AIR PHOTOGRAPHY AND ARCHAEOLOGY: ACHIEVEMENTS AND PROSPECTS

VIJFDE KROON-VOORDRACHT

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J. K. S. ST JOSEPH

UNIVERSITY OF CAMBRIDGE

GERRIT HEINRICH KROON
(1868–1945)

THE BEGINNINGS OF ARCHAEOLOGICAL AIR PHOTOGRAPHY ARE ill recorded but they certainly precede the invention of the aeroplane. In England, the practice of making ascents in hot air balloons was a passing fashion at the end of the last century. Some of these ascents started from spreading lawns that formed part of landscape gardens around large country houses, and occasionally a camera was carried to record the scene from what was then a novel view point. Ridge and furrow ploughing appears incidentally in these views which rank amongst the earliest aerial photographs of archaeological features, though the potential of the new technique was not yet recognised. Two photographs of Stonehenge, taken in 1906 from a 'war balloon' and printed in *Archaeologia* a year later, are believed to have been the first aerial photographs of a well known archaeological site to have been published (Capper, 1907). This early connexion between archaeological observation and military flying is interesting, since the practice of reconnaissance and the development of suitable cameras and film owe much to military necessity. Many archaeologists familiar with the smooth chalk downland of southern England and northern France, where major earthworks are plainly visible, may have pondered upon the advantage of an overhead view, but only O.G.S. Crawford, later to become the first Archaeology Officer at the British Ordnance Survey, seems to have considered and discussed its significance.[1] As a geographer, his understanding of landscape and experience in fieldwork gave him the qualifications essential to a successful aerial observer, while his flying experience convinced him of the value of air reconnaissance for research into landscape history and archaeology. When first appraised, the military role of the aeroplane was considered to be principally in target-spotting and in reconnaissance. In archaeology, Crawford considered the main advantage of the new technique to lie in the greatly increased speed of reconnaissance, while the distant view point enabled large earthworks to be studied comprehensively in a fashion unattainable on the ground.

To Crawford, who gained his first flying experience during the

war of 1914–18 in the detailed observation of military trench-systems and other installations on the Western Front (Crawford, 1955, ch. 10), the opportunities afforded by aerial observation of archaeological monuments came, as it has come to many others since, as a challenge. It was no chance that in England archaeological air reconnaissance began in Wessex. The firm chalk downland provided the right conditions for operation of the first military aircraft, and it was in Wessex that some of the earliest airfields were laid out. Sixty-five years ago large tracts of Salisbury Plain were untouched by modern ploughing so that man-made disturbances of prehistoric and later times could be discerned and studied from the air. No surface is more sensitive to disturbance than this smooth chalk downland cropped close by grazing sheep.

Crawford was not alone in developing this opportunity. In 1924 he organized with Alexander Keiller an aerial survey of archaeological sites on Salisbury Plain; this was possibly the first occasion on which aerial photography was specifically planned to record the archaeology of a region. The book, *Wessex from the Air*, in which the results were published in 1928, set a standard for such surveys that has seldom been surpassed. Today aerial photographs of hill-forts, as of many other earthworks, if not commonplace, are at least relatively easy to come by, but looking back over fifty-five years, *Wessex from the Air* was a most remarkable achievement for its time, as contemporary reviewers noted. The greater part of the book comprises an account based largely upon Crawford's field-work of the visible remains at some fifty different sites, each of which is illustrated by a vertical air photograph and by a plan. The majority of the photographs are of earthworks, but in some half-dozen instances archaeological features seem to be recorded as 'crop marks' – a term then coming into use.

The years 1923–9 probably saw the peak of Crawford's work in archaeological air reconnaissance. Besides his own survey of Wessex, he was active in securing and preserving photographs taken by the Royal Air Force on training flights, whenever such photographs recorded features of archaeological interest (Craw-

ford, 1955, p. 168). For this he was well placed by reason of his official position at the Ordnance Survey, and the results of this endeavour were published as two *O.S. Professional Papers* (1924 and 1929 a), which explain the technique and define the scope of the new method of research as he then saw it. The *Papers* contain a selection of official photographs, and together with *Wessex from the Air*, they left no doubt of the value of aerial photography as an aid to field-work. Crawford himself possessed very considerable skill with a camera, having used photography to illustrate his field work in many parts of Britain and elsewhere. In aerial reconnaissance he quickly recognized the importance of choosing the conditions of lighting, the state of growth of vegetation and the time of day calculated to yield the most telling photographs. These points were illustrated by pairs of photographs of a given site seen in Summer and in Winter, with diffuse lighting beneath cloud cover and in bright sunlight, of buried features under corn and under stubble, and of earthworks in the oblique light of morning or evening and at midday.

In the late 1920s and 1930s the principal exponent of this new technique in archaeology was Major G.W.G. Allen, another aerial observer in the war of 1914–18. Allen, an engineer and skilled pilot, had the energy, enterprise and resources to undertake archaeological reconnaissance for some ten successive years, using his own aircraft and a camera of his own construction. His flights extended over the country within range of a light aircraft based near Oxford.

Three important conclusions emerged from Allen's work. Firstly the demonstration that chalk downland was by no means the only terrain to yield crop marks; the gravels of the upper reaches of the Thames produced marks exceeding in extent and degree of detail any hitherto recorded on the chalk. Secondly, he established beyond doubt the value of returning again and again to a given site. The photography of a complicated site, like the painting of a great picture, is never finished. Photographs taken year after year under differing conditions of vegetation, as the agricultural rotation brings different crops to each field in turn, showed that what

is indistinct or obscure on one occasion might be clearly seen on another. Moreover, his photographs demonstrated that certain crops are more sensitive than others in their response to buried features. Thirdly, his flying was not all confined to late Spring and Summer. A site had to be carefully studied. The weather, the date of photography in relation to the date of sowing of a crop, the time of day, and the incidence of sunlight are all factors to be considered. The high standard of Allen's photography shows how well he had mastered the subject (Anon. 1948). Useful observations may be made in any chance flight, but each site has its own problems and leaves its own kind of mark upon the crop or terrain so that it requires careful and repeated study if it is to be photographed to best advantage.

Another aspect of Allen's work deserves mention: his surveys were remarkable for the very multiplicity of discoveries. There began to be some appreciation of the problems that would inevitably arise if the rate of acquisition of new knowledge continued or increased. Clearly, publication of only a few selected photographs would not be enough. Two plans, based upon Allen's photographs, showing all the crop marks then known in small areas of the Thames valley, represented the first attempt to plot the totality of information provided by the new technique (Allen, 1938 and 1940). Allen's two plans foreshadow much recent work designed to portray the regional archaeology of a district as revealed by aerial reconnaissance[2].

Both Crawford and Allen belong to the pioneering phase of archaeological air photography. It is not always remembered that the conditions under which they operated were very different from those now prevailing. There were comparatively few airfields, no traffic-control system except in the immediate vicinity of major airports, few 'danger areas' and only a rudimentary meteorological service. It was not altogether unusual for light aircraft to land in a convenient meadow either to draw fuel at a nearby garage, or to avoid bad weather. The successful practice of archaeological air reconnaissance called then, as now, for a crew of at least two, the

closest co-operation between pilot and observer being essential. Many archaeological sites are by no means easy to see, and an observer must be able to guide his pilot so that the aircraft is in the best position for photography. Allen, however, was an exception: he both piloted the aircraft and took photographs himself. This perhaps accounts for the fact that in such a large proportion of his photographs the archaeological 'target' at which he was aiming is recorded from the optimum angle of view and usually in the centre of the picture. Crawford's contribution was of a different kind. His interest in aerial photography arose largely from his great accomplishments as a field archaeologist. He regarded aerial reconnaissance as a natural extension of field survey, enabling an observer to cover the country more quickly, and at the same time to record innumerable details not so easily seen at ground level (Crawford, 1953, ch. 4). His enthusiasm sparked off notable enterprises besides the 1924 survey of Wessex, made jointly with A. Keiller; there were his two flying excursions to Scotland in 1930 and 1939, on the second occasion (Crawford, 1939) having as pilot C.G.M. Alington, who had already flown him round the Eastern Mediterranean. In these expeditions Crawford's main role was as navigator and map reader, leading his pilot to sites of interest, and it was Alington who took the photographs. If the results cannot always compare in quality with Allen's work, it should be remembered that Crawford's later expeditions were conducted in haste, snatching opportunities afforded by suitable weather, whereas Allen, operating mainly over his home territory, was able to choose his time, taking the photographs himself over a countryside with which he was familiar.

The first air photographers acquired skill in interpreting landscape during their experience of flying in Service aircraft. The military interpretation manuals of the time were extensively illustrated with photographs of trench-systems and other disturbances characteristic of contemporary warfare (War Office, 1924). Just the same kind of skill is needed to interpret the works of ancient man as he scarred the surface of the ground with his settlements and

buildings, his fortifications and agriculture. The potential value for archaeology of photographs taken by military aircraft on training flights was realised by several scholars. However, it seldom proved possible to arrange for Service aircraft specially to photograph features of archaeological interest: in Britain three notable exceptions were the reconnaissance of sites in Northern Ireland undertaken by the Royal Air Force in 1927–9, the vertical surveys of Hadrian's Wall made in 1930 and 1937, and a survey of much of the Cambridgeshire Fenland to assist the work of the Fenland Research Committee. The first yielded valuable records of earthworks and of sites unrecognized before (Chart 1930), the second interesting views of well known forts along the Wall, but added little to knowledge.[3] The third recorded almost for the first time the extinct water-courses (roddons) which belong to a period before the fens were drained in the seventeenth century. The roddons and associated remains are an invaluable guide to the pre-drainage geography of the Fenland (Plate 2), knowledge of which is essential for all archaeological field-work in the area.[4]

It is interesting to reflect upon the state of archaeological air reconnaissance in Britain in 1939. The photographs that had caught public attention were the striking views of large and well preserved hill-forts, and remarkable individual discoveries like the Stonehenge Avenue, the timber circles at Woodhenge and at Arminghall,[5] and the Roman town at Caistor by Norwich, where the plan of many of the essential features was revealed.[6] The power of aerial reconnaissance as a means of discovery was beginning to be demonstrated by Allen's work, but that the number of buried and invisible archaeological sites was likely to be so great was not yet realized.

The extent of aerial reconnaissance over the desert and semi-desert terrain of the Middle East in the early years of flying has not always been appreciated. There, many ancient sites are plain to see and could hardly fail to catch the attention of an observer. Crawford was quick to appreciate the value for history of some of the remarkable photographs taken overseas, and he arranged in 1929 to

make a tour of Royal Air Force bases in the Middle East (Crawford, 1929). His aim was to ensure the preservation of whatever records there might be of sites of archaeological importance. The first such photographs from that area were probably those taken in southern Palestine in 1917 by the German Air Force, and in Mesopotamia, in 1917–18, by the Royal Air Force, published respectively by Dr. Wiegand in 1920 and by Colonel Beazeley in 1919–20 (Plate 3). Some of the remarkable ancient sites of the Tigris-Euphrates plain were photographed from the air by military aircraft of both Britain and France towards the end of the war of 1914–18 and in succeeding years. Their astonishing state of preservation is shown very well by the illustrations accompanying Beazeley's account of his work (Beazeley, 1919). Similarly, a series of photographs taken in 1924 and 1928 from British military aircraft, operating from Amman, yielded an unexpectedly detailed record of the famous Jewish fortress of Masada and of the Roman siege-works around it (Richmond, 1962). Inevitably, official flights in military aircraft could not be expected to provide more than occasional opportunities for photography of ancient sites. It needed the drive and energy of an enthusiast to appreciate the potential for archaeological photography of training flights by military aircraft, and to devise an acceptable programme of research. The enthusiast was le Père Poidebard, of the University of Beirut, who was able with the co-operation of local units of the French Air Force to reconnoitre adjoining parts of Syria during the years 1925–32. His surveys are an outstanding contribution to the study both of Roman military organization and also of settlements in one of the eastern frontiers of the Empire, and the monographs in which he published his results have hardly been matched since (Poidebard, 1934; Mouterde and Poidebard, 1945). Poidebard's work was followed by the surveys of Sir Aurel Stein who in 1938–9 reconnoitered the Roman frontier works along the Jebel Singara, now in north-west Iraq. In such trackless and largely unmapped desert, most ancient sites were visible on the surface, and the principal value of an aircraft was to provide a means of rapid reconnaissance of features hitherto unrecorded because of their

remoteness. To be successful, operations in such conditions call for careful appreciation of the archaeological potential of the area in question, otherwise much effort may be spent in unprofitable random flying.

Equally remarkable was the survey by Colonel Baradez of the Roman frontier system extending for some 600 km. in the North African desert, from southern Tunisia westwards across Algeria south of the Djebel Aurès. The frontier comprised a wide belt of country which was crossed by a network of military roads with forts placed at strategic points, and it included in some sectors continuous lines of ditch. This elaborate defensive scheme which may have lasted from the second to the fourth century, separated Roman from barbarian territory and protected an extensive agricultural region that subsequently reverted to waste (Baradez, 1949).

An official account of the contribution of aerial photography to military intelligence in the war of 1939–45 has yet to be published. Under stress of military necessity, the development of motor-driven roll-film cameras has multiplied photographs to an extent that could scarcely have been foreseen, and the vast collections from different theatres of operations called for teams of specialist interpreters. Notwithstanding the hazards that war-time operations inevitably involved, the results often showed how photographs might remain of value to the historian and archaeologist long after they had become out of date for their original purpose. Reconnaissance photographs in the Mediterranean theatre revealed patterns of Roman land use in astonishing detail: in an urban scene, vertical photographs sometimes demonstrated the growth and planning of an ancient and modern city more clearly than they could ever be discerned on any plan. Seldom do opportunities arise in wartime specially to photograph features of archaeological interest, although the site of the Roman town at St. Albans, in Hertfordshire, was recorded on vertical photographs at the height of a summer drought in 1940, when parch marks revealed unknown details of the town-plan (Corder, 1941). Later in the war, photography organized by John Bradford, then serving in the Royal Air

Force, of sites in Apulia shows for the first time that many features of the ancient landscape of Italy could be seen from the air with exceptional clarity (Bradford, 1957).

Experience in war brought growing appreciation of the value of aerial survey for many aspects of planning. Complete vertical surveys of several countries in western Europe were undertaken, an exercise sometimes repeated at regular intervals. The skills of commercial firms were in growing demand for the mapping of ill-known or unmapped regions, to assist agricultural development or the search for raw materials. Such work occasionally yielded photographs of value for archaeology, for example, by showing in undeveloped countries the settlements of primitive peoples still existing.

A number of archaeologists, like Bradford, who served in photographic interpretation units with the Allied Air Force in the war of 1939–45, perceived that the greatly increased facilities for reconnaissance provided by modern aircraft might transform archaeological air photography, but opportunities for such work were not easy to secure. Here, Cambridge took a lead. Use of a light aircraft of the Royal Air Force on training flights was authorized by the Air Ministry to carry out a limited amount of aerial reconnaissance, and the photographs so obtained accumulated to form the nucleus of a collection. In due course, the University of Cambridge appointed a 'Committee for Aerial Photography' with a first duty to obtain and make available aerial photographs for teaching or research. The work of the Committee gradually expanded so as to meet the needs of many subjects, but a large proportion of the flying continued to serve history and archaeology (Committee for Aerial Photography, Annual Reports, 1950 onwards). The unexpected harvest of results obtained in the Summer drought of 1949 emphasized the importance of using every possible moment of flying time in such exceptional conditions, while in later years extension of reconnaissance to include Wales, Scotland and in due course Ireland (Norman and St. Joseph, 1969), showed that the technique was of wide application.

When flying facilities could no longer be provided by the Air Force, Cambridge was able to purchase a suitable aircraft and to appoint a pilot. As Service aircraft could be made available only when not needed for official duties, and then only at certain times of year, the new arrangement permitted much greater flexibility of operation. The full scope of this technique soon came to be realized: every season of the year and every type of terrain provided unexpected opportunities for specialized reconnaissance. That Britain offers as extensive a range of archaeological sites as can be found in any area of comparable size is due to the variety of its geology and soils, the ever changing weather, the wide extent of arable land, and the fact that anciently successive waves of human invasion swept over these islands. The problem was how to ensure the continued provision of a suitable aircraft with pilot and trained observer ready to make the most of the few sustained periods of good weather afforded by the uncertain British climate.

The photographs, now numbered in hundreds of thousands, taken on the widely ranging flights sponsored by the 'Committee for Aerial Photography', comprise the *Collection of Aerial Photographs* of the University of Cambridge.[7] Over the years, others with flying experience have also taken to the air, operating independently or through a county archaeological unit, and the contributions of these private fliers have added substantially to the photographic coverage of Britain's cultural heritage. Recently the Royal Commissions on Historical Monuments for England and for Scotland, which have the task of compiling *Inventories* of all constructions and sites of archaeological or historic interest, have undertaken aerial surveys specially in connexion with their work.[8]

A similar interest in aerial photography as an aid to archaeology has developed elsewhere in Europe. Sometimes this was due to the initiative of individual enthusiasts. Such enterprise might be stimulated by previous photographs taken in war time, leading to more extensive reconnaissance sponsored by official organizations. Results have varied with the circumstances of each country: geology and terrain, depth of the water-table, climate, vegetation, and

the pattern of modern agriculture being the principal determining factors. The harvest season varies with the latitude and from one crop to another: cereals, perhaps the most important type of growth for producing crop marks, ripen progressively earlier southwards across Europe.

In Italy, the corn-growing areas of Apulia have yielded crop marks as distinct as any recorded, revealing, it may be, plans of Neolithic settlements or Roman agriculture, not in vague outline but with all the clarity of an engineer's blue print (Bradford, 1957, pls. 25–8).[9] Thus, for agriculture, not only the main land divisions appear, but the pits dug at the planting of olive groves or orchards. In Tuscany, observations of the differential parching of vegetation or of differences in the tone and colour of soils in freshly ploughed land have immensely increased our knowledge of the extent and planning of large Etruscan cemeteries. The vegetation was usually rough grass growing in uncultivated pastures, and the colour contrasts in the soils were seen as differences between whitish gypsum or tufa, excavated from tombs, and the dark cultivated humus (Bradford, 1957, ch. 3, pls. xxx–xxxvii). Elsewhere in Mediterranean lands, the upstanding remains of ancient civilizations, however well known, are seen from the air with a new unity of vision. Aerial photographs bring a fresh appreciation of individual buildings or of whole townscapes, whether in Greece or Italy, or in the Roman colonies of north Africa. One aspect of Roman land use that gives rise to a particularly impressive visual effect when seen from the air is 'centuriation', a carefully planned system of land-division. In Italy itself, in Dalmatia and Tunisia, the land boundaries, laid out with astonishing regularity, can be traced over wide areas as a chequer-board pattern either as slight earthworks sometimes defining modern agricultural boundaries, or as crop marks (Bradford, 1957, ch. 4, pls. xxxviii–xlix; Caillemer and Chevallier, 1953).

In countries north-west and north of the Alps, France, Germany and Austria, the most notable achievements of aerial reconnaissance so far, have come from cultivated land, where the texture and

composition of the top layers of soil are in marked contrast with the subsoil. Wherever ancient disturbances have cut through the soil into the rock or subsoil beneath, and the land has subsequently been reconditioned, the levelled ground never returns to its geological compactness, and will ever after continue to affect the vegetation growing over it. Opportunities for aerial observation of such buried features vary widely with the circumstances of geology and vegetation. The development of soil or crop marks is specially influenced by such superficial deposits as alluvium, terrace gravels, residual clays, limon, and, in northern Europe, glacial clays, sands and gravels in great variety. In France, much of the northern half of the Paris Basin is covered with limon deposits – fine-grained yellow-brown loams that may have originated as wind-blown dust in the closing phases of the Quaternary ice age. The Beauce plateau between the Seine and the Loire, composed of porous and fissured limestone, and the wide chalk uplands of Picardy are largely covered with limon, a soil ideal for grain and beet cultivation, but one that does not favour the development of crop marks except under optimum conditions. It was Monsieur Roger Agache who first demonstrated in Picardy that ancient disturbances in such soils could be distinguished most effectively in conditions of rapid drying after wet weather. Such 'damp marks' are transient effects varying from district to district. To record them a careful watch on local weather conditions must be maintained, in order to seize the best moment for observation: a sudden clearance following heavy rain in late Winter or early Spring may provide the opportunity.[10]

In the low lying districts of the Netherlands, a country of waterways and windmills like the Cambridgeshire Fens, further reconnaissance than has been undertaken so far is needed before the scope for aerial observation becomes clear. The alluvium of the main rivers is remarkable for the absence of crop marks, and this may be due to the persistently high level of the water-table. Moreover, in a river valley liable to periodic inundation, floodwaters deposit layers of sand and silt, effectively burying earlier land surfaces and contemporary archaeological features. The compara-

tive paucity of known archaeological sites in certain river valleys like the lower course of the Severn or the middle course of the Rhône may thus be explained. Agricultural land liable to flood tends to be used as pasture rather than arable, so that conditions do not favour the discovery of buried sites. A high water-table also prevails in the silts and sands that form the fertile area of West Friesland, but there observation from the air, made after a first ploughing of grassland now being turned over to arable, has revealed clear patterns of old creeks and water courses, of enclosure-ditches and other man-made features related to prehistoric settlements. No doubt the settlement-pattern was determined by the height of the surface in relation to contemporary sea-level. As in the river valleys, the land is so flat and low lying that repeated inundations may have caused deposition, burying the old land surface under layers of silt: only when such later levels are worn away or dispersed by ploughing, will the former surface be revealed. The effect is somewhat akin to the masking of prehistoric landscapes by a growth of peat such as has occurred in the west of Ireland and in parts of Scotland. Loss of the peat by wastage or by digging for fuel in modern times may reveal once more the early cultural landscape.

Results of reconnaissance over Denmark,[11] southern Sweden and Bavaria[12] emphasize the wide scope of this work. When earthworks exist in relief they may be photographed from the air by paying attention to shadows; when the ground has been levelled, buried features may continue to be visible as differences in the soil, or in the colour and texture of the vegetation. Herr Braasch has recently demonstrated for the upper basin of the Danube, what Dr. Scollar had shown for the Rhineland, namely how fragmentary is our present knowledge and how much awaits discovery (Christlein and Braasch, 1982). Perhaps the greatest scope in Europe for future work of this kind lies in the lower basin of the Danube, a region that has seen the comings and goings of countless ancient peoples, who will have left their own distinctive marks upon the land. There, archaeological observation from the air has hardly

begun: what a chance awaits some young scholar, able to work within the official Archaeological Service of one of the countries concerned.

In tropical regions, detection from the air of archaeological features encounters particular difficulties, not least because of the masking effect of jungle, rain-forest or swamp. Responses in growth to differences in the soil, even in cultivated land, are not normally found in crops like maize, millet and rice, nor in plantations of tea, coffee and sugar cane. The features most likely to be recognized are large, upstanding structures or earthworks. Identification of ruined cities in the jungles of India and Thailand, of remains of the Maya civilization in Central America, of pre-Columbian ruins in Peru,[13] and of large earthworks in Thailand (Williams-Hunt, 1950) and Fiji (Parry, 1977, 1982) show how rewarding reconnaissance of such territory can be. Vertical photography is most likely to suit the prevailing conditions and particularly to overcome the difficulty of plotting aerial photographs of land with a dense forest canopy.

From this summary, necessarily incomplete, it should be abundantly clear that, in archaeology, aerial observation has become a means of research of the greatest value, capable of yielding results that cannot be obtained so quickly and often cannot be obtained at all by observation on the ground or in any other way. If the technique as practised by competent observers has now become one of the principal means of archaeological discovery, the question may be asked what of the future? Many countries of the Old World offer important opportunities for the study of human history, opportunities which can be exploited by air photography only, and more graphically demonstrated by it than by any other method.

Existing collections of aerial photographs record but a fraction of the information awaiting discovery. The agricultural land of Europe is a palimpsest of history covering a longer span of time, and often as intimate an aspect of the subject as any written source. Until scholars became aware of these results, it was hardly possible

to estimate the range and extent of the new information. If the achievements have been great, a time comes to take stock of the present position, and to consider future prospects. An interest in the interpretation of aerial photographs extending over fifty years, and active participation in aerial reconnaissance, may be some qualification for the task.

The prime function of aerial reconnaissance is the gathering of information. In countries where photography has been long practised, experience has shown that a continuing flow of discoveries may be expected, even though the weather dictates that some years are notably more productive than others. In Britain, half a century ago, the work was still in a pioneering stage, and the technique had scarcely been applied outside the south of England. The scope for archaeological air reconnaissance in Scotland, Wales and Ireland was largely unknown, and experience was acquired slowly after the war of 1939–45. There were then few collections of photographs of archaeological interest. It came to be realized that much could be learnt in almost all areas of the country once the limitations of the method had been appreciated. Inevitably, flights over country archaeologically unexplored require careful preparation if the best results are to be achieved. An observer is well advised before taking to the air to acquaint himself with the known distribution of archaeological sites, and with the extent of arable land and fertile soils. Reconnaissance might profitably begin over country where crop marks are to be expected, such as cultivated land producing cereal crops on light soils, and might then proceed to less promising terrain. In a programme designed to serve needs other than archaeology, there may be occasion for flights over areas regarded as archaeologically unrewarding. However, it is in the nature of reconnaissance to yield surprises, and there are a good many instances of archaeological sites, sometimes preserved as substantial earthworks, being brought to notice unexpectedly, having escaped previous attention because of their remoteness from the beaten track. It need not be emphasized that results in any single year are unrepresentative. Reconnaissance has

to be repeated over a number of years and at different seasons before even a rough assessment can be made of the archaeological potential of land hitherto unexplored. As work proceeds, a pattern of results will begin to emerge. Certain areas and certain soils are recognized to be more productive than others, while on the archaeological map some districts remain uncompromisingly blank. Scrutiny of marshes, permanent pasture and moorland may reveal unrecorded earthworks but no buried features. Woods, orchards, market-gardens, and heathland covered by heather and bracken are unrewarding. With time, this disparity may become less marked: a year of extreme drought will multiply discoveries many fold. Photography in Winter and Spring, when deciduous trees are bare and vegetation is at a minimum, may reveal earthworks hidden at other times: differential melting-patterns of snow and hoar-frost may emphasize features in such low relief that they had escaped previous attention, or pick out soil differences that are a guide to ancient disturbances.

The cultural landscape as seen from the air includes elements of very diverse character and of differing degrees of complexity. The remains of fortifications, the sites of farm buildings, the vestiges of ancient agriculture may be plain to see, and their age and purpose not difficult to assess. The majority of ancient sites, however, have long been levelled or buried, so that no remains are visible in relief to guide a field-archaeologist. Differences in the vegetation and the soil may then provide the only clue to vanished features. Such differences, often difficult to see, are transient, their appearance varying with the weather, the lighting and the state of growth. The full significance of the delicate patterns of shade, colour and texture which reveal the complications of an ancient site may be difficult to appreciate. The necessary skill in observation and photography is acquired only by continuing reconnaissance at different seasons of the year. Success comes with persistent scrutiny and the experience to distinguish what is significant from what is not. Some features, a ring-ditch, an old field-boundary, or a line of road, may seem simple enough, but even the simplest marks may

be misleading.[14] How much more is this so with complex features, as when structures of different ages occupy the same ground. Repeated observation will then be necessary, for details invisible one year may often be clearly seen in another (Plates 16–17). Return visits spread over many years will usually add points of interest and sometimes points of great value. Faint marks may be easily missed, or be difficult to recognize amongst distracting patterns caused by the agricultural treatment of the land.

Some tracts of country such as alluvial terraces in river valleys, chalk downland, and deposits of firm glacial sands and gravels are often productive of crop marks, while country composed of heavy clays and marls may yield little in an average year. Flying is expensive, and it is understandably more satisfactory to all concerned to obtain positive results, than to bring back a report of land reconnoitered, but where nothing was seen. For this reason reconnaissance tends to become concentrated on those areas found to be rewarding, while less rewarding terrain is neglected, a practice that may well yield inaccurate distribution patterns. The process of discovery is unending and nowhere can the possibilities have been exhausted. Nonetheless, so much is now known about buried features in certain districts, that for this very reason further work should be concentrated on areas normally unproductive of crop marks, particularly so in extreme weather conditions when marks may be seen on land where they are not ordinarily visible. Only thus can the imbalance induced by the varied treatment of the land or by differences in soil and vegetation be overcome. Even so, a map on which results are plotted may indicate the degree to which different crops and soils favour the development of crop marks, rather than the actual distribution of buried sites.

In reviewing the results of archaeological air reconnaissance over the last few years the multiplicity of discoveries permits only the briefest account of some of the principal categories of sites. The description relates largely to Britain, because Britain is the country best known to the writer. Equally far-reaching results are being obtained, or may well be expected elsewhere. Indeed, discoveries in

one country often suggest lines of investigation in another.

In Britain, as in adjoining countries of north-west Europe, relics of the Quaternary landscape, relatively untouched by man, are difficult to find. The surface has been progressively modified by human activities during the last six or seven millennia, and the countryside as we now know it is largely a product of the last few hundred years. Perhaps the nearest approach to the early post-glacial land-surface to be found in southern Britain is at East Walton Common (Norfolk). There, aerial photographs show a rare survival (Plate 1): an area of a hundred hectares or more of undulating ground where sinuous gravel ridges outline hollows probably formed by the melting of lenticular masses of ice. The structures somewhat resemble the 'pingos' known in arctic terrain. More often, photographs show the geographical setting of the rock-shelters and raised beaches, the sand dunes and heaths, where shell-middens or finds of flint suggest occupation by Mesolithic and even earlier peoples.

The first human interference with the land probably scarred the surface so slightly that traces hardly survive. Certainly the habitation-sites and wind-breaks on old beaches and on shore-lines of vanished lakes are not easy to recognize from the air. The earliest constructions of considerable size known to British archaeology are the 'causewayed enclosures' or 'interrupted ditch systems' now heavily denuded by weathering. Reconnaissance has brought to light many more of these structures (Plate 4); their range is now known to extend beyond the chalk downland where they were originally identified (Palmer, 1977). Reliable deductions about distribution are impossible for a category of which there are very few examples: when several score are known to exist, valuable inferences can be drawn, for instance about their relationship to other ancient features. It has long been recognized that ritual monuments, or 'henges' (Plate 5), occur in association with cursus, those strange 'processional avenues', or whatever they were, that in outline resemble the large runways of airfields. However, near Fornham All Saints (Suffolk), aerial observation has identified

crop marks of an interrupted ditch-system and of a cursus which are seen to occupy in part the same ground. Careful excavation at the points of intersection should be able to establish an order of succession. This is a good example of the power of aerial photography to throw different features into visible relationship, either establishing their relative age, or showing where digging could settle the problem. For certain categories of site only one or two well preserved examples now remain in Britain, a fact mainly due to the destructive effects of long-continued ploughing.

The precise character of some of these early structures is by no means certain, and further knowledge is likely to come only by digging. When few examples of a given class of site exist it is a delicate question whether even one should be excavated, since a large proportion of the category is thereby destroyed; moreover, the site chosen for excavation may not be representative. That aerial reconnaissance should be able to multiply the number of known sites is invaluable. The increased total enables the range of size and shape to be assessed and there is a greater chance of finding a site with water-logged deposits in which is preserved organic material that may throw light upon the contemporary climate and environment.

Space does not permit detailed discussion of the contribution of aerial reconnaissance to our knowledge of the principal categories of antiquities. The practice of observation and photography from the air has proved to be so powerful a means of discovery that many distribution-maps have been transformed and much re-thinking is necessary about such fundamental questions as areas of settlement and population densities.

The evidence provided by aerial photography is by no means always easy to use. It is common practice on reconnaissance for oblique (Plates 1, 5–19, 21–26) rather than precision vertical photographs (Plates 2, 4, 20, 27) to be taken, since oblique photographs are the easier to obtain and are the more economical of flying time. With oblique photography, a choice of angle and of direction of view is possible. Many crop and soil marks are most clearly seen

through only a narrow arc of the compass, the direction depending on the weather and the angle of illumination. Photographs taken from other points may show less, or even no trace of marks at all. In oblique photographs, the scale varies across the picture but computer rectification may yield a reasonably accurate plan provided the ground surface is not too uneven.[15] Vertical photography allows no choice of direction of view. Use of a photogrametric camera makes it possible for overlapping pairs of photographs to be examined through a stereoscope so as to obtain an image of the surface in relief. Such photographs may also be made the basis of detailed contoured plans, given appropriate instruments and adequate ground control. Both points are of great value for the study of earthworks, but vertical survey calls for an aircraft heavy enough to provide a stable platform for precision photography, and the operation requires more flying time.

The scale and variety of man-made constructions of seven millennia or more ago often evoke surprise. Over successive periods of prehistory, the diversity of construction increases, as does the skill in handling raw materials, chiefly earth, stone, wood and thatch. The principal needs were for dwellings, for defences and fortifications against other human beings or animals, for stockades to enclose domesticated beasts, and for land free of trees and scrub, with soils suitable for cultivation. Inevitably such activities scarred the land surface. Some of the delves from which materials were won, of the quarries for earth and stone, and of the pits, shafts and mines from which flint and metallic ores were extracted can still be recognized, though the great majority of these disturbances have been obscured by subsequent centuries of land use. Interference with the land surface was also caused by the digging of post-pits and trenches for foundations, by the excavation of ditches and by the building of ramparts for defence, while disposal of the dead might involve the digging of graves, and perhaps the erection of mounds or mortuary enclosures (Plates 6–7). Reclamation of land for agriculture involved the uprooting of trees, the clearance of bushes, and the removal of boulders, while

the practice of cultivation smoothed the natural surface and left characteristic marks as spade-cuts and plough-furrows that might reach to the subsoil. The traces of such ancient activities have for the most part been greatly altered by centuries of weathering and, in lands long inhabited, by subsequent human interference. The constructions of one age may be modified and obliterated by those of another (Plates 11, 14); such features as survive in relief may be difficult to interpret, and no trace at all of the majority of early constructions is ordinarily to be seen on the surface.

While the opportunities provided by aerial reconnaissance are great indeed, the problems are all too evident. The distant view best obtained from the air can bring new understanding of earthworks (Plates 8, 10). A photograph preserves an image that can be studied at leisure so that the relationship between different elements not always appreciated at the time of flight, may become clear. Earthworks may occupy undulating ground; a complicated site often includes elements aligned in various directions, calling for repeated observation to take advantage of illumination from different angles and at different times of year. When there are no features in relief, variations in the composition and texture of soil, or in the colour and growth of vegetation, often provide a clue to buried remains. Under favourable conditions a levelled site may appear so sharp and clear that nature and purpose may be in little doubt (Plate 17), and an observer familiar with the terrain may be well aware of a moment of discovery. However, for every site so revealed there are very many seen in such vague and incomplete outline that their character is uncertain. Detail may indeed be seen in terms of crop marks and parch marks, but even in exceptional circumstances, when a multiplicity of minor features is visible, a site is seldom seen in its totality (Plates 12, 13). The variety of prehistoric remains determines that certain elements only are seen from the air at one time. It follows that aerial photography, as commonly practised, inevitably reveals an incomplete picture. Frequently, only comparatively large disturbances promote crop marks. However, some cultivated crops, such as cereals, which in

their active stage of growth provide a sensitive register of buried features, respond progressively to differences in the soil. Thus, reconnaissance needs to be repeated at close intervals if all the different responses are to be recorded. The character of many of the 'enclosures' (Plate 9) recorded as crop marks in any extensive programme of reconnaissance cannot be determined in the absence of knowledge of the minor internal features. Yet without identification, the compilation of maps showing discoveries grouped by type or period is hardly possible, and yet such information is needed in planning future surveys.

Distribution maps of archaeological features take various forms: they may relate to districts where much aerial reconnaissance has been undertaken. Discoveries in a single year's survey can be indicated on a map even at a small scale. However, as results accumulate problems of presentation arise. The amount of new information becomes unwieldy, since the experience gained from repeated scrutiny of the surface enables observers to recognize buried features from ever slighter indications. So the number of known archaeological sites increases, and the rate of discovery from the air usually far exceeds that achieved by ground survey. Reconnaissance annually repeated expands or reinforces the distribution pattern and the full significance of this growing body of information may be difficult to appreciate. Features plain to see may correspond closely to recognized types, but the majority show only faintly, and their plan may be manifestly incomplete, so that questions of character and date raise varied problems of interpretation. When a favoured area happens to have been occupied time and again, aerial photographs not seldom show a maze of overlapping marks[16] (Plates 12, 13). At such sites, the recutting of ditches, the continued digging of pits, and the superimposition of new structures on old can be elucidated only by excavation.

In the Roman Age the evidence of archaeology can be checked against the written word, which in later centuries becomes the principal source of evidence. Much of the prehistoric settlement pattern no doubt survived in the frontier provinces of the Empire,

but the sophistication of the new Age left characteristic marks in its roads, its fortifications and its civic enterprise. Military remains lend themselves particularly well to study from the air. The structures of a Roman fort, ramparts, ditches, metalled roads and buildings, are of such variety that even in unfavourable conditions there is a good chance that some feature may be visible, while the standardized planning may enable a fort to be recognized from a minimum of evidence (Plates 15, 17). Moreover, forts are usually planned as if members of a system: study of their distribution may suggest where missing elements are to be sought. Of the temporary works of the Roman army, camps – the halting-places of troops on the march, on campaign, or on manoeuvres – are the features most commonly seen. In Britain, they are found along natural routes to the frontiers, or beyond, or beside military roads, or in the neighbourhood of outpost forts (Fig. 1). The most notable gain has been in the increase in the number of known camps. In Scotland, fifteen had been recognized up to 1939; the number now exceeds 160, nearly all the discoveries being achieved by aerial reconnaissance. Large camps may occur in sequence as if marking the progress of an army on operations. The new knowledge has brought greater appreciation of the extent of troop movements, and attempts have been made to relate some of the camps to campaigns recorded in history. Similar studies should be possible in other frontier provinces.

Roman civic enterprise has often been recorded in aerial photographs, whether in Mediterranean lands, as extensive upstanding ruins of fortifications and of public and private buildings, or elsewhere, when crop marks of a buried site have enabled a town plan to be traced in unexpected detail (Plate 18). The study of centuriation has already been mentioned: in the northern frontier provinces certain examples of this system of land division have yet to be demonstrated, but other aspects of the Romanization of the countryside are no less remarkable. In Britain, the so-called 'Celtic Fields' which extend widely over the chalk downs were amongst the first archaeological features to be studied from the air (Craw-

ford, 1928). The visible remains have now been greatly reduced by modern ploughing, and recent studies of Celtic Fields in the Netherlands are all the more important (Brongers, 1976). The field-systems on the limestone areas of the Pennines (Plate 20) and on the light soils of the New Red Sandstone outcrop in Nottinghamshire (Riley, 1980) perhaps indicate increased agricultural production under Roman rule. The Roman exploitation of the fertile silt fens of north Cambridgeshire and south Lincolnshire involved the construction of extensive drainage works (Plate 21). Ditches defining farmstead sites, field-boundaries and roads are most easily mapped from the air (Phillips, 1970). To ensure the desired direction of flow of water in so flat a landscape calls for careful levelling, since gradients accurate to 1 in 500 are in question. A development very different in character has been revealed by M. Agache's long continued reconnaissance of Picardy, namely a dense distribution of Roman villas (Plate 19) in the Somme valley (Agache, 1975 and 1978). This must imply a very considerable farming enterprise, part of a highly organized agricultural system related to the villas.

Space does not permit any lengthy account of the contributions of aerial reconnaissance to later periods of history. In the twilight centuries that, in Britain, followed the Roman Age, knowledge of Saxon settlements and cemeteries has been greatly increased by the same technique. One of the most important achievements was the discovery of Saxon royal vills at Yeavering (Plate 22), Milfield and Sprouston, to mention only the three in Northumbria. This made possible Dr. Hope-Taylor's extensive excavations at Yeavering, revealing an unexpected wealth of detail, and establishing that this was in all probability the *Ad Gefrin* of Bede, the place where St. Paulinus preached Christianity to King Edwin (Hope-Taylor, 1977). So is aerial photography able to illuminate what is vague or obscure in the written record. There follow the Middle Ages with all their power of organization, treating the Christian religion as a reality and thus causing it to leave an even more impressive mark upon the land that was left by the ritual monuments of prehistoric

times (Knowles and St Joseph, 1952). The towns (Plate 27) and castles and the village economy (Beresford and St Joseph, 1979) represent the outward form of feudal organization, a simpler substitute for Roman forms of government in a less complex society.

The new knowledge, yearly increased by continuing reconnaissance, is so extensive that adequate recording of the information can scarcely keep pace with the rate of discovery. Now that there are specialized collections in which the coverage of archaeological features amounts to hundreds of thousands of photographs, adequate identification, interpretation, plotting and indexing of the material has become an urgent task calling for staff with appropriate skills and experience. This is all the more important since a fraction only of the new information is ever likely to be printed on Ordnance Maps, however large the scale: indeed there are areas in Britain where the archaeological information, largely derived from aerial reconnaissance, far exceeds the modern conventional detail. The crisis brought about by this explosion of information is very real, not least because of the difficulty of checking all the results on the ground (Hampton and Palmer, 1977). It is no exaggeration to say that observations made in a single flight may call for hundreds of hours work on the part of trained field archaeologists. The gain in knowledge is so overwhelming as to have outstripped the possibility of immediate publication, and it is no wonder that there is a general lack of awareness of the position.

The preparation of distribution maps of archaeological features, however they have been recorded, is not difficult. But such maps can be only an approximation – made progressively more accurate by successive revisions – to the actual distribution, since varying patterns of land use and factors influencing flight-planning will bias the results. Thus, a single summer's flying may produce spectacular photographs that make significant additions to knowledge, but so limited a sample cannot be a sure guide to the archaeological potential of the area overflown, and contributes but a small quota to the actual distribution of archaeological sites. A

continuing programme of reconnaissance is essential to provide the fullest information. The infinitely varied pattern of the man-made landscape, in which archaeological features appear for the most part as minor details, often so faint as to be difficult to recognize, presents an aerial observer with a challenge. The factors that determine whether buried features are visible are for the most part well understood, though the limitations they impose are not always appreciated. The successful practice of observation from the air calls for an unusual combination of qualities. To the requirements of the necessary experience, and the specialized knowledge of at least one of the subjects served by the technique, there should be added extreme acuity of vision, a willingness to take an interest in a wide range of subjects outside an observer's own speciality, and the kind of mind that can switch from one subject to another in the few seconds of opportunity that flying affords.

In archaeology, aerial reconnaissance is generally recognized to be an indispensible means of research. Most information is likely to come from flights carefully planned with regard to problems calling for solution. Flying is expensive, and opportunities for photography may be restricted by weather or terrain: nevertheless under favourable conditions, aerial survey will yield results out of all proportion to its cost. Such conditions occur relatively seldom and may come at short notice: immediate need then arises for an aircraft and pilot with trained observer and camera. To maintain an aircraft on standby for archaeological work is uneconomic, and there is thus considerable advantage if archaeological survey can be organized as part of a comprehensive programme designed to serve many subjects. Only so is it possible to use to the full the varied opportunities that flying affords and incidentally to reduce to a minimum unproductive transit flights.

Results so far represent a small fraction only of the information awaiting recovery, nevertheless the new knowledge has profoundly altered already-existing distribution maps. In areas that have been most extensively reconnoitered, a developing pattern of human settlement over several millenia has begun to emerge. The

work has also brought a change of attitude to the conservation of the cultural heritage. Upstanding visible antiquities have long been accepted as an important part of the man-made landscape, but levelled and invisible sites have seemed of less concern, their very identification often depending upon some chance clue. That the number of buried, invisible sites of many periods of archaeology is greater than the total already known is now becoming recognized. Since these buried remains have survived untouched by previous excavators, much of their stratification and their structures may lie intact, so that they are often of great value for research, a fact with far-reaching implications for those concerned with decisions as to what to preserve and what not. Hitherto, most archaeological air reconnaissance has taken place over Western Europe and parts of the Middle East: as the work is extended to other lands, yet more of the cultural landscape will yield its secrets, a heritage that belongs to no single country alone, but one in which all the civilized world may claim a share.

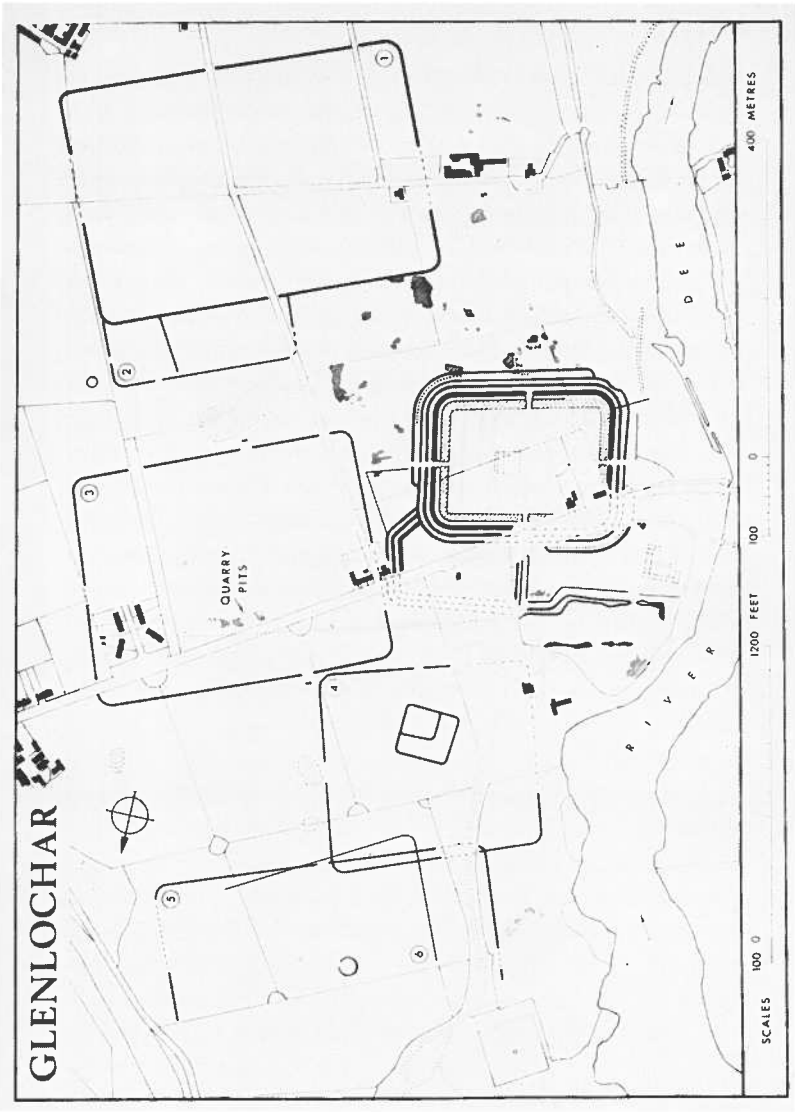

Fig. 1 Glenlochar, Kirkcudbright. A Roman military base beside the river Dee, in south-west Scotland. There are several superimposed forts, and a series of temporary camps spread over more than one kilometre of country. This plan has been prepared from aerial photographs taken over thirty years. (Compare pls. 16–17).

1 Crawford 1953, 45–6; Deuel 1973, 40; and see the 'Discussion' following Crawford's paper read in 1923 to the Royal Geographical Society: Crawford 1923, 360–6.

2 Compare, for example, the plans of crop marks published in R.C.H.M., England 1960, or those of the upper Thames valley in Benson and Miles 1974. The survey of the Fenland in Roman Times (Phillips 1970) and of field-systems between Mansfield and Doncaster (Riley 1980) are more recent essays in plotting on maps the details of ancient landscapes.

3 Richmond, I.A., *Journ. Roman Studies*, XXXIII (1943), 50–1.

4 See *e.g.* Phillips 1970, a study that draws on aerial photographs from various sources.

5 For the Stonehenge Avenue, see Crawford 1928, 13–5, pl.i; for Woodhenge, see Crawford, *Antiquity* I (1927), 99–100, and *idem* (1929a), 30 and 32, pls. xii–xiii; for Arminghall, Crawford, *Antiquity* III (1929), 257–9, pl. i, and Clark, J.G.D., *Proc. Prehist. Soc.* II (1936), 1–51 (excavations).

6 Wheeler, R.E.M., *Antiquity* III (1929), 182–7, plate.

7 For the aerial photographs in the Cambridge University Collection there is a catalogue and a detailed card-index arranged by locality and by subject. For vertical surveys, transparent 'cover traces' enable the areas photographed to be identified quickly.

8 See *e.g.* Hampton, J.N. in Wilson, D.R. ed. (1975), 118–25; R.C.H.M., Scotland (1976 onwards).

9 Also Bradford, J. and Williams-Hunt, P.R., Siticulosa Apulia, *Antiquity* XX (1946), 191–200, pls. i-iv; Bradford, J., *Antiquity* XXIII (1949), 58–72, pls. i-vi.

10 Agache, 1978, and many previous papers by the same author published by the Society of Antiquaries of Picardy.

11 For a recent example of the use of aerial photographs in Denmark as a guide to excavation, Nielsen, J.N., *Journ. of Danish Archaeology* I (1982), 105–17, fig. 2.

12 For aerial photographs of archaeological sites in Germany taken before 1938, see Crawford 1938.

13 Deuel 1973, chs. 9 and 10.

14 For the interpretation of aerial photographs of archaeological features, see Wilson 1982.

15 Scollar, I., in Wilson, D.R. ed. (1975), 52–9: Palmer, R., A computer method for transcribing information graphically from oblique aerial photographs, *Journ. Arch. Sci.* IV, 283–90.

16 This is well illustrated by plans of crop marks at Mucking, Essex of features that indicate settlement from Neolithic to modern times, and at Gosbecks, south-west of Colchester (Iron Age and Roman): see *Aerial Archaeology* IV, (1980) figs. 32 and 34.

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The photographs were all taken over England with the exception of Nos. 3, 19 and 24. The oblique views are from a height of some 400 to 500 m above ground level.

1 East Walton Common, Norfolk. A fragment of the Quaternary land surface is preserved in this small area that has never been cultivated. *July, 1968.*

2 The Fenland, near Chatteris, Cambridgeshire. This vertical photograph has recorded two entirely different landscapes. The curving bands, light in tone, mark extinct waterways with their tributaries and creeks that were in being before the fens were drained. They are in complete contrast with the neat pattern of rectangular fields, established after the drainage of the Fenland in the seventeenth century. The whole area is given over to arable cultivation, and the black peaty soil contrasts with the light coloured silt of the old river courses. *Scale: c. 1:27,000. April, 1969.*

3 Samarra, Iraq. A vertical photograph which records a small part of the caliphate city established in the ninth century. Elaborate buildings, palaces, town-houses, and processional roads appear clearly, being masked only by a light covering of sand. The remains extend over some 40 km beside the Tigris to the NNW of Baghdad. *Scale: c. 1:5,000. About 1919.*

4 Orsett, Essex. A prehistoric enclosure comprising three circuits of interrupted ditch revealed by crop marks. The site which lies on a gravel terrace of the river Thames amongst an abundance of other crop marks, is almost certainly the oldest archaeological feature in the area. *Scale: c. 1:1,200. June, 1970.*

5 Henge, Hutton Moor, Yorkshire. A ritual monument consisting of a great bank perhaps 100m in diameter with inner and outer ditches, all interrupted for entrances at opposite ends of a diagonal. The remains, which have been considerably flattened by long continued ploughing, are seen by differential growth in a crop of wheat. *July, 1949.*

6 Barrow cemetery, Carnaby, Yorkshire. A cemetery comprising some hundreds of burials each of which is surrounded by a shallow ditch in the form of a square. At the centre of each square an interment pit is usually visible. This site, which was discovered by aerial reconnaissance, lies on gravel: a number of similar cemeteries are known on the chalk wolds of the East Riding. *August, 1970.*

7 Barrow Hills, Radley, Oxon. Crop marks in a field of wheat reveal several ring-ditches of Bronze Age barrows: a double-ditched rectangle – possibly a mortuary enclosure, circular settings of pits for timber uprights and small square shapes, possibly *grubenhaüser*. A number of graves may just be discerned near the centre of the photograph. The photograph is a good illustration of the variety of structures that come to light in a single field. *June, 1959.*

8 Hill fort, Herefordshire Beacon. An Iron Age hill fort, roughly circular in shape, has been enlarged by the construction of wing-like extensions along the crest-line of the hill.
Within the nearer wing, slight scoops, or hollows, probably indicate the position of huts. The small earthworks at the very summit are usually taken to be the remains of a Norman earth-and-timber castle. *June, 1964.*

9 'The Roveries', Salop. These crop marks of an apparently simple enclosure defended by two ditches, are representative of many such sites in the Welsh Marches, and elsewhere. Only the larger disturbances in the soil have caused crop marks.
Gullies, pits, foundation trenches and post-holes fur huts may well be present but such shallow structures seldom affect the crop. The precise character and date can only be determined by excavation. *July, 1967.*

10 Ewe Close, Cumbria. This Romano-British farming settlement lies on a part of the limestone fells that has never been ploughed in modern times so that the remains are exceptionally well preserved. In this photograph, taken in winter, the oblique sunlight picks out details of the earthworks so that successive development stages of the settlement can be distinguished. *January, 1967.*

11 Orton Waterville, Huntingdon. An extraordinary complex of buried archaeological features is revealed in a field of wheat. They have caused differences of a few centimetres in height of growth of the crop, and these are emphasized by the slanting sunlight. There are ditches, recut time and again, pits and post-holes, which probably belong to an Iron Age settlement laid out on a gravel terrace of the river Nene. *June, 1966.*

12 Butterwick, Yorkshire. These crop marks occupy the floor of a small dry valley in the Wolds of Yorkshire. They reveal the plan of a prehistoric (Iron Age) settlement of bewildering complexity. The value of such a photograph to a would-be excavator is evident, for it shows in general terms what he is going to find and where to find it. *June, 1970.*

13 Kelmscot, Oxon. A settlement of the Iron Age or 'Roman Iron Age', on the gravels of the river Thames, west of Oxford. The crop marks suggest that there were different phases of occupation, as the ditches and some of the enclosures for huts have been recut many times. *July, 1959.*

14 The Parks, Oxford. The photograph demonstrates the effect of drought on the mown grass of a playing field within the city of Oxford. It also permits conjecture as to how much archaeology has been lost beneath the nineteenth and twentieth century building-spread of large towns. *September, 1976.*

15 Risingham, Northumberland. The remains of this Roman fort of 1.8 ha., form a bold platform beside the river Rede, 16 km north of Hadrian's Wall. The fort is known to have been occupied from the second to the fourth century. The visible buildings in the interior are so irregular as to suggest that

they belong to a very late Roman phase, or that they are the work of squatters who in a later age established themselves within the Roman defences. *January, 1967.*

16, 17 Glenlochar, Kirkcudbright. Both these photographs show the site of an important Roman base in south-west Scotland. The first view, taken in a normal summer, reveals no ancient features. In the second, taken during a severe drought, a large Roman fort (3.4 ha.) is visible in all essential details of the plan. Text-fig. 1, prepared from photographs taken over many years, shows the fort and a whole range of temporary camps beside it. None of these are ordinarily visible on the surface. *July, 1949 and July, 1953.*

18 Wroxeter, Salop. Almost the whole of this Roman provincial town (of 75 ha.) lies in farmland, and photography repeated year by year has revealed much of the plan of buried buildings. This photograph shows large town-houses with courtyards, corridors and ranges of rooms. In other parts of the town, public buildings, temples and shops have been recorded. *July, 1949.*

19 Villers-sous-Ailly, Somme, France. Aerial view of the plan of a small Gallo-Roman villa: principal building with gallery facade and corner towers. Photo R. Agache. *March 1973.*

20 Grassington, Yorkshire. Romano-British farming settlements and field systems established on a limestone terrace beside the river Wharfe. The ground is snow-covered and the remains are picked out by sunlight reflected from the crests and slopes of the earthworks. The impression gained is that the farming was much more intensive then than now, when the whole area has reverted to sheep grazing. *Scale: c. 1: 5000. February, 1973.*

21 Fenland, Spalding Common, Lincolnshire. The fertile silt fens in the flat country west of Spalding were exploited in Roman times. The photograph is an interesting record of planned land use on a large scale. A straight length of main road is picked out by the side-ditches: branch roads lead to farmstead sites. Buildings do not appear, but the rectangular enclosures around them (as in the foreground) are clear enough. The

meandering black lines represent the natural water courses from a time before the fens were drained. *March, 1954.*

22 Old Yeavering, Northumberland. This site must be amongst the most interesting archaeological discoveries ever made in Britain by aerial reconnaissance. The photograph shows the plan of a number of timber halls and other buildings, besides ditches outlining part of a Dark Age fort. Extensive excavation has shown this to be an Anglo-British centre of early Northumbria – in all probability the *Ad Gefrin* of Bede where King Edwin had a northern palace, and where Paulinus preached Christianity in 627, achieving mass conversions. *July, 1949.*

23 Warborough, Oxon. A number of rectangular enclosures are visible near the edge of a gravel terrace beside a small tributary of the Thames. The site lies 1 km east of the well known Augustinian Abbey at Dorchester. Within the right-hand enclosure are many small regularly oriented marks, apparently of an early Christian cemetery. Further to the left are traces of timber buildings. It would be interesting to know whether these timber structures may have belonged to the College of secular canons established at Dorchester in the seventh century, or to cathedral buildings from the time when Dorchester first became a bishop's see. *June, 1962.*

24 Staa, north-west of Vester Hasing, Aalborg, Jutland. A dark growth of corn reveals the position of a number of houses with floors dug down into the gravel subsoil. The houses are up to 35 m long. Short of excavation, their date can only be conjectured, but the boat-shaped plan of three of the buildings suggests that they may belong to the Viking age. *June, 1967.*

25 Ingarsby, Leicestershire. These earthworks mark the site of a medieval village that flourished in the fourteenth century and has now long been abandoned. The hollow ways of the streets and lanes, the position of a village green, and the boundaries between crofts can be discerned in the snow-covered surface. The desertion which probably took place between 1450 and 1550 was probably due to a change in agricultural practice from arable to sheep farming. *February, 1978.*

26 Gainsthorpe, Lincolnshire. This deserted medieval village lies on a belt of limestone, 30 km north of Lincoln. The even tone of the surface, caused by a light covering of snow, combined with oblique winter sunshine has enabled not only the lanes and boundaries of the village to be recorded but also many individual buildings. *February, 1978.*

27 York. Many aspects of the growth and planning of an ancient and modern city can be more readily discerned on aerial photographs than in any plans yet available. This ground at the confluence of the river Ouse with its tributary the Foss, was first chosen by the Romans as the site of a legionary fortress. North lies towards the top left-hand corner. Near the Minster, the web of winding streets, with small, closely packed buildings, represent medieval York clasped with in the great Plantagenet earthen bank that formed the city's defence. The sprawling housing estates of the last century and a half, and the great railway station (bottom left-hand corner) testify to the city's continued development as a centre of trade and communications. *April, 1973.*

28 Padbury, Buckinghamshire. This photograph records two different agricultural landscapes. The medieval landscape of 'open fields' with arable land in ridge and furrow, and the modern landscape here created by lines radiating from the village centre – evidently the lines laid down by the enclosure surveyors nearly three centuries ago. *May, 1953.*

29 Oreton Common, Farlow, Salop. The small mounds somewhat like prehistoric barrows are composed of earth and waste rock from the excavation of shallow coal-pits. The site of each shaft is marked by a hollow in the centre of each mound. Such earthworks which occur on coal-bearing formations in different parts of Britain are an interesting aspect of 'industrial archaeology'. At Farlow, the pits may be of seventeenth or early eighteenth century date. Part of this waste land has since been enclosed by squatters: their small fields overlie some of the waste heaps. *December, 1965.*

Plate 1
East Walton Common, Norfolk. A fragment of the Quatenary land surface.

Plate 2
The Fenland, near Chatteris, Cambridgeshire. Two contrasting landscapes: the old river courses and the superimposed pattern of cultivation.

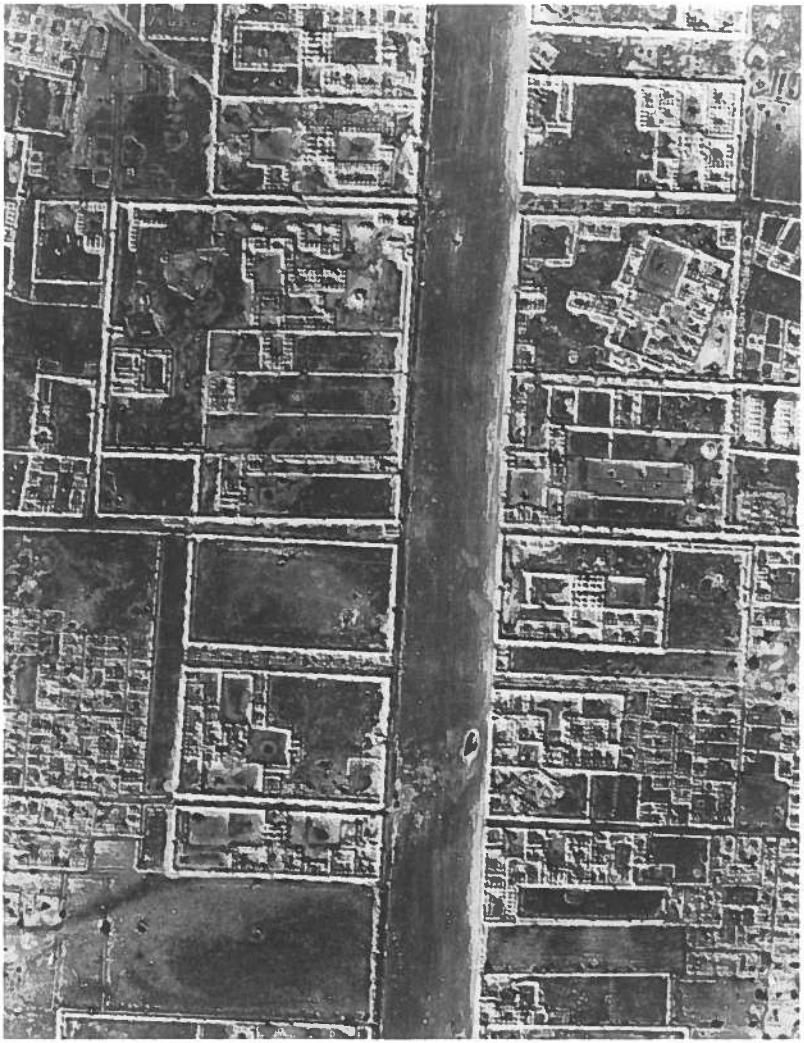

Plate 3
Samarra, Iraq. Medieval city.

Plate 4
Orsett, Essex. Prehistoric enclosure.

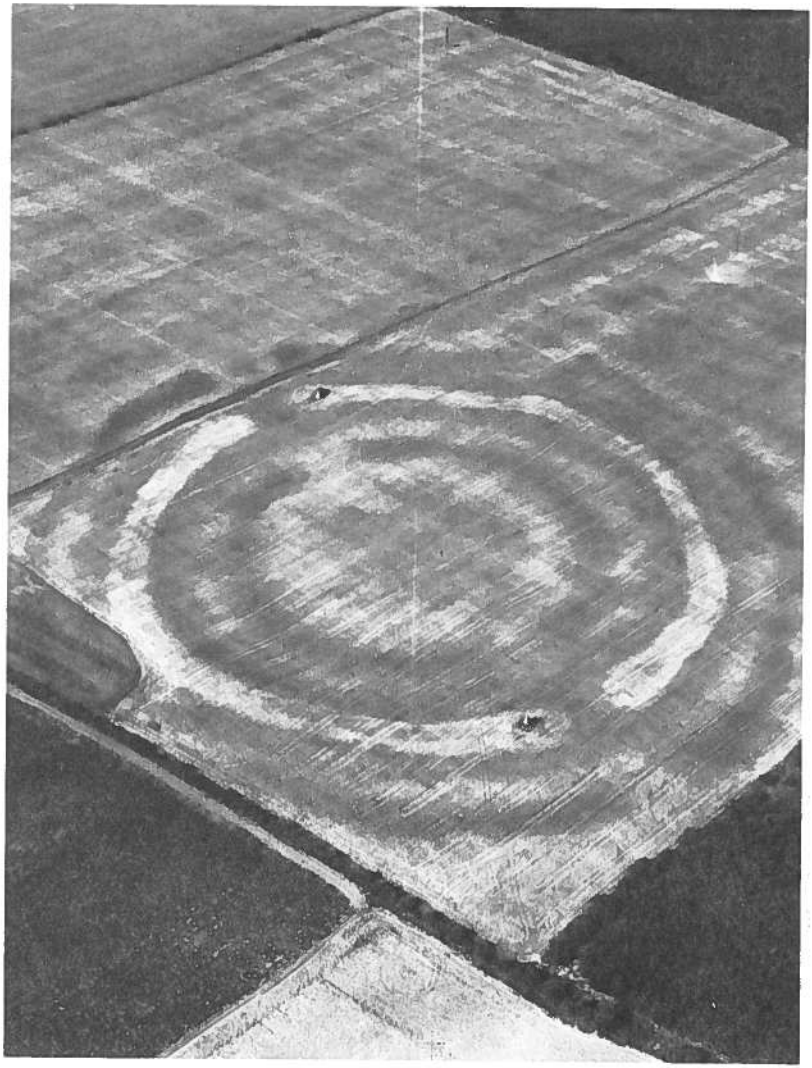

Plate 5
Hutton Moor, Yorkshire. Henge monument.

Plate *6*
Carnaby, Yorkshire. Barrow cemetery.

Plate 7
Radley, Oxon. Bronze Age barrows and other features.

Plate 8
Beacon, Herefordshire. Iron Age hillford.

Plate 9
'The Roveries', Salop. Enclosure.

Plate 10
Ewe Close, Cumbria. Romano-British farming settlement.

Plate 11
Orton Waterville, Huntingdon. Probably Iron Age settlement.

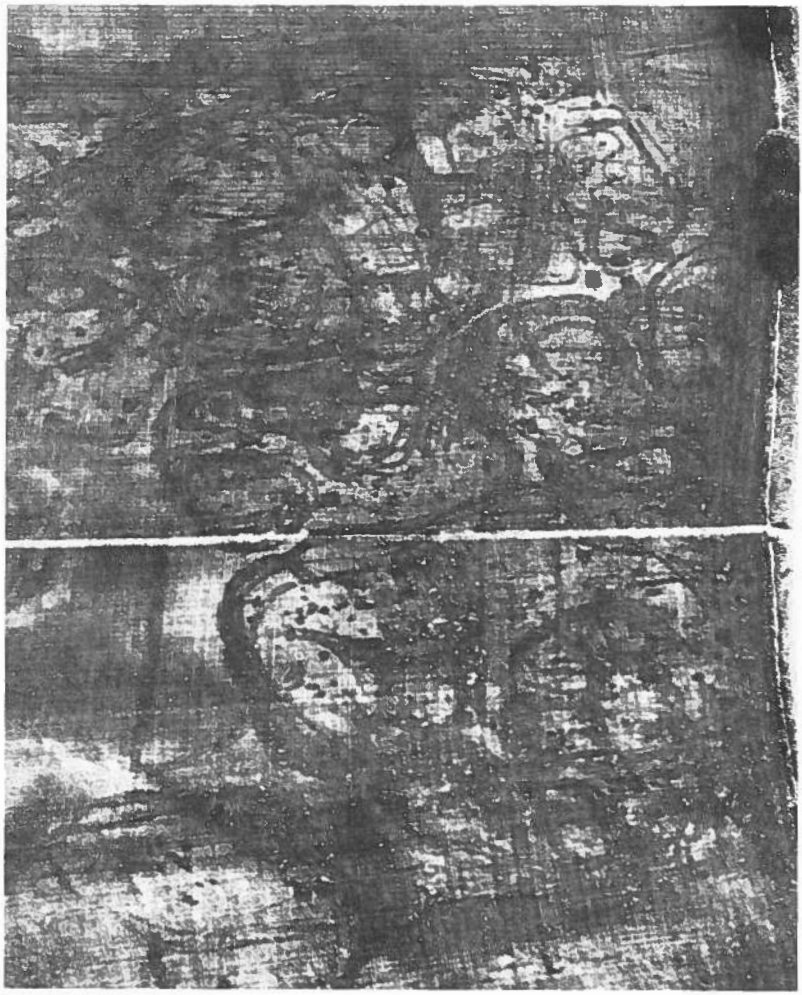

Plate 12
Butterwick, Yorkshire. Iron Age settlement

Plate 13
Kelmskot, Oxon. Iron Age or 'Roman Iron Age' settlement.

Plate 14
The Parks, Oxford. Archaeological remains within the city of Oxford.

Plate 15
Risingham, Northumberland. Roman fort.

Plate 16
Glenlochar, Kirkcudbright. The site of a Roman fort, taken in a normal summer. See plate 17.

Plate 17
Glenlochar, Kirkcudbright. The same site as plate 16 taken during a severe drought.

Plate 18
Wroxeter, Salop. Roman provincial town.

Plate 19
Villers-sous-Ailly, Somme, France. Small Gallo-Roman villa.

Plate 20
Grassington, Yorkshire. Romano-British farming settlements and field systems.

Plate 21
Spalding Common, Lincolnshire. Planned land use on a large scale in Roman times.

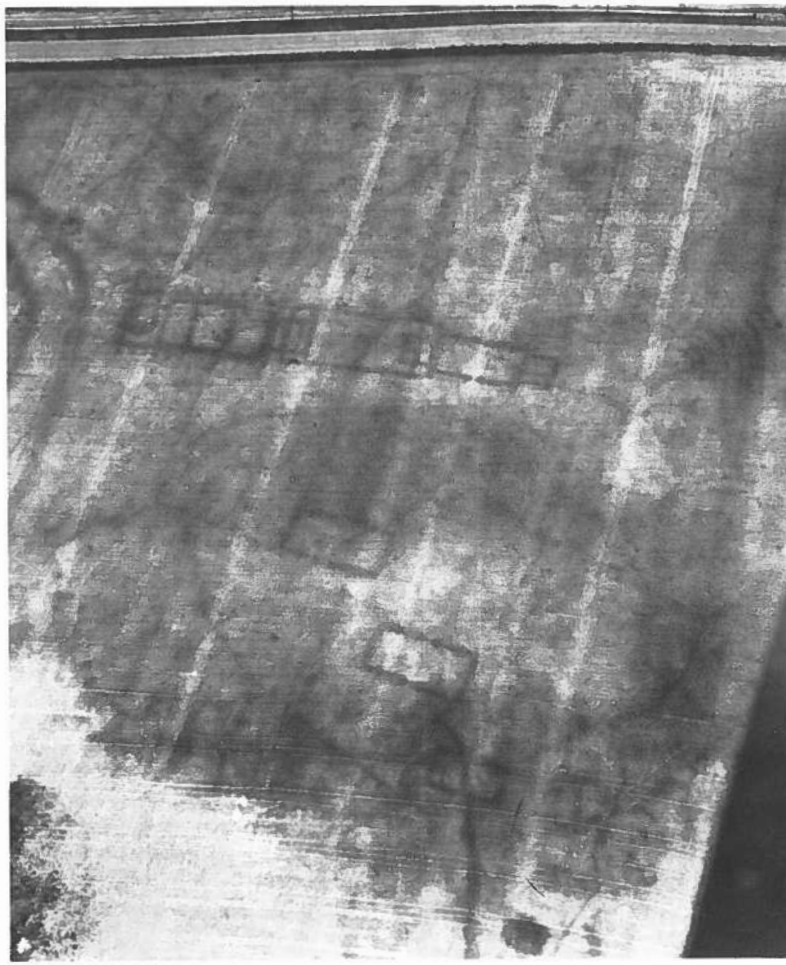

Plate 22
Old Yeavering, Northumberland. An Anglo-British centre of early Northumbria.

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Plate 23

Warborough, Oxon. Early Christian cemetery and traces of timber buildings.

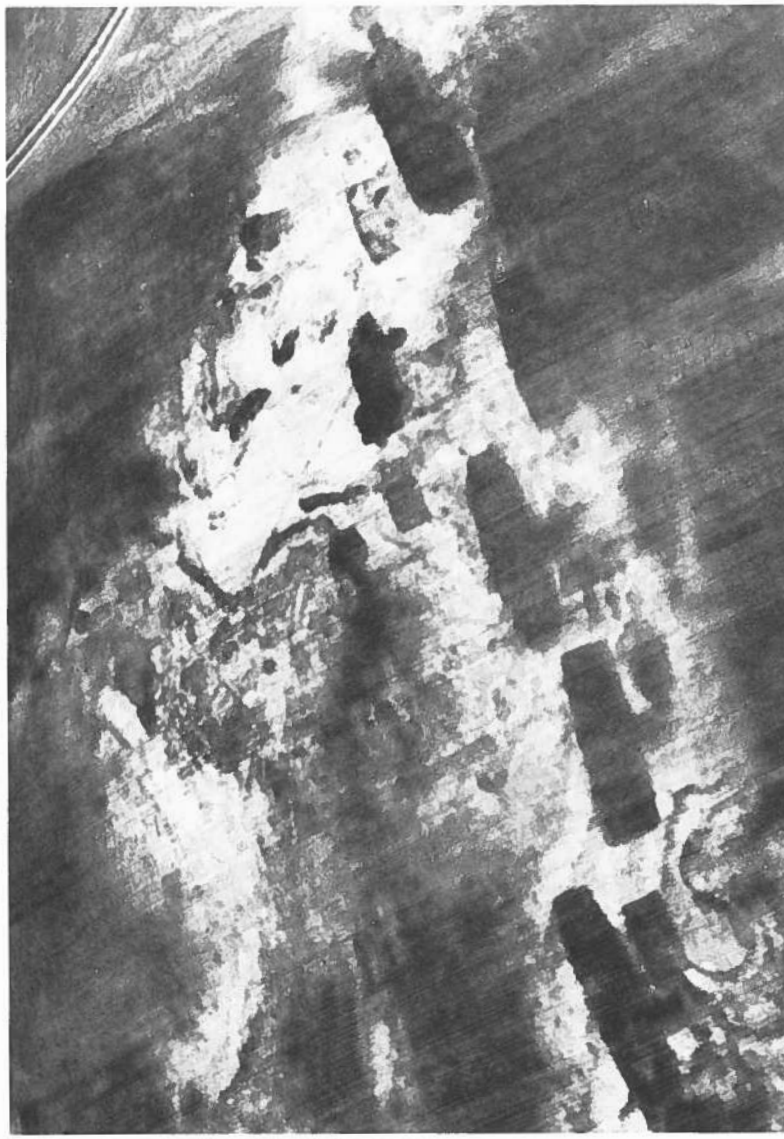

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Plate 24
Staa, Aalborg, Jutland. Boat-shaped houses, probably belonging to the Viking age.

Plate 25
Ingarsby, Leicestershire. Deserted medieval village.

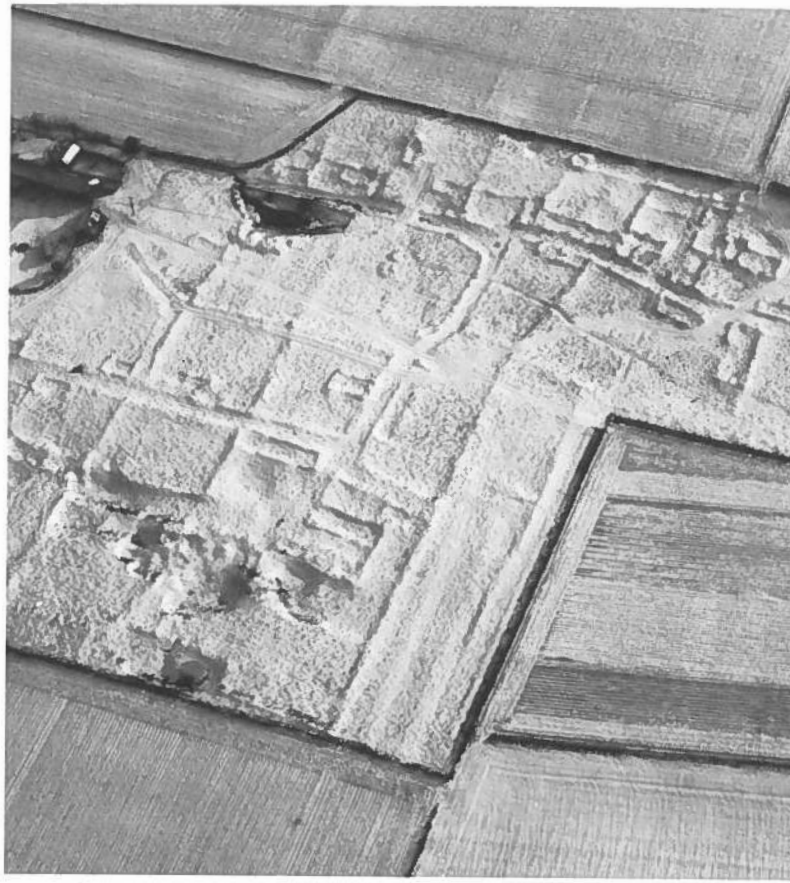

Plate 26
Gainsthorpe, Lincolnshire. Deserted medieval village.

Plate 27
York. The growth and planning of an ancient and a modern city.

Plate 28
Padbury, Buckinghamshire. Two different agricultural landscapes.

Plate 29
Oreton Common, Farlow, Salop. 'Industrial archaeology': small mounds of waste material from shallow coal pits.