 45 and 46 comparing 5th Edition track coverage in the SE Pacific with tracks currently held by NGDC and there was little difference. How should the flow of data be improved? Dr Loughridge responded that although the NGDC held data from a still limited number of countries the number was increasing.
- 33 On the other hand Dr Loughridge said he did not know of any activity by Dr Sharman's Working Group on Data Assimilation. Dr Smith asked why this was so. Dr Loughridge could not explain the lack of action other than by saying Dr Sharman had a heavy workload. The Chairman stated that the WG could still do good work. Sir Anthony Laughton pointed out that three members of the WG were present. Mr Cherkis replied that he had had no contact with Dr Sharman; he had received no replies to his emails. But whenever he (Cherkis) finds new data he submits it. The Chairman

remarked again that in his view the dataflow was the problem and not Dr Sharman's workload. Mr Monahan thought that Mr Cherkis had provided the answer. If he needed data for a specific project he went looking for it; this was a better approach.

- 34 Mr Monahan agreed that the NGDC was at the heart of the solution of the dataflow problem. Dr Jakobsson had discovered that a lot of data were not there. For example, scientists in US universities withhold their data for a long time until after they have been published. The Chairman asked whether perhaps people were unaware of how they could contribute their data? How proactive was NGDC in seeking out data? Mr Monahan added that GEBCO needs to demonstrate the benefits of contributing data.
- 35 The Chairman noted that the VHOs had recently been 'out of the loop' regarding data assimilation. Dr Loughridge suggested that Rear-Admiral Guy's circular letter in 2002 had been very specific and had elicited little response. He reminded the Sub-Committee that Mr Pharaoh had suggested that ENCs were used instead. Mr Cherkis responded that the NGDC website provided links to world-wide data repositories that can be very forthcoming when asked for data for research use, which was exactly GEBCO's objective. Why didn't GEBCO ask national oceanographic data centres directly for data? Dr Loughridge responded that that approach had often been very successful but the data could be used only for the stated purpose and not for any other purpose. In answer to a question from Sir Anthony Laughton, Dr Loughridge confirmed that the holdings of Dr Fisher, either tracks or soundings, had yet to be submitted to NGDC. Dr Goodwillie explained there was a good reason for this. Many track lines used by Dr Fisher were made available to him with certain restrictions that do not allow him to pass on the data to others. Dr Loughridge wondered how in general pressure could be applied to obtain data that had not been submitted to NGDC. Should approaches be made to individual Principal Investigators, to labs, to NSF Program Managers (in the US) or to funding agencies?

5.5 Access to GEBCO data

- 36 Dr Jakobsson expressed the view that the GEBCO grid, and updates to it, should be freely available over the web but not the total content of the GDA such as track lines and software. The Chairman added that sample charts should be available for downloading over the web as well. He also would like to see GDA sales in North America by credit card. Dr Loughridge thought that the Guiding Committee should first discuss the issue of GDA sales because it could affect the long term viability of GEBCO. He also thought that GEBCO could not prevent the GDA being copied or repackaged. Sir Anthony Laughton asked what legal redress the data 'owners' would have? Any legal action would depend a lot on the cost involved. Dr Smith suggested that if GEBCO products were updated fast enough it would be possible to outpace the hackers. Mr Tani's view was that the GEBCO GDA-CD should always be the best so updates should be provided free and on-line.
- 37 Sir Anthony Laughton asked how marketing of the GDA-CD was going to be addressed. No reply was forthcoming other than a comment from Mr Monahan that if the GDA was freely available over the web then marketing would be less of a problem.

6. CLOSURE OF THE MEETING

- 38 There being no other business the Chairman closed the meeting at 1800.

ANNEX 1

Twentieth Meeting of the GEBCO Sub-Committee on Digital Bathymetry

09.00 Saturday 12th April, 2003

INTERNATIONAL HYDROGRAPHIC BUREAU, MONACO

AGENDA

1. Opening of the meeting
1. Conduct of the meeting
 - 1.1 Adoption of the Agenda
 - 1.2 Tabling of documents
 - 1.3 Local arrangements
2. Centenary Edition of the GEBCO Digital Atlas (GDA-CE)
3. Update on bathymetric activities world-wide
4. Future perspectives
 - 4.1 Future of SCDB, its format and Terms of Reference
 - 4.2 Response to SCOR Working Group 107 Recommendations
 - 4.3 Updating GEBCO bathymetry
 - 4.4 Future directions for the GEBCO Digital Atlas
5. Any other business
6. Closure of the meeting

ANNEX 2

Bathymetric data sets offered to GEBCO

by Andrew Goodwillie

The following bathymetric data sets were offered to GEBCO by visitors to the GEBCO booth at the EGS/AGU/EUG Joint Assembly in Nice, France (7-11 April 2003).

1. South coast of France. Data collected by SHOM. Informant and contact: Florent Lyard, CNES. Email Florent.lyard@cnes.fr.
2. Shallow water data from northern Australia, compiled by Lance Bode, Townsville, Queensland. Informant and contact: Florent Lyard, CNES. Email: Florent.lyard@cnes.fr.
3. Caribbean Sea and south of Barbados. Multibeam survey compiled at Ifremer by Alain Mascle, IFP, France. Contact him via George Mascle; email gmascle@ujf-grenoble.fr. These data may be available for GEBCO use.
4. Mid-Atlantic Ridge. Multibeam grid (500 m), 15°N - 40°N. Contact: Pascale Gente, University de Bretagne Occidentale, Brest, France. Email: gente@univ-brest.fr.
5. Azores area. Multibeam grid (1 km), 35°N - 45°N , 23°W - 38°W. Contact: Pascale Gente, University de Bretagne Occidentale, Brest, France. Email: gente@univ-brest.fr.
6. Indian-Pacific Oceans. Bathymetric compilation for half of the Indian-Pacific Oceans. Compiled by Neville Exon at Geoscience Australia, Canberra, ACT. May have to approach through Richard Cooper, GA Business Office. Contacts: neville.exon@ga.gov.au, richard.cooper@ga.gov.au.
7. Azores area. Bathymetric grid (1 minute) collected during the MOMAR project. Available to GEBCO. Contact: nuno.lourenco@fc.ul.pt.

ANNEX 3

National Geophysical Data Center Report to GEBCO

April 2003

Monaco

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 May 2002 Meeting of the GEBCO Sub-Committee on Digital Bathymetry, the National Geophysical Data Center (NGDC) has responded to 213 international requests for digital marine geology and geophysics data or information from 54 countries of which 37 are IHO Member States. This contrasts with over 899 sales requests within this category from within the U.S. during the same time frame. NOAA's customer tracking management system no longer tracks requests that don't result in a data sale.

Version 4.1 of the global Marine Trackline Geophysics CD-ROM (GEODAS) became available in June 2002. The new release contains improvements to the GEODAS software, and adds over 1 million nautical miles of new bathymetry obtained from 316 cruises containing over 6.6 million digital soundings. An additional 54,000 soundings were assimilated during this reporting period, originating from 24 cruises covering over 57,000 nautical miles.

In 2002, NGDC began archiving a new data set consisting of digital, shallow-water, side-scan, sonar imagery collected during National Ocean Service (NOS) hydrographic survey operations. These data contain digital files of trackline side scan 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, nearly two terabytes of data has been archived. The sheer volume of the data is providing IT challenges in the areas of data archive, access, and product generation.

NGDC's U.S. coastal database grew by 23 surveys and 1.2 million soundings during the reporting period. The database now contains over 73 million soundings from 6038 surveys, providing valuable input to bathymetric basemaps, Geographic Information Systems, geophysical exploration, coastal engineering studies, and near-shore projects. This database is the primary data source for NGDC's Coastal Relief Model efforts.

NGDC's multibeam database continues to grow as well. During 2002, 9 multibeam surveys were delivered from the Woods Hole Oceanographic Institution, 66 from Scripps, and one from Germany for an addition of 18 gigabytes of data. These data include tracklines from the U.S. West Coast, the Atlantic, near Mexico in the NE Pacific, and in the South Pacific. NGDC has placed this data into our 3590 tape library archiving system using Tivoli software.

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. GEODAS includes an on-line system for automated creation of Custom Data CDs. This system will soon be able to create Custom Data DVDs. Currently users can automatically create a CD with the GEODAS data of their choice, and have it mailed to

them, usually within a day.

Version 4.1 of the GEODAS software includes new capabilities, including the capability of using GEODAS datasets on DVD. DVD is expected to become the default media for these datasets. GEODAS Hydro-Plot can read a variety of formats (including MGD77 and various XYZ formats), can display magnetics and gravity data in addition to bathymetry, and can display a data set overlaid on top of a reference data set.

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

Quality Control Procedures

NGDC has recently incorporated new features of the GEODAS Hydro-Plot program into the process of assimilating new data. In the past, a few random soundings were manually compared to GEBCO maps for verification of realistic depth values. This process was time consuming and limited in scope. Now, using Hydro-Plot, all depth values are screen plotted and overlaid on top of a reference data set (ETOPO2) for easy identification of gross errors. Additional review may then follow using depth profiles produced using GMT (Generic Mapping Tool).

NGDC recently held preliminary meetings with Dr. Paul Wessel of the University of Hawaii, School of Ocean & Earth Science & Technology (SOEST) to discuss quality control of NGDC's marine trackline geophysical data. Dr. Wessel has received a grant from the National Science Foundation to develop tools and procedures for both along-track, and between-track-crossover, analysis of errors in NGDC's GEODAS marine geophysical trackline data holdings. The primary goal of the proposal is to submit NGDC's trackline geophysical data archive to a rigorous quality assessment and provide corrections where appropriate. A secondary goal is to provide web-based access to a global database of bathymetry, magnetics, and gravity crossover errors that would be a first, quantitative, quality assessment of the data. This project promises to be a major step forward in answering customer requirements for quality measures on NGDC's global marine geophysical data.

I-C. Creation of a Database of International Non-Standard Bathymetry

NGDC is continuing to develop and conceptualize a new international database of non-standard bathymetry using a modified version of the GEODAS software. These data come from files consisting of depth values organized by geographic area rather than time sequential points along a trackline. NGDC has not identified an appropriate name for this database, and will use the database as an NGDC internal tool to maintain an inventory of bathymetric and hydrographic data holdings, which do not fit into the GEODAS Marine Trackline Geophysics Database (e.g. digitized charts, gridded data, point data....). Future direction, development, and timeframe will be influenced by the nature, type, and critical mass of data necessary to spawn independent databases.

To date, 171 data sets, from 13 data sources, containing a total of over 1.2 million soundings comprise the database. Data comprising this database were submitted in several different data formats requiring modification of the GEODAS assimilation programs to incorporate the various data formats. Data coverage is primarily in the Barents and Kara Seas, Caribbean, Canadian Arctic, and the Mediterranean.

Additionally, NGDC has recently decided to provide a public access mechanism for numerous trackline data files that have been previously identified as too noisy (poor quality) for assimilation into the existing Marine Trackline Geophysics CD-ROM product. NGDC plans to make this data available via user download from the NGDC web site under a “user beware” caveat. Users would be able to download these poorer quality data and incorporate these files into their existing Marine Trackline Geophysics Database. If at a future date users are able to quality control these data, NGDC would re-accept these improved data files for incorporation into the Marine Trackline Geophysics Database. Currently, NGDC does not have the resources to conduct quality control checks and error corrections beyond the present, cursory inspections.

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 Co-operation 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 has now been completed for Lakes Erie, St. Clair, Michigan, and Ontario; and is well along to completion for Lakes Superior and Huron.

NGDC maintains web pages for Great Lakes bathymetry. These pages provide direct links to the web of related external organizations including NOAA/ GLERL, the Canadian Hydrographic Survey, and the Great Lakes Information Network. During 2002, an average of 19,414 hits per month were recorded for the Great Lakes web pages at NGDC.

Developments during the period May 2002 – April 2003:

Lake Huron: Contouring of Lake Huron is progressing slowly, the main lake body is complete, and contours have been drawn for all of Georgian Bay and North Channel. The

raster to vector digitization of the hand drawn contours is now entirely being completed at NGDC. This has resulted in significant savings and has allowed for better quality control of the resulting vector data.

Lake Superior: Progress for Lake Superior is underway; contours for the Michigan coast, starting in Whitefish Bay are being completed by colleagues at GLERL. The western third of Lake Superior has been contoured and digitized. The operational plan is to complete the contours for the U.S. side of the lake, which is well underway, and then to begin work on the Canadian side.

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

Dr. Michael S. Loughridge and Dr. George F. Sharman participated in the 31st Annual UJNR Sea-Bottom Surveys Panel Meeting of the U.S. - Japan Co-operative Program in Natural Resources, held in Durham, New Hampshire, USA, in November 2002. 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.

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

The web pages of the World Data Center for Marine Geology and Geophysics, Boulder, collocated with those of the US National Geophysical Data Center's Marine Geology and Geophysics Division, averaged 1,536,721 hits per month during 2002, compared with 974,020 hits per month during 2001. During 2002, users downloaded an average of forty-six gigabytes of data from the MGG web site each month. NGDC's web software no longer reports unique users or countries at the Marine Geology and Geophysics Divisional level, as identified in previous reports.

II-D. WOCE Data Assembly Center for Bathymetric Data

In December 1993, NGDC was officially named as a Data Assembly Center for bathymetric data acquired on World Ocean Circulation Experiment (WOCE) cruises. During 1994, procedures were established for data submission and for data exchange with WOCE participants. The data collection period for WOCE ended in 1997, however cruise data continues to arrive for assimilation into the IHO DCDB database. During 2001 and early 2002, many of the attribution and quality control problems were resolved, in anticipation of the release of the final WOCE dataset. In the past year, 37 WOCE cruises were added to the Marine Trackline Geophysics Database. Version 4.1 of the Marine Trackline Geophysics CD-ROM, released in June 2002, included bathymetry from 85 WOCE cruises. An additional 17 cruises that have not passed NGDC's preliminary quality control screens, will be made available in their current condition for free download from the NGDC web site.

II-E. ETOPO2

NGDC has produced a new, high-resolution database of global topography and

bathymetry. To be named "ETOPO2," this 2 arc-minute, latitude-longitude gridded database supersedes ETOPO5 and TerrainBase, which are 5-minute databases. The ETOPO2 data are generated from Global Land One-kilometer Base Elevation (GLOBE) project digital data bases of land elevations, combined with Smith and Sandwell (1997) measured and estimated sea floor topography, IBCAO Arctic bathymetry, re-sampled on a 2-minute latitude/longitude grid, and the Naval Oceanographic Office's (NAVOCEANO) Digital Bathymetric Data Base, Variable Resolution, level 0 (UNCLASSIFIED0 (DBDBV). The data base improvement results from accumulated data and pioneering, satellite-based work of Smith and Sandwell. The data are packaged on a CD-ROM in two binary raster formats, and as subsets compatible with NGDC's GridXlator software. The subsets are accessed through a web browser HTML interface. Color, shaded-relief imagery derived from the data is available to assist the user in area selection.

II-F. Public Distribution of DBDB-V, version 4.1

NGDC is now the official public distributor for the entire, CD-ROM-based version of NAVOCEANO's DBDB-V level 0, an unclassified digital bathymetric database that provides ocean depths at various grid spacings. Copies of the DBDB-V data and software were received in 2002 by NGDC. Work is underway to develop a CD-ROM product with a suitable user interface for distribution to the general public. A CD-ROM version of DBDB-V is available on request. A web page to this effect is in preparation. Regional extraction of smaller sub-sets of data will continue to be downloadable from the U.S. Naval Oceanographic Office web site.

II-G. NOS Bathymetric Fishing Maps

The NOS Bathymetric and Fishing maps, scanned as part of a Data Rescue Program, are now available as digital images on a 7-volume series of CD-ROMs. These topographic maps of the seafloor portray the size, shape, and distribution of underwater features through detailed depth contours at a scale of 1:100,000. The maps contain Loran-C rates, distribution and identification of bottom sediment types, and known bottom obstructions in addition to standard depth information. Color maps are in compressed MrSID form with decompression software (Viewer) supplied on the CD-ROM. Preliminary maps (part of the collection which were never published and are only available as black & white images) are stored in CCITT (Consultative Committee for International Telephone and Telegraph) Group 4 TIFF (Tag Image File Format) form. For more information, see the data announcement: <http://www.ngdc.noaa.gov/mgg/fliers/01mgg01.html>. NOS will also be offering on-line access to the images.

Transfer into the digital realm was driven by continued demand and limited remaining stock. These maps are no longer being generated by NOS, and NGDC has already depleted the existing color stock for maps in the more popular fishing regions of Gloucester, Massachusetts, eastern coastal regions of Florida and the Ewing Bank region in the Gulf of Mexico. Commercial and private fishermen can utilize these digital images in onboard computer systems during an expedition, or print the images on a traditional paper copy at a local print shop.

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

III-A. IOC Regional Mapping Projects

In addition to participation in GEBCO, NGDC staff continue 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 participant in the IBCSEP.

1. Gulf of Mexico and Caribbean (IBCCA)

The National Geophysical Data Center hosted the Eighth International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico (IBCCA) Editorial Board Meeting from March 3 –5, 2003. Participants and observers from Costa Rica, Ecuador, France, Mexico, Monaco, Peru, Russia, the United States, and Venezuela attended the meeting. Color proofs of six IBCCA sheets were reviewed and agreements regarding data exchange and data distribution for the project were negotiated. The meeting was followed by two days of training sessions presented by NGDC staff on data management and applications.

A CD-ROM series, containing vector contours and DEM data with color imagery for the completed areas, is scheduled for release by the Instituto Nacional de Estadística, Geografía, y Informática (INEGI) in Mexico this year. The next IBCCA Editorial Board Meeting was 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)

On October 30-31, 2002, Dr. David Divins participated in the Fourth Session of the Editorial Board of the IOC-sponsored regional bathymetry project International Bathymetric Chart of the Arctic Ocean (IBCAO), held in Honolulu, Hawaii. Dr. Divins made a presentation on the activity of the IBCAO website, hosted by NGDC. NGDC is currently making available, via the web, the first version of the gridded and vector data for the IBCAO, as well as images and documentation. NGDC will publish a version of the IBCAO image as part of its Research Publication series. NGDC will provide part of the necessary funding. Ron Macnab, through a Grant with the U.S. Navy, will provide the remaining funds.

4. Western Indian Ocean (IBCWIO)

Two proofs of IBCWIO sheets were presented and reviewed at the Eighth International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico (IBCCA) Editorial Board Meeting in Boulder, Colorado during the first week of March 2003. The next Editorial Board Meeting of the IBCWIO has been postponed without a definite rescheduled date.

5. Eastern Atlantic (IBCEA)

France, Portugal, and the United Kingdom continue to be active in sheet generation, and NGDC has contributed to these sheets by providing editorial review prior to printing.

6. Baltic (IBCB), (Proposed)

During the reporting period, there has been no activity regarding formation of an International Chart of the Baltic (IBCB). Initiation of an ICB Project was discussed at the Eighth Session of the IOC Editorial Board for the IBCM. NGDC and the U.S. ocean mapping community support the formation of an ICB Project.

7. Eastern South Pacific (IBCSEP)

The first Editorial Board meeting International Bathymetric Chart of the South East Pacific (IBCSEP) is tentatively scheduled for October 2003.

8. Western Pacific (IBCWP)

No meeting of the International Bathymetric Chart of the Western Pacific (IBCWP) Editorial Board was held, or is scheduled in 2002-2003.

9. Southern Ocean (IBCSO), (Proposed)

The idea of forming the International Bathymetric Chart of the Southern Ocean (IBCSO) was given tentative approval by the IOC, however formal approval is not expected until the IOC General Assembly in June 2003. On November 1, 2002, there was a meeting of those interested in the formation of the IBCSO in Honolulu, Hawaii. NGDC's David Divins attended this meeting. At this meeting, there was a review of available data sources and a discussion of methodology on how to generate the bathymetric chart and database. NGDC provided Dr. Hans-Werner Schenke, acting as preliminary Chairman of the IBCSO, a copy of the Trackline Geophysics CD-ROM so that work could begin before the IOC General Assembly meets. It was agreed that the structure of the IBCSO would follow that of the IBCAO, generating a gridded product as opposed to paper charts.

III-B. GEBCO Reviewers Report:

1. North-East Pacific Ocean

While there are no major mapping programs in the Northeast Pacific, there are numerous local 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. However, small-scale regional mapping is not being done at any institution. Coastal Baja California is being mapped at Scripps along with regions of the central eastern Pacific on a piecemeal basis. NOAA has a continuing interest in the Juan de Fuca Ridge. The Naval Oceanographic Office is surveying parts of the Southern California Borderland. As these data become available, they will serve to reinforce a well-populated database of bathymetry for the north-eastern Pacific basin.

Although, it may be considered outside the scope of the North-East Pacific, there has been considerable activity in the Hawaii Island region. The Monterey Bay Research Institute (MBARI) has operated their research vessel R/V WESTERN FLYER in the Hawaiian region, while the Scanning Hydrographic Operational Airborne LIDAR Survey (SHOALS) System operated by the U.S. Army Corps of Engineers and the Naval Oceanographic Office, conducted LIDAR surveys in both the Hawaiian Islands and off California. The United States Geological Survey has also been actively surveying with shallow water multibeam technology in coastal Californian and Hawaiian waters.

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. The SHOALS LIDAR system has also been utilized to conduct surveys in U.S. coastal areas of the Gulf of Mexico.

III-C. Consultative Group on Ocean Mapping

The Ninth Session of the Intergovernmental Oceanographic Commission (IOC) Consultative Group on Ocean Mapping (CGOM) will meet 12-13 April 2003 in Monaco.

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

1. GEBCO On-Line Activities

1A. GEBCO Web Pages

The GEBCO web pages were completely redesigned prior to the December 2002 American Geophysical Union (AGU) meeting. Information on the new GEBCO 1-minute bathymetric grid and the GEBCO Centenary celebration April 14-16 in Monaco were added to the pages. The GEBCO booth at AGU was manned by Dr. Andrew Goodwillie and featured the new GEBCO 1-minute bathymetric grid. This new grid was plotted up for display purposes, and has also been supplied for the EGS meeting scheduled to be held in Nice, France, in early April 2003. Access to the GEBCO web pages has nearly doubled over the last year, averaging 4664 hits per month. NGDC no longer identifies unique users or countries at the Divisional level, as reported in previous years.

1B. IBCWIO Web Pages

There have been no new updates of the IBCWIO web pages during the last year. Only nine of the thirteen months during the reporting period recorded hits above NGDC's accounting software threshold. For these nine months, the average hits per month totalled 1766. 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. The average number of IBCAO hits per month during 2002 and through January 2003 was 15586, more than doubling the average hit count in 2001.

1D. IBCM Web Pages

There have been no new updates to the IBCM web site during the year. Only seven of the thirteen months during the reporting period recorded hits above NGDC's accounting software threshold. For these seven months, the average hits per month totalled 1569. This average would be lower if the totals for all months could be identified.

1E. IBCCA Web pages

The IBCCA web site was updated to include links from an undersea gazetteer (for sheets 1-02, 1-03, and 1-04) to PDF images of the features. Portions of the pages are available in Spanish, courtesy of the Instituto Nacional de Estadística, Geografía y Informática (INEGI). The site averaged 11547 hits per month during the reporting period, increasing from 7389 during 2001.

1F. IBCEA Web Pages

There have been no new updates to the IBCEA web site during the year. The IBCEA site received an average of 2934 during 2002, increasing from 1739 hits per month during 2001.

1G. GEBCO Gridders List Server

During the past year, traffic has tapered off 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) for the West coast of the United States is now complete. 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. Bathymetric contour data were supplied by Mexico's Instituto Nacional De

Estadística, Geografía E Informática (INEGI) for an area off the northern Mexican coast where there were no available NOS sounding data. Volume 6 covers the southern California coastal area, Volume 7 covers both northern California and southern Oregon, and Volume 8 covers northern Oregon and Washington. The CRM is an ideal base layer for all sorts of scientific and coastal zone management activities, fishing and fisheries work, and hazard modeling. All NOS data were converted to a common horizontal datum, NAD83, while the vertical datum for individual surveys was retained.

The next areas to be completed will be the coastal regions of Hawaii and Puerto Rico, which will be followed by Alaska.

Appendix I

Sources of data contributed to the NGDC during calendar year 2002:

Germany
Japan Oceanographic Data Center
Lamont Doherty Earth Observatory
National Imagery and Mapping Agency
National Oceanic and Atmospheric Administration
Ocean Drilling Program
Scripps Institution of Oceanography
U.S. Army Corps of Engineers
U.S. Geological Survey
U.S. Naval Oceanographic Office
Woods Hole Oceanographic Institution
World Ocean Circulation Experiment

Appendix II

Number of NGDC Marine Geology and Geophysics digital data products distributed by country between April 1, 2002 and March 31, 2003. Countries receiving data through UNESCO's Intergovernmental Oceanographic Commission (IOC) project to provide essential earth science data to new institutions in 26 developing nations are identified with an asterisk

<u>Products</u>	<u>Country</u>		
4	*Argentina	1	Malaysia
9	Australia	4	*Mauritania
1	Austria	4	*Mauritius
2	Belgium	7	*Mexico
4	*Benin	3	Monaco
7	Brazil	4	*Morocco
4	*Cameroon	4	*Mozambique
40	Canada	9	Netherlands
4	*Chile	1	New Zealand
4	*Columbia	4	*Nigeria
4	*Comoros Islands	8	Norway
4	*Cote-d'Ivoire	4	*Panama
4	*Czech Republic	1	Papa New Guinea
1	Denmark	5	*Peru
4	*Dominican Republic	3	Portugal
5	*Ecuador	4	Republic of Korea
21	France	6	Russia
21	Germany	4	*Senegal
4	*Ghana	4	*Seychelles
4	*Guinea	1	Singapore
2	Iceland	6	Spain
5	Indonesia	1	Switzerland
1	Israel	4	Taiwan
5	Italy	4	*Tanzania
9	Jamaica	4	*Togo
30	Japan	4	*Tunisia
4	*Kenya	54	United Kingdom
4	*Madagascar	1	Yemen

Appendix III

Number of cruises with bathymetry added to the Marine Trackline Geophysics, GEODAS CD-ROM, ver. 4.1, 2002 (since last CD-ROM, ver. 4.0, 1998):

USA	137
United Kingdom	135
Australia	16
Canada	7
Germany	6
France	5
Russia	4
Netherlands	2
University of Tokyo	2
Argentina	1
Spain	1
Grand Total	316

Number of cruises with bathymetry added to Marine Trackline Geophysics database since the May 2002 GEBCO meeting, and also since the release of GEODAS CD-ROM, ver. 4.1, 2002):

Japan	17
Germany	6
USA	1
Grand Total	24

Number of cruises with bathymetry received during this reporting period, May 1, 2002 to March 27, 2003:

USA	99
Germany	7
Japan	4
Grand Total	110