

AN INTRODUCTION TO THE STUDY OF ARCHAEOLOGY FROM THE AIR

Part 1: Technique

By

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With the advent of the aeroplane a new approach to the location of archaeological sites has been opened up and in recent years many archaeological sites of the first importance have been discovered through the medium of air search. In the West air search has been employed for many years but in Eastern Asia — due, no doubt, to more hazardous flying conditions and difficulties of photographic processing — little work has been undertaken to date. With the rapid advancement of aircraft during the war years some of these difficulties are now lessened or even wholly overcome and it is the intention of the writer in this initial paper to introduce to his Siamese readers the general principles of air search, both visual and photographic, and to contrast conditions in Europe with those in Siam.

Although, of course, archaeological sites can be noted visually it is normally convenient to record them photographically. The writer proposes to deal with aircraft, cameras, types of air photographs and suitable scales in that order and thereafter to describe in detail some typical sites, both European and Siamese, as seen from the air. For those who wish to pursue the subject in greater detail than it is possible to give in this brief paper a select Bibliography is added as an appendix. As far as possible recent works have been given but it is emphasised that the majority of European archaeological matters are dealt with in periodicals which rapidly become out of print and difficult to obtain.

Aircraft.

During the war the tendency has been for photographic reconnaissance aircraft to become fast and unarmoured and to fly at great altitudes. The standard British Royal Air Force Spitfire and Mosquito both fly at altitudes of between 25,000 and 30,000 feet at speeds in excess of 400 miles per hour. Notwithstanding, the development of air cameras has kept pace with the aircraft. With the return of peacetime conditions, however, there has been an inclination to return to slower aircraft operating at lower altitudes, though operational squadrons continue to be equipped with fast machines.

No organisation below State level can expect to run these high performance aircraft as an economical proposition nor for archaeological purposes are such aircraft entirely satisfactory. A light, high-wing monoplane of the Piper Cub or Auster variety is more suitable. Relatively slow, easily manoeuvrable and economical to run, archaeological sites can be inspected from such aircraft at comparative leisure. The high-wing is important. Low-wings tend to obstruct the view and make photography difficult. Perhaps the ideal aircraft would be a helicopter from which the site could be initially located from the air and immediately afterwards examined on the ground but at the time of writing this type of aircraft is not readily procurable.

Flying Technique.

A team of three is ideal — pilot — navigator — photographer. However, many light aircraft have room for two only and in these cases it has been the writer's experience that, whilst the pilot can combine controlling the machine and map reading, the photographer is fully occupied with observing for sites and handling the camera. If the camera is a fixture in the plane and not hand-held the photographer can manage the map and keep a log book. It is essential that the pinpointing of sites on the map is done at the time of photography. Otherwise endless difficulty will be experienced later in relating sites to their proper locations. For this reason a map of

one inch to the mile or 1,000,000 is to be preferred to the normal smaller scale flying maps. Accurate pinpointing calls for good quality maps and, as yet, certain parts of Siam are inadequately covered. In such cases a system of course and time must be evolved for the approximate plotting of sites seen. This necessarily calls for some skill in air navigation and the maintenance of a careful log book. The latter should be kept in any case. Rough notes may be made in the air and a fair copy completed on the ground immediately after the flight.

For the initial location of sites it is best to fly at about 2,000 feet. Once a site is seen it can then be photographed at a lower altitude from various angles. It is also a good idea to take distant views of the site to give a general impression of environment and to check its position the more accurately. Archaeological air photography calls for first rate teamwork between the pilot and photographer and aircraft in which both sit side by side are to be preferred. Where pilot and photographer sit one behind the other an adequate means of communication must be established.

Air Cameras.

The British Royal Air Force F. 24 camera with a range of lenses from $3\frac{1}{4}$ inches to 20 inches, a focal plane shutter and giving a negative five inches square is ideal. It employs a roll film available in exposures of either one hundred or two hundred and fifty frames and can be adapted for either hand-held or automatic use. Several of the photographs illustrating this paper were taken with this type of camera. But it is not essential to use a specialised air cameras. Excellent results can be obtained with a ground camera of the Leica variety provided a lens of long focal length and sufficient speed of shutter is available. For normal use a lens of five or eight inch focal length is adequate. With miniature cameras special care must be taken with the fine grain development of negatives. The detailed description of this type of camera is rather outside the scope of this paper and the reader's attention is directed

to the various camera handbooks issued by the makers, many of which contain chapters on air photography.

In taking air photographs it is desirable to hold the camera away from any part of the aircraft to eliminate vibration which can occur in the air even at shutter speeds of one three hundredth of a second. This vibration factor makes the mounting of a camera, with its attendant difficulties of sighting beyond the scope of the average amateur and the writer advises hand-held photography for the best results. Oblique photographs can be taken over the side of the aircraft without difficulty. Several vertical photograph can be taken by putting the aircraft into a tight bank but, if prolonged, this is rather an uncomfortable proceeding. If long series of vertical photographs are desired it is better to arrange for a glass or plastic panel in the floor of the cockpit.

Air Photographs.

Air photographs are either vertical or oblique. Both have certain advantages and both have certain drawbacks.

Vertical photographs (*Plate 1 a*) present a plan view of the ground immediately below the point of exposure of the camera. Vertical photographs have the advantage of uniform scale, thus enabling measurements to be taken, and two or more vertical photographs of the same site taken consecutively can be merged to give a stereoscopic impression of heights and depths. On the other hand they give an unfamiliar view of the ground since many features are recorded in terms of reflected light rather than in their true colour values. Thus two roads, the one of white concrete, the other of black tar, both having a smooth surface may appear equally light in tone whilst a field of ripe yellow corn will seem much darker due to the shadows cast by the individual plants. A little practice in comparing vertical photographs with the map and with the ground will soon accustom the user to their peculiarities. Vertical photographs have an additional disadvantage in that they are somewhat

difficult to obtain except from an aircraft specially fitted for this type of photography.

Oblique photographs (*Plate 1 b*), present the more familiar perspective view. On the other hand they diminish the height of the structure recorded; if taken too low there is a certain amount of "dead ground", tall objects in the foreground concealing those behind, and measurements can not be taken. Against these disadvantages must be set the ease with which oblique photographs can be obtained. Best results are achieved with a "corner view" as illustrated.

Scale.

With verticals for archaeological purposes the best scale depends on the object being photographed. To show the details of a building a scale as large as 1:1,000 might be required. At the other extreme, sites do show in Siam on photographs as small as 1:50,000 (nearly an inch to a mile) though little detail can be seen and measurements are liable to a considerable error. Much of the wartime cover obtained by the Allied Air Forces for intelligence purposes was at a scale of 1:10,000 and in Siam, where, in the past, most of the smaller structures have been of wood and no longer show, this scale is convenient for the examination of surrounding earthworks and the larger temple buildings and palaces. Normally a vertical photograph can always be enlarged to twice or three times its contact size. It should be remembered that enlargement will not produce details which can not be seen in the original print with the aid of a glass but it is often convenient to enlarge for purposes of reproduction.

There are various methods for obtaining the scale of vertical photographs. If the flying height above ground level and the focal length of the lens are known the scale can be calculated from the formula,

$$\text{Scale} = \frac{F}{H \times 12}$$

where F is the focal length of the camera lens in inches and H is

the flying height in feet. Conversely this formula can be used for determining the flying height to obtain photographs of a given scale. If these factors are not known the scale of the photograph may be calculated from a map. In this case the formula is,

$$\text{Scale} = \frac{D}{d} \times \text{map scale}$$

where D is the distance between two points on the photograph and d is the distance between the same two points on the map. Three or more points should be taken for each photograph since both it and the map may be distorted.

Finally, if the length of some large object on the ground is known the formula,

$$\text{Scale} = \frac{\text{Ph.}}{\text{G.}}$$

will provide an answer. Here Ph. is the length of the object on the photograph and G. the length of the same object on the ground. Needless to say in all the above formulae measurements must be in the same units.

There are methods for calculating the scale of oblique photographs but they require such exact details of camera tilt and flying height that they are generally impracticable for the amateur. The results desired by oblique photography must be calculated in terms of flying height, distance from the object photographed and focal length of camera used. For instance to photograph Wat Arun in Bangkok an excellent picture can be obtained with a lens of eight inch focal length from a height of 300 to 400 feet over the Memorial Bridge. To achieve the same results with a five inch lens distances and flying heights would be cut by 5/8 and so on. Too short a focal length will cause bad distortion with close up pictures; too long, foreshortening. Lenses of between 8 and 14 inch focal length produce the best results and, as noted before, with square or rectangular structures, the corner view makes the better picture. Care must be taken not to get in the shadow side if the sun is shining brilliantly or detail will be lost but should the sun be cloud obscured this point may be ignored.

Plotting Photographs.

Once a collection of photographs has been started it can very easily get out of hand if it is not well indexed. The first essential is to index the negatives. Each should be marked with a code number, the date, camera used, time, height, and if possible the place, i.e.

A 11; 21.4.91.; F. 24, 8"; 1440; 400'

Angkor Wat. SW.

That is a photograph, the eleventh on sortie A, taken on 21 April, 2491 with an eight inch lens F. 24 camera from height of four hundred feet at 1440 hours and covering Angkor Wat from the South-West. This is an oblique photograph. With verticals the direction would be missed out but an arrow can show the direction of North. A word of caution here to those who may use RAF photographs. The arrow on these is more often an indication of the direction of the aircraft's flight unless the North point is specifically marked as such. If obscure areas are being dealt with it is a good plan to add geographical co-ordinates - latitude and longitude - or grid references to a well known map series. The initial trouble will be repaid in the long run. The direction on obliques can be either the position of the aircraft in relation to the object photographed i.e. SW., or the direction in which the camera is facing, i.e. NE. There is no objection to either method provided that once adopted it is adhered to. Once this data is on the negative it will be automatically transferred to the print - a great time saving if a number are to be run off and distributed to various places. Oblique photographs can be conveniently indexed by cards in alphabetical order of geographical name or by plotting on a map (plate 2).

Vertical photographs require the same data on the negative but are more difficult to describe in words. No written description can ever give in simple terms the exact extent of a series of vertical photographs and the best method is to plot them on a large scale map. If there are a number of photographs taken at the same date

it will only be necessary to plot sufficient photographs to just overlap each other. If several series of photographs are taken of one site, different colours or lines must be employed to differentiate the sorties.

Plate 2 shows a run of vertical photographs over Angkor, French Indo-China, together with the oblique photograph which is reproduced in *Plate 1 b*. In practice, for charity, it is best to have individual sheets for verticals and obliques. Tracing cloth or paper can be used to minimise expenditure on maps.

Appearance of Sites on Air Photographs.

Having given the basic principles of air photography we are now in a position to discuss the appearance of sites as seen from the air. In Europe sites seen from the air fall into three main groups and several lesser groups. The more important are :—

Crop-mark Sites.

Shadow Sites.

Soil-mark Sites.

Crop-mark Sites.

Any structure of which traces still remain, even though the present top soil is undisturbed, will have an effect on the crop growing above. The extent of this effect depends on a number of factors such as the depth of the remains below ground level, the nature of the crop above, the geology of the neighbourhood and the general weather prevailing during the year. A site which will appear clearly one year when there is a drought is by no means certain to appear the next under more normal conditions even if the same crop is sown. Likewise a crop-mark which appears in corn one year is less likely to appear in a root crop the following even though the weather conditions are identical. There is no point in elaborating variations further since these types of crops do not

occur in Siam.* The exception is grass which obeys the same rules though to a lesser degree. The governing factor in crop-mark photography is the amount of moisture available to the crop or grass above. Certain features — pits, ditches, post holes and the like — retain moisture and the crop above advances more rapidly. The effect is less marked in grass than in crops such as barley or wheat but it is most pronounced when the archaeological sites are in well drained areas. The effect in the crop is marked in the early stages by much thicker growth over the moist area and later, when the crop has ripened, by a greater height which casts a shadow. The richer growth also takes slightly longer to ripen. Certain moisture-loving weeds may grow on the damp areas and not elsewhere (*Figure 1*). The net result in each case is to produce a denser growth with resultant darker tones which show on the air photograph. It is almost impossible to appreciate these marks on the ground whilst the crop remains uncut but the writer traced a site on a mown field in Italy by the weeds growing over the ditch area. In fairness it should be added that this particular site had already been noted from the air whilst the crop was still growing. These crop-marks can be conveniently termed "positive crop-marks"

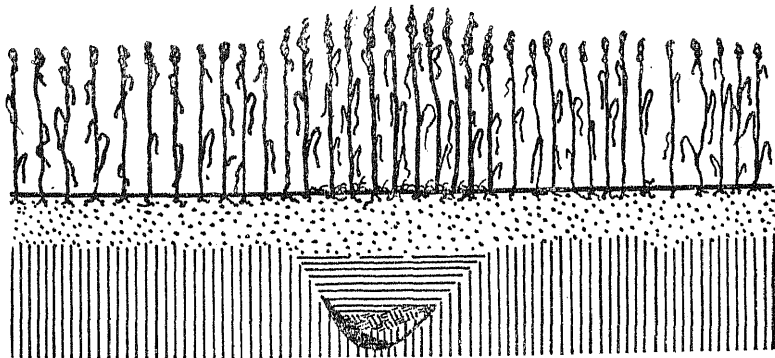


Figure 1

Hard surfaces such as roads, walls, floors and the hard sub-soil thrown out of ditches have the reverse effect in denying mois-

* *The work by Riley listed in the bibliography deals with this subject in some detail and should be consulted by those interested.*

ture to the growing crop. The crop is thinner and less developed, the bare earth underneath tends to shine through and a light toned area is produced on the air photograph. This type of feature has a decided effect on grass during dry spells. In growing crops, early in the morning or late in the evening when the sun is low, these sites may become dark in tone due to the shadow of the taller surrounding crop falling on the stunted growth (*Figure 2*). These crop-marks may be termed "negative crop-marks".

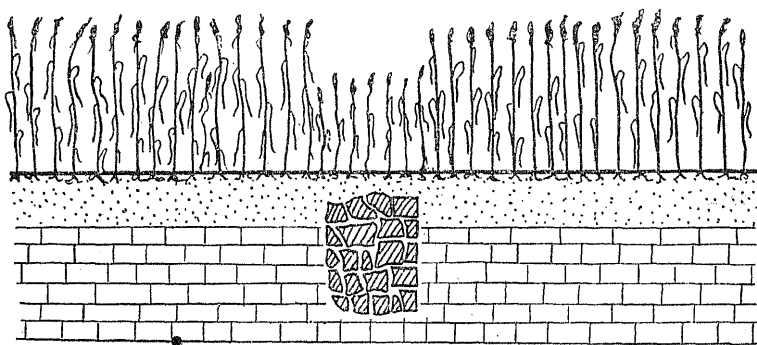


Figure 2

Some sites where both a rampart and a ditch have been constructed will show both negative and positive crop-marks. Furthermore certain natural features may also show as crop-marks. Old river courses are a typical example. Their irregularity readily distinguishes them from artificial features and being outside the scope of this paper are not described in further detail.

Shadow Sites.

Faint earthworks in grassland may show when conditions of long shadow prevail. Rougher vegetation, bushes for example, will obscure such sites which will appear on cultivated ground as normal crop-marks. The chalk downs of England are one of the best areas for sites of this nature but they also show well on desert sites covered by a fine drift of sand.

Soil Marks.

Soil marks are the traces of earthworks in ploughed fields which would again appear as crop-marks were the sites planted. For example, a partially ploughed out rampart and ditch constructed in an area of white chalk subsoil will show light on the rampart and outer lip of the ditch and dark in the centre of the ditch. A certain amount of the rampart and lip will have spread into the ditch so that the dark toned area seen will be only a proportion of the actual ditch width. Continued ploughing will eventually destroy such a site but it will still show as a crop-mark under favourable conditions.

There are various other applications of aerial search mostly in the form of map amplification. Modern field systems may give the clue to vanished villages. Then, many towns have had a long history and although original houses may not exist the early layout may still remain. Most towns in Europe have been mapped but often slight depressions marking former defences or successive changes of plan have been ignored by the cartographer. Vertical air photographs form an excellent medium to illustrate these changes.

Such then are the main groups of sites seen from the air in the West — crop-marks (both positive and negative), shadow sites, soil marks. Let us now turn to Siam and consider the possibilities of these types of site in our own country.

Crop-mark Sites in Siam.

The essential features in crop-mark photography are the denial or abundance of water and a suitable crop, including, for negative crop-marks, grass. It will be appreciated at once that a paddy-field, flooded for part of the year and hard caked mud for the remainder, is not the medium for showing crop-marks. However, areas of grass do occur in Siam and although the writer has not seen good crop-marks in grass in Siam, there is an excellent example on the outskirts of Saigon, French Indo-China where similiar climatic conditions exist. No doubt Siamese sites will appear in time. There

does exist a form of "crop-mark" which provides a pointer to ancient sites. The ramparts of former towns, the banks in between ancient field systems and the silted tanks and platforms of early temples all support denser growths of trees than the surrounding countryside. We must regard these sites as our Siamese crop-marks together with any grass sites which may be found in the future.

Shadow Sites.

Here again the dense vegetation on abandoned sites tends to obscure this feature. There is no site known to the writer at the moment which comes into this class.

Soil Sites.

These again require special conditions — dry ploughed fields — which are not found in Siam.

Tracing Town Development.

This type of photography is particularly applicable to the towns of Northern Siam many of which remain unmapped. Chiangmai, Lampang, Lamphun, Nan and Phre all show changes and additions to the original plans and will be discussed in a later article. Lopburi is shown in *Plate 8*.

Conditions Peculiar to Siam.

Although there are few examples of the foregoing other than our special tree "crop-mark" and town development sites there are a number of advantages of air search in Siam.

The most obvious is, of course, the ease with which large tracts of jungle can be examined. Siam is not an easy country to travel at the best of times and in the jungle one may easily pass within a few yards of a major archaeological site and suspect nothing. By air search it is possible to cover an area in a few hours which would take as many months on the ground with the added assurance that any substantial remains are bound to show.

There is another type of site which is peculiar to countries cultivating wet paddy. The irrigation system of paddy fields depends on careful graduation of levels and any old work is likely to be avoided even if nothing appears above ground level. The grouping of paddy fields therefore may provide a clue to a variety of sites.

For various reasons formerly populated areas have become swampy. It is often possible to trace former canals and field systems under the present water level by vertical photographs.

A number of early sites in Siam are located in caves. It is quite impossible to note a cave on a vertical photograph and very unlikely that it will be seen obliquely unless the mouth is unobscured by trees or bushes.

There are various other features which show from the air which are more of a topographical nature although not unconnected with archaeology. In Southern Siam the beaches have been building up for many years and former coast lines can be clearly seen from the air. Islands which have become absorbed into the mainland can be located and in northern Malaya there is at least one historic reference to such a site. There may be similar references for Siam but, initially, this is a task for the historian rather than the archaeologist. Again, there are raised beaches and former river courses — features which show from the air but seldom appear on even the largest scale map. The archaeological technique in such cases is to locate a key site on the ground and then to search for other sites which display the same topographical conditions. This is really map amplification and not direct recognition of archaeological sites as such. The writer has used this approach with some success in Malaya.

Finally, in the field of anthropology, comes the location of aboriginal peoples from the air. In the Northern Hills and in Southern Siam are many primitive tribes, the Wa, the Negritos and others, several of whom follow a nomadic or semi-nomadic existence. Below the tops of the forest trees they can not be detected but once they fell the jungle they are readily apparent. With more settled

peoples whole culture groups can be mapped out. The long houses of the Borneo Dyaks and the Ple-Temiar in Malaya are typical examples.

Summary.

It will be seen, then, that certain types of archaeological sites can be determined from the air in Siam. These sites are necessarily limited to fairly substantial structures — stone buildings and large earthworks — the wooden buildings of the masses having perished irretrievably. The main classes are :—

Crop-mark Photography.

Ramparts, banks of field systems, temple platforms and tanks may show by denser tree formations. Negative crop-marks may be seen in grass but none have been noted to date.

Jungle Search.

Large areas of jungle can be covered in a short space of time and whilst some sites may remain obscured there is a far better chance of location than by ground methods.

Cultivation Disturbance.

Regular patterns of paddy fields may give the clue to ancient sites which disturb the irrigation system.

Town Planning.

In the absence of large scale maps the successive developments of towns may be traced.

Marshes.

In some cases it may be possible to trace early occupation by former canals and field systems in marshy areas.

Map Amplification.

Air photographs can be used to amplify topographical information on maps by locating former islands and beach lines and potential archaeological sites, given a key site.

Anthropology.

In certain cases it may be possible to trace modern culture groups of aboriginal peoples. So much for the theory and suggested practice of archaeological air photography in Siam. It now remains to illustrate and describe such typical sites as space permits.

Part 2: Illustrations

The following pages of plates and explanatory notes illustrate the techniques and practice of aerial photography of archaeological sites as described in the preceding text. These plates were prepared by the author from original aerial photographs taken by the British Royal Air Force, the British Royal Navy, Eagle Air Photos Ltd., and by the writer.

*Plate 1. (a and b)**Vertical and Oblique Air Photographs.*

Angkor Wat, French Indo-China.

Lat. 13 25' N., Long. 103 51' E.

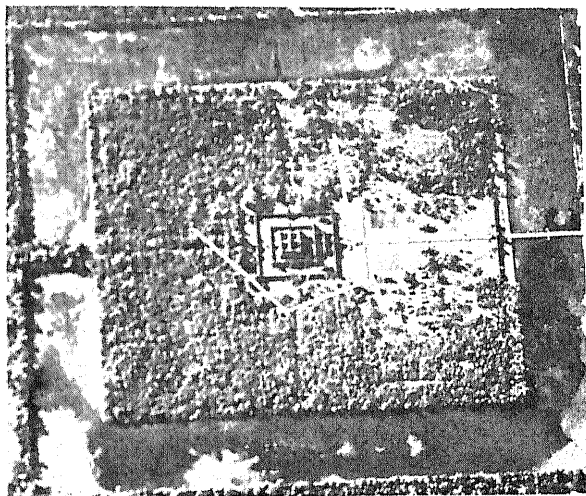
A contrast between vertical and oblique air photographs. The vertical photograph (a) gives a plan view of the structure. Note how the various heights of buildings are indicated by their length of shadow and how some ground features are hidden under the trees.

The oblique photograph (b) gives a more familiar view of the ground.

Vertical photograph by RAF, January, 1946. F. 52 camera with 20" lens at 20,000' Scale, 1. 12,000.

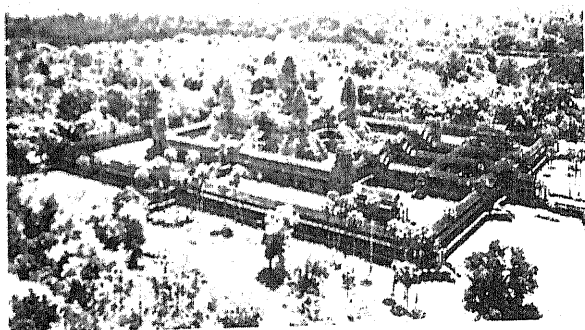
Oblique photograph by the writer, February, 1946. Taken from Piper Cub with F. 24 camera. 5" lens at 200'.

Plate 1 (a)



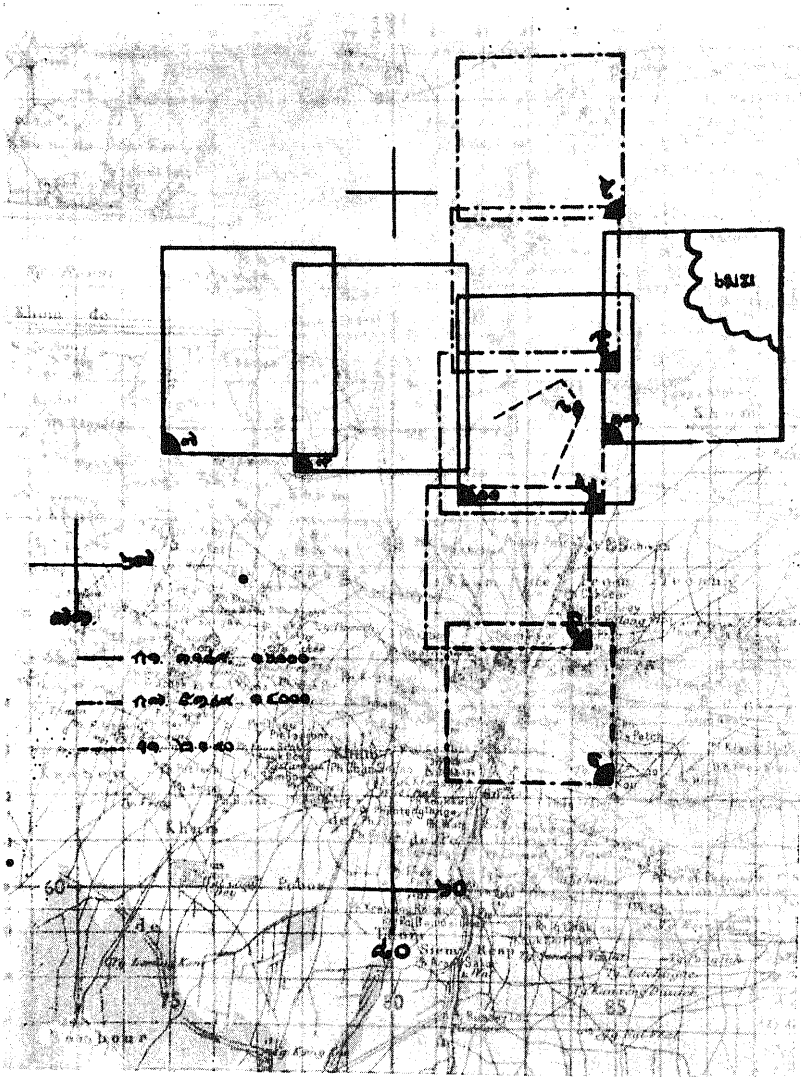
British R.A.F. (Crown Copyright Reserved)

Plate 1 (b)



Photograph by the writer

Plate 2



*Plate 2.**Plotting Air Photographs.*

Angkor, French Indo-China.

Two runs of vertical photographs and an oblique photograph of Angkor Wat plotted on a trace over the standard 1:100,000 map series. This is a convenient scale for plotting vertical photographs but is rather on the small side for obliques.

Note that only sufficient verticals to just overlap each other are plotted — this is to avoid a mass of confusing lines which would not serve any useful purpose — and that different line systems are used for the various sorties. On the original trace these are in contrasting colours for further emphasis. Sortie data is noted on the edge of the map and cloud obscured areas are also shown. If desired, a comment on the quality of the photographs may be added, *i.e.* good, poor etc. Note the “tie-in” marks on the trace to allow correct co-incidence with the map grid.

Normally oblique and vertical photographs should be plotted on separate traces.

*Plate 3 (a).**Crop-mark and Soil-mark Photography.*

San Severo, Italy.

Lat. 41 40' N., Long. 15 20' E.

A Neolithic-Chalcolithic habitation site showing prolonged occupation near San Severo in South East Italy. The triangular field, planted with corn, in the top left of the photograph shows the clearest patterns – a series of circular ditches originally surrounding huts and a number of deeper ditches marking successive modifications in the major defences. The area to the right is planted with vines, a less favourable medium for crop-marks, and here the ditches alone can be traced. Note especially the prominent rectangular earthwork to the right. Most marked in the vine area it appears as a soil mark in the ploughed field and finally as a light toned area in the coarse scrub below where the bushes appear somewhat allergic to moisture. Various other ditches can be traced in the plough.

Vertical Photograph by the RAF, June, 1945. F. 52 camera with 20" lens at 10,000' Scale 1. 7,000.

Plate 3 (b).

Saigon, French Indo-china.

Lat. 10 40' N., Long. 106 37' E.

Various negative crop-marks on the outskirts of Saigon. Running diagonally across the photograph are the fortifications of Nguyen-duc-Tham, A.D. 1772 (B.E. 2315), the dark line marking the ditch with a trace of a rampart behind. Cutting through this and running parallel with the road are later Annamite defences of 1860 which merge into the tombs at the bottom of the photograph. Note the small square fort in the middle of this defence line which is super-imposed on an earlier work. To the West of the road in the region of the racecourse is a pattern of streets marking the site of a large town which pre-dates the 1772 earthworks.

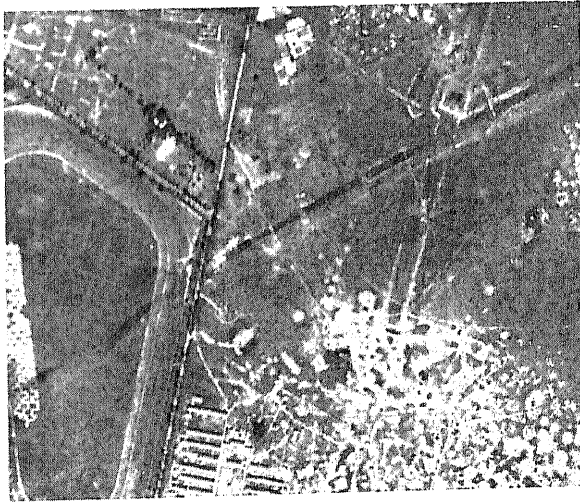
Vertical Photograph by the RAF December, 1945. 12" focal length camera at 10,000'. Scale 1.12,000.

Plate 2 (a)



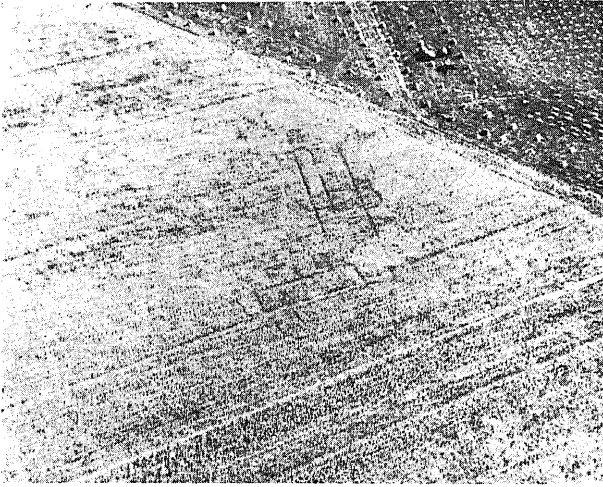
British R A F (Crown Copyright Reserved)

Plate 2 (b)



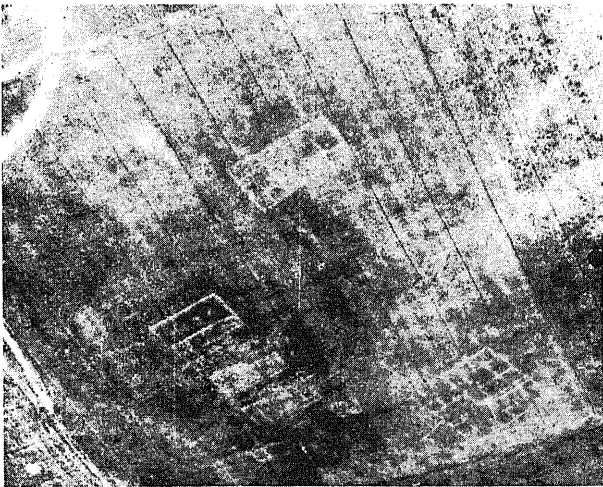
British R A F (Crown Copyright Reserved)

Plate 4 (a)



Eagle Air Photos Ltd.

Plate 4 (b)



Photograph by the writer.

Plate 4 (a).

Negative Crop-mark Photography.

Littlewick, Berks, England.

Lat. $51^{\circ} 30'$ N., Long. $00^{\circ} 46'$ W.

A Roman villa Farmstead photographed just before the harvest. Taken when the sun was low this site shows the reverse effect caused by the shadows of the more advanced growth falling across the situated plants over the walls. The site was occupied up to the end of the 4th. century A.D. (B.E. 850 - 900).

Subsoil; chalk.

Oblique photograph by Eagle Air Photos Ltd., 1947. F. 24 camera.

Plate 4 (b).

Troia, Apulia, Italy.

Lat. $41^{\circ} 21'$ N., Long. $15^{\circ} 10'$ E.

Another Roman country estate with main house, servants, quarters and various outbuildings seen in growing corn shortly before the harvest. This photograph, which was taken in the middle of the day, shows the effect of white reflected light through the weak growth on top of the walls. Pottery found on the site suggests a 2nd. century A.D. date. (B.E. 650 - 750). Subsoil, alluvium and gravel.

Oblique photograph by the writer, May, 1945. F. 24 camera with 8" lens from Argus aircraft at a height of 1,000 feet.

Plate 5.

Shadow Sites.

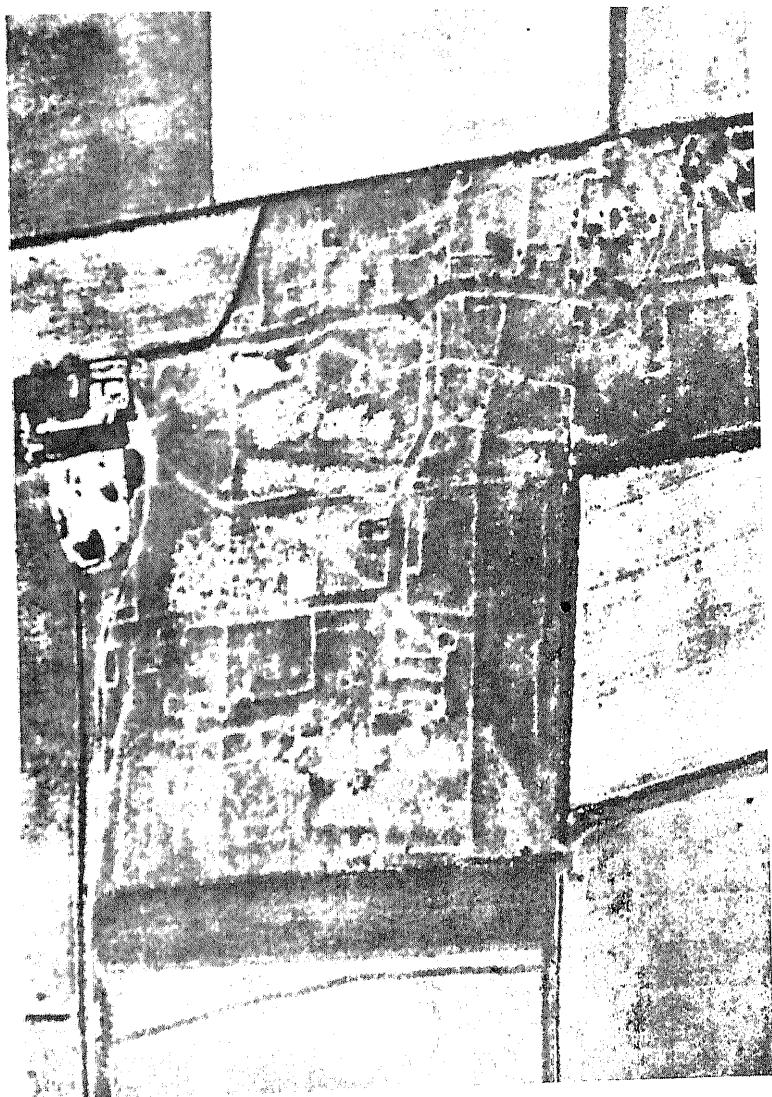
Gainsthorpe, Lincolnshire, England.

Lat. 53 28' N.; Long. 00 35' W.

Part of a mediaeval village in England which was abandoned and in ruins before 1697 A.D. (B.E. 2240). The remains of buildings, walls and streets can be clearly seen in this photograph and they show partially by the shadow they throw and partially by reflected light. The whole area is under a grain crop.

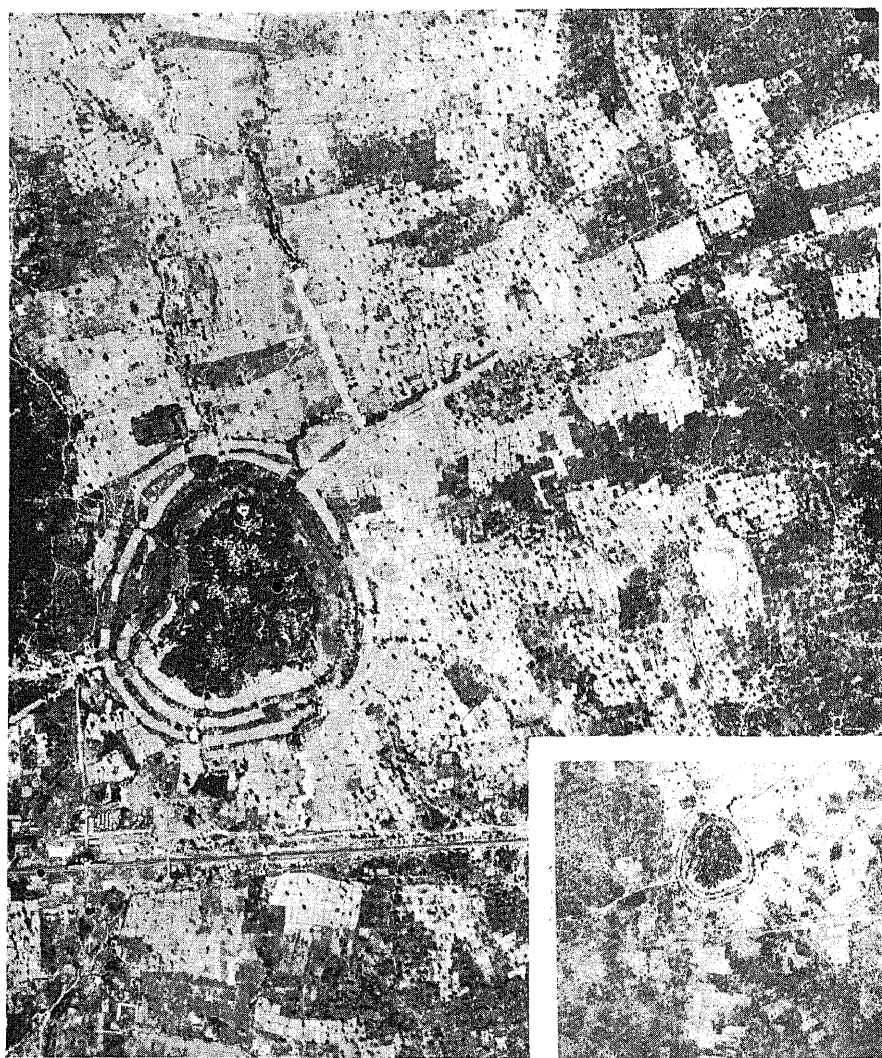
The writer is obliged to J.S.P. Bradford, M.A., F.S.A., Pitt Rivers Museum, Oxford for supplying this photograph, which was taken by the Ordnance Survey in April, 1925 from a height of 4,000 feet.

Figure 2.



Ordnance Survey Photograph

Plate 6.



British R A F (Crown Copyright Reserved)

Plate 6.

Crop-mark Photography, Siam.

Ban Thamen Chai,

Lat. 15 02' N.; Long. 102 56' E.

This village, a few miles East of Korat is typical of a series of towns with multiple ramparts found in this area and probably dating from the Mon or early Mon-Khmer period. The town has originally had a triple moat and wall now partially destroyed by paddy fields. This feature is, of course, quite clear on the ground but the air view gives a more comprehensive picture. What shows is the growth of bushes and trees on the raised areas which have not been leveled by paddy fields.

Vertical Photograph by the RAF, January, 1945. F. 52 camera with 20" lens at 25,000' Scale, 1:15,000.

Small inset. The same site at a scale of 1,500,000.

*Plate 7.**Positive Crop-marks Siam.*

Wat Kosin Narai,

Lat. 13 51' N.; Long. 99 51' E.

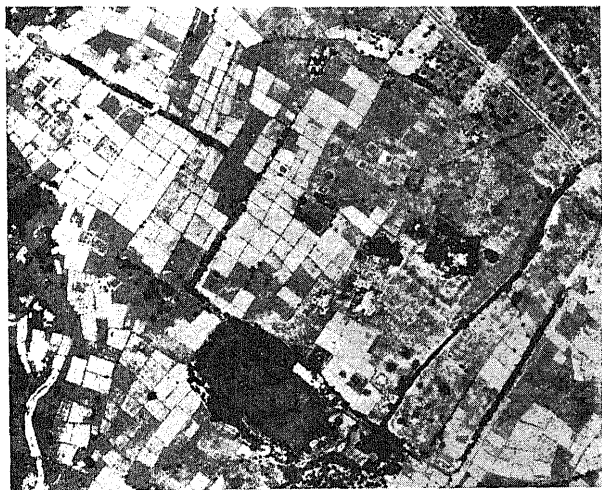
P'ong T'uk in the neighbourhood of Bang Pong has produced some of the earliest remains yet found in Siam but this site shown here which is immediately over the river appears to have escaped notice.

Various features can be seen from the air. Most prominent is the outer ditch and rampart forming a rectangle, about 2,600' by 2,350', marked for the greater part by a double line of traces. Adjoining this area on the north side is a large tank, 1,150' long by 525' wide whilst slightly offset from the centre of the main site is an enclosure ditch, 520' square and some 45' wide (a) showing as a positive crop-mark in the abandoned paddy fields. This probably marks the site of an important temple. No building can be seen at this scale but there is a tank, some 160' wide and on the east of the ditch traces of another site. To the north are faint traces of a rectangular enclosure, 185' by 195' (b) and there appears to have been another site at (c) where there is a small structure 50' square in the middle of a suggestive rectangle of trees. What seems to be an early waterway (d) links the southwest corner of this area to the river and there is a branch to (e). The symmetrical line of trees (f) leading in from the east suggests a former causeway which can not now be traced beyond the limits of this photograph.

P'ong T'uk itself on the other side of the river does not show from the air and it is quite possible that here is the more important site.

Vertical photograph by the RAF, May, 1945. F. 24 camera with 20" lens at 24,000°. Scale, 1.14,400.

Plate 7.



British R A F (Crown Copyright Reserved)

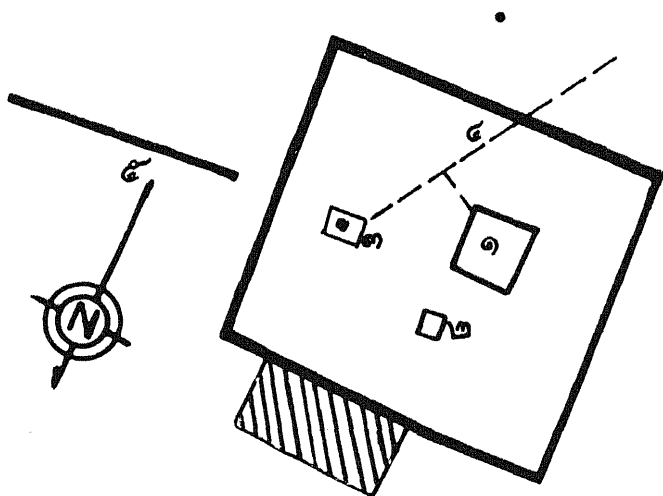


Plate 8.



British R A F (Crown Copyright Reserved)

*Plate 8.**Tracing Town Development.*

Lopburi, Siam.

Lat. 14 48' N., Long. 100 37' E.

Lopburi has one of the longest histories of any town in Siam. This photograph covers a portion only of the town but shows several interesting features. Running across the centre is the trace of the former town wall and ditch clearly defined by an enriched growth of bushes and small trees (a). There are pools of water still remaining in the ditch at several points. Parallel to this, at a distance of four hundred yards, are the vestiges of another ditch (b). There appear to have been several structures of some importance between the two ditches and two large enclosures are especially prominent near the large white buildings (c).

Further afield, at the top of the photograph, is another extensive ditch (d) and the regular field pattern to this area indicates much development at some period. All these features are noted from air observation and only ground investigation can establish their exact nature and date.

Turning back to the town several well known sites are seen — Wat Sam Yot (e), Wat Mahatat (f), the Royal Palace (g) and another early building (h). The writer landed in the field near Wat Sam Yot in February, 1946 and noticed several lines of foundations showing through the turf some of which can be seen rather faintly in this photograph.

Vertical Photograph by RAF, January, 1945. F. 52 camera with 36" lens. Scale about 1.10,000.

*Plate 9.**Map Amplification.*

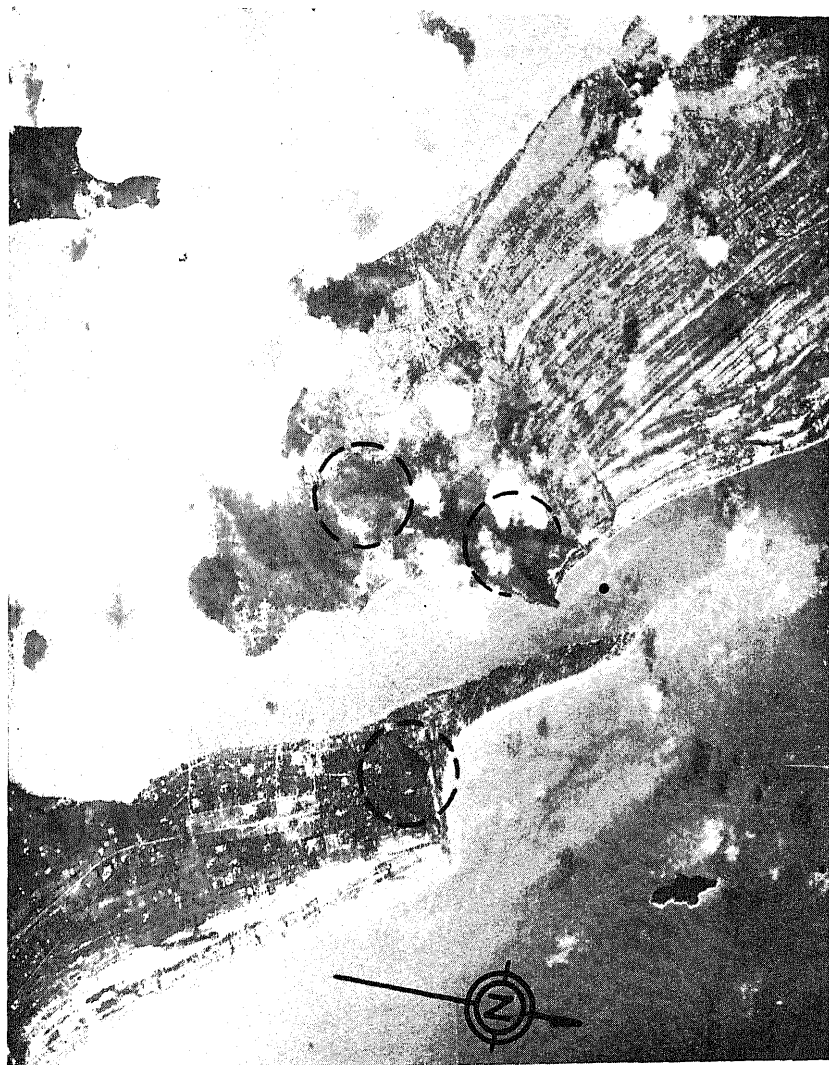
Songkhla, Siam

Lat. 7°13' N., Long. 100°35' E.

A good example of "beach buildup" common along this part of the coast. Originally this area was under the sea with three small rocky islands (ringed in the photograph). The parallel white lines represent successive sand bars which show as slight ridges on the ground whilst the darker areas are patches of vegetation in the sheltered areas between each ridge. A feature of this nature is seldom shown on the map. Such an area may build up very rapidly and examples of an advance as much as five miles in two thousand years have been recorded. Here a new area is building up along the spit North of Songkhla. As yet it is still under water but the small white spots of the waves breaking show that there is little depth at this point. The main archaeological problem is determining which was the beach at any one period. Ground search alone will provide the answer.

Vertical Photograph by the Royal Naval Fleet Air Arm, February, 1945. 24" lens at 25,000 feet. Scale 1.13,000.

Plate 9.



British R.N. Photograph (Crown Copyright Reserved)

Appendix A.

Select Bibliography.

The following list gives the more important recent works on archaeology from the air. Most of these are in archaeological journals published in Great Britain.

General Works.

RILEY, D.N., "The Technique of Air Archaeology"
Archaeological Journal, Volume CI, 1944.

CRAWFORD, O.G.S., "Air Photography for Archaeologists"
Ordnance Survey Professional Papers,
New Series. No. 12, 1929 (out of print).

Special Techniques.

WILLIAMS-HUNT, P.D.R.
"Archaeology and the Topographical Interpretation
of Air Photographs"
To be published in *Antiquity* this year.

Crop-mark Photography.

BRADFORD, J.S.P., and WILLIAMS-HUNT, P.D.R.,
"Sitticulosa Apulia"
Antiquity, No. 80, December, 1946.
Neolithic-Chalcolithic sites in Italy.

BRADFORD, J.S.P., "Etruria from the Air"
Antiquity, No. 82, June, 1947.
Etruscan tombs in Italy.

French-Indo-China.

PARIS, P., "Anciens Canaux Reconus sur Photographies
Aeriennes dans les Provinces de Ta-Key et de
Chau-doc."
Bulletin de l'Ecole Française d'Extrême-Orient,
Tome XXXI, 1931.

GOLOUBEV, V., "Reconnaissances Aeriennes au Cambodge"

Bulletin de l'Ecole Française d'Extrême-Orient,
Tome XXXVI, 1936.

MALLERET, L., "Les Anciennes Citadelles et Fortifications de
Saigon."

Bulletin de la Société des Etudes Indochinoises,
Tome X, No. 4, 1935.

MALLERET, L., "A la Recherche de Prei Nokor."

Bulletin de la Société des Etudes Indochinoises,
Tome XVII, No. 2, 1942.

Siam.

WILLIAMS-HUNT, P.D.R.,

"Circular Earthworks in Eastern Siam; An Air
Survey."

In course of preparation for Antiquity.

Malaya.

WILLIAMS-HUNT, P.D.R. "Notes on Archaeology from the Air
in Malaya"

Journal of the Royal Asiatic Society, Malayan Branch,
Volume XXI, Part 1, 1948.

From time to time excellent examples of archaeological air
photographs are published in the Illustrated London News.
