field geologists acquire as a part of their normal experience. But an understanding of geology and its relation to terrain features can be acquired only through many years of training and experience. Research teams composed of geologists and scientists in related fields can do a better job working together than as individual workers, for the experience and ideas of each contribute to the success of the whole group. Consultation and exchange of ideas are valuable in this field in which so much depends on the recognition of complex and extremely varied relationships.

CONCLUSION

Photo-interpretation is a valuable technique in military geology, especially so, because, in military geology, it is often impossible or impracticable to visit the area under study. What can be accomplished by photo-interpretation is limited by the knowledge of the interpreter, however acquired, of the geology and geography of the area being studied. Photo-interpretation as a technique is deserving of attention during peacetime as a fruitful field for research. Nevertheless, our major effort should now be spent in acquiring and organizing for ready reference as a much fundamental scientific knowledge as possible of the world's geology and geography based on field investigations.

INTERPRETATION OF MILITARY INSTALLATIONS FROM AERIAL PHOTOGRAPHS

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IN ATTEMPTING to find an adequate approach to a discussion of interpretation of military installations from aerial photographs, it is necessary, in the writer's opinion, to consider the technique primarily as a military procedure rather than as an independent technical operation.

The first problem encountered in identifying military installations from aerial photographs, is what military situation exists. Before photography can be obtained for interpretation, it is necessary that the area to be photographed be determined, then the type and scale of photography must be determined. The photographic interpreter next considers the general military situation in the selected area from the point of view of the enemy. The general type of military installations that may be sited in the area are thus established. The military photo interpreter knows, before he looks at his photographs, that he is going to find, for example, coastal defenses ranging from underwater obstacles, beach obstacles, and infantry defenses to heavy coast-defense installations. Or perhaps it is a different military situation being covered, a situation requiring study of enemy supply installations, or the communication network supporting a tactical front, or the tactical front lines. It is thus seen that the interpretation of military installations consists of much more than just looking at photographs and recognizing thereon all military installations. Actually, this work must be a well organized part of intelligence directing well planned efforts toward many specific objectives.

Military photo interpretation in World War II had several degrees of value, varying in relation to the military situation. There were situations of a nature that severely limited useful applications of photo intelligence, and there were other military situations in which photo intelligence played a primary role in both strategic and tactical results. It is necessary that the influence of these several types of situations on photo intelligence be understood before a satisfactory comprehension of the whole problem can be obtained. Consequently,

they are reviewed here, and the way in which photo intelligence applies to each is discussed briefly.

The first military situation we shall assume to be that in which we found ourselves in the early period of World War II. At that time, we found it necessary to hunt out vulnerable locations in the boundaries of enemy-occupied territory. Economic and political strategic decisions were, of course, the first factors which served to delineate general locations for attack. After these first definitive decisions, photo intelligence gave the answer to the next important decision:—the location of weak points in the enemy's defenses. Photo intelligence provided this information as a result of having had repetitive photo coverage of the vital boundaries. Interpretation of this photography and careful recording of all defenses thus found gave detailed defense information on the desired location when needed. This phase of photo intelligence corresponded with strategic intelligence and consequently was known as strategic photo intelligence.

The next military situation we may assume to be that which existed when a successful penetration had been made of the enemy's boundary defenses: a beachhead or bridgehead had been established within which it was necessary to build up men and arms in numbers sufficient to enlarge the penetration. The enemy reacted by attempting to contain the beachhead. Photo intelligence again played its major role of disclosing location, type, and density of enemy defenses being prepared. Communications and supply systems were also disclosed and critical points selected as targets.

The next stage of military development was the breaking out of the beachhead and overrunning portions of enemy-occupied country. The major contribution of photo intelligence to this phase of military operations lay in the detailed terrain and road information which was made available for planning the breakthrough and its exploitation. Once the attack was started and a breakthrough occurred, photo intelligence, in the same way as other intelligence, lost much of its value and was not again of importance until the lines of fighting became stabilized.

An instance occurred in Italy in 1945, in which photo intelligence proved of major value, even during the rapid overrunning of the Po River Valley. In this case, the American Fifth Army had broken through the German defenses in the Northern Apennines and was racing north across the Po Valley toward the Alps. The Germans were hastily retreating toward a prepared defense line based on the Po River. Overprinted maps of the Po defenses, prepared from photo intelligence, were rushed out to the advancing troops, who in one known instance used the information to beat the retreating Germans to prepared defenses they were intending to occupy. When the Germans reached these defenses, from which they intended to make a stand, they found Americans occupying them.

From the above, it is apparent that photo intelligence consisted of an integrated program of study not only of front line defenses but of all areas in which defenses were being constructed, and in which operations might take place.

Each level of command, beginning with the top planning levels and extending down to and including the soldier with his rifle, has use for photographic interpretation of military installations. The photographic interpreter, therefore, finds it necessary to adjust his work to meet the needs of the several military units, and his method of work varies with each different type of military unit or level of command that he serves. It is therefore necessary to discuss work of military photo interpretation at the several levels of command, if we are to understand how effective results were obtained.

During World War II, it was common practice on the part of the enemy to

construct fortifications and defense lines well within areas under their control, sometimes as far behind the active front as three or four hundred miles. Individual positions within these interior defense lines were carefully hidden by camouflage or by covering them with earth, as fast as they were completed. Once these positions had been built and new vegetative cover had hidden the marks of spoil, it became impossible to identify their purpose by photographic interpretation; in fact, where particularly effective camouflage had been accomplished, positions could not be seen at all. It was necessary, therefore, that photography of interior defense lines be obtained several times during their construction, in order that photo interpreters could observe all defenses under construction, before completion and camouflaging obscured the presence and form of positions.

A classic example of this type of problem occurred with the construction in Italy of the "Adolf Hitler Line," some seven or eight miles behind the "Gustav Line." The "Gustav Line" was based on Cassino and the Rapido and Liri Rivers.

The story of the discovery of this new defense line began when a Fifth Army photo interpreter found a large camouflaged structure well within German-held territory. Careful study of shadow patterns indicated that this structure consisted of an elevated net of camouflage with no visible sides to the structure. This brought within the field of consideration the possibility that the purpose of the camouflage was not to hide an actual object but rather to hide an activity. In a short time, more of these camouflaged structures appeared, and each one was plotted on map work sheets on which all defenses were plotted as they were found.

These camouflaged structures, as they became more numerous, fell into the obvious pattern of a carefully planned line of defenses. However, photo interpreters had still not seen any specific defenses; in fact, they had seen nothing more than camouflage-covered frameworks. During this period of development, every available source of information in addition to aerial photographs was exploited in order to learn what was taking place under those camouflage nets. Bits and pieces of information began to accumulate giving support to the theory that a new defense line was under construction, and also providing information on what types of positions were being constructed. As the work was finished on the positions, the camouflage nets began to come down. Photo interpreters had been impatiently waiting for the opportunity to view photography of these positions after removal of the camouflage netting. What they found on their photographs when the camouflage was removed were very minute marks, most of which were ultimately identified after much painstaking study of repetitive photographic coverage. It was considered probable that, if the precise location of each of these positions had not been learned by the identified camouflage, the entire defense line would have escaped the attention of photo interpreters. However, by knowing exactly where to look for each position, it was possible for the interpreters to pick up the individual defenses for further analysis.

This story of the development of the "Adolf Hitler Line" emphasizes the value of the several levels of work of photo interpreters as used in the Mediterranean theatre. There were the strategic interpreters who followed defense construction far within enemy-held territory. The results of their work were turned over to Army level interpreters, who continued to follow defense construction work until Allied lines pushed on to within four or five thousand yards of the defense line. At that time, all information obtained theretofore was turned over to the photo interpreters at Division level, who had responsibility then for

keeping track of all additional developments until the area was finally taken over by our troops.

It would have been an impossible task for a divisional interpreter to have attempted the location and identification of fortifications in a prepared defense line where, in many instances, the positions had been prepared one to three years before. It thus becomes clear that the military photo interpreter isolated with aerial photos could produce a relatively small amount of information compared with the amount produced by a complete intelligence organization using photographic intelligence as a basic method of obtaining and checking information.

A brief summarization of types and scales of photography used for military photo interpretation is necessary before proceeding to a discussion of technique of interpreting. Scale of photography for military interpretation is a subject that has created many divergent views, and the type of photography—oblique versus near-vertical—also has created two schools of thought.

Considerable research has been done in efforts to determine the optimum photographic scale for various military installations. In the writer's opinion, it is not yet proven that any one scale of photography is the best scale for military interpretation; however, optimum scale ranges have become more or less accepted. Within these ranges, it is usually possible to identify most military installations that are not obscured by cover or effective camouflage.

For near-vertical reconnaissance photography, a scale range of 1/9,000 to 1/12,000 has proven practical. Scales larger than 1/9,000 have, in past experience, been unsatisfactory for three reasons. Too small an area is covered per photograph. An increased number of runs over the target would overcome this problem; however, in wartime it is essential to lower rather than to increase the time of aircraft over the target in order to keep aircraft losses within reasonable limits. Large scale photography in the past war also usually resulted in blurred prints due to aircraft speed, and in insufficient overlap of photographs, preventing stereoscopic study. These last two factors were largely mechanical problems that have recently been solved; however, the first problem—that of reduced area covered per photograph—is still unsolved. Experience in the Mediterranean theatre during World War II, with camera equipment available at that time, indicated that the value of the few additional defenses, identifiable through large scale photography, was not worth sacrificing the gain in numbers of defenses identified by photographing a larger area from which a more complete analysis of total defenses could be made. Thus, we find in this question of what is the best scale, a point of demarcation from which one inclines either toward more accurate photo interpretation through obtaining larger scale photography, or else toward more complete intelligence of the enemy possibly at the expense of accurate photo interpretation of specific items.

Obviously there can be no right or wrong answer to the question of which of the above choices is the better one. For the man whose ultimate objective was photographic interpretation, the larger scale photos were the answer; however, the military photographic interpreter in World War II could not be left with that objective. His primary mission was the production of intelligence. Aerial photos were his source of information, and he was forced to sacrifice detailed precision identification to quantity of data wherever this could be done without causing loss of validity.

It was also found that medium scale photography (1/9,000–1/12,000) did not necessarily preclude complete detailed identification of military installations. Variable factors of light, negative and print quality, type of terrain, natural

cover, and types of installations all had their individual influence on the proportion of the total installations that could be identified and on how completely each could be identified and described. Where all of these factors combined favorably, as they did in a few instances, little additional information of value could have been obtained from photographs of larger scale.

Oblique photography versus near-vertical photography was another question that aroused much discussion in World War II. Each type had then, and has now, its devotees. Here again the writer chose the middle road. Oblique photography was found to be the only completely satisfactory means of obtaining detailed examination of many beach defenses, while near-vertical photography was used for most other purposes.

Experiments were conducted with oblique photography during the Italian campaign; however, the results for interpretation of military installations were disappointing. It was found that the aircraft were forced by enemy action to fly "on the deck," resulting in such a limited area being photographed that very few installations were covered. Losses of aircraft were very high on this type of mission, and the small value of the results caused early cessation of further efforts. After these initial efforts to use oblique photography in the Italian theatre, no further oblique photography was permitted for military interpretation, except in a very few instances where there was vital need for detailed information on limited areas.

In light of these experiences, which resulted in practically exclusive use of near-vertical photography for identification of military installations in the Mediterranean theatre, all further references to photography concern near-vertical photography of scales ranging from 1/9,000 to 1/12,000 unless otherwise specified.

Let us consider now the photo interpretation done at the lowest echelon. This echelon was, normally, a task force of regimental size, or a division. Photographic interpretation at this level was intended to provide information of the enemy and of enemy held territory that was primarily of interest and value to the task force or division. This information consisted of the identification and location of enemy infantry positions, machine gun positions, mortar positions, antitank guns, barbed wire, mines, obstacles, roads and trails, terrain features and characteristics, and cover. It is worth noting, at this point, that it was necessary to so describe the location of these enemy installations that proper weapons could be brought to bear upon them; otherwise the information served no purpose. Insofar as minor positions, such as foxholes and machine gun positions, were concerned, the usual weapon brought to bear upon these was the M-1 rifle in the hands of an infantryman. From the viewpoint of the infantryman, that phase of photographic interpretation which brought him detailed identifying information concerning the location of the enemy foxholes was of the utmost importance, and all of the very finest photographic interpretation was worthless to him unless, through the information it gave him, he was able to destroy the enemy before being destroyed. This viewpoint will reappear later in this paper with a further discussion of techniques used to meet the problems involved. Meanwhile let us explore the methods of working used by the photo intelligence officer assigned to a task force or division.

The first step in the photo interpreter's work was a general study of aerial photos of the front line area. From this study the interpreter learned the general terrain and cover characteristics of the area. This is normal military information, and mentioning it as an objective of study occasions no surprise. From here on, however, the study became more intensified and went far afield from usually

accepted military information. The photo interpreter hunted out, on his aerial photographs and by background reading, all possible details on rural patterns and practices, and catalogued in his mind all those conditions of local customs which were normal. For example, in the Northern Apennines in Italy the farm people stacked their grain carefully and without waste. When a photo interpreter located a stack of grain with surrounding waste, that stack was immediately considered as an object of suspicion; and experience justified this practice as the waste very often was the sign of disturbance to the grain stack caused by an enemy position being hidden there.

Now let us stop for a moment and investigate the plausibility of the inference in the previous statements—that is, that a photo interpreter can identify loose scattered grain on an aerial photograph taken from a height of about 20,000 feet. Rather than make a definite "yes" or "no" answer, it is preferable to describe the basis used for determining whether a grain stack has been disturbed. In brief, it was primarily a determination based upon definition in the photographic image, and secondarily a determination based upon tone in the photograph. The usual Italian grain stack was a very tidy affair. In a good quality photographic print, these stacks of grain appeared as sharply defined objects usually against earth backgrounds. A very small amount of straw or loose grain scattered around the base of the stack destroyed the sharp definition normal to an undisturbed stack. So, although obviously it was not possible for the photographic interpreter to state positively that he identified loose grain at the foot of the stack, the condition which he did see was the normal photographic reproduction of a stack with loose grain scattered about its base. Hence, it may be considered that the interpreter had identified loose grain. This technique failed to satisfy completely the self-imposed standard of photo interpreters that only what was actually seen on photographs was reported; however, results justified the practice.

Another difficulty meriting discussion is inherent in the above case, and that is how far does the photo interpreter go in drawing conclusions concerning the cause of disturbance in the grain stack. In solving this problem, the photo interpreter found it necessary to consider the location of the stack in relation to other known military items nearby in order to decide first what object if any would most likely be hidden in the stack. If the conclusion was that a weapon was probably hidden there, then the photo interpreter considered what the weapon was apt to be, considering in this phase, the enemy order of battle, organization, distribution of weapons, and the size and siting of the suspect position. By this process, which normally was a process of elimination, the suspect position frequently could be specified as to probable use. The photo interpreter did not forget, however, that he was limited to reporting only that which he definitely saw on his photographs; therefore, in the case of the disturbed grain stack, where he had identified only that a grain stack existed and that it had probably been disturbed, his decision as to how to report the item was tempered by experience and by his knowledge of the enemy's tactical situation and habits. A common method used in similar cases was to report such an item as "suspected enemy-occupied grain stack," or if there was sufficient additional evidence, "suspected machine gun in grain stack." The photo interpreter in cases of this type was continually faced with the difficult decision of whether to disregard such an item because he could not definitely identify it as a military objective, or to report it regardless. If he failed to report it, and later it turned out to be an enemy machine gun that caused havoc among friendly troops, the effect on the interpreter was serious. On the other hand, if he reported too many items

which failed to materialize as actual enemy positions, he lost value to his unit in that his information was rated as having poor reliability.

There seems to be no method or technique available to alleviate difficulties of this kind. Experience indicates it to be a matter of accurate primary interpretation, good analysis of probabilities, and enough understanding of the enemy's practices to end up with a high average of correct information.

To return to the principal theme, the photo interpreter gained all possible knowledge of the rural patterns of his front line area. The architecture of buildings was important, in order that variations from normal could be easily spotted and given intensive study. Routes and normal modes of travel of local inhabitants were studied in order to have available a background upon which abnormal activities showed up immediately.

With an adequate background of local practices, such items as paths across fields were easily assigned appropriate significance. Critical road widths that could not be measured with sufficient accuracy by photo interpreters in the field could frequently be accurately determined by knowledge of the normal local practices.

Now let us assume that the photographic interpreter had obtained the necessary basic knowledge of his assigned area. His next step was viewing aerial photos of the actual front line area and identifying the thousands of small excavations which covered portions of his photographs. The smallest of these enemy positions, the foxhole for an individual soldier, measured about *.2MM* long in a photo of 1 to 10,000 scale. A foxhole, usually termed a weapon pit, was identified by considering first the location, then shape and size. The conventional foxhole was rectangular in shape. With the shape of the position accurately determined by visual stereoscopic analysis of the aerial photograph, measurements and siting would establish its identity.

One of the more easily identified positions of World War II was the German mortar position. This position, on a photo of 1/10,000 scale, measured about *.5MM*$\times$*.1MM*. The technique used in identifying these items was primarily one of actually seeing what was on the photograph and relating the visual pattern seen to a known form. It was essential to isolate from disruptive influence of shadows and spoil, the actual outline of the excavation. This involved painstaking visual analysis of the object with stereoscopic aid. Once the excavation outline was determined accurately, the standard type German mortar position was easily identified by its characteristic shape. Measurement of the central hole in the position gave an answer to the question of weapon size, that is, whether the position was for a light or heavy mortar. Site of the position, in relation to the front, other terrain features, buildings, and trees, were important factors contributing to identification of the position. For example, the high trajectory of a mortar permitted emplacement close behind embankments, buildings, and trees, whereas flat trajectory weapons, such as machine guns and antitank guns, required unobstructed fields of fire.

No attempt was made to specify whether or not positions for light weapons were occupied, primarily because the weapons were rarely visible in the photography. Further, light weapons such as machine guns and mortars were portable and were moved frequently to alternate positions. These factors led to reporting all minor defense positions without reference to occupancy, as "machine gun position" or "light mortar position."

Antitank gun positions, when occupied, were usually camouflaged by netting. Since the camouflage nets prevented visual identification of the position as to purpose, ground information, i.e., information from prisoners, was required to

supplement the work of the photo interpreter. The way in which this worked in actual operations is explained by the following example. A photo interpreter found two small areas covered by camouflage. Nothing other than the two areas of camouflage netting was visible on the photographs. These two items were plotted on a map as "camouflaged objects," and reported through normal channels. Within a few days, a German prisoner of war reported the existence of two antitank guns 100 meters apart under camouflage netting, and gave their general location. The reported information coincided with the location of the two camouflaged objects both as to location and as to distance between the objects. As the sites of the two objects did not preclude use of antitank guns, the weight of evidence enabled the photo interpreter to identify definitely the two objects.

The technique used in identifying the two areas as being under camouflage net was the simple visual recognition of two small rectangular areas having a tone and texture different in appearance from the balance of the immediate area, plus comparison of the area with photographs taken at an earlier date. The comparison showed the terrain and cover that had existed prior to the installation of the camouflage netting.

In those instances where anti-tank gun positions had not been camouflaged, the identification technique was similar to that used in identifying the mortar position. The first step was to determine by visual analysis the actual shape of the excavation. The next step was to obtain the inside dimensions of the position. The third step consisted of tentative identification of the position through matching its shape and dimensions with known examples of enemy positions. Final identification was made by bringing into consideration the siting of the position. If the siting was satisfactory for the weapon, as tentatively identified, then the position was considered as being definitely identified.

Minefields were frequently identified on aerial photographs by identification of the pattern of spoil marks made where mines had been buried. Positive identification of a minefield could frequently be made, and in addition the location of each mine could be established, as well as distance between mines and between rows of mines.

Identification procedure consisted of the same steps used for other identifications. The first step was visual identification of a pattern of small, round, faint discolorations on the photographs. The next step was measurement of distance between rows and between individual spots of discoloration. Minimum distance between mines was rigidly controlled by space required to prevent sympathetic detonation, and effective patterns for minefields were few in type. In addition there was no known condition which would create photographic effects similar to those created by a minefield. The nearest thing in appearance to a minefield was a belt of barbed wire where spoil spots were created for each post. Invariably measurement of distance between spots in a wired area gave distances within the minimum distance required between mines. Consequently, if the pattern of discolorations conformed to standard minefield patterns, if the distance between spots was not less than the minimum required to prevent sympathetic detonation, and if the siting was logical for a minefield, then positive identification was made.

Recognition of barbed wire was usually accomplished through accumulation of bits of photographic evidence. It was rarely that the wire could be seen, although occasionally it would be visible when the wire was in belt form over a good background, with sunlight falling on the wire. Usually the most dependable identifying characteristic was created by uncontrolled growth of vegetation beneath the wire; however, when wire was laid in areas of uncultivated ground

such as a marsh area, this factor was of no value. In cultivated areas, the uncontrolled growth of vegetation beneath the wire showed the distinctive pattern of military barbed wire entanglements. Oblique photography taken from low levels provided prints that enabled most complete identification of barbed wire installations; however, in many operational areas, low level reconnaissance was prohibited by enemy defensive tactics.

It was shown earlier that the photo interpreter at division level started his interpretation of defense lines with a considerable fund of data which identified and located defenses prepared in the area long before his division came near. Thus it would seem that the divisional interpreter had a relatively easy task in being required to identify and report only those additional defenses prepared after his division reached the immediate area of the defense line; but this did not prove true.

The infantry division, or the armored division, represented the action agencies, the units that carried out the plans made by higher echelons. These were the units that had responsibility for destroying the enemy and his fortifications on which so much information had been collected by higher echelons. Where photo intelligence showed hundreds of individual defenses along a division front, the division found it necessary to treat each defense installation as a separate problem to be attacked and destroyed. The mere fact that a machine gun position, mortar position, or weapon pit existed at a certain point was no longer adequate information. It was necessary to know how this position could be reached on foot or in a tank without being seen by the enemy or exposed to his defensive fire power. Consequently, the last stage in the use of photo interpretation was one of the most vital of all of its activities. It was at this level that the results of photo intelligence, if properly used, resulted in important reduction in casualty rates among our troops, caused high rates of loss and destruction to the enemy, and enabled speedier, more effective advances against the enemy.

Let us explore now the problems involved in obtaining effective use of the detailed defense information which had accumulated in the hands of the photographic interpreter. Obviously the photo interpreter did not man the weapons that were used to break down those defenses. It was his responsibility then to insure that those who did man the weapons had as much information about those enemy defenses as the photo interpreter had obtained from his study of photographs of the defenses.

First, let us consider the extent of information available to the photo interpreter. Taking as an example an identified machine gun position, the photo interpreter, with his birdseye view, saw the machine gun position in relation to all other identifiable surrounding features such as trees, shrubs, paths, hills, etc. The interpreter had sufficient information to enable him to determine precisely where that machine gun position was, even though it could not be seen as he approached it on ground level.

Now let us consider the extent of information available to the infantryman who was assigned the mission of attacking the machine gun position. At best he had a 1/25,000 scale map with the approximate position of the machine gun marked on it. Trees which existed did not appear on his map, nor did bushes, fence lines, or paths. Hills and contours were only approximations on his map. The result was that the infantryman had only a general idea of where he was located and where the machine gun was located, but he was lost if he failed to find the well hidden machine gun position before its occupants spotted him.

The inherent difficulty in this problem was not necessarily a function of cartographic accuracy. It was more truly a problem of translating knowledge available to the interpreter into a form that gave the same complete information to the actual user of the information—in this example, the infantryman.

Various methods were used in efforts to overcome this difficulty of translating photographic information into a medium that would provide complete usefulness to the military user. The most practical answer applied in the Mediterranean theatre was the use of uncontrolled mosaics, in conjunction with maps. These mosaics, issued down to platoon leaders, were used to record defenses found by photo interpretation, and employed in this manner, went far toward solving the problem of translation. However, there was still much to be desired, and it is hoped that the photographic and photogrammetric sciences will find more satisfactory answers before wartime needs develop again.

The photo interpreter whose job it is to supply an armored force with photographic intelligence, has problems differing considerably from those of the infantry division interpreter. The armored force needs, first of all, information concerning routes and terrain.

Route and terrain information for the armored force means just where tanks can travel and where they cannot go, what obstacles exist such as ditches, walls, brush, trees, and hills too steep to pass over either up or down, as well as the ability of the terrain surface to support tank traffic. In addition to these factors having to do with the movement of armor over the surface of the ground, maneuver room for the armor, and enemy tactics for defense against armor must be considered.

Enemy infantry defenses do not play as important a part in the work of armored force interpreters as terrain work. However it is still required that this defense information be interpreted and made available to infantry units operating with the armor.

It is clear from the above, that the armored force photo interpreter needs a varied background of knowledge and a facility for relating what he sees on the stereo-photos to his knowledge of terrain and armored force tactics.

The armored force photo interpreter needs to have a comprehension of soil types and their weight bearing capacities. He needs to understand tactics of his own and the enemy armored forces. He must know enemy anti-tank tactics and weapons. He must know tank and armored vehicle capabilities and limitations. And added to this broad background, there is required the ability to translate what he sees on aerial photos into trafficability, and tactical information for use by his unit.

Several photogrammetrical problems continually plague the armored force interpreter, and are, frequently, of very serious import in tactical planning. Basically, these problems relate to accurate measurements of small linear distance and accurate measurement of small differences in elevation.

Examples of tactical problems of these types are given to clarify their importance.

In many places in Europe and Africa, narrow roads of ancient origin are still in use. Through the years of use, these roads have sunk deeper and deeper below the level of the surrounding terrain. These sunken roads may often be as much as 8′ to 10′ deep, and having been made by carts, range in width from 7′ to 9′ at the bottom. Many of our armored vehicles in World War II were about $7\frac{1}{2}$′ wide. These vehicles would get stuck in sunken roads less than about 8′ wide at the bottom. Armored force interpreters were frequently called upon to state

whether or not these narrow sunken roads were passable for tanks. It was obviously impossible with field equipment to make these refined measurements within accuracy limits required.

Similarly, there were occasions when stream widths were required to be established within a few inches of accuracy in connection with the laying of special types of bridging. Here again, the armored force interpreter was unable to provide adequate answers.

Small elevations, such as terrace walls, were of vital concern too. Tanks can climb a vertical step of a height equal to the height above ground of the center of the tank's front axle. This height is normally measured in inches; consequently, the techniques available to the interpreter in the field for height determinations, were not adequate.

These are problems which should be of great interest to photogrammetrists, and the solution of them would be of great value to military photographic intelligence.

Photo Intelligence had an additional specialized field of activity in counter-battery work. This work consisted of locating and plotting enemy artillery batteries. Here, again, all sources of intelligence, including aerial photographs, were funnelled through the counter-battery photo intelligence officers. By these methods all enemy artillery locations were established and changes noted.

Photo interpretation for each level of command, and for each type of operation used the same basic technique for identifying the content of aerial photographs. However there were major differences in what was being searched for, and consequently, differences in the knowledge requirements for photo interpreters.

There has been much confused thinking concerning the "Photographic Interpreter," particularly as to what makes him a photographic interpreter.

The content of this paper indicates quite strongly that a military photographic interpreter is actually an intelligence analyst with an additional skill for interpreting aerial photography. It has been made apparent that skill in reading aerial photos does not stand alone, but is, in fact, a facility for recognizing on aerial photographs, those items which fall within the specialized field of the intelligence analyst. It follows, then, that the first requirement leading to identification of military installations on aerial photographs is a thorough knowledge of all types and forms of military installations which may be encountered. Upon this foundation there is added the knowledge of what these installations look like on aerial photographs, and knowledge of photogrammetric measuring techniques which can be applied as needed to further refine accuracy of identifications.