

HYDROGRAPHIC SURVEYING AND NAUTICAL CHARTING: A COORDINATED EFFORT OF THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO)

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Paper published in TERRA ANTARTICA, 1994, I(2), pp. 413-417.

Introduction

The IHO is an intergovernmental consultative and technical organization which brings about:

- a. The coordination of the activities of national hydrographic offices.
- b. The greatest possible uniformity in nautical charts and documents.
- c. The adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys.
- d. The development of the sciences in the field of hydrography and the techniques employed in descriptive oceanography.

The Organization was founded in 1919 and the Secretariat, the International Hydrographic Bureau (IHB), has been established in the Principality of Monaco since 1921.

PECULIARITY OF HYDROGRAPHIC SURVEYS IN ANTARCTICA

Hydrographic surveys are strictly associated with the history of the sea explorations and Antarctica is no exception.

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The first surveys, with the associated nautical charting, date back to 1820 after the discovery of King George Island, South Shetlands, when the British Admiralty published a chart after Edward Bransfield's voyage to the South Shetland Islands. The Admiralty chart was actually published on 30 November 1822.

Nowadays after the development of hydrography and cartography three nations provide complete coverage around the Antarctic continent: USA (US Defense Mapping Agency), UK (Hydrographic Office) and the Russian Federation (Head Department of Navigation and Oceanography).

Other countries which carry out hydrographic surveys and produce nautical charts of Antarctica are: Argentina, Australia, Brazil, Chile, Ecuador, Germany, France, Japan, Italy, Uruguay, Peru, Spain and New Zealand.

Hydrographic surveys in Antarctica, as in the case of other types of oceanographic research, are mainly affected by the hostile environment and by the presence of sea ice. Nearshore surveys imply a previous knowledge of the coastal topography which is not easy to achieve. At present, photogrammetry and satellite imagery are the two methods used for coastal topography; both methods are affected by meteorological conditions and both are expensive.

Aerial photogrammetry is still considered the most accurate way to obtain topography at a given scale especially when this latter is around 1:25,000 or larger, while satellite imagery has been used to scale 1:50,000 (INT charting).

Nearshore soundings must invariably be associated with tide measurement in order to reduce measured depth to the sounding datum. The error of such reduction should not exceed the errors for depth measurement established by the IHO standards (IHO publication S-44).

Tide gauge stations, set up near almost all the Antarctic scientific bases, provide Hydrographers with tide values sufficient to apply the needed corrections to the measured depth. A list of the existing tide gauge stations is kept up to date by the IHB.

To carry out soundings in navigable areas (free or partially free from sea ice) boats and ships must be fitted with position fixing, echo sounders and a heave compensator. When multibeam echosounders are used, precise platform's roll and pitch measurement should be available. Frequent determination of the water column structure is also essential for reducing the depth measurements obtained by the oblique beams.

In areas covered by ice, soundings can be obtained by:

- spot measurements (either making holes in the ice or superimposing the echo sounder's transducer on the ice surface);
- continuous lines obtained towing the transducer on the ice;
- airborne electromagnetic bathymetry systems such as the TIBS employed in the Arctic by the Canadian Hydrographic Service.

Positioning: during the 1980's the most common methods for positioning nearshore soundings (up to 20 miles) have been those based on transponders sometimes associated with optical intersections; satellite positioning (either Transit or GPS) was used for offshore soundings.

In the 1990's GPS, which is now fully operational, associated with DGPS is going to be the sole method of positioning. Positions obtained with GPS satisfy the accuracy standards established by IHO and are referred to the World Geodetic System 84 which has been adopted as the geodetic datum by the new series of the INTERNATIONAL NAUTICAL CHARTS as recommended by the IHO.

STATUS OF HYDROGRAPHIC SURVEYS AND NAUTICAL CHARTING IN ANTARCTICA (as reported in the IHO publication S-59)

As from 1991, following the invitation extended to the IHO to participate, as an expert, in the work of the XVth Antarctic Treaty Consultative Meeting (ATCM) and the need for improved coordination of hydrographic surveying and charting as a result of the increasing scientific activity and maritime traffic in the area, the IHB began collecting information from the IHO Member States on their activities in Antarctica. The data are collated in IHO publication S-59 available to the general public and updated by the IHB on a yearly basis.

The first part of the publication presents, in graphical form, the existing published nautical charts for Antarctica. Two examples of graphic indexes of the publications, the first dealing with small scale charts, the second with large scale charts, are given herewith in Figures 1 and 2.

As one can see, the present charting coverage of the Antarctic waters is not uniform because there was no coordination on this production in the past and every nation produced its own set of charts to meet its own national requirements.

The second part of the publication includes, in graphical form, the area covered by hydrographic surveys carried out by the various countries. A colour coding system, associated with the scale and the sounding technique used, has been adopted to classify the surveys according to their quality. The data quality is referred to the standards established by the IHO in publication S-44. When hydrographers speak about "quality of survey data", they first bear in mind navigation safety. In simple terms, the highest quality rating is attributed to those data which give 100% certainty that all navigational hazards are shown on the chart. Data quality must be assessed by the surveyor and ultimately by the Hydrographic Authority which published the chart.

The IHO has established rules and specifications for assessing the reliability of the survey data and consequently provides reliability diagrams on the charts.

These rules and specifications are generally met by the Hydrographic Offices even if we are still far from a uniform application of them. The debate for assessing

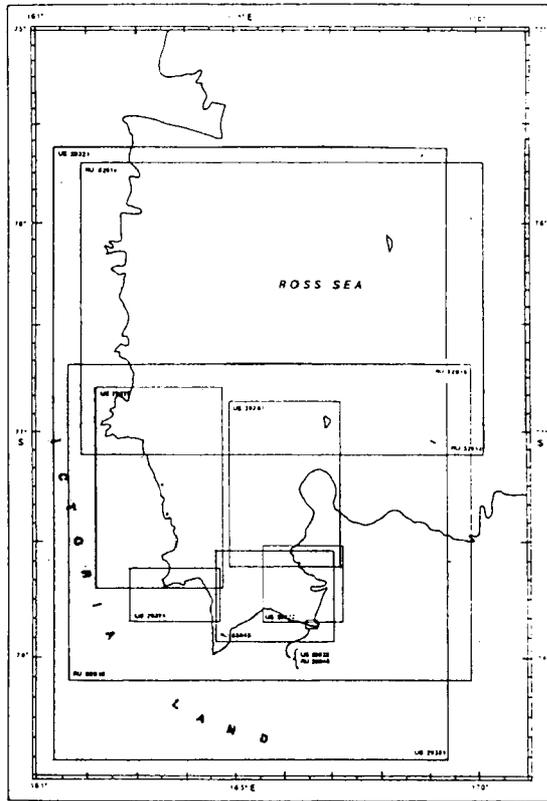


FIG. 2.- An example of graphic indexes of publications of large scale charts.

Table I - Subdivision of hydrographic surveys in Antarctica

Class	Scale	Sounding technique
1	>1:75 000	Multibeam swath soundings
*2	>1:75 000	Vertical beam side scan sonar
*3	>1:75 000	Vertical beam only
4	<1:75 000	Multi beam swath soundings
*5	<1:75 000	Vertical beam side scan sonar
*6	<1:75 000	Vertical beam only

* Line spacing 10 mm at survey scale.

THE IHO PERMANENT WORKING GROUP FOR COOPERATION IN ANTARCTICA

To improve this situation the XIVth International Hydrographic Conference, in May 1992, established an IHO Permanent Working Group on Cooperation in Antarctica. The main points of the Working Group Terms of Reference are :

- to develop an INT Chart scheme covering all Antarctic waters;
- to examine the status and quality of hydrographic surveys and encourage the publication of source reliability diagrams on all published charts of Antarctica;

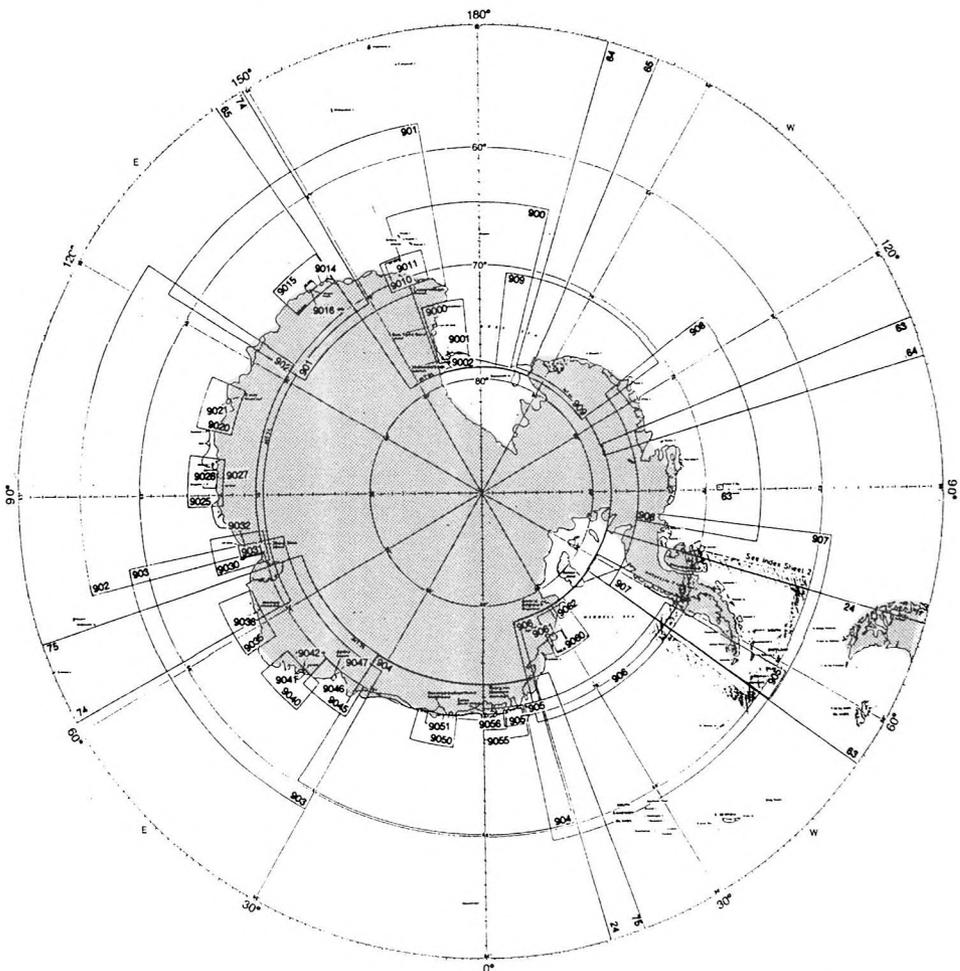


FIG. 3.- International charting scheme of the Antarctic nautical cartography.

- to identify the survey and charting requirements taking account of advice of COMNAP and other organizations;
- to establish and maintain liaison with GEBCO organization concerning Antarctic bathymetric data collection;
- to maintain appropriate liaison with relevant scientific organizations including SCAR, IOC and COMNAP;
- to produce annually a report of the status and plans for hydrographic surveys (S-59 updating).

The Working Group is open to all the IHO Member States who are interested in hydrography and navigation in Antarctica. At present the following nations participate in the Working Group: Argentina, Australia, Brazil, Chile, China, Ecuador, France, Germany, Greece, Italy, India, Japan, Korea, New Zealand, Norway, Peru, Russia, South Africa, Spain, UK, Uruguay and USA. The Chairman is Mrs. B. BOND, UK HO. The working group, which has its secretariat at the International Hydrographic Bureau, met in 1992, 1993 and in 1994 and works very actively by correspondence.

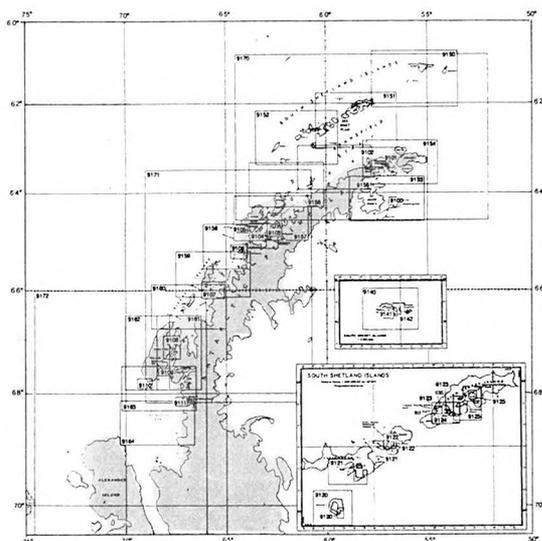


FIG. 4.- Medium and large scale charts in the region of the Antarctic Peninsula.

A scheme of international nautical charts at small, medium and large scales has been proposed by the IHB and a consensus on it has been achieved by almost all nations participating. The concept of the International charts is that each chart of an agreed scheme is made by a producer nation following the IHO standards and is reproduced by all other IHO Hydrographic Services interested in having that chart in their own portfolio. Once a nation has accepted the producer status of a given chart the other IHO nations will hopefully pass on all the data they possess on the area which has to be charted.

Data contained in nautical charts made upon this agreement will be formatted in the IHO standard exchange format, known as DX-90 or S-57 (from the

number of the IHO publication which describes that standard). This will permit the creation of the Electronic Navigational Chart Database.

Each chart database, once constituted, will also be available to the scientific community and in particular to SCAR. For scientific purposes detailed bathymetry can also be created by the nations concerned upon request.

The international charting scheme of the Antarctic nautical cartography is given in Figures 3 and 4. The schemes comprise 6 charts at scale 1:10,000,000, 10 charts at scale 1:2,000,000 and 77 charts at scales ranging between 1:500,000 and 1:5,000. Most of the medium and large scale charts are concentrated in the region of the Antarctic peninsula (Figs. 3 and 4).

THE IHO DATA CENTRE FOR DIGITAL BATHYMETRY AND THE GEBCO

An IHO Data Centre for Digital Bathymetry (IHO DCDB) operating at the US National Geophysical Data Center of Boulder, Colorado (USA), since 1990, is continuously accumulating new digital bathymetric data from contributing agencies. The DCDB is the focal point for digital bathymetric data services for IHO Member States.

In publication S-59 a diagram (Fig. 5) shows the density of oceanic soundings south of 60°S stored at DCDB which can be used by the IHO Hydrographic Services to compile international charts.

The DCDB data will be used by the GEBCO Guiding Committee (composed of 5 IHO members and 5 IOC members) to prepare the 6th edition of the GEBCO chart in which the Antarctic waters will be represented by one sheet at scale 1:6,000,000. The sixth edition will be in printed and digital form.

The new edition will be made with the contribution of 5 IHO Member States (Argentina, Australia, Chile, New Zealand, United Kingdom) under the auspices of IHO and IOC (Intergovernmental Oceanographic Commission of UNESCO).

Lastly the effort of the German Alfred Wegener Institute should be mentioned in the creation of a Bathymetric chart of the Weddell Sea which will be composed of one chart at scale 1:3,000,000 and 12 charts at 1:1,000,000. Sounding data come from the existing cartography and from original multibeam surveys carried out by the German Research Vessel POLARSTERN. A representative of the Alfred Institute attends the meetings of the IHO PWGCA as an observer.

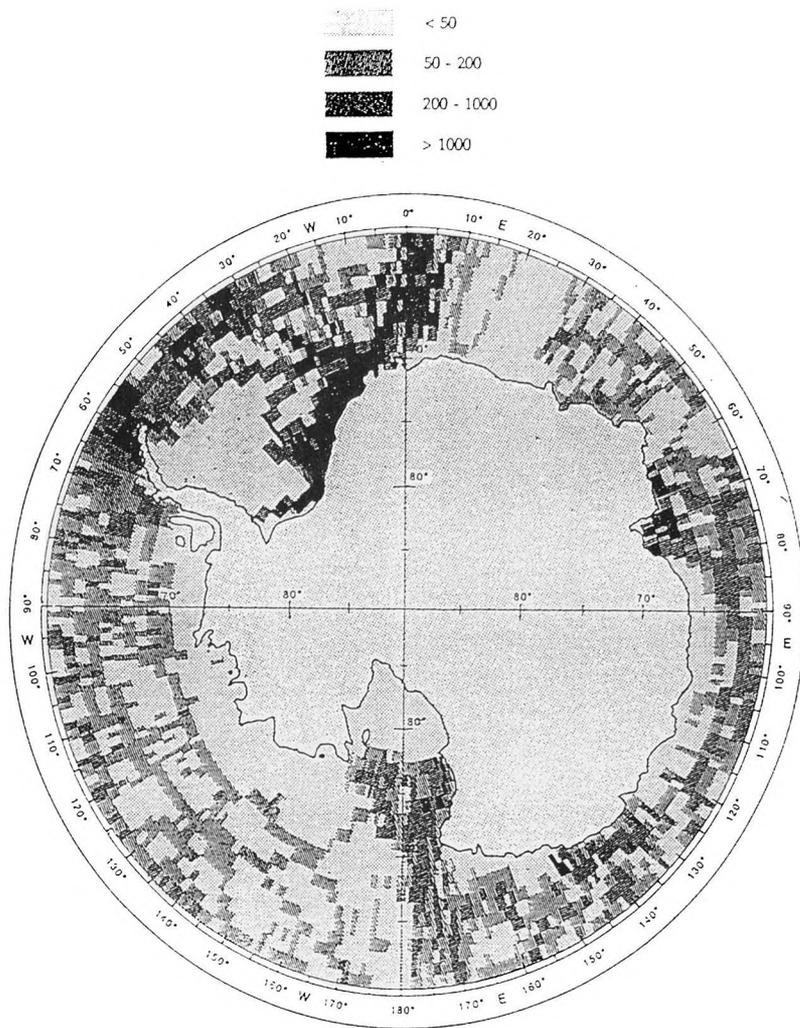


FIG. 5.- Density diagram of oceanic soundings south of 60°S.

CONCLUSIONS

The IHO, which is fast moving towards the standardization of nautical charting, attaches great importance to this particular enterprise; the needs of safety of navigation are rapidly increasing in Antarctic waters because of the numerous scientific vessels navigating around the continent, as well as the growing number of touristic trips organized. We, the IHO, feel that it is our precise responsibility to intervene in the coordination of hydrography and charting in that environmentally difficult sea area in order to achieve the best cost effectiveness ratio.