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ANNEXES

1. OPENING OF THE MEETING

1 The Nineteenth Meeting of the joint IOC-IHO General Bathymetric Chart of the Oceans Sub-Committee on Digital Bathymetry (SCDB XIX) was held at the Elliot Alumni Center of the University of New Hampshire, Durham, New Hampshire, USA on 16th and 17th May 2002.

2 The Chairman, Dr Meirion Jones, opened the meeting at 8.30am. Those present were the Chairman, Robert Anderson, Mike Carron, Norman Cherkis, Dan Donnell, David Divins, Robin Falconer, Jose Frias, Guenter Giermann, Andrew Goodwillie, John Hall, Peter Hunter, Martin Jakobsson, Tony Laughton, Mike Loughridge, Laurent Louvart, David Monahan, George Newton, Bill Rankin, Hans-Werner Schenke, George Sharman, Walter Smith, Shin Tani, Pauline Weatherall and the Permanent Secretary.

2. CONDUCT OF THE MEETING

3 The Agenda for the SCDB was adopted (Annex 1).

3. GEBCO DIGITAL ATLAS

4 The meeting began by reviewing progress on the production of the new GEBCO Digital Atlas (GDA).

3.1 Contoured data

3.1.1 Indian Ocean

5 Ms Weatherall reported that the digitisation was now complete of the bathymetric contour and trackline control charts provided by Dr Fisher for the greater Indian Ocean. The base data set had covered over 250 original charts of both contours and tracklines at a scale of approximately 1:1 million (4 inches per degree longitude) and over the years these had been supplemented by a further 600 update sheets. All of these charts had been edge matched both internally and with the GDA data in surrounding areas. The coastline was based on World Vector Shoreline (WVS) north of 60ºS and on the latest version 3.0 of the SCAR coastline data set south of this latitude. Ms Weatherall further reported that the digital vector contour data set had been transferred to Dr Goodwillie for gridding. The Sub-Committee unanimously recorded its thanks to Dr Fisher and noted his enormous contribution to GEBCO in revising the bathymetry of a quarter of the world's oceans. Thanks were also recorded to Ms Weatherall for her major contribution in digitising these data.

3.1.2 Weddell Sea

6 Ms Weatherall reported that she had received updated bathymetry (digital contours and tracks) from Dr Schenke for the northern area of the Weddell Sea and had incorporated these data into the GDA. There was some overlap with Sheet 97.2 (see Annex 3) where edge matching had been done on the contours in collaboration with Dr Schenke. In response to an enquiry from Dr Smith, it was explained that the grid had not been used in making the edges match.

3.1.3 New Zealand

7 Ms Weatherall reported that the tracks and contours for the NIWA chart around New Zealand had been incorporated and edge matched into the GDA.

3.1.4 North Atlantic Ocean

8 Since the last meeting, SHOM had delivered to BODC the bathymetric contours and trackline control data for IBCEA sheets 1.06, 1.09 and 1.10 (Sheet 1.08 had been delivered earlier). The data were delivered in digital form and, in order to conform to GEBCO requirements, SHOM had

kindly incorporated contours at 500m intervals into the data set in addition to the standard 200m interval contours included on the printed sheets. Ms Weatherall reported that these data had been successfully edge matched and incorporated into the GDA. Mr Louvart stated that SHOM had just finished IBCEA Sheets 1.11 and 1.12 in the eastern equatorial Atlantic and were ready to send these data to BODC. Mr Louvart agreed to look into the possibility of adding the 500m contour interval data before submitting the data set [Action Mr Louvart]. It was agreed that, subject to the data being submitted without delay, they should be incorporated into the next release of the GDA. The Chairman agreed to contact Mr Louvart by email to expedite delivery of the data set and also to arrange for the gridded version of the dataset to be submitted to Dr Carron well before the end of September [Action: Dr Jones and Mr Louvart].

9 The Chairman was pleased to report that the Instituto Hydrografico of Portugal had kindly agreed to make the data for IBCEA Sheet 1.01 available for GEBCO and had delivered a digital version of their data to BODC. Ms Weatherall reported that, with the assistance of Mr Hunter, she was actively engaged in incorporating these data into the GDA.

10 Ms Weatherall reported that she had incorporated data from IBCCA sheets 1.01 to 1.04 into the GDA and for trackline control had digitised information from the data source diagram provided by NGDC. Dr Frias stated that IBCEA sheets 1.05, 1.06, 1.09 and 1.11 were now available although not all edge matching work had been completed. Without wishing to further delay completion of the next release of the GDA, it was agreed to investigate the possibility of including the data from sheets 1.05 and 1.06.

11 Ms Weatherall further reported that work was virtually complete in incorporating and edge matching into the GDA the various update sheets in the Northeast Atlantic compiled by Mr Hunter at SOC. This included adding the chart supplied by Dr Sibuet of IFREMER for the Bay of Biscay which had been compiled with contours at 200m intervals and for which Mr Hunter had supplied interpolated contours at the missing 500m interval levels. Dr Smith enquired whether the GDA would include the original source contours if they did not correspond to an integral multiple of 500m. The Chairman reassured members that original contours would be on the GDA but that BODC always tried to ensure that GEBCO contained seamless contours at the standard GEBCO depths (i.e. at 200m, 500m and at 500m intervals thereafter).

3.1.5 Arctic Ocean

12 Dr Jakobsson had provided BODC with digital contours derived from the IBCAO grid and Mr Cherkis had visited BODC in summer 2001 to assist in editing these contours and ensuring a proper edge matching with the existing GDA contours. The WVS had also been added although for the northern coast of Greenland an improved coastline had been provided by the National Survey and Cadstre, Denmark for the use of GEBCO.

3.1.6 Antarctic Ocean

13 It was also confirmed that the SCAR coastline (version 3) would be included in the GDA.

3.1.7 The Gulf

14 In response to a question from The Chairman, Dr Carron confirmed that a grid of the Gulf would be included, sourced from either NAVOCEANO or from Dr Hall. The depth was everywhere less than 500m and contours would be generated from the grid.

3.2 Gridded data

15 Dr Carron summarised the constraints involved in producing a 1’ grid for the GDA; principally the grids and contours must match each other. Mr Rankin had completed the South Atlantic. The Southeast Pacific had been completed by Dr Carron except for the addition of a new shoreline. In the NIWA and NE Australia areas a 1’ grid had already been supplied. A 1’ grid had been derived from a finer grid supplied by Japan for the NW Pacific. Mr Hunter and Mr

Macnab had supplied a grid of the N Atlantic. Mr Hunter, Dr Carron and Dr Hall had all been involved in gridding the Mediterranean but new contours had to be generated. Dr Hall had also worked on the Caspian Sea, the Red Sea and the Gulf. Finally the Indian Ocean is being gridded by Dr Goodwillie using Dr Fisher's contours. The Arctic had been gridded by Dr Jakobsson and his team. The Caribbean Sea contours were needed by the end of September. Dr Carron estimated that all the gridding should be completed by September-October 2002 and would then require one month for final checking.

16 Dr Carron went on to mention the areas of overlap between sub-areas. Here edge-matching had been done by Mr Hunter, Ms Weatherall, Dr Carron, Dr Fisher and NIWA.

17 Finally Dr Carron mentioned the problematical SE Pacific. The charts of Dr Mammerickx were based on a relatively poor distribution of soundings. There had been no time to add new data. He had tried to use synthetic bathymetry from Smith and Sandwell but it differs in texture from reality. Dr Carron said he would try to collect all available data and decide which gives the better result [Action: Dr Carron]; there were a lot of options. Dr Falconer pointed out that some GEBCO data in the SE Pacific was 30 years old even though a lot more data now existed. GEBCO would lose credibility if it published the GDA without such data. He believed that GEBCO should use synthetic bathymetry, which has track control, even if it is 1-2 years old. Dr Sharman agreed and pointed out that 'synthetic bathymetry' was not really synthetic if other geophysical data had been used to constrain the contours. The Chairman observed that although ideally we should use the current interpretation combined with satellite altimetry to fill in gaps he considered there was insufficient time to do this for the new GDA.

18 Dr Carron concluded that in his opinion GEBCO could submit the final gridded data to BODC in late September 2002. The Chairman responded that he wanted a preliminary grid of the whole world as soon as possible to test software. Dr Carron replied that he expected new IBCM data from Dr Hall and it would be better to use these grids if available. In his opinion it would be better if all the IBCs would deliver their completed products to GEBCO, as did the IBCAO. But it might be necessary to do some sort of quality assurance checks even at a crude level. Dr Sharman said he entirely agreed. He had found gaps in the SW Pacific contours of the Louisville Ridge where they should be continuous.

19 Dr Carron continued that he considered that there should be no lake contours on the GDA; there are problems of different datum levels e.g. the Caspian Sea datum is at –27m relative to WGS-84. Dr Jakobsson concurred; he had encountered problems over glaciers and lakes using the GLIMPSE database over Greenland but not with the KMS data set which he had used to locate the glaciers. Dr Smith responded that he would like the GDA to show wet and dry areas irrespective of their relationship to sea-level. Dr Carron concluded that such difficulties were encountered only in a few areas. In a subsequent discussion Sir Anthony Laughton enquired whether any digital datasets existed over major lakes, such as Lake Baikal. Dr Smith replied that Russia had surveyed Lake Baikal and Dr Carron responded that he would accept any good data but he did not have the resources to chase it [Action: Dr Smith].

20 The Chairman said he was concerned at the risks of delay in gridding the GDA which had to be delivered by the end of September. Dr Carron summarised the risks. A few areas were not yet gridded. Dr Goodwillie stated that his goal was to complete gridding of the Indian Ocean by the end of September. Dr Loughridge enquired about the completion of the documentation. Dr Carron replied that the gridders would write it. The Arctic documentation was already complete; Mr Hunter would write the Atlantic documentation. Editing for consistency between different areas would also be needed. The Chairman asked what were the risks in the N Atlantic; he foresaw problems in the western part. Mr Hunter replied that there no problems but one or two new datasets had to be incorporated. The north-west and south-west were done, the continental shelf grid around the British Isles was nearly complete and all the available IBCEA data had been delivered to BODC.

21 Dr Sharman, supporting a suggestion by the Permanent Secretary, declared that the schedule had to be worked backwards from the release of the GDA at the Centenary Conference. The GDA will always be out of date as soon as it is published; updates after publication can always be posted on the Internet. Dr Loughridge and Sir Anthony Laughton concurred that a hard deadline had to be set; there was a risk of losing credibility if GEBCO did not deliver on time. Dr Carron responded that Internet issues had been put to the Guiding Committee for years without any result. He thought that the CD presentation alone was basically unsatisfactory. The Chairman agreed that the GDA will be the basis for further updates over the Internet and that there should be a firm cut-off data for data to be put on the new CD of the end of September. Dr Carron concluded that some time was also needed to put the GDA together after the delivery of the grids and he would put pressure on people to write the documentation now [Action: Dr Carron].

22 The Chairman stated that he would be preparing a glossy booklet to accompany the release of the GDA CD-ROM which would recognise those who had contributed to the GDA. He would consult Dr Carron about the text covering the gridding work [Action: Dr Jones and Dr Carron].

4. WORLDWIDE REVIEW OF BATHYMETRIC MAPPING

4.1 Reports of the GEBCO Bathymetric Editor and GEBCO Digital Atlas Manager

23 Mr Hunter, Bathymetric Editor, gave his report for 2001-2002 (Annex 2). Work had focused on the production of gridded bathymetry for the North Atlantic, specifically the north-west, in collaboration with Mr Macnab, the south-west, west of Great Meteor Seamount and the continental shelf around the British Isles. Other activities included the Editor's recent participation in a survey cruise for UNCLOS purposes over the Falkland Plateau in which the GDA contours proved to be of particular value. Mr Hunter said he would try and acquire the survey data for GEBCO [Action: Mr Hunter]. Dr Loughridge cautioned that such data did not enter the public domain automatically.

24 In response to a question from Dr Falconer, Mr Hunter confirmed that he had not been involved in an Editorial role with countries other than that those mentioned in his report. Sir Anthony Laughton enquired whether he had made any approaches to reviewers to acquire new data. Mr Hunter replied that he had not done so in the past year although he had kept an eye on the literature. For example, he had learnt that Geoscience Australia (formerly AGSO) have two projects that have bathymetry in their descriptors, including one that has a 30' resolution grid as an output.

25 Ms Weatherall, Digital Atlas Manager, gave her report for 2001-2002 (Annex 3). The main activity had been the production of final digitised contours and track lines for inclusion in the GEBCO Digital Atlas (GDA). Indian Ocean contours supplied by Dr Fisher had all been digitised. Other data passed on to the new GDA included contours and some coastlines from the Weddell Sea, New Zealand, Gulf of Mexico, eastern North Atlantic Ocean and the Arctic Ocean. In some cases edge matching of contours with adjacent areas had to be carried out.

4.2 Arctic Ocean

26 Dr Jakobsson reported with news from the IBCAO (Annex 4) whose last meeting had been held in May 2001. A lot of maps and gridded datasets could now be downloaded over the Internet. Version 1.0 of the grid was finished with a gridding interval of 2.5 km (equivalent to about a 1' geographical grid) in a polar stereographic projection. Over glaciers the GLIMPSE and KMS datasets had been merged and the ice surface had its own colour scheme. The dataset had also been updated with topography from GLOBE, the removal of false depths, bad tracks and some false seamounts and the addition of some 1991 *Polarstern* hydrosweep data. The IBCAO was

very popular. He was trying to improve the dataset by using other information including gravity.

27 Mr Newton updated members on his recent Article 76 work with the US State Department. The US Navy is more than willing to install SCICEX equipment on a submarine if asked. An ice-breaker can also be involved in the support of multichannel seismic reflection profiling. If funded such a project would take 2-3 years to complete.

28 In a separate discussion Dr Anderson reminded members of the *Healy/Polarstern* survey of the Gakkel Ridge. Dr Hall added that the ice-breaker *Odin* had spent 5 days over the Lomonosov Ridge conducting a site survey for a drill site proposed in IODP Proposal 533.

29 Dr Schenke presented charts based on 50 days surveying spread over a decade in the Fram Strait area. Nine charts at 1:100,000 scale had been completed.

4.3 Antarctic Ocean

30 Dr Jakobsson mentioned that the DBDB5 compilation of bathymetry in Antarctic waters had been used to generate a 2' gridded dataset. Ron Macnab and others were keen to create a new Antarctic chart, comparable to the IBCAO chart, which could make use of Antostrat data [Annex 5]. Dr Schenke suggested that Glen Johnson of SCAR, who has a lot of relevant data, should also be involved. Dr Falconer added that a proposal existed in New Zealand to map the Ross Sea. Sir Anthony Laughton enquired about the boundaries of the proposed chart (the IBCSEP cuts off at 60ºS) and possible interactions with the IBCSEP. Dr Divins thought that because the Antarctic chart would be gridded in the same way as the IBCAO there should be no problem in merging it with the IBCSEP.

31 In response to Sir Anthony Laughton's query that the new chart might become a new IBC of the Southern Ocean Dr Giermann interposed that, although this sounded an exciting project, any new IBC had to be agreed by 130 countries and would need the blessing of the IOC and CGOM. Dr Schenke added that, although impressed by the amount of data held by NGDC, the AWI plans to work with the BAS and Spanish groups in the Scotia Sea. He then broadened the discussion by suggesting that in future any work on Southern Ocean bathymetry should involve SCAR. Dr Giermann responded that the proponents of the any new IBC should also consider the Antarctic Treaty Organisation which holds a biennial conference involving mainly non-scientific delegates but with observers from the IOC and the IHO. Dr Schenke added that the IHB also has a Hydrographic Commission of the Antarctic chaired by Rear Adml. Guy. Sir Anthony Laughton asked whether any proposal for a new IBC should be discussed by the Guiding Committee before approaching IOC? If so, more details were required. Dr Giermann suggested that the Sub-Committee should report to the GEBCO Officers who could then inform the Guiding Committee which was not scheduled to meet until 2003!

32 Dr Falconer pointed out that this discussion was all very well but people may just decide to get on and create the new chart. The creative activity and the bureaucratic discussions could proceed in parallel. The Chairman concurred; that was exactly what had happened regarding the IBCAO.

33 Dr Schenke reported that six 1:1 million charts of the Weddell Sea, with 50 or 100 m contours based on a 1km grid, had been completed. The observed ocean current vectors in the Weddell Sea are consistent with the bathymetric charts. He stated that Dr Udintsev continues to work on the west side of the South Shetland Trough round into the SE Pacific; he had recently carried out a multibeam survey in the Scotia Sea.

34 Dr Falconer informed the committee that a New Zealand proposal exists to compile the bathymetry of the Ross Sea based on existing data, some of which comes from fishing vessels.

The Chairman commented that the Australian Antarctic Division also possesses data and Dr Falconer offered to find out how to funnel this data into the NGDC [Action: Dr Falconer].

35 Dr Schenke ended by informing members that he was the GEBCO representative on the SCAR Geodesy and Geographic Information Working Group. Not all bathymetric data were submitted to the WG. Research ships tend to acquire single beam bathymetry but supply ships nothing at all.

4.4 Atlantic Ocean

36 Dr Jakobsson reported a new project to map the US continental margin. Funding would come from many sources but mostly from NGDC. Existing track lines had already been compiled, using an Oracle interface with the GEODAS system but also including NIMA and USGS data, and could be interrogated for metadata.

37 Dr Schenke reported on work done by the *Polarstern* in the Porcupine Basin area, in conjunction with the Irish Geological Survey and universities, under the auspices of the EU-funded Geomound Project. The objective was to use back-scattered sound to locate deepwater carbonate mounds and coral banks. A DTM, which included Porcupine Seabight and the western Rockall Trough, had been constructed to an accuracy of 50±4 m. A second cruise was planned in 2003 in the same area with the submersible Viktor 6000.

38 Dr Frias next reviewed the status of the IBC of the Caribbean and the Gulf of Mexico (IBCCA) (see http://www.inegi.gob.mx and Annex 6). Seven countries had been involved (Cuba, USA, Mexico, France, Venezuela, Colombia and Costa Rica). The sheets had been compiled at a scale of 1:250,000 and contoured at 200 m, or even more closely. All geographical names had been approved by SCUFN. Each sheet has a panel with basic information about the IBCCA. Eight sheets (1 through 6 and Sheets 9 and 11) out of a total of 16 were now available. Work, including edge matching, is now proceeding on Sheets 12, 13, 14 and 17. Problems had been encountered with different spatial co-ordinate systems and with contours that had been produced at 250 m intervals. Land topography was not available in certain areas. Although magnetic and gravity anomalies may be added later this was impossible at present because out of the 25 countries in the area many small island states had no observations and a variety of different regional fields had been used.

39 The Chairman enquired how the 8 charts to be released over the Internet were to be sold. Dr Frias replied that the IBCCA was making a list of institutions willing to sell the charts. The plan was to send .pdf files to users for printing but in addition to print 300-500 paper copies of each sheet (each in two halves because of physical limitations). Sheets 4 and 9 were already printed. Dr Sharman enquired whether the gridded data would be available for the GDA by the end of September. Dr Frias replied that a gridded dataset and vector contours were already available. Mr Rankin reported that he already had Sheets 1 through 4 but it would be nice to have Sheets 5 and 6 as well. Dr Frias agreed that the latter two sheets could be copied to NGDC [Action: Dr Frias] but some edge matching would be required. Dr Sharman stated that he would try to get the gridded data to Mr Rankin and the contours to Ms Weatherall [Action: Dr Sharman]. In answer to concerns that this new data might delay publication of the GDA the Chairman stated that Sheets 5 through 9 would be needed by mid-June 2002. Mr Louvart said that SHOM had asked IOC for help to complete Sheets 10 and 16 in November 2001 because it lacked resources. SHOM would update Sheet 9 which had already been printed. Dr Giermann cautioned that IOC was under the impression that other IBC charts would be published first and that no help was likely to be forthcoming from the IOC in the next few months. The Chairman concluded the discussion of the IBCCA by thanking Dr Frias for presenting the exciting progress that had been made.

40 Mr Hunter informed members that the British Geological Survey was currently digitising contoured sheets to generate a digital vector database, initially of the UK then eventually along

the NW coast of continental Europe. The bathymetry was based on Admiralty (Hydrographic Office) sheets at 1:250,000 scale. They mainly covered the shelf but beyond that limit relied on the IOS bathymetry.

41 Sir Anthony Laughton recalled that in 2001 the Guiding Committee had heard about the regular passages of the RRS *James Clark Ross* to the South Atlantic. The British Antarctic Survey (BAS) were prepared to collect, but not process, multibeam data. Mr Hunter replied that he had discussed the situation with Mr Peter Morris (BAS). One difficulty was the lack of Neptune processing software at SOC; how was this to be paid for? Dr Schenke said he had encountered a similar problem when AWI was asked to collect multibeam data over the Mid-Atlantic Ridge; there were no funds for the personnel to collect and process the data. Although Dr Hall offered to process any such data it was concluded that the first step should be for Mr Hunter to request Mr Morris to conduct a trial acquisition [Action: Mr Hunter].

42 Dr Hall reported on his work in the Caspian and Black Seas which included the assimilation of about 1000 Russian charts. The charts had been scanned at NIMA and quality assured by Dr Hall before gridding. The depths were referenced to both WGS-72 and WGS-84 datums. He had gridded over 196,000 Black Sea soundings at a spacing of 0.25'. The Caspian Sea had involved about 186,000 soundings. Coverage was good except in the southern (Iranian) sector. Definition of the coastline was also problematical as was the 27 m datum offset. Finally he hoped to acquire more multibeam data in the Eastern Mediterranean to fill gaps in deep water. He now has an operational system to map Israeli waters down to a depth of 800 m.

4.5 Indian Ocean

43 Activities in the Indian Ocean were considered under the discussion on digitising and gridding Dr Fisher's charts (see Sections 3.1.1 and 3.2).

4.6 Pacific Ocean

44 Dr Schenke reported the results of work in the Eltanin impact area (55ºS, 85ºW). Meteorite debris had been found in cores. Two expeditions had produced some very high quality cartography with four 1:100,000 and two 1:200,000 sheets.

45 Dr Divins informed members about the immense project to produce an IBC of the Western Pacific involving over 100 sheets at 1:1 million scale [see Annex 7]. Progress had been very slow and in 2001 it had been proposed that the project divide into two parts. Australia and New Zealand had produced a gridded dataset. There had been no action in SOPAC Area 6. Japan and Korea had completed multibeam surveys of their EEZs. Russia had been most active in producing sheets, at least five. Area 3 is proving to be the biggest problem. In answer to questions Dr Divins confirmed that the EEZ areas were mostly covered by multibeam surveys but oceanward mostly only soundings were available which led to different styles of contouring. Dr Falconer interjected a comment on the relationship between IBCs and GEBCO (a discussion paper on this subject can be found in Annex 8). He was not sure that the IBCWP realised that in New Zealand NIWA was not interested in producing new charts, it did not have the resources, but only wanted to offer raw data to the IBC. Mr Tani similarly commented that although Japan was conducting multibeam surveys of its EEZ (for which he was responsible) it was not interested in publishing charts at 1:1 million or even 1:100,000 scales because demand is changing so fast. If charts are produced then that will be done by print-on-demand. Dr Divins confirmed that both Russia and China were still eager to publish just paper charts.

46 A discussion ensued on the merits of contouring sparse data against re-surveying and on which datums to use for different types of data. Mr Tani gave examples of the differences he had encountered between satellite altimetry derived (SAD) bathymetry and multibeam surveys using Tokyo, WGS-84 and SAD datums. SAD bathymetry and the Tokyo datum differed on average by only 1 cm. The differences between SAD bathymetry and WGS-84 datum were

mostly random, on average 43 cm, and showed up bad ship tracks. Dr Carron thought that there were two major sources of error 1) the ship data used to calibrate the SAD bathymetry and 2) errors from the SAD bathymetry itself. Stripy errors on charts can be due to errors in both position and depth; satellites were well positioned but some ship data were questionable. Dr Smith explained some of the limitations of SAD bathymetry. If there are errors in soundings (whether from Geodas or other sources) that are used to calibrate interpretations of satellite gravity then the calibration can be in error and this will affect a whole chart! Once SAD bathymetry has been produced sometimes attempts are made to add soundings from ships and this may generate huge discontinuities which are smoothed out. Thus a single ship track can lead to a swath of 'bad' pixels. He suggested that Mr Tani possessed the ideal dataset to investigate these issues and that if GEBCO added weight to this suggestion it might help to ensure it happened. The Chairman concurred that is was worth exploring such comparisons in the Japanese EEZ, the extensive multibeam coverage in the area would provide an ideal test bed for analysing the strengths and weaknesses of SAD bathymetry [Action: Mr Tani]. Dr Falconer commented that this would be an ideal subject for a GEBCO-sponsored PhD student.

47 Dr Divins continued by describing the inaugural meeting of the IBCSEP in Valparaiso in October 2001 at which an Editorial Board and a Chief Editor had been nominated. The concept of an IBCSEP had been well received. Each coastal state will have its own area of responsibility but data will be shared. To start with a traditional approach will be followed of producing contours and gridded data at 1:1 million scale. A new grid will be produced in Phase 2 but first it was necessary to identify all the data collected over the last 30 years. The group plans to meet annually during regional hydrographic conferences. The next meeting will be in 2003. The Chairman asked how to the data were being compiled. Dr Divins replied that soundings were being compiled on 1:250,000 plotting sheets and that copies of all the sheets were being assembled by the Chief Editor in Chile. Rear Adml. Guy enquired whether the Chief Editor of IBCSEP was aware of the responses from VHOs to the IHB's Circular sent out in 1999 in which some VHOs had already committed to sharing data. Dr Divins responded in the negative but said that, for the purposes of the IBCSEP, Chile had already agreed to make available its contours and even gridded data.

48 Dr Sharman reported on activities in the NE Pacific. There had been no major regional mapping activity but a lot of ship surveys had taken place e.g. in the Gulf of California and off Hawaii. It appeared that regional mapping had become the province of the IBCs. Sir Anthony Laughton responded that currently the IBCs cover only 5% of the ocean surface and it was important to realise that GEBCO has a global remit whereas the IBCs are purely regional.

4.7 Mid-Ocean Ridges

49 Sir Anthony Laughton commented that the committee had just considered the global ocean but what was being done about the assimilation of mid-ocean ridge multibeam surveys into GEBCO? Dr Carron responded that personally he was keen to consider the technical issues of merging such data into GEBCO after the new GDA had been launched [Action: Dr Carron]. Dr Loughridge confirmed that RIDGE data was reaching the NGDC.

5. RELATED ACTIVITIES

5.1 IHO Data Centre for Digital Bathymetry, World Data Center for Marine Geology and Geophysics and NGDC activities in support of IOC/GEBCO

50 Dr Sharman reported on the activities of the NGDC (Annex 9). Growth in accession of single beam soundings continued apace, such that holdings doubled every 10 years. For comparison, US hydrographic surveys doubled every 20 years but this was about to change drastically with the acquisition of multibeam data in shallow water and with digital sidescan. The accession of multibeam data was growing at the same 10-year rate but the volume of data involved was

several orders of magnitude greater. There had been a 23% increase in requests for data from outside the USA. Regarding marine geology and geophysical data, on-line accesses were now (first quarter of 2002) running at 1.2 million per month and 40 Gb of data were being downloaded per month. There had been a shift from the use of Geodas CDs to online downloading.

51 The NGDC was involved in all 6 IBCs, the new IBCSEP and the proposed IBC of the Baltic. The IBCSEP will include an element of training; two people per year will spend a week at NGDC. NGDC had received an award at the Beijing meeting of the International Cartographic Association for mapping the Great Lakes. NGDC had contributed in October 2001 to the National Geographic Atlas of the Oceans.

52 New NGDC products include ETOPO2 on a CD-ROM, which is a blend of the IBCAO, Smith & Sandwell predicted bathymetry, a global 1 km land grid, DBDB-V etc. (Dr Smith pointed out that although ETOPO2 contains SAD bathymetry it was not identical to the original Smith & Sandwell product. ETOPO2 is based on a latitude, longitude grid and not a Mercator grid. The Smith & Sandwell product used a 2' grid based on odd numbered minutes of arc whereas ETOPO2 uses even minutes. Thus some information was lost in converting from Smith & Sandwell to ETOPO2). A new marine trackline CD-ROM would appear in 2002. Both these products would include information to assist US coastal hydrography and fishing. Future plans include putting DBDB-V on two CD-ROMs to complement the USNOO source of DBDB-V. Improvements in Geodas include new editing tools and Hydroplot. New coastlines were available with customisable resolution. Work was proceeding on a coastal relief model (merged topography and bathymetry). The northern Gulf of Mexico was complete and Alaska, Hawaii and Puerto Rico had yet to be done. There had been problems with vertical datums but a reference datum now existed for the whole USA.

53 Dr Goodwillie commented that today 'soundings' are often derived from the centre beam of a multibeam survey and asked whether the NGDC77 format would still be used in 5-10 years time. Dr Sharman assured him it would. The Chairman asked whether all countries contributed data equally to NGDC? Dr Sharman replied that he expected a large flow of data from Japan and from Lamont-Doherty Earth Observatory which was 10 years behind in its data transfer. NGDC is proactive in seeking data but would like GEBCO's assistance. NGDC reports annually to the IHB. Rear Adml. Guy offered that the IHB could remind member states to submit data even from particular areas. Dr Sharman replied that he would prepare a table of what data had been obtained from which countries [Action: Dr Sharman]. Mr Tani enquired whether NGDC had reached the point where data was being accessed equally from CDs and over the Internet. Dr Sharman responded that the media available were defined by staff workload and by data assimilation rates. NGDC might move over to DVD soon but realised that this might not suit all customers. Dr Loughridge added that NGDC was happy to allow direct Internet access to metadata. Mr Tani said the reason he asked the question was that he was concerned at the contrast between the new GDA on CD-ROM and the Internet access offered by NGDC.

5.2 International Hydrographic Bureau

54 Rear Adml. Guy wished to draw members attention to two items. First, there was concern within the IHO about the credibility of GEBCO. There was concern about the relevance of GEBCO activities to the aims and objectives of the IHO. For example, a current major problem for the IHO/IMO is the poor charting of Lake Victoria (19th century surveys for 20th century charts) yet it is traversed by ferries large enough to carry trains. If altimetry data could be used to show where future ship surveys should concentrate their activities that would be extremely useful. Dr Smith offered to respond to this request [Action: Dr Smith]. Second, IHO data has to be in the S-57 standard format and IHB would like to make it ISO compatible [Annexes 10,11]. There should be a product specification for hydrographic data. Although 32 out of 34 states favour a standard specification the problem was complex because 22 subsets of data have been

identified. The IHO would like to identify some standardisation for the exchange of data e.g. for the exchange of data with GEBCO. When asked to clarify exactly what he wanted Rear Adml. Guy said he would like to come up with a draft specification that could be submitted to GEBCO, as producers of data, for comment. After further discussion it was agreed that Dr Sharman should liaise with the IHB on this matter on behalf of the Committee [Action: Dr Sharman].

55 Rear Adml. Guy then drew the Committee's attention to IHO Special Publication 23 'Limits of Oceans and Seas' which was published 50 years ago and is still in demand. A new draft is being prepared by Michel Huet, in conjunction with a consultant Adam Kerr, which will not be definitive but which will describe regional practice. Some sensitive issues were holding up the final draft but the IHO Legal Advisory Committee had suggested use of a device whereby parties could sign up to the draft 'with reservations' to get round this. The final draft may appear by the end of August or September 2002. Once approved the draft would be made available in .pdf format because it contains a large number of chartlets. The final document would be published in 6 months time but because it would be only an advisory document it might be circulated in draft form only. In discussion Dr Loughridge suggested that a digital representation of SP-23 would be very valuable as a search tool particularly with a vectorised version of the sea area limits. NGDC would be prepared to generate such a product [Action Dr Sharman].

6. ANY OTHER BUSINESS

6.1 Access to bathymetry over the Internet

56 An inconclusive discussion took place concerning setting up a web site to give everyone links to sources of bathymetry for different geographical areas. Dr Jakobsson considered that new techniques and browsers could be used to seek data. Dr Hall mentioned the web site of the Avid company that sells products aimed at exchanging large digital datasets (http://www.avid.com/index_nf.asp).

6.2 Geographical limits to undersea features

57 Dr Falconer recalled that during the 2001 meeting he had raised the issue of the geographical limits of features e.g. in the area around New Zealand. The background was that the Gazetteer only listed point locations. He had begun to pick boundaries from GEBCO Sheet 5-10 but stopped after reaching 34 features. In some cases a hierarchy of features had to be established e.g. the Louisville Ridge was both a ridge but also lay within the SW Pacific Basin. Another problem was at what depth to define the Kermadec Trench. Nevertheless polygons could be displayed according to the class of the enclosed feature e.g. show all rises, ridges etc. He concluded that this might be a useful approach but asked who would do it in the GEBCO community. There were also potential political problems. Dr Smith thought that potentially this approach was very interesting; it had educational and scientific uses and would also help in plate tectonic reconstructions. Rear Adml. Guy thought that this suggestion would involve much more work than was currently involved in naming features and wondered who would do it. Dr Carron replied that this was an exciting approach; we should not think about the problems but regard the suggestion as an opportunity. The meeting encouraged Dr Falconer to continue his investigations [Action Dr Falconer].

6.3 Specification of the International Bathymetric Charts

58 Dr Divins informed members that at the last CGOM meeting a standard specification for each IBC was recommended even though it was recognised that some IBCs had developed their own specifications. Dr Travin and Mr Huet were going to complete the specifications including scale, contour interval, etc. Dr Divins thought that a draft document existed.

7. DATES AND PLACES FOR THE NEXT MEETINGS

59 The next meeting will take place at the IHB, Monaco on the occasion of the GEBCO Centenary Conference in April, 2003. Preliminary dates are 16th (p.m.) and 17th April.

8. CLOSURE OF THE MEETING

60 The Chairman thanked all those who had contributed to the discussions and closed the meeting at 12.45pm on 17th May 2002.

ANNEX 1

Nineteenth Meeting of the GEBCO Sub-Committee on Digital Bathymetry

The University of New Hampshire, Durham, New Hampshire, USA
09.00, 16 May
09.00, 17 May (am only)
2002

AGENDA

1. OPENING OF THE MEETING

2. CONDUCT OF THE MEETING

    2.1 Adoption of the Agenda
    2.2 Tabling of Documents

3. PUBLICATION OF GEBCO DIGITAL ATLAS (THIRD EDITION)

    3.1 Completion of contour vector updates & associated documentation
    3.2 Completion of the gridded data set & associated documentation
    3.3 Software interface to the GDA (Third Edition)
    3.4 Contents of the GDA (Third Edition)
    3.5 Publication of the GDA (Third Edition)

4. REVIEW OF BATHYMETRIC MAPPING WORLDWIDE

    4.1 Report of the GEBCO Bathymetric Editor
    4.2 Arctic Ocean
    4.3 Southern Ocean
    4.4 Atlantic Ocean and adjacent seas
    4.5 Indian Ocean
    4.6 Pacific Ocean

5. RELATED ACTIVITIES

    5.1 IHO Data Centre for Digital Bathymetry and NGDC
    5.2 Undersea Feature Names Database
    5.3 Shorelines
    5.4 Shallow Water Bathymetry

6. ANY OTHER BUSINESS

7. CLOSURE OF THE MEETING

ANNEX 2

Report of the GEBCO Bathymetric Editor (GBE) April 2002

Peter Hunter, SOC, UK

Work this year by the GBE has continued with the production of a gridded bathymetry for the North Atlantic. The main areas have been: the continental shelf around the British Isles, the Northwest Atlantic margin of Canada, the Southwest North Atlantic and the area to the west of Great Meteor Seamount.

Continental shelf around the British Isles and the North Sea

This work has used navigation charts produced by the United Kingdom's Hydrographic Office to provide contours and depths as source material has continued in the same way as described last year. The principal area of interest was to the west and north of Ireland where errors had been identified in an earlier version of the grid.

Northwest Atlantic margin of Canada

As reported last year, the incorporation of the GSC/CHS gridded bathymetry of the continental margin around Canada has not been easy. The method described last year was used, but it was still necessary to edit the original Canadian grid by displaying it with the aid of the HydroPlot software from NGDC.

Southwest North Atlantic

The grids of the Atlantic margin of the USA and the Gulf of Mexico have been combined with existing grids derived from the GEBCO contours. Some problems in deeper water were identified and solved. Also, areas in the Caribbean Sea gave problems, particularly those having large extents very close to the surface.

Great Meteor Seamount

New contours were drawn to fill in a gap in earlier compilations; these have been digitized but not yet gridded.

There are still a number of new digitized contours that need to be incorporated, including IBCEA 1.01; it is expected that this work will be completed very soon.

Other Activities

The GBE recently participated on a six week long cruise around the Falkland Plateau. This cruise carried out a multibeam bathymetric survey for UNCLOS purposes. During the cruise the GBE was able to see how various datasets, such as the GDA and GEODAS, could be used to help in the work.

The GDA contours were of particular use, more so than if they had been in gridded form. There were a number of differences with the new data, as would be expected, but on the whole the GDA contours were fairly accurate.

The GEODAS dataset was extremely useful for providing profiles to identify the foot of the slope.

ANNEX 3

Report of the GEBCO Digital Atlas Manager April 2001 – May 2002

Pauline Weatherall, POL, UK

The following is a progress report on the work done to finalise the digital bathymetric contour and trackline control data sets for inclusion in the GEBCO Digital Atlas, GDA.

Indian Ocean Area

Work is now complete on the digitisation of the bathymetric contour and trackline control charts supplied by Dr. Robert L. Fisher for the greater Indian Ocean area. The area covered by the data set is shown in the attached diagram. The bathymetric contours and tracks were digitised from charts at a scale of approximately 1:1million (4 inches per degree of longitude). The standard contour intervals of 200m, 500m and then 500m intervals thereafter were included on the bathymetric contour charts and in some areas the 100m bathymtric contour is also included.

Work on the digitisation of this data set has been ongoing over the last ten years. Originally the data set consisted of over 250 (each) bathymetric contour and trackline control charts. This has been supplemented over the years by over 600 sections of update charts, as more data became available to Dr. Fisher.

Dr. Fisher has also provided bathymetric contours and trackline control charts for the area of the edgematch of the western boundary of his data set and the surrounding GDA data sets, i.e. 5.12 and 5.16. This takes the western boundary of the Indian Ocean data set out to 12°W between 24°S and 56°S, and 12°W between 60°S and 66°S. Dr. Fisher also provided bathymetric contour and trackline control data for the area 20°W-10°W; 56°S-60°S and this has now been included in the GDA data set.

For the Red Sea area, bathymetric contours have been taken from GEBCO sheet 5.05.

The digital coastline for the Indian Ocean area, north of 60°S, has been taken from the World Vector Shoreline data set (1:1 million scale). South of 60°S the coastline data are taken from version 3.0 of the SCAR coastline data set (1:1 million scale).

Weddell Sea Area

Dr. Hans Schenke has provided digital bathymetric contour and trackline control data sets for the area 60°S-66°S; 75°W-15°W and 66°S-68°S; 63°W-15°W. The bathymetric contours are at 100m intervals. Bathymetric contours and trackline data were also provided for the area 66°S-71°S; 2°W-2°E and these data have now been included in the GDA.

Digital coastline data have been included in the data set from version 3.0 of the SCAR coastline (full resolution).

New Zealand Area

As reported at previous meetings, we have received digital bathymetric contour and trackline control data from NIWA for the area around New Zealand (157°E-167°W; 24°S-57° 30'S). The bathymetric contours are at 50m intervals from 50m to 250m and then at 250m intervals from 500m to 10000m.

The data have now been edgematched with the surrounding GDA data sets. Staff at NIWA provided help with this work. The boundary of the NIWA data set and Dr Fisher's data set in the region of 157°E has now been further edited.

Digital coastline data have been included from the World Vector Shoreline data set (1:1 million scale).

North Atlantic Ocean Area

1. Gulf of Mexico Region

As reported at previous meetings, we have received digital bathymetric contour data for the area 98°W-69°W; 24°N-33°N from NGDC. The bathymetric contour data are at 100m intervals, from 100m to 5600m. However, only the 200m interval and 500m interval contours are continuous throughout the data set. In addition bathymetric contours at depths of 20m, 40m, 60m, 80m and 150m are also present. In some areas bathymetric contours are also present at 20m intervals from 5400m to 5520m and at 10m intervals from 5530m to 5660m in some areas.

Digital trackline control data for this area have been taken from a data source diagram provided by NGDC.

The bathymetric contours for this region have been edgematched with the surrounding GDA data sets.

Digital coastline data have been included from the World Vector Shoreline data set (full resolution).

2. Eastern North Atlantic Region

The attached diagram shows the coverage of the data sets received for the eastern part of the North Atlantic for inclusion in the GDA.

As reported previously, we have received digital bathymetric contour and trackline control data from SHOM for IBCEA sheet 1.08. This year we also received from SHOM, digital bathymetric contour and trackline control data for IBCEA sheets 1.06, 1.09 and 1.10. The bathymetric contours in these data sets are at 200m intervals. However, bathymetric contours at 500m intervals are also included from 500m to 7500m. A one-minute interval DTM for the Northeast Atlantic Ocean area was also supplied by SHOM.

Mr. Peter Hunter of SOC has provided bathymetric contour charts and digital bathymetric contour data sets for the eastern part of the North Atlantic. The following summarises the data sets received:

1. 15°W-5°W; 32°N-38°N (approx. area) - 12 charts at scales between 1:275,000 and 1:1:520,000, contours at 100m intervals, contours are present at 20m intervals in some abyssal plain regions
2. 28°W-21°W; 26°N-34°N (approx. area) - data supplied in digital form, contours at 100m intervals
3. 18°W-14°W; 31°N-33°N (approx. area) - data supplied in digital form, contours at 20m intervals between 4300m and 4620m.
4. 47°W-20°W;18°N-33°N (approx. area) – 13 charts at scales between approx. 1:1.2million and 1:0.7million, contours at the standard 500m intervals, however contours at 100m intervals are present out to approximately 30°W
5. 30°W-26°W; 30°N-35°N (approx. area) – data digitised from charts at a scale of 1:1.4 million, contours at 500m intervals, however contours at 100m intervals are present in places

Bathymetric contour data have also been provided for IBCEA sheet 1.01(15° 20'W-7° 20'W; 36°N-44°N) by the Instituto Hidrografica, Portugal. The bathymetric contours are at 200m intervals. Additional bathymetric contour data at 500m intervals have been digitised and added to the data set.

Trackline control information has been provided in the form of a data source diagram.

For the Bay of Biscay region (16°W-0°E;42°N-50°N) digital bathymetric contour and trackline control data have been taken from charts supplied by Dr. Jean-Claude Sibuet of Ifremer. The bathymetric contours are at 200m intervals. Peter Hunter has provided additional bathymetric contours at 500m intervals. These contours have now been digitised and added to the data set.

Arctic Ocean Area

A CD-ROM containing bathymetric contour, gridded bathymetry data and source data files has been provided by Dr. Martin Jakobsson for the IBCAO data set, north of 64°N. The bathymetric contours are at the following depths: 20m, 50m, 100m, 150m, 200m, 250m, 300m, 400m, 500m and then 500m intervals thereafter.

During July 2001, Mr. Norman Cherkis kindly worked on the edgematching of the bathymetric contours from the IBCAO data set with the surrounding GDA along the 64°N boundary. Mr. Cherkis also carried out some minor editing of the IBCAO contours to remove artefacts from the gridding process.

Digital coastline data from the World Vector Shoreline data set (1:1million scale) has been included in the data set, except for the region of northern Greenland where the coastline is taken from a data set provided by the National Survey and Cadstre, Denmark.

Other Data Sets Received:

Version 3.0 of the Scar coastline data set at the full resolution, 1:1million scale, 1:5million scale and 1:10million scale.

ANNEX 4

The International Bathymetric Chart of the Arctic Ocean (IBCAO): Activity report for 2002

Martin Jakobsson and Ron Macnab
On behalf of
the Editorial Board of the International Bathymetric Chart of the Arctic Ocean

Background

During the AGU fall meeting in 1999 a Beta version of the International Bathymetric Chart of the Arctic Ocean (IBCAO) was introduced to the geophysical community. This introduction was followed by an article in EOS (Jakobsson *et al.*, 2000), and IBCAO was made publicly available through a web site hosted by the National Geophysical Data Center (http://www.ngdc.noaa.gov/mgg/bathymetry/arctic/arctic.html) in early March of 2001. Since the release, IBCAO has been widely circulated and used in Earth Science applications. The website has ca 500-1000 visitors/week, which makes it one of the most popular of all web sites hosted by NGDC.

The most recent IBCAO editorial board meeting was held in May 2001 at the Center for Coastal and Ocean Mapping/ Joint Hydrographic Center, University of New Hampshire (Jakobsson and Macnab, 2001). During this meeting updates of the bathymetric model were discussed, as well as the generation of bathymetric contours for the GEBCO Digital Atlas and additional digital formats to be made available for the IBCAO user community.

Updates and release of new formats and bathymetric products

Version 1.0 of IBCAO, which followed the IBCAO Editorial Board meeting in New Hampshire, was released during the fall of 2001 and shown at the AGU meeting in San Francisco (Jakobsson and the IBCAO Editorial Board, 2001). In addition, new formats and bathymetry products were made available through the NGDC hosted web site during the fall of 2001. The updates of the IBCAO bathymetric chart include:

1. Corrections of dubious features in Norwegian waters and off the coast of Svalbard, identified by the Norwegian Petroleum Directorate (NPD)
2. New multibeam data covering an area of ca 180 000 km^2 off the coast of Norway, received from NPD
3 New incorporated data from Alfred Wegener Institute, including processed Hydrosweep data of the Fram Strait, North of Svalbard and the Lomonosov Ridge
4. Corrections of a dubious seamount-like feature in the Canadian Basin
5. Correction of a dubious submarine track in Barrow Strait
6. Update of Alaskan topography using GLOBE

New formats and products available at the IBCAO web site:

1. ArcInfo and Intergraph MTA grid formats
2. Geographic grid with a resolution of 1° x 1°
3. Bathymetric contours derived from the grid, representing depths of 20, 50, 100, 150, 200, 250, 300, 400, 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, and 5000 m
4. Poster-size maps with contours plotted on top of a shaded relief in postscript format

References

Jakobsson, M., and IBCAO Editorial Board Members, 2001, Improvement to the International Bathymetric Chart of the Arctic Ocean (IBCAO): Updating the Data Base and the Grid Model, EOS Transactions, American Geophysical Union, v. 84.

Macnab, R., and Jakobsson, M., (eds), 2001, IOC/IASC/IHO Editorial Board for the International Bathymetric Chart of the Arctic Ocean, GSC Open File 4185. p 1-33.

Jakobsson, M., Cherkis, N., Woodward, J., Coakley, B., and Macnab, R., 2000, A new grid of Arctic bathymetry: A significant resource for scientists and mapmakers, *EOS Transactions,* American Geophysical Union, v. 81, no. 9, p. 89, 93, 96.

ANNEX 5

An Antarctic Bathymetric Compilation: a Follow-up to IBCAO?

A discussion paper for the GEBCO 2002 Meetings

Ron Macnab (GSC Retired) and Martin Jakobsson (CCOM/JHC)

The Southern Ocean that surrounds Antarctica remains a challenge to the Ocean Science community because its seabed has not been thoroughly mapped. In recent years, numerous organizations have been involved in piecemeal surveys, making it desirable to begin assembling all available information in order to rationalize the knowledge that does exist, and to indicate where additional observations need to be collected. The prospect of undertaking such a compilation has been discussed informally with individuals who are affiliated with organizations in a number of countries that have Antarctic interests, and the response has been generally favourable.

The IBCAO project has served as a practical demonstration of how to proceed with a regional bathymetric compilation, bringing together many disparate sets of observations from widely-separated sources. The lessons learned from this initiative, and the methodologies that have been developed, would lend themselves easily to a comparable operation in the south polar region.

We suggest therefore that the ocean bathymetric community, as represented by GEBCO and IOC, consider such an undertaking as a means of promoting international cooperation to enhance our knowledge and understanding of the region's seabed. We further suggest that IBCAO be used as a general administrative and technical model for the undertaking.

A recommended approach for initiating this proposed activity would be to appoint a small Task Force that would establish contact with individual and organizational stakeholders for the purposes of (a) enlisting their support, and (b) conducting a preliminary data inventory. Based on the outcome of these initial contacts, the Task Force would draft a project proposal for circulation throughout the bathymetric community, and eventually for submission to GEBCO and IOC.

Such an initiative is timely in view of the ongoing deliberations of the Antarctic Regional Hydrographic Commission, which is currently chaired by the IHB. Moreover, SCAR is supporting the development of the Cybercartographic Atlas of Antarctica, and appears to be interested in extending this enterprise to encompass the seabed that surrounds the continent.

ANNEX 6

INTERNATIONAL BATHYMETRIC CHART OF THE CARIBBEAN SEA AND THE GULF OF MEXICO (IBCCA)

Report on IBCCA Project

José Luis Frias Salazar

An Informal Working IBCCA Meeting was hosted by the Instituto Cubano de Hidrografía (ICH) and GEOCUBA in Havana, Cuba, 13 -14 December 2001.

Participants from Cuba (GEOCUBA), Colombia (CIOH), USA (NGDC), Mexico (INEGI), and the IOC Secretary attended the meeting .

The participants reviewed of the status of each sheet and reassigned the compilation of several sheets to facilitate the completion of the project.

A CD-ROM series containing vector contours files for the completed areas of the Gulf of Mexico and part of the Caribbean Sea is rescheduled for release by the Instituto Nacional de Estadistica, Geografia e Informatica (INEGI) in Mexico this year. (1-01, 1-02, 1-03, 1-04, 1-05, 1-06, 1-09, 1-11. June/02), (1-07, 1-08. Aug/02), (1-13, 1-14. Oct./02), (1-15 1-17Dic./02)..

Sheets 1.12, 1.10, and 1.16, under the responsibility of Costa Rica and France no progress have been made on these sheets.

The project is proceeding with editing, printing and creation of data sets of general of the sheets that are in progress at INEGI.

The Chief Editor is continuing with sending all the proposal list of undersea feature names by the Compilers to the Sub-Committee on Undersea Feature Names (SCUFN) for its examination.

NGDC established a list server for IBCCA to facilitate the communication between Editorial Board Members.

A Web Page for IBCCA Project, to promote the Regional project via INTERNET: http ://www.ngdc.noaa.gob/mgg/ibcca/ib_start.htm.

Ing. Mario A. Reyes Ibarra, General Director of Geography at INEGI, is the new Chief Editor of IBCCA replacing Ms. Guadalupe López Chávez.

The 8th Session of IBCCA has been reschedule for October 2002 and will be hosted by the National Geophysical Data Center (NGDC) in Boulder, Colorado, USA

ANNEX 7

Report on progress of IBCWP Project

Lin Shaohua, IBCWP China
[edited by RB Whitmarsh]

In order to prepare a comprehensive progress report on the IBCWP Project Prof. Hou Wenfeng, Chief Editor of the IBCWP Editorial Board, sent a letter to the members of the Editorial Board by e-mail, fax or mail in March, 2002 asking for status reports of the IBCWP Projects of the Member States. So far, responses were received from six members: Russia, Japan, the Republic of Korea, Vietnam, Philippines and Australia. The following summaries are based on their reports.

I. Progress of the IBCWP project

Russia is the Responsible Country of sub-region 1. The Russian Head of Department of Navigation and Oceanography is responsible for 14 sheets of sub-region 1. They have prepared 12 initial plotting sheets at a scale of 1:500,000 based on which 3 chart sheets were compiled at the scale of 1:1,000,000, namely sheets 1-12, 1-13 and 1-14. Diazo copies were presented at the 3rd session of the Editorial Board in 2000. At present, the preparation of four other plotting sheets at a scale of 1;500,000 is being carried out to compile sheet 1-11. Technical targets for plotting sheets at a scale of 1;500,000 in order to compile sheet 1-10 are being prepared.

Japan is the Responsible Country of sub-region 2. They have compiled and published eight bathymetric charts at a scale of 1:1,000,000 in the Japanese EEZ. Now they are compiling sheet 2-11. The process is still continuing.

The Republic of Korea is a participating country in sub-region 2.Regarding the IBCWP Project, they started an integrated survey in 1996, including bathymetric surveys covering the Korean EEZ, and will continue until 2003, using a multibeam system. By 2001 they had completed a survey covering the east and west coasts of Korea and partially published bathymetric charts at a scale of 1:500,000. In 2002, they will survey an area covering 29,000 km^2 in the south-east. The survey will be completed in 2003 covering the whole Korean EEZ. The bathymetric charts covering the whole area will be published by 2008.

As the Responsible Country of sub-region 3, China has collected detailed soundings along its coastal waters; a large quantity of bathymetric data was collected. Six proof copies of sheets of sub-region 3 (sheets 3-6, 3-7, 3-11, 3-12, 3-16 and 3-17) have been compiled at a scale of 1;1,000,000 in accordance with the specifications of the IBCWP Project. Depth contours at 500m, 1500m, 2500m, ….., at a 500m interval, were interpolated on the charts according to the proposal by Mr. Desmond P.D. Scott so as to meet the requirements of the GEBCO Atlas and the relevant articles of the UNCLOS.

Following the integration, development and optimisation of computer cartography/GIS software and hardware, a computer-aided compilation and publication system for bathymetric charts was established on the basis of commercial software such as ArcView, Arc/Info, Map/Info, Mapobject, CorelDraw etc. Its functions include: image and graphic scanning input, multi-media making, colour printing and internet transmission etc. It provides

advanced, standardised, precise and fast technical support for the making of bathymetric charts. Experience has shown that the system has comprehensive functions, a friendly interface and is simple to operate and maintain.

The Philippines and Vietnam participate in sub-region 3. The Philippines is currently undertaking multi-beam surveys on the EEZ areas to the east and west of it. This is part of a 10-year programme to complete the survey of the whole Philippine EEZ and continental shelves. They are compiling bathymetric charts covering the south-west EEZ area. Vietnam is continuing to compile and produce sheet 3-6. They collected some new bathymetric data from some parts of the Vietnamese sea area from some marine hydrographic and geophysical surveys carried out by the Institute of Oceanography. Thus they updated the database for sheet 3-6. They assessed the new collected materials and set up the digital database, especially for sheet 3-6. Two drafts of sheet 3-6 at a scale of 1:500,000 have been compiled and plotted. Work is planned to continue on sheet 3-6 in 2002. They will complete the compilation and plotting work of sheet 3-6 at scales of both 1:500,000 and 1:1,000,000 in 2003 provided that the financial and technical support meet the IBCWP specifications.

No response was received from Malaysia. However, it is known that Malaysia was compiling sheets 3-16 and 3-17 in accordance with the IBCWP specifications.

Australia, the Responsible Country of sub-region 4, has also made progress in the IBCWP Project. Under a new policy, a range of fundamental datasets produced by Geoscience Australia will become progressively available on the Internet for free. This new policy of making spatial data more readily available, particularly over the Web, has significant implications for the IBCWP. An important dataset released in the past few months is a gridded dataset of bathymetry and onshore topography covering all of sub-region 4. All the contour maps of the sub-region 4 series of 1:1,000,000 map sheets can be easily generated from this dataset, with the requisite contour levels and colour schemes. GIS mapping packages such as Petrosys, Caraibes, GMT and ArcGIS are used at Geoscience Australia for such map production. Detailed working gridded datasets of parts of sub-region 4 have also been produced at Geoscience Australia recently, which cover several of the southernmost sub-region 4 series of map sheets. This dataset has not yet been released into the public domain, but this is expected to happen in the next couple of months.

No response was had from New Zealand. It is known that they had agreed to take responsibility for sub-region 5. They had collected bathymetric data from their continental shelf margin to produce and update the 1;1,000,000 charts of the New Zealand sea areas. They had decided to take account of the IBCWP Project when they did this work.

II. Future Development Plan of the IBCWP Project

1. Until now, all the compiled sheets are based on the bathymetric data and the depth contour data collected by their respective compiling Member States. These data are not comprehensive due to the absence of international exchange. Thus, the Responsible Countries cannot provide accurate evaluations and statistics about quantity, density and so on of the bathymetric charts submitted by the Member States. In order to guarantee the accuracy and quality of the compilation sheets, the Responsible Countries and the Member States should strengthen their co-operation. Comprehensive analysis and data exchange should be carried out of bathymetric data, depth contours, graphic shapes and

trends etc. so that the Member States have a common understanding of the seafloor topography expressed by the depth contours.

2. At scales from 1:250,000 to 1;500,000 coastline and terrestrial contour files should be established in sub-regions 2 and 3 by the use of updated data.

3. A multi-beam sounding system for data collection and processing should be set up to overall collect the multi-beam sounding data and the depth contour graphics in the IBCWP region. The are used to modify, complement and update the compiled bathymetric charts.

4. Co-operation and the exchange of data should be strengthened among Member States. Data exchange and applied research on data transmission by the Internet should be carried out and promoted between the Responsible Countries and the Member States, so as to speed up the progress of the IBCWP Project.

5. Concerning the geographical names and nomenclature of undersea features, support is expected.

6. Concerning the proposed training workshop, to be supported by the US NGDC, we hope it can be conducted as soon as possible.

ANNEX 8

The Digital Bathymetric Chart (DBC): the Future Shape of GEBCO/IBC?

A discussion note for the GEBCO 2002 Meetings

Ron Macnab (GSC Retired) and Martin Jakobsson (CCOM/JHC)

Introduction

With the GEBCO organization about to enter its second century, it would be timely to consider alternative delivery methods for the organization's bathymetric products. At the same time, it might be useful to consider whether it would be feasible and/or desirable to seek a closer integration of GEBCO=s mapmaking activities with comparable undertakings elsewhere, particularly the International Bathymetric Chart (IBC) series of the IOC's Regional Ocean Mapping Programme.

GEBCO and IBC

Without delving into the separate histories of GEBCO and IBC, it would seem that the reasons for having two series of bathymetric charts are rooted in a time when cartographic considerations (data availability, geographic coverage, scale, projection, contour interval, colour scheme, etc.) dominated the time-consuming and labour-intensive production of paper charts, and justified the existence of two distinct product lines. Now that the bathymetric sciences have wholeheartedly adopted digital technology, it seems legitimate to question whether these early considerations should still determine our approach to the visualization of ocean mapping information.

The advantages of digital data

Modern bathymetric observations tend more and more to be in digital form, from the moment of their acquisition until their deposition in digital data bases, from which they may be extracted by users for more digital manipulation and visualization. Data in digital form lends itself to a much wider range of processing and interpretive options than the traditional printed chart, with far less effort and time required to achieve results that would have been unimaginable just a few years ago. In this environment, the production of printed charts is almost a secondary process: satisfactory output is a given if the underlying data sets are adequate, and the appropriate cartographic parameters are selected. Moreover, the production of custom charts is now a routine matter for satisfying specialized requirements - in most instances, these maps appear first on a computer screen, after which they are transferred to paper. To ignore this trend and to adhere to the practice of producing standard paper charts in cookie-cutter fashion, is to invite rejection in a world where the computer is accepted as an everyday tool.

It is worth emphasizing here that none of the aforementioned processes need imply an abdication on the part of skilled and experienced operators: modern, well-designed computer systems should and do leave open the option for human intervention wherever and whenever it is needed. The essence of intelligent computer processing, it should be recalled, is to let the machine perform repetitive operations under human control and direction.

The Digital Bathymetric Chart (DBC)

It is proposed that GEBCO and IOC consider adopting digital methodologies for the production, distribution, and advanced visualization of bathymetric information in user-friendly form. One way to do this would be to package global bathymetric information and related facts in a series of information layers: locations of data points, bathymetric grids at varying resolutions, depth contours at standard intervals, the IHO Gazeteer, IHO Limits of Seas and Oceans, national maritime boundaries, etc. The package would include easy-to-use GIS software that allowed users to combine and visualize selected layers within defined geographic limits, and to manipulate this information to produce special effects e.g. shaded relief maps, custom depth contours, oblique views, fly-throughs, etc. The option for producing printed output would be available, of course, as would be the capacity to export selected data to external GIS environments for specialized manipulation and for combination with other types of information.

In essence, what's being suggested is an extension of the current undertaking to build a new GEBCO Digital Atlas, one that would feature added information layers and an unprecedented array of functionalities for handling and visualizing that information.

The cost implications of such a proposition cannot be ignored. It is suggested that the package outlined above could be sold for a modest price to encourage its widespread acceptance and use, with a subscription fee for regular updates. This could be complemented by a network of franchised, high-quality printing operations, which would produce standard or custom charts on demand for a fee that could be partially remitted to the sponsoring organization for its use in defraying at least a portion of the cost of producing and maintaining the DBC. Not all organizations have the time or the resources to produce their own large-format plots, so it is anticipated that such a service ought to satisfy a popular demand.

It is beyond the scope of this discussion note to develop an organizational structure that could assume the administrative and technical tasks involved in the implementation of the above proposition. However, should GEBCO/IOC see some merit in the idea, it is suggested that a prototype be developed that is based on the existing IBCAO grid, which is already in a form that would be highly amenable to this kind of packaging.

ANNEX 9

Reports by George Sharman, NGDC, Boulder, USA

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 2001 Meeting of the GEBCO Sub-Committee on Digital Bathymetry, the National Geophysical Data Center (NGDC) has responded to 265 international requests for marine geology and geophysics data or information from 40 countries of which 29 are IHO Member States. International product sales increased by 22.7% during this reporting period. This contrasts with over 2586 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 Trackline Geophysical Data Base (GEODAS), is in the final testing phase, and is scheduled for release in June 2002. The new release will contain improvements to the GEODAS software, and will add over 1 million nautical miles of new bathymetry obtained from 320 cruises containing over 9.1 million digital soundings. Until this new version is released, new data are available for download from NGDC's web pages. Over 3 million records of trackline data were assimilated during this reporting period, originating from 119 cruises covering over 340,000 nautical miles.

Many unique data sets were received in 2001 and early 2002 including numerous WOCE trackline bathymetry, LIDAR, shallow and deep water multibeam bathymetry (in gridded, point data, and imagery form), and a digital file containing over eleven hundred cruises or data sources (over two million soundings) of unclassified global bathymetry identified by the National Imagery and Mapping Agency during an exercise to document data availability towards future United Nations Convention on the Law of the Sea efforts.

NGDC’s multibeam database continues to grow as well. During 2001, 15 multibeam surveys

containing 19 gigabytes of data were delivered from the Woods Hole Oceanographic Institution. These data include tracklines from the U.S. West Coast, Alaska, the Atlantic, near Mexico in the Pacific and in the Equatorial Pacific. NGDC has placed most of these data into our 3590 tape library archiving system using Tivoli software.

NGDC's U.S. coastal data base grew substantially during the reporting period as well. Version 4.1 of the National Ocean Service Hydrographic Surveys Database was released in fall 2001, adding 513 new surveys to the database. The database, now contains over 71 million soundings from 6017 surveys, providing valuable input to bathymetric basemaps, Geographic Information Systems, geophysical exploration, coastal engineering studies, and nearshore projects. The new release contains improvements to the GEODAS software, including enhanced visualization software, and horizontal datum conversion utilities. New scanning procedures implemented for this update identified and allowed correction of 5781 erroneous soundings from 20 surveys. This database is the primary data source for NGDC's Coastal Relief Model efforts.

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 now includes an on-line system for automated creation of Custom Data CDs. With this system users can automatically create a CD with the GEODAS data of their choice, and have it mailed to them, usually within a day.

New versions (4.1) of the Marine Trackline Geophysics CD set and the NOS Hydrographic Surveys CD set have been completed. Version 4.1 of the GEODAS software includes new capabilities, including user tools to visually edit data downloaded from the CD sets in a graphical window (Hydro-Plot) for both Windows and Linux Xwindows. GEODAS Hydro-Plot can now read a variety of formats, including XYZ and MGD77, can display magnetics and gravity data in addition to bathymetry, and can display a data set overlaid on top of a reference data set. Also included are new versions of the coastline files and new routines for display and for saving coastline subsets as files in several formats. The new coastlines are sub-sampled via a sophisticated routine which efficiently performs on-the-fly generalization to a chosen resolution. These generalized resolutions are built into the GEODAS coastline files in

the new GEODAS 2-D Vector Format, allowing easy extraction to a given resolution.

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

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, ten data sets, from eight institutions, 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 capability or resources to conduct quality control checks and error corrections beyond cursory inspections.

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

NGDC, in it's 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 Cooperation on New Bathymetry for the Great Lakes

New bathymetry for the Great Lakes has resulted from a long-term international cooperative 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 2001, an average of 15559 hits per month were recorded for the Great Lakes web pages at NGDC.

Developments during the period April 2001 – May 2002:

Lake Ontario: The Lake Ontario poster competed in the International Map Exhibition at the 20th International Cartographic Conference held in Beijing, China, August 6-10, 2001, receiving an award for excellence in cartography from the International Cartographic Association. The poster competed with fifty international entries, winning first place in the category for best nautical map. Over 1200 maps and atlases were entered by 30 countries in eight categories.

A paper by Holcombe, T. L., J. S. Warren, D. F. Reid, W. T. Virden, and D. L. Divins, entitled Small Rimmed Depression in Lake Ontario: An Impact Crater?, was published in the Journal of Great Lakes Research, 27(4), p. 510-517.

Lake Erie: Dr. Troy L. Holcombe and Lisa A. Taylor of NGDC, in cooperation with scientists from the Canadian Hydrographic Service, NOAA's GLERL, the Cooperative Institute for Limnological and Ecosystems Research, and The Ohio State University have prepared two research papers that will be peer reviewed and published as part of NGDC's online refereed publication series.

Lake Huron: Contouring of Lake Huron is progressing slowly, the main lake body is complete, leaving approximately 15% of Georgian Bay and North Channel remaining. 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 Cooperative Program in Natural Resources (UJNR)

Dr. Michael S. Loughridge and Dr. George F. Sharman participated in the 30th Annual UJNR Sea-Bottom Surveys Panel Meeting of the U.S. - Japan Cooperative Program in Natural Resources, held in Tokyo, Japan, December 2001. 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 974020 hits per month during 2001, increasing to 1,242,107

hits per month during the first three months of 2002. NGDC's web software can no longer report unique users as identified in previous reports. An average of forty gigabytes of data were downloaded from the MGG web site each month during that period. Hits from within the United States continue to dominate, however, over 22 percent of internet traffic originates from domains outside the United States, including hits from over 100 other countries accessing the pages. Hits from Australia, Canada, France, Germany, Japan, and the United Kingdom (alphabetically) comprise roughly 10% of the total. Other countries in the top twenty accessing MGG pages include Spain, Italy, the Netherlands, Norway, Sweden, Mexico, Greece, the Russian Federation, Brazil, Switzerland, Belgium, Denmark, and Finland. Accesses to individual portions of WDC-MGG pages may vary in user origin by subject. Estimates do not include accesses to MGG's FTP area.

A new development during the reporting period is the creation of a "Custom Data CD" capability through customer web access. The NGDC www allows users to search for data of interest and download the data onto a custom CD which is shipped to the user. Current marine related databases available include Marine Trackline Geophysics and National Ocean Service Hydrographic Surveys.

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 the Marine Trackline Geophysics Database. Version 4.1 of the Marine Trackline Geophysics CD-ROM, scheduled for June 2002 release, will include 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 data base of global topography and bathymetry. To be named "ETOPO2", this 2 arc minute, latitude-longitude gridded data base supersedes

ETOPO5 and TerrainBase, which are 5-minute data bases. 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, and IBCAO Arctic bathymetry, re-sampled on a 2-minute latitude/longitude grid. 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

During 2001, NGDC became the official public distributor of the U.S. Naval Oceanographic Office's (NAVOCEANO) Digital Bathymetric Data Base – Variable Resolution (DBDB-V), level 0 (unclassified). DBDB-V level 0 is an unclassified digital bathymetric data base 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. It is expected that the CD-ROM version of DBDB-V will be made available by the second quarter of 2003. 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)

Lisa Taylor of NGDC attended a working IBCCA meeting in Havana, Cuba in December of 2001. Participants from Cuba, Colombia and Mexico, as well as the IOC secretary reviewed the status of each sheet and reassigned the compilation of several sheets to facilitate the completion of the project.

The next IBCCA editorial board meeting has been rescheduled for the fall of 2002, and will be hosted by the NGDC in Boulder, Colorado. A CD-ROM series containing vector contours and DEM data with color imagery for the completed areas is rescheduled for release by the Instituto Nacionale de Estadistica, Geografia, y Informatica (INEGI) in Mexico this year. Bathymetry has been completed for much of the IBCCA area, and most of the completed bathymetry has been scanned to digital media. The project is proceeding with editing, printing, and creation of data sets.

NGDC established a list server for the project to facilitate communication between editorial board members.

2. Mediterranean Sea (IBCM)

The Ninth Session of the Editorial Board, originally scheduled for November 2000 in Israel was postponed, and a new meeting date has not been established. There was no other reportable NGDC activity during the past year.

3. Arctic Ocean (IBCAO)

On May 27-28, 2001 Dr. David Divins attended and participated in the Third Session of the Editorial Board of the IOC-sponsored regional bathymetry project International Bathymetric Chart of the Arctic Ocean (IBCAO), held in Durham, New Hampshire. Dr. Divins made two presentations, one on activity of the IBCAO website, hosted by NGDC, and one on the possibility of new data from the US Coast Guard cutter Healy, a newly commissioned high latitude research platform. A gridded database for the entire Arctic has been generated with a spacing of 2500x2500 meters using all available bathymetric information. 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.

4. Western Indian Ocean (IBCWIO)

The next Editorial Board Meeting of the IBCWIO is scheduled for the end of July 2002 in Maputo, Mozambique. Two new data sources became available this year that fall in the area of Sheet 1-05, encompassing the Seychelles Islands and the joint responsibility of the Seychelles and the United States. These data include a NAVO survey in the approach to Mahe Island and a survey of the North Seychelles Continental Margin conducted by the UK Royal Research Vessel Charles Darwin. Sheet 1-05 will be updated with this data before submittal to the chief editor.

NGDC established a list server for the project to facilitate communication between editorial board members.

5. Eastern Atlantic (IBCEA)

The French Naval Hydrographic and Oceanographic Service (SHOM) led the major activity in the project this year, printing Sheets 1-01, 1-06, 1-09, 1-10 and 1-11. NGDC contributed to these sheets by providing editorial review before they were printed. Images of all four printed sheets are now posted on the NGDC maintained IBCEA website at http://www.ngdc.noaa.gov/mgg/ibcea/start_e.htm.

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 IBCB 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 IBCB Project. NGDC has agreed to assist with funding support for an inaugural meeting of the IBCB.

7. Eastern South Pacific (IBCSEP)

Dr. David Divins attended the inaugural meeting of the IOC sponsored International Bathymetric Chart of the South East Pacific (IBCSEP), held during the week of October 3-5, 2001, in Valparaiso, Chile. Other countries participating in this meeting were Chile, Columbia, Peru, and Ecuador. Dr. Divins presented an overview of the very successful International Bathymetric Chart of the Arctic Ocean (IBCAO) project and suggested that the newly formed IBCSEP project adopt a similar implementation strategy. The success of the IBCAO was primarily due to the generation of a gridded database as opposed to the more traditional vector contour approach being used by the other five IOC-IBC projects. This idea was well received. NGDC agreed to provide technical training for one person from each of the participating countries for a week over the next two years. The first such visit was by Ms. Pilar Ortiz of the Servicio Hidrografico y Oceanogr fico de la Armada (SHOA), the Chilean Hydrographic and Oceanographic Office, from 14 through 18 January 2002. The week was spent studying data management, corrections and adjustments, use of satellite altimetry data, GIS applications, tectonics implications for bathymetry, preparation of compilation sheets, and digitizing of hydrographic soundings and contour information.

8. Western Pacific (IBCWP)

No meeting of the IBCWP Editorial Board was held, or is scheduled in 2001-2002. During the inter-sessional period, Dr. David Divins completed the minutes of the 3rd session of the Editorial Board and provided them to the Chief Editor as a PDF file for distribution to all Editorial Board members. A table with the official coordinates of all sheets in sub-regions 1-3 was generated and also provided to the Chief Editor for further distribution.

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 northeast 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 northeastern 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 data bases 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

During the week of 10-15 May 2001, Dr. David Divins participated in the Eighth Session of the Intergovernmental Oceanographic Commission (IOC) Consultative Group on Ocean Mapping (CGOM) meeting in St. Petersburg Russia. Reports on the progress for each of the IOC Regional Mapping Projects, GEBCO, and the GAPA Atlas project were presented. Also at this meeting a recommendation to IOC to initiate a new IBC project in the South East Pacific was made, as well as for the adoption of a common set of specifications for all new

IBC projects.

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

1. GEBCO On-Line Activities

1A. GEBCO Web Pages

Revisions and upgrades of the GEBCO web pages continue. A consolidated, alphabetical GEBCO personality list was completed enabling changes to contact information to be made in one location. Access to the GEBCO web pages has been fairly steady over the last year, averaging 2733 hits per month. NGDC can no longer identify the number of unique users, as reported in the previous year.

1B. IBCWIO Web Pages

There have been no new updates of the IBCWIO web pages during the last year. Access to the pages averages 1150 hits per month.

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

The IBCAO version 1.0 grid, created July 11, 2001, was posted to the IBCAO web site in geographic and polar stereographic form, including images suitable for download and printing. Subscriptions to the ibcao_announcements list have grown from 250 to 340 over the last year. The average number of IBCAO hits per month during 2001 was 6744, while this number has almost tripled to 19666 hits per month during the first three months of 2002.

1D. IBCM Web Pages

There have been no new updates to the IBCM web site during the year. The number of hits per month has been below the threshold limits of NGDC's web accounting software.

1E. IBCCA Web pages

The IBCCA web site continues to be accessed heavily. Portions of the pages are available in Spanish, courtesy of the Instituto Nacional de Estadística, Geografía y Informática (INEGI).

The site averaged 7389 hits per month during 2001, while the number increased to 13694 during the first three months of 2002.

1F. IBCEA Web Pages

There have been no new updates to the IBCEA web site during the year. The IBCEA web pages were released to the public in December of 2000 in both English and French with extensive assistance from Service Hydrographique et Océanographique de la Marine (SHOM). The IBCEA site received an average of 1739 hits per month during 2001, while the number increased to 3233 hits per month during the first three months of 2002.

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

During this reporting period, the Coastal Relief Models for Florida and the U.S. Gulf Coast were completed and made available as volumes 3 (Florida-Alabama), 4 (Louisiana-Mississippi), and 5 Texas) of the CD-ROM series. IBCCA contours were used to supplement the NOS hydrographic data for these areas. Coastal Relief Model development for the US West Coast is continuing with quality control of the NOS sounding and multibeam bathymetric data, and available academic multibeam bathymetric. These data will be used as input for the generation of the Coastal Relief Model (CRM) for this region. The quality control work has begun for southern California, proceeding northward; and for offshore Washington State, proceeding southward. Topographic data have been assembled for the West Coast including data from the USGS and data collected from the space shuttle during the Shuttle Radar

Topography Mission (SRTM). Starting with the West Coast, all NOS data will be converted to a common horizontal datum, NAD83, while the vertical datum for individual surveys will be retained.

ANNEX 10

IHO HYDROGRAPHIC METADATA REQUIREMENTS

Tony Pharaoh, IHB, Monaco

Background

At the Cape Town meeting of the TSMAD sub-working group on S-57 extensions, it was agreed that metadata should be considered as a Work Item for the further development of S-57. This information paper has been produced for work item 2.5 (metadata) for consideration by next extensions sub working group meeting. (3-5 June 2002 CHS Canada).

Introduction

In the paper chart world, metadata is displayed in the title block of charts, and may also be recorded in various chart catalogues. In this form, metadata is readily apparent and easily transferred between chart producers and users. When charts are in a digital form, metadata is equally as important, but its development and maintenance often require a more conscious effort on the part of data producers and subsequent users. Increasingly, hydrograhpic organizations are collecting, storing and archiving large quantities of digital data. The complexity and diversity of these data have increased over the past decade. They are no longer confined to digital source and reproduction files, (used for paper chart generation), but now also include a variety of digital nautical products. Digital hydrographic data holdings are becoming an important national asset that must be managed and controlled. In order to achieve this, Hydrographic Organizations will need to record information about the data (i.e. metadata) and make it available for easy accesses. As hydrographic data holdings proliferate, a common metadata standard, will facilitates the management, dissemination and reuse of digital data.

Benefits of Metadata

Metadata allows a producer to describe a dataset fully so that users can understand the assumptions and limitations of the data, and can evaluate the dataset's applicability for its intended use. As personnel change within an organization, data may lose their value if the meta information is not properly recorded. The documentation of metadata may seem burdensome, however a lack of knowledge about an organizations data can lead to duplication of effort, inefficiency and the loss of revenue. Metadata is also important element in the creation of a spatial data clearinghouse, where potential users can search for the data they need for their intended application. (A Geospatial Data Clearinghouse is a location, typically accessed through the World Wide Web (WWW), which provides information about the availability of the spatial data holdings of an organization).

Examples of Metadata

Data Identification: Title, Area covered, Themes, Currentness, Restrictions.

Data Quality: Accuracy, Completeness, Logical Consistency, Lineage.
Spatial Data Organization: Vector, Raster, Type of elements, Number.
Spatial Reference: Projection, Grid system, Datum, Coordinate system.
Entity and Attribute Information: Features, Attributes, Attribute values.
Data Distribution: Distributor, Formats, Media, Price.
Metadata Reference: Metadata currentness, Responsible party.

Within S-57, meta data has been defines at three levels, namely, at the dataset level, the object level, and at the attribute level. The scope of metadata elements presently defined in S-57 (especially at the dataset level) do not conform with international metadata standards and are no longer adequate for future data discovery, retrieval and reuse of the increasingly diverse data holding of most hydrographic organizations.

Types of Metadata Queries may include:

Queries about data entities:
- What is the data?
- Where is the data?
- What are the data characteristics?
- Where did this data come from?
- What is the quality (accuracy, lineage, resolution) of this data?

The basic metadata queries about process entities:
- What can one do with this data?
- What types of spatial and geometric operators are available?
- How can data be imported (acquired)?
- How can entities like various data layers and spatial objects, be created, deleted and updated?
- How can the results of analysis be presented?

Conceptual Models for Metadata Management

There is a close relationship between data and metadata. The form of this relationship depends on the models for both data and metadata. The conceptual model for hydrographic data will have to describe the actual data and the natural relationships found in that data. A good conceptual model should be meaningful to both database managers and the non-technical end users. Metadata should also include information that allows data identification and selection based on the properties of data such as content, sources and quality. It must therefore be efficiently and effectively accessible for a range of procedures.

Note: This usually calls for a database management system, since metadata is also data. In some data models, part of metadata is an integral part of the data itself which is referred to as a self-describing database (Typically found in the Object Oriented Database Management Systems). However in most relational databases, metadata, is stored in separate deductive (meta)data layers. Most DBMSs contain a data dictionary, which is used by the DBMS itself for data definition and for maintaining data integrity. Data dictionaries may be accessible for metadata queries by users.

The need for standardization

The full potential of metadata, should not only be considered at the isolated database level, but also as a distribution of separate databases that may be spread over a wide geographical area. This model requires the use of a common data standard and metadata standard. Although it has been decided that future extensions to S-57 will be based on the ISO/TC211 suite of standards, for the purposes of this study, it is recommended that the US FGDC Content Standard for Digital Geospatial Metadata should also be considered.

US Federal Geographic Data Committee (FGDC) - Content Standard for Digital Geospatial Metadata

This standard specifies the information content of metadata for a set of digital geospatial data. It was designed to help prospective users of geospatial data to determine what data exists, the fitness of this data for their applications, and the conditions for accessing the data. The standard establishes the names (and groups) of metadata elements, their definitions, and information about the values that are to be provided for the metadata elements. It specifies the elements needed to support three major uses of metadata: (1) to maintain an organization's internal investment in geospatial data, (2) to provide information to data clearinghouses and catalogs, and (3) to provide information needed to process and interpret data transferred from another organization. The standard establishes a common set of terminology and definitions for concepts related to metadata, including:

- the names of data elements and compound elements (groups of data elements) to be used,
- the definitions of these compound and data elements, and
- information about the values that are to be provided for the data elements.

The standard specifies information content, but not how to organize this information in a computer system or in a data transfer, or how to transmit, communicate, or present the information to a user. The standard supports the development of profiles that enable the based definition of a subset of the metadata entities and/or elements that are used by a specific discipline or organization. (A profile is subset of the metadata entities and elements of the base standard that describes the application of the CSDGM Standard to a specific user community. Profiles may also contain extended elements. See – “Shoreline Metadata Profile of the Content Standards for Digital Geospatial Metadata”)

ISO TC211 DIS 19115 – Geographic information – Metadata

This International Standard defines metadata elements, provides a schema and establishes a common set of metadata terminology, definitions, and extension procedures. When implemented this International Standard will:

- Provide data producers with appropriate information to characterize their geographic data properly.
- Facilitate the organization and management of metadata for geographic data.
- Enable users to apply geographic data in the most efficient way by knowing its basic characteristics.

- Facilitate data discovery, retrieval and reuse. Users will be better able to locate, access, evaluate, purchase and utilize geographic data.
- Enable users to determine whether geographic data in a holding will be of use to them.
- An important component of the standard is the data dictionary which describes the characteristics of the metadata.

The standard also makes provision for metadata extensions and profiles. The following types of extensions are allowed:

- adding a new metadata section;
- creating a new metadata codelist to replace the domain of an existing metadata element that has “free text” listed as its domain value;
- creating new metadata codelist elements (expanding a codelist);
- adding a new metadata element;
- adding a new metadata entity;
- imposing a more stringent obligation on an existing metadata element;
- imposing a more restrictive domain on an existing metadata element.

The creation of an IHO community profile based on the ISO/TC211 metadata standard 19115.

This International Standard 19115 defines almost 300 metadata elements, with most of these being listed as "optional". They are explicitly defined in order to help users understand exactly what is being described. If extensive additional metadata elements are required for IHO use, it may be necessary to develop a "community profile". This may require that a specific set of metadata elements are defined as mandatory (i.e. certain existing optional metadata elements may need to be defined as mandatory for IHO use). For IHO requirements we may want to establish additional metadata elements that are not in this International Standard. For example, it may be necessary to develop metadata elements for the status of datasets within a system to help manage production. However, these added elements will not be known outside the community unless they are published.

Note: A community profile should also describe issues such as field sizes and domains for all metadata elements. If one system within a community uses thirty-two characters for the title of a dataset and another system handles eight characters, interoperability will not be achieved. Standardizing selected domains within a community is important to allow more efficient searches and better system control. Community profiles are described in ISO 19106.

Conclusion

The information needed to create metadata is often readily available when the data are collected or produced. A small amount of time invested at the beginning of a project may save money in the future. Data producers and users cannot afford to be without documented data. The initial expense of documenting data clearly outweighs the potential costs of duplicated or redundant data generation. However in the absence of an IHO metadata standard, harmonization of metadata information between member organization can not be achieved. Metadata has also been recognised as a key element for the development of national and global spatial data infrastructures.

ANNEX 11

S-57 Bathymetric data Product Specification

Tony Pharaoh, IHB, Monaco

Introduction

At the 8th TSMAD meeting of the S-57 extension sub-working group, it was recognised that there was a requirement to handle bathymetric data within S-57. It was therefore decided that a work party should be tasked to develop an information paper on the subject, for consideration by the TSMAD working group, and for comment by the wider hydrographic community.

Background

In 1999 the IHB conducted a survey (via Circular Letter), to obtain the opinions of Member States, regarding bathymetric data requirements. **Circular Letter 16** of 1999 dated (30 March 1999) proposed that S-57 be expanded to cater for additional hydrographic data types other than ENC data. Attached to the Circular letter as Annex A, was a questionnaire requesting replies to the following questions:

1. "What types of data should be included under the term "hydrographic data"" ?

2. "Do Member States agreed with the proposal that:

a. the IHO WG on Standards for Hydrographic Surveys (S-44) be tasked to define "HYDRO" features and to identify those which should form a "HYDRO" product.

b. the IHO CHRIS Committee be subsequently tasked to amend or extend S-57 and to develop a "HYDRO" Product Specification, as necessary".

Thirty-four responses were received of which thirty-two answered "yes" to questions 2.a and 2.b. In response to question 1, the following is a cumulative list of data types were submitted;

- Bathymetry
- Tides (predicted and measured)
- Geophysical data (seismics, gravity, magnetics)
- Coastal and port features
- Bottom structure
- Side Scan Sonar and R.O.V images
- Horizontal datum parameters
- Salinity and temperature profiles
- Horizontal datum parameters
- Sediment types
- Sound speed profiles (CTD data)

- Various types of metadata
- Bathymetric grid data
- Current rate and direction
- Geodetic points – gravity
- Multibeam backscatter imagery
- Satellite imagery
- Engineering plans
- Photographs
- Sailing directions/views
- Navigation marks
- Wreck information
- Baseline determination

Clearly, it is neither feasible nor desirable to extend S-57 to provide for all of the proposed data types under a single "HYDRO" Product Specification. The S-57 object model does not presently make provision for temporal, raster or matrix data types. Some of the listed data types may also be outside the scope of S-57, and may be better served by other standards that have been purpose build by organizations that are responsible for such data types. (e.g. GF3 or MGD77 for geophysical parameter).

The responses do clearly indicate however, that there is a requirement to accommodate bathymetric data as a priority within the S-57 standard. As raster and matrix models are added to S-57, it will be possible to accommodated additional data types.

The requirement for a Product Specification for Bathymetric Data

Fair Charts - data management and data audit.

CHAPTER V - Regulation 9 - Item 1, of the draft text of SOLAS convention states that "Contracting Governments undertake to arrange for the collection and compilation of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation."

Furthermore Regulation 25 of the SOLAS convention states at clause 1, that; "All ships shall carry adequate and up to date nautical charts, sailing directions, lists of lights, notices to mariners, tide tables, and all other nautical publications necessary for the intended voyage."

Underpinning all of the nautical products listed above is a rich and diverse archive of hydrographic source data. Over that past two decades, much of this data has been digitized or collected using different computer systems and software, and these data are consequently stored in a variety of proprietary formats, and to varying degrees of data density.

In the event of maritime accidents such as groundings, these data, and in particular hydrographic surveys, often become the authoritative source on which legal cases are substantiated. It is therefore of extreme importance, that

any information shown on the chart, can be traced back to its original source. (In the case of bathymetric data, this would typically be the "Fair Chart" (hydrographic survey) however it could also include certain raw survey data records).

ENC Compilation - Presently, most ENC's are being digitized from existing paper chart sources, however increasingly, they will be compiled/generated from integrated hydrographic databases. This process of ENC generation could be facilitated, if "approved" hydrographic surveys, were encoded in conformance with the S-57 data structure and content data model. The Fair Chart product specification would describe how fair charts should be encoded managed and exchanged using the S-57 format. Such a product specification would be far less rigorous than the one for ENC production.
It is recommended that "approved" fair charts, which are digital equivalents of the hard copy versions, should:

- Use the S-57 data model and specify a required level of topology.
- Use S-57 objects and attributes. It may be necessary to define a subset of objects/attributes as determined in specifications for hydrographic surveys (e.g. General Instructions for Hydrographic Surveyors NP 135), or to include additional objects/attributes. See existing specification "National Hydrographic Data Content Standard for Coastal and Inland Waterways – Public Review Draft" developed by the FGDC Bathymetric Subcommittee.
- Include standard metadata items for survey quality parameters (see paper on CATZOC – S-44 quality relationships). It should also include ISO 19115 metadata items, which will aid data management and data discovery, and will support the development of national spatial data infrastructures. (See TSMAD paper on Metadata – link when available).
- Define an encapsulation format for data transfer. (Probably XML – needs discussion).

Benefit - An S-57 specification providing common structure and formant for hydrographic survey data, and associated metadata elements will help ensure the effective use and exchange of hydrographic data between multiple agencies, organizations and other users, and will facilitate the development of national and global spatial data infrastructures. It will also ensure semantic consistency when capturing geospatial bathymetric information in support of electronic charting purposes, and other GIS applications. It should also result in cost saving associated with more efficient data management and reduced data translation costs.

Bathymetric Maps – a product of increasing importance.

The mandate for many hydrographic organizations to conduct surveys exclusively for the purposes of nautical charting has expanded to include many additional activities such as continental shelf delineation, coastal zone, and offshore resource management. Bathymetric maps, which are required to support these types of activities, are becoming an important hydrographic product. The demand for digital bathymetric maps for other scientific and

recreational activities is also increasing. Bathymetric maps encoded using the S-57 format, could be used to support ENC production as wall as many additional GIS related products. See paper on converting bathymetric maps to S-57). In the process of being translated.

Other types of bathymetric data types may include high density sounding data, sidescan sonar, multibeam backscatter data and derived data products, such as seabed elevation models. (e.g. color encoded depth images or sun-illuminated seabed terrain images). Although all of these data types may be helpful for chart compilation it is recommended that, their format, structure and portrayal should not be restricted by a product specification. However the development of a common data model for these data types would facilitate the exchange of data at this level.

The requirement to use S-57 as an exchange format for Hydrographic Survey data exchange

The existing formats used for processing hydrographic data have traditionally been relatively simple in structure. Mass data collection technologies such as multi beam echo sounders and airborne laser survey systems however, have resulted in a growing need for more complex data structures. Added to this is a requirement to maintain many of the pre processed field parameters so that data can be regenerated if necessary.

Presently there are a number of data formats that are being used for the exchange of hydrographic survey data. For a brief description of the known formats, click here. For convenience, hydrographic survey data will be considered under the following three requirement levels.

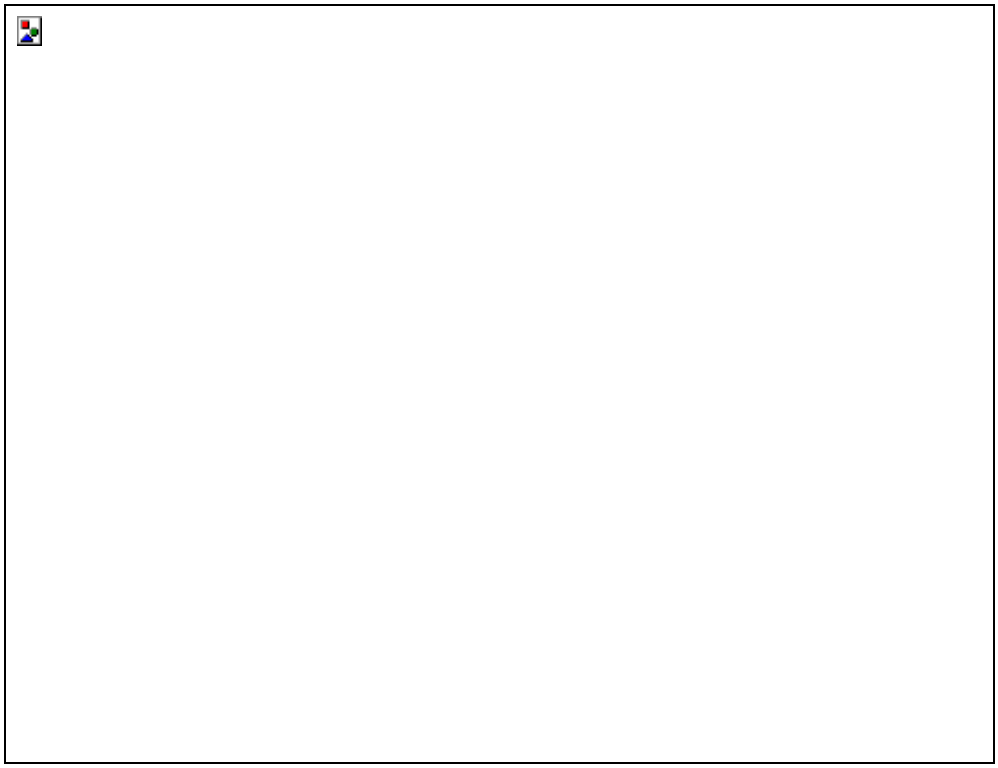
Reduced data. The digital equivalent of the hard copy Fair Chart. It is recommended that this should be an S-57 product, which is encoded in accordance with an S-57 Product Specification as described above.

Full density processed data. The requirement for a specification for processed full density sounding data that is in a cleaned fully integrated form (i.e. reduced for position, elevation, orientation and water column). Ideally, this formant should make provision for all soundings although quality flags should be added to indicate whether the data have been rejected or are perhaps outside the specified survey order (see S-44). This data may be used for the generation of other hydrographic products such as high resolution bathymetric contour interpolations and gridded seabed models. (Although S-57 does not yet make provision for raster and gridded data models for these data types, they will be included in edition 4.0).

For a description of how full density multibeam data has been processed using the S-57 format, see – “Processing Multibeam Data Through to S-57 (Mike Gourley, CARIS, Fredericton, N.B., CanadaPeter Schwarzberg, CARIS BV, Heeswijk, The Netherlands Guy Noll, NOAA Coast Survey Development Laboratory, Silver Spring, Md., U.S.A)”.
http://www.thsoa.org/pdf/h01/6_3.pdf

Almost all hydrographic raw data is derived from one or other sensor. The ISO/TC211 standard 19130 (Sensor and data models for imagery and gridded data) describes many of the sensor data parameters for hydrographic sonar in addition to some generic metadata elements that are described in ISO standard 19115 (Metadata). It is recommended that **ISO 19130** should, as far as possible, be used as the basis for defining the data model for raw data. Raw data will essentially be unedited, and although they should not include invalid or corrupt data, they will include all data needed to derive the next two levels of data. A common data model describing raw data elements would facilitate the development of interfaces to read and process raw data.

The scope of data levels and processing requirements, is described in the diagram below. At the apex of the triangle, are the Fair Chart and bathymetric map, which are both products of data in the two lower levels. It is recommended that both these products should be rendered in accordance with new S-57 Product Specifications.



ANNEX 12

List of Charts Presented at the Meeting

The following bathymetric and other charts were tabled for the consideration of the meeting.

1. Indian Ocean (2002), 1;6,000,000, 0-110ºE, 0-60ºS, gridded bathymetry from RL Fisher's 6th Edition contours – [Goodwillie]
2. Indian Ocean (2002), 1;6,000,000, 20-60ºE, 0-30ºS, example of trackline coverage [Goodwillie]
3. Indian Ocean (2002), 1;6,000,000, 0-60ºE, 20-360ºS, example of trackline coverage [Goodwillie]
4. Caspian Sea (2002), 1:3,000,000, 35-48ºN, 44-57ºE, shaded relief land and sea, soundings from 107 HDNO charts [Hall]
5. Black Sea (2002), 1:3,000,000, 40-48ºN, 26-43ºE, shaded relief land and sea, soundings from 162 HDNO charts [Hall]
6. North Atlantic (2002), 1:1,000,000, 36-44ºN, 15º20'-7º20'W, IBCEA contour chart 1.01. Instituto Hidrografico Lisbon [Weatherall]
7. Indian Ocean, 1;15,000,000, 30ºN-72ºS, 28-172ºE, bathymetric contours supplied by RL Fisher from his 6th Edition for the GDA [Weatherall]
8. Weddell Sea, 1:7,000,000, 58-75ºS, 78ºW-5ºE, bathymetric contours supplied by AWI for the GDA [Weatherall]
9. SW Pacific ocean, 1;10,000,000, 5-65ºS, 150-160ºE, bathymetric contours supplied by NIWAR for the GDA [Weatherall]
10. Arctic Ocean, 1:8,000,000, 62-90ºN, 0-360º, bathymetric contours from IBCAO for the GDA [Weatherall]
11. Gulf of Mexico, 1:4,000,000, 23-34ºN, 68-98ºE, bathymetric contours from IBCCA sheets 1.01, 1.02, 1.03, 1.04 for the GDA [Weatherall]
12. NE Atlantic Ocean, 1:7,000,000, 10ºS-50ºN, 55ºW-5ºE, bathymetric contours from IBCEA sheets 1.01, 1.06, 1.08, 1.09, 1.10, Ifremer and SOC for the GDA [Weatherall]
13. N Gulf of Mexico and W Atlantic Ocean (2000), 1:1,000,000, 24-34ºN, 68-98ºW, IBCCA sheets 1-01, 1-02, 1-03 and 1-04 [Lisa Taylor]

WORLDWIDE SEAFLOOR SWATH-MAPPING SYSTEMS

VESSEL NAME	OPERATOR	SYSTEM	INSTALL YR
AUSTRALIA:			
CASUARINI (Leeuwin Survey Launch)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	1997
COOK (retired, disposed of)	ROYAL AUSTRALIAN NAVY	SEABEAM	1965 (retired)
DUYFKIN (Melville Survey Launch)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	1998
FANTOME (Leeuwin Survey Launch)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	1997
GEOGRAPH (Melville Survey Launch)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	1998
JOHN GOWLAND (Melville Survey Launch)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	
INVESTIGATOR (Leeuwin Survey Launch)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	1997-1998
LEEUWIN	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	2000
MELVILLE	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	2000
MEDA (Melville Survey Launch)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	1998
TOM THUMB (RAN School Ship)	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20	1998
"Reserve"	ROYAL AUSTRALIAN NAVY	ATLAS FANSWEEP-20 (2 systems)	1997, 1998
	ROYAL AUSTRALIAN NAVY	RESON SEABAT	
	FUGRO SURVEY PTY. LTD	RESON SEABAT	
	JAMES COOK UNIVERSITY	RESON SEABAT8101	1999
	RACAL-AUSTRALIA	RESON SEABAT 9003-350	
	SEISMIC ASIA PACIFIC	SEABEAM 1055 Dual frequency	uprade 2000
	WOODSIDE PETROLEUM	ATLAS FANSWEEP-10	1993
AUSTRIA:			
ALPHA	DANUBE OPERATION AUTHORITY-VIENNA	ATLAS FANSWEEP-20	1996
WIEN 3	DANUBE OPERATION AUTHORITY-VIENNA	ATLAS FANSWEEP-20	1996
WIEN 4	DANUBE OPERATION AUTHORITY-VIENNA	ATLAS FANSWEEP-20	1996
	B.M. FUR VERKEHR SCHIFFAHRTSBEHORDE	SIMRAD EM-3000 (DUAL)	1996
BANGLADESH			
	OCCIDENTAL PETROLEUM OF BANGLADESH	RESON SEABAT	
BELGIUM:			
BELGICA	BELGIAN MATHEMATICAL MODEL OF THE NORTH SEA	SIMRAD EM-1002 (retractable hull unit)	1999
JACQUELINE	SILT-ZEEBRUGGE	ATLAS FANSWEEP-20	1996
OOSTEND 11	SILT-ZEEBRUGGE	ATLAS FANSWEEP-20	1996
PAREL II	ADMINISTRATIE WATERWAGEN EN	SIMRAD-EM3000D	2001
	ZEEWEGEN, AFDELING MARITIEME SCHELDE	----------	---------
TER STREEP	DIENST DER KUSTHAVENS	SIMRAD EM-950	1994
BRAZIL:			
TAURUS	BRAZILIAN NAVAL HYDROGRAPHIC OFFICE	SIMRAD EM-1000	1998
	BRAZILIAN NAVY	RESON SEABAT 9001-350	
BRUNEI			
	BRUNEI SHELL PETROLEUM COMPANY SDN BHD	RESON SEABAT	
CANADA:			
ANNE S. PIERCE	SEAMAP GEOSURVEYS INC	SIMRAD EM-1002 (w/hull unit)	1999
FREDERICK G. CREED	CANADIAN HYDROGRAPHIC SERVICE	SIMRAD EM-1000	1991
DOLPHIN (ROBV)	CANADIAN HYDROGRAPHIC SERVICE	SIMRAD EM-1000	1990
FUGRO JACQUES	FUGRO	RESON SEABAT 8101	
MATHEW	CANADIAN HYDROGRAPHIC SERVICE	SIMRAD EM-100	1990
PETREL	CANADIAN CENTRE OF INLAND WATERS	SIMRAD EM-3000	1995
PIPIT	BEDFORD INSTITUTE OF OCEANOLOGY	SIMRAD EM-3000	1995
PLOVER	CANADIAN HYDROGRAPHIC SERVICE	SIMRAD EM-3000	1995
PUFFIN	INSTITUTE OF OCEAN SCIENCE	SIMRAD EM-3000	1995
REVISOR	CANADIAN HYDROGRAPHIC SERVICE	SIMRAD EM-3000	1997
SMITH (SWATH/SWEEP SYSTEM)	CANADIAN HYDROGRAPHIC SERVICE	NAVITRONICS (210 kHz)	
R.B.YOUNG	CANADIAN HYDROGRAPHIC SERVICE	SIMRAD 1002 (with hull unit)	1999
	CANADIAN HYDROGRAPHIC SERVICE	SIMRAD EM-100	1989
	DEFENCE RESEARCH ESTABLISHMENT-ATLANTIC (DREA	RESON SEABAT 8125	2002
	ST. LAWRENCE SEAWAY AUTHORITY	RESON SEABAT	
CHILE:			
CABRALES	CHILEAN NAVY	ATLAS HYDROSWEEP MD-2, FANSWEEP-20	1999
CHINA:			
DAYANG YI HAO	CHINA OCEAN MINING RESEARCH ASSOCIATION	SEABEAM 2112.360 (12/36 kHz)	1995
FEN DOU 4	MINISTRY OF GEOLOGY-GUANGZHOU	SIMRAD EM-3000, EM-950	1997
HAI-YANG 4	MINISTRY OF GEOLOGY	SEABEAM 2112	1995
HAE-YANG 2000	MINSTRY OF TRANSPORTATION	SEABEAM 2112.360 (12/36 kHz)	1998
HUBAOYU 2378	SHANGHAI WATERWAY BUREAU-CMSA	ATLAS FANSWEEP-20	1999
"SURVEY VESSEL"	SHANGHAI PORT AUTHORITY	ATLAS FANSWEEP-10	1993
	BOHAI OIL COMPANY	TRITON-ELICS HYDROSUITE	2001
	BUREAU OF YANGTZE RIVER HYDROLOGY	RESON SEABAT 9001S	1998
	CHNA MARITIME SAFETY ADMINISTRATION	ATLAS FANSWEEP-20	2001
	EGS SURVEY COMPANY-HONG KONG	ELAC BCC II-180 kHz (3 sys)	1994, 1996, 1997
	EGS SURVEY COMPANY-HONG KONG	SEABEAM 1050 D (DUAL FREQ-upgrade)	1999
	EGS SURVEY COMPANY-HONG KONG	SEABEAM 1180	2000
	FIRST INSTITUTE OF OCEANOGRAPHY	SIMRAD EM-3000, EM-950	1997
	HARBIN SHIPBUILDING INSTITUTE	RESON SEABAT	
	HONG KONG CIVIL ENGINEERING (HYDROGRAPHIC DEPT)	ODOM ECHOSCAN	2000
	HONG KONG MARINE DEPARTMENT	RESON SEABAT 9001S-350	
	HONG KONG MARINE DEPARTMENT	SIMRAD EM-3000	1997
	HONG KONG POLYTECHNIC UNIVERSITY	SEABEAM 1185	2000
	INSTITUTE OF GEOPHYS. & GEOCHEM. EXPLOR.-HONG KONG	ELAC SEABEAM 1180	2002
	INSTITUTE OF OCEANOLOGY-CHINESE ACAD. SCIENCE	RESON SEABAT	
	JIANXI INSTITUTE OF WATER RESOURCES-JUIJIANG PORT	RESON 8101	2000
	MINISTRY OF GEOLOGY	SIMRAD EM-3000, EM-950	1998
	MINISTRY OF GEOLOGY-SHANGHAI	SIMRAD EM-3000, EM-950	1997
	SECOND INSTITUTE OF OCEANOGRAPHY, HANGZHOU	SEABEAM 1050 D (DUAL FREQ)	1998
	SHANGHAI WATERWAY BUREAU-CMSA	ATLAS FANSWEEP-20	2000

**SEABEAM 1180/II and ELAC BCC /II-180 KHz are identical

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WORLDWIDE SEAFLOOR SWATH-MAPPING SYSTEMS

	STATE OCEANIC ADMINISTRATION - SECOND INSTITUTE	RESON SEABAT 8101	2000
	SOUTH CHINA SEA INSTITUTE OF OCEANOLOGY	RESON SEABAT	
	THIRD INSTITUTE OF OCEANOGRAPHY, XIAMEN	SEABEAM 1180 (DUAL)	1999
		ATLAS FANSWEEP-20	2002
		ATLAS FANSWEEP-20	2002
CROATIA			
	BRODARSKI INSTITUT	RESON SEABAT	
DENMARK:			
DIGI	EIVA A/S	RESON SEABAT 8101-210	
EKKO	EIVA A/S	RESON SEABAT 8101-210	
GRIBBEN	ROYAL DANISH ADMIN OF NAVIG. & HYDROGRAPHY	ELAC BCC-180 kHz	1992
MARIDAN 600 AUV	MARIDAN SURVEY A/S	RESON 8125	2001
SKA 15 SURVEY VESSEL	ROYAL DANISH ADMIN OF NAVIG. & HYDROGRAPHY	SEABEAM 1180 (upgrade)	1999
SKA 16 SURVEY VESSEL	ROYAL DANISH ADMIN OF NAVIG. & HYDROGRAPHY	SEABEAM 1180 (upgrade)	1999
	COPENHAGEN HARBOR AUTHORITY	RESON SEABAT 9001	
	DANISH FOREIGN MINISTRY	RESON SEABAT	
	DANSURVEY	RESON SEABAT	
	EIVA A/S	RESON SEABAT 9001-350 (2 systems)	
	KYSTINSPEKTORATET	RESON SEABAT	
	ORESUNDSFORBINDELSEN	RESON SEABAT	
	ROYAL DANISH ADMIN OF NAVIG. & HYDROGRAPHY	ELAC BCC-180 KHz (4 sys)	1991, 1994 (3)
	SOVOERNETS MATERIELKOMMANDO	RESON SEABAT	
	STOREBOELTSKONSORTIET	RESON SEABAT	
	SVITZER A/S	RESON SEABAT 9001-350	
ESTONIA			
	ESTONIA MARITIME BOARD (ENMB)	RESON SEABAT	
FINLAND:			
SUUNTA	FINNISH NAVY	ATLAS FANSWEEP-10	1993
	FINNISH NAVY	RESON SEABAT	
	FINNISH MARITIME ADMINISTRATION-HYDROG OFFICE	RESON SEABAT 8111	1997
	FINNISH MARITIME ADMINISTRATION-HYDROG OFFICE	RESON SEABAT 8101 (2 systems)	1999
FRANCE:			
L'ATALANTE	IFREMER	SIMRAD EM-12 (DUAL), SIMRAD EM-950	1990/1994
BORDA	S.H.O.M.	THOMSON SINTRA ASM, SIMRAD EM-1002S	1988, 2001
L'ESPERANCE	S.H.O.M.	SIMRAD EM-12 (DUAL)	1992
JANUS	COMEX	RESON SEABAT 8101/Triton Elics HS150	2001
LA PÉROUSE	S.H.O.M.	SIMRAD EM-1002S	1999
LA PLACE	S.H.O.M	SIMRAD EM-1002S	2000
MARION DUFRESNE II	IFRTP (FRENCH POLAR INSTITUTE)	THOMSON MARCONI TSM 5265	1996
MOUETTE	PORT AUTONOME DE DUNKERQUE	ATLAS FANSWEEP 20	2000
LE SUROIT	IFREMER	SIMRAD EM-1000, EM-300 (1x2° system)	1991, 1997
VH 90	S.H.O.M.	ATLAS FANSWEEP 20	2000
BHO HYDROGRAPHIC VESSEL	ALSTOM	SIMRAD EM-1002, EM-120	2002
	DRAGES PORT	SIMRAD EM-3000	2001
	FRENCH NAVY	SIMRAD EM-12, SIMRAD EM-950	1990/1994
	LD CANOCEAN	RESON SEABAT	
	GTM DUMEZ	SIMRAD EM-3000	1998
	GROUPE DE ETUDES SOUS MARINE DE LA ATLANTIQUE	RESON SEABAT	
	MESURIS	RESON SEABAT	
GERMANY:			
BALTIC	WASSER UND SCHIFFARTS AMT-STRALSUND	SIMRAD EM-3000D	2002
BIENE	WASSER UND SHIFFARTS AMT-HAMBURG	SIMRAD EM-3000 D	1998
DEEPENSCHRIEVER II	PORT OF HAMBURG	ATLAS FANSWEEP-20	1996
DEEPENSCHRIEVER III	PORT OF HAMBURG	ATLAS FANSWEEP-20	1996
DENEB	BSH	ATLAS HYDROSWEEP MD	1993
KOMET	BSH	ATLAS FANSWEEP 20 (2 systems)	1998
KOMET 4 (Komet Survey launch)	BSH	ATLAS FANSWEEP 20	1998
KOMMANDOR JACK (ex-Valdivia)	O.S.A.E., BREMEN	SIMRAD EM-120, SIMRAD 1002	1999
JENS UWE LORNSEN	WASSER UND SCHIFFARTS AMT-TONNING	ATLAS FANSWEEP 20	1998
METEOR	DFG/BMFT/RF	ATLAS HYDROSWEEP DS	1986
WFS PLANET	TNSW EMDEN	ATLAS HYDROSWEEP DS-2	***2002***
POLARSTERN (Icebreaker)	ALFRED-WEGENER-INSTITUT FUR POLARFORSCHUNG	ATLAS HYDROSWEEP DS-2	1994
REIHER	WASSER UND SHIFFARTS AMT-DUISBURG	SIMRAD EM-3000 D	1998
SONNE	BMFT/RF	SIMRAD EM 120	2001
SOUNDING SYMPHONY	O.S.A.E., BREMEN	ATLAS FANSWEEP-10	
STORCH	G.K.S.S.	SIMRAD EM-3000	1998
TAGENS	WASSER UND SHIFFARTS AMT-REGENSBURG	SIMRAD EM-3000 D	1998
UNKELSTEIN	WASSER UND SHIFFARTS AMT-BINGEN	SIMRAD EM-3000 D	1999
WEGA	BSH	ATLAS HYDROSWEEP MD	1991
WEGA	BSH	SIMRAD EM-3000D	2001
	NAVITRONICS GmbH (Schaeffermeier)	RESON SEABAT 9001-350	
	NICOLA ENGINEERING	SIMRAD EM-120 (portable system)	1999
	NICOLA ENGINEERING	SIMRAD EM-3000 (portable system)	1999
	WASSER UND SCHIFFARTS AMT-BREMERHAVEN	ELAC BCC II 180 kHz	1998
	WASSER UND SCHIFFARTS AMT-TONNING	RESON SEABAT	
GREECE			
AEGAEO	GREEK NATIONAL CENTRE FOR MARINE RESEARCH	SEABEAM 2120	1999
	GREEK NATIONAL CENTRE FOR MARINE RESEARCH	SEABEAM1180	2000
	HELLENIC NAVY HYDROGRAPHIC SERVICE	SIMRAD EM-1002	2001
HUNGARY			
GYÖR 1	NORTH-TRANSDANUBIAN DISTRICT WATER AUTHORITY	ATLAS FANSWEEP 20	1997
ICELAND			
ARNI FREDRIKSSON	ICELAND MARINE RESEARCH INSTITUTE	SIMRAD EM-300	2000

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WORLDWIDE SEAFLOOR SWATH-MAPPING SYSTEMS

INDIA:			
DARSHAK	NAVAL HYDROGRAPHIC OFFICE	SEABEAM 2112	1996 (2)
INVESTIGATOR	NAVAL HYDROGRAPHIC OFFICE	SEABEAM 2112	1998
SURVEY LAUNCHES (2)	NAVAL HYDROGRAPHIC OFFICE	SEABEAM 1180 (6 systems)	1996 (2), 1998 (4)
R/V ???????	NATIONAL INSTITUTE OF OCEANOGRAPHY	SEABEAM 2112	1999
SAGAR KANYA	NATIONAL INSTITUTE OF OCEANOGRAPHY	ATLAS HYDROSWEEP DS	1989
	NATIONAL INSTITUTE OF OCEAN TECHNOLOGY	RESON SEABAT 8101-350	1996
INDONESIA:			
BARUNA JAYA	BAKO SURTANAL (INDONESIA SURVEY CO)	SEABEAM 1050	1994
BARUNA JAYA I	BAKO SURTANAL (INDONESIA SURVEY CO)	SIMRAD EM-1000	1996
BARUNA JAYA I (SURVEY LAUNCH)	BAKO SURTANAL (INDONESIA SURVEY CO)	SIMRAD EM-950	1996
BARUNA JAYA II	BAKO SURTANAL (INDONESIA SURVEY CO)	SIMRAD EM-1000	1996
BARUNA JAYA II (SURVEY LAUNCH)	BAKO SURTANAL (INDONESIA SURVEY CO)	SIMRAD EM-950	1996
BARUNA JAYA III	BAKO SURTANAL (INDONESIA SURVEY CO)	SIMRAD EM-12 (DUAL)	1996
	R&D CENTRE OF OCEANOLOGY	SIMRAD EM-950, EM-1000	1996, 1997
	P.T. CALMARINE	RESON SEABAT	
	P.T. CALMARINE	SEABEAM 1180	1999
IRELAND			
BLIGH	GLOBAL OCEAN TECHNOLOGIES (GOTECH) LTD	SIMRAD EM-120 / EM-1002	2000
CELTIC VOYAGER	MARINE INSTITUTE, DUBLIN	SIMRAD EM-950, SIMRAD EM 1002S	1999, 2000
SIREN	GLOBAL OCEAN TECHNOLOGIES LTD	SIMRAD EM-120 (2x2) / EM-1002	2000
	GLOBAL OCEAN TECHNOLOGIES LTD	SIMRAD EM-12 / EM-1002	2000
ISRAEL:			
ETZIONA	IOLR Ltd / GEOLOGICAL SURVEY OF ISRAEL	SIMRAD EM-1002	2001
ITALY:			
MAGNAGHI	ITALIAN HYDROGRAPHIC OFFICE	SEABEAM 1050 MK II upgrade	1998
ODIN FINDER	GAS ASSISTANCE AND SERVICES (GAS)	SIMRAD EM-300, EM-3000	1999
RAVELLO	DIAMAR	?????	
RAIS	CENTRE OCEANLOGICO MEDITERRANEO (CEOM)	SIMRAD 3000	1997
TELIRI	ELLETRA	SIMRAD EM-12, SIMRAD 3000, SIMRAD EM-950	1996
THETIS	CNR ISTITUTO DI ACOUSTICA	RESON SEABAT 8111-ER	2001
	AZIENDA REGIONAL PER LA NAVIGAZIONE SUL PO	RESON SEABAT	
	CNR ANCONA	SIMRAD EM-3000	2000
	COMMUNICATION TECHNOLOGY SRL	ODOM ECHOSCAN	1999
	GEOLAB	SIMARD EM-3000	2001
	GEOLOGICAL ASSISTANCE AND SERVICE	SIMRAD EM-3000	1997
	INTERMARINE	SIMRAD EM-300 (2 systems)	1999
	INTERNATIONAL MARITIME ACADEMY-TRIESTE	ELAC BCC-180 kHz MkII (2 sys)	1997
	IMPRESUB	ELAC BCC-50 kHz Mk II upgrade	1997
	NAUTILUS SURVEY COMPANY	ELAC BCC Mk II -180 kHz	1997
	NORDEST RILIEV	SIMRAD EM-3000D, EM 300	1999
	SNAMPROGETTI	RESON SEABAT	
JAPAN:			
CHIBA-MARU (317t)	CHIBA PREFECTURE / FISH EXP.	FURUNO HS-200/II	1992
DAINISENSYU-MARU (18t)	AKITA PREF. FISH. RESEARCH & MGMT CTR	FURUNO HS-200/II	1991
ECHIGO-MARU (187t)	NIIGATA PREFECTURE / FISH EXP.	FURUNO HS-200/II	1996
FUKAE-MARU	KOBE UNIV.-MMA	FURUNO HS-100	1987
HAMASHIO	JMSA / 3RD REGIONAL MARITIME SAFETY HQ	RESON SEABAT 8101 (ER)	2000
HAKUHO MARU	UNIV. TOKYO	SEABEAM 2120	1999
HAKUREI MARU II	MMA/DORDO	ATLAS HYDROSWEEP DS	1991
HAYASHIO	JMSA / 7TH REGIONAL MARITIME SAFETY HQ	RESON SEABAT 8101 (ER)	1999
ISESHIO	JMSA / 4TH REGIONAL MARITIME SAFETY HQ	RESON SEABAT 8101 (ER)	1999
ISOSHIO	JMSA / 10TH REGIONAL MARITIME SAFETY HQ	RESON SEABAT 8101 (ER)	2000
IWAKE MARU	FUKUSHIMA F.R.S.	ATLAS FANSWEEP-15	1999
IWATE-MARU	IWATE PREFECTURE	FURUNO HS-200/II	1990
IZU	JAPAN MARITIME SAFETY AGENCY	FURUNO HS-200/II	1996
KAIREI	JAMSTEC	SEABEAM 2112.004	1996
KAIUN-MARU (208t)	AOMORI PREFECTURE / FISH EXP.	FURUNO HS-200/II	1993
KAIYO	JAPAN MARITIME SAFETY AGCY / HYDROGRAPHIC DEPT	SEABEAM 2000	1993
KAIYO (SWATH HULL)	JAMSTEC	SEABEAM	1983
KAIYO-MARU (299t)	NIIGATA PREFECTURAL KAIYO HIGH SCHOOL	FURUNO HS-200/II	1994
KOTAKA-MARU (59t)	FISHERIES AGENCY / NANSEI REGION	FURUNO HS-200/II	1994
KURUSHIMA	JMSA / 6TH REGIONAL MARITIME SAFETY HQ	RESON SEABAT 9001S	1997
MEIYO	JMSA / HYDROGRAPHIC DEPARTMENT	SEABEAM 2000	1997
MIRAI	JAMSTEC	SEABEAM 2112.004	1996 (upgrade '99)
MIYAKO	TOKYO MET/FISH EXP.	FURUNO HS-100	1987
MOGAMI-MARU (98t)	YAMAGATA PREFECTURE / FISH EXP.	FURUNO HS-200/II	1991
MYOJIN-MARU NO. 8	FISHERIES AGENCY	FURUNO HS-100	
NATSUSHIMA (Shinkai 6500 mother ship)	JAMSTEC	SEABEAM 2000	
NOJIMA, (820t)	JMSA (3rd REGION / YOKOHAMA	FURUNO HS-100	1985
OJIKA (861t)	JMSA (2nd REGION)	FURUNO HS-200/II	1990
OKISHIO	JMSA / 11TH REGIONAL MARITIME SAFETY HQ	RESON SEABAT 8101 (ER)	1999
OSHIMA-MARU (226t)	OSHIMA NAT'L COLLEGE OF MARITIME TECHNOLOGY	FURUNO HS-200/II	1993
OYASHIO-MARU (178t)	HOKKAIDO PREFECTURE / FISH EXP.	FURUNO HS-200/II	1990
RISHIRI (960t)	JMSA (1st REGION / KUSHIRO)	FURUNO HS-100	1987
SATSUMA (1250t)	JMSA (10th REGION)	FURUNO HS-100	1995
SHOYO	JMSA/HYDROGRAPHIC DEPARTMENT	SEABEAM 2112	1997
SURVEY LAUNCH	JMSA/HYDROGRAPHIC DEPARTMENT	RESON SEABAT 9001S	1995
SURVEY LAUNCH	JMSA/HYDROGRAPHIC DEPARTMENT	RESON SEABAT 9001S	1997
TAJIMA (140t)	HYOGO PREFECTURE / TANNBA FISH OFFICE	FURUNO HS-100	1988
TAKUYO	JMSA / HYDROGRAPHIC DEPARTMENT	SEABEAM 2100	upgrade '95
TANEICHI-MARU (33t)	IWATE PREFECTURE / TANEICHI HIGH SCHOOL	FURUNO HS-500	1989
TENYO	JMSA / HYDROGRAPHIC DEPARTMENT	SEABEAM 1180	2000
TONAN-MARU (174t)	OKINAWA PREFECTURE / FISH EXP.	FURUNO HS-200/II	1994
UZUSHIO	JMSA / 5TH REGIONAL MARITIME SAFETY HQ	RESON SEABAT 8101 (ER)	2000
WAKATAKA-MARU (692t)	FISHERIES AGENCY / TOHOKU REGION	FURUNO HS-200/II	1994
YOKOSUKA (4500t)	JAMSTEC	FURUNO HS-10, SEABEAM 2112	1989, 1999

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YOSYU (60t)	EHIME PREFECTURE	FURUNO HS-100	1985
08 AGS	JMSDF	SEABEAM 2112.004	1997
	4TH PORT CONSTRUCTION BUREAU	RESON SEABAT 8124	1999
	AERO ASAHI CORPORATION	RESON SEABAT 9001S-350	1996
	AKITA FISHERIES RESEARCH STATION	RESON SEABAT 8101-300	1997
	DISASTER PREVENTION RES. INST. / KYOTO UNIVERSITY	FURUNO HS-500/II	1991
	EHIME UNIVESITY	RESON SEABAT 8101	2000
	ENGINEERING INSTITUTE	ATLAS FANSWEEP-10	1993
	FUYO MARINE DEVELOPMENT	RESON SEABAT 8101 (ER)	1999
	GOYO CORPORATION	RESON SEABAT 9001S	1999
	JAMSTEC	FURUNO HS-200	1987
	JMSA/HYDROGRAPHIC DEPARTMENT (HQ)	RESON SEABAT 9001S-350	1995
	JAPAN SELF DEFENSE AGENCY	RESON SEABAT 8101-300	1998
	KAGOSHIMA FISHERIES RESEARCH STATION	RESON SEABAT 9001S-350	1996
	KOKKUSAI KYOGO CO LTD.	SIMRAD EM-3000D	2000
	KOKUSAI AERIAL SURVEY	RESON SEABAT 9001S-350 (2 systems)	1996, 1999
	KOKUSAI MARINE ENGINEERING CORP.	RESON SEABAT 9001S-350	1995
	NAT'L FEDERATION OF MEDIUM TRAWLERS	FURUNO HS-100	1988
	OCEAN ENGINEERING CORP.	RESON SEABAT 9001S-350 (3 systems)	1996, 1998, 1999
	PENTA-OCEAN CONSTRUCTION CO., LTD.	RESON SEABAT 9001	1996
	SANYO TECHNO MARINE, INC.	RESON SEABAT 9001S-350 (2 systems)	1995/1997
	SHIZUOKA FISHERIES RESEARCH STATION	RESON SEABAT 9001S-350	1994
	SINKO CONSTRUCTION CO., LTD.	RESON SEABAT 9001S-350	1996
	TAISEI CONSTRUCTION CO., LTD.	FURUNO HS-500	1987
	TOA CORPORATION	RESON SEABAT 9001S-350 (2 systems)	1995
	TOKYO PORT BUREAU	RESON SEABAT 8101	1998
	TOTTORI FISHERIES RESEARCH STATION	RESON SEABAT 8101-300	1997
	TOYO CORPORATION	RESON SEABAT 9001S-350	1994
KOREA:			
BORARO 1	NORI	SIMRAD EM-3000	2000
HAE YANG 2000	KOREAN HYDROGRAPHIC SERVICE	SEABEAM 2112.360	1997
IODO	KORDI	SIMRAD EM-1002	2000
ONNURI	KORDI	SEABEAM 2000	1992
TAMHAE II	NORI	SIMRAD EM-3000, EM-950	1997
	HYUNDAI I.C.T.	RESON SEABAT	
	KOREA INST. OF GEOLOGY, MINING & MATERIALS	SIMRAD EM-12, EM-950	1996
	KORDI	RESON SEABAT	
	KORDI/SAROK	SIMRAD EM-3000D	1998
	NORI	SIMRAD EM-3000	1999
LATVIA			
	MARITIME ADMINISTRATION OF LATVIA	RESON SEABAT	
LITHUANIA			
	HARBOR AUTHORITIES, KLAIPEDA	ELAC BCC-180 KHz	1995
MALAYSIA:			
K.D. PERANTAU	ROYAL MALAYSIAN NAVY	ATLAS HYDROSWEEP MD-2	1997
PLUTO (Perantau Survey Launch 124)	ROYAL MALAYSIAN NAVY	ATLAS FANSWEEP 20	1997
UTARID (Perantau Survey Launch 123)	ROYAL MALAYSIAN NAVY	ATLAS FANSWEEP 20	1998
TEKNIK KEMBARA	TL GEOHYDROGRPHICS SDN BHD	SUBMETRIX ISIS 300	
TEKNIK PERDANA	TL GEOHYDROGRPHICS SDN BHD	SIMRAD EM-120, EM-1002	2000
	TL GEOHYDROGRPHICS SDN BHD	SIMRAD EM-1002	2000
	JURUKUR TEGUH (M) SDN BHD	ODOM ECHOSCAN	1999
MALTA			
FRES	ALEXANDER NAVIGATION CO LTD	SIMRAD EM-120 / EM-002	2000
MEXICO			
SHOGUN	SEAPROD	RESON SEABAT 9001	2000
NATO:			
ALLIANCE	SACLANTCEN-LA SPEZIA	ATLAS HYDROSWEEP MD	1990
ALLIANCE	SACLANTCEN-LA SPEZIA	SIMRAD EM 3000	1997
NETHERLANDS:			
ANS	BOSKALIS	SIMRAD EM-3000	1998
ARCA	RIJKSWATERSTATT NORTHZEE	SIMRAD EM-3000 (DUAL)	1997
BLOMMENDAL	RIJKSWATERSTAAT	BATHYSCAN 300	
CHR. BRUNINGS	RIJKSWATERSTAAT	SIMRAD EM-100	1989
CYGNUS	RIJKSWATERSTATT / ZUID-HOLLAND	ATLAS FANSWEEP 20	1998
BURSKYES	VAN OORD (fallpipe)	BATHYSCAN 300	
EUROWERKEN	PORT OF ROTTERDAM	ATLAS FANSWEEP-20	1996
FAIRWAY	BOSKALIS	SIMRAD EM-3000	1997
HOUTVLIET	RIJKSWATERSTAAT	SIMRAD EM-3000 D	1997
JACKY	BOSKALIS	SIMRAD EM-3000	1997
MARGO	BOSKALIS	SIMRAD EM-3000	1996
OCTANS	RIJKSWATERSTAAT	SIMRAD EM-950	1993
PAVO	RIJKSWATERSTAAT / ZUID-HOLLAND	ATLAS FANSWEEP 10, FANSWEEP 20	1994
QUEEN OF THE NETHERLANDS	BOSKALIS	SIMRAD EM-3000D	1997
SEAHORSE	ROCKWATER	SIMRAD EM-3000	1998
TROLLNES	RIJKSWATERSTAAT	RESON SEABAT 9001	
WIJTVLEIT	RIJKSWATERSTAAT / ZEELAND	SIMRAD EM-1002	1999
	NETHERLANDS NAVY	RESON SEABAT	
	ALLSEAS BV	RESON SEABAT	
	BALLAST NEDAM DREDGING	RESON SEABAT	
	BOSKALIS	SIMRAD EM-3000 (2 systems)	1996, 1997
	BOSKALIS	SIMRAD EM-3000S	2000
RESEARCH VESSEL	DAMEN SHIPYARD	SIMRAD EM-1002	2002
	DREDGING INTERNATIONAL	RESON SEABAT	
	HAM DREDGING	RESON SEABAT 8101	1997

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	HAM DREDGING	RESON SEABAT 9001-350 (2 systems)	1999
	NeSA	RESON SEABAT 9001-350 (5 systems)	
	NeSA	RESON SEABAT 9003-350	
	NeSA	RESON SEABAT 8101-300 (2 systems)	
	NeSA	RESON SEABAT 8125 (4 systems)	1999
	OCEONICS INTERSITE BV	ATLAS FANSWEEP-10	1990
	SEATEAM BV	RESON SEABAT	
	TIDEWAY OFFSHORE AND MARINE CONTRACTORS	RESON SEABAT 9001-350	
	VAN OORD	RESON SEABAT 9001S-350 (4 systems)	
NEW CALEDONIA (FRANCE)			
	IRD.UMR GEOSCI AZURE LAB DE GEOL/GEOPHYS	SIMRAD EM -1002	2001
NEW ZEALAND			
SMB ADVENTURE	ROYAL NEW ZEALAND NAVY	ATLAS FANSWEEP 20	1999
HMMS RESOLUTION	ROYAL NEW ZEALAND NAVY	ATLAS HYDROSWEEP MD-2/30	1999
TANGAROA	NIWA	SIMRAD EM-300	2001
	BTW ASSOCIATES, LTD	RESON SEABAT	
NORWAY:			
ARGUS ROV	ARTEC SUBSEA	SIMRAD EM-3000	2001
BERGEN SURVEYOR	STOLT-NIELSEN NORWAY	SIMRAD EM-100	1988
DIV. "U"	FORSVARETS FORSKNINGSINSTITUTT	SIMRAD EM-100	1989
G. O. SARS	UNIVERSITETET I BERGEN / INSTITUTE OF MARINE RESEARCH	SIMRAD EM-300, EM 1002, SM-2000	2002
GEOGRAPH	GEOCONSULT A/S	SIMRAD EM-1000	1991
GEOFJORD	GEOCONSULT A/S	SIMRAD EM-100, EM 300 (1° system)	1986/1997
GEOFJORD	GEOCONSULT A/S	RESON 8125	2001
GEOMASTER	GEOCONSULT A/S	SIMRAD EM-1000	
GEO SCANNER	FUGRO GEODETIC / GEOTEAM	SIMRAD EM-1000, EM-1002	1993, 1999
GEO SURVEYOR	STOLT COMEX SEAWAY	SIMRAD EM 300 (1° sys), EM-3000	1997
HYLSFJORD	BLOM A/S	SIMRAD EM-950, EM-3000	1993, 1998
HUGIN AUV	HUGIN PROJECT	SIMRAD EM-3000 (2)	1996
HUGIN 3000	GEOCONSULT A/S	SIMRAD EM-3000	2002
ICE KING	ICE KING A/S	SIMRAD EM-100	
LANCE	NORWEGIAN HYDROGRAPHIC SERVICE	SIMRAD EM-100	1987
NORDKABEL	BLOM A/S	SIMRAD EM-1002 (with hull unit)	1999
NORTH SEA SURVEYOR	STOLT-NIELSEN NORWAY	SIMRAD EM-100	
ODIN-FINDER	FORSVARETS FORSKNINGSINSTITUTT	SIMRAD EM-100 (sold to Italy-GAS)	
SIMRAD	SIMRAD SUBSEA	SIMRAD EM-1000	1991
SIMRAD ECHO	SIMRAD SUBSEA	SIMRAD EM-950	1994
SJØMÅLEREN	NORWEGIAN HYDROGRAPHIC SERVICE	SIMRAD EM-1002 (with hull unit)	1999
SJØTROLL	NORWEGIAN HYDROGRAPHIC SERVICE	SIMRAD EM-3000D	1999
	ALCATEL CABLE A/S	RESON SEABAT	
	CONOCO-NORWAY	RESON SEABAT	
	DEEP OCEAN A/S-DPII	RESON SEABAT 8111	2000
	DEEP OCEAN A/S-DPII	RESON SEABAT 8125 (3 sys.-HIROV 3000)	2000
	ELF AQUATAINE-NORWAY	RESON SEABAT	
	FORSVARETS FORSKNINGSINSTITUTT	SIMRAD EM-1002 (with hull unit)	1999
	GEOCONSULT A/S	ATLAS FANSWEEP-10	1990
ROV	GEOCONSULT A/S	SIMRAD EM-3000 (DUAL)	1997
	GEOCONSULT A/S	RESON SEABAT	
	GEOTEAM	RESON SEABAT	
	MAERSK OLJE & GAS	RESON SEABAT	
	NORSKE HYDRO	RESON SEABAT	
	NORSK SHELL	RESON SEABAT	
	NORWEGIAN HYDROGRAPHIC SERVICE	SIMRAD 3000D	1999
	NORWEGIAN HYDROGRAPHIC SERVICE	SIMRAD 3000D	1999
	STATOIL	RESON SEABAT	
	STOLT-COMEX SEAWAY	SIMRAD EM-3000 (DUAL)	1996
ROV	STOLT-COMEX SEAWAY	SIMRAD EM-3000D	1999
	STOLT-COMEX SEAWAY	RESON SEABAT	
	TROMSO UNIVERSITY	RESON SEABAT	
	WESTMINSTER OFFSHORE	RESON SEABAT 9001-350 (2 systems)	
PANAMA			
	PANAMA CANAL COMMISSION	ODOM ECHOSCAN (2 systems)	1998
PERU			
	PERU NAVY - HYDROGRAPHIC OFFICE	ATLAS FANSWEEP-20	2000
PHILIPPINES			
PRESBITERO	NAT'L MAPPING & RESOURCE INFO AUTH-DENR	SEABEAM 2112.360	1997
VENTURA	NAT'L MAPPING & RESOURCE INFO AUTH-DENR	SEABEAM 2112.360	1997
	NAT'L MAPPING & RESOURCE INFO AUTH-DENR	SEABEAM 1180 Mk II upgrade (2 sys)	1997
	NAT'L MAPPING & RESOURCE INFO AUTH-DENR	ELAC BCC II 180kHz	1997
POLAND:			
ANIA	PORT OF GDANSK	SIMRAD EM-3000	1995
DOKTOR LUBECKI	MARITIME INSTITUTE-GDANSK	RESON SEABAT 9001	1996
NAVIGATOR 21	UNIVERSITY OF SCZECZIN	SEABEAM 1180	1998
	MARITIME OFFICE - STETTIN	SIMRAD EM-3000	1997
	HYDROGRAPHIC INSTITUTE / GDYNIA	ATLAS FANSWEEP-10	1994
	URZAD MORZKI	ATLAS FANSWEEP-20	1998
PORTUGAL:			
CORAL	INSTITUTO HIDROGRAFICO (IHPT)	SIMRAD EM-950	1995
DON CARLOS I	INSTITUTO HIDROGRAFICO (IHPT)	SIMRAD EM-120	2001
	INSTITUTO HIDROGRAFICO (IHPT)	SIMRAD EM-3000	2001
ROMANIA			
ANGELIC SALIINI	PORT OF CONSTANZA AUTHORITY	ATLAS FANSWEEP -20	1997

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WORLDWIDE SEAFLOOR SWATH-MAPPING SYSTEMS

RUSSIA:			
AKADAMICIAN IOFFE	INSTITUTE OF ACOUSTICS-RAS	HOLLMING EKHOS XD	1989
AKADAMICIAN M.A. LAVRENTYEV	RUSSIAN ACADEMY OF SCIENCES	HOLLMING EKHOS II	
R/V DMITRY MENDELEEV	P.P. SHIRSHOV INSTITUTE OF OCEANOLOGY-RAS	HOLLMING EKHOS MD	
AKADAMICIAN BORIS PETROV	V.I. VERNADSKY INSTITUTE OF GEOCHEMISTRY-RAS	ATLAS HYDROSWEEP DS-2	2002
AKADAMICIAN NIKOLAY STRAKHOV	P.P. SHIRSHOV INSTITUTE OF OCEANOLOGY-RAS	HOLLMING EKHOS II	
AKADAMICIAN SERGEI VAVILOV	INSTITUTE OF ACOUSTICS-RAS	HOLLMING EKHOS XD	1989
ECARMA	POSEIDON	SIMRAD EM-1000	1996
GELENDZHEK	RUSSIAN CENT. MAR. GEOL. & GEOPHYS. EXPED.	SIMRAD EM-12	1995
PETER KOTTSOV	RUSSIAN HYDRO OFFICE / (Long term lease to Racal, UK)	SIMRAD EM-12S, ELAC BCC Mk II	1990, 1998
GS 525	MINISTRY OF DEFENSE	ATLAS FANSWEEP 20	1998
	PORT AUTHORITY-KALININGRAD	SIMRAD EM-3000	1997
	PORT AUTHORITY-SANKT PETERBURG	SIMRAD EM-3000	1997
	YUZHMORGEOLOGIYA	SIMRAD EM-3000D	2001
SAUDI ARABIA:			
KARAN 8	ARAMCO	SIMRAD EM-1000	1994
	ARABIAN OIL COMPANY	RESON SEABAT	
	ARAMCO	RESON SEABAT 9001S-350 (2 systems)	
	MacARTNEY A/S	RESON SEABAT	
SINGAPORE:			
SEA WIND	FUGRO GEODETIC PTE LTD	SIMRAD EM-950	1994
SIMRAD ECHO	KONGSBERG SIMRAD ASIA PTE, LTD	SIMRAD EM-950, EM-3000	1994/1997
SINGAORA	FUGRO GEODETIC PTE LTD	SIMRAD EM-1000	
	ASHTEAD TECHNOLOGY S.E. ASIA	RESON SEABAT 9001-350 (2 systems)	
	ASHTEAD TECHNOLOGY S.E. ASIA	RESON SEABAT 9001-800	
	HYDRONAV	TRITON-ELICS HYDROSUITE	2001
SOUTH AFRICA:			
PROTEA	RSA NAVY-HYDROGRAPHIC DEPARTMENT	ATLAS HYDROSWEEP MD	1992/1993
IVAN PRINCEP	TRANS HEX GROUP	RESON SEABAT 8125	2001
NAMAKWA	TRANS HEX GROUP	RESON SEABAT 8125	
	DE BEERS MINING	RESON SEABAT	
	UNDERWATER SURVEYS	RESON SEABAT	
SPAIN:			
HESPERIDES	CONSEJO SUPERIOR DE INVESTIGACIONES CEINTIFICOS	SIMRAD EM-12S-120, EM-1002	1990/1999
VISCONDE DE EZA	IEO	SIMRAD EM-300	1999
	CASTELLON HARBOR	RESON SEABAT	
	CONSEJO SUPERIOR DE INVESTIGACIONES CEINTIFICOS	SIMRAD EM-300	2000
	GEOMYTSA	RESON SEABAT 9001-350	
SWEDEN:			
ALE	SWEDISH NATIONAL MARITIME ADMIN (SNMA)	ELAC BCC-180 KHz Mk II	1998
JACOB HAGG	SWEDISH NATIONAL MARITIME ADMIN (SNMA)	ELAC BCC-180 KHz Mk II	1998
JOHAN NORDENANKER	SWEDISH NATIONAL MARITIME ADMIN (SNMA)	ELAC BCC-180 KHz	1995
MR. BEAM	MARIN MÄTTEKNIK	SIMRAD EM-950	1994
	FORSVARETS FORSKNINGSANSTALT	RESON SEABAT	
	MARIN MÄTTEKNIK	SIMRAD EM-3000D	2000
	MARIN MÄTTEKNIK	SIMRAD EM-1002	2000
	SWEDISH NAVY	RESON SEABAT	
	BOFORS UNDERWATER SYSTEMS AB	RESON SEABAT	
TAIWAN ROC:			
TAKUAN	MINISTRY OF TRANSPORT & COMMUNICATION	SIMRAD EM-12(DUAL), EM-1000	1994
	NATIONAL TAIWAN UNIVERSITY	RESON SEABAT 9001S-350	
	SUN-YAT SEN UNIVERSITY	RESON SEABAT 9001-350	
TURKEY:			
CESNEI (ex-USNS Silas Bent T-AGOR 26)	TURKISH NAVY, DEPT OF NAVIG, HYDROG & OCEANOGR.	SEABEAM (upgrade in 2001)	2001
CUBUCLU	TURKISH NAVY, DEPT OF NAVIG, HYDROG & OCEANOGR.	SEABEAM 1050 D (DUAL FREQ)	1997 (upgrade)
MESAHA 1	TURKISH NAVY, DEPT OF NAVIG, HYDROG & OCEANOGR.	SEABEAM 1180	2000
UNITED ARAB EMIRATES:			
	UNIQUE SYSTEMS	SIMRAD EM 3000	1999
UNITED KINGDOM:			
CHARLES DARWIN (RRS)	NERC / SOUTHAMPTON OCEANOGR. CENTRE	SIMRAD EM-12 S/120	1993
DISCOVERY (RRS)	NERC / SOUTHAMPTON OCEANOGR. CENTRE	GLORIA (system retired)	
EASTERN EXPLORER	RACAL SURVEY LTD	SEABEAM 1050 D upgraded 1998	1997
HMS ECHO	ROYAL NAVY / VOSPER THORNYCROFT (UK) LTD	SIMRAD EM-1002	2001
Survey motor boat	ROYAL NAVY / VOSPER THORNYCROFT (UK) LTD	SIMRAD EM-3000	2001
HMS ENTERPRISE	ROYAL NAVY / VOSPER THORNYCROFT (UK) LTD	SIMRAD EM-1002	2001
Survey motor boat	ROYAL NAVY / VOSPER THORNYCROFT (UK) LTD	SIMRAD EM-3000	2001
FARNELLA	JOHN MARR SHIPPING	GLORIA (system retired)	Retired
GEO PROSPECTOR	FUGRO-GEOTEAM LTD	SIMRAD EM-300	1996
GEO SEARCHER	FUGRO-GEOTEAM LTD	SIMRAD EM 1002	2001
GEO SURVEYOR	FUGRO-GEOTEAM LTD	SIMRAD EM-1000	1997
GLEANOR	MINISTRY OF DEFENCE	ATLAS FANSWEEP-20	1997
JEAN CHARCOT	FUGRO-GEOTEAM LTD	SIMRAD EM-12, EM-1000	1991/1992
L'ESPOIR	SVITZER LTD. / BRITSURVEY	ATLAS HYDROSWEEP DS-2, FANSWEEP-20	1994, 1998
MAGELLAN	SVITZER LTD. / BRITSURVEY	ATLAS HYDROSWEEP MD-2	1994, 1997
MERIDIAN	SVITZER LTD. / BRITSURVEY	ATLAS HYDROSWEEP MD-2	2000
MERCATOR	SVITZER LTD. / BRITSURVEY	ATLAS FANSWEEP-20	1996
NESBITT	MINISTRY OF DEFENCE	ATLAS FANSWEEP-20	1996-1997
ORIENT EXPLORER	RACAL SURVEY LTD	SEABEAM 1050 D	1997
OWEN	MINISTRY OF DEFENCE	ATLAS FANSWEEP-20	1998
JAMES CLARK ROSS (RRS)	NERC / BRITISH ANTARCTIC SURVEY	SIMRAD EM-120 (1x1)	2000
SCOTIAN SHORE	MARITIME SURVEYS LTD	RESON SEABAT 8160	2001
HMS SCOTT	ROYAL NAVY	SASS IV	1997

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WORLDWIDE SEAFLOOR SWATH-MAPPING SYSTEMS

SEA EXPLORER	GARDLINE SURVEYS LTD	SIMRAD EM-1000	1996
SEA SURVEYOR	GARDLINE SURVEYS LTD	SIMRAD EM-12, EM-950	1999
SEA TRIDENT	GARDLINE SURVEYS LTD	SEABEAM 1050 MW	1999
	MINISTRY OF DEFENCE	ATLAS FANSWEEP-20	1997
	ALLUVIAL MINING COMPANY	RESON SEABAT	
	ASHTEAD TECHNOLOGY LTD	RESON SEABAT 9001-600 (2 systems)	
	ASHTEAD TECHNOLOGY LTD	RESON SEABAT 8101-300	2000
	ASHTEAD TECHNOLOGY LTD	RESON SEABAT 9001S-350 (2 systems)	
	ASHTEAD TECHNOLOGY LTD	RESON SEABAT 8125 (2 systems)	2000
	ASSOCIATED BRITISH PORTS	RESON SEABAT	
	BARROW IN FURNESS PORT AUTHORITY	RESON SEABAT	
	BRITISH PETROLEUM	RESON SEABAT	
	CABLE AND WIRELESS MARINE, LTD	RESON SEABAT	
	CALEDONIAN GEOTECH	RESON SEABAT	
	CHEVRON OIL COMPANY	RESON SEABAT	
	COFLEXIP STENA OFFSHORE	RESON SEABAT	
	DONALD CAMERON	RESON SEABAT	
	DRA	RESON SEABAT	
	EGS SERVICES	RESON SEABAT	
	ENTERPRISE OIL LIMITED	RESON SEABAT	
	EUROPEAN MARINE CONTRACTORS	RESON SEABAT 9001S-350 (2 systems)	
	FUGRO-UDI LTD	RESON SEABAT	
	GEOCONSULT	OMNITECH ECHOSCOPE 1600	
	HARWITCH HARBOUR AUTHORITY	RESON SEABAT 9001-350 (2 systems)	
	HERIOT-WATT UNIVERSITY	RESON SEABAT	
	HMB SUBWORK LTD.	RESON SEABAT	
	J.P. KENNY	RESON SEABAT	
	MAFF - MARINE LABORATORY	RESON SEABAT	
	MARCONI-UDI	RESON SEABAT	
	McDERMOTT MARINE CONSTRUCTION	RESON SEABAT	
	MORRISON-McLEAN ASSOCIATES	RESON SEABAT	
	NORCOM TECHNOLOGY, LTD	RESON SEABAT	
	OCEANSCAN, LTD	SIMRAD EM-3000 (LEASE)	1996
	OCEANSCAN, LTD	RESON SEABAT 8101	1998
	OCEANTEAM	RESON SEABAT	
	OCEANEERING	RESON SEABAT	
	OCTOPUS MARINE SYSTEMS	ELAC BCC 180 kHz Mk II (2 sys)	1996, 1997
	OCTOPUS MARINE SYSTEMS	SEABEAM ELAC 1180	
	OCTOPUS MARINE SYSTEMS	OMNITECH ECHOSCOPE 1600	
	OSAE	RESON SEABAT 9001-350 (2 systems)	
	OSAE	RESON SEABAT 9001-500 (2 systems)	
	OSPREY LEASING, LTD	SIMRAD EM-3000	1996
	RACAL SURVEY LTD	SEABEAM 1050 D (2 sys.) upgrad 1998	1996, 1997
	RACAL SURVEY LTD	SEABEAM 1180 (2 systems) upgrad1998	1996, 1997
	ROSS OFFSHORE	RESON SEABAT	
	ROYAL NAVY TRAINING SCHOOL	SIMRAD EM-3000	2001
	SAGA OIL AND GAS	RESON SEABAT	
	SCANTRON LTD / EIVA	RESON SEABAT 9001-350 (2 systems)	
	SHELL UK	RESON SEABAT	
	SONSUB	RESON SEABAT	
	STENA OFFSHORE	RESON SEABAT	
	STOLT-COMEX SEAWAY	RESON SEABAT	
	SUBSEA OFFSHORE	RESON SEABAT 9001-500	
	SUBSEA SURVEY	RESON SEABAT	
	TOTAL OIL	RESON SEABAT	
	UDI LTD	RESON SEABAT	
	UNDERWATER EXCAVATION INTERNATIONAL LTD	RESON SEABAT	
	WIMPOL LIMITED	RESON SEABAT	
UNITED STATES OF AMERICA			
US ARMY CORPS OF ENGINEERS			
	ANCHORAGE	RESON SEABAT 9001-350	
	BALTIMORE	ODOM ECHOSCAN	1998
	BUFFALO	RESON SEABAT 9001-350	
	CHICAGO	RESON SEABAT 9001-350	
	DETROIT	RESON SEABAT 9001S-350	
	GALVESTON	RESON SEABAT 9001-350	
	GALVESTON	ODOM ECHOSCAN (2 systems)	1998
	JACKSONVILLE	RESON SEABAT 9001-350	
	LOS ANGELES	RESON SEABAT 9001-350	
	LOS ANGELES	ATLAS FANSWEEP 20	2001
	LOUISVILLE	RESON SEABAT 9001-350	
	MEMPHIS	RESON SEABAT 9001-350	
	MOBILE	RESON SEABAT 9001-350	
	MOBILE	RESON SEABAT 8125	2002
	NEW ENGLAND	RESON SEABAT 9001-350	
	NEW YORK	RESON SEABAT 8101-300	
	NEW YORK	ODOM ECHOSCAN	1998
	NORFOLK	RESON SEABAT 8101-300	
	PORTLAND	RESON SEABAT 8101-300	
	SAN FRANCISCO	RESON SEABAT 8101-300	
	SAULT ST. MARIE	RESON SEABAT 8101-300	
	SAVANNAH	RESON SEABAT 8101-300	
	SAVANNAH	RESON SEABAT 8125	2002
	SEATTLE	RESON SEABAT 8101-300	
	SEATTLE	ELAC SEABEAM 1185/TEI ISIS	2001
	ST. LOUIS	RESON SEABAT 8101-300	
	VICKSBURG	RESON SEABAT 8101-300	
	WALLA WALLA	RESON SEABAT 8101-300	
	WATERWAYS EXPERIMENT STATION	RESON SEABAT 8101-300	
	WILMINGTON	RESON SEABAT 8101-300	

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US COAST GUARD			
USCGC HEALY (WAGB-20) (Icebreaker)	US COAST GUARD	SEABEAM 2112 (Ice)	1999
	US COAST GUARD	RESON SEABAT	
US COAST SURVEY-NOAA/NOS			
NOAAS DAVIDSON	NOAA/OMAO	HYDROCHART	(ret '89)
NOAAS DISCOVERER	NOAA/OMAO	SEABEAM	1986 (ret. '96)
NOAAS HECK	NOAA/OMAO	RESON SEABAT 9001	1992 (ret. '95)
NOAAS MT MITCHELL	NOAA/OMAO	SEABEAM	1987 (ret. '95)
NOAAS RAINIER	NOAA/OMAO	SEABEAM 1180	1999
RAINIER RA-1)	NOAA/OMAO	RESON SEABAT 8101 ER	1998
RAINIER RA-3	NOAA/OMAO	SEABEAM 1180	2000
RAINIER RA-4	NOAA/OMAO	SEABEAM 1180	2000
RAINIER RA-6	NOAA/OMAO	RESON SEABAT 8101 ER	1998
NOAAS RONALD H. BROWN (AGOR-26)	NOAA/OMAO	SEABEAM 2112A	1997
NOAAS SURVEYOR	NOAA/NOS	SEABEAM	1979 (ret. '95)
NOAAS WHITING	NOAA/OMAO	HYDROCHART II (removed)	1989
NOAAS RUDE	NOAA/OMAO	RESON SEABAT 9003	1994
S/V BAY HYDROGRAPHER	NOAA/NOS	RESON SEABAT 9001	1997
	NOAA/NOS	RESON SEABAT 8125 (4 systems)	2002
US ENVIRONMENTAL PROTECTION AGCY	USEPA	RESON SEABAT	
US FISH AND WILDLIFE SERVICE	USFWS	RESON SEABAT	
US GEOLOGICAL SURVEY	USGS - Woods Hole	SUBMETRIX 2000 - 234kHz	2001
US NATIONAL BIOLOGICAL SERVICE	USNBS	RESON SEABAT	
US NAVY / MSC OPERATED			
USS BOWDITCH (TAGS-21)	NAVOCEANO	SASS	1965 (ret.)
USNS BOWDITCH (TAGS-62)	NAVOCEANO	SIMRAD EM-121A (1° system)	(insvc '96)
USNS SILAS BENT (TAGS-26)	NAVOCEANO	SEABEAM (to Turkey-TCG CESNEI)	1989 (ret '99)
USNS BRUCE HEEZEN (TAGS-64)	NAVOCEANO	SIMRAD EM-121A (1° system) / EM-1000	1999
USS DUTTON (TAGS-22)	NAVOCEANO	SASS	1965 (retired)
USNS MATTHEW HENSON (TAGS-63)	NAVOCEANO	SIMRAD EM-121A (1° system) / EM-1000	1995
SURVEY LAUNCH #34009	NAVOCEANO	SIMRAD EM-3000	1998
SURVEY LAUNCH #34010	NAVOCEANO	SIMRAD EM-3000	1998
USNS HARRY HESS (TAGS-28)	NAVOCEANO	SASS	1965 (ret '90)
USNS ELISHA KENT KANE (TAGS-27)	NAVOCEANO	SEABEAM	1989 (ret '92)
USNS LITTLEHALES (TAGS-52)	NAVOCEANO	SIMRAD EM-100-upgrade to EM-1002	1999
USNS MATTHEW F MAURY (TAGS-39)	NAVOCEANO	SASS IV (to California Maritime Academy)	1989 (ret '94)
USNS JOHN MCDONNELL (TAGS-51)	NAVOCEANO	SIMRAD EM-100-upgrade to EM-1002	1999
USNS MIZAR (TAGOR-11)	NAVOCEANO	SEABEAM	(ret '90)
USNS ALBERT MYER (T-ARC-6)	NAVOCEANO	SEABEAM	1992
USNS NEPTUNE (T-ARC-2)	NAVOCEANO	SEABEAM	(ret '91)
USNS OBSERVATION ISLAND	NAVOCEANO	SASS	1965 (retired)
USNS PATHFINDER (TAGS-60)	NAVOCEANO	SIMRAD EM-121A (1° system), EM-1000	1994, 1998
USNS MARY SEARS (TAGS-65)	NAVOCEANO	SIMRAD EM-1002, EM-121A (1°system)	2000
USNS SUMNER (TAGS-61)	NAVOCEANO	SIMRAD EM-121A (1° system), EM-1000	1994, 1998
USNS TANNER (TAGS-40)	NAVOCEANO	SASS IV (to Maine Maritime Academy)	1990 (ret '93)
USNS WATERS (TAGS-45)	NAVOCEANO	SEABEAM	1992
USNS WILKES (TAGS-33)	NAVOCEANO / SPAWAR	SEABEAM (to Tunisia)	(ret '95)
USNS WYMAN (TAGS-34)	NAVOCEANO	SASS IV/BOTASS	1989 (ret '99)
USNS ZEUS (T-ARC-7)	NAVOCEANO	SIMRAD EM-121 (1° system)	(tbret '97)
R/V LANEY CHOUEST	NAVOCEANO	SEABEAM	1988
SEA LION / ORCA	COMSUBDEVGRU 1	SIMRAD EM-950	1994
ORCA I (ROV)	NAVOCEANO	SIMRAD EM-950	1994
ORCA II (ROV)	NRL	SIMRAD EM-950	1994
	NAVAL FACILITIES ENGINEERING COMMAND	SIMRAD EM-3000	1998
	NAVOCEANO	RESON SEABAT 9001-350	
SURVEY LAUNCHES	NAVOCEANO	SIMRAD EM-3000 (10 systems)	1998, '99, 2000, '01
	NRL	RESON SEABAT 9001-350 (2 systems)	
	NUWC-KEYPORT WA	SIMRAD SM 2000/Triton-Elics HS150	2001
	US NAVY	SIMRAD EM-1002 (2 systems)	1999
	USN EXPLOSIVES ORD. DISPOSAL CTR-INDIAN HEAD	SIMRAD SM-2000 (4 systems)	2000
US RESEARCH INSTITUTIONS			
ATLANTIS (AGOR-25)	W00DS HOLE OCEANOGRAPHIC INSTITUTION	SEABEAM 2112A (Ice)	1995
ATLANTIS II	WOODS HOLE OCEANOGRAPHIC INSTITUTION	SEABEAM	1983
BELLOWS	UNIVERSITY OF FLORIDA	SIMRAD EM-3000	1998
ROBERT CONRAD (AGOR-3)	LAMONT-DOHERTY EARTH OBSERVATORY	SEABEAM	1984 (ret '89)
MAURICE EWING	LAMONT-DOHERTY EARTH OBSERVATORY	ATLAS HYDROSWEEP	1990
KA'IMIKAI O KANILOA	UNIVERSITY OF HAWAII	SEABEAM 2100	
KNORR (AGOR-150	WOODS HOLE OCEANOGRAPHIC INSTITUTION	SEABEAM 2112	1994
MELVILLE (AGOR-14)	SCRIPPS INST OF OCEANOGRAPHY	SEABEAM 2000	1992
MOANA WAVE (AGOR-22)	UNIVERSITY OF HAWAII	MR 1 (SEAMARC 1)	
NATHANIEL PALMER (Icebreaker)	NSF/EDISON CHOUEST	SIMRAD EM12/ (ICE) (1°x2°)	2002
ONRUST	MARINE SCIENCE RESEARCH CTR-(SUNY)-STONYBROOK	SIMRAD EM-3000	1998
ROGER REVELLE (AGOR-24)	SCRIPPS INST OF OCEANOGRAPHY	SEABEAM 2112A (replaced: 2000)	1995
ROGER REVELLE (AGOR-24)	SCRIPPS INST OF OCEANOGRAPHY	SIMRAD EM-120 (2x2) / EM-1002	2000, 2001
THOMAS THOMPSON (AGOR-23)	UNIVERSITY OF WASHINGTON	SIMRAD EM-300 (1°x1°)	2002
THOMAS WASHINGTON (AGOR-10)	SCRIPPS INST OF OCEANOGRAPHY	SEABEAM (to Chile)	1981 (ret '92)
KILO MOANA (AGOR-26) SWATH VESSEL	UNIVERSITY OF HAWAII	SIMRAD EM-120	2001
	UNIVERSITY OF HAWAII	SIMRAD EM-1002	2001
	WOODS HOLE OCEANOGRAPHIC INSTITUTION	RESON SEABAT	
US STATE AGENCIES			
	ALASKA FISHERIES	RESON SEABAT	
	HAWAII UNDERSEA RESEARCH LABORATORY	RESON SEABAT	
	MISSOURI DEPT OF TRANSPORTATION	RESON SEABAT	
	NEVADA WATER AUTHORITY	RESON SEABAT	

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US COMMERCIAL OPERATORS			
CAPTAIN PETE	WEEKS MARINE	ODOM ECHOSCAN	2001
COASTAL SURVEYOR	C&C TECHNOLOGIES (to NOAA/UNH CCOM-2002)	SIMRAD EM-3000D (portable)	1999
DAVIDSON	OCEAN SERVICES LLC	RESON SEABAT 8150-F	2000
DIAMOND REEF	GREAT LAKES DREDGE AND DOCK	ATLAS FANSWEEP-20	1998
ROBERT I ENGLE	HANSON PROFESSIONAL SERVICES INC	RESON SEABAT 9001S-350	1996
EDISON CHOUEST	CHOUEST	SEABEAM 1050/ER	1997
FALCON EXPLORER	PGS, HOUSTON	SEABEAM 2112A	1997
HUGIN (UUV)	C&C TECHNOLOGIES	SIMRAD SM-2000	1999
INEZ McCALL	C&C TECHNOLOGIES	SIMRAD EM-3000D (portable)	1999
INLAND SURVEYOR	C&C TECHNOLOGIES	SIMRAD EM-950 (portable)	1993
MERLION	C&C TECHNOLOGIES	SIMRAD EM-12S	1997
NEUVILLE	GREAT LAKES DREDGE AND DOCK	ATLAS FANSWEEP-20	2000
NORTELLA	BELL GEOSPACE	SIMRAD EM-3000(DUAL); EM-950, EM-12S	1996, 1997
OCEAN ALERT (retired 2001)	C&C TECHNOLOGIES	SIMRAD EM-300 (1X2°)	1997 (ret. 2001)
OCEAN EXPLORER	SCIENCE APPLICATIONS INTERNATIONAL CORP.	RESON SEABAT	
OCEAN SURVEYOR	C&C TECHNOLOGIES	SIMRAD EM-1000	
S/V SEABAT 1	C&C TECHNOLOGIES	RESON SEABAT 9001SS-350	
SEIS SURVEYOR	JOHN CHANCE AND ASSOCIATES	SEABEAM 2100	1996
SHOAL RUNNER	GREAT LAKES DREDGE AND DOCK	ATLAS FANSWEEP-20	1999
SURF SURVEYOR	C&C TECHNOLOGIES	SIMRAD EM-950 (portable)	
	ALLIANT TECHSYSTEMS, INC.	RESON SEABAT	
	ALLIED SIGNAL-OCEAN SYSTEMS	ELAC BCC-180kHz	1996
	ALLIED SIGNAL-OCEAN SYSTEMS	RESON SEABAT 9001S-600	
	APPLIED REMOTE TECHNOLOGY-RAYTHEON	RESON SEABAT 9001-350	
	ARC SURVEYING AND MAPPING	SIMRAD EM-300 (2X4°)	1997
	ASHTEAD TECHNOLOGY, INC.	RESON SEABAT 8160	2001
	CH2M HILL	RESON SEABAT	
	CHEVRON USA INC.	RESON SEABAT	
	CHUSTZ SURVEY	RESON SEABAT 8125	2002
	COASTAL SYSTEM STATION	RESON SEABAT	
	C&C TECHNOLOGIES	RESON SEABAT 9001S-350	
	C&C TECHNOLOGIES	SIMRAD EM-2000 (spare)	2000
	CRA INC.	RESON SEABAT	
	CRA NW	RESON SEABAT	
	CRA-NW	ELAC BCC-180 kHz	1995
	DAVCO	ECHOSCAN	2000
	DAVID EVANS AND ASSOCIATES	RESON SEABAT	
	DIMCO	ODOM ECHOSCAN	2000
	FUGRO USA	SIMRAD EM-2000 (spare)	2001
	FUGRO WEST, INC.	RESON SEABAT	
	GAHAGAN & BRYANT	ODOM ECHOSCAN	1998
	GEORGIA PACIFIC	RESON SEABAT	
	GLOBAL EXPLORERS	RESON SEABAT	
	GOLDER ASSOCIATES	RESON SEABAT	
	GREAT LAKES DREDGE & DOCK	ATLAS FANSWEEP-20	2001
	INTERNATIONAL INDUSTRIES, INC./RENTMAR	ATLAS FANSWEEP-10	1991
	INTERNATIONAL INDUSTRIES, INC./RENTMAR	ODOM ECHOSCAN	
	INTERNATIONAL INDUSTRIES, INC./RENTMAR	RESON SEABAT	
	JOHN CHANCE AND ASSOCIATES	ELAC BCC-180 kHz	1996
	JOHN CHANCE AND ASSOCIATES	ATLAS FANSWEEP-10	1992
	JOHN CHANCE AND ASSOCIATES	RESON SEABAT 9001-350	
	JOHNSON-McADAMS	RESON SEABAT 9001S-350	
	LOCKHEED MISSILES AND SPACE, INC.	RESON SEABAT	
	MANSON CONSTRUCTION	RESON SEABAT 8125	2002
	MORRIS HEBERT & ASSOCIATES	RESON SEABAT	
	OCEAN SURVEYS INC	RESON SEABAT	
	OCEANEERING TECHNOLOGIES	RESON SEABAT 8101-300	
	OCEANIC IMAGING CONSULTANTS, INC.	RESON SEABAT 8101 (2 systems)	2000
	P.T.I. ENVIRONMENTAL	RESON SEABAT	
	RLDA SURVEYING AND MAPPING	ODOM ECHOSCAN (PUERTO RICO)	1998
	PELAGOS CORPORATION	RESON SEABAT	
	PERRY TECHNOLOGIES	RESON SEABAT	
	PORT OF LOS ANGELES	RESON SEABAT	
	RACAL SURVEY INC.	RESON SEABAT	
	RACAL-NCS	RESON SEABAT 8101-1200	
	ROGERS SURVEYING	RESON SEABAT 8101	2000
"DEMO"	SCIENCE APPLICATIONS INTERNATIONAL CORP.	SIMRAD EM-3000	1997
	SCIENTIFIC SERVICES, INC.	RESON SEABAT	
	SEAFLOOR SURVEYS INTERNATIONAL / FUGRO	RESON SEABAT	
	SEARCH AND SURVEY, INC	RESON SEABAT	
	SEA VISUAL, INC.	RESON SEABAT	
	SOLUS SCHALL	RESON SEABAT	
	SQUIRE ASSOCIATES	RESON SEABAT	
	SUMMIT TECHNOLOGIES	RESON SEABAT	
	SURVEY EQUIPMENT SERVICES, INC.	RESON SEABAT	
	TERRA SURVEYS, INC.	RESON SEABAT	
	TRITON ELICS INTERNATIONAL INC.	RESON SEABAT	
	VERNON F MEYERS & ASSOCIATES	RESON SEABAT	
	WILLIAMSON & ASSOCIATES INC.	RESON SEABAT	
URUGUAY			
S/V OYURVIDE	SERVICIO DE OCEANOGRAFIA, HIDROGRAFIA Y METEROLOGIA	SEABEAM 1180	1998
VESSEL NAME	**OPERATOR**	**SYSTEM**	**INSTALL YR**

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