THE MILITARY GEOGRAPHIC INSTITUTE OF COLOMBIA

by

Dr. BELISARIO RUIZ WILCHES,

DIRECTOR OF THE MILITARY GEOGRAPHIC INSTITUTE OF COLOMBIA.

(Reproduced from "The Military Engineer", N° 180, Washington — Nov.-Dec. 1939, page 446).

The Military Geographic Institute of Colombia was founded in 1934. The general plan of organization and operation was approved by Executive Decree of August 30 of that year. In this Decree the Director was authorized to proceed to Europe to acquire such instruments as he considered necessary for the Institute and personally to study the organization and methods of operation which similar institutions in the countries of Europe might recently have adopted.

The immediate aim of the Military Geographic Institute is the preparation of a sectional map of the country and its publication in adequate sheets on a convenient scale for military purposes, and the publication of similar sheets for use on official as well as private engineering projects under certain conditions. A secondary purpose is to direct its studies in such a manner as to be useful for the international advancement of geodesy.

ORGANIZATION.

The Institute is in charge of a Chief of the Institute, and a Sub-directorate, originally known as the Secretariat, which replaces the Director in his absence.

The office of the military technical advisor provides liaison between the Directorate and the country's military organization under the Ministry of War.

The section of Accounting and Control, under the supervision of the Sub-directorate, is charged with the care of records and storage. It contracts for necessary personnel and makes authorized disbursements.

The technical department is divided into three divisions, (1) Astronomy and Geodesy, (2) Aerial Photography, and (3) Mapping. These three divisions are in turn subdivided into sections which have been arranged according to requirements and amount of work. These subdivisions are as follows :

The Division of Astronomy and Geodesy contains the sections of astronomy, geodesy, field astronomy, topography, and nomenclature.

The Division of Aerial Photography is composed of the control and filing sections; the groups subordinate to the above mentioned section, for instance, the two field parties, each with pilot, mechanic, photographer, and observer; and the laboratory section, which takes care of developing and printing photographs.

The Mapping Division is composed of the offices for developing, drawing, photocopying, offset, photolithography, and printing.

INSTRUMENTS AND FACILITIES.

The equipment of scientific instruments was personally selected by the Director, Belisario Ruiz Wilches, Civil Engineer, in various parts of Europe, so as to meet requirements, within the limits of available funds, for carrying out the work that had been planned. This has been done with generally satisfactory results. Subsequent purchases were made, to take advantage of improvements in instruments or new apparatus for the purpose of correcting certain deficiencies which had been noted, or for commencing such geophysical investigations as may offer means for improving geographical exactness and of aiding in the study of profiles.

Since May, 1936, the Military Geographic Institute has occupied its own building, constructed in accordance with special plans. This building, at first sufficiently large for the work of the Institute, is today somewhat inadequate and should be enlarged to take care of the increase in work. Alterations to enlarge the building are being started.

ACTIVITIES.

Field work, already well organized, will commence very soon. The work of the Institute has, in fact, covered only a period of approximately two and a half years.

The general method used for aerial photographic surveys requires the exact fixing of geodetic points in order to correlate aerial photographs of the terrain to these points, generally called control points. The following is a superficial description of this class of work :

Control points for transfer from photographs are supported by a geodetic net of great precision, the specifications for which are similar to those of the second " Saxon-American " network. The basic geodetic network — now under way — commences from the Astronomical Observatory of the Institute in Bogotà, and has been completely terminated on the left bank of the Cauca River, or in other words, begins at the nucleus of the eastern cordillera and is to be supported on the spurs of the western cordillera after traversing the central one in the vicinity of the " Nevado del Tolima ". The area covered by this network is a little over 10,000 square kilometers, having more than 3,500 meters above sea level. Besides this network there has already been completed a network of equal precision which connects the ports of Barranquilla and Cartagena in the Atlantic Region with supporting bases in each of these ports. Geodetic bases (five) have been measured with Invar 50-meter ribbon tapes; vertical and horizontal angles have been determined through the employment of geodetic apparatus of high precision manufactured by the houses of "Wild" (T-3) and Zeiss. For the purpose of giving an idea of the precision of the geodetic work, we quote below the characteristics of the section of network between the 75th and 76th meridians west of Greenwich (Ibagué-Armenia traject):

Strength of figures between bases : $R = 87$

Tribuna-Perales Base :

Length : 2848.991 meters
Precision : 1/664200 (average of relative error in longitude)

Piedras Base :

Length : 2899.376 meters
Precision : 1/593009 (average of relative error in longitude)

Average error in the closure of triangles : 2".6

Discrepancy between measured and calculated base at Piedras :

Measured : 2899.376 meters.
Calculated : 2899.351 meters.
Relative error : 1/117288.

Geodetic figures have been adjusted one by one by the method of least squares, and in some cases general compensation has been carried out by length and bearings from base to base. In order to carry out adjustment by azimuth, Laplace points have been established at certain distances, fixing the astronomic co-ordinates with probable errors of less than 1", thanks to the use of portable high-quality meridian theodolites and chronometers and chronographs which carry first-class certificates from the observatories of Neuchâtel and Besançon.

The astronomical observatory of the Institute is equipped with first-class instruments such as an Askania Werke theodolite with telescope length of 200 diameters, a 102-m. lens, focal length of 108 cm., automatic electric micrometer, et cætera. A free pendulum which operates at uniform pressure and constant temperature is installed in an underground room; an Abraham chronograph with double oscillograph and lastly, complete equipment for issuing automatic rhythmical time signals which the Institute proposes to place in operation in the near future by means of its own broadcasting station.

Returning to the geodetic net, it should be mentioned that plans for its construction were adapted from those used by the Coast and Geodetic Survey. In the above described section of the network it is noted that the value of R was well within tolerance permitted

by the "Saxon-Americans" for first-class networks, which is 110. It is also well to note that the relative discrepancy between bases was less than 1: 25,000, which is the limit established by the Coast and Geodetic Survey of the United States for first class triangulation.

Altitudes of geodetic stations have been determined by means of careful observation of vertical angles between stations, eliminating geodetic refraction by means of reciprocal observations. The results obtained have been very satisfactory since they indicate probable errors of 0,5 m. in heights of vertices. Furthermore, apparatus for commencing precision leveling are in the possession of the Institute.

Calculation of the network has been performed by accepted methods, that is to say, by computation of geodetic co-ordinates of vertices, after securing adjustment or general compensation of errors. In this operation the international or Hayford ellipsoid was used in order to comply with recommendations of the International Geodetic Congress held at Madrid in 1924.

Now, since topographic control points for transfer from photographs are, as mentioned above, supported in the geodetic network already described, this produces great precision in the preparation of sheets into which the general map of the country has been divided.

INSTRUMENTS FOR TOPOGRAPHIC MAP-MAKING.

The instruments possessed by the Institute for the transfer of photographs are as follows:

One Zeiss-Aerophotograph G.m.b.H., Jena, 1937 series, Stereoplanigraph for the drawing of maps on any scale with stereoscopic sights of arbitrarily guided axes.

One "Wild" Autograph for terrestrial views.

Two sets of wide-angle "Multiplex" aerial projectors for cameras having a focal length of 100 mm.

One set of "Multiplex" aerial projector equipment for the cameras having a focal length of 210 mm.

One transfer apparatus for panoramic camera photographs.

One stereoscopic transfer apparatus and radial triangulator.

Complete photographic equipment, including a large camera for photographic reproduction.

The foregoing simple description gives an idea of the first class instruments possessed by the Institute for its work of photographic transfer. As we said at the beginning, this equipment was personally acquired in Europe by the Director of the Institute, who was commissioned for this purpose by the National Government and who, besides attending the Second International Congress of Aerial Photography, had occasion to make a minute study of the organization and work of several foreign geographic institutes, such as the Berlin, Berne and Paris Institutes.

The Institute has modern "Offset" lithographic presses for the printing of map sheets in five colors. Also, it has quite expert native operators. It might be mentioned here that the Institute's personnel in the various sections (astronomers, geodesists, transfer engineers, and flight personnel) is entirely Colombian, with the exception of the German engineer who set up the transfer equipment and who taught its operation to Colombia engineers in charge of this section.

The sizes agreed upon for each sheet of the map are: 7'30" in longitude and 5' in latitude, which gives approximately 13 1/2 by 9 km. Scale 1: 25,000 and contour lines of 25 meters.

THE GEOGRAPHIC MAGAZINE OF COLOMBIA.

In the first number of the *Geographic Magazine of Colombia* (official organ of the Military Geographic Institute) for November, 1936, there is a detailed description of the establishment and aims of the Institute. It also contains a description of the general technical organization and process for securing each cartographic plate. In subsequent numbers of the magazine (2,3 4 and 5) some of the aerial photographic equipment used by the Institute

is described as well as some parts of the transfer processes. Schematic plans of the geodetic networks from Bogotà to Cartago and of the Atlantic Coast have also been printed. Similarly, description is given of methods of calculation of astronomic positions, of partial adjustments of figures, altitudes of triangulation vertices of topographic control points, of length of base lines, and other similar descriptions.

PAST AND PRESENT WORK OF THE INSTITUTE.

There follows here a short resumé of the principal work which has already been performed by the Institute as well as the projects upon which the Institute is now engaged.

Sheets of the Geographic Map of Colombia: Map sheets 86-A-4: 86-B-4: 87-D-1; 98-A-1; 98-B-1 covering the Barco Concession in the Department of Norte Santander. Scale: 1: 25,000, contour lines every 25 meters. Printed in six colors. Size 55 by 37 centimeters, equal to a width of 7'30" of parallel by a height of 5' on the meridian.

Special projects for different branches of the Public Administration:

(1) Aerial photographic exploration of the Sarare River. Scale: 1: 10,000. This work was carried out for the Communications Commission which had to choose a route to the eastern plains.

(2) Plan of Bogotà. Scale 1: 10,000, contour lines every 10 meters. Prepared for the occasion of the Fourth Centenary of the Capital of the Republic.

(3) Map of the Rio de Oro Region. Scale: 1: 10,000. For the Ministry of Foreign Relations.

(4) Map of the new Aquaduct of Bogotà (Regadera Dam). Scale 1: 12,500.

(5) Map of a section of the Magdalena River in the vicinity of Barranca Bermeja. Scale 1: 12,000. For the Navigation Section of the Ministry of Public Works.

(6) Palanquero Air Base and Environs. Scale 1: 25,000.

Work now on hand. (1) Tax map of the municipality of Fontibón. For the Ministry of Finance. Scale 1: 10,000. Total area 8,000 hectares. Of this order 4,000 maps have already been transferred and 2,000 printed. Thus, practically 60 per cent of the work has been completed.

(2) Catacumbo Oil Zone. Mapping of approximately 3,000 square kilometers for the Colombian Petroleum Company. Approximately one-third of this area or 1,000 square kilometers already has been transferred from photographs.

(3) Map of the Department of Atlantico. Scale: 1: 25,000.

(4) Map of the Bogotà Sabana. Scale 1: 25,000.

In addition to the above mentioned work, the aerial photographic section has made 4,000 square kilometers of mosaics on a scale approximately 1: 30,000 for the Colombian Petroleum Company. It has also made mosaics of Bogotà, Barranquilla and Cartagena on scales of 1: 10,000, 1: 25,000 and 1: 10,000 respectively. The area covered by the geodetic net of the Atlantic Coast (4,000 square kilometers) has been entirely photographed and is ready for transfer. The mosaic of the Atlantic region from Barranquilla to the Panaman border is also ready.

In the zone covered by the Bogotà-Cartago geodetic network— which, as mentioned at the outset, has already been completed— photographs have been taken of the Bogotà Sabana, the area between Ibagué and the Magdalena River, and the region between the Central Cordillera and the Cauca River.

CONCLUSION.

In concluding this brief review we should mention that during these two and a half years of work it has not as yet been possible to start the special geophysical studies for which the following instruments are to be used: One Askania-Werke, large model torsion balance, with complete automatic register, to determine horizontal gradients of gravity as well as differences in curvature of the principal sections of the "geoide" and their positions; one magnetometer for determining declination and inclination of the magetic needle and the

horizontal component of the terrestrial magetic field; and a Sterneck quadripendular apparatus for determining gravity.

As may be seen from the above, the Military Geographic Institute of Colombia is duly organized successfully to engage in practical and cultural work of great importance to the country, and is typical of the degree of advancement attained by the engineering profession in Colombia.