African west coast, and vice versa. If one were to take dividers and make measurements on a globe it would be found that dimensions agree closely.

A realization of this phenomenon brought about a new conception of the nature of the earth's crust and movements or drifts of land masses. A new theory was evolved, called the Theory of Displacement of Continents, sometimes referred to as the displacement theory. One great advantage of this theory over many scientific theories is that its immediate solution is possible by accurate astronomical determinations.

To test the theory, a world-wide network of longitude stations, the differences of longitudes of which were to be determined simultaneously, was laid out in 1926 by international agreement. The same net was reobserved in 1933. The main-scheme station of this net observed by the Coast and Geodetic Survey was station "Niu" located 7 miles south-east of Honolulu, Hawaiia. The first set of observations at this station were made in October and November 1926, by Lieut. E. J. BROWN, and the second set in October and November, 1933, by Lieut. (j. g.) J. P. LUSHENE.

The results are as follows :

Longitude of "Niu" (west of Naval Observatory at Washington, D. C.).

5 hours 22 minutes 39.531 seconds (1926)
5 hours 22 minutes 39.538 seconds (1933).

The result shown for 1933 is a preliminary one and may be subject to a slight change when adjusted to the network of the world. The difference between the observations of 1926 and 1933 is only .007 second. Since the probable error of the observations is about .005 second it appears that there is no drift between the observatory at Honolulu and the Naval Observatory at Washington, D. C. The advocates of the displacement theory would expect a movement of perhaps 5 to 10 meters per year, but the results do not show this to be the case.

The observations were made with a BAMBERG broken telescope transit and with the quarter-meter, half-second gravity pendulum, which served as a precision timepiece. It is interesting to note the high accuracy that can be obtained with these instruments

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COMMON ERRORS OF INEXPERIENCED PERSONNEL IN THE COMPILATION OF AIR PHOTOGRAPHS.

by

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Beginning in 1933, the compilation of large scale line maps from air photographs by the Coast and Geodetic Survey has been expanded to include surveys of the coast line and intra-coastal waterways of the greater part of the East Coast and extensive areas of the Gulf Coast and Pacific Coast. The surveys now planned include approximately 700 maps on a scale of 1:10,000 and 1:20,000 with a few 1:5000 compilations in the vicinity of New York City. The office reviews of about 250 of these maps have been completed to date.

It is my purpose to discuss the most common errors found in the office reviews of the compilations and the methods of instruction devised to avoid repetition of those errors.

These maps are compiled by the radial line method and, except for contours, practically all detail appearing on the photographs is shown.

The maps are designed to furnish the large scale topographic surveys necessary for use with the hydrographic surveys of the Bureau and for correction and construction of charts. An endeavor is made to maintain standards of accuracy such that these compilations will serve as base maps for future revision surveys. It is proposed to construct

a base map on which well defined recoverable points are located with such accuracy that they may be used for future control of one or a few photographs so that revision of localized areas can be made without extensive resurveys and without appreciable loss of accuracy. This requires that objects such as tanks, stacks, lights, and beacons, corners of wharves and prominent buildings, etc..., shall be located within 3 to 5/10ths of a millimeter of their correct positions relative to the triangulation control. The instructions to the compilation parties require that recoverable objects be so distributed either by marked stations or by selection of natural objects as to furnish control points at a maximum distance of one mile apart along the waterways. In some areas the distribution of recoverable points is much closer than this. Permanent survey marks of other Federal and local organizations are connected to and shown on these compilations. The positions of these marks then furnish the necessary connecting points for application of the surveys of these organizations to the charts.

The compilations are made by field parties centrally located in the areas to be mapped. These parties are in charge of officers of the Coast and Geodetic Survey who have been specially trained in this work. When completed in the field, the compilations are forwarded to the Washington Office for reproduction. Each compilation is accompanied by an overlay sheet for names and a descriptive report. The compilations upon receipt in the Washington Office are reviewed by experienced compilers. Names are then added and the maps reproduced by photo lithography.

The compilation parties in the beginning of this project were instructed to complete and forward to the office a few of their compilations as soon as practicable. This is very desirable in beginning any extensive mapping work, particularly with inexperienced personnel. In this case the first compilations from each party were reviewed carefully in the Washington office and supplemental instructions forwarded as became necessary.

The office review of the compilations consists essentially of:–

1. A check of the projection.
2. Check of the adequacy of control, of the adjustments made to the radial plot, and the density of minor control points.
3. Careful comparison with contemporary hydrographic and plane table surveys to determine whether all information is properly coordinated.
4. Check upon the completeness of detail and information needed for charting.
5. Check of the junctions with adjoining compilations.
6. Check of the geographic names shown.
7. Check upon the projection numbers shown at the margin of the compilation.
8. Check upon the number of and accuracy of location of recoverable control stations located by the compilation between the triangulation control.

We use in the office reviews a form which consists of a check list which accompanies the compilation until all items have been properly reviewed and the compilation is completed. The office review is then summarized in a report as to the completeness and accuracy of the compilation. This report is attached to the Descriptive Report which is permanently filed for future reference.

In nearly all cases the office verification of the first compilations received from the field parties showed:–

1. Errors in location of details.
2. Omission of information of importance for charting.
3. Lack of uniformity in drafting. Lack of knowledge of the type of drafting which would reproduce readily by photo lithography.

An analysis of the cause of the errors found showed these to be due largely to inexperience and the resulting lack of appreciation of the precautions required. Causes of the largest percentage of the errors noted are listed as follows:–

1. Lack of sufficient control to reveal errors in the photo plot.
2. Errors in drawing projections and in inking the projection lines.
3. Errors in plotting control points.
4. Insufficient field inspection. This source of error should be emphasized. In nearly all cases of the first compilations there had been a decided tendency to trace detail which was not clear and well defined on the photographs and which should have been clarified by adequate field inspection,
5. Inaccurate mounting of five lens photographs.
6. Heavy and inaccurate marking and transfer of triangulation stations and minor control points on the photographs.
7. Drawing heavy radial lines on the photographs and in making the radial plot.

8. Location of an insufficient number of minor control points, resulting in large adjustments when tracing the detail.

9. Insufficient study of detail under the stereoscope, particularly as regards the location of buildings. Frequently shadows and perspective position of the roofs of the buildings had been included with the base.

10. The use of objects for control points which had been moved since the date of the triangulation. This was particularly true where triangulation positions of lights and beacons were used for control.

The methods devised to avoid repetition of these mistakes consisted of:–

I. Sub-division of labor within the party. The chiefs of parties found early in this work that the most effective method is to have each step in the compilation performed by the men best qualified for that work. The sub-division included:–

1. Drawing projection and plotting control points.
2. Checking the projection and plotting of control.
3. The radial line plot.
4. Check of radial line plot.
5. Transfer and inking of detail.
6. Review of the compilation by the most experienced compiler on the party. This review should be a close examination of the compilation and a check by placing the photographs under the celluloid to see that all points fall along the radial line from the center of the photographs.

II. Specifications that a data sheet be included in the descriptive Report showing by whom each step in the compilations was accomplished and with the signature of the men responsible. With this sheet there is no question as to responsibility for any step work and the men can be held strictly accountable for poor work.

III. Specifications for the inclusion in the Descriptive Report of a review form to be signed by the Chief of Party and by the office reviewer. This form is a check list designed to force attention to the most common errors and omissions.

IV. Examples of photographs were sent out to all parties illustrating the density of minor control points required and the precision necessary in pricking radial points and drawing radial lines.

V. Copies of the office reviews containing the criticisms of the compilations were forwarded to the Chiefs of Parties with such comments as were necessary.

VI. In case where replotting of any part of the compilations was necessary, it was returned to the field party with instructions for additional work to be accomplished.

VII. Printed copies made without retouching the negatives were returned to the respective parties as soon as possible with notes indicating the changes in drafting necessary to facilitate the reproduction.

A summary of the results obtained from these compilations to date as regards their use for the construction and correction of charts, and as regards their adequacy as base maps, is given here.

For the navigable charts complete information is required as regards any details of importance to the mariner, including the topographic details adjacent to the waterways, land marks, and aids to navigation. Such details must be located with sufficient accuracy that well defined points such as the land marks and aids to navigation, corners of wharves, etc., shall not be out of position more than 3/10 of a millimeter on the scale of the finished chart. The charts are published on scales of 1:20,000 to 1:80,000 as compared to the scales of the compilations of 1:10,000 and 1:20,000. This gives, in general, a reduction of 1/2 to 1/4 from the plotting scale, and the required accuracy is thus obtained. A few of the first compilations had to be entirely replotted. Others were partially replotted to insure that no plottable errors in important details would carry over to the charts.

The requirements for base maps are rigid because they are to be used on the same scale as plotted. To repeat, it is proposed to construct a map on which well defined recoverable points are located with such accuracy that they may be used for future control of one or a few photographs so that revisions of local areas can be made without extensive resurveys and without appreciable loss of accuracy. This requires that such points be located within 3 to 5/10ths of a millimeter of the correct position relative to the triangulation control. These requirements are rigid for any graphical method of plotting. Approximately fifty per cent of the compilations up to this time are of sufficient accuracy to be used as base maps. Those compilations which are not quite up to these standards have been restricted both by the quality of the photographs and by

the inexperience of the personnel, but more largely because of the latter. These requirements are being fulfilled to a much greater extent on the compilations recently received.

Experience up to the present time indicates that the methods employed are adequate to obtain the accuracy required for base maps. However, while the principles of radial line plotting are relatively simple to understand, the technique, particularly the painstaking care which is necessary for accurate work, can be acquired only by extensive experience. It is suggested that the best method in beginning a new project with inexperienced personnel is to have each new man re-compile a map which has already been satisfactorily completed. This would furnish a training period and would assist in eliminating those men not capable of executing the details and precise drafting required. Not much additional expense would be incurred as the revision of a poor first compilation is very often as expensive as an entirely new compilation. Furthermore, the revision is seldom as satisfactory as the new compilation.

The training methods and checks described will produce base maps but only if applied with strict attention to detail and accuracy in every step of the work.

THE ACCURACY OF SOUNDINGS AND POSITIONS OBTAINED BY METHODS USED IN THE UNITED STATES COAST AND GEODETIC SURVEY

by

PAUL A. SMITH

(Extract from an article in *Transactions of the American Geophysical Union*, Washington, August, 1935).

With the advent of acoustic methods in navigation and in Hydrographic Surveying, the field of accurate hydrographic surveying has been extended to several hundred miles off the coast, and many details of the ocean-bottom now can be obtained and charted with far greater fidelity than was possible in the past. The discovery of submarine valleys at the edges of the continental shelves, and the development of the details and configuration of the ocean-bottom in greater depths as aids to navigation, are opening up a wealth of information for the use of geologists and oceanographers. This paper has been prepared in answer to repeated inquiries as to the accuracy of soundings, that is, the probable errors of soundings both in depth and in position.

Long ago, charts were adequate if they showed only the shore-line, important shoals which were dangerous to navigation, and the main passable channels, with a few additional soundings to give the navigator a rough idea of the depths. With increased speed of ships, the need for more details of the ocean-bottom has grown until now, with modern high-speed vessels equipped with echo-sounding devices, it would appear that a good contour map is desirable to satisfy all the needs of modern navigation. A sudden change, however, from the present practice of charting to one that shows only the depth-curves with soundings given only for the least depths and the depths of the valleys or depressions, would not be accepted readily by the majority of seagoing people. It should be realized that, unless undisputed evidence that a certain depth-curve occupies a certain position is obtained, the cartographer hesitates to show the curve. Where soundings are not adequate to completely prove the form, the geologist usually interprets the shapes from his experience and knowledge of various geological forms, but the cartographer maintains that too much imagination is used in such delineation by geological interpretation. For these reasons it has been the policy of the Coast and Geodetic Survey to show on its charts only such depth-curves as can be determined with certainty. This applies to the detailed surveys made in shoal waters. The general form of the 100-fathom curve and in some cases that of the 1000-fathom curve have been shown on small-scale charts.