

concerning the different projection systems and a guide for the identification, in the majority of cases, of the projections of a chart according to the appearance of the meridians and parallels; a brief outline of the principal properties of the projections is also given.

In Chapter V the different ways of defining direction are dealt with: sight; winds and currents; cardinal points and the mariner's compass; orientation; bearing; course; radio and mercatorial bearings; azimuths; forward and back azimuths; geodetic lines.

Chapter VI touches upon the technique of chart construction, taking up first the important question of the selection of the scale, construction of the natural scale in general and, in particular, the marginal scale of the MERCATOR chart; this is followed by considerations on representation of the relief, either by contour lines or by hachures, special adaptation to the contour lines of charts; selection of soundings; representation of shoals and dangers; (extracts under these two headings are given below); general remarks on echo sounding.

A few descriptions of new instruments used in chart construction terminate the volume. These instruments, tending to maintain the accuracy of and to speed up production, include, for instance, a projection ruling machine; the 50-inch precision camera, which is capable of making negatives 50×50 inches in size, mechanical stippling devices. Advice is given as to precautions to be taken when selecting the form, size, spacing, etc. of letters whether the lettering be by hand or by machine; the use of conventional symbols, retention of original geographical names; artistic finishing; engraving of views of the coast.

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REPRODUCTION

(Extract from *Cartography*, Special Publication No 205, U.S. Coast and Geodetic Survey, Washington, 1936).

Changes in the methods of chart production during the past 15 years have been radical and essential, particularly with respect to methods of printing. The chief concern of the day is, first, to place before the public the benefit of surveys and information before they become obsolete, and, secondly, to eliminate appreciable scale distortion inherent in former processes. Much has been accomplished in these two problems: the *first* has been accomplished through a lesser number of intermediate steps between the commencement of compilation and the printing of a chart, and by the distribution of various parts of the reproducing work among different individuals; the *second* has been accomplished by a new method, the description of which will follow.

Scaling errors of charts pulled directly from copperplates, in former years had errors of shrinkage and distortion of as much as 4 per cent. This error was not due to the copperplate itself but to the process of printing. By the present use of baryta paper an impression is taken from the inked copperplate, and by the photolithographic process a transfer practically true to scale is made to a sensitized aluminium plate, from which the chart is printed.

Scaling errors of charts by lithographic process from vellum drawings were also considerable. Due to unequal shrinkage or the meeting of opposites in granular texture, the forced matching of adjacent vellum sheets frequently caused great annoyance in the processes of reproduction and in the final result.

While serious attention has been given to errors of map projection, the greater errors of reproduction have heretofore too often escaped notice. In the present rigorous requirements of military operations and navigation, shrinkage and distortion errors of the magnitude of former years are too serious for the purposes which maps and charts are intended to serve, and are inadmissible in calculations. The new mechanical processes have indeed added in recent years as much glory to the progress of cartography as have the improvements in methods of survey and the mathematics of map projection.

The copper engraving medium or method which has the benefit of certain advantages, had formerly certain decided inadequacies. Modifications in this method resulting in the saving of time in printing and in scale improvement were originated in the Coast and Geodetic Survey. A new procedure in the copperplate process which offers facility in handling, consists in constructing a projection on copper which provides for cutting the plate into sections or quarters similar to the method used in the following chapter. This does away with the large-size plates of former years, thus enabling two or more engravers to work on the same chart at the same time.

PHOTO-ALUMINOGRAPHY.

This method produces a chart that conforms perfectly to a desired scale. In this process sheets of high-grade bristol board are similarly mounted on opposite sides of aluminium plate, allowing spaces between the several sheets. The mounting on both sides prevents buckling and insures a permanently flat working surface. The practice of constructing the complete projection and the junction lines of sections (in halves or quarters) of a large chart upon a single plate of paper-mounted aluminium, has served not only to secure scale maintenance, but has made it possible to cut the original plate into its joining sections and to distribute the work more economically.

Each section with adjoining junction lines repeated is provided with convenient margins in the original mounting. It is then compiled and, after verification, the several parts or sections are sent to another branch of the service for purposes of photographic transfer to glass negatives. The finished cartographic work is then done by one or several lithographic artists according to the speed required in making the chart ready for publication. The film sides of the negatives are given a coat of asphaltum which permits the compiler's drawing to be clearly seen but which destroys its printing qualities, thus enabling the artist to cut-in or engrave through the asphaltum and photographic emulsion the configuration and lettering in a standard degree of finish. In the next stage, on nautical charts, the soundings and bottom characteristics are cut-in by a sounding engraving machine.

After the negatives are cut they are process-printed and assembled on a sensitized grained aluminium plate. The usual long interval between surveys and their publication in chart form has thus been reduced to a minimum period of time in which the compiler and engraver have specialized in their individual fields.

By the new process of photo-aluminography the printed chart as it comes from the press is accurate in scale and free from distortion, but, in use, it will be found distorted to the amount that the paper upon which it is printed is later on affected by atmospheric conditions.

SELECTION OF SOUNDINGS

(Extract from *Cartography*, Special Publication No 205, U.S. Coast and Geodetic Survey, Washington. 1936).

It should be borne in mind that no feature of the chart is of more importance than the selection of soundings which will represent the hydrographic features properly and clearly. As the survey sheets are generally of a much larger scale than the chart, and each sounding line contains as many of the soundings as can be plotted thereon, it is obvious that the chart can show only a small percentage of the soundings. Moreover, it is objectionable to crowd the chart with unnecessary soundings which detract from its clearness and show only a lack of skill on the part of the cartographer.

Before selecting the soundings, the charting material should be studied thoroughly until the control, the plane of reference, the unit of soundings, and the dates of the surveys are clearly established, and a mental picture of the general characteristics of the locality has been acquired; otherwise an intelligible selection is impossible.

The soundings on shoals or rocks discovered with the wire-drag should be charted first in the compilation of a chart, and after such charting, previous surveys of the same area should be examined for less depths than the drag depths. A careful study should be made as to the source of such information, whether from a survey sheet or not, and its probable value for retention purposes. Then should follow the soundings that will bring out clearly all other shoals by their least depth. Subject to the foregoing, the soundings over areas completely developed should be shown fairly uniformly and without crowding.

The selection of channel soundings should be based on the line of maximum depths running with the channel. A hydrographic curve on the original sheet will generally serve this purpose. No pencil notations, lines, or marks should be made on the original survey sheets, and all preliminary studies should be made on tracing paper for transfer to the chart compilation.

If there are channel ranges, a line of soundings on the range should be selected, or suitable legend employed. After this is done, an intermediate temporary curve, if necessary, may be obtained from the original survey sheet which will serve to define the navigational limits for a