China and India, the two most important centers, national Museums of Natural History which would serve as centers of anthropological, biological and geological investigation of the Far East.

Aleš Hrdlička

U. S. National Museum

SURVEYING FROM THE AIR

The great possibilities of airplane photography in connection with the water and land work of the Coast and Geodetic Survey are looming up as a potential factor in expediting the mapping of our waterways and interior surveys. This very important subject has been the object of careful study and experiments by officers of the Survey, in collaboration with the other branches of the government, during the past year and the rapid advance in aerial photography, first seriously undertaken during the war, now promises, with proper development, a method of surveying that will probably far exceed expectations over the old methods in rapidity, economy, and minuteness of detail.

No little stress should be laid on the fact that, not only are the possibilities good for an early and complete revision of our shore topography, but the opportunities that present themselves for assisting materially in our hydrographic work shouldn't be underestimated.

With the necessary facilitates and cooperation supplied by the Army and Navy Aviation Corps to the Coast and Geodetic Survey, experience has already proven the value of aerial photography over the old method of surveying in revision surveys of our coast lines.

This work so far, is divided into two branches, *Aerial Photo-Topography,* and *Aerial Photo-Hydrography,* and the results are shown in the following recent practical demonstrations:

AERIAL PHOTO-TOPOGRAPHY

In July, 1919, experiments were made at Atlantic City, N. J., to ascertain the adaptability of airplane photographs for use in topographic mapping. The area in the vicinity at Atlantic City was chosen as it is characteristic of so much of the coastal plain territory of the Atlantic coast. This project was essentially experimental in character, but developed into one of practical value, as the photographs are being used in a revision of the charts of the New Jersey coast.

This work was done in cooperation with the Air Services of the Army and Navy. Both land and sea planes were used, and in addition several photographs were made from a dirigible. Three types of mapping cameras were tried out, the "L" type, K-1, and Trilens. An officer of the survey kept in close touch with the work and furnished the ground control, constructing special targets in some cases.

A mosaic was constructed by members of the Air Service of the Army, using the photographs made with the K-1 mapping camera. These were taken at an altitude of 7,000 feet, using a lens of 10 inch focal length, with a resulting scale of about 1:8,000. A rough control scheme was first laid out, and the mosaic constructed over this.

This mosaic and also the individual photographs have been the subject of study by engineers of the survey, especially with reference to control and interpretation. Various methods of reduction for chart use were tried out. A study was made of the accuracy of mosaics and individual photographs. The possibilities of control using the photographs themselves to establish a graphic triangulation, have been investigated. The most important point brought out from the study of the results of the work at Atlantic City, was the possibilities in revision work, especially along those sections of the Atlantic coast where the shoreline is subject to frequent changes owing to the action of the sea.

AERIAL PHOTO-HYDROGRAPHY

At the same time that the experiments at Atlantic City were being made, a distinct line of investigation was being pursued at Key West, Florida. Photographs were made by the Naval Air Service to determine the pos-

sible use of aerial photographs in connection with hydrographic surveys. The primary object in view was the elimination of wire drag work, especially in the clear water of the Florida coast. An attempt was made to photograph small coral heads and pinnacle rocks, as it is the existence of these needle-like dangers to navigation that require the use of a wire drag. The equipment at the Air Station at Key West was limited, but thorough tests were made with that available. Various types of cameras were used, as well as different combinations of filters and plate emulsions. Photographs were made at altitudes of from 200 feet up to 4,000 feet, and under various light conditions. It was hoped that some combination of the various factors involved would produce satisfactory results.

The problem of control was solved, by including in each photograph, two vessels of the survey. The photographs could not be corrected for tilt with only two known points as a base, but the control as furnished by the positions of the two vessels, was found to be sufficient for the experiments.

A well-surveyed area near Key West was chosen, and the vessels proceeded on parallel courses over this area at full speed, the plane flying forth and back above the course. The courses and positions of the vessels were recorded as in ordinary sounding work. The photographer in the plane recorded the exact time that each exposure was made, with other data such as altitude, exposure, plate, filter, etc. Each photograph was later oriented by plotting the positions of the vessels on the chart at the instant the exposure was made.

These experiments proved very conclusively that photographs from the air, using present day equipment, are of little practical value to the hydrographer. When any of the underwater features did appear in the photographs, contrast in color was the most prominent, with no indication as to whether the contrast indicated shoal or deep water. Vari-colored bottom, of uniform depth, appears in the photograph as apparent difference in depth. Many charted shoals are not indicated in the photographs, while adjacent ones show clearly. Taken altogether, the results are so uncertain, that the chances of eliminating field work in hydrography are very remote. Developments in the art of photography may change this viewpoint.

REVISION OF THE COAST OF NEW JERSEY

In March, 1920, the Army Air Service photographed the coast line of New Jersey from Cape May to Seabright. A single flight was made using the K-1 camera. The plane flew at an altitude of 10,000 feet, and under very good air conditions. The camera was mounted in gimbals, with a lead weight at the lowest point to assist in maintaining the optical axis of the camera in a vertical position. Level bubbles were placed on the camera, to aid in keeping the camera in the proper position. This is the most satisfactory way to suspend the camera, and control its verticality, at the present time. The photographs are being used for a revision of the charts of the coast of New Jersey. The individual photographs are 18×24 cm. in size, and the approximate scale is 1:10,000. The photographs are mounted in strip mosaics, for convenience sake, not over four feet in length. The length is generally determined by the position of control points. This composite photograph is compared with the topographic sheet of the same area, and control points identified. The scale of the photographic mosaic is determined, and by means of the pantograph, the data are reduced to the scale of the chart, and transferred from the photographs to tracing paper.

The photographing of this 120 miles of coast line took less than two hours time in an airplane. The development of the films and printing took two days time of one man. Two rolls of film were used, a total of 183 photographs. The work of interpreting the photographs, assembling mosaics, comparison with topographic sheets, and reduction to the scale of the chart of the outside shore line required 15 days of office work by one engineer.

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