

## FIFTY YEARS AGO ...

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### GENERAL BATHYMETRIC CHART OF THE OCEANS

Descriptions of new bathymetric data obtained by oceanographic expeditions and consequent changes to the earliest editions of GEBCO sheets were covered by the following articles published in the *Hydrographic Review*, Vol. XIII(1) of May 1936.

#### THE NAMING OF NARES AND PUERTO RICO DEEPS

On 26th March 1875, HMS *Challenger*, Captain Sir George S. NARES, while cruising between St. Thomas, Virgin Islands and the Bermudas, found a maximum depth of 3,875 fathoms = 7,087 metres situated in Lat. 19°42' N, Long. 65°07' W.

The *Physical chart of the world showing the track and soundings of HMS Challenger 1873-76*, which accompanies the report of this celebrated expedition, drawn up by Sir John MURRAY in 1885, places this sounding in a vast enclosed area including depths of from 3,000 to 4,000 fathoms and extending north from the Caribbean Islands to approximately Lat. 29° N; this area corresponds to the deepest zone of the western part of the North Atlantic Ocean. On this chart no special designation is given to this deep ocean area.

In 1888, Sir John MURRAY published in *The Scottish Geographical Journal* an article entitled: *On the Height of the Land and the Depth of the Ocean*, to which a bathymetric world-map, printed in colours and dated 1887, was annexed; in this study the author gives as the maximum depth of the North Atlantic Ocean, a sounding of 4,561 fathoms = 8,341 metres, taken on 27th January 1883 by the US Coast and Geodetic Survey vessel *Blake* (Lt. Cdr. Charles D. SIGSBEE) situated in Lat. 19°39.2' N, Long. 66°26.1' W. This sounding is about 75 miles west of the maximum depth obtained eight years previously by the *Challenger*. Sir John MURRAY's coloured map places the *Blake* sounding and that of the *Challenger* within the same 3,000 fathoms depth contour line surrounding the above-mentioned area of maximum depth.

In 1893, the Nautische Abteilung der Marineleitung, Berlin, published its *Weltkarte zur Uebersicht der Meerestiefen*, etc., and in 1899, Dr. Alexander SUPAN published in Part VIII of Petermanns Mitteilungen. his *Tiefenkarte des Weltmeeres*.

On these two German bathymetric charts the depth contour lines are in metres, and on them the area of maximum depth greater than 6,000 metres is divided into two parts.

Dr. SUPAN states that he had wished to give purely geographical denominations to the different forms of submarine relief and, on his chart, the northern part of the area in which we are interested is included under the general legend : *Nord-amerikanisches Becken*, while the south part of the area, that which contains the two maximum North Atlantic soundings just mentioned, bears the name of : *Portorico-Graben* (\*).

On 18th January 1902, the US brig *Dolphin* (Commander Albert GLEAVES) while sounding in these waters obtained the sounding which to-day is still considered to be the maximum depth of the deep, namely, 4,662 fathoms = 8,525 metres, situated in Lat. 19°35.0' N, Long. 67°43.3' W.

The first edition of the General Bathymetric Chart of the Oceans, published in 1904 by Prince Albert of Monaco, shows the three special soundings of 7,086, 8,341 and 8,526 metres all included under the designation of *Ravin de Puerto Rico* and separated from the other deep area of the *Bassin de l'Amérique du Nord* (North American Basin) by soundings of 5,120 and 5,139 metres.

In his book : *The Depths of the Ocean*, published in 1912, Sir John MURRAY inserted a bathymetric chart of the oceans showing the greatest deeps. In addition, a special sheet contains details of the North Atlantic taken from the most recent sources up to the year 1911. In this chart, Sir John MURRAY gives to the ocean deeps the names of the persons or ships which had discovered them. The three above-mentioned soundings are shown on this chart within a vast enclosed area corresponding to the 3,000 fathom depth contour line covering more than half of the *North American Basin*; it bears the name of : *Nares Deep* from the name of the commander of HMS *Challenger*. The *Ravin de Puerto Rico*, the name of which does not appear on Sir John MURRAY's chart, is thus included in : *Nares Deep*. The following is the description of *Nares Deep* given in his book by Sir John MURRAY :

“*Nares Deep* is the largest deep lying wholly in the Atlantic Ocean, and at the same time the deepest. Its outline is most irregular, extending from Lat. 18° N to 34° N, and in the neighbourhood of the West Indies the floor of the deep sinks to depths exceeding 4,000 fathoms over a limited area, the maximum depth being 4,662 fathoms, recorded by the USS *Dolphin* in 1902. This deep is estimated to cover an area of 697,000 square miles”.

Thus the *Ravin de Puerto Rico* would be the deepest part of *Nares Deep*.

The bathymetric chart published in 1912 by Dr. Max GROLL of the Institut für Meereskunde, University of Berlin, accompanying his book : *Tiefenkarten der Ozeane*, is constructed in metric depths. On it, therefore, depths greater than 6,000 metres are separated into two distinct zones.

The second edition of the General Bathymetric Chart of the Oceans, published in 1912 by the Prince of Monaco so as to conform with the suggestions of Sir John MURRAY's bathymetric chart published in 1911, re-established the name of *Nares Deep* for the zone of depths exceeding 6,000 metres, the centre of which lies approximately in Lat. 25° N, Long. 60° W. Thus delimited, *Nares Deep* is separated from the *Fossé de Puerto Rico* by a depth of 2,926 metres which, besides, is shown on Groll's chart, but which is an erroneous figure originating in a non-conversion from fathoms to metres and which is in reality a sounding of 5,690 metres.

(\*) Sir John MURRAY's bathymetric chart and Dr. SUPAN's Tiefenkarte had been presented to the 7th International Geographic Conference held at Berlin in 1899. The Conference nominated a Committee of oceanographers, one of whom was the Prince of Monaco, for the purpose of arranging for the construction of a general chart of submarine relief, to decide as to the use of the terminology employed to designate the various forms of ocean bottom, and also as to the choice of names for their indication.

This Committee, presided by H.S.H. the Prince of Monaco, met at Wiesbaden on 15th and 16th April 1903, and then adopted a proposal submitted by Professor THOULET concerning the synonymy of terms employed to designate the various forms of ocean bottom in the principal languages, with the proviso that entire liberty should be allowed to inventors in the choice of the name, whether that of a man, of a ship, geographical, or any other, to be given to any special configuration of submarine soil, the right of each inventor to remain intact on condition that he be in reality the first discoverer. (See : Bulletin du Musée Océanographique de Monaco, No. 21, 25th December, 1904).

The bathymetric chart of the Atlantic Ocean which accompanies Dr. SCHOTT's publication : *Geographie des Atlantischen Ozeans*, Hamburg, 1925, divides into two parts the depths of this area greater than 6,000 metres.

The bathymetric chart of the Atlantic Ocean issued in 1934 by the Institut für Meereskunde of Berlin along with the Report of the German *Meteor* Expedition, 1925-27, separates these same depths into four zones, namely by a Ridge to which Drs. Theodor STOCKS and Georg WÜST, in their booklet : *Tiefenverhältnisse des offenen Atlantischen Ozeans*, give the name of *Porto Rico Schwelle*.

In May 1934, the U.S.A. Hydrographic Office published on the back of its Pilot Chart for Central American Waters a bathymetric chart of the Caribbean Sea. This chart shows the *Fosse de Puerto Rico* under the legend : *Puerto Rico or Nares Deep* delimited by the 3,500 fathom line.

Lastly, on the third edition of the General Bathymetric Chart of the Oceans published in April 1935 by the International Hydrographic Bureau, the area in which we are interested is shown in three zones of depths greater than 6,000 m. The name of *Nares Deep* has been retained for the northern zone, the name of *Puerto Rico Deep* being reserved for the southern part.

On this chart, a decrease of the area of depths greater than 6,000 metres may be noted; the cause of this decrease is the growing intervention of soundings less than 6,000 metres which result from a constantly widening knowledge of these waters. We have in consequence an appreciable deformation in the outline of deeps which had originally been shown as rather vast.

If an endeavour were made to trace on the chart the 5,486 metre = 3,000 fathom contour line, it would be seen that it is, notwithstanding, possible to reunite all the depths in this area greater than 3,000 fathoms, including the *Puerto Rico Deep*, in a single enclosed area.

It will be noted in conclusion that the maximum sounding coming within *Nares Deep* as it appears on the third edition of the General Bathymetric Chart of the Oceans is a sounding of 6,995 metres = 3,825 fathoms, lying in Lat. 26°32' N, Long. 60°06' W, and that this sounding seems, in reality, to have been obtained in 1852 by the US Brig *Dolphin*, Commander S.P. LEE.

The principal sources of the other soundings greater than 6,000 metres lying within the deep are 1895, HMS *Rambler* (Commander G.E. RICHARDS); 1898, HMS *Rambler* (Commander H.E. PUREY-CUST); 1903, HMS *Goldfinch* (Commander F.G. LEARMONTH).

H.B.



## DIE TIEFENVERHÄLTNISSE DES OFFENEN ATLANTISCHEN OZEANS (Depth conditions in the open Atlantic) by Th. STOCKS and G. WÜST

The International Hydrographic Bureau has received a reprint of a paper forming part I of the third volume of the results of the *Meteor* Expedition. It accompanies a fine bathymetric chart in colours, on a scale of 1 : 20,000,000, and describes the methods by which the latter was drawn up. The chart is on Lambert's equivalent azimuthal projection, with centre on the equator; its scale in the region of the equator is about half that of the General Bathymetric Chart of the Oceans published at Monaco, and in middle latitudes about a third. The differences in scale of the two charts, and in their objects, are sufficient

to explain many of the differences between them. It is of interest, moreover, to compare this new chart with sheets  $A_1$  and  $A'_1$  of the General Bathymetric Chart of the Oceans, third editions of which the International Hydrographic Bureau has recently completed.

In the Monaco chart, efforts were made, by inserting as many soundings as legibility permitted, to give as complete and accurate a picture as possible of our knowledge of the bottom relief as obtained exclusively from soundings; Messrs. STOCKS & WUST, in their chart, have attempted to give a general view of the bottom formation of the ocean, to serve as a basis for the oceanographic and geological exploitation of the material collected by the *Meteor* Expedition. Thus, in the latter chart, only a small number of figures has been inserted; the contour lines have been drawn at 500 m intervals, neglecting the minor details, generalising, and even occasionally stretching the forms a trifle to make them stand out better. This, to our way of thinking, increases the hypothetical character of many of these contours; the authors, however, are far from denying this character and have, indeed, brought it out very well by representing the contour lines in those parts where their trace is more uncertain than usual by fine pecked lines, or even by interrupting them, and by indicating them by the colour only in those places where information is lacking altogether. It is obviously necessary to draw contour lines to be able to appreciate the main bottom forms at a glance, but we may be certain that any new sounding profile will necessitate their modification, often in no small degree. The fact of having very closely spaced soundings on profiles lying from 300 to 500 miles apart, and only sporadic soundings between them, does not make it possible to discover how the very numerous inequalities of the bottom which the profiles reveal are connected between one profile and another. On page 17 the authors show two completely different drawings of contour lines, which they obtain in the region south of Ascension with the same soundings. In the first drawing, the method known as that of valleys and spurs leads them to include all the neighbouring inequalities in the general system of the great ridge by enveloping curves; in the second, the elevations and depressions have been connected together from one profile to another through this region which is poor in soundings, thus supplementing the principal ridge by a series of narrow crests and depressions approximately parallel to it. We think we may agree with the authors that both solutions are equally incorrect.

Very often the echo soundings along the profiles show, on the crests, differences of 800 to 1,000 m within distances of 10 km; and in the basins, differences of 200 to 300 m within the same interval. The bottom of the sea is thus not flat as has been thought, and nothing but profiles which are but a few kilometres apart would enable us to understand the connection between the different inequalities of the bottom and to draw the isobaths every 500 m with some approach to truth. What then would become of the various rises and basins which the present generalisation causes to appear quite clearly?

Certainly, the great Atlantic ridge which traverses the whole length of this ocean is an indubitable and particularly remarkable characteristic thereof. We are far from being acquainted with all its summits and we do not know whether, if we confine it within 4,000 m isobaths, breaks must be shown in these or not. A curious fact is that no profile obtained by echo has shown any. And so we have not thought it necessary to indicate on the Monaco chart either the break, which appears to be rather improbable, which Messrs. STOCKS & WUST show as hypothetical near Lat.  $8^\circ$  N, nor even the one which they call the "Romanche Furrow". The latter would cut the ridge near the Romanche Trough at a depth of more than 4,500 m. In this very uneven region soundings are rare and the rise, if it is not broken, is certainly very narrow; but it is not without interest to state that the existing soundings are insufficient to prove the existence of the "Romanche Furrow".

We must call attention to the fact that in cases where soundings are insufficient the authors have frequently had recourse to the notion of *potential bottom temperature* to assume the existence of breaks or sills, enabling or preventing exchanges of water from taking place, and explaining the temperature differences observed. Therein we have a most interesting question, which has been very completely discussed by WUST in *The Hydrographic Review*, Vol. X, No. 2, November 1933, pp. 209-218; but it is still merely a hypothesis which appears to us to require verification by an absolutely independent examination of the depths.

We associate ourselves fully with the hope of the authors when they say that one of the most profitable undertakings would be a systematic sounding, by closely spaced

transversal profiles, of a portion of the main ridge, and that it is desirable that the work of the *Meteor* be continued by interpolating new profiles spaced about 60 miles apart.

Messrs. STOCKS and WÜST's book contains a list of the documents utilised in the plotting of the rough sheets, which were on a scale four times that of the final publication (those of the International Hydrographic Bureau are on a scale 10 times that of the General Bathymetric Chart). We see in it an interesting demonstration of the progress made since 1912 (the date of the publication of Max GROLL's chart) in the knowledge of the forms of the sea bottom, but also an indication of the considerable task which remains to be accomplished, both in the area remaining to be sounded and in the necessity for numerous researches into matters of detail.

One of the regions in which the state of knowledge has advanced most is the Scotia Sea, which presents so many analogies with the Caribbean Sea, and in which the extensive work done since 1926 has defined the great morphological lines and settled many details.

On the continental slopes, echo soundings have generally shown steeper gradients than were expected, and have brought to light new furrows, veritable canyons gashing the continental plateau.

The chart under discussion shows us the two great east and west Atlantic depressions divided into a certain number of basins by rises joining the great ridge to the continent and sometimes taking the aspect of a grid. It is a convenient division for oceanographic study, but we must not exaggerate its morphological importance. The soundings are often insufficiently numerous for the existence of certain rises to be other than hypothetical. Some of them appear to be, and could perhaps be compared, as Alexandre SUPAN has done, with watersheds which are hardly apparent on the spot. Their presence is particularly called for by observations of *potential bottom temperature*. The Walfisch and the Rio Grande Ridges are the most typical and the least disputable examples.

In a general way, the deeps of more than 6 000 m are of smaller area than had been thought, and it is possible that new soundings will narrow them down even further. Sounding by line in such depths was of special difficulty, and the drift of the ship during the great length of time occupied by the sounding might be the cause of too great an estimate of the depth. The two deepest trenches are the Puerto Rico Deep and the South Sandwich Deep. The 6,000 m isobath of the Puerto Rico Deep extends roughly 2° further eastward on the chart of the International Hydrographic Bureau than on that of Messrs. STOCKS and WÜST, on account of the utilisation of an echo profile taken in March 1933 by the *Atlantis*, of the Woods Hole Institution.

The terminology of the General Bathymetric Chart of Monaco uses, in principle, the French translation of the German terms defined in 1903 by Dr. SUPAN (\*). The name *Seuil de l'Atlantique* has been retained in the 3rd edition, rather than that of *dorsale (Rücken)* used by Messrs. STOCKS and WÜST, which it appears to us should be reserved for a narrower elevation than a rise, with steeper slopes. Furthermore, we do not wish, except for very good reason, to change a nomenclature established by particularly competent geographers. This is why we have retained the name, *Crête de Walfisch*, as it existed in the 2nd edition (September 1913) of Sheet A'iv, instead of the name *Walfisch-Rücken* used in the German chart. We have deleted the names *Dépression de l'Atlantique Est* and *Dépression de l'Atlantique Ouest*, simply to make the chart clearer.

We have also retained the names of the chief deeps which recall celebrated oceanographers. The German authors have replaced them by names of basins describing their geographical positions. Their method has undoubted advantages : but this division into basins often seems somewhat complicated and is also, in many places, of a hypothetical character. In a few respects the authors have modified SUPAN's nomenclature : (1) in adopting the terms *Labrador Rise* and *Newfoundland Rise* instead of *Newfoundland Ridge* and *South Newfoundland Rise* which were apt to be confusing; (2) to the northward of the Azores Plateau they draw a distinction between the *Spanish Basin* and the *West Europe Basin*, separated by the *Biscay Rise*; (3) they denote by *Puerto Rico Rise* a small bulge which separates the North American Basin from the Guyana Basin.

(\*) See *The Hydrographic Review*, Vol. V, No. 2, Nov. 1928.

As we have already said, for reasons of clearness we have avoided overloading our chart with names covering large surfaces; in return, we have distinguished the greater part of the less extensive banks by names, which are generally those of the vessels that discovered them. To those shown on the 2nd edition we have added : Kelvin Bank; Ampère Bank, an extraordinary elevation rising to 60 m among depths of nearly 4,000 m, discovered on 4th March 1935 by the French Cable Ship of that name; also the Echo Bank, Tropic Bank, Schmitt-Ott Rise and Admiral Zencker Bank, discovered and named by the *Meteor*. The naming of these details did not enter into the framework imposed upon themselves by the authors of the German chart. The latter, with its accompanying study, will be found to have caused a distinct advance in the oceanography of the Atlantic.

P. V.



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