

MILITARY MAPPING*

*Lt. Colonel Russel M. Herrington
Corps of Engineers, U. S. Army*

I FULLY appreciate the fact that it is unnecessary to stress the importance of maps to members of this Society. However, my subject, Military Mapping, is of such peculiar importance, particularly at the present time, as to deserve special mention. It is a broad and important subject and one which would require a lengthy discussion if all its phases were to be properly considered. I propose, therefore, to briefly describe for you the existing setup in the Army for the accomplishment of mapping missions; to tell you of the military application of recent advances in aerial photographic mapping methods; and to indicate to you some of our present problems.

Maps are essential to the efficient and successful operations of all echelons from the office of the Commander in Chief down to the smallest combat unit, the squad. It is almost impossible to conceive of any military operation being conducted without maps of some sort. They may vary from accurate and detailed maps produced during peace, when time is not important, to hasty sketches or photographs of an area, prepared under combat conditions. Maps have always been an important factor in military operations. Today—with present tactics—that factor assumes far greater proportions than ever before. Heretofore, military operations moved comparatively slowly, and Commanders had more time to get out field orders. Today operations move with “blitzkrieg” speed, and the Commander’s decision in the form of an order must be transmitted with utmost dispatch, in briefest and simplest form. The presentation, in graphic form on a map, of dispositions, lines of attack, supply points, boundaries, etc., is the quickest and surest method for that transmittal.

In military operations the timely production and supply of maps is essential to ultimate success, just as is the procurement and distribution of rations, rifles, gasoline, oil, ammunition, etc. The responsibility for map procurement and issue is jointly charged to the Air Corps and the Corps of Engineers. It is the function of the Air Corps to procure necessary aerial photographs. It is the function of the Corps of Engineers to prepare and issue in final form all maps. Of course, the operations of the Air Corps and the Engineers are performed in accordance with policies and programs promulgated or approved by the General Staff.

While I shall not attempt to go into the Air Corps phase of this subject, I should state that the Air Corps has set up special photographic units to work with the Army topographic units. The equipment of these Air Corps units has been developed to operate with the photogrammetric equipment of the Corps of Engineers.

In explaining the mapping organization of the Corps of Engineers, it might help to review briefly the whole Army organization. First, we have the War Department in Washington which is responsible for the general policies, administration, and supply of the Army as a whole. Next we have the General Headquarters in the field, under which a group of Field Armies operates. Then comes the Field Armies which in turn are composed of a group of Corps. Finally the Corps are subdivided into Divisions.

The Army mapping organization is such that each of these sub-divisions down to and including the Army Corps has a corresponding mapping unit.

* Presented at Annual Meeting, Washington, D. C., January 24, 1941.

The War Department is served by the Engineer Reproduction Plant in Washington—a complete lithographic map reproduction plant. Aside from furnishing general maps required by the War Department, it will assist the mapping units in the lower echelons by reproducing existing maps within their areas. In both of these tasks the assistance of other government agencies and private plants will be utilized. In addition to map reproduction the War Department may need some field survey work. No special military organization has been set up for this. When work of this nature is required and there are no survey troops of lower echelons available, the assistance of other governmental or private agencies will be requested.

General Headquarters, referred to as G.H.Q., will be served by a G.H.Q. topographic battalion similar to the Army Battalion which I shall discuss later. This unit will produce special maps required by G.H.Q. and assist the topographic units of lower echelons whenever necessary.

Each of the four Field Armies in turn will have a topographic battalion, composed of field surveyors, photo-mappers, and reproduction personnel. These units produce maps for the immediate need of the Army units. It is in this unit that photogrammetry plays a vital role. An Army pushing forward must have maps not only of its own area but also of enemy territory. Rapid mechanized advances, artillery fire at extreme ranges—as much as 40,000 yards (almost 25 miles), and bombing operations—these are but a few of the reasons that require our possession of maps extending deep into enemy territory. It is the function of the Army Topographic Battalion to produce these maps.

Although the Army Topographic Battalion is trained and equipped in map production, you know as well as I, that it is a time-consuming operation. We can foresee situations, where, even with the best organization it would be impossible to produce maps as early as required. Therefore, we have carried the mapping organization one step further down to the Corps Topographic Company. This company will be equipped to do limited lithographic reproduction and will be trained to prepare mosaics or single photographs as a form of map substitutes for areas urgently needed, before regular maps can be produced. There will also be some surveyors with this company for control work and to assist the field artillery in obtaining orientation data.

Besides the mapping units, the Corps of Engineers maintains at Wright Field, Dayton, Ohio, an Engineer Detachment which develops and tests new photogrammetric equipment, and cooperates with the Air Corps in developing the camera equipment used for mapping purposes.

Having given you the general picture, I should like now to discuss in somewhat more detail the Army Topographic Battalion. It, in my opinion, is the most important and has the most difficult task to perform.

To execute rather extensive missions on relatively short notice, a large organization with trained personnel and adequate equipment for the complete mapping cycle, i.e. field control, photo-mapping, reproduction, and distribution, must exist prior to the need for its services. The Army Topographic Battalion is organized with this fact in mind. The Battalion is composed of:

- A Headquarters and Service Company of approximately 100 men.
- Two field surveying companies of approximately 180 men each.
- A photo-mapping company of approximately 300 men.
- A reproduction company of approximately 250 men.

The Headquarters and Service Company aside from its administrative and supply functions contains Battalion Headquarters personnel, which plans and supervises the work of the Battalion as a whole, and is charged with the distribution of completed maps.

The field companies, as their name implies, are engaged in establishing ground control for aerial photographic mapping. They are trained and equipped to triangulate, traverse, level, plane table, and do picture pointing. (The latter term refers to the identification and marking of control points on the photographs.) In actual operations it will be the function of these companies to establish bands of control as close to the front line as possible, and to cut in identifiable points in enemy territory. In certain situations it may not be possible for these companies to start from a standard datum, and an assumed datum will be necessary. In such cases the G.H.Q. Battalion will be called on to bring forward or establish a standard datum.

The photo-mapping company is a complete unit for the production of maps from aerial photographs. Its basic photo-mapping equipment is the multiplex, but it is also equipped with the stereo-comparagraph as a reserve and training instrument. Aside from the actual compilation of the map, this company executes the necessary drafting work preliminary to reproduction of the maps in colors. In short, it is given aerial photographs and available ground control, and told to prepare the maps to the point where reproduction starts. Speed in production is necessarily the basic aim of the topographic battalion. Its organization and training, and in particular the methods employed in the photo-mapping company are based on that requirement. Three shift operation is provided in order to reduce the amount of equipment and working space, and work is broken down into small individual tasks on the order of an assembly line.

The Reproduction Company consists of equipment and personnel to execute all types of lithographic or photographic map reproduction. I mention photographic reproduction because half-tone reproduction of photographs or mosaics may sometimes be necessary. As would be expected in an organization of this nature, *ozalid* or blue printing, photostating and contact photographic printing are provided for.

The reproduction company has in effect two separate plants to operate. One plant we may term a stationary plant which will be set up semi-permanently. The other is a plant in which the equipment is set up in special trailers. Thus we will have a mobile plant to accompany the advance echelon of the Army and to provide a map reproduction source for the Army regardless of its location.

Any kind of mapping requires time-consuming operations. There are many problems involved, and many varying situations to be met, but with the setup I have indicated I believe we can successfully meet all requirements.

To point out the military application of advancements in the art of mapping I would like to reminisce a little.

Prior to our entry into the War in 1917, no topographic troops as such existed. Such mapping as was done was accomplished by regular engineer units, in areas we could occupy or sketch by ground methods.

In 1917 the first topographic battalion was organized. It operated throughout the war, but was primarily concerned with map reproduction because the A.E.F. was operating in territory which had been completely mapped.

After the World War it was realized that special topographic troops were essential and that the greatest effort in training should be directed toward rapidity of production. The possibilities of mapping from aerial photographs were also more fully realized. So, although the 29th Engineers was disbanded immediately after the war, another topographic battalion was established in 1920 when the Army was reorganized. This battalion, later redesignated the 29th Engineers, has been employed ever since on practical development work aimed

at increasing its rate of production and at securing maps of territory, denied to us by the enemy, by photogrammetric extension of control.

The first phase of its training was conducted by Colonel J. W. Bagley, now retired from the Army. He developed the multilens camera which is still in use, starting first with the three lens camera and progressing to the four and five lens camera. In recent years two five lens cameras have been employed in tandem, producing a tandem composite.

Colonel Bagley also employed the radial method of horizontal control extension, commonly used today in many forms and variations. Later he developed means of using the horizontal control and relief displacements to determine elevations.

For increased speed in ground control work, triangulation by the use of searchlight beams was tried, and then the combination of searchlight beams and Bilby triangulation towers.

All these were used and tested by the topographic battalion with a view to gaining speed in production of maps of inaccessible territory.

Developments in foreign methods and equipment were also studied, and wherever they appeared to be applicable to our problems they were tested. Expensive, complicated and bulky instruments were purchased and tried by the Engineer Detachment at Wright Field, but they did not fill the Army's need for simple instruments on which a large number of men could be employed simultaneously, in what we can term mass production.

Of course the 29th Engineers did not have a monopoly on experimentation with the use of aerial photographs. Contemporaneously, other government and private agencies were studying means of adopting aerial photography to their particular needs. Methods so developed have been combined with Army methods whenever possible and advantageous.

As a result of these efforts, as would be expected, great progress has been made.

I recall that in 1930, we figured that a topographic battalion of about the same strength as our present war strength battalion, could make contoured maps on a limited front within friendly territory by a combination of ground and photographic methods, and planimetric maps to a depth of about 10 miles in enemy territory from photographs alone. Of course we could add form lines to the planimetric maps.

The planimetric data were, of course, tied in to radial line control plotted from the aerial photographs. These photographs were taken along flight lines laid out in definite patterns to provide the strongest type of control determination.

At that time the contoured maps were prepared by compiling planimetric information obtained from aerial photographs, then sending a large number of plane table parties to the field to add contours to sheets prepared from the photographs.

What we considered then as a noteworthy accomplishment appears rather insignificant today. Since then we have, I believe, capitalized on the information and experience gained in the earlier years. While basic principles have remained the same, improvements in photographic material and equipment and in photogrammetric instruments and their application, have increased the possibilities many fold.

Photogrammetrical instruments of comparatively simple design have been perfected with which contoured maps can be compiled. Some require ground control in the overlap of a stereoscopic pair, whereas with others, control from one

pair can be bridged through several pairs until additional ground control is reached. Outstanding among the latter instruments is the Multiplex, Aeroprojector. The Army has adopted it as its basic photo-mapping instrument. It is a portable instrument and is not so complicated that soldiers with reasonable intelligence cannot be taught to operate it. It is adapted to bridging control for limited distances with excellent accuracy, for comparatively greater distances with satisfactory accuracy, and for indefinite distance with fairly satisfactory results. It is an instrument with which we can completely compile a map, or we can use it solely for obtaining control for other photogrammetric instruments such as the stereo-comparagraph, the Abrams Contour Finder, and kindred instruments.

From my remarks concerning this instrument and the use of the field companies, it is easy for you to visualize our application of modern advances in photo mapping. With bands of control along the front line, photographic extensions can be made into denied areas. By this method, maps can be compiled of areas extending deeply into enemy territory.

Many of you have no doubt already framed a question regarding the accuracy of these maps compiled without ground control. I will first answer it in rather an evasive manner.

To be able actually to compile contoured maps in enemy territory, even at accuracies less than standard, is so much better than we visualized not so many years ago, we cannot help but be satisfied. Extensions forty to fifty miles with average vertical errors of less than 100 feet (and the majority less than 50 feet), and horizontal errors less than 100 yards, cannot be thrown out as entirely unsatisfactory. We would prefer that the average errors be less than 25 feet vertically and 33 yards horizontally. However, in visualizing our problems, you must remember that speed enters into the picture as a primary factor, and during hostilities we must make use of the type photography we can get. An active enemy is not going to sit idly by while we take aerial photographs at ideal altitudes and with the precision of peace time photographic missions. We therefore have to strike a balance which I doubt can be expressed in absolute tolerances that represent objectives in accuracy. In the final analysis, the specification must read, "the best map procurable by the time it is needed."

Another means of aid also comes to mind in connection with ground control. You all know the value of additional reliable ground control in photographic mapping. Especially is this so in connection with photographic control extension. It is my belief that if all control surveys in this country had been and were properly recorded, tied into standard datum, and standardized there would be little need of additional control for map compilation. This of course is not a new thought. The desirability of standardizing control surveys has been recognized for years and some advances to that end have been made. I think a great deal more can be accomplished, and should be done in the interest of national defense. Some uniform system of recording data should be set up in all government agencies, and state agencies should be urged to use the same system. Control surveys should be classified in accordance with certain adopted standards and permanent markers be tied into standard datum. Moreover, sketches should be made of control points on the ground which can be identified on aerial photographs. This procedure will entail additional costs but the additions will not be nearly so great as a new survey. I, therefore, recommend to this Society, as an aid to national defense, and as an aid to organizations and individuals engaged in photomapping, the fostering of such an objective.

And now in closing I should like to point out that the Army now has the best

mapping organization it has ever had, and that organization is to be increased in the very near future. Our equipment is now up-to-date and constant efforts are being made to improve it. We are continually endeavoring to improve our accuracy and at the same time hold and if possible increase our speed. In these endeavors we earnestly solicit aid from members and organizations of this Society.

DISCUSSION OF COLONEL HERRINGTON'S PAPER

Captain E. E. Pollock, U. S. Marine Corps.

Captain E. E. Pollock, U. S. Marine Corps was asked to discuss the paper "Military Mapping" presented by Lt. Colonel Russell M. Herrington, Corps of Engineers, at the Annual Meeting of the American Society of Photogrammetry. Captain Pollock was unexpectedly ordered away from the United States just prior to the meeting. The following quotation is from a letter received from Captain Pollock.

QUOTE: "If I were to discuss this paper by "remote control," so to speak, my main topic would be along the line suggested by Colonel Herrington;—that is, the vital necessity of producing reasonably accurate maps with the greatest possible speed. This concept of mapping is so foreign to a trained cartographer or topographer's instincts that it is worthy of mention. In a military situation where a map—the best map possible is needed by a certain day and time, one much more accurate delivered some days later will not answer the purpose. If this rather heretical concept can be introduced to the assembled group of photogrammetrists, who I assume are at present more than ever before thinking in terms of military mapping, it may stimulate lines of thought which may ultimately evolve short cuts in time without loss of accuracy. I would also like to re-emphasize Colonel Herrington's point relative to the assistance which previous survey work, well annotated and recorded can mean in event military maps must be cantilevered out from control already established."

ANNOUNCING THE NEW

M - 10 REFLECTING STEREOSCOPE WITH BINOCULAR ATTACHMENT

Hinged Binocular Attachment has field of view over two inches in diameter with four-power magnification—Convergent Binocular axes prevent eyestrain—no ghost images—Variable Magnification Adjustment, workable while continuously viewing pictures and substantially without moving them, permits exact fusion of images differing in scale up to fifteen per cent.—Optional Supporting Means,—hinged legs or rear bracket support.

Full Details on Request

HARRISON C. RYKER, INC.

365 FIFTH STREET

OAKLAND, CALIFORNIA