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A short and polite response to Robert Bewley’s debate on crop marks (AARGnews 13, 49) is to quote from David Wilson’s Air Photo Interpretation for Archaeologists (1982, 53-54): ‘Crop-marks are visible differences in growth caused by buried archaeological remains.’. Even better, because it does not specify an archaeological-only cause, came from the e-mail of an antipodean Anon: ‘Crop marks are changes in the appearance of crops (usually cereal crops) caused by variations in the depth, fertility and available moisture of the soil.’. Given that we have these perfectly acceptable definitions I see no reason at all why there is any need to accept and follow the ignorant misuse of the term by most archaeologists. Surely it’s better to try and educate them?

Martin Gojda (see his piece in this issue) must be one of this year’s happiest people since winning funding for the world’s first major research project that, from its beginnings, will integrate aerial survey with other forms of archaeological investigation. Wonderful news and, knowing Martin, I’m sure that AARG will be kept informed of progress.

However, the situation in Europe is worrying me slightly as neither Martin’s note nor the recently published Archäologische Prospektion (briefly reviewed by Marilyn Brown in ‘Books of Interest?’) show any evidence of the use of aerial photographs to make maps. By ‘maps’ I do not mean detailed large-scale plans of sites (which, as Helmut Becker is always pleased to demonstrate, can be recorded better by geophysics) but those 1:10000-scale compilations which may enable us to begin to understand how features related to one another and, in places, formed networks of tracks, fields and settlements. The detailing of individual sites may be better left for the ground-based surveyors and excavators: to borrow Jim Pickering’s telescope analogy, it is by using the thing back-to-front that we can tap the real power of aerial survey. By combining appropriate aerial photographs through interpretation and mapping we are able to record, and so study, past landscapes and patterns of settlement. This, surely, is the archaeological role for aerial survey as no other means of investigation has the ability to record these tracts of past landuse so cost-effectively.

If there is one thing to be learned from the British experience must be that the post-reconnaissance work of interpretation and mapping needs to run in parallel with the aerial photography. To ignore this aspect of study leaves aerial photography as not much more than an extremely efficient means of finding sites. I fear though, that aerial work in Europe is already taking this direction although we may perhaps replace the British concept of ‘finding sites to excavate’ with a European one of ‘finding sites to geophysicise’. In either case, the efficiency of aerial recording will provide a rapidly accumulating surfeit of unordered data within which only the occasional gem may be remembered.

Samantha Duncan was one of my students in an Oxford extra-mural course, Diploma in Applied Archaeology, and her paper in this issue is a slight modification (as is its title) of her assessment paper for my module. I agree with Sam, as I hope we all will do, about the need for a university post in Britain before we are able to begin to tackle many of the questions and problems that have arisen as a result of aerial photography. But I would question whether this person should be an ‘aerial archaeologist’. Much more important is that such a post should go to ‘a real archaeologist’ with the education and conviction to use the information on aerial photographs as one component available for study and who has the vision to use them to study the past in ways which we have barely begun to evolve.

Aerial photographs probably comprise the largest existing heap of archaeological data certainly the largest virginal heap and certainly that holding the greatest amount of barely known information. Classification of what has been recorded is one way of
beginning to use it to study the past. Inclusion of two contributions on classification in this issue may cause a few groans but they make an interestingly complementary pair: one reviewing and then looking forward, the other showing a way forward. We need to continue to develop classifications [deliberately plural] in order to tackle some of the archaeological questions arising from interpretation of aerial photographs and, importantly, we need then to be shown what was achieved using them.

This is another satellite-heavy issue. Maybe this is because much of the current work is new work, and we are beginning to build up a picture of what may, or may not, be possible by interpreting these images. I am eagerly awaiting the first claim to be a satellite archaeologist – surely a logical development of an aerial one? Vertical photographs are one of my things at the moment and don’t all deserve the bad press they usually are given. It may be useful to remind County Archaeologists whose counties are flown at intervals that it may be possible to specify your preferred dates of photography for any future surveys. This was done in Bedfordshire in 1996 with amazingly successful results that produced a record that would have been impossible to record (and, yes, I do mean impossible) by our usual oblique methods. Other counties already hold archaeologically valuable verticals. Buckinghamshire, for example, was photographed (by accident rather than design) in mid-August 1995 under conditions which provided a county-wide record of surviving ridge and furrow and some excellent pictures of other earthworks. In any case, it will be worth the archaeologists proposing a preferred date as it seems that other users within County Councils don’t mind within twelve months when the survey is flown. If we expect further dry summers (or why not any summers), vertical sorties flown at appropriate times will return information otherwise unrecorded. And they give the luxury of time to look, think, pursue and question that the airborne observer does not have.

I recently received two annual reports, Essex Aerial Survey, for 1995 and 1996. The Essex team is to be congratulated on their rapid processing of each year’s reconnaissance and on these well-produced in-house reports. The reports summarise results of reconnaissance for each year, but in fact also offer quite a bit of thinking about survey method, the hows and whys of why, how and where things show (‘cropmarkology’ in Riley-shorthand) as well as sprinklings of archaeological comment (mini-research in a way) on some of the features photographed and mapped. By linking their aerial reconnaissance to the in-house National Mapping Programme, survey in Essex seems to move towards an ideal situation of positive feedback from the two related aspects. Maybe if there are to be any further external NMP contracts they should be linked to a flying grant. Well, we can hope....

Finally, for those of you who have the technology, CUCAP can deal with enquiries by e-mail at: aerial-photography @lists.cam.ac.uk. They have also compiled a growing home page (http://www.aerial.cam.ac.uk/) which may be reviewed by Michael Doneus in a future issue.

Please note also my own changed e-mail address: rog.palmer@dial.pipex.com. This follows my change to a server which ought to make it easier for transfer of files from the majority of AARG members when you send me your contributions!
CHAIRMAN’S PIECE

Cathy Stoertz

I must begin my first chairman’s piece with the customary, but no less heartfelt, thanks to those committee members who ‘retired’ at the last meeting - Marilyn Brown, Jo Elsworth and Gillian Barrett. They will be a hard act to follow. Special thanks are due to Jo, who worked so hard on AARG 1996 and then took extra time to provide useful advice to the new committee when she probably had other things on her mind (and welcome to Rebecca Laura, born 21 November 1996). Marilyn is staying on as vice-Chairman, so we will continue to benefit from her experience.

At AARG 1996 I was impressed by the degree of persistence, integration of techniques and interdisciplinary co-operation which was evident in so many of the projects presented to the meeting. At a time of still-decreasing funds, when attitudes to the support of ‘the heritage’ - even the definition of ‘the heritage’ - are being reassessed almost daily (in Britain, anyway), these are among aerial archaeology’s strongest points. They should be emphasised and extended at every opportunity.

It was also encouraging to see imaginative new developments: who would have thought that aerial archaeology could be made accessible to the blind? This is the kind of innovation that is so ingenious it seems simple, and yet I’m sure it never occurred to most of us even to tackle the problem. On more conventional lines, the GIS-linked, computer-generated representations being produced by RCAHMW and others have achieved such quality that even I would now be willing to abandon hand-crafted final drawings. The depth of information and the flexibility of depiction offered by GIS far out-weight the remaining slight loss of interpretative subtlety. Now there’s progress for you!

Reconnaissance in Britain is still producing ‘new’ discoveries even after 70 years; the law of diminishing returns has been disproved through increasingly well-targeted projects. At the same time, other colleagues in Europe are just beginning the task of primary discovery. The Potsdam conference, last summer’s training project in Hungary, the Raphael Project and other initiatives have created many opportunities for the exchange of skills - and I wonder whether we more experienced practitioners may, in the end, learn even more from this exchange than those at the beginning of the process.

If ‘we’ are to presume to offer our advice and expertise to ‘them’, we must look carefully at our own approach to aerial archaeology in the late 20th century. Many aspects of established practice have come about for largely historical reasons, to do with the development of British archaeology. If nothing else, others can be spared the ‘error’ phase of the trial-and-error which has shaped British survey methods. Beyond this modest goal is the opportunity for both ‘old hands’ and those with a fresher view to design survey techniques appropriate for the next century, incorporating new technology and the best of past experience but leaving behind some of the more cumbersome baggage. This is an exciting and challenging prospect and one which, I hope, will keep aerial archaeology alive and growing for a long time.
HONORARY SECRETARY’S REPORT

Toby Driver

Taking over from the excellent work of Gillian Barrett, as the new Secretary of AARG, was not easy at first and I have come to appreciate the work involved in keeping accounts, subscriptions, minutes and general correspondence up to date.

However, with a fresh start I have been keen to ring a few changes, some of which were already being discussed before I became Secretary. It was at times difficult in the past for members to keep track of their subscriptions, particularly if payment was made at the autumn conference and then a March reminder was received in the new year. Sending out subscription forms to all members, old and new, this January has brought the database up to date and, with paid-up information now included on address labels, members will hopefully be in no doubt over the years for which they have paid.

The option to pay for 3 years at once was welcomed by many. As well as saving on administration and postal costs, the option has temporarily added to the Research Group’s funds. It has been useful to some overseas members, for whom I understand sterling payment can be difficult. With this in mind, AARG UK bank account details will be included on all future reminders for all those who find direct transfer of funds easier and cheaper than posting. They are also reproduced below for future reference.

I have made efforts to raise the profile of the Research Group in archaeological circles, with the inclusion of conference details in the Council for British Archaeology’s Briefing, and Group details in Current Archaeology’s Directory of British Archaeology 1997, the latter with a circulation of some 14,000 subscribers.

AARG membership now stands at around 180 fully paid-up members in 22 countries (including the United Kingdom), and as letters pour in I am seriously considering taking up stamp collecting...

AARG Bank account details:

Account name: AERIAL ARCHAEOLOGY RESEARCH GROUP
Account No. 0396885
Bank sort code: 30-99-99
Bank address: LLOYDS BANK PLC, 2 PAVEMENT, YORK YO1 2NE, UK
Tel (UK): 01904 630131 Fax (UK): 01904 610319

Please notify the Secretary of all direct bank payments.
AARG ANNUAL MEETING 1997

Date: 17-19 September 1997
Place: The University of Edinburgh

Proposed sessions:

**Aerial Archaeology in Scotland** - a look at projects with ‘aerial’ beginnings.

**Back to the Future in survey?** - Rog Palmer has (been) volunteered to organise a debate on the proposition that ‘Routine oblique photography is too much like “cherry picking” to constitute “real” survey. Is it time to go back to block blanket coverage?’ Start your indignation simmering now!

**Developments in Europe** - The Raphael Project and survey experiences beyond the shores of Britain.

Plus the usual opportunities for informal entertainment and cultural exchange, and a Friday field trip.

It is hoped that the formal sessions will emphasise survey strategies and approaches to project planning, integrated studies and extensions from aerial beginnings.


DERRICK RILEY BURSARY FOR AERIAL ARCHAEOLOGY

This annual award is offered to assist the bursary holder in the making, analysis or interpretation of aerial photographs. The bursary provides financial assistance up to the sum of £500 to help meet travel, flying expenses, film processing or similar costs necessarily incurred during the work. The panel will accept applications for smaller amounts and reserve the right to make two, smaller, awards if this is adjudged to be the most beneficial decision in any given year. In recognition of Derrick’s encouragement of young scholars preference may be given to younger applicants.

Application forms can be obtained from:
Professor Keith Branigan
Dept of Archaeology and Prehistory
University of Sheffield
Sheffield S10 2TN
UK

...to whom completed forms should be returned by April 30

Successful applicants will be informed before the end of May.
FORTHCOMING EVENTS

TREASURES OF OUR COMMON PAST IN EUROPE: HISTORY WRITTEN IN THE EARTH
LUFTBILDARCHÄOLOGIE IN ZENTRALEUROPA

Funding has been provided by the European Commission for an exhibition, opening at Prague in October then moving to Dresden, a conference at Prague on 10 October 1997 at the exhibition opening, and a workshop for students etc in Pecs in (probably) January 1998.

Behind the gloss there is a series of aims: to allow scientific exchange between ‘aerial archaeologists’; to register standards of documentation in national photo archives; standardisation and coordination of picture data and of scientific treatment of aerial photographs between the countries involved in the project [?]; popularise ‘aerial archaeology’ with the help of intensive PR campaigns; plan international communications for ‘aerial archaeology’.

Because of the country’s apparent advances, Britain is involved as consultant.

[Based on information – much in German – provided by Otto Braasch]

REMOTE SENSING APPLICATIONS IN ARCHAEOLOGY

May 29-31, 1997, St. Cloud State University, Minnesota, USA.

The conference will provide a common forum for specialists and individuals interested in Remote Sensing and Archaeology. Sessions will include:

- Aerial and Satellite Photography
- Color and Thermal Infrared Photography
- Thermal and Multispectral Satellite Imagery
- Multi-Band Radar Imagery

Each session will include the necessary introductory material, a discussion of the development of technology, and case studies in the application of specific remote-sensing platforms. Software demonstrations and information concerning data sources will also be included as part of the conference. Some hands-on activities will be organized.

Send correspondence to: RSAA@eleftheria.stcloud.msus.edu
or Benjamin Richason, Spatial Analysis Research Center, Dept. of Geography, St. Cloud State University, St. Cloud, MN 56304

Further information, updates, and on-line forms will be available on the conference home page: http://eleftheria.stcloud.msus.edu/RSAA. Publication is also likely to be on the Web.

SPUREN-SUCHE AUS DER LUFT

This exhibition, subtitled Luftbildarchäologie in Sachsen-Anhalt, continues until 31 December 1997 at the Landesmuseum für Vorgeschichte Halle. The blurb doesn’t name the photographers.
The 8th of February 1997 marked the thirtieth anniversary of the first flight for archaeological reconnaissance made by the RCHME. The Air Photographs Unit (APU), as it was then known, was established in 1965 under the direction of John Hampton OBE, who came from the Archaeological Division of the Ordnance Survey. Initially the purpose of the Unit was to create a library of air photographs and make them available for reference and further study, as part of the National Monuments Record (NMR).

At that time, aerial reconnaissance for archaeology was being carried out by Professor St Joseph of Cambridge University, whose flights traversed most of Great Britain. There were also a number of ‘individual flyers’ notably Arnold Baker and Jim Pickering who concentrated on regionally focused reconnaissance.

John Hampton soon realised that the resources then being applied to reconnaissance were nowhere near adequate if these archaeological sites were to be recorded before their widespread destruction. He therefore successfully initiated a reconnaissance programme which set out to cover England systematically taking advantage of favourable conditions as they occurred. The objective of that first flight, on the 8th of February 1967, was to ‘evaluate the economics, techniques and practicability of NMR air photography’ and it was designed to search arable areas for soil marks and record extant features such as hillforts.

The weather on the day was sunny but the early morning mist did not clear sufficiently until after midday. Taking off at 13.00 from Fairoaks airfield (Chobham, Surrey) in an Auster (a high wing training aircraft), the flight lasted one and a half hours and a number of sites showing as soil marks were recorded. Apart from the rather cramped space in the cockpit due to the ‘rather large pilot’ and several technical observations, the conclusion from that first flight about aerial photography was that ‘there is no reason to think that an efficient recording tool could not be developed by NMR’.

From 1967 to 1984 the vast majority of the 750 flights made (from Biggin Hill) were directed towards recording archaeological sites in all their different forms though other aspects of the landscape including some architectural subjects were also recorded. During this period the staff situation for those engaged in reconnaissance remained fairly stable. John Hampton was the aerial archaeological investigator (except for 1983 when this duty was largely carried out by Tim Gates) and the aerial photographic duties were shared by John Parkinson, Ron Parsons and Dank Silva.

In 1984, approaching retirement, John Hampton relinquished his flying duties which were taken over by Roger Featherstone supported by aerial photographers Dank Silva, Mike Roberts, John Hutchins, Tom Patterson and Ian Savage. In 1989 the APU relocated some staff to York and established a new northern reconnaissance programme organised by Bob Bewley. This northern operation is based at Sherburn-in-Elmet and the first flight, piloted by Anthony Crawshaw, took place on 29th of June 1989. For the past three years Peter Horne and Dave MacLeod have been responsible for that programme with Anthony continuing to pilot. Flying also continues in the south, headed by Roger Featherstone, but has now moved base to Kidlington, Oxford to be nearer RCHME’s new headquarters in Swindon. Both teams fly in Cessna 172 aircraft and now take their own colour and black & white photographs using 35mm and 70mm formats.

Since 1967, 1460 sorties have been flown by the RCHME sometimes involving two or even three flights and over eight hours in the air in a single day. An estimated 6500 hours have been flown of which 900 have been flown since 1989 by the team in York. This reconnaissance has led to the discovery and recording of a vast number of archaeological sites covering every period from the Neolithic to the Second World War which are recorded on over 211,000 oblique photographs now deposited in the air photographs library of the National Monuments Record Centre (NMRC).

Whilst the majority of photographs are of archaeological sites the range of subjects is wide
ILFORD PROFESSIONAL DELTA 100 - A NOTE

Pete Horne and Dave MacLeod

During the cropmark season in 1996 we experimented a little with using 35mm Ilford Professional Delta 100 in a Leica R5 whilst continuing to use 70mm Ilford Aerial FP4 as our main black and white film.

Initially a ground test was done photographing a parched grass area in a mixture of sun and shade from a first floor window. The test was done using both Ilford FP4 and Delta 100 in a 35mm camera with a 2x Yellow filter. 15x enlargements were made (equivalent to a 20” x 14” print) and these were examined with the naked eye and through a 4x lens. No significant difference was noted between the two in terms of grain size and sharpness but the increased contrast of the Delta over the FP4 was immediately noticeable.

On the basis of this test the film was subsequently used on a number of flights, though no proper aerial comparative test was carried out. The results seem to bear out our initial reactions, ie the increased contrast of Delta was beneficial in showing cropmarks whilst not providing the extreme results found with Technical Pan.

The film itself requires only standard processing in standard chemicals and seems to be reasonably tolerant to exposure variations; the increased contrast will on occasion lead to a need for careful printing. We will certainly be continuing to use this as our standard 35mm film for cropmark photography, whilst using 70 mm Aerial FP4 as our main medium, but will try and do some proper aerial tests when time allows.

Another new film we are interested in is Ilford SFX 200. This is meant to have very interesting characteristics relating to the near visible IR and therefore may have good potential for cropmark photography – has anyone got any experience?
BOHEMIA: A LONG-TERM GRANT AWARDED TO THE AERIAL PROJECT

Martin Gojda

The project of Bohemia Aerial Archaeological Survey was launched in 1991 (first flights started a year later; see Gojda 1993a; 1993b; 1994) in the Institute of Archaeology, Czech Academy of Sciences, Prague. In 1993 a state funded grant entitled The non-destructive method of aerial archaeology and its application in the investigation, documentation and protection of the historic landscape of Bohemia was awarded to the project for the period 1994-96. It seems to be the only project grant focused exclusively on aerial archaeology (and subject to no other research project limiting aerial prospection territorially or chronologically) in central-eastern Europe.

Since 1995 a completely new set of the so-called complex grants initiated. These are considered to be given to those groups of scholars of research or university institutes who inevitably need high-cost machines and other special and expensive investments for their proposed projects. The Department of Spatial Archaeology of the Institute, of which the author is a full-time member, applied for this grant, but failed. Nevertheless, the proposal has been evaluated highly and the applicants encouraged to pass the application, a little bit modified, next year once again. We were informed that first of all it is the intention to buy an aircraft for research purposes that has attracted the group of scholars who decide upon the allocation of grants (or money in other words) to single project proposals.

In 1996 the team decided to stress the non-destructive methods, and specifically aerial survey, in the proposal and to apply once again. We managed to get over the first run. Of the ten submitted project proposals within the group of humanities and social sciences only four, including ours, were selected to the second run. At the beginning of December 1996 we were invited to advocate our proposal personally and just ten days later we were officially informed that our project is one of two which won the competition and were accepted.

In practice this means that the aerial project in Bohemia will now be radically intensified. The length of the grant support to the aerial project is six years (1997-2002). In spring 1997 a Cessna 172 will be bought and a permanently available pilot.
employed so that all year round the aircraft and its crew would be ready to start. We expect to increase the number of flying hours perhaps ten times in comparison to our hitherto possibilities. Financial background will also make it possible to buy efficient computer hardware and software, precise GPS for post-reconnaissance surface survey, caesium magnetometer, etc., and to employ some documentation staff for processing the photographs and organizing the image database and air-photo library/negatives + slides archive.

The project, entitled PREHISTORIC SETTLEMENT PATTERN OF BOHEMIA: The potential of non-destructive methods in archaeology involves altogether 12 graduated scholars (headed by the author), mostly educated in archaeology, but also in geophysics and environmental studies. It seeks to identify the principal features of the settlement network of prehistoric Bohemia: its links with the natural environment, demographic characteristics, its internal structure, its continuity over time and the roots of changes affecting it, the practical and the "non-functional" aspects of spatial arrangement of prehistoric sites, as well as the current state of archaeological resources as resulting from specific formation processes on one hand, and previous research strategies on the other. The participants of the project aspire to achieve significant advances in this field using aerial archaeology and other non-destructive techniques, the creation of database systems and the introduction of computer analysis of spatial data (GIS). The results of the project are also expected to contribute to the development of methods of archaeological site prediction, important from the perspective of archaeological heritage management.

References
The development of aerial photography in New Zealand archaeology
(continued from the previous issue)

Kevin L. Jones

PART II

Some archaeological examples

Fortifications

Pa have been the subject of scholarly inquiry or conjecture since Joseph Banks’ first observations in 1769-70 (Banks, 1962: 395-475) in the course of the voyage on the Endeavour under the command of then Lieutenant James Cook. Attention in the modern era commenced with the work of Elsdon Best, a museum ethnologist, who published The Pa Maori in 1927. He had earlier published Maori Agriculture (Best, 1925). This is the same period as O.G.S. Crawford’s (1924) Air Survey and Archaeology and the later joint work with Alexander Keiller, Wessex from the Air (Crawford and Keiller, 1928). In Best’s work, however, there is not the least inkling that aerial views would have assisted his analysis. The capacity to take aerial photographs hardly existed in New Zealand at that time.

Typical features of pa are ditches and banks, sometimes multiple, in a wide range of natural environments such as ridges, promontories, or terrace edges which were selected for ease of defence. On ridges or ridge ends, the defensive elements often comprise single or double (rarely, triple) transverse ditches and lateral ditches or steepened scarps. ‘Ring-ditch’ forms, in which the ditch and scarp encircles a more or less rounded hill top, are common in some regions (Fig. 5). On flat land, single or double ditches and banks, rectangular in plan, enclose the terrace scarp, or straight sections cut off points in alluvium. Occasionally, broad points are cut off by ditches and banks forming a dog leg in plan, drawn across the point and along the scarp line leading down to lower flood-prone terraces (Jones, 1990). Pa may range in area from 200 m² to 50,000 m².

Aerial photographs have been used elsewhere in the Pacific, notably in the study of earthwork fortifications in Fiji (Parry, 1977).

Aerial photographs have continued to be of use in documenting pa. In Hawke's Bay, Allen (1994), based at the University of Los Angeles, conducted an extensive survey relying in part on aerial photographs in order to map and interpret size of pa and their spread through the district.

Sites of nineteenth-century origin

Sites include those related to warfare, both intertribal and as response to the colonial process, as well as pastoral or agricultural, and industrial activities. Earthwork fortifications fall into four broad periods: (a) the musket wars of c. 1810-1835, when intertribal warfare flourished, with muskets more readily available to northern tribes (Smith, 1910) and allowing them a strategic advantage in the settling of ancient rivalries; (b) the Northland phase of the New Zealand Wars in 1845-46 when British marines and troops engaged in two failed attacks in the inland Bay of Islands and one successful attack at Ruapekapeka; (c) the main Taranaki and Waikato phase of the New Zealand Wars in 1860-1864 (e.g., Prickett, 1980); and (d) the last phases of the New Zealand Wars in which, under the 'self-reliant' policy, New Zealand-financed Armed Constabulary fought for and occupied ground in regions outside the Waikato and northern Taranaki theatres (mainly south Taranaki, Bay of Plenty and the East Coast) in 1865-1870 (Cowan, 1983; Belich, 1985). Figure 6 shows Inman’s redoubt in south Taranaki calculated to control the coastal route and the ground ‘as far as a rifle shot inland’, as General Cameron remarked at the time. From 1870-1880, fortifications were maintained to protect military settlements on the ‘frontier’ and, in the very last year of the decade as forward positions for the clearing of Maori settlements erected in defiance of Government instructions.

Aerial photographs can be of use in the illustration of industrial archaeology, most notably gold-mining. Gold was discovered on the Coromandel Peninsula in 1852, in Nelson/Marlborough in 1857, in Otago in 1861, and on the West Coast in 1864 (Williams, 1974). Hard rock quartz mining was predominant on the Coromandel and in parts of the other regions. Much of the evidence today is covered in forest. In the semi-arid Central Otago region gold-mining remains are readily available to the aerial photographer. Here
Figure 5. Ring-ditch pa near Tirau, Waikato. An elevated section of ridge line is defended by transverse ditches and banks and long sections of lateral scarps. Rectangular storage pits lie on well drained ridges. Age of occupation, probably 200-400 years B.P. Photo credit: Kees Sprenger, Waikato Museum of Art and History.

Alluvial mining, sometimes on terrace country, was predominant. There were probably some innovations in cruder forms of alluvial exploitation using water from races, notably ‘blowing down’. In this practice, the water is flooded over broad sloping terraces and the surface broken up by picks. The gravels are borne away by the water to a tail race and riffle or settling box. Later the California sluice monitor was in widespread use, allowing a much deeper working face. This required prospecting at depth of terrace deposits (by digging shafts into likely deposits) and elaborate stacking of boulders into tailings which also guided water into the settling boxes (Fig. 7).
Figure 6. Inman’s redoubt, Manawapou River, south Taranaki, built 1865-66. Flanking angles lie at opposing corners to give enfilading fire into the ditches. The site has been contracted from a larger redoubt, the outline of which still shows. The depressions at the head of the small gully at left are the remains of hut sites. Photo credit: the author.

Analytical work built on aerial photographs
The most important analytical uses to date have been for mapping of extensive horticultural plots in coastal and volcanic stonefields. Polynesian horticulture was transferred from the tropics into temperate New Zealand. Maori came to rely on root crops which had to mature in a short (compared with the tropics) growing season. A number of techniques, including site selection, shelter, mounding, and mulching with gravels, were used to improve soil and air temperatures through that growing season. On the surface, horticultural sites take three general forms: (a) stone constructions on stonefields on low coastal terraces with remnant boulder beaches (Fig. 8) (Leach, 1976; McFadgen, 1980a; 1980b), or stonefields of volcanic origin; (b) trenches dug into colluvial slopes or alluvium (Barber, 1989), the exact function of which in the horticultural system has proved to be controversial; and (c) borrow or quarry pits for gravel. There is general agreement that the long linear heaps of stones, or stone rows (not unlike the reaves of England), demarcated plots and created pathways through plots that would be highly tapu at certain stages or for certain people.

In 1969, Helen and Foss Leach of Otago University commissioned low-level, large-scale (1:1,600) aerial photographs of the Palliser Bay (north-eastern Cook Strait) coast, flown in January 1970. Along with ground-checking, this aerial photographic work allowed the mapping of stonefield horticulture over some 25 km of the narrow coastal strip. From this Helen Leach (1976; 1979) was able to publish detailed maps and analyse plot sizes and plot orientation on the coastal landform, down to the detail of stone-lined pathways. Aerial photographs have continued to offer unparalleled insights into the function of the plots, choices of soil types, land tenure practice, and the relationship between plot locations and settlement more generally considered.

In the late 1960s and early 1970s, an Auckland postgraduate student, Agnes Sullivan (1972; also maps filed with site records), mapped extensive areas of south Auckland volcanic stonefields. Bruce McFadgen (1980a; 1980b), a postgraduate student in survey, geomorphology and archaeology, mapped stone row systems and their soils in the southern and central coastal districts. A decade later, Doug Sutton (1982) of the University of Auckland arranged the taking of low-level vertical and oblique photographs of the Pouerua volcanic stonefield and pa complex in the inland Bay of Islands. In contrast to coastal Palliser Bay, the stonefields here had limited stone rows, but many distinctive stone piles, flat-topped and stone-revetted mounds, stone-revetted terraces, and some areas of trench garden plots. On Banks Peninsula, Canterbury, Jacomb (1996, pers. comm.) recently completed vertical coverage at large scale of some horticultural features.

Work on distinguishing pre-European horticultural sites from historic ploughing also relied on oblique aerial photographs (Nichol, 1983; Walton, 1982).

Trenches draining and defining horticultural plots have been relatively little
Figure 7. 'Herring bone' tailings, Northburn historic reserve, near Cromwell, Central Otago. Head races can be seen as soil marks in the area of recent border diking foreground. The races fed the sluice monitors at the working face. As the face advanced large boulders were stacked to remove them from the face and to guide the flow of gravels to the sluice boxes and tail races. Date of working, about 1870-1880. Photo credit: the author.
Figure 8. Horticultural stone rows at foot of high terrace, Clarence River. The rows run down slope dividing of equal amounts of desirable ground and allowing access from the coastal strip to the right. Age, probably 400-600 years B.P. Photo credit: the author.
investigated. The historical vertical aerial photographs in Northland sometimes show spectacular arrangements and wide areas of such trenches (Jones, 1994: 67-69).

In the pre-European period, borrow pits were used to take gravel from sub-surface seams to add to the surface of soils (for aerial photographs, see Buist, 1976; Walton and Cassels, 1992; Cassels and Walton, 1992; Jones, 1994: 62) where they raised the soil temperatures by a significant margin, perhaps extending the already short growing season by 15-30%.

**Aerial photographs and site protection**

Aerial photographs were quickly recognised as a potential source of information on the lost archaeological landscape, to determine rate of loss, and to elucidate otherwise cryptic fragmentary remains. Earthwork sites have suffered terribly from urban encroachment. Brown (1961; 1962) and Sullivan (1972: 153) mapped and recorded extensive areas of the pa and horticultural stonefields of the Auckland Isthmus. Elsewhere, farm livestock (especially dairy cows or beef cattle) and farm roading have done great damage which would be difficult to monitor in the long term without photographic records (see Prickett, 1985). Aerial photography, repeated at intervals to catch images of sites in good condition and to monitor degradation will be of benefit.

With the passing of the Historic Places Amendment Act 1975, and its hard-won protective measures for archaeological sites, there was a surge in primary recording, both for development projects such as afforestation and more widely in area surveys. Aerial photographs, often commissioned by the development agency (e.g., the former New Zealand Forest Service), were in extensive use for survey and documentation of site location for land management purposes. Some purpose-flown vertical and oblique aerial photographs were also taken in the course of district surveys and archaeological site inspections for statutory protection, but these were shoe-string affairs.

Besides their uses in reconnaissance, aerial photographs have been used as a primary mapping base. Although not generally cost-effective, they have been used to map the extent of sites at a scale of 1:10,000 and to register (notify the landowners of) sites under powers in the Historic Places Act. The most extensive projects to date have been in the Bay of Plenty and East Coast districts. Valuation rolls showing ratepayer's names are indexed to 1:10,000 cadastral (legal boundary) maps and provide a convenient way to ascertain just who owns which site or part of a site. It is a simple matter to overlay the field record of sites over the cadastral map, and to read off the land appellation. The landowner can then be determined and notified of the site.

**Concluding remarks**

Until the late 1950s, illustration was the principal purpose of the medium in historical and landscape studies in New Zealand. From that period a number of significant developments occurred that set a trend towards much closer analytic purposes. They were rooted in the experience of site recording, going back to the late 1950s, but received their first critical expression in the work of Gorbey (1967, 1970).

Scanning of existing vertical aerial photographs was common in the early 1960s which saw a great increase in the volume of archaeological site recording in New Zealand. The conventional vertical aerial photographs from the immediate post-war period are a great asset in field survey. Also, the earliest air photos were taken in slow aircraft which often flew all day over the survey scene at a relatively low altitude; all-season work was a feature and altitudes were low - negative scales of 1:12,000-16,000 are not uncommon. As a result, both shadow definition of features and the size of features make for clear images.

There is no central repository of archaeological aerial photographs. For general aerial photographs the central repositories are New Zealand Aerial Mapping Ltd., Hastings, under contract to the Crown, with copies of all photographs held by Land Information New Zealand (formerly the Department of Survey and Land Information), Wellington. Significant holdings are also held by Landcare Research, Ltd. (a Crown-owned research company), Palmerston North, specialising, at its Palmerston North site, in remote sensing and image analysis. Also of interest to
archaeologists is a nation-wide programme of oblique aerial photography by Lloyd Homer, commenced in 1959, for the New Zealand Geological Survey (now the Institute of Geological and Nuclear Sciences Ltd.), Lower Hutt.

The earlier vertical air photographs, used in stereo pair runs for areas up to 60 km square, were valuable in reconnaissance: to determine relict terrace landforms indicating old river courses and levels suitable for settlement (Jones, 1990); to indicate areas or zones worth searching by foot; as a record and often the only record of sites; as an aid to field sketches of the plans of sites, some of which could be large (1,000 metres or more long) and of very complex topography (e.g., Groube 1960: 28); and finally as an aid to identifying the exact position of a site and its extent where the mapped base at inch to the mile (100' contours) or the current 1:50,000 (20 m contours) was inadequate.

Most aerial photography in New Zealand has concentrated on upstanding earthwork fortifications. Compared with elsewhere in Polynesia, these fortifications exist in great numbers in New Zealand, and it is not surprising that they have been, and continue to be, the subject of most attention. The other field of interest where aerial photography has made a real analytical contribution is horticulture, but again this is based on archaeological sites with relief features.

Very little work has been possible on cropmarks, probably because physical soil conditions, climatic factors and contemporary agricultural practices do not allow for any significant degree of visibility. This stands in remarkable contrast to the lowland European situation where many eras can be layered on to the landscape and indeed into single sites. The New Zealand situation is more akin to that of two broad situations in the United Kingdom: (a) the uplands which, from the late bronze age, were only occasionally occupied at times of peak pastoral land use (e.g., Butler, 1991); and (b) the lowland landscapes of the Medieval period. Both landscapes exhibit features which are more or less synchronous and rich in detail to the same degree as New Zealand.

The condition of the surface detail of many New Zealand sites can on occasion be quite fine, and may often represent a single phase of occupation (for example, Figure 6). New Zealand archaeologists are probably too little conscious of the volume and the relatively recent age of their earthwork fortifications. Surprisingly little work has concentrated on within-settlement analyses of pattern. Wider patterns of contemporaneous occupation in the landscape have also been ignored. The assumed shortness of the time scale has led to a straining for unachievable precision in establishing contemporaneity - instead of simply modelling in some allowance for span of occupation.

Acknowledgements
For comments on the manuscript I thank Associate Professor Helen Leach, Dr Aidan Challis, Dr Bruce McFadgen, Dr Alastair Buist, Tony Walton, Dr Nigel Prickett, John Holloway, Jean-Christophe Galipaud, Lynnette Clelland and Rog Palmer. The New Zealand Department of Survey and Land Information kindly allowed reproduction of the vertical aerial photograph. Drafting is by Chris Edkins and I am grateful for his excellent work. Parts of this paper will appear in Australian Journal of Historical Archaeology and their agreement to this arrangement is appreciated.

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THE WAINWAY CHANNEL: 
AERIAL PHOTOGRAPHIC EVIDENCE OF LAND RECLAMATION

Alison Deegan

In June 1996, Air Photo Services Ltd was commissioned by Romney Marsh Research Trust (RMRT) to undertake a detailed aerial photographic assessment of the Walland Marsh; an area surrounding the ancient Wainway Channel on the Sussex/Kent border, in south-east England. The area is defined by TQ940190 and TQ995210, excluding 0.4km and 0.5km blocks from the south-east and south-west respectively.

The aim of the assessment was to accurately map and interpret the system of walling associated with the 17th century restriction and reclamation of the Wainway Channel and its adjacent natural drainage systems. The assessment, undertaken during September and October 1996, resulted in 1:2500 scale mapping accompanied by a full report and gazetteer of sites (Deegan 1996).

Sources

Photographs held at the National Library of Air Photographs (NLAP) and at the East Sussex Record Office in Lewes were consulted for this assessment.

No specialist oblique photographs of this area were held at NLAP. This situation is common over much of Romney Marsh although work by RMRT and for this assessment show the area to be rich in upstanding and levelled archaeological remains. The lack of specialist photography is, I suspect, indicative of a dismissive approach to more recent archaeology in an area not rich in crop-marked sites. Fortunately the dearth of oblique photographs was not to the detriment of the project. Of the thirty-plus vertical sorties consulted, several were of excellent quality and clarity, taken at a large scale and in the most appropriate lighting conditions to record the feature types of this area. Moreover, as the project progressed it became clear that oblique aerial photography would not be a suitable medium for recording the extensive walling and drainage systems. Although carefully-targeted oblique photographs could better record the interrelationships between features, these would probably be better discerned by ground investigations.

*The Romney Marsh Irregular*, a newsletter produced by RMRT, afforded a valuable insight into the types of features to be observed on Romney Marsh. It reports on a wide range of pertinent archaeological, documentary and sedimentological investigations and reflects the truly multi-disciplinary approach to academic and local interest studies in this area.

The features

With a long history of sheep farming on the marsh it was expected that many features would survive upstanding having been rarely, if ever, under the plough. However aerial photographs show increasing numbers of fields being brought into an arable regime in recent years.

The potential for recording plough-levelled features under crop on the heavily alluviated marshland was considered to be low. This was corroborated during the assessment in those few fields that have been under an arable regime throughout their photographed history. Despite the relative ubiquity of features such as marsh creeks across the whole study area, no crop-marked examples were recorded in these fields. This illustrates an important point that
an absence of evidence does not indicate an absence of features. However the lack of crop-marked evidence did not restrict the recording of levelled features. Fortunately the tonal contrast between the alluvial soils and the material of constructed features, such as the embanked elements of the walls, is marked. Thus bare, recently-ploughed, soils showed archaeological features as much paler deposits clearly visible on the aerial photographs. The silts of the marsh creeks were similarly visible.

**The archaeological and natural environment**

The Wainway Channel was recorded as a substantial waterway, capable of carrying cargo loads, on Symondson's map of 1596 (Eddison 1989). The sinuous route of the channel, running east to west, is now much silted up but still visible as a depression, when viewed stereoscopically, or when holding water in wetter times of the year.

From 1620 to 1700 the Channel was confined by a series of east-west aligned landward and seaward crosswalls, including the Wainway Wall, until the land was entirely reclaimed. These crosswalls reduced the catchment area of the Channel until all drained water was diverted and dispersed by other means. This system was augmented by shorter, variously-aligned, auxiliary walls, some of which may have been reinforcements, suggesting that the system was susceptible to minor breaches. Each wall was constructed as a bank with either one or two ditches alongside. The walling system, as previously identified by soil survey, is clearly recorded, whether extant or levelled, on the aerial photographs. Moreover, this assessment identified previously unrecorded elements of the walling system.

This confinement of the Wainway Channel has had an observable effect on the drainage systems of the marsh. There is a considerable contrast between the dendritic pattern of drainage seaward of the Wainway Wall and the more regular parallel distribution of marsh creeks north of the wall. This Wall lies just seaward of the boundary between the alluvial deposits associated with the reclaimed channel and the older marine alluviums to the north. Thus although the morphology of the drainage systems may relate to their differing geologies the development of the dendritic marsh creeks south of the Wall are a natural response to the anthropogenic changes brought about in the channel.

The relic marsh creeks are observable as either flooded channels (low upstanding features) or as soil marks where the silts deposits have been cut by the plough. The modern landscape is divided into land units by maintained channels which also serve to drain the land. All such features have been active waterways since the earliest available aerial photographs were taken. The relationship between these maintained channels and the relic marsh creeks, both north and south of the wall, would suggest them to be elements of the natural drainage systems which have been dredged and even straightened in some cases. In several places there is clear evidence of the relationship between the walls and the marsh creeks. In some cases walls can be seen to have been built across, and in others cut by, the creeks.

Prior to the active land reclamation, this area had been subjected to major sea incursions and associated depositions of shingle which can be seen as upstanding banks (when viewed stereoscopically) with slight evidence of grass parching in dryer months. A shingle bar extending north-east of the Broomhill Levels has been attributed to major storms in the 13th century (Tooley 1989). The subsequent breaches in the bar, clearly visible on the photographs, have been dated to the 16th century (Eddison 1989). The considerable
complexity of the walling around this bar suggests a response to threats of inundations from two sides – the Wainway Channel and the sea. The relationship between the walling and the shingle bars, here and to the south-west at Point Farm, suggests the walls were constructed to augment and reinforce the natural barrier afforded by the shingle.

In terms of achieving its end, the reclamation was relatively successful. The success may be attributable to the sensitivity, whether conscious or not, to natural adaptations brought about by the artificial restriction of the channel. The settlers of the marsh adopted the natural drainage pattern and used it to their own ends and utilised the natural barriers available to them.

Ironically the success of the reclamation of the channel is now bringing about the destruction of this complex system. Shingle has been extracted from several locations, mostly before the earliest aerial photographs were taken, resulting in loss of unrecorded archaeological and natural features: modern drainage has allowed the introduction of arable farming with resultant plough damage and wide-scale levelling of natural and anthropogenic features; and the development of Camber as a seaside town since the 1950s has also resulted in the loss of considerable information with regards to sea defences.

Archaeologists are still in the preliminary stages of understanding this once-dynamic and complex system. Hopefully, the clear and informative mapping produced from aerial photographs for this assessment has indicated the areas with greatest potential for illuminating relationships between elements of the system. This will allow productive targeting of ground-based investigation, excavation and sedimentological investigation. Eventual synthesis of this work should tell us much that is applicable to aerial photographic investigations in similar environments.

_The Wainway Project_ was funded by Romney Marsh Research Trust with a major contribution by Sussex Archaeological Trust.

References


GLEANINGS FROM OTTO
sent over past weeks by Otto Braasch and editorially compiled

Climate data in World Wide Web
Produced by COLA (Center for Ocean-Land-Atmosphere Studies at Calverton, USA), its division of the world into ten areas makes this a little coarse for most archaeological reconnaissance although by downloading it is possible to zoom in. Pages include mapping of current and forecast (14 day) soil moisture. Three addresses appear on the faxes received.

http://www.vol.it/mirror/grads.iges.org/home.html  (general introduction)
http://grads/iges.org/pix/clim.html  (climate outlooks)
http://grads.iges.org/pix/soil4.html  (soil moisture outlook)

Israel
The Israeli Ministry of Foreign Affairs has made two richly graphical exhibits available on the web. *Archaeology From the Air* presents birdseye views of over 20 sites, each with an explanatory caption. Included are the Northern Palace of Masada, the Qumran Caves, Megiddo, the Amphitheatre and Aqueduct in Caesarea, Belvoir Fortress, and Rugum Hiri (the "Wheel of Giants") among others. These aerial views not only show each site, but the surroundings as well, giving geographical perspective. *Jerusalem in Old Maps and Views* contains images of 14 maps of the city, arranged chronologically from AD 565 (the oldest detailed map in the world, according to the site) to 1905. Each map is accompanied by an explanatory caption. Note that both these exhibits are extremely large, as the images are not thumbnails that connect to larger images. However, if your connection is fast enough, these exhibits are well worth viewing.

*Israel Archaeology from the Air*  http://www.israel-mfa.gov.il/mfa/archair.html
*Israeli Ministry of Foreign Affairs*  http://www.israel-mfa.gov.il/mfa/
WHO'S AFRAID OF MORPHOLOGICAL ANALYSIS?
Samantha D. Walker

Introduction
In a perfect world, an air photograph of an otherwise unknown and undocumented site would be regarded as a mandate for archaeological investigation. In this same perfect world all archaeologists would have job security and there would be no interest in quarrying gravel. Unfortunately, the real world is imperfect and financial resources are lacking for comprehensive investigations of thousands of sites known only from the air. This lack leads, in turn, to a paucity of archaeological information about such sites. Where excavation information does exist, so does a bias which shows that excavation has concentrated, primarily, on types of site which are of easily identifiable form, thereby increasing our knowledge about what was already known. When it comes to comparing air photographs with existing excavation information, the bias is reinforced and the vast majority of sites known from the air go unclassified and undated.

Air photographs show four things. Firstly, they show sites which would otherwise remain unrecognised and unknown. Secondly, they show these sites clearly as they would appear on a plan. Thirdly, the combined view offered by several air photographs may show how sites relate geographically to one another in a given landscape. Finally, they show sites in the context of local topography. These four attributes of air photographs all relate to aspects of the physicality of sites (shape and location) and it is a natural progression that archaeologists looking to glean more from aerial photographs showing sites with similar though unidentical characteristics would look to the form and location to tell them more. This leads to morphological and spatial analysis. Neither morphological analysis nor spatial analysis can get very far without the other, therefore, archaeologists examining morphology must take into account the landscape as a whole.

The validity of morphological analysis
To date, it would seem that morphological analysis has not answered the questions asked of it, but rather created a new set of questions with which to contend, not the least of which is whether or not morphological analysis is a valid way of trying to understand the past landscape of Britain.

According to Chambers, morphology is the science of form and may be applied to physical features of living organisms and words, as well as land features. Whimster provided the best context for morphological analysis with respect to air photographs when he wrote: "Archaeological understanding emerges from the ... systematic search for pattern and order." But he adds a caution: "Rarely can the typological arrangement of material be regarded as definitive ... Each exercise in classification is instead no more than an analytical procedure designed to generate hypothesis about the date and function of the evidence under review. Once the first hypotheses have been tested, the provisional classificatory framework should be replaced by more refined successors which will in turn allow increasingly penetrating secondary inquiry." (Whimster, 1989, 26).

Morphological analysis of sites on aerial photographs is a relatively young discipline that is still evolving. Some of the earliest work was done on iron age sites (c.AD300 to 1850) in southern Africa with approaches varying from relatively simple (Mason 1968) to some of the pioneering computer analyses (Maggs 1976; Jones 1978). While classifications developed by different researchers vary, interesting observations still come to light. Palmer's 1976 study of interrupted ditch enclosures in Britain was the first effort to study a particular type of enclosure objectively while using excavation information to provide controlling figures for a chronology. The results of his study indicated that it was valid to study enclosures by type and even pointed to division that might be made within the type, based on
morphology (Palmer, 1976, 178). His study also pointed to the validity of studying shape in the context of topographical settings demonstrating that causewayed enclosures are generally on or near hilltops and are locally high (Palmer, 1976, 166). This begs the question of whether or not a correlation between location and plan might relate to function.

In 1983 Palmer used a computer plotting of a test sample of 437 sites to develop a model of pre-Roman Iron Age settlement in Wessex. Excavation material from 28 test sites was used to create a chronological structure that was then applied to a test area, Popham, Hampshire. Palmer asks three questions of the information: "1. Can sites recorded by air photography be ordered in any meaningful way? 2. Can air photograph sites be related to excavated and dated sites and thus fit a chronological sequence? 3. Can any classes so formed be applied to a discussion of the development of the landscape?" (Palmer, 1983, 41). Palmer gave evidence indicating that enclosures are related to other enclosures at a certain distance, that enclosures can be linked to field systems at two different ranges of distance and that most enclosures touch or lie in close proximity to linear ditches (Palmer, 1983, 47). Any statistician would point out that 28 sites out of 437 is not a statistically significant sample and such limited evidence naturally leads one to be cautious of any conclusions drawn. Four years later, Wilson published a critique of Palmer's study in which he concluded that the shape-types Palmer used in his analysis were too general to be used to develop a chronology for the area (Wilson, 1987, 22).

In 1987 the RCHME developed a methodology for the classification of sites recorded on aerial photographs and in 1988 developed a computer program called MORPH to catalogue the information. MORPH was originally created to aid the RCHME in assessing the relative value of aerial photograph sites for preservation under the aegis of the Monuments Protection Programme. But how does one assess the relative value of a site when one knows so little about it and its relatives? At this point archaeologists were not equipped to determine which sites were worthy of preservation as there was no way of deciding which features were typical or atypical of a region and dates were sorely lacking (they still are). In a critique of MORPH, Hingley asserts that "the best types of classification are those that are problem oriented" (Hingley, 1991, 38). Palmer takes it a step further, pointing out that the problems driving the questions may vary from region to region depending on available information about sites (Palmer, 1989, 57). Palmer also suggested, with respect to MORPH's simplistic categories that "a simple classification will provide only a superficial understanding of the sites" (Palmer, 1991, 32). However, one may ask whether MORPH is intended to aid understanding or just to classify?

In response to these criticisms, Startin explains that the classification project does not seek to replace the efforts of researchers who make sense of the sites through morphology, but "simply to model one part of the process ... to convert data into information in a way which allows us to explain the process to others, and thus to delegate the
work" (Startin, 1991, 7). One of the researchers doing some of this work was Fenner, who conducted a pilot project for the RCHME in the Thames Valley using MORPH2. A total of 11252 sites of which more than 90% are crop marks has been documented and recorded on the database. In her conclusions it is clear that MORPH does little to further understanding of these sites: "The Thames Valley project successfully updated the transcriptions of aerial photographs for 1450 square kilometres of the Upper and Middle Thames Valley" (Fenner, 1995, 99). Granted, 44.9% of the sites are "new" to national and local records, demonstrating that the exercise has done much to increase the amount of up-to-date information available, but little to garner new and further understandings of that information. Fenner asserts in her conclusion that the pilot study "allowed the methodology of morphological recording in particular to be tested to the full" (ibid.). But her morphological analysis (requesting that the computer find sites similar to a group of crop marks in Gloucestershire) produced a list on which, true to form, "all of the most similar sites were known from aerial photography only, so a date for the group could not be suggested" (ibid.). Inconclusive evidence, though characteristic of morphological analysis, cannot be considered a test of methodology for morphological analysis.

In addition, MORPH does not and, perhaps cannot, take into consideration the interconnectedness of sites within a landscape. As mentioned above, morphological and spatial analysis are mutually reinforcing in that understanding how sites relate to one another in the landscape may help lead to understanding their function. For example, while in the Oxfordshire Uplands individual settlements are logical units for analysis, on the gravels of the Thames Valley, groups of settlements shared resources and it would be wrong to try to study individual settlements in isolation (Hingley, 1991, 42). Similarly, Whimster found simple morphological analysis useful with his isolated enclosures in the Welsh Marches, but that such an analysis on its own would reveal little about the Trent Valley complexes. In answer to this, Startin states that the "project will also produce plotted information which can be reduced to 1:25,000 scale and amalgamated to an overview of the landscape" (Startin, 1991, 8). Hampton points out, however, that before one can know how the landscape worked, there is a need to establish contemporaneity within the elements that comprise what is essentially a cartographic inventory (Hampton, 1991, 46) and until more dates are gathered for the sites, this state of affairs will remain the same. Even Fenner notes a need to look at the landscape in her work on the Thames Valley project and noted then that "the artificiality of studying a relatively small geographical area in isolation from its surrounding landscape was also recognised. Such work needs to be done on a national basis as proposed by the National Mapping Project" (Fenner, 1995, 100). Thus it seems necessary to enable MORPH or any other classification strategy to be aware of those features within certain distance ranges which may illuminate how various features in the landscape relate to one another.

The creators of MORPH wanted to make sure that their categories did not allow for "soft options like 'other' or 'miscellaneous'" (Edis, et.al., 1989, 114). It is interesting to note that in Palmer's 1983 study, he allowed a field in his computer-based morphological analysis for an intuitive assessment of constructional phases (Palmer, 1983, 41). Perhaps such subjective notes are helpful to morphological analysis. Whimster warns against allowing objective and subjective approaches to photographic evidence to become mutually exclusive alternatives (Whimster, 1989, 34). It seems that by standardising the categorising of site information, one runs the risk of losing sight of what is subtly different or unique about a region. There are many things that one may argue MORPH is or is not, but there is certainly something it cannot be: intellectually brave. It must be left to archaeologists to make the leaps that will reveal the prehistoric landscape and, therefore, there must be room within MORPH's categories and descriptors that allows an archaeologist some intellectual movement and flexibility.
Further needs

Palmer states that several roughly similar morphological studies in Britain "show that analysis of air photo evidence combined with whatever 'factual' information is available can go so far and no further towards increasing our knowledge of the past. The cause of the halt is clearly lack of dating evidence" (Palmer, 1989, 58). Morphological analysis was originally pursued with the hope that once all the considered sites for a particular study had been categorised according to shape, one could then look at the existing excavation material and on the basis of that provide a date range for sites of similar shape. Unfortunately, very few sites have been excavated and there is not enough information on which to base chronologies.

Authors on the subject acknowledge these needs and make recommendations for further work. Palmer suggests that area studies, such as that demonstrated for the Popham area, may prove of use in formulating an excavation policy in the chosen area. "Use of attribute analysis can provide pointers to features, or parts of sites, that appear likely to be key points for small-scale question-oriented excavation" (Palmer, 1983, 51). Palmer also calls for further field work in Wessex in order to answer some of the questions raised by his analysis as well as the undertaking of similar studies in other parts of the country. With respect to simple enclosures at Danebury "broad morphological/chronological divisions already proposed ... may prove a useful classificatory scheme, but excavation of key points is clearly a desirable next step" (Palmer, 1984, 27).

Wilson calls for the results of aerial photographic analysis to be made available by publication so that earthbound archaeologists will have an opportunity to take notice of the evidence (Wilson, 1987, 22).

Whimster provides a veritable manifesto of what work is needed to further understanding of sites. The first stage of what he calls his "exploratory programme" would consist of trial excavations in order to acquire basic dating evidence, geophysical information and ascertain the extent of archaeological survival in different topographical and environmental zones. Where trial excavations are not possible there should be superficial field inspection and systematic field walking. This first stage would indicate those sites which might tell more about function and date requiring further investigation. And that's not all. Whimster also makes recommendations on everything having to do with aerial archaeology from archival storage to camera specifications to standards for archaeological interpretation and classification (Whimster, 1989, 88-93).

Fenner calls for national and local archaeological records to be brought up to date as soon as possible so that "appropriate policies for protection and mitigation can be developed" (Fenner, 1995, 94). Fenner mentions that while publishing her work on the Thames Valley, 13 new sites were reported and additional information about 27 other sites came to light thereby pointing to a need for continued reconnaissance along with programs for revision and transcription.

In at least one case, a simple version of the sort of mapping and interpretation that goes into morphological analysis has proven beneficial in an "integrated survey" (Palmer, 1995, 169) combining air photo interpretation and field survey. The Fenland Survey located and recorded over 2500 sites between 1976 and 1994. Field walking located sites of surface scatters which indicated targets for future aerial observation. Sites were also identified by photo interpretation and subsequent field walking revealed further archaeological evidence (Palmer, 1995, 169-171). Such a combining of efforts, produces a result that is greater than the sum of its parts and is only one of the ways in which aerial evidence can enhance archaeological work and understanding.

What is clear is that Britain has a tremendous archaeological resource in the form of aerial photographs of archaeological sites. While excellent efforts have been made to make sense of them through morphological
analysis without the benefit of archaeological excavation, too many questions remain. Is morphological analysis a valid method of studying sites only known from the air? It is uncertain whether we have enough information to answer that question. Palmer makes the unsettling point that morphological analysis assumes that there were defined types or a "fashion" in enclosure form at the time that they were being built (Palmer, 1991, 35). He also points out, in reference to a project integrating air photo interpretation and field survey in the Fenlands project, that "we can identify sites from the aerial photographs likely to be settlements where we would expect to find scatters of material, but if these sites are not settlements then many of the assumptions made in morphological analysis of crop-marked features are invalid" (Palmer, 1995, 174).

Pryor's sheep stockyards are a possible case in point. Drawing on his experience and expertise as both an archaeologist and a sheep farmer, Pryor interprets a collection of enclosure in the Fenlands, which are morphologically similar to other enclosures in the same area, as "community stockyards" where regular gatherings of livestock and people took place (Pryor, 1996, 317). A 'house' in one of the enclosures produced nothing in the way of ordinary settlement debris and the ditches and banks represented more labour than marking enclosures boundaries might sensibly require. The ditches and banks do, however, resemble the sort of narrow path or 'race' which renders sheep docile and easy to control, inspect and sort (ibid.). Therefore, Pryor interprets the enclosures as auction rings where livestock were culled and exchanged (ibid.). Pryor also asserts that, "Regular gatherings at the communal stockyards would have been important social occasions, doubtless attended by ritual and ceremonial. With this the simple distinction between a 'domestic' landscape of fields and stockyards and a 'ritual' landscape of henges, cursuses and barrows begins to break down" (ibid.). This example points to the importance of broadening understanding of sites which may be morphologically similar to others in order to further understanding of the greater landscape as a whole.

What we know so far is that morphological analysis has gone as far as it can without the benefit of excavations to produce a working chronological framework for various morphologies. Not only can air photography evidence prove useful in categorising sites for field work (Palmer, 1976, 178), but air photographic evidence and analysis should be a prerequisite for further fieldwork (Palmer, 1983, 53). It remains to be seen if the classifications established will be supported by dating information and only once that has been done will anyone be able to say with any certainty that morphological analysis is valid.

What can be done to rescue morphological analysis from a future as exclusively a planning tool when it has every potential for being developed into an archaeological tool? A couple of things: firstly, there has to be some excavating. Through morphological analysis, one may identify those elements which recur in the shapes and layouts of enclosures. Once these have been identified, selective excavation must be executed to investigate a number of examples of each type so that a date range may be established. Once there is a working date range for a type of enclosure in a region, then that chronology may be used to provided working chronologies for other regions based on similar morphological forms until further excavations are conducted. The ability to place thousands of sites, about which little is known, into a working chronology will go far in aiding archaeologists with understanding the landscapes in which they conduct their work and conservationists with protecting sites. It would be naive to assume that the first chronology developed would be totally correct, but it would allow morphological analysis to continue to be developed rather than allowing its development to come grinding to a halt. Recalling the words of Whimster, quoted earlier in this article, one is reminded that testing the categories developed is the sensical next step in the development of morphological analysis.

Any region that has been mapped and analysed would be a good place to start. Danebury and its environs, for example, have been well mapped and morphological types
offered (Palmer, 1984). While the sort of spot excavation recommended here will not provide the detailed archaeological site analysis archaeologists like to have, it will begin to provide an understanding of landscapes about which we understand very little. When engaged in question-driven research, it is impossible to know less when one is finished than when one started. One really only runs the risk of understanding how very little one knew to begin with.

The funding this sort of project would require is not easily had and would most likely be obtained within the realm of academia. So, before morphological analysis gets its much-needed chronological framework, there will have to be a university post created for an aerial archaeologist. Development of an inter-disciplinary course of study drawing from Anthropology, Archaeology, City Planning, Sociology, Geography, Geology and Agricultural Science might be very interesting. Call the course "Ancient Landscape Studies" or "Growth and Structure of Ancient Communities". The inter-disciplinary approach of such a course would require a figurative and literal bird's-eye-view of any landscape under evaluation. Enter the Aerial Archaeologist. Perhaps then funding will become available to pursue some of the themes unique to aerial archaeology including testing the validity of its analytical methods.

References


Palmer, Rog, 1991. Approaches to Classification, AARGnews 2, 32-37


Abstract

This paper describes the use of digital image processing and artificial intelligence techniques for the analysis of the archaeology visible in vertical aerial photographs. The primary use of the software package described is to automatically collect accurate measurements regarding earthworks/enclosures, and then to apply a classification scheme based on these measurements in order to automatically classify monuments as they are found.

Introduction

The Windows 95 based Aerial Archaeology System (AAS) allows the user to apply various digital image processing techniques to digitised aerial photographs. It maintains a database of photos, and the products derived from them as they are studied. The main products are: Digital Elevation Models (DEMs) and measurements plus classifications of user-identified monuments. By identifying National Gridreferenced control points in the photos, the DEMs and photos are automatically oriented and their scales computed. In the future the package will allow data to be exported in a common format - probably AutoDesk's DXF - which will allow for importation into most GIS and CAD systems.

Digitised Aerial Photographs

Using a scanner, photos are imported into a computer as bitmaps - grids of square pixels each of which is a single colour or greyscale intensity (figure 1).

Most automatic "image understanding" techniques are based on the manipulation of these pixels - possibly millions of them - and the analysis of the spatial relationships between them. Each pixel is stored of course as a number (normally in the range 0 to 255 for greyscale bitmaps, where 0 is black and 255 is white).

Figure 1. Part of a digitised aerial photo with a section enlarged to show its pixels.

It is fairly straightforward to carry out digital "dark-room techniques" on bitmaps - indeed a variety of shareware and public domain software packages providing this functionality are readily available. By applying techniques such as interactive contrast stretching, the user can study photos more effectively (Scollar, 1990).

Figure 2. A photo with poor contrast and the result of applying a contrast stretch.

In figure 2, a photo with poor contrast and the result of applying a contrast stretch is shown. Here the greyscales have been stretched out over the entire valid range [0, 255]. Visual interpretability is improved since the eye is
capable of distinguishing only large changes in greyscales, and only 20-30 different greys in total (Scollar, 1990).

Another important category of digital image processing techniques is based on the application of "filters" to bitmaps. Filtering is a flexible technique which replaces pixels with some user-defined function of themselves and their neighbours. An important class of filters are used for edge enhancement - by emphasising pixels which deviate strongly from their neighbours.

Given a stereo pair of photos, measurements can be made between corresponding points in the overlapping region, to determine the approximate height of these points. The measurements made are of the parallax apparent in the direction of flight of the plane - and can be made between any clearly distinguishable points in the photo overlap (Slama et. al. 1980).

This manual technique has been automated in the AAS package. The bulk of the computational work is carried out during the "cross-correlation" stage, where each of the pixels in the first photo is matched to a corresponding pixel in the second photo. Depending on the speed of the computer and the nature of the photos and landscape, it can take between 30 minutes and 2 hours to determine the parallax value for all of the pixels in the overlap, assuming approximately \( \frac{3}{10} \) million pixels are in the overlap (typical for photos scanned at 150 dots per inch). Resulting from this is a reasonable DEM of the overlapping region (some distortions will occur with regard to the accuracy of the grid spacing). The system rejects small "noisy" contours resulting from errors in the cross-correlation stage or from trees, houses, etc. confusing the computer. The gaps are then filled in from neighbouring pixels (figure 3).

**Figure 3.** (a) A section of an aerial photo. (b) A "false surface lit" rendering of its calculated parallax values. The contour interval obtained is dependent on the resolution at which the photos are scanned as well as the flying height of the plane. The interval in this example is about 1 metre - from a 150 d.p.i. scan at a flying height of c.1.51Qn. The best that could be obtained from this photo would be about 25cm intervals, i.e. with scanning at 600d.p.i. - which is about as much information as there is available in the original photo. (c) The parallax map with errors removed.
Shape Extraction

The first step in automatic "scene understanding" is often the application of an edge-enhancement filter. This class of filter determines how different pixels are from their neighbours: abrupt changes in brightness normally imply edges of objects. The aim is to automatically recognise objects in the scene, which are normally characterised by their edges (Boyle & Thomas, 1988). The human mind is very good at visual interpretation, filling in the gaps in objects and ignoring unimportant information. The task of recognising objects from their edges is however very difficult to program a computer to do. If an edge enhancement filter is applied which assumes that even small changes in brightness represent edges, then the result is that true edges are lost in the "noise" - see figure 4.

Figure 4. Plentiful lines => desired edges masked by noise.

If however a filter that produces relatively few edges is used, the problem is that line fragments will have to be somehow "stuck together" into coherent and meaningful shapes (see figure 5). The problem lies in trying to turn imperfect and noisy line fragments into extracted objects.

The author has experimented with a variety of approaches - e.g. by rejecting short line fragments and sticking the remaining long fragments together; or by the application of directional edge detection filters and then only tracing lines whose pixels' edge directions change in a strictly clockwise or anti-clockwise direction.

Figure 5. Sparse lines => desired edges not fully traced.

In fact traditional edge detection - adequate for industrial applications where objects are typically of very high contrast to their backgrounds - is not adequate for automatic understanding of archaeology in the landscape. The edges of archaeological features are simply of too low contrast when compared to the modern features visible in the photos.

One approach that is often used when looking for circular shapes is to sum the number of edge pixels at a given distance from a point, thereby examining evidence for the existence of a circle centred at that point (Durham et. al. 1993; Lemmens et. al. 1993). However, earthwork features are not perfect circles, but tend to be sub-circular. The AAS software makes use of the fact that it is looking for lines that form arclike shapes. It finds and sticks together arcs from circles with varying radii and centre points. The following steps are carried out in this procedure:

1. The user identifies an approximate area (rectangle) containing the shape (figure 6), and provides an approximate "circularity" measure. It is assumed that a
small region around the centre of this area contains all candidate centres.

Figure 6. The user chooses a feature to analyse by defining a rectangle with the computer's mouse.

2. Candidate diameters for arcs to be tested are chosen in the range x% and 100% of the longest rectangle side, where x% is larger for features that are more circular and x < 100.

3. For each candidate centre and radius, 50 discrete 7.2° arcs around the circle are tested.
   • At each point on the circumference of each arc, a pixel brightness is calculated using nearest-neighbour interpolation applied to the pixels in the bitmap (since the points on the arc will not fall neatly on the bitmap pixels). A pixel brightness is also interpolated at the same point in the same arc with a radius of 1 pixel less.
   • The difference between these yields a truly directional edge strength outwards from the centre of the arc. These strengths are summed over 12 points on each arc.

Figure 7. 200 arcs are extracted. In this picture, the darker arcs are the stronger ones (i.e. ones in which the directional edge strength - the rate of change in pixel brightness - was higher).

4. The 4 best arcs (those with the highest sum of edge strengths) between all tested circles at each of the 50 arc positions are used to build the final shape - i.e. 200 arcs in total, with varying radii and centre points (figure 7).

5. Any outlying arcs whose radii are more than a given amount above or below the average are discarded - this amount is also a function of the "circularity".

6. The shape is drawn using a weighted moving average of radius and centre position, which smoothes the arcs into a coherent shape and approximates at weak areas where there is little or no evidence of edges. The smoothing angle (defining the number of arcs taken into account in an average) is user defined. Arc strength (sum of edge strengths) is used as a weighting factor, so arcs with good evidence affect the shape more (figure 8).

Figure 8. The user experimentally decides which "circularity factor" gives the best result.

7. The computer has traced the strongest edges, which tend towards the centre of a bank in the places where an upstanding bank is perpendicular to the light shining on it, since the strongest edges are apparent at the edges of shadow. The extracted shape however tends to drift across the inside of the banks at the places where these banks are parallel to the sunlight, thereby distorting the shape extracted (this is visible in figure 8). The user can therefore click with the mouse on the edges of a shape at the places where he or she sees distortion. After each click the computer moves the closest arc to each click to meet the correct position. The shape is calculated again with this revised arc centre and radius. A few well-placed clicks are sufficient to correct any distortions in the computer-extracted shape (see figure 9).
Classification

Given a set of training cases and the "correct" classification for each case, the computer will be taught to categorise new features as they are found. The "correct" answers used during training may be supplied by a human expert or through cluster analysis. The AAS software already includes a neural network simulator, which is being trained initially to classify Irish enclosures.

Artificial neural network (ANN) simulators are computerised representations of specific problem domains which function in a way similar to our understanding of how the human brain operates. ANNs are trained to accept a set of input stimuli (e.g. a set of measurements) and to respond with one or more numerical outputs. Their strength lies in the fact that they learn from training cases: they are not programmed with rules in the way that traditional artificial intelligence systems are. ANNs are therefore very useful for working with problems in which rules are difficult to determine, and are commonly applied to classification problems (Bishop, 1995).

Conclusions

The collection of sets of measurements for earthwork enclosures using the AAS is currently in progress, and will be reported to the AARG in due course.

Automatic Measurements

A variety of useful measurements can be automatically derived from the extracted monument shapes. The 6 measurements currently made for enclosures by the AAS software are outlined in table 1. Some of these measurements are based on the shape of the monuments. (See Castleman, 1979). Others are made with reference to the DEM previously calculated for the photo in which the monument appears.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Calculation</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circularity</td>
<td>Perimeter²/Area.</td>
<td>Minimised at 4 D for a circle</td>
</tr>
<tr>
<td>Rectangularity</td>
<td>Object's area divided by area of its minimum enclosing rectangle</td>
<td>Maximised at 1.0 for a rectangle</td>
</tr>
<tr>
<td>Elongation</td>
<td>Length/Width</td>
<td>Length and width are calculated with respect to the principal axis of the shape</td>
</tr>
<tr>
<td>Total area</td>
<td>Pixels x area in photo of 1 pixel</td>
<td>Area (m²) represented by a single pixel is calculated automatically from user-supplied control points</td>
</tr>
<tr>
<td>Slope</td>
<td>Slope of best-fit plane</td>
<td>X,Y,Z ground co-ordinates of the points in the monument are submitted to a 3D linear regression</td>
</tr>
<tr>
<td>Aspect</td>
<td>Compass direction of best-fit plane</td>
<td>Orientation of photo/DEM is automatically calculated from user-supplied control points</td>
</tr>
</tbody>
</table>

Table 1. The measurements made by the AAS software for enclosures visible in vertical aerial photos.
The shape extraction and classification system should also be applicable to crop and soil marks and to previously mapped features through the use of digitised hand-drawn maps as well as photos.

Crop and soil marks are often studied in terms of shape and size, but measures of association are considered more significant than those of position (slope, aspect) in this case (Edis et al., 1989). Some work would have to be made in the area of formalising the association of features, in order for the existing AAS software to be applied to this area.

The author would like to thank Rog Palmer for his help in refining this article.

References


NEW VERSIONS OF AERIAL

Two new versions of AERIAL are now available:

- AERIAL 4.13 has been written to run on Windows 3.1 or 3.11 to produce vector outline rectification.
- AERIAL 5.04 is the most recent edition of the digital image package.

Enquiries as usual to John G B Haigh, Department of Mathematics, University of Bradford, Bradford, West Yorkshire BD7 1DP, UK Phone 01274 384278

More detailed information on their immediate predecessors appeared in *AARGnews* contributions by John Haigh in 1993 and 1996.

Haigh, J G B, 1996. Another member of the AERIAL software family. *AARGnews* 12, 26-33.
Introduction
Responsibility for excavation and survey in that area of the reservoir to be created by the Birecik Dam which will cover the site of the ancient Greek and Roman city of Zeugma was assigned to the French government's Mission to Zeugma, in collaboration with the Museum of Gaziantep. The French mission is led by Catherine Abadie Reynal, now of the Ecole Normale Superieure in Paris and also lecturing at the University of Nantes. Only areas beneath the 400-metre contour line are being investigated at this stage, the height of the Euphrates river at the dam construction site being about 340 metres above sea level. Following a first reconnaissance in 1995, a team was established with various types of expertise. The author was invited to participate in view of his theoretical knowledge of remote sensing and interest in archaeological applications of this technology in the Middle East.

Although use of earth observation satellites to assist archaeology is relatively new, some institutes in France have developed a certain expertise and the technology has been widely used in Central and North America. In the Middle East, satellite photographs have been used by archaeologists primarily as a substitute for aerial photographs and for large-scale maps, which are notoriously difficult to obtain in many of the countries concerned. The only serious attempts to apply aerial photography to archaeology in the area were those of Poidebard and Stein in the 1920s and 1930s. Since then aerial photography has been largely impossible, although a limited amount has been done in Israel and especially in Jordan.

However, the potential value of satellites for archaeology is much broader than the immediate needs of prospecting and surveying. They may be of assistance in the identification of features of archaeological interest and they can be used to plan ground surveys. If available in multispectral format, they may also be used to study current vegetation, land use and water sources, with a view to establishing patterns of cultivation and settlement in the past; and they may be used as the basis for the creation of Geographic Information Systems (GIS). The last possibility is of especial interest for a region that is rich in historical and archaeological interest and will soon disappear beneath a reservoir.

Examination of satellite photos for the area of Zeugma has been much facilitated by two visits in 1996. The first such visit in May enabled the author to obtain an idea of vegetation and topography; the second in October, during the season of excavations, provided the opportunity for a more detailed exploration of the area, for the obtaining of GPS measurements and for a comprehensive check on those sites identified by an earlier survey of the valley in 1989.

Choice of imagery
Remote sensing for archaeology requires as high a level of detail as is possible to obtain. This usually means - at present - KVR1000 photos acquired by Russian reconnaissance satellites for much of the world since the 1980s and now commercially available. In theory, these photos have a spatial resolution of 1.5 to 2 metres, i.e. objects greater than 2m across should be readily visible. Other satellite imagery is however also regularly used by archaeologists, in particular SPOT and LandSat imagery with spatial resolution of 10 metres for SPOT, 20 metres for SPOT multispectral and 30 metres for LandSat. Potentially radar imagery, such as that provided by the ERS-1 and ERS-2 satellites or by Radarsat, is also of great interest given its capacity to 'see through' vegetation and even, in special conditions, through sand.

For this project, a KVR1000 photo was purchased for an area of about 35 by 15 kilometres above and below the site of the dam. This photo was taken on 11 June 1990.
from a height of 230 kilometres. A print and digital version of a SPOT panchromatic image of 7 September 1991, covering a wider area to the West and South, was also provided through the Centre National d'Etudes Spatiales in Paris (CNES).

Image Processing
Both the KVR and SPOT images were initially provided in photographic format. The KVR diapositive was enlarged to provide a more detailed picture of the areas of immediate interest around the twin towns of Seleucia and Apamea on right and left banks of the Euphrates respectively (which together make up the city of Zeugma) and also around the mound or huyuk of Honun, 10 kilometres to the North, which is the site of excavations, undertaken by the Institut Francais d'Etudes Anatoliennes of Istanbul. In practice, the largest individual objects visible on these photographic enlargements were about 5 metres across. The KVR enlargements were useful especially in that they allowed certain features, such as the outline of the fortifications of Apamea and the walls of the Roman legionary camp, to be immediately identified.

To obtain the maximum benefit from such images the digital version is needed to permit further processing and enhancement on a computer. Several attempts were made to obtain a digitised version of the KVR photo and a complete image of the original diapositive was eventually acquired. Each pixel in the digitised version was 25 square metres, although this size is artificially limited by the need to place the whole photo in one file and the resulting very large size of this file (about 20 Megabytes).

Two portions of this image are annexed at the end of this report. The first is included to give an idea of the area covered and the major sites mentioned here, while the second covers the area of Zeugma only and, it is hoped, provides an impression of the capability of the KVR satellite.

Attempts were made to enhance and to rectify or "geo-reference" both images, in order to remove internal distortions and to provide map coordinates which would allow their use together with such maps as are available for the region and together with other satellite images. The image processing software used was "Idrisi for Windows", initially on a Pentium PC. The ground co-ordinates were obtained by GPS on two visits, using a hand-held Gannin 40 machine, which provides the position of the machine on the earth's surface theoretically accurate to 15 metres (but artificial distortions introduced by the US Department of Defense reduce this to 100m). In this case iTTM coordinates were used. The ground control points were selected for their visibility from space and three readings were taken on different days for each point.

Results of satellite survey
* Right or south-west bank
The identification of structures of archaeological interest has been less successful than hoped. The area of Zeugma is characterised by a high degree of erosion on the right bank, around the conical hill of Belkis - thought to be the acropolis for the Hellenistic city. Most of the city of Seleucia is now under several metres of earth and rubble hillwash. Like aerial photographs satellite images are likely to be more useful for archaeology in less hilly areas, where erosion and deposition have not affected the landscape so severely.

Thus, although traces were found on both the images of the legionary fortress (above the area to be inundated), it was disappointing not to see the city walls or the ancient bridge. Some few such traces were visible on the ground both West and, possibly, East of the city, but the nature and precise location of the walls and of the bridge remain uncertain.

About six kilometres to the North, in a fertile part of the valley, the large huyuk of Horum, thought to be the site of the late Roman town of Urima, is visible on both satellite images. If they are sufficiently prominent, such mounds throw a considerable shadow in morning and evening and are generally visible on the SPOT panchromatic image as well as the more detailed KVR1000 photo.
Roads remain problematic. A distinct straight line along the present course of the river on a low bank about 2 metres above the flood plain runs ESE to WNW past the modern village of Belkis, continuing on towards the supposed site of the bridge and the still extant road tunnel just above the river. Part of this "road" - that running past the bath complex discovered in May 1996 East of Belkis - has now been totally destroyed. The satellite photos are therefore the only record available. Given the difficulty of passage along the river to the south-east, where the hills come down in a steep cliff at the site of Tilhane, it seems probable that this ancient roadway - if such it was - ascended to the plateau West of Birecik by one of two valleys still currently used as lanes and clearly visible on the photos. A prominent huyuk at the village of Gunalti, West of Birecik, may have been a first destination for this route on the way down to Carchemish.

The route from the West may have descended to the river a little to the North of Zeugma itself, possibly at Honun. Traces of a Roman road have been reported North-East of Gaziantep, shown on Wagner's fine map of the area in the Roman period as crossing towards the river to the North of Zeugma. The SPOT image does show traces of a possible Roman road crossing from the Nzip Cay to the West. Further investigation is required and an additional KVR satellite photo of the area to the West may be necessary.

Aqueducts and other traces of water engineering are also visible, in part, on the ground but sadly not from space, at least not in the area examined so far. Quarries are the other major man-made feature which might be expected to be visible from space. Two series of ancient quarries were known in this area prior to 1996, at Ehnes (Arulis) and on top of the mountain Kalazan Dag on the left bank (see the annexe and below). A third series of ancient quarry workshops distributed along an escarpment was discovered by the author just outside the area covered by the KVR1000 photo. These were not visible on the SPOT panchromatic image at all, although the escarpment concerned is just visible.

The well-known quarries at Ehnes are visible on the KVR1000 satellite photo, although the high reflectance from the bare stone shows up as almost white and little detail can be obtained.

Other traces of the ancient world that might show up on satellite photos in such an area include field boundaries. Roman centuriation in particular has been noted on satellite and aerial photos from areas such as Tunisia and the Istrian peninsula. Although field boundaries do show very clearly on the KVR and SPOT images, none of the typical large squares of regular size which have been identified as evidence of Roman centuriation in other regions around the Mediterranean appear on the two images obtained.

The large numbers of ancient underground tombs, which are characteristic of the area, are of course features impossible to identify from space.

* Left or North East bank

The area of Apamea presents the opposite problem to that of Seleucia. Instead of being hidden by landslips, this ancient city is low-lying and covered by rich alluvial soil that has built up following the regular flooding of the Euphrates that continued until the construction of the Ataturk dam 100 kilometres upstream.

The existence of Apamea as a fortified city remained in doubt until this last season, when the original Hellenistic walls of large, finely-cut, limestone blocks were excavated. The line of the wall had been indicated both by Wagner and by Algaze, who had noted the deep wells dug by local farmers, which had made use of the city wall's foundations to prevent collapse. However, almost all of the city had been buried by alluvial deposits.

Considering this situation, it is perhaps surprising that the KVR1000 satellite photograph revealed so clearly the walls of Apamea, especially to the North and East. The visibility of this line may in part be ascribed to the changes of direction of field boundaries as well as to slight changes in ground level. The excavation of the wall, especially of the remains of its Northern alignment, and its subsequent mapping
were facilitated by the clear indications provided by this photograph. However, apart from the huyuk by the village of Tilmusa, which is just inside the walls and currently a village cemetery, no other evidence of the city was visible from space, nor indeed is visible on the ground.

A neighbouring huyuk to the North, that of Tilbes, is also visible, especially on the KVR 1000 photo. This site is currently being excavated by a Spanish team, led by the University of Madrid. Like the mound of Horum on the opposite bank, it was described by Algaze in the results of his 1989 survey. Amongst the discoveries this season was a series of strange holes under water along the East bank of the river between Tilbes and Tilmusa, which may be associated with a river port. These holes are not apparent on the satellite images and neither satellite appears to have the capacity to reveal information about sites under water. As on the right bank, there was a lack of success in identifying lengths of Roman road. Quarries, however, were clearly visible on the KVR 1000 image on Kalazan Dag. To the south-east of Apamea, on a cliff above the river and directly opposite the construction site of the dam, a hitherto unrecorded site was discovered during field work by the author. It included a possible fort (two walls at right angles built of large stones facing both in and out) and about 40 dwellings. This site too - identified provisionally as of Byzantine date from some "late" potsherds - was not visible on either image. It has probably been destroyed by the construction work.

* KVR and SPOT

The KVR photograph proved clearly superior to the SPOT image in its usefulness for identifying sites of archaeological interest and as an aid for survey work. Of the 46 sites below the 400 metre contour identified in Algaze's Euphrates survey of 1989 which fall within the area covered by the KVR photo, 20 could be identified from space. Many of the remainder were visible on the ground only as surface scatter of artefacts. The SPOT panchromatic image showed up fewer sites, but mounds, as well as major earthworks such as the walls of the legionary fortress at Zeugma, were easily recognisable. The SPOT image on CD-ROM covered a larger area and roads were clearly visible. The lower price per square kilometre for SPOT images may make them a more cost-effective source for study of ancien roads than other higher-definition but higher-priced images. (The KVR1000 photo was charged at the rate of $2.1 per square kilometre.)

Satisfactory combination of the KVR and SPOT images has been achieved for some areas, using the 'Resample' programme in Idrisi to create "georeferenced" images with GPS control points and then, using the 'Composit' programme to display the SPOT original image, a stretched version of the latter and the KVR photo on the three different colour guns (Red, Green and Blue). The value of this exercise, in terms of the increase in ease of interpretation, was doubtful. In any case, it should be noted that the GPS readings are accurate only to within 100 metres and an RMS error of about 6 (equivalent to 60m in this case) was therefore accepted for the georeferencing. This would not meet the standards of professional cartographers.

* Possible improvements

Interpretation of both images would have been easier, and perhaps more fruitful, if it had been possible to "drape" them on computer over a Digital Terrain Model which may be "twisted" on screen, to create the illusion of a three-dimensional representation. Such a model can be created by stereoscopy and combining two SPOT images taken at different angles, although the process is expensive. The alternative would be to use the aerial photos of the region that were the basis for the military 1:25 000 maps. Both aerial photos and maps are subject to military secrecy laws and are unavailable to the public, but DTM's have been created in this way for other archaeological projects in Turkey by a firm in Ankara with special access to the aerial photos. However, 1:6 000 scale plans of this area, with contour lines, are apparently available for purchase from the sales office of the Turkish Military Cartography Department, but none have been acquired by the Zeugma Mission.
In the absence of multispectral images, no analysis of the vegetation of the area has been attempted, although it has proved possible, by analysis of the spectrum of the SPOT panchromatic image using ERDAS, to isolate water and damp areas in general, areas of sparser vegetation and areas of rock, roads and bare earth. It is hoped to acquire a Landsat image of the area which will permit a more detailed analysis and which should allow the creation of a model showing land uses at the date of the satellite overflight. The whole region seems to be undergoing an agricultural revolution with the introduction of modern, mechanised farming techniques. Deep ploughing and the abandonment of small plots may entail the widespread destruction of the archaeological remains of the area, even outside the area affected by the dams, as was foreseen by Algaze. Inclusion of this information in a GIS could permit comparison of occupation of the land at different periods.

As indicated in the introduction, it is this establishment of a GIS which is likely to prove the most fruitful use of satellite images for this area. Such a database would provide firstly a visual record of the area, which - if a DTM were also to be available - could take the form of an imaginary "fly-through" of the valley on video. This visual record would indicate those sites of archaeological interest and would offer both a text for each such site (which might be linked to detailed excavation reports) and photographs, maps and plans. As such it would be an ideal tool both for displaying the valley and its sites in a museum and also for establishing an archive of material for scholarly and educational use. Such a database could furthermore provide the framework for publications about the sites of the valley on the Internet. (A first such Internet Web Site about Zeugma has already been established by David Kennedy and a second is now available through the server of the Luxembourg lstitut Supérieur de Technologie.)

**Future Plans**

Examination of both the satellite images available is continuing using the ERDAS programme of the IST in Luxembourg and IDRISI, which is much simpler to use. Attempts to enhance the panchromatic images and to reveal additional features of interest are being made by stretching the different parts of the spectrum of computer data, by applying various filters to the data and by creating false colour composites from the original and enhanced images combined. However, these efforts have not yet resulted in a noticeable improvement in the clarity of the original images.

Attempts will be made to coordinate the work on satellite images with that of the archaeological surveyors and of the geomorphologist. It is intended to provide regular reports on the IST Internet website now being established about this and other aspects of the work at Zeugma as reports become available.

Insofar as resources and time permit, analysis will be extended to a multispectral image such as Landsat - suitable images have been identified for specific dates in the growing season. Declassified American intelligence photographs from the 1960s - which may now be ordered over the Internet - will also be studied.

The last and most demanding stage is likely to be the creation of the GIS. The satellite images will form the basis of this, and attempts will be made to show changes in vegetation as a result of modern farming techniques as well as incorporating information from a wide variety of other sources.

**Conclusion**

Study of the two satellite images available has proved to be of great help in understanding the area and its sites. The KVR1000 photo is comparable to aerial photos in quality and level of detail, while even the SPOT panchromatic image permits a detailed view at a scale of roughly 1:25 000.
A single photo does not permit stereoscopic viewing and it was therefore initially difficult to interpret the relief. However, visits to the area resolved most such problems. In this respect, creation of a DTM from a SPOT stereo pair would be a great help, although the cost might be difficult to justify.

Digitising of the images, enhancement by computer processing and enlargement of specific areas allows a level of analysis of features of archaeological interest which would otherwise be impossible. The resulting screen images were printed, sometimes with added colour tints (using the programme Aldus Photostyler), and proved of great assistance in the field. It would be wrong to exaggerate the usefulness of this technology to archaeology. Oblique aerial views which show up archaeological features to great advantage in Northern Europe are clearly impossible at present and the difficulty of obtaining satellite images of particular areas at particular seasons and times of day introduces an important element of chance. Also, they remain expensive to buy and difficult to process.

Nevertheless, especially in countries where aerial photography is impossible and large-scale, upto-date maps unavailable, such techniques are likely to remain invaluable for understanding archaeological sites in their context. Zeugma may not be an ideal location for displaying the potential of the technology because of the problems of erosion and alluviation mentioned above, but there can be little doubt that remote sensing will be an extremely useful tool for archaeologists in the future throughout the Middle East, particularly as better images, with more detail in terms of both spatial and spectral resolution, become commercially available.

Doubts were raised in some quarters concerning the desirability of using a technology with military significance in areas which are potentially unstable and where the security authorities are unwilling to permit aerial photography. Although no specific written authorisation was received from the Turkish authorities, the photographs and images used in this project are all freely available and in the public domain. In any case, the two satellite images obtained so far are both more than five years old. Informal discussions with the Turkish Ministry of Culture did not result in any objection to their use, which this Ministry considered to be covered by the general research permits issued to the Archaeological Mission to Zeugma.

This is extracted from an annual report for 1996. The full version is available on the Internet at: http://www.ist.lu/zeugma/

Endnotes
1 For a recent review of their work, see Kennedy D. and Riley, D., 1990. *Rome's Desert Frontier from the air*, Austin, Texas.
5 Chris Lightfoot, personal communication, 18.10.96
8 Algaze, *ibid*, p.23.
KVR1000 photo: Euphrates valley

KEY:
A = Ehnes (Arulis) - Roman quarries
B = Kahtin (Erenköy)
C = Horım (Urima?) - huyuk
D = Ayran
E = Hellenistic (?) quarries on Fakirdag (off photo)
F = revines with bridge piers
G = Roman watch tower (Yukarı Çarık)
H = Tilbes - huyuk
J = Kalazan Dag - quarries
K = Altınova (Hobab) - tombs
L = Belkis tepe
M = Tilves - huyuk
N = Tilhane tepe
O = Sürtepe - huyuk
P = Hacinebi - Uruk period village
Q = Gunûhi - huyuk
R = Birecik

Scale - approx 1:125 000

Extract from KVR1000 photo: Zeugma

Key:

A = Roman military camp
B = Bahce Dere (site of baths)
C = Road tunnel through overhanging cliff
D = Belkis tepe (Acropolis)
E = Villas and other buildings now under excavation
F = Col - 2 tombs recently excavated
G = Modern water tower, also ancient conduits
H = Late Roman piers; once thought to be base for a bridge
J = Terrace, possibly quay
K = Baths with mosaics
L = Corner of walls of Apamea
M = Byzantine (?) fort and village
N = Huyuk at North corner of Apamea

Scale - approx 1:20 000

Anthony Comfort, January 1997
In the last issue of *AARGnews*, the potential of recently declassified American CORONA photoreconnaissance satellite imagery for use in archaeological studies was described. In order to investigate the suitability of CORONA imagery for studies in Britain, a KH-4B image print covering part of the south of England was purchased from the US Geological Survey. Although approximately 75% of the image was cloud covered, a fortuitous break in the cover to the south west of Andover revealed the area surrounding the hillfort at Bury Hill. Whilst the outline of the circular tree-covered ramparts of the hillfort was readily visible on the image, none of the ancient banks, ditches and barrows in the nearby fields mapped by Rog Palmer as part of the Danebury Project could be identified (Fowler, forthcoming).

Since cloud-free CORONA coverage of the British Isles is very limited, images covering an area to the south of Budapest, Hungary, have now been purchased to further assess the utility of this material for archaeological use. The area was chosen to allow comparisons to be made with aerial photographs taken on the occasion of the 1996 Aerial Archaeology Training Project (Bewley *et al.*, 1996).

The three KH-4B images had been acquired on 10 May 1968 and cover an area of approximately 8000 km². A 9 by 14 km extract of one of the images that covers the environs of the airfield at Kiskunlachaza (47° 10' N 19° 4'E) is shown in the accompanying figure. This image is an enlargement of the original 1:250,000 scale contact print and was made by digitally scanning the print at 300 dots per inch. The pixel size of the resulting image extract corresponds to approximately 1015 m on the ground. By photographically enlarging from an image negative and then scanning, it is expected that the resolution can be improved to 2-4m.

On the image extract, the paved runway, taxiways and hardstandings of the airfield are particularly apparent and provide a useful landmark. In the upper right hand corner, the eastern branch of the river Danube can be seen as a broad dark linear feature. Within the fields to the west of the airfield, old river channels on the Danube floodplain can be readily seen. Further marks within fields are visible but are difficult to interpret in the absence of an appropriate map and some knowledge of the known archaeology of the area.

This quick look at one of the three KH-4B images is encouraging and suggests that CORONA photographs are likely to be of use to aerial archaeologists in Eastern Europe. Further analysis is in progress and it is hoped to present some of the results in future issues of *AARGnews*.

**References**


KH-4B CORONA satellite image of Kiskuniachaza airfield, Hungary.

Image acquisition date 10 May 68

Approximate scale
The collection of Literature concerning archaeological prospection (e.g. magnetic prospection, resistivity prospection, radar prospection and last but not least aerial archaeology) has been underway since 1989. In 1992 a special bibliography program, LARS (Leistungsstarkes Archivierungs- und Recherce-System), was bought by the Archaeological Prospection Group in Munich. This program enables the use of the bibliography as a relational bibliography as well as a full text bibliography.

Possible applications of LARS are:

1) The processing of structured, as well as non-structured, data.
2) Questions – as well as search techniques.
3) Archiving – a full-text retrieval-system.
4) Programmable output format.
5) Specific definition of the data-input.

The bibliography of the department is structured in the following way:

2) Type of publication: For example, paper, book, unpublished report, etc.
3) Special subject: For example, aerial archaeology, magnetic prospection, resistivity prospection, etc.
4) Title
5) Author(s)
6) Editor
7) Key words
8) Journal (for example AARGnews)
9) Issue Year
10) Volume Nr.
11) Pages
12) Publisher
13) Place of issue
14) Full text (for example abstract of the paper, or additional information of the publication).

All these different points can be connected by the search items "and" and/or "or" and "as well as". Besides this the program enables "navigation" through the whole or parts of the data. This function is comparable to the search: "Where else can I find this?". By this some special goals can be connected to another portion of special goals. We have to point out that our bibliography is limited by the hardware only.

At the beginning of 1997 our bibliography contained in total more than 7000 entries. Among many others the main subjects of the bibliography are:

<table>
<thead>
<tr>
<th>Special Subject</th>
<th>Number of entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial archaeology</td>
<td>&gt; 2000</td>
</tr>
<tr>
<td>Archaeomagnetism</td>
<td>&gt; 250</td>
</tr>
<tr>
<td>Electromagnetic prospection</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Geochemistry</td>
<td>&gt; 700</td>
</tr>
<tr>
<td>Image processing</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Magnetic prospection</td>
<td>&gt; 500</td>
</tr>
<tr>
<td>Prospection methods</td>
<td>&gt; 400</td>
</tr>
<tr>
<td>Radar prospection</td>
<td>&gt; 150</td>
</tr>
<tr>
<td>Remote sensing</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Resistivity prospection</td>
<td>&gt; 300</td>
</tr>
</tbody>
</table>

The following examples are given for one entry with the most typical output format as cited in:

1) Geophys. J. International

New features within the henge at Avebury, Wiltshire: Aerial and geophysical evidence. Antiquity, 70, 639-646.

2) Nature

3) Standard listing

DN== # 6812
TY== paper
FA== resistivity prospection aerial archaeology
TI== New features within the henge at Avebury, Wiltshire: Aerial and geophysical evidence
AU== Bewley, R.H., Cole, M., David, A., Featherstone, R., Payne, A., Small, F.
SW== aerial archaeology resistivity prospection Avebury henge monuments Wiltshire England
ZN== Antiquity
EJ== 1996
BA== 70
SE== 639-646

Since the conception of this bibliography, much information has become available via the Internet. However, to our knowledge there is at the moment no special bibliography available containing so much information about aerial prospection. Although we prepared this bibliography at first to help ourselves, we feel that anyone who wants to use it for scientific work on the subject should have some information from us. So anybody who sends us a 3¼ disk can have any information we can extract from the bibliography. However one should keep in mind that many entries have been done by occasional workers or students who are not too familiar with the subject and not every entry has been read by us. Therefore the list is not complete in the key words. There are still mistakes to be found, and that it can never be complete. Therefore we would be happy to have from each reader a list of his own literature as an author to check against our list, and to get information about new literature especially on aerial archaeology and prospection for archaeology. We would also be happy to get Xerox-copies of some papers that are not easily available in public or university libraries.

For further information please feel free to contact the authors of this paper. We realise that our bibliography is far from complete and there are several papers and publications that have escaped us, but we hope in time to remedy this situation. If anyone is aware of something we might have missed, we would appreciate being informed so that we may include it in the bibliography.
RCHME GRANTS FOR REGIONAL FLYING 1996/97

Roger Featherstone

It has been much more difficult to provide the regional flyer’s with financial support in 1996/97 than in previous years. With a budget of only £5000 at the beginning of the year, the decision was made not to disperse money in the usual way i.e. to allocate it in advance of summer and winter flying. Instead, it seemed preferable to wait and see how the crops responded to the weather conditions on a regional basis and then allocate the money where it could be used most effectively.

Towards the end of June it became clear that very good conditions were developing in some parts of the country, especially eastern counties, so grants totalling £2000 were given immediately for flying in Essex, Norfolk and Suffolk. At the beginning of July the situation there had developed even further and another £1000 was given for flying in Essex, Norfolk and Suffolk. Good crop mark sites were also appearing in other parts of the country and the remaining £2000 was shared between Cornwall, Shropshire, Tees Valley and West Yorkshire. At the same time action was taken which succeeded in increasing the budget by a further £5000.

In the second week of July soil moisture deficit figures were generally over 120mm in central and southern areas and over 160mm in southern Lincolnshire and western Norfolk. The effect of these exceptional conditions was to produce a wealth of new sites in profusion and quality on the more difficult clay soils and particularly in Bedfordshire, Cambridgeshire, Essex, Lincolnshire, Norfolk, Northants and Suffolk. Further grants totalling £1500 were therefore made for flying in Essex, Norfolk, Northants and Suffolk. In response to developing conditions elsewhere in the country, grants totalling £3870 were shared between Cornwall, Isle of Wight, Northumberland, Shropshire and West Yorkshire. As can be seen in the list below, the final total of grants made was £10,870.90.

Most flyers who received grants were able to supplement their budgets with money from local sources in addition to providing their own time. Unfortunately, there were a few who did not receive a grant and were not able to find any local money. To their great credit there were a few flyers who, without any grant, won sufficient local support to carry out really useful programmes and these include Frances Griffith and Bill Horner in Devon and Jill Collens and Rob Philpott in Cheshire/Merseyside.

The following is the list of grants allocated to regional flyers:

- Cornwall £1500
- Essex £1750
- Essex for Suffolk £500
- Isle of Wight £300
- Norfolk £2250
- Northants £500
- Northumberland £1702.40
- Shropshire £1000
- Tees Valley Archaeology £500
- West Yorkshire £868.50

Total £10870.90

It is always difficult to say exactly how many hours of flying the grants generate but we estimate it is over 100. From the reports which flyers have sent in we know that the total they have flown so far this financial year is a very respectable 240. They photographed an estimated 3500 sites of which approximately 1000 were new to the record. A summary of the year’s flying together with details of some of the sites recorded will be published later this year in Antiquity and some flyers will be publishing more detailed papers on the results of their work in local journals.

As many readers will know, the RCHME has not only undergone a long and at times painful restructuring but it has also had its budgets severely cut. It is hoped that 1996/97 was the nadir with prospects for 1997/98 looking (slightly) more encouraging. The Royal Commission does take its role as a co-ordinating body for aerial survey very seriously and it is with this in mind (and the demise of the CBA Aerial Archaeology Committee) that there are now two regular meetings a year with regional flyers in England.
BOOKS OF INTEREST?  REVIEWS AND COMMENTS


One of life’s pains for the active air photographer is to see images so degraded on the printed page as to rob them of their original impact. One of the pleasures is to explore other countries and other archaeologies through the familiar perspective of the aerial view. Whatever our fascination with why and wherefore, or with theoretical constructs of the past, the springing point of archaeology still lies in the physical remains of objects, constructions and deposits left by peoples and individuals of earlier times. A central attraction of aerial reconnaissance, as of field archaeology and (dare I say it?) excavation, is the emphasis that it places on direct observation and recording of the physical evidence, within a process that then spreads from ‘site’ to ‘landscape’ and ultimately (with other sources of evidence) to archaeological understanding in the wider sense.

Happily, this remarkably well-priced volume serves up a splendid dollop of pleasure, with hardly a moment of pain. Under a Maori title which means ‘Landmarks from the Sky’ (note the self-deprecating initial participle in the sub-title) the book is an appetite-whetting introduction to New Zealand archaeology, with references and an ample bibliography for those who want to dig deeper (in any sense of the word). While alluding to excavation results - and of course to written and oral sources - the book sticks firmly to the description and discussion of the physical remains of Maori and European archaeology from the past eight centuries, as illustrated or revealed through air photographs.

That said, the text - and the extended captions which accompany each photograph - place individual sites or site types in their broader context of topography, climate, ecology and agricultural practice (or practicability). This is done through sympathetic linking of text and photographs, and by the regular use of (close) oblique and (wider) vertical views of the same locality, along with interpretative drawings which help the reader to tease ever more from the individual images. The photographs themselves, with only one or two exceptions, are reproduced to the highest quality - sharp, strong on detail and exhibiting a full tonal range, not the muddy uniformity that disfigures so many other books on air photography.

Kevin Jones draws on the wide range of vertical and oblique photographs available in New Zealand, including many from his own purpose-made flights of recent years. The clarity of the island atmosphere (and no doubt the author’s careful choice of images) lends them an often striking crispness - as if from the proverbial ‘50-kilometre’ day that British air photographers lust for and (very occasionally) enjoy. The text, by an author who clearly cares deeply about the things he describes (he works for the New Zealand Department of Conservation), is clear, informative, honest about the many uncertainties, and calculated to retain the interest of the specialist and serious lay reader alike. The book moves easily from the general to the particular. An introduction to archaeology and aerial photographs leads into five chapters on settlement patterns, pa (hillforts, more or less), horticulture, other economic activities, and 19th-century fortifications (including those of the European incomers). There follow eight regional reviews, showing adaptations to differing topographical and climatic
circumstances, and each exploring selected ‘themes’ in greater detail - a particular form of pa, for instance, a specialised gardening activity, or physical remains from the 19th-century New Zealand Wars. Further chapters deal with more recent industrial activities, and with mission settlements and early (European) farming. A ‘Postscript’ argues for, and illustrates the difficulties of, continuing archaeological air photography in New Zealand (or anywhere else, come to that), and closes with a discussion of archaeological conservation in a modern industrial and agricultural context.

There are only small quibbles. The text refers to individual photographs but fails to give page references. Occasionally chapters end rather abruptly, with no final ‘coda’, however brief. The design is attractive and practical, but one of the many fine double-page pictures (pages 68/69) has lost important parts of the image compared with the interpretation drawing on the preceding page.

But these are tiny complaints compared with the book’s manifest merits. If you want to see a startling landscape, and an archaeology that both resembles and profoundly differs from our own, through images that will restore your faith in printed black-and-white air photography, rush out and buy this book*. Better still, buy two copies and give one to a close friend, or to someone who doesn’t believe in the power of ‘aerial archaeology’ to contribute distinctively to our understanding of the past.

* From Victoria University Press, PO Box 600, Wellington, New Zealand; tel 496 6580, fax 496 6581, Email Victoria-Press@vuw.ac.nz; payment preferably by credit card; add NZ$31.00 for airmail delivery (1-2 weeks), NZ$19 for economy mail (4-6 weeks).

Chris Musson: 28 February 1997


This final volume in the series on the Cambridgeshire Fenland is an excellent example of what can be achieved when a well-planned study is designed from the outset to incorporate both environmental and archaeological evidence, based on the integration of field survey, documentary research and air-photo interpretation. It still doesn’t happen often enough.

The first section, on southern Cambridgeshire, offers a detailed exposition of that region’s very complicated environmental history, followed by descriptions of the field evidence for different phases of human activity. The information is initially set out parish by parish and supported by 1:40,000 maps combining environmental and archaeological data to illustrate successive landscapes. A concluding regional summary allows a broader overview, and a separate 1:25,000 map of the Old West River shows a particularly rewarding swathe of Romano-British landscape.

The second section deals with the Wisbech region, in the northeast, whose environmental background (silt fen) is sufficiently uniform to allow the area to be discussed as a whole. Three further detailed maps at 1:25,000 present a truly remarkable reconstruction of land use
during the Romano-British period. The degree of land management and the shape and arrangement of the settlements, fields and trackways are hauntingly reminiscent of similarly-dated sites on the Yorkshire Wolds, although constructed in an entirely different environment - and there are even a few square barrows.

Of course this reviewer has a particular interest in, and an unashamed bias in favour of, the air-photo mapping elements of this work - and this stuff is really exciting! I find the separate larger scale maps especially pleasing. The use of coloured layers shows immediately that Wisbech Romano-British sites are clustered along roddons. The relict water courses have become dry corridors for settlement, industry and transport - and you can see how this landscape works. You couldn’t ask for a better demonstration of the value of integrated survey and mapping.

These maps also, however, provide a useful caution for anybody (including myself) who might be tempted to think that intensive field walking survey will explain everything we have mapped. The proportion of find-concentration spots to mapped detail is dispiritingly small. And the enclosures over which finds haven’t been recovered are identical to those where they have been. Clearly there is still much to learn about the correlation between aerially- and terrestrially-recovered evidence.

Inevitably I have a couple of quibbles. To a non-local reader, references to unfamiliar place names (without supporting grid references) can be confusing; an easily consulted key map showing the parishes, villages, rivers etc - perhaps as a fold-out, or an additional separate sheet - would have been helpful. And the text which accompanies the larger scale maps can be difficult to follow because the sites are numbered within their parishes, but the parish boundaries are printed very faintly.

Terminology, as always, poses some difficulties. The word ‘site’ is used as a short-hand for ‘a concentration of surface finds discovered during field survey’. While understandable, references to ‘a site over part of a cropmark’ still sound odd, especially when ‘site’ also sometimes means ‘archaeological site’ in a more general sense. And I couldn’t help noticing that Rog hasn’t managed to prevent the principal author’s use of ‘cropmark’ for ‘a levelled or buried archaeological feature or features for which evidence can be detected through differential growth of the overlying vegetation’. We probably just have to accept that short-hand is a great convenience, as long as we all know what it means.

But these are minor points. The most important achievement of the Fenland Project is its integrated use of a range of survey techniques and the clarity with which the results have been analysed and presented. The text is interesting as well as detailed and the illustrative maps are excellent. The book’s production, using glossy paper, means that both text and figures are crisp and clear: every small map detail is visible and meaningful. The unbound larger scale sheets work well and the use of tone and colour allows layers of evidence to be combined to superb effect. Detailed environmental information, coupled with intensive field survey and documentary research, laid over an air-photo survey which complements both strands: this is what we all wish we could do with all of our landscapes.

Cathy Stoertz: February 1997
ISBN 3-87490-541-1. DM 68.

This soft-cover volume of some fifty papers, written in German by members of the Bavarian Landesamt für Denkmalpflege and their collaborators, brings together, in 331 pages, the results of concentrated survey over many years, in the air and on, or into, the ground. The papers divide broadly into discussions or expositions of methodology and examples of the results of this prospection on the understanding of Bavarian archaeology of the last eight thousand years. The essays on Neolithic settlements and later prehistoric burial sites are particularly striking.

Many of the individual sites will be familiar to members of AARG, who have attended the annual conferences. What will also be familiar is the quality of the aerial photography and the presentation of the geophysical evidence. What is not so familiar is the publication of this graphic material in the quantity and quality that appears here. The volume is lavishly illustrated in a combination of high quality colour and black-and-white photographs and line drawings, that make it a useful purchase even for those (like myself) whose German is both limited and rusty. It also shows how many publications including aerial photographs fall short of what is possible and desirable. Helmut Becker has kindly offered to purchase copies on behalf of members at a discount of 25% plus postage. This brings the price down to DM 51, which at the current exchange rate of 2.56 to the pound sterling makes the book a considerable bargain.

Marilyn Brown

SPECIAL OFFER:

Two volumes in the Cambridge Air Survey series are for sale. £8.00 each, £15 for the pair (both offers include postage):

- Natural Landscapes of Britain from the Air (1990)
- Britain’s Changing Environment from the Air (1990)

Post to: Dr R E Glasscock, Dept of Geography, Univ of Cambridge, Downing Place, Cambridge CB2 3EN, UK.
Cheques payable to: R E Glasscock, Geography of Britain Acct
SITES OF INTEREST?

surfed by Michael Doneus

It is said, that the Internet started in 1969 with a node of the Arpanet in Los Angeles, connecting four computers. Today, more than 5 million computers (tendency: rapidly increasing) are linked to the Internet. The World Wide Web (WWW) is only a small - but maybe the most interesting - part of the Internet. It is used to publish multimedia documents, which can be read by anyone having an Internet access (and enough money for the telephone bill). Such a multimedia document (which in fact can consist of many documents, pictures, sounds, videos, virtual worlds etc.) is called “Homepage” and is located at a “Site”. The structure of the document is not necessarily linear (as for example a written text) but dynamic. That means, that every document can be linked to any other document, image, sound etc. already published at the WWW. Imagine, you are reading a book containing a footnote, which is pointing at a passage in another article. If you are lucky, you will find it in your library. If not, you will have to wait days or weeks to get it. In a WWW document, the footnote would be a “Hyperlink” and if you click at it with your mouse cursor, the other article will come to your screen instantly. Anyway, what makes the WWW interesting for us is that it is (or could be) a comparative cheap, fast and world-wide media to publish information. An aerial photograph, for example, can be scanned and put to the WWW (in colour!) within 5 minutes. A homepage could potentially be read by any of the 50 million estimated users of the Internet. Only a few books have this number of copies – and you can get and distribute information without leaving your working place.

As you can imagine, there are thousands of homepages and, scanning around, it sometimes seems that the whole World Wide Web is full of rubbish. Therefore, it was Rog, who suggested that I collected a list of homepages, which could be interesting for us. Be aware, that the addresses of the sites, which are presented in this issue, can change within a few months, since the whole WWW has a dynamic structure. If you find any interesting homepages out there, please e-mail their addresses either to me (Michael.Doneus@univie.ac.at) or to Rog (rog.palmer@dial.pipex.com), so that we can put them in one of the next issues.

ArchNet

“http://spirit.lib.uconn.edu/ArchNet/ArchNet.html”
ArchNet, published by Thomas Plunkett and Jonathan Lizee, University of Connecticut, is the first address for archaeologists. It is a Virtual Library for Archaeology and therefore, its main purpose is to provide archaeological links. You can search its database or browse through the sites listed by subject area or by geographical region. For some reasons, they don’t have the subject “Prospection”. Therefore, you will find aerial archaeological or geophysical applications under several different subjects (for example Mapping and GIS, Geoarchaeology...). There is also a list of featured sites, which are homepages, “that ... make a significant contribution to the way in which the World Wide Web is used by archaeologists for research, teaching, and publication”.

Bradford Archaeological Prospection Resources

“http://www.brad.ac.uk/acad/archsci/subject/archpros.html”
One of the best listings of resources relevant to archaeological prospection. It is maintained by Armin Schmidt, Dept. Of Archaeological Sciences, University of Bradford. Most of the links are concerned with geophysics and geophysical prospection reports (mostly from the UK). The list of homepages containing aerial archaeological material is much shorter (which is of course due to the fact, that there are not very many aerial archaeological resources at the WWW).

**The Aerial Archaeological Newsletter**

“http://www.nmia.com/~jaybird/AANewsletter/”

The aerial archaeological newsletter is an electronic magazine published by Tom Baker, a recent member of AARG. He is aerial photographer in New Mexico, USA. The newsletter is not only intended for aerial archaeologists and therefore also contains introductory essays. A main theme of the first volume are aerial surveys in Mexico (with lots of aerial photographs). There are news and links to other sites as well as a small “shop”, where you can order, for example, posters. Contributions to this e-zine are welcome.

**Archaeology in Baden Wuerttemberg - a pilot’s view**

“http://www.bawue.de/~wmwerner/english/braasch.html”

Although this site consists of aerial photographs from Otto Braasch, it is not maintained by Otto, but by Wolfgang Werner, a fan of his photography. It is a selection of nice photographs showing archaeological sites of all ages from the area of Baden Wuerttemberg.

**Archeo Prospections - Vienna**

“http://www.univie.ac.at/Projekte/Idea/Prosp/”

Archeo Prospections is an interdisciplinary co-operation between archaeologists, geophysicists and computer scientists. Involved are the Central Institute for Meteorology and Geodynamics, Hohe Warte Vienna, the Aerial Archive at the Institute for Prehistory of the University of Vienna, the Department of Pattern Recognition and Image Processing at the Vienna University of Technology and IDEA. The site shows basics of geomagnetic prospection, including data acquisition, data processing, archaeological interpretation and 3D modelling out of geomagnetic data. Additionally, most of the magnetically prospected sites from Austria can be accessed through a clickable map. The site is partly in German language.

**The Aerial Archive - Aerial Archaeology in Austria**

“http://www.univie.ac.at/Luftbildarchiv/”

This site, which is maintained by myself, tries to give an introduction to aerial archaeology, its methods, aims and applications. Additionally, our work at the aerial archive - taking aerial photographs, archiving, interpretation and photogrammetrical analysis - is described. There are several photographs from Austrian archaeological sites. This homepage is designed for the archaeologist as well as for the public. Therefore, it contains also basic stuff.

**Aerial Photographs of Dorset**

“http://www.dorset-cc.gov.uk/aerial.htm”

Here, you can find aerial photographs of mainly archaeological sites of the area of Dorset. Among these are Shaftesbury, Challbury Hillfort and the Cerne Giant. The photographs are complemented by informative texts.
SPOT Coverage of the UK
“http://cs6400.mcc.ac.uk/maps/spot/”
MIDAS provides an on-line SPOT satellite data service. You can get information on the SPOT programme, data structure etc. A nice feature is the clickable map of the UK, where you can choose your region of interest and then get a zoomed picture with all of the SPOT coverage. After selection, the SPOT image is shown on your screen. The SPOT satellite data are available for non-commercial purposes to registered users at academic institutions possessing a site licence. How to get the licence, is explained there.

Aerial Photographic Archive for Archaeology from the Middle East
David Kennedy from Australia has published this page. The archive contains over 5000 photographs. The Page gives brief information on the “Remote Sensing for Archaeology in the Middle East Project”, which is funded since 1991 by the Australian Research Council. About 4000 photographs from 1953 were examined and some 20,000 sites were identified on them and the details transcribed on transparent overlays at 1:25,000. Some nice vertical and oblique photographs are shown and a list of publications concerning this project is added.

NASA Jet Propulsion Laboratory
A list of airborne radar images is shown here. All of them were made over famous archaeological sites from China and the near east. You can look at them and get them via Internet even in full resolution (up to 15 Megabyte(!) per image - will certainly try your telephone bill). A detailed technical and archaeological discussion is provided with each image.

KODAK
“http://www.kodak.com”
Interesting for everybody, who is using or wants to use KODAK products. Comprehensive site, showing information on any product, as for example aerial films, digital cameras, scanners or photo-CD. There is also a guide to better pictures, although it does not explain, how to take better aerial photographs !?

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MORE WORLD WAR TWO PHOTOGRAPHS ?

The following note is from U.S. National Archives and Records Administration:

'Our foreign aerial photography is.... confined to World War II vintage coverages of those foreign areas where U.S. military forces were involved - particularly the South Pacific and parts of the European theater. We also hold a significant collection of German-flown aerial prints covering large parts of Europe, the Soviet Union, North Africa and the Middle East during World War II.'

Contact:  Cartographic and Architectural Branch, National Archives at College Park, 8601 Adelphi Road, College Park, Maryland 20740-6001, UNITED STATES
LETTER

Sir,

I write in response to your editorial in AARGnews 13, which I hope was written tongue-in-cheek in order to provoke a response. Should that be the case, here is said response. At the start I should declare my interest, as being heavily involved in the taking of oblique aerial photographs.

In the ideal world I agree that we should be able to access all available information before starting, and indeed during, a flight. However, we do not live in such a world and this ideal is not likely to be attainable for many years to come. To whinge about the unobtainable is a futile exercise. So, what are we to do if an opportunity to record a hitherto unknown site presents itself? Sit on our hands and bemoan our lot? As you are doubtless aware, some pieces of the landscape only show very infrequently; you seem to be advocating that we do not record them, for want of comprehensive prior study and back-up.

The pragmatic approach that I am suggesting may not produce the ideal product, but an imperfect picture is better than none at all. In addition, to decry the 'amateur' approach smacks of arrogance, since nobody emerges wet and howling into this world clutching an aerial camera. All aspire to professional standards, but to insist that nothing but the best will do may well lead to the bind that urban archaeology seems to have got itself into; the highest professional standards are so expensive that nobody can afford to pay archaeologists to find out more and more about less and less. Everybody starts as an amateur, even the most 'professional' of our past masters, as you noted. In this context, the recent initiative of 'Regional Fliers' meetings, partly in order to improve the standard of photography, is to be applauded.

There is also the risk, inherent in the approach you seem to suggest, that we will get into a circular argument. One looks at all available evidence first, decides that an area needs more examination and then photographs it. But what about areas that have no cover at the moment - they might never be studied under your suggestion. To reply that 'Oh, I really meant so-and-so', is not the point. Editorials should not be mere musings on paper; if necessary, they should even be edited.

Obliques versus verticals? It is my contention that a competent aerial photographer will always be able to equal, and often better, the archaeological information content of a vertical photograph of a site, when taking an oblique. As for satellites, one can only echo the famous remark of Dr. Johnson about dogs walking on their hind legs - "It is not done well; but you are surprised to find it done at all". Any airborne photographer, vertical or oblique, who turned in a photograph with a resolution of 1.8 metres (see the same issue of AARGnews) would not be invited to repeat the exercise.

Should your editorial not have been written tongue-in-cheek, then I am tempted to agree with the writer in that same issue of AARGnews who implied that you should be 'sectioned'. For those not familiar with current usage here, I do not mean 'sectioned' in the archaeological sense of putting a spade through something, although doubtless there are those who would support this interpretation, but 'sectioned' as in the relevant section of The Mental Health Act.

You keep taking the tablets and we'll keep taking the photographs.

Yours faithfully

Anthony Crawshaw, 15 Kings Staith, YORK, YO1 1SN (17/2/97)

I am not too familiar with the Mental Health Act but, believe it or not, the Editorial in AARGnews 13 was carefully thought out, edited several times, and intended to say what it did. Your letter serves to emphasise (to me!) the arse-about-face way in which aerial survey is currently managed. Do I see a sacred cow beginning to wriggle..? Enlightenment is intended to be part of AARG 97. (Rog)
LIST OF CONTRIBUTORS

Anthony Comfort
46 Montée Willy Goergen
L-7322 Steinsel
Luxembourg
e-mail: anthony.comfort@restena.lu
or acomfort@europarl.eu.int

Alison Deegan
9 Manygates Lane
Sandal
Wakefield WF1 5NT
Britain

Mag. Michael Doneus
Institute for Prehistory
Franz Kleingasse 1
A-1190 Vienna
Austria
e-mail: Michael.Doneus@univie.ac.at

Toby Driver
RCAHMW
Crown Buildings
Plas Crug
Aberystwyth
Ceredigion SY23 1NJ
Britain

Jörg Fassbinder & Robert H. Hetu
Archaeological Prospection & Aerial Archaeology
Bayerisches Landesamt f. Denkmalpflege
Postfach 10 02 03
D-80076 MÜNCHEN
Germany
e-mail: KL91101@sunmail.lrz-muenchen.de

Roger Featherstone
Aerial Survey
RCHME – NMRC
Kemble Drive
Swindon SN2 2GZ
Britain
e-mail: swincsd@rchme.gov.uk

Martin J F Fowler
60 Harrow Down
Badger Farm
Winchester
Hants SO22 4LZ
Britain
e-mail: 106224.1544@compuserve.com

Martin Gojda
Archeologický Ústav Csav
118 01 Praha 1 – Malá Strana
Letenská 4
Czech Republic

Kevin Jones
Department of Conservation
PO Box 10420
58 Tory Street
Wellington
New Zealand
e-mail: KJones@sard.nzc.nzonline.ac.nz

Sam Redfern
Information Technology Centre
University College
Galway
Ireland
e-mail: sam.redfern@ucg.ie

Cathy Stoertz
Aerial Survey
RCHME – NMRC
Kemble Drive
Swindon SN2 2GZ
Britain
e-mail: swincsd@rchme.gov.uk

Samantha D Walker
35 Halstead Grove
Solihull
W Midlands B91 3YX
Britain
e-mail: 100130.2342@compuserve.com