



REPRESENTATION OF RELIEF ON CHARTS

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(Translation from the Spanish text)

IN an article published in Nos. 11 and 12 (1922) of the *Bulletin of the Royal Geographical Society of Madrid* some observations were made on the subject of the representation of relief on charts.

I have some knowledge of this subject for I am (and I have been for several years) occupied in the drawing and publication of charts and I see those which are sent by other nations in exchange for ours. I have therefore, before me, more than sufficient material to enable me to add something which, I believe, completes the above-mentioned interesting article.

The writer proposes that differences of level, both of the land and of the sea-bottom, should be represented on charts by curves only. It is certain, however, in the case of submarine levels, that he must compromise in shallow waters, by showing a few sounding; but his ideal appears to be a chart on which land would be shown by bands or zones of shades of sepia increasing in density with increase of altitude and bounded by lines of equal altitude (hypsometric lines). The seas would be in shades of blue, increasing in density with the depth, each shade being bounded by isobathic curves or depth-lines. In other words, a chart somewhat similar to the Prince of Monaco's Bathymetric Chart of the Oceans.

It must be noted that every chart or map is a conventional representation of terrestrial reality and that this convention, this craft which suppresses, ignores or exaggerates one or other of the details or aspects of reality varies with the object for which the chart or map is intended and is the guide or standard of which the cartographer should never lose sight, for it is in accordance therewith that he must construct the chart or map.

Oceanographers naturally desire to have a graphic representation of the medium in which the phenomena take place and which form the

objects of their research, and as till now (in Spain at any rate), there have not been any other but navigational charts, they require that these be modified to serve the purposes of oceanography and fishery.

This is not possible for the following reasons :

Projection.

It is well known that navigational charts are drawn on Mercator's projection which produces great deformation in coast lines and disproportion in area, particularly in those zones which are not near the Equator, but it allows loxodromic or rhumb lines to be represented as straight lines. This advantage outweighs the deformation mentioned above. Oceanographic and Fishery charts, in which the distribution and proportion of the physical phenomena of the sea have so much importance, should be drawn on the " equivalent " projection (Flächentreue, true to area, as the Germans call it).

Charts are made on very varying scales according to their uses, *i. e.* for long trans-oceanic voyages, for long or short coasting or for entering into harbours, roads or bays. Such a variety of scales which moreover, is unnecessary to Fishery charts, does not permit the adoption of a standard for the various details represented.

Representation of terrestrial relief.

This has no importance to the navigator, who is interested only in details of the zone near the coast and in the indication of those points which are remarkable from seaward. Full details of that part of the land which is included in the chart may and should be shown on charts of large scale and on plans of ports and anchorages since thereon there is scarcely any deformation and it is useful to have a plan of the land in the vicinity of the position where the vessel is anchored.

The contour or isohypsometric curve system does not convey the form of the land except where the curves are very close together or where the differences of level are very accentuated. The system is excellent on large scales for proposed public works and on small scale for sketches for physical geography but never for maps. Scarcely a single country uses it. Our Geographical Institute, which adopted this system for its National 1/50,000 map, is now experimenting, in view of making the form stand out on the sheets, with shades which accentuate the differences of level better than curves by themselves.

The Deposito has published several charts of the Balearic Isles and

of the Galician coasts with contours but not omitting to represent in detail the coastal zone and the remarkable summits. As to representation by the hachure and oblique lighting method, which is that which best gives the impression, not only of the relief but also of the character of the ground, particularly if no colour but black is used, there are perfect examples thereof amongst our charts. There was a few years ago, a group of artist engravers in this Office which produced work which has been and is the admiration of both Spaniards and foreigners *. Only those charts produced by the Frenchman COLIN can be compared with them.

The loss of these artists and the high cost of the method have brought about that, at the present time, not so much stress is laid on the engraving of topography.

Representation of submarine relief.

All who know anything of topographic work are aware that the isohypsometric curves, or contours of dry land, are determined by joining the points of equal altitude in the various levelling lines which are run over the ground and by interpolating equidistant contours between the points of differing altitudes, the numerical data obtained by levelling being always completed by the notations made on the field-sketch and by the recollection of the land formation as seen by the topographer.

That is to say that even in the representation of land formation seen there is always some inexactitude or imagination.

What then may not happen when we are dealing with submarine relief where we know nothing beyond the depth at the points of sounding ? **

We cannot, therefore, refrain from showing the soundings for they are the only precise data known. The depth lines, which are most useful in conjunction with soundings, serve to guide the eye in reading the latter and to indicate the limits of the zones of defined depth. The selection of the soundings, sparse in those parts where the bottom is flat and both numerous and precise in order to show up shoals and danger-spots, as also

* E. g. Charts Nos. 910, From the Bidasoa to Machichaco ; 19 A. San Sebastian (1884 edition) ; 17 A, Cartagena ; 818, Cabo de Palos and the Hormigas islands ; 238 A, Alfaques (includes the Sierra del Montsia) ; 305 A, San Felix de Guixols ; 310 A, la Salva and many others.

** Photographic exploration of the sea-bottom from aircraft is still in the experimental stage.

the tracing of the depth-lines, is the work in which the ability of the cartographer is brought out in the highest degree.

It is only in very detailed hydrographic surveys that the depth-lines can be drawn with any confidence and, as we must publish many charts even when the data which we possess are few, to adopt the system of depth-lines only would entail withholding from publication the charts of those zones which have not been minutely explored, or else to have different systems of representation according to the degree of this minuteness.

The representation of the sea-bottom by the exclusive use of depth-lines can be adopted only on charts on small scales, *i. e.* on those which embrace large areas in which the general formation or the major features of the relief are to be shown and not the detail required by the navigator.

One of the points which must not be lost sight of with reference to navigational charts is the confidence with which they must inspire the user. If depth-lines only are shown, all charts will inspire the same confidence. On the other hand, numerous and uniformly spaced soundings give the impression of a conscientious survey whereas rare soundings or lines thereof in but few directions give the impression of areas explored in no very great detail and in which the navigator should move with greater caution than in others.

To sum up in a few words — the essentials on a navigational chart are the soundings. As I said above, depth-lines are most useful to divide the soundings into zones, to show up shoals and to guide the eye of the user of the chart (*See* charts of the Asturian coast, Nos. 932, 933 and 934).

N. B. — No country uses either the systems of depth-lines only for its navigational charts, or that of depth-lines and soundings in the zone of shallow water, but always soundings, soundings and soundings without, however, omitting to show a few depth-lines.

The English, whose charts embrace the seas and coasts of the whole world are very prodigal with soundings, as also are the Germans, the Dutch and the Danes, whose charts are perfect examples of what charts should be.

The North Americans and the Chileans who, in the New World, pay the greatest attention to this type of work, follow the same custom.

The following is a curious detail in connection with this discussion as to the merits of soundings and of depth-line. When we published our chart Nos. 926, which extends from Monte Louro to Cabo Torinana, it was produced with but few soundings but was very rich in depth-lines. We sent the usual exchange copy to the British Admiralty which, in due course, wrote asking "How was it possible for you to determine the

depth-lines in such detail?" to which we replied "Thanks to the several hundreds of soundings which we took". We were then asked "Would you kindly supply us with a tracing of these soundings?" "Why, certainly" we said, "here it is".

And, during the following month, we received a copy of British Admiralty chart N^o 3764, Spain-West Coast, Cabo Torinana to Punta Carreiro, on which appeared all the soundings which we had omitted to engrave on ours.

The following economical reason, in addition to the nautical reasons adduced for the non-adoption of depth-lines only, is opposed to the representation of the zones of defined depth by bands of various tones of blue:—Charts must be corrected very frequently, therefore quick printing and the use of a process which permits of easy correction of the plates are imposed. Consequently engraved copper-plates and a single printing, in black, are used.

A few Hydrographic Offices use lithography, but only for the purpose of producing a uniform land-tint and a band of blue between the coastline and the five metre line.

All information as to lighting, buoys and beacons, courses and bearings for entering harbour, tides, local currents, semaphores, time signals and other data and notices with reference to mooring, going alongside, entering and leaving harbour are most useful to the navigator and, consequently, their insertion on the chart cannot be omitted. None of these data interests the oceanographer and, to no great extent, the fisherman.

On the other hand the figures of soundings which indicate the depth are nearly always accompanied by an abbreviation representing the quality of the bottom (stones, sand, mud, etc.) information of great importance to Physical Geography of the seas and of interest to navigators in regions where they must, or may have to, anchor and also in those where, on account of fogs, it may be necessary to obtain the ships position by sounding.

These data have undoubtedly greater interest for the Oceanographer, and even for the fisherman, than for the navigator but the generalisation of the representation thereof (suppressing purely local and precise information at the point of sounding) by means of a wash of conventional colour for each of the qualities of the bottom can only be done on small scale charts and not on navigational charts, as is the case also with reference to the exclusive adoption of depth-lines.

The mixture of such colours with the various tones of blue used to indicate the depths and with other data necessary to navigators would make the chart confused and very costly.

If, for these adverse reasons, the generalisation of the representation of the quality of the bottom is considered undesirable and the corresponding abbreviations are shown at the points where soundings were taken then it is not worth while to suppress the soundings.

From all the above I think that it may be clearly deduced that I was correct in the statement made at the beginning of this article, *i. e.* that in the majority of cases it is impossible to reconcile the cartographic requirements of the navigator with those of the oceanographer and the fisherman and that the only satisfactory procedure would be to provide separate navigational, oceanographic and fishery charts. But not separate surveys, for there is but one reality. A single survey only should be made with all possible detail and minutiae and then, from this original survey, the marine cartographer would draw his chart and the oceanographic and fishery cartographers theirs, and they would all three be distinct conventional representations of one and the same reality. It would be similar to that which occurs on land where, from the very detailed topographic survey, economic, military, agricultural, industrial and such like maps are obtained.

So far only the Navy has undertaken hydrographic surveys and it should continue to do so ; but this modern application of this work for most interesting, though not purely nautical, purposes (such as for oceanography and fishery) should serve as a basis in order that the Civil Departments which are interested therein should contribute and add thereto in order that such work may be carried out more quickly and with better equipment and they should, at the same time, indicate what physical or biological data should be obtained, while the hydrographic survey is being made, to serve the above mentioned extra-nautical ends.

I believe that nothing but mutual advantages would result from such reciprocal support and collaboration. *

* I have dealt rather more fully with some of the points mentioned in this article in the following publications: *Peñalara*, No. 79, July 1920. The representation of Mountains by means of contours. *Revista General de Marina*, December 1921, Gnomonic and Orthodromic Charts. *Iberica*, No. 388 July 1921, The Hydrographic Charts of the Coasts of Spain.

