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The Contribution of Aerial Photography to Archaeology in Jordan: with special reference to the Roman period

What distracted me all the time was the unexpected view of the villas and gardens of Roman Branchidae. I would never willingly dig again without air reconnaissance.

(Sir John Myres, Lecturer in Ancient History at Christ Church, Oxford, 1895–1907, recounting his flight as an artillary observer for the fleet over Turkish Didyma in 1916[1].)

Aerial photography is one of the older techniques available to the archaeologist: the first aerial photograph of an archaeological site—Stonehenge viewed from a balloon—was taken as long ago as 1906[2]. Although subsequent developments were slow, the improvement of aircraft design and the need for aerial reconnaissance during the First World War gave the new technique an impetus which soon pushed it into the forefront of archaeological methods. In any examination of the early pioneers of the technique it is evident that the major work and the great developments in application were made in Western Europe and North America, but equally, one should not overlook the activities of aerial photographers in the Middle East. Indeed, some of the very earliest aerial archaeology took place in the Middle East, and it was undoubtedly amongst the most spectacular.

A small beginning was made as early as 1913, in the Sudan, where Sir Henry Wellcome experimented with cameras suspended from kites to photograph his excavations; in 1916, Theodore Wiegand, took aerial photographs of archaeological sites in the Sinai Desert; and, further east, in Iraq, Col. Beazeley discovered that the bewildering ground traces around the site of the ninth century Islamic city of Samarra, were transformed into the clearly laid out lines of an extensive city with many miles of streets, houses, palaces and gardens along the banks of the Tigris[3]. The earliest such archaeological photographs known for Jordan are dated to 1922, but I have heard of two aerial mosaics covering Amman and Salt which were taken by the Royal Flying Corps and must, therefore, be dated to 1917–18 at the latest. Fortunately the stimulus given to aerial archaeology in the Middle East by the Great War was not lost; indeed, work between the two wars centred on Iraq, Syria and Jordan amongst the Arab lands. Most of the activity was carried out by two great explorers. In 1926, Père Antoine Poidebard, began his great surveys over Syria which continued with little interruption for almost 16 years and culminated in his magnificent books on the Roman *limes* and another on the ancient city of Tyre[4]. Scholars today are less inclined to accept all of his interpretations and conclusions but it is no exaggeration to say that Poidebard massively extended what was known and completely revolutionised our understanding of the eastern desert frontier[5]. Furthermore, many of his discoveries would never have been traced by ground survey and such a field survey without the aid of aerial reconnaissance would have been more than a lifetime's work for a whole team of archaeologists. So much was discovered that even now, almost half a century later, very little of Poidebard's material has been exploited by field archaeologists[6].

On a less intensive scale and less well-known are the surveys from the air by the British explorer Sir Aurel Stein. Stein's interest stemmed from his remarkable journeys of exploration into Russian and Chinese central Asia and into Persia, as a result of which he developed a keen awareness of the potential contribution of the aerial photograph to the archaeologist working in remote and rugged terrain[7]. Personal contact with Poidebard, whose work he greatly admired, gave him the idea of extending the Frenchman's

[1] Quoted by T. J. Dunbabin in his obituary for Myres in the *Proceedings of the British Academy*, 1955, 357.

[2] J. E. Capper, *Archaeologia*, 60 (1907), 571, PLS 69–70. For a convenient and highly readable account of the history of aerial archaeology, the reader is referred to L. Deuel, *Flights into Yesterday*, Pelican, 1973. The standard work on aerial archaeology—now 25 years old but still unsurpassed—is J. Bradford, *Ancient Landscapes*, London, 1957 (reprinted 1974).

[3] G. A. Beazeley, 'Surveys in Mesopotamia during the War', *GJ*, 1920, 109–27.

[4] A. Poidebard, *La Trace de Rome dans le desert de Syrie*, Paris, 1934; *Le Limes de Chalcis*, Paris, 1945 (with R. Mouterde); *Un grand port disparu, Tyr*, Paris, 1939.

[5] For assessments of Poidebard's contribution see the reviews by Sir George MacDonald, *Antiquity*, December, 1934, 373–80 and by Sir Aurel Stein, *GJ*, 87 (1936), 66–76; *cf.* the account in Deuel, 94–112.

[6] *Cf.* M. Hassall, *PEQ*, 104 (1972) 159f. and Bradford, *loc. cit.*, 4; Poidebard, *La Trace de Rome*, 14.

[7] See the obituary by C. E. A. W. Oldham, *Proc. Brit. Acad.* 29 (1943), 329–48; esp. 338f. and the recent biography by J. Mirsky, *Aurel Stein*, Chicago, 1977, 459, 494, 509f.

work in Syria by complementary aerial surveys over Iraq and Transjordan which would complete the map of the Roman *limes* from the Tigris to the Red Sea. Stein's interim reports—infuriatingly vague from so meticulous a man—announced exciting new discoveries in both areas during his surveys of 1938 and 1939[8]. Unfortunately the Second World War prevented immediate publication and, at the time of his death, in Kabul in 1943, Stein was still voicing anxiety over the safety of those of his aerial photographs which he had had to leave behind on the airfields of the Middle East when he had ended his survey.

Finally, in this brief survey of early pioneers, in which the services of both the French and British air forces were vital, two men, both serving members of the Royal Air Force, and both in Jordan, deserve mention *honoris causa*. Flight Lieutenant P. E. Maitland was the first to publish—in 1927—aerial views together with discussion, of what he called 'The Works of the Old Men': the complex of walls, enclosures and other man-made structures to be found in the north east of Jordan and overlapping into Syria, Iraq and Saudi Arabia[9]. Two years later, in 1929, Group Captain L. W. B. Rees, VC, commander of the Royal Air Force in Transjordan from 1927 to 1929, produced his own publication in the same journal. Rees, an enthusiastic amateur archaeologist, produced more aerial photographs and commentary on sites in Jordan which underlined even more convincingly just what could be achieved from the air in archaeology[10].

Contribution of aerial archaeology

Aerial archaeology and photographic interpretation are now mature and highly skilled techniques; some would call aerial archaeology a science, still others have sought to make it an independent discipline. For that first photograph of Stonehenge in 1906, and for many subsequent photographs, such as those of Wiegand, the aircraft or balloon was being used as little more than an elevated platform from which a novel perspective could be gained. Photographs such as those of Beazeley in Iraq had clearly begun to reveal that the aerial view was not simply to be regarded as a curiosity but as an important means of learning more about a site. Aerial photographs were already making contributions ranging from simply aiding understanding by placing a site in its local geographical context or illuminating its character by means of the bird's-eye view, through to revealing features, invisible on the ground, both around known structures and in regions where nothing of any sort was even suspected from surface examination.

The major breakthrough in aerial archaeology came with this revelation that from the air one could 'see' features which were too slight to be noticed by or intelligible to a ground viewer, and to 'see' features *totally* buried which left no visible trace in the configuration of the land. For the first category, one has only to think of Crawford's discovery of the Roman siegeworks and encampments around the city of Hatra in Iraq[11]. Invisible buried features such as the ditches of the Roman road from Palmyra to Hit were picked up by Poidebard in Syria and the discovery of such buried features is now well-established.

The principles on which these techniques are founded are essentially very simple though there are a bewildering number of permutations of each, and knowing when and where archaeological features may be 'found' is a highly skilled task[12]. They may be briefly summarised: where remains exist on the ground surface but are slight or unintelligible, their character may be revealed by viewing them at particular times of the day. The principle is simple: seen from the air in the middle of the day there is little detectable tonal difference between the feature and the background; seen in early morning or late afternoon when the sun is low, even the slightest banks cast a dark shadow or produce a highlight which is tonally detectable. Once it was discovered that the time of day mattered, people such as Poidebard could begin to find these *shadow sites* with much more success. Next, there are buried features. In essence, if a pit, a trench, or a ditch is dug, the soil in and over that disturbance will be darker, richer and will retain moisture longer. Consequently, in spring when the land is drying out, these buried features will take longer to lose their moisture and from the air will appear as dark *soil marks*, especially if ploughing brings the soil to the surface. A good example is the fourth century Roman fort at Scaftworth, Yorkshire, totally invisible on the ground, but clearly revealed by the dark soil of the ditches. Later, when crops, grass and even weeds begin to grow on the land, those that are over the top of the pit or ditch will have more moisture and will grow faster and ripen faster than those on either side. Viewed at different times it will stand out first as a darker green as it grows and later it will begin to turn yellow when everything else is still green. Again, the process could be seen at Scaftworth later in the same year. These *crop, weed or parch marks* work in exactly the same way but in reverse, if the buried feature is a wall. Then, of course, there will be less moisture and the cramped roots of the plants will be slow to develop. The technique has been used to discover the outline of buried structures in the western Mediterranean and to trace buried road surfaces such as that leading south from Athens. One of the most celebrated examples of crop-marking comes

[8] A. Stein, *GJ*, 92 (1938), 62–6; *JRAS*, 191 (1938), 423–6; *GJ*, 95 (1940), 428–38; *JRAS*, 194 (1941), 299–316.

[9] C. E. Maitland, '"The Works of the Old Men" in Arabia', *Antiquity*, I (1927), 196–203; *cf.* Bradford, 51f.

[10] L. W. B. Rees, VC, 'The Trans-Jordan Desert', *Antiquity*, III (1929), 389–406; and ibid 89–92. *Cf.* Bradford's remarks, *loc. cit.*, 51, n3.

[11] O. G. S. Crawford, 'Air Photographs of the Middle East', *GJ*, 73 (1929), 501f.; *cf.* Crawford's autobiography, *Said and Done*, London, 1955, 193f. The subsequent examination of the photographs by Bradford, *loc. cit.*, 71–5 is important, some of them being those taken for Stein in 1938–9.

[12] One of the best treatments is that by D. N. Riley, 'The Technique of Air Archaeology', *Archaeological Journal*, 133 (1946), 1–16. Bradford, *loc. cit.*, 1–84, esp. 13–84 is excellent. Refinements and discussion continue: see for example J. N. Hampton, R. Palmer *et al.*, 'Implications of Aerial Photography for Archaeology', *Archaeological Journal*, 134 (1977), 157–93 and D. R. Wilson (ed.), *Aerial Reconnaissance for Archaeology*, CBA Research Report No. 12, London, 1975.

from only a few miles east of Oxford at the Roman villa of Ditchley where the house, barn, well, threshing-floor, enclosure wall and drive-way all stand out in the crops and can be drawn with ease from the photograph[13]. In Syria, Poidebard discovered that the best time to find soil marks was in the early spring as the land dried out, while differential crop or weed marks appeared best in the rains of autumn or the spring, both periods of rapid growth[14].

In short, aerial archaeology has revolutionised archaeological work in many countries and given some archaeologists an embarrassment of material. Its principal contribution is not in the number of discoveries themselves but in very forcefully revealing that the large, well-known sites are merely the tip of an iceberg and are all too often quite unrepresentative of their period. Today, in several countries, the many thousands of flimsy buried remains detected from the air are being mapped and investigated, and archaeologists are turning more to look at entire landscapes rather than just isolated sites within a landscape. Some of the techniques which have made discovery and interpretation possible have already been proven in the Middle East. There is no reason to doubt that they cannot all be employed in Jordan to our considerable benefit, and I shall turn now to looking at a number of recent specific cases from both the Middle East in general and from Jordan in particular.

Case studies—Middle East

The great programmes of aerial archaeological research of Poidebard and Stein at the eastern end of the Mediterranean were not continued after the Second World War. Nevertheless, there have been a number of important contributions in various areas of the Middle East from Algeria to Iraq. The most significant has been the research of Jean Baradez on the Roman *limes* in southern Algeria[15]. Baradez employed the well-established techniques of Poidebard and Crawford utilising, principally, existing vertical photographs, and recovered a detailed plan of the frontier installations and settlements along the desert's edge. Further east, in Libya, R. G. Goodchild too employed aerial photography to locate the remains of settlements of the classical period[16]. On the coast of North Africa, Royal Air Force vertical photographs taken in 1943 over Tunisia have been used to good effect to reveal not only the well-known harbours of Carthage but also the traces off-shore of innundated quays and, inland, something of the land usage in Roman times is preserved in the striking and widespread traces of centuriation blocks[17]. In the coastal area of Cyrenaica, aerial photography has recently played an important part in clarifying the nature of various settlements[18].

At the other end of the Arab world, John Bradford produced aerial photographs not only of such well-known sites as Hatra, Nimrud and Samarra but also a magnificent view of a little-known and inaccessible stretch of Roman road fronted by a stone wall on a Royal Air Force photograph of 1938–9[19].

In Syria there have been still more significant developments. Useful work has been done around both Dura-Europos and Palmyra from aerial photographs[20] but the most important development has been at Homs, the Roman city of Emesa. Emesa became a Roman *colonia* in the early third century[21]. Like other eastern cities granted the title *colonia* at this time it has usually been thought of simply as a change of legal status giving the inhabitants certain privileges but not involving the procedure of earlier times by which new settlers were brought in and land measured out and distributed to them in regular blocks. In the course of examining some vertical aerial photographs of the Emesa area, van Lière observed that one could detect in the modern road and field layout on the eastern side of the city, the clear traces of the centuriation which one associates with traditional Roman *coloniae*[22]. Centuriation is well-known and extensive in the western half of the Roman Empire in France, Italy, Yugoslavia and Tunisia but, until this discovery at Emesa, none had ever been reported anywhere in the lands from Turkey to Egypt[23]. The discovery is important historically too, since it is now evident that the change of status need not have been merely a change in legal privileges for the existing citizens but clearly involved the introduction of new settlers to whom land was allocated. Not only must historians modify their views about the practical effects of such grants of colonial status in the third century, but archaeologists should also be alive to the possibility of such evidence being found around other late Roman *coloniae* throughout the East: especially those such as Singara and Resaina in Mesopotamia with garrisons whose veterans would have made suitable colonists. The importance of van Lière's discovery cannot be over-emphasised: as is well-known, such centuriation is very difficult to detect on the ground and only the most detailed of maps would have allowed it to be picked up. But for the aerial photographs, this area of centuriation would have remained unknown still.

Finally, before turning to look at Jordan, it is interesting to note the use of aerial photographs by the survey teams working in Saudi Arabia. Despite the small scale—1:60,000—they were able to employ them effectively in the

[13] Photographs are reproduced by Deuel as plates 10 and 11; *cf.* p. 84, FIG. 12.

[14] *La Trace de Rome*, 105–7.

[15] J. Baradez, *La Vue aérienne: Fossatum Africae*, Paris, 1949.

[16] R. G. Goodchild, *Libyan Studies*, London, 1976.

[17] H. Hurst, *Archaeological Journal*, 55 (1975), 11–40, and R. A. Yorke and J. H. Little, *International Journal of Nautical Archaeology and Underwater Exploration*, 4 (1975), 85–101.

[18] G. D. B. Jones and J. H. Little, 'Coastal settlement in Cyrenaica', *JRS*, 61 (1971), 64–79.

[19] *Op. cit.*, PLS 24, 19 and 18.

[20] J. Johnson, 'The Dura Air Photographs', *Archaeology*, September, 1950, 158–9; D. Crouch, 'Use of Aerial Photography at Palmyra: a Photo Essay', *Berytus*, 22 (1974), 71–104.

[21] Digest, 50.15.1.4.

[22] W. J. van Lière, 'Ager Centuriatus of the Roman Colonia of Emesa (Homs)', *AAAS*, 8–9 (1958–9), 55–8.

[23] Bradford, *op. cit.*, 145–216.

detection of networks of canals spreading out from some major springs.[24]

Case studies—Jordan

The single most extensive piece of aerial archaeology carried out in Jordan was the survey of Sir Aurel Stein in 1939 covering, as it did, the steppe and lava areas from H5 to the Gulf of Aqaba. Stein's notes show that over two hundred aerial photographs were taken for him by the RAF of specific archaeological features in this area and it is tragic that they seem not to have survived. Fortunately, a quantity of material—some going back to 1922—*is* available still and my immediate intention is to examine a few specific areas in which this can be exploited before going on to a more general discussion of the contribution of aerial photography to archaeological work in Jordan.

Qasr Bayir, quite well-preserved until this century, was tragically destroyed in 1929 when the British military authorities sanctioned the building of a police post nearby which made use of the Roman material[25]. Fortunately, the site had been visited by Brünnow and Domaszewski a generation before and, as a useful complement, this Royal Air Force vertical view of 1927 records the fort and its immediate vicinity. I need hardly say that the value of aerial photographs for simply making a record of sites is immense.

Almost 80 years ago the members of the Princeton University Expedition visited *Qasr el-Hallabat*, recorded many inscriptions and planned the fort and mosque[26]. Their two visits were very short ones—on the first occasion they were driven off by a snow storm—and it would not be just to fault them for not preparing a full site plan. Nevertheless, as any visitor to Hallabat knows, the fort is only the centre of a complex of ancient remains most of which are now protected with a fence erected by the Department of Antiquities. Just outside the fence, however, lie some remains which make a splendid shadow site. The traces are visible on the ground but show up to best advantage when viewed both obliquely with the sun low, and vertically.

The numerous archaeological remains around and at the foot of the slopes on which the fort stands would have required considerable time and effort if traditional planning methods had been employed. As it was, we were able to concentrate our efforts on preparing detailed plans of individual structures in the time at our disposal. A site plan (see FIG. 1) of all the known features was prepared months later in England working from a series of vertical aerial prints of the site and environs. For all *practical* purposes it is clear that this site plan is perfectly satisfactory[27]. On the other hand, the availability of the photographs enabled us to devote the time of expensive field-work to tasks *which could only be carried out on the ground.*

It has been known for some years that amongst the many walls and man-made features in the north-eastern desert, was a wall to the north-east of Qasr el-Hallabat (see FIG. 2) which was distinctive because of its perfect straightness; the inference was made that it was Roman and it was associated with the fort[28]. Attempts to find this wall occupied the better part of two days searching in the difficult area of lava boulders, until we were guided to it by a local policeman who himself had a great deal of difficulty re-locating it. The character of the wall was easily determined but the task of plotting it on a map, measuring it and determining its relation to the fort some miles away was considerably eased by subsequent access to some aerial photographs. These again allowed mapping to be carried out in England while the time in the field was devoted to detailed examination. It need scarcely be said that the location of the wall would have been much easier had I waited a few days until the photographs were available.

My final example is from the oasis of *Azraq*. Today the well-preserved remains of the *castellum* beside the northern pools are surrounded by the Druse village which laps close up to the walls. In view of the very considerable importance of the site beside a major water source and at the head of the great Wadi Sirhan route down into Saudi Arabia one does not need specific evidence before proposing that the location would have been occupied from very early times onwards[29]. In short, the modern village is probably built over the remains of earlier structures associated with the thirteenth century Arab fort, the third and fourth century Roman fort, and the pre-classical inhabitants. Fortunately, the village only grew up about 1930 and we have the evidence of aerial photographs of the 1920's. O. G. S. Crawford visited the fort in 1928 and spoke of 'remains of habitations of unknown age' all around[30]. No intelligible traces remain today but an oblique view of that period bears out his observation. More important, vertical photographs reveal the outline of an earlier Roman fort of the traditional playing card shape. Such an earlier fort could, of course, have been inferred, but the print preserves the only surviving evidence of it[31].

A feature common to most of the above examples is the contribution made by *old* aerial photographs, a feature which is not simply a matter of availability. In many ways, the contribution which an old aerial photograph can make to

[24] R. MacAdams *et al.*, 'Saudi Arabian Archaeological Reconnaissance', *Atlal*, I (1977), 24f., 32. The authors express the hope of mapping areas of extensive remains by means of low level high resolution aerial photography.

[25] K. A. C. Creswell, *Early Muslim Architecture*, Oxford, 1969, 642.

[26] H. C. Butler *et al.*, *The Publications of the Princeton University Archaeological Expeditions to Syria in 1904–5 and 1909*, Leyden, 1907–21, II.A.2 and III.A.2.

[27] Poidebard, *La Trace de Rome*, 12–44; Bradford, *loc. cit.*, 63 *et seq.* and 143f.; N.B. 63 n.3.

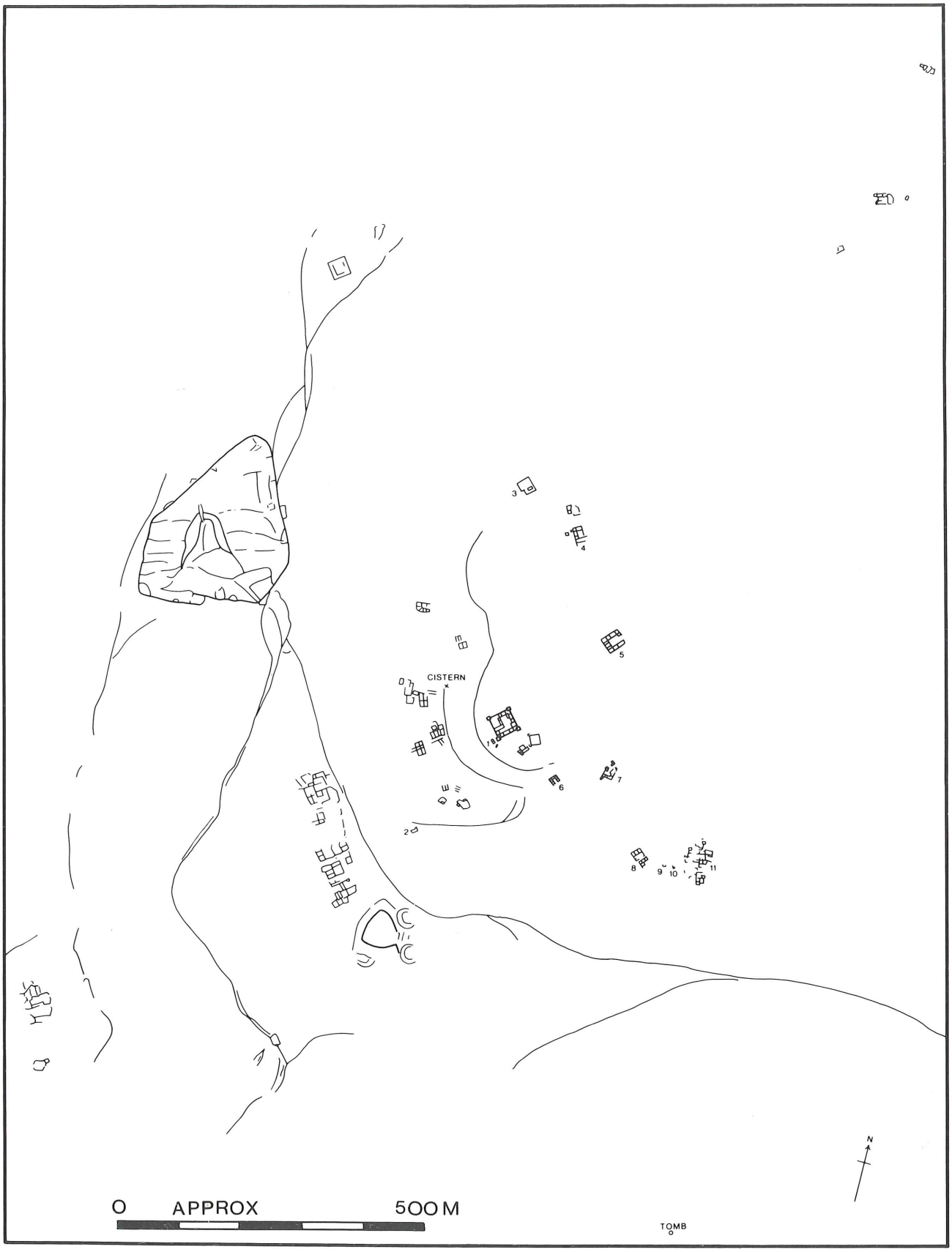
[28] G. L. Harding, *The Antiquities of Jordan*, 1967, 153.

[29] G. L. Harding, 'Recent Discoveries in Jordan', *PEQ*, 90 (1958), 7–18; esp. 7–9. The Latin inscriptions speak for themselves as does the dated building inscription above the main entrance recording (re)construction in the early thirteenth century; for the popularity of the site amongst the early Islamic rulers of the area, see A. Musil, *Palmyrena*, New York, 1928, 285 relating to the eighth century.

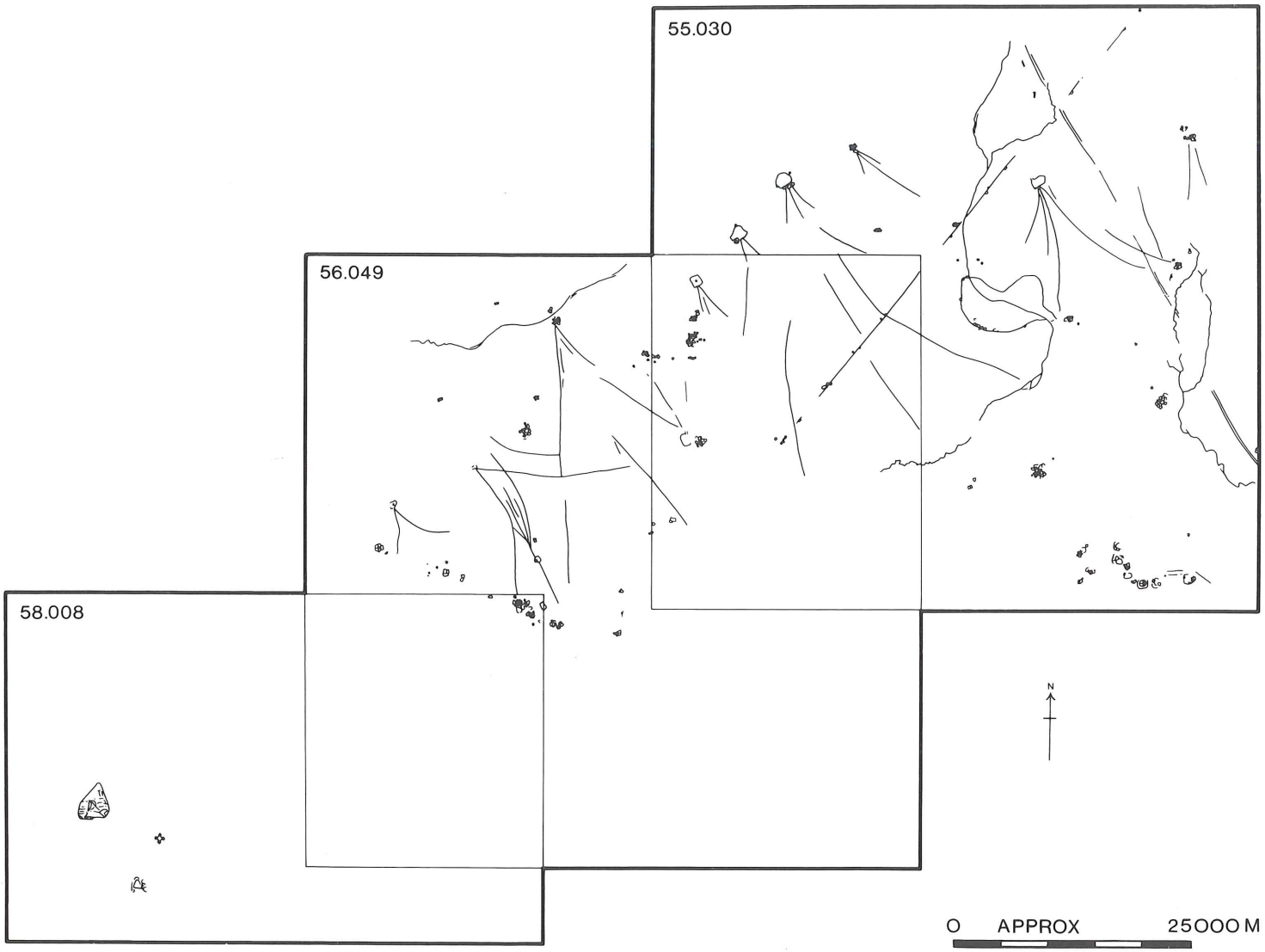
[30] O. G. S. Crawford, *Said and Done*, 196.

[31] D. L. Kennedy, 'The Frontier Policy of Septimius Severus: some new evidence from Arabia', *Proceedings of the XII Congress of Roman Frontier Studies 1979*, Oxford, 1980. Since giving the preceding paper in 1979 I came across the very same observation made by Crawford, *GJ*, 73 (1929), 507.

1. Qasr el-Hallabat site plan.



2. Qasr el-Hallabat and desert wall.



archaeological research in Jordan is one which is unique to the Middle East. Today, Jordan is a country with spreading cities, towns and villages, modern industrial plants, an advanced road network and expanding agriculture. However, unlike most western countries this is not the outcome of a century or two centuries of development but, in the main, of the last 30 or 40 years. In Britain, for example, the Agricultural and Industrial Revolutions of the eighteenth century swiftly wrought dramatic and permanent changes in the man-made landscape destroying and damaging not only thousands of individual archaeological sites but changing the face of the land both by the imposition of canals, railways, roads and cities and by eliminating the widespread traces of age-old agricultural systems. On the one hand, industrialisation and a rapidly expanding population ensured that many well-preserved ancient remains which it had never been worth anyone's time to remove, were finally destroyed or encroached upon; on the other, traces of prehistoric, Roman and Medieval field systems were removed by the revolutionary changes in land usage and exploitation.

Jordan, like most of the Middle East, has been saved from this widespread destruction in that *her* agricultural and industrial revolutions have happened this century, much of it within the last two generations[32]. Even today, one can learn a great deal about the extent and nature of agricultural exploitation in earlier times, about the size and spread of population from examining their surviving traces. Nevertheless, much has already been lost and more will go in the near future as development proceeds. It should be obvious, therefore, that while good aerial coverage may be vital in saving remains from future destruction, old coverage will preserve much that has already gone. Ideally, such old coverage would have been from 50 or 60 years ago, but material even half that

[32] It is interesting, however, to read Gertrude Bell's observations on the Roman fort at Qastal when she saw it in 1906; on a previous visit it had been some distance from the nearest agriculture but now, 5 years later, fields came right up to the walls on all sides: G. Bell, *The Desert and the Sown*, London, 1919, 34.

age is almost as good. In short, it has been possible for Jordan and other Middle East countries to have much of their pre-development landscape preserved on film as a permanent record; such an option has never been open to most European countries. One has only to think of the excitement with which British, German or Italian archaeologists turn to paintings, etchings, and drawings—even early photographs—of monuments and sites as they were before the eighteenth and nineteenth centuries to realise that there is little they would not give to have had aerial coverage of *their* countries before industrialisation[33].

The obvious question then is about what is available. Some aerial photographs were taken in 1917–18 but few of these have survived. It is clear that many more were taken by the Royal Air Force in the next 10 years. The first important landmark, however, is 1928. In that year, O. G. S. Crawford, the great pioneer of aerial archaeology in Britain and the founder of the journal *Antiquity*, visited the Middle East motivated, as he himself records, by the realisation that no official body in Britain was concerned with the archaeological inheritance of Britain's overseas Empire[34]. Crawford made official visits to Royal Air Force camps in Iraq and Transjordan both for flights and for the specific purpose of collecting the nucleus of a photographic archive of these countries. The process of collecting was successful—though resisted in Iraq by the commanding Air Marshal. However, Crawford himself accepted that the intention of building-up the archive would not succeed. Apart from RAF opposition there was the simple fact that training photographs and unwanted photographs were destroyed at six-month intervals. In short, it would have required someone to tour the RAF camps twice yearly to collect the material. The project lapsed; the material brought back in 1928 is now lodged in the Institute of Archaeology in London and its evident quality makes it all the sadder that the archive did not succeed.

The next landmark would have been the material of Sir Aurel Stein in 1939 but that seems not to have survived. However, it is evident that much photography was done if judged only from the prolific amount of Crown Copyright photographs with which Nelson Glueck illustrated his publications[35]. Moreover, there is every reason to assume that wartime activities in the Middle East would have given an impetus to aerial reconnaissance over not only Jordan and Iraq but also Syria. The survival of *any* of this material seems unlikely: in 1945–6 most was simply destroyed and such as survived of North Africa and Europe was due to the personal intervention and energy of John Bradford. The tragedy of such a loss is highlighted by the superb quality of the wartime photography as may be illustrated from the Carthage material of 1943.

Next, there is the Royal Air Force today. Whatever material they destroyed from pre-1945, they still have some photographs taken immediately after the war. The extent of their coverage is still unknown and, since it is small-scale (1:50,000 and 1:35,000) it is less valuable than one might have hoped, though considerably better than nothing.

Finally, there is the vertical survey carried out by Hunting Surveys in 1953 of most of Jordan. I have been able to make valuable use of this material through the courtesy of the Department of Antiquities which enabled me to acquire some prints.

Summary

The above account has, I hope, indicated something of the very respectable pedigree of aerial archaeology both in the Middle East in general and in Jordan in particular. Some conclusions can be set out without difficulty. First, it is clear that all of the techniques of aerial archaeology utilised in Europe and North America can be applied equally well in Jordan. Shadow sites are obvious; expanding agricultural activities will reveal buried sites as soil marks; differential growth marks too are possible both from domesticated crops in the western areas of Jordan and from weeds, grass and scrub in the steppe and desert. Considerable amounts could be learned from planned flights in spring and autumn each year. The objectives of examining existing photographs and of taking new coverage would be the traditional ones of re-assessing *known* sites when viewed from a new perspective, and the discovery and recording of *unknown* features. The potential too, for the examination of historical landscapes is obvious: no one has yet attempted to map the traces of ancient terracing or of field boundaries[36] and no one has recorded and plotted the numerous 'kites' and other man-made structures in the desert[37]. The task of mapping can *only* be carried out from aerial photographs; the quantification and precise location of such features could be very revealing of the extent, scale and nature of human activity in Jordan, but should be done in any case simply because they are beginning to disappear. Cost is always a difficulty: aerial photography is not cheap. However, from both my own experiences as outlined and from the experience of scholars in many other countries, it is abundantly clear that aerial archaeology is cost-effective in terms of discovery and time saved on the ground in survey and excavation.

[33] An obvious example is with the city of Rome where much that is now gone was recorded on paper or canvas by visitors in early medieval times; even in the nineteenth century one of the great gateways in the city walls was totally destroyed—fortunately it was recorded in 1869 on some of the very earliest photographs ever taken: I. A. Richmond, *The Walls of Rome*, Oxford, PL. XVIII.

[34] *Said and Done*, 188–200.

[35] For example N. Glueck, *The Other Side of the Jordan*, 1940; *Deities and Dolphins*, 1966.

[36] *Cf.* Crawford, *Said and Done*, 196 referring to field walls and terraces around Umm el Jemal and around Bosra, 'whose field-walls are perfectly preserved (but unrecorded), row upon row.'

[37] *Cf.* the remarks of R. MacAdams *et al.* (note 24 above) concerning 'kites' in Saudi Arabia, 34–6, esp. 36: 'Together, these two categories of site, the circles and the "kites", present a major problem of archaeological research which requires separate and intensive study. The first prerequisite is accurate planning of a large sample of both, showing not only individual arrangements but also relationships with one another and with the topography. This study can best—indeed, can only—be accomplished with the help of good quality aerial photography in view of the difficulty of seeing many of these structures from the ground, among the boulders of the *harra*.'

Finally, I might say that it is my hope to begin an extensive multi-period survey in the north-eastern desert in 1981 which would continue for a number of years. It is already clear from an examination of the available aerial coverage that there are a good many otherwise unattested features which must be investigated on the ground and, if possible, I intend to begin the task of mapping the walls, circles and kites in the lava and steppe areas[38].

Appendix

Aerial Photographic Archive for Archaeology in the Middle East

Following discussions with various interested parties, I established the above Archive at Sheffield University in 1979 where facilities were put at my disposal by the Department of Ancient History and Classical Archaeology. At the time I was unaware of Crawford's abortive attempt to do much the same almost exactly 50 years before. Such an Archive is no less necessary now than it was then and the objectives are broadly the same. The Archive is intended to bring together in a single centre accessible to all interested scholars, as much aerial photography of the Middle East as is available in collections and private hands. Some 700 photographs form the nucleus, coming from a handful of collections as well as individual donations by former Royal Air Force personnel stationed in the Middle East. No immediate large accretions to the collection are anticipated but negotiations are in hand to obtain substantial quantities not otherwise available at the moment. In the meantime it is hoped that continued additions will come from scholars and others holding aerial photographs of the Middle East who are willing to donate them or allow copies to be made.

Initial funding has been provided by generous grants from the Craven Committee and the Seven Pillars of Wisdom Trust. It is hoped that the accession of substantial quantities of material would be paralleled by placing the Archive on a sounder financial footing by regular grants from one or more sources. Furthermore, unlike Crawford's proposed archive, I would hope that this collection would not simply be available but actively exploited by, at the very least, a part-time researcher, whose work can be followed-up by the essential *verification au sol* and excavation.

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