

# PORTO-RICAN — NICARAGUAN AERIAL SURVEY.

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(Extract from the Report of LIEUTENANT C. Mc GAULY, U. S. N.,  
COMMANDING OFFICER OF THE AERIAL SURVEY DETACHMENT, published by permission of  
REAR-ADMIRAL W. R. GHERARDI, U. S. N., HYDROGRAPHER).

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The detachment consisted of four commissioned officers and eighteen enlisted men. Three OL-8A airplanes were assigned to this detachment by the Bureau of Aeronautics. The planes of the detachment were not equipped with radio because of the weight and space required and of the limited personnel allowance.

The camera equipment furnished this detachment consisted of the following :-

- 4 K-3A Aerial mapping cameras with mounts and view finders ;
- 1 F-4 Aerial oblique and mapping camera ;
- 1 5X7 Aerial oblique camera ;
- 1 Cinematograph camera, 200 ft. model,
- 1 Cinematograph camera, automatic ;
- 1 View camera ;
- 1 Graflex.

The U. S. S. *Vireo* was assigned as tender after the necessary alterations had been made for the carrying of an airplane OL-8A.

## MAPPING OPERATIONS IN PORTO RICO.

The detachment was ready in all respects for mapping operations on 15th December. The photographic laboratory was completed and cameras tested and installed in planes. The best available maps of the island were secured from the Department of the Interior and flight lines laid out on these charts. These lines ran approximately North and South and covered areas about twenty miles long and about ten miles wide. After the first day of flying, it was found that it would be impossible to fly lines North and South due to the drift of the plane and that the winds aloft in Porto Rico were generally from the East at a force of from 18 to 25 miles per hour.

It was also found that an OL-8A plane, with three men and a full load of gas plus cameras and equipment, required forty to fifty minutes to climb to an altitude of ten thousand feet. To maintain 12,000 feet would result in a great loss of time and overwork the motors. Mr. ESTEVES, of the Department of the Interior, agreed that an altitude of ten thousand feet was satisfactory to the Porto Rican Government. The increase in film required and flying time was considered negligible. It was decided to take the photographs at an altitude of 10,000 feet instead of 12,000 feet.

The best map of the island was taken and 33 areas laid out which covered the entire island. These areas were approximately twelve miles long and ten miles wide. Lines were drawn in the areas three quarters of a mile apart and running East and West.

Each plane had a crew of three during mapping operations. The Navigator sat in the back seat and was responsible for directing the pilot along the flight line. The pilot was in the front seat and charged with the duty of keeping the plane always at the correct altitude, level, and was guided by the Navigator. The pilot practically flew blind and watched his instruments continually. He had strings attached to his wrists by which he was guided on the proper course by the Navigator who stood up in the back seat and navigated by the flight map and objects on the ground. The plane flew back and forth over the area to be photographed, flying alternately to the East and to the West.

The photographer was in the bottom of the plane and operated the camera. He had a view finder which enabled him to determine when to take pictures so that they would have the required advance overlap. The number of pictures taken per minute depended



*Porto-Rican Survey — Levé à Porto-Rico*

upon the speed of the plane over the ground. When heading into the wind, the pictures are taken slower than when heading down wind. There is a hatch in the bottom of an OL-8 A plane through which pictures are taken, and another hatch over which the view finder is mounted.

It is essential that straight lines be flown and if a plane veers off its course at any time, the required side overlap will not be obtained. It is very difficult to find objects on the ground that can be properly lined up and used as guides by the Navigator. One error we found was that the charts were not accurate, and if the Navigator flew according to the map and objects on the ground, the pictures would not have the required side overlap due to the objects on the ground being different than as shown on the chart. We found that some towns were as much as a mile out of position on the charts.

Approximately three hundred and thirty exposures were required to map one of the ten by twelve mile areas near the coast line at an altitude of 10,000 feet.

The film was taken to the laboratory and developed and printed. Three prints were made of each exposure. One set of prints was then laid out on a large table and inspected to see if they had the proper overlap and to insure that there were no holidays.

During the first part of our stay in Porto Rico we found that the coastal areas were more often clear than the inland areas. We found that the mountains that rise four thousand feet near the southern coast throw the scale of the pictures out so that it would be almost impossible to connect the entire island in one mosaic. A mosaic could be made in sections, however, and each section used separately. When we mapped over the mountains the scale of pictures changed from 1:10,000 to 1:6,000 or 1:7,000, depending upon the height of the mountain.

The greatest factor in aerial mapping is the weather. A clear day with no clouds or cloud shadows over the area to be mapped is necessary.

During the time that the detachment worked in Porto Rico (15 December to 10 March), there was not one cloudless day. From daylight until eight or nine o'clock in the morning the sky is often absolutely devoid of clouds. Between eight and nine o'clock the trade wind springs up from the East and fleecy white clouds immediately begin to form. These clouds form first over the mountainous areas and soon cover the entire island. They vary in altitude, but run all the way from 1,500 feet to above 10,000 feet.

On innumerable days while in Porto Rico it was possible to take off and get from five to ten thousand feet altitude and be above the clouds. The grounds would be visible through scattered cumulus clouds and the sky overhead would be perfectly clear. This condition provides excellent flying weather but makes mapping impossible.

There were few generally rainy days and we generally had sunshine every day with occasional showers.

During our entire stay there was not a time when it was clear over the mountains in the eastern part of the island during the time when pictures could be taken. Due to the shadows it is impossible to take good mapping pictures in the mountainous areas before ten o'clock in the morning.

With the exception of one forced landing, due to motor failure which put one plane out of action for a month whilst waiting for new parts, no other trouble was encountered with the planes.

A photographic hop would last from one to five and a half hours. The planes took off regardless of the local weather conditions for their area. Each pilot was assigned several areas in order of their preference, and was thus enabled to take advantage of unexpected clear spots.

It takes about three hours' work at 10,000 feet on a perfect day to complete an area of 120 square miles. In addition, it takes forty or fifty minutes to climb to 10,000 feet and thirty to forty-five minutes to return from twenty to sixty miles to San Juan.

The three planes of the detachment were equipped with regular service instruments with the addition of the new Mark V compass and a level flight indicator. The new compass was all that could be desired being especially helpful in steering a steady course during mapping runs, to say nothing of navigating across our water hops while in transit to new bases of operations. The level flight indicators were absolutely worthless on account of the extreme oscillation of the pointer — the regular plane altimeters varied considerably so that it was necessary to take all altimeters up in the same plane and obtain corrections to maintain a mean photographic altitude.

The film was stretched across overhead battens in the print assemble room. This room was sufficiently long and high to take a full roll of film. As many as ten rolls

of film were dried at one time, although drying, at times, was slowed by damp weather. After washing, the prints were dried on sections of stretched cheesecloth, they were then trimmed and sorted by runs and checked for the proper number of prints (three for each negative).

Cameras and view finders had to be completely checked over prior to each flight for loose screws, bolts and loose lenses. Material suffered considerably from rust and corrosion due to the damp salt-laden sea breezes; this was especially true of laboratory equipment. Some trouble was encountered with electric current variation in the photographic laboratory during printing. There were very few instances of static on the film; it is believed that this was due to care in handling film during magazine loading and placing of film on the developing apron.

It was the practice to deliver a complete set of prints covering an area to one time. One set of these prints were then laid out on the table and pieced together to determine the runs necessary to be made over and to find holidays. A special chart of holidays was kept and these rephotographed as the opportunity presented itself. It was difficult to run lines three quarters of a mile apart and keep them all entirely straight. The holidays were surprisingly few and only 10 - 15 % retakes were necessary to complete the areas. A few areas were delivered with holidays or insufficient overlap which this detachment could not retake due to weather conditions and time available.

All cameras functioned satisfactorily in Porto Rico, and the resultant prints were of excellent quality. Eighty-four rolls of film were exposed, developed and three contact prints made from each negative. 26,489 mapping prints were delivered to the Porto Rico Government. 410 hours were flown for photographic purposes in Porto Rico. It was estimated before our departure from Norfolk that about 200 hours flying would be required to complete the survey. The great increase in flying time was caused by lack of mapping weather. On only one or two occasions did we complete an entire area in one flight. Three hours flying at 10,000 feet on a perfect day will complete an area. We had no perfect mapping days and we completed some areas by getting three or four "runs" on a three hour or four hour flight, drifting fleecy clouds would then halt operations. This made necessary four or five flights to complete the 15 "runs" in an area.

66 % of the island's area was mapped.

The Insular Government had planned to use the "radial line control" method in plotting the aerial photographs. Prints to be plotted accurately and readily by this method should have a sixty percent advance overlap and a fifty percent lateral overlap. The Navy Department's agreement with the Insular Government stated that a 25 % lateral overlap was to be maintained. A mosaic map is difficult to assemble from prints with only 25 % side overlap, for with this overlap it is necessary to use portions of the prints toward the edge where distortion and tilt are more prevalent than in the central portion. It is not thought practical to assemble a mosaic map of the entire island as one map from prints made at 10,000 feet, as the changes in elevation of the ground amount to 4,000 feet.

A fairly accurate mosaic map could be made by assembling the prints by sections depending on the elevation of the terrain. Due to the changes of elevation sections would necessarily be of a different scale. Prints over the mountainous regions can be used in the construction of a line map where a system of ground control has been established. The prints do not match due to a change in ground elevation, but common points in adjacent prints fall in the same azimuth even though they fail to match by a considerable distance. This error is corrected from ground control data obtained in the field. Regardless of the overlap in mapping prints they can be used for the sketching of topography, for each print shows all topographical features present in the area covered. The same completeness of topography can not be noted in ground work.

Although not definitely stated in the original agreement, it was my understanding before our departure that this aerial survey was to be a soil survey. This does not require the exactness necessary in the making of a topographical map from aerial pictures with ground control. 60 % longitudinal overlap and 25 % side overlap are sufficient for work in the field in making a soil survey. An accurate controlled mosaic is difficult to make of a small flat area, and a great undertaking in a large area with both mountainous and flat terrain.

#### GULF OF PARIA SURVEY.

In December the Navy Department ordered the *Hannibal* to discontinue surveying

the northern coast of Cuba and to begin a survey of the Gulf of Paria in South America. The *Vireo* with one plane aboard and the necessary personnel and photographic material was ordered to arrive at Trinidad and report to the *Hannibal* by 1 February in connection with the Paria Survey. The other two planes were ordered to continue with the Porto Rican Survey.

By noon 26 February the entire area had been photographed with the exception of five miles of coast line of the Venezuelan Peninsula. This proved to be the most difficult part of the job. The afternoon of this date and the whole day afterwards the plane was over this area ready to photograph, in case there was a break in the clouds. Several breaks did occur, but before the run started another layer of cloud would cover it up. It was just at the end of the second day and after hope had been given up that the clouds broke and the crew was able to complete this stretch, which finished the survey. These last five miles of coast line took a little over twelve flying hours.

During the afternoon of Saturday, 28 February, about two hours after the survey work was completed, Cap. JENNINGS took off with a photographer to obtain obliques of the landing field and town of Maturin. Twenty minutes later the plane crashed in a very small field on the outskirts of town. According to the pilot's statement the control wires seemed to have frozen and he lost control. The plane with the exception of the engine was a total wreck. All, except the pilot, who received severe lacerations over his left eye, escaped with only slight bruises.

THE NICARAGUAN SURVEY.

On the 23rd March both planes went out twice and we completed Chiriqui Lagoon, Almirante Bay and the main coast line to a point about thirty miles North of Port Limon. One plane proceeded to Bluefields on the 24th and photographed the coast from Monkey Point to and including Bluefields Lagoon, before landing there for the night. The other plane proceeded to Coco Solo with the exposed film for development. On this flight camera and photographer were carried in the event that clear weather be found along the coast. This plane returned to Almirante the same day without making an exposure.

On the 27th both planes took off in an endeavour to complete the coast line between Monkey Point, Nicaragua and the point South of San Juan del Norte where the work had stopped on the 23rd. One plane was forced to return to Almirante with a broken flying wire; the other photographed the coast between San Juan del Norte and Monkey Point, refuelling at Bluefields and returning to Almirante. This left a gap of only thirty odd miles to complete the coast North of Almirante to Bluefields.

On 28th March one plane completed the thirty miles gap South of San Juan del Norte, and on the 30th, while one plane was to the northward, photographing anchorages and small boat landings, the other worked around Chiriqui Point. On the 31st one plane went out and completed the coast to about sixty miles North of Coco Solo.

Total hours flown by the detachment.....	732
Total hours flown for photographic purposes .....	490
Number of rolls of film exposed .....	131
Total number mapping prints made .....	29,921
Total number oblique prints .....	3,416

