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NOTES ON THE INTERPRETATION OF AEROPLANE PHOTOGRAPHS.

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The following notes, which have been prepared by the General Staff, are issued in order to facilitate the accurate location of important military features by means of aeroplane photographs; they amplify and supersede the notes contained in S.S. 445 (issued in November, 1916). The photographs have been selected by the Armies concerned, and represent the different natures of ground on the whole front between the Sea and the Oise.

These notes should be studied in conjunction with S.S. 537, "Summary of recent information regarding the German Army and its methods," Chapters I., II. and VI.

GENERAL STAFF (INTELLIGENCE),
GENERAL HEADQUARTERS,
March, 1917.

NOTES ON THE INTERPRETATION OF AEROPLANE PHOTOGRAPHS.

I.—GENERAL.

1. The examination of photographs.—Before commencing the examination of photographs, every opportunity should be taken of studying on the ground objects similar to those which may require to be identified on a photograph. Thus, captured hostile trenches and positions should be visited until the different types of German works become thoroughly familiar.

The configuration and nature of the ground should be studied in order that a correct impression may be gained of the siting of the features on a photograph.

Every opportunity should also be taken of studying the ground from the *air*.

During the actual examination of a photograph, the following points should be remembered; they are placed in order of importance:—

(*a*) Study the best available map with great care, so that the configuration of the ground and the salient details are thoroughly familiar. During the whole examination of the photograph, keep the map with you for constant comparison with the photograph.

(*b*) Ascertain the direction of light.

(*c*) Concentrate your whole mind on the particular objects which you are seeking. Do not let your attention wander to subsidiary objectives. Follow every traverse and detail with a pointer in regular and logical order, but be careful not to mark the photograph.

(*d*) Examine the photograph as an item of independent evidence and then compare this evidence with reports of visual observation, locations given in Intelligence Summaries, and evidence of reliable prisoners. Eliminate those portions of this evidence which are obviously wrong; consider the likely places for the objects referred to in the remainder, and verify them. Avoid "special pleadings" and do not allow yourself to read in a photograph what you *want* to see.

(*e*) Compare the photograph with earlier photographs of the same locality; it is from such comparisons that valuable results are obtained. This applies in particular to the appearance of objects on a photograph as affected by the changes of season.

(*f*) Be particularly careful to avoid obliterating detail when annotating or marking photographs.

2. Shadow.—Shadow plays a most important part in the interpretation of photographs. It is essential to ascertain the direction of light in order to decide whether the point under osbervation is convex or concave, and in order to get an idea of the depth or height of cuttings and embankments by comparison with the length of shadow cast by other objects.

3. Alterations in detail.—New photographs are useful in discovering alteration in old detail, as for instance the comparison between an old cadastral plan and a recent photograph, showing how a road has been altered in the course of time.

4. Necessity for verifying doubtful points.—A great deal of the patience and care taken in the study of aeroplane photographs is wasted unless verification of doubtful points is obtained from the inspection of captured trenches. It is not enough for a few people to view these points. A more practical and quite a simple way is to make a model of them before the machine guns or trench mortars have been removed and the emplacements dismantled.

II.—MACHINE GUNS.

1. Machine gun emplacements.—Emplacements for machine guns are either open or covered. Both types are difficult to locate with certainty. In examining photographs, special attention should be paid to any traverse, the size, shape or angle of which departs from the normal. Oblique photographs are a valuable aid in discovering machine gun emplacements.

2. The open emplacement takes the form of a square clay or concrete platform let into the parapet. It varies in appearance according to the altitude of the sun, and may show up either as a white mark with a dark edge or as a comparatively dark square. The latter is hard to distinguish from the many dark nicks in the parapet, which may be sentry posts or firing recesses.

3. The covered emplacement, which is concreted or otherwise strengthened, should be the object of particular attention, as it requires special treatment at the hands of our artillery and trench mortars, when once located. Though the use of covered emplacements is tending to diminish, a certain number may be expected in each sector. Their sites are selected with a view to:—

(*a*) A good field of fire (preferably enfilade).

(*b*) Concealment from direct observation from the immediate front.

(*c*) Rapid removal of the machine gun.

For the above reasons, they may be looked for:—

(i.) Where an angle occurs in the trench system within convenient reach of a communication trench, with dug-outs for the gun crew close at hand.

(ii.) Close to the base of a well-protected sap, from the head of which a sentry can give warning and prevent the gun from being rushed.

(iii.) Occasionally behind the parados.

A covered emplacement may be discovered by a "V" shaped mark in the forward edge of the parapet, where the latter has been cut away to allow the gun to traverse. At the back of this "V," or close beside it in the trench if the emplacement is entered from the side, may be found a dark nick similar to a dug-out entrance. Sometimes a very short trench is cut out to it.

At times the position of a covered emplacement is revealed by a square mark on the forward slope of the parapet; this occurs when the sun is shining at a slight angle behind the opening, but not at a sufficient angle to show up the "V."

III.—TRENCH MORTARS.

1. Types.—The Germans use various types of trench mortar, of which the regulation rifled patterns are the light, medium and heavy.

2. Siting.—The following are likely sites for trench mortar emplacements:—

(*a*) In the shallow disused trenches which often exist behind the German fire trenches, a portion of which is deepened to take the mortar.

(*b*) Immediately in front of the parapet of a fire trench.

(*c*) By the side of a communication trench.

(*d*) Along or near the terminus of a trench tramway (especially in the case of heavy trench mortars).

Many trench mortar emplacements can be found by following a line drawn parallel to our own front line at a distance of about 500 yards. Others must be searched for anywhere up to about 700 yards from our front line.

3. Light trench mortar emplacements.—Light trench mortars are often fired from open emplacements to allow a rapid change of position, and it is difficult to distinguish their emplacements from latrines or store pits. One difference, which is by no means universal, is that trenches leading to trench mortar emplacements are more often zig-zagged or traversed than in the case of trenches leading to latrines. It is only by close co-operation with ground observers that these emplacements can be definitely located.

4. Medium and heavy trench mortar emplacements are casemated and much more conspicuous. They can generally be recognized by an almost square, darkish mark in the centre of a mound or ring of earth. This square mark is the top of the funnel up which the mortar fires, and differs in appearance according to the angle of light; it may be black, diagonally black and grey, or grey with a short, oblong, dark slit.

IV.—BATTERIES.

1. The location of batteries as affected by topographical conditions.—Types of battery emplacements, and the degree of difficulty in locating them accurately, differ according to the topographical features on the various sectors of the front. The area opposite the British may be divided as follows:—

(*a*) The thickly populated mining area.

(*b*) Close country with scattered houses, frequent woods, hedges and orchards.

(*c*) Closely wooded country.

(*d*) Country intersected by ravines and sunken roads.

(*e*) Open country.

(*a*) *In the mining area*, the ground is usually broken, and numerous dumps and quarries afford cover. The house problem is a difficult one. Sections of a battery or single guns may be detached and placed irregularly. In "Cités," the houses are of stereotyped pattern, and may all have been knocked about. *Débris* litters the ground and helps to conceal tracks or traces of frequent use. Guns are placed in casemates in a house, a portion of which is pulled down over them to give extra cover; this has the effect of giving the house an appearance similar to that of any other ruined building in the vicinity.

(*b*) *In close and flat country*, in addition to houses, there are many hedges and orchards which afford good battery positions. Fields are bounded by ditches, which are not always shown on the map, thus rendering location difficult.

(*c*) *In wooded country*, especially if the woods are of any extent, batteries are difficult to locate with accuracy owing to the fact that, just when conditions are most favourable for air photography (*i.e.*, in spring and summer), the leaves and natural cover are thickest. Camouflage with fresh branches and undergrowth is a simple matter, and tracks which can be seen entering a wood are soon lost inside it.

(*d*) *In country intersected by ravines and sunken roads*, batteries can be dug into the sides of a ravine or road and well hidden. The roads are all more or less used, because they afford natural cover, and signs of extra use at any point are not too apparent.

(*e*) *In open country*, where there are few villages and woods, batteries are almost invariably dug in and provided with heavy cover. For this reason they are more obvious, except where special care is taken to incorporate them into existing trenches.

2. Types of emplacement.—Apart from batteries in houses, emplacements are best considered in two categories—normal and abnormal.

Normal emplacements are almost invariably casemated and provided with heavy cover. They may be classified roughly as :—

(*a*) Trench emplacements, *i.e.*, with the gun pits built into existing trenches or into specially constructed trenches.

(*b*) Emplacements entirely dug in in the open and concealed by various artificial devices.

(*c*) Emplacements dug into road banks, ravines or hedges.

(*d*) Emplacements in woods.

Abnormal emplacements are few in number and are better illustrated than described.

3. Construction.—The principal object is to provide cover for men as well as guns, and it may be taken for granted that, unless the battery is in or on the edge of a village, where the personnel can be billeted in an adjacent house or cellar, each battery will have dug-outs and ammunition stores close to or adjoining the pits. These dug-outs may be at either end of the position, in between the pits or close at hand. In nearly every case they will be as heavily protected as the pits themselves.

An increasingly common feature with batteries in exposed positions is a covered trench leading from an adjacent road or trench, enabling personnel and ammunition to enter the battery without leaving tracks above ground.

It is important to note the grouping of pits, which are not always equally spaced.

When batteries are forced to retire, the Germans have almost invariably constructed emplacements of the normal type in the new position. It has been exceptional to find guns firing in the open.

4. Concealment.—It is evident that increasing care is taken to conceal emplacements and to defeat the camera. As, however, the Germans usually start to construct camouflage after a battery emplacement has been completed, their attempts are rendered abortive, owing to the fact that the emplacement will probably have been photographed several times during the various stages of construction.

Blast marks made by the guns help to defeat camouflage. Under ordinary conditions, they show up as white scores where the surface has been blown away by the discharge, or, in snow photographs, as black smudges. In dry weather, blast marks may be visible for some time after the position has been vacated, and are therefore not a proof that an emplacement is occupied. In themselves they only prove that a position *has been* active, not that it *is* active—a distinction which is liable to be forgotten.

Photographs have, however, proved that an emplacement is active :—

(*a*) By an immediate snow photograph.

(*b*) By a photograph of the guns actually firing.

V.—RAILWAYS AND TRENCH TRAMWAYS.

Much information of tactical and strategical importance can be gained from a close study of railways and trench tramways.

1. Employment.—Besides the normal gauge lines, which were mostly built before the war, the Germans have made an extensive use of the light railway system in the occupied portions of France and Belgium, and have extended this system near the front by new construction on a large scale. Personnel, stores and material are brought up by branch lines, which run to nearly all important points and villages in the front line system, and battery groups and single heavy batteries are almost entirely supplied by this method. Supply dumps will almost necessarily occur at the breaks of gauge, as well as at various points along the tracks.

2. New construction.—The light railway systems may be divided into three groups :—

(i.) 1·00 m. and 0·80 m. gauge, of which the former is the more common.

(ii.) 0·60 m. gauge.

(iii.) 0·40 m. gauge.

In the first of these groups, new work has consisted in extending the existing lines in operation before the war. The second and third groups have come into existence since the commencement of trench warfare, and are found only in the forward areas.

As far as possible, 0·60 m. gauge has been used in all new work, as this standard lends itself for several reasons to the requirements of field warfare.

Metre gauge has, as a general rule, been used in new construction only where lines of that gauge already existed, and where the use of a different standard would cause needless transhipment. The use of 0·40 m. gauge is restricted to the more forward trench tramways where mechanical traction is rarely used

The German forward railway systems are constantly being altered, especially during active operations. Light lines spring into being to serve a definite purpose, such as the construction of a new line of defence or the regrouping of artillery, and are taken up as soon as they are no longer required. The mark of the track remains for some time after the rails and sleepers have been removed, and photographs of such areas should be carefully examined for signs of deterioration or disuse.

3. Characteristic appearance on a photograph.—*Light railways* (1·00, 0·80 and 0·60 m. gauge) can be distinguished on a photograph by:—

(*a*) The straightness with which they run.

(*b*) The absence of any series of sharp curves.

(*c*) Embankments and cuttings at points in their construction.

(*d*) Bridges by which they cross streams or trenches.

They will also follow contours and defiladed ground.

Trench tramways (0·40 m. gauge) may be recognized by:—

(*a*) The narrowness of the track, which shows as a fine line on the photograph, probably owing to the natural inclination of men to walk between the rails.

(*b*) Their sharper curves where they continue into the trench system.

(*c*) The absence of traverses in the trench in which they are laid.

Railways have a tendency to appear darker on a photograph than used roads or tracks.

VI.—TRACKS.

Tracks form a valuable guide to the enemy's movements, but are sometimes neglected because they are obvious.

The clues which they afford deserve enumeration:—

(1) They disclose routes from railhead to billets and from billets to trenches. Even after the trenches are reached, the main communication trenches may be distinguished by tracks running alongside, made by carrying parties at night, or by working parties employed in the upkeep of important trenches.

(2) They throw light on the limits of sectors, the study of which is important.

(3) They disclose dumps; battery positions; headquarters; wire which is otherwise invisible, and gaps through it; patrol paths; observation posts; in villages, those houses which are important centres; advanced listening posts; fortified shell holes; in suitable weather when tracks show up immediately, the activity of working parties.

As in the case of railways, the traces of tracks remain for a long time, and photographs should be examined for signs of disuse, such as new and continuous wire, or broad and unbridged trenches passing across them.

The value of a combined study of tracks and railways in giving assistance to machine guns and artillery for indirect fire, especially at night, is obvious. When made special targets during more important operations, the resulting confusion and disorganization of the enemy's system has proved very serious to him.

VII.—BURIED CABLES AND AIR LINES.

1. The study of cable trenches and air lines.—It is important that buried cables and air lines should be marked down when fresh, as they tend to disappear quickly, and in course of time become more and more invisible. They should be studied in conjunction with railways and tracks, as they all come under the heading of communications.

2. Cable trenches are a valuable aid in discovering the positions of headquarters, telephone dug-outs, camouflaged batteries, observation posts and important centres. Where the buried cables end, the air line system can be picked up.

Cable trenches can be distinguished, when open, by their more or less straight course and narrow construction, and when filled in by their irregular definition and somewhat "woolly" appearance. Where they cross over other trenches, a gap appears, as the lines are passed under the trench flooring.

3. Air lines appear as a series of regular white dots, these being the displaced earth where the poles have been erected. These dots are connected by a thin white track, which is made by the men walking from pole to pole putting up the wire or patrolling the line.

Air lines will sometimes come to life again on a photograph if the ground has been cultivated or ploughed, and they then show up as a succession of small dark islands, where the soil round the posts has not been disturbed. In clear photographs the shadows thrown by the poles can be seen.

VIII.—DUG-OUTS AND MINE SHAFTS.

1. Dug-outs can be detected in several ways, especially in a photograph taken while they are under construction. It is then possible to see the entrances to the shafts. These appear as black nicks, usually in the corners on either side of a traverse, where the maximum amount of protection from shell fire is afforded.

When dug-outs are made, a large amount of earth is thrown out which varies with their depth. This earth is apparent on older photographs.

Increasing care, however, is now being taken to conceal defences, and the earth thrown out is frequently well scattered and quickly becomes difficult to trace.

If the photograph is sufficiently clear and the light falls favourably, it will still be possible to see the black nicks which represent the entrances. These are still clearer if the point where the fire step has been cut through can be seen.

In snow photographs, dug-outs under construction are very obvious.

2. Mine Shafts show a similar black nick in the traverse, but their location is more difficult. The entrances are sometimes protected by splinter-proof cover built across the trench.

An indication of their presence is the large amount of spoil brought up from the galleries and spread about in the vicinity.

IX.—TRENCH CONSTRUCTION AND GENERAL DEFENSIVE SYSTEM.

Trench construction may be considered under the following headings:—

(1) Stationary or trench warfare, with steady and methodical additions and improvements to defences.

(2) Special trench construction indicating that an attack is anticipated.

(3) Special trench construction indicating that an attack is intended.

(4) Construction of defences during a battle.

In case (1), photographs can be studied at length and more or less at leisure.

In cases (2) and (3), there will be at least a few days for study.

In case (4), only a rapid investigation of photographs is possible, requiring a quick decision regarding, and immediate dissemination of points of interest.

1. Stationary or trench warfare.—(*a*) *General organization of a German Position.* At least two, but more often three, successive positions or systems of defence are prepared, each position consisting of two or more continuous lines. These lines include strong points such as villages, farms or woods which may happen to be situated in the forward area. In fact, the normal procedure, when taking up a new position, is to fix on a general line of natural strong points, and to prepare these for defence first, and then to join them up by fire trenches. The first indication that a new line is being constructed is usually the appearance of trenches covering villages and woods.

Support and reserve lines usually include a number of closed works, heavily wired, full of dug-outs, and with a liberal supply of communication trenches to facilitate the speedy passage of the garrison to any threatened point.

(*b*) *The determination of sector boundaries.* The division of a defensive system into sectors and sub-sectors affords a study of considerable importance. At intervals in the front-line trench, short sections may be found where the amount of earth thrown up is noticeably small. These may indicate the permanent limits of a company sector. There is a natural tendency for a company to commence work about the centre of its sector, leaving the flanks until the last, in case any subsequent alteration in the sector limits should result in another company enjoying the benefit of its labours.

Each sector is fed by several communication trenches, decreasing in number in proportion as the distance from the first line increases. Between the first trench and the second and third trenches of the front-line position, there are many communication trenches. Between the front-line position and the second-line position there may be more, but scarcely ever less than two main feeders—an IN track and an OUT track. There are generally two from the second-line position to the third-line position or to rest billets.

From a study of the map and photographs, determine the two main communication trenches. Compare the latter with the tracks that converge on or run beside them, and note where these tracks branch off to the front-line trench. An examination of the points where the branch tracks end should give the approximate limit of the sector. Draw a pencil line through this point, and proceed to construct the next sector. Three of these sectors will give the regimental boundaries of a Divison.

It will be found that each sector is like a human hand and arm, with the main arteries running down the arm and feeding the spread fingers through the smaller veins which lead to the finger tips and return.

Topographical features, such as canals, rivers, main roads or railway lines, occasionally form natural divisions between sectors and enable one boundary to be determined.

2. Indications that an attack is anticipated.—The following are indications that an attack is anticipated:—

(*a*) New lines of barbed wire, behind which occasional traverses and dug-outs appear, marking the trace of an intended new line.

(*b*) General strengthening and deepening of trenches.

(*c*) Addition to existing wire.

(*d*) Rapid construction of intermediate and switch lines.

(*e*) An increase in battery positions.

3. Indications that an attack is intended.—The following are indications that an attack is intended:—

(*a*) A sudden increase of artillery activity or in the number of battery positions.

(*b*) An increase in the number of communication trenches.

(*c*) A series of saps pushed forward and hastily linked up.

(*d*) Possibly, in the case of small attacks, new assembly trenches in or behind the front line trenches, or numerous small **T** shaped trenches or recesses for holding extra groups of men belonging to the second wave of the assault.

(*e*) A rapid increase in the number of light railways.

4. During a battle.—The conditions during a battle render the interpretation of aeroplane photographs far more difficult, for the following reasons:—

(*a*) Artillery preparation and continuous bombardment cut up the ground and obliterate trenches and landmarks.

(*b*) Battery positions are destroyed or captured, and new ones appear everywhere.

(*c*) New lines of defence may be scattered, and may consist merely of a line of fortified shell holes; these may be either detached, or improved and linked up to form part of a new defensive organization in conjunction with any available natural cover.

The following are some of the more important points which should be looked for:—

(i.) Tracks into shell holes which may contain detached parties or machine guns.

(ii.) Old battery positions, many of which are wired round and, when occupied by infantry, will form local strong points.

(iii.) Blocks and barricades across communication trenches.

(iv.) New tracks across country.

(v.) New active battery positions.

X.—OBLIQUE PHOTOGRAPHS.

Oblique photographs give a view such as an observer from a high hill is accustomed to see. Hence, though necessarily somewhat distorted, they convey more information to the unskilled student of air photographs than do vertical photographs.

They disclose details such as machine gun emplacements otherwise hidden, identify individual trees of which only the tops can otherwise be seen, and indicate the contours of the country.

They also give valuable assistance in working out the heights of embankments and the depths of sunken roads.

XI.—STEREOSCOPIC EFFECT WITH AIR PHOTOGRAPHS.

1. Method of use.—When any locality is photographed, two or more exposures are often made in order to ensure that one plate at least covers the area. Very often two or more of them do so, and may give a stereoscopic effect if looked at through a stereoscopic viewer.

To obtain this effect, take the two photographs of the object (two copies of the same photograph will not do—a fact which is not always recognized), and place one photograph on the top of the other, so that the features on one coincide with the same features on the other.

Draw the top photograph aside, keeping the features under examination parallel the whole time, until at about 2 inches apart the images will again fit, and houses and trees will stand up as in nature.

The photographs must be placed in the order in which they were taken, *i.e.*, the left hand picture on the left side, as otherwise the features will appear reversed and houses will sink into holes, and cuttings will become embankments.

At first the number of images may be confusing, but a few minutes' practice will be enough to accustom the eyes to pick up the two required.

2. Value.—Stereoscopic photographs reveal, for example, depressions and slopes which are not distinguishable on a vertical single photograph.

By showing up objects in relief, they enable the artillery to estimate the amount of cover over emplacements and the nature of their protection, thus materially assisting them to determine what nature and calibre of gun is required to deal with them effectively.