PLOTTING AND PUBLICATION OF ECHO SOUNDINGS

Summary of Replies received to Circular-Letter N° 8-H of 1934.

Report by the International Hydrographic Bureau, Monaco, 1937.

Circular-Letter N° 8-H of 6th November 1934 was issued by the International Hydrographic Bureau for the purpose of collating the opinions of competent departments so that the best methods of plotting and publication of echo soundings might ultimately be adopted. The text and explanatory note of this Circular-Letter are here reproduced, followed by extracts from the principal replies received to date :

" Thanks to the methods of sonic-sounding, which tend to oust entirely all other methods, hydrographic and oceanographic observers obtain a much greater number of soundings more easily and much more rapidly; but this increase in the number of soundings very seriously complicates the work of plotting and may necessitate a new method of publication to take the place, particularly, of the lists of deep sea soundings issued by various organisations.

The Directing Committee considers that it would be of advantage to examine these questions and to obtain opinions thereon with the object of adopting better methods of plotting and publication of these soundings.

2. *Wire soundings,* whether taken on the continental shelf for making hydrographic charts or in the ocean depths for oceanographic researches, are collected in lists, which give their positions also, these being obtained either from land marks or by astronomical observations. Such lists are kept in the archives of Hydrographic Offices, of Oceanographic Institutes and of other organisations, and may be consulted there.

(a) *Soundings taken by wire or by line for hydrographic purposes* are plotted by the Hydrographic Offices on scales which, usually, are sufficiently large to allow all but very few of them to be shown. Thus a representation of the bottom is obtained which is practically as complete as the soundings taken allow. The charts published from these plotting sheets show, more or less completely according to their scales, the principal details of the bottom.

(b) *Wire soundings for oceanographic purposes* were fairly few and far between and thus they could be published in the form of lists wherein the position of each sounding could be given. Such are the " Lists of Oceanic Soundings ", which the British Admiralty renders such great service by publishing annually ever since 1887, the " List of Oceanic Depths " published by the Hydrographic Office of Washington D.C., the lists inserted in the French " Annales Hydrographiques " and in the German " Annalen der Hy-

drographie ", in the pamphlets published by the Cabinet Scientifique du Prince Albert de Monaco and in a very large number of reports of oceanographic works. These soundings were mostly so far apart that they could all be plotted on small scale charts.

Excepting the charts of certain particular oceans and seas, the General Bathymetric Chart of the Oceans published by the Cabinet Scientifique du Prince Albert de Monaco is the largest scale chart in existence on Mercators projection. It is on a scale of 1 : 10,000,000 at the equator and the polar regions are shown on the gnomonic projection. Nevertheless, owing to the large number of soundings now being obtained by the echo method this scale was found to be too small for inserting all the soundings when the International Hydrographic Bureau undertook to prepare a new edition of the Chart; consequently plotting sheets were made, or projected, on a scale ten times as large and this allows practically all the soundings to be plotted.

3. *Echo soundings* have now almost entirely replaced wire soundings, for, by means of them, it is possible to make a more complete and at the same time more rapid examination of the depth. Of the various methods used a distinction must be made between that where a reading of the sounding is taken by means of an index on a scale and that which results in a practically continuous record of the depth on a band of paper.

(a) *Soundings read from a dial.* These are collated into lists like wire soundings but they are much more numerous and it is usually impossible to plot all soundings taken on the continental shelf on the plotting sheets. The depth is better known, in fact it is known in such detail that it becomes impossible to represent all these details of the bottom by inserting soundings on plotting sheets.

It would seem that the best method of retaining a graphic representation of all the details would be to construct, on squared paper, diagrammatic sections of the courses followed which would show, by their indentations, even the smallest irregularities observed and would facilitate the selection of those soundings which the scale will permit to be shown. By examining the sections and the plotting sheet a real equivalent of a list of soundings would be available. On such sections the vertical scale would be fixed and, naturally, would be much larger than the horizontal scale, which could be varied according to the complexity of the bottom.

It would seem that this same method should be adopted for representing oceanic sonic soundings also. They are usually so close together that plotting sheets on which they can all be inserted can no longer be used. Hence, the second volume of the Scientific Results of the Meteor Expedition gives a complete list of all the soundings taken and this is completed by a supplementary volume which contains sections on all the courses run (see : Hydrographic Review Vol. XI, N° 1, May 1934, page 138). As the Hydrographic Bureau could not enter all these soundings, which were frequently less than 1 mile apart, on its plotting sheets (scale about 1 : 1,000,000), these sections were found to be most useful for selecting those soundings which should be plotted.

(b) *Automatically Recorded Soundings.* Though it may be amply sufficient in ordinary navigation to be able to read off the depth from a dial at any time, in surveying and other scientific operations it will always be preferable to obtain an automatic record which avoids all possibility of serious error in reading off and which, by its continuity, gives a much more faithful representation of the bottom.

But then the soundings are so close together that it is practically impossible to make a list of them and the question arises as to how the results of such work are to be published.

4. Mainly with the object of keeping the General Bathymetric Chart up to date, the International Hydrographic Bureau was instructed to collate all information on every sounding taken outside the continental shelves (Resolution N° 23 of the 1st Supplementary International Hydrographic Conference, Monaco 1929 — see Proceedings page 245) and a standard form for recording them was laid down. When the soundings are recorded automatically on a band of paper as it unwinds, this form may still be used to enter positions of the ship (corresponding to entries on the record) and the necessary information for the correction of the soundings. But, in order that the Bureau shall have all the information obtained during the work, reproductions of the sections obtained must be appended to it. These reproductions would be the same as the diagrammatic sections referred to under 3 (a); they appear to be neither difficult nor expensive to prepare, for it would be necessary merely to make a careful copy, with register marks for the squaring, on tracing paper and this is much more rapidly done than the printing of a long list of soundings.

The soundings taken and recorded, being almost infinitely numerous, could not be entered on the plotting sheets but, when provided with the sections, the International Hydrographic Bureau would be in a position to select the soundings to be inserted. If the scale of the plotting sheets be too small for the proper representation of certain areas, others on a larger scale could be prepared on which a greater number of soundings could appear. (*)

This method is obviously that employed by the Hydrographic Offices for making their charts from sounding operations on the continental shelf. As said under 3 (a), the plotting sheets cannot represent all the details given by the recording band, but the Offices suit their scales to their requirements and are free to make them as large as they like if they find any advantage in showing all the details known.

5. As far as *deep sea soundings* are concerned it is evident that, if the International Hydrographic Bureau be provided with copies of the band

(*) Terrestrial cartographic organisations found themselves in a similar position when air photography gave them much greater detail than could be entered on their plotting sheets and maps. The solution has sometimes been adopted of publishing atlases which give, on opposite pages, a reproduction of the mosaic of photographs with all their details (and imperfections also) and a map of the corresponding areas.

records and of the field-books, which are the indispensable complements thereof, it would have complete information, but this would require it to undertake the work of making careful abstracts. Such work would entail a staff which the Bureau would find difficulty in providing and it could usually be better done by the surveyor who took the soundings. The sending of copies of the band records could be avoided by adopting one of the following methods :—

(a) By forwarding to the International Hydrographic Bureau a carefully drawn up tracing of the soundings plotted, such tracing being on the same or larger scale than the plotting sheets of the Bureau (Mercator, 1 : 1,000,000 at the equator). Provided that the soundings inserted on the tracing have been judiciously selected and corrected and are as numerous as the scale permits, the work of the Bureau would be much facilitated and would have all desirable guarantees of accuracy.

(b) By forwarding to the International Hydrographic Bureau a list of soundings on the standard form, selecting and correcting for this purpose, from the band records, the most characteristic of the soundings separated by about 1 mile, or

(c) By the authors of the survey drawing up and sending to the International Hydrographic Bureau continuous sections made from the band records after the soundings thereon have been corrected.

---

6. The Directing Committee would be pleased to be informed of the opinions of the Hydrographic Offices and other competent organisations on the following :—

(I) *What method of plotting and of publication of sonic soundings (taken with or without automatic records) on the continental shelf is used or will be used by the Hydrographic Office ?*

(II) *Which is considered to be the best method of forwarding to the International Hydrographic Bureau the results of sonic sounding work (with or without automatic records) carried out beyond the continental slope ?"*

The following countries and organisations have forwarded their replies to the above-quoted Circular-Letter :—

France; Monaco; Netherlands; International Commission for the Exploration of the Sea, Copenhagen; Sweden; Canada; Egypt; U.S. Coast and Geodetic Survey; U.S. Hydrographic Office; Great Britain; Brazil; Germany; Japan; Siam; Chile; Portugal.

The I. C. E. S., Copenhagen, Canada, Egypt, Siam, Chile indicate in their replies that they have no special remarks to submit concerning the two questions asked in the Circular-Letter.

The following countries have not yet sent their replies to the International Hydrographic Bureau :—

Norway; Russia; Poland; Denmark; Belgium; Spain; Italy; Greece; Australia; China; Argentina.

FRANCE (13-XI-1934) :

1) *The rules recommended by the* Service Hydrographique *for the plotting of sonic soundings taken on the continental shelf are as follows :*

The band-records to be stuck into special books in which are entered all the data which are used for fixing — (generally speaking, for the soundings referred to, the astronomical position and the D. R. data).

2) *Of the three proposed methods of communicating the soundings to the I. H. B. the* Service Hydrographique *prefers the first :-*

Despatch to the Bureau of a copy of the special plotting sheets prepared by the Service on a scale slightly larger than 1 : 1 000 000 at the equator, or in areas for which special plotting sheets have not been drawn up, a reduction to the scale of 1 : 1 000 000 of a selection of the soundings taken from the sounding sheet.

However, already it is apparent that the means available at the French Service Hydrographique *are insufficient to ensure the carrying out of this programme.*

MONACO (16-XI-1934) :

The best method for sending to the International Hydrographic Bureau the results of echo soundings seems to be that mentioned under a, *para.* 5 *of the letter in question.*

It is probable, however, that a few authors of surveys might not be able to make use of this method, finding it more suitable to use method b *or* c. *The essential in every case, whatever the method chosen, is that the results of the authors be accurate.*

NETHERLANDS (16-XI-1934)

1) *The echo sounding machines in use in the Netherlands East Indies are not provided with a recording apparatus. The soundings, read from a dial or taken by means of the phone, are noted down in field books. The most characteristic of these soundings and as many as possible of them are, after having been corrected, plotted on the fair sheets.*

The form and profiles of the sea bottom in the East Indian Archipelago make clear that there is no use for specially reporting to the I. H. B. echo soundings taken on the continental shelf. The charts of these territories show much more detail than necessary for the general bathymetric chart.

The deep sea soundings might be brought to the knowledge of the Bureau by photos or tracings of the fair sheets but these sheets are constructed on a much larger scale than the bathymetric chart (1: 1 000 000, 1: 500 000 and larger) and the selection of the soundings taken might be left to the surveying officer in command. As an example of this point of view I beg to draw attention to the bathymetric chart of the oceanic expedition of Hr. Ms. Willebrord Snellius *which will be published in Volume II, Oceanographic Results, Part 2, Soundings and Bathymetric Charts.*

If in future the surveying vessels in N. E. I. might be provided with recording instruments, these will only be used in shallow depths and not outside the continental shelf.

The question of echo sounding in Holland need not be discussed. In the Netherlands West Indies the deep sea soundings taken by various vessels are taken only in the neighbourhood of the isles and appear on the sea

charts already published or yet to be published. These soundings were not recorded automatically; only relatively few soundings were taken.

The oceanic soundings collected and to be collected on the various voyages of Dr. Vening MEINESZ *with a submarine may be found in his publication* Gravity Expeditions at Sea *of which Part II was recently published. These too are relatively sparse, as these boats have no recording instrument.*

2) *The hydrographer of the Netherlands agrees with the Directing Committee that in many cases a copy or tracing of the records taken might be the best and most economical way of forwarding to the I. H. B. the oceanic work done.*

The choice whether to collect and publish the soundings in lists, in diagrams, or in copies of the records might well be left to the hydrographic offices, after the clear way in which the Directing Committee of the I. H. B. explained its point of view in Circular Letter N° 8.

SWEDEN (19-XI-1934) :

1) *The echo sounders now in use are all fitted with recorders. From the recording bands soundings are selected with a frequency according to the scale of the plotting sheet on which they are inserted. The charts issued are based on these plotting sheets and this is the only way of publication of the sonic soundings.*

2) *No sonic sounding work is carried out beyond the continental slope by this Service, and therefore no positive suggestion can be made.*

U. S. (Coast and Geodetic Survey) (24-XI-1934) :

This Bureau rarely obtains soundings beyond the limits of its published charts. The usual method of plotting soundings for all our charts will be applied as well to echo soundings, both on the continental shelf and those obtained beyond the continental slope. Selected soundings on the continental shelf will be published on scales seldom exceeding 1: 1 000 000. In the main, the charts will be on the approximate scale of 1: 500 000.

Soundings obtained beyond the continental slope will be published in general on a scale of about 1 : 1 000 000. In one section (Gulf of Alaska) it may be necessary to plot selected soundings on a scale of 1: 4 500 000.

For the foregoing reasons, it is believed that the published charts of this Bureau will furnish the best medium for forwarding the results to the International Hydrographic Bureau or to individual foreign Hydrographic Offices.

U. S. (Hydrographic Office) (27-XI-1934) :

1). *In order to have a complete record of all soundings, wire or sonic, received at the U. S. Hydrographic Office, an index card system has been adopted for use in plotting soundings either on the continental shelf or in deep sea areas.*

The four quadrants of the earth (delineated on a Mercator projection chart of a scale 1° longitude = 4 inches) were divided into index cards of uniform size. Each of these cards is divided into four degrees of longitude and from 2 degrees of latitude at the Equator to less than one degree near the Poles.

Sounding data received are plotted on the card or cards for their particular area. In order not to lose the identity of a sounding, a special symbol in colour is marked near the sounding. On the right side of each card, there

is a blank column where the authority for the soundings with each individual symbol is entered.

In cases where the soundings become so numerous (mainly on the continental shelf) that there is insufficient room for plotting all soundings, other cards constructed on a larger scale are attached.

This Office prints and distributes, free to navigators, a special blank form (N^{os} 23 and 23a) in which are provided columns for entering the time of observation, the coordinates, the depth value, the temperature of water, the speed, course of ship, bottom, etc. The navigator is also requested to state the type of apparatus used and its calibrated velocity. The largest percentage of the sounding data is sent to this Office on the above described form. Yet, a considerable amount is forwarded on blue prints or other plotting sheets. In case the data received are incomplete, a special request for detailed information is written and, if no satisfactory reply is obtained, the soundings in question are rejected and not plotted on the index cards.

Up to the present date, the U. S. Hydrographic Office has not accepted any table of corrections to sonic soundings for temperature, pressure, or salinity of the water. The majority of the soundings received are uncorrected, except in a few cases where the navigators have applied their own correction values.

11) *From the above data, this Office publishes annually a "List of Oceanic Depths", available to the International Hydrographic Bureau, and thus meets the requirements described under paragraph 5 (b), page 5, of the I. H. B. letter of 6th November, 1934.*

The majority of the sonic soundings received are in the form of typewritten lists. In many instances, the published "List of Oceanic Depths" does not contain all of the soundings. Copies of the complete record of soundings taken might be furnished the I. H. B. but it is believed that the published lists contain enough selected soundings for all practical purposes.

GREAT BRITAIN (13-XII-1934) :

1) *Sonic soundings on the continental shelf obtained by H.M. Surveying Ships are forwarded in lists, the selection of soundings listed being carried out in the ships concerned.*

Instructions in this connection are contained in para. 40 of Section III of General Instructions to Hydrographic Surveyors 1933, which reads as follows :—

> *"The results of deep sea soundings are to be forwarded in duplicate on Form H-37 as soon as possible after they have been obtained. This applies equally to Wire and Echo Soundings, and, in the case of the latter, the number of soundings listed is to be such that they will appear at intervals of not more than half an inch on the largest scale Admiralty chart of the vicinity, unless the unevenness of the bottom justifies a closer selection. All soundings of 100 fathoms and over are to be included on this Form, unless they are part of a detailed survey for which a fair chart is rendered."*

These lists are embodied in the "Lists of Oceanic Soundings" published annually by this Department.

11) *The publication referred to above is supplied to the I. H. B., and advance lists of soundings are forwarded as received in accordance with this Department's communication H. 8766/32 of 18th January, 1933.*

These arrangements appear to be perfectly satisfactory.

As the work of selecting soundings is carried out by the Surveying Ships, it is not considered that any useful purpose would be served by supplying the I. H. B. with reproductions of the Sections.

BRAZIL (29-XI-1934) :

The Director General of Navigation has sent the necessary instructions to all vessels provided with echo sounding appliances. Observations and results will be sent to the I. H. B. in accordance with para. 6 of the Circular-Letter referred to.

GERMANY (19-I-1935) :

All German echo sounding appliances use the fixed velocity of sound of 1500 m/sec.

A) *Echo distances of less than 200 metres are converted into true depths as far as possible and are inscribed on the chart in the same way as wire soundings (ordinary soundings).*

Echo distances over 200 m. are entered on the chart as rough echo distances, i.e. as read off the apparatus with the fixed velocity of 1500 m./sec., in heavy upright characters.

B) *In publications (Supplement to the* Nachrichten für Seefahrer *and Report on the Work of the* Meteor, *Part II.), each echo sounding is accompanied by :*

a) *The position by latitude and longitude as accurately as possible.*

b) *The rough echo distance (at 1500 m/sec.) as read off the apparatus,*

c) *The true velocity of sound at the position and the corrected echo distance based thereon.*

This last must as a rule be taken for the Depth as a correction for slope of bottom is not generally possible for want of data as to the amount and the direction of the slope.

The bathymetric charts of the Atlantic and of the waters around Iceland drawn up by the Institut für Meereskunde *of Berlin, contain* corrected *echo distances, i.e. the echo soundings have been corrected into true Depths by means of the local velocity of sound.*

In ships of the State's Navy echo sounding appliances with automatic recording, for purposes of practical surveying and oceanographic research, have not been introduced and, on this subject, no definite information can yet be given.

The I. H. B. will receive, as heretofore, the German Echo Soundings in the Supplements to the Nachrichten für Seefahrer *which are issued annually.*

JAPAN (28-I-1935) :

1) *As regards the method of plotting and publication of sonic soundings on the continental shelf, the Hydrographic Department of the Imperial Japanese Navy is at present employing the echo sounding apparatus of "reading off" type only, and the soundings obtained therewith are plotted on charts after correction and careful selection. No special publication thereof is prepared by this Department.*

2) *As regards the method of forwarding to the I. H. B. the results of sonic sounding work carried out beyond the continental slope, this Department is of the opinion that it would be the most suitable to send the Bureau a carefully drawn up tracing of the soundings on the same or larger scale than the plotting sheet of the Bureau (Mercator, 1: 1 000 000 at the Equator), as stated in* (a) *of paragraph 5 of I. H. B. letter.*

PORTUGAL (4-X-1935) :

At present only the Mozambique Hydrographic Expedition uses an echo sounding appliance; this is a Langevin-Florisson model registering to 375 metres' depths, non-recording.

Echo soundings are taken on the continental shelf to depths of 300 metres; beyond this depth, wire soundings are taken.

In plotting the soundings, a scale double that of the chart is used and the soundings are distributed, in lines running E-W, 1500 metres apart. The space between the lines is also 1500 metres.

In running these lines, the surveying vessel is brought to the position marked on the plotting sheet and the depth is then determined either by echo or by line; the sounding, the observed angles, Depth and nature of bottom, are then entered in the field book, the Portuguese equivalent to "sonic" being added where soundings have been obtained by echo.

Between each of these soundings, indications as to depth are observed on the scale of the sonic sounding machine, so that its variations may be noted; the least depth observed is selected for insertion on the chart.

In cases where marked unevenness of bottom is observed, a careful investigation is carried out so that the least depth found in the area may be entered on the chart.

The Expedition makes no observations by sonic apparatus beyond the 300 metres' depth which, on the Mozambique coast, is situated very near the continental shelf where a rapid fall between 100 and 300 metres occurs.

The opinion of the leader of the Expedition is that, of the three methods mentioned in the Circular-Letter, method (a), *paragraph 5, is to be preferred.*