

AIR PHOTO APPLICATIONS IN WALES, UK: EXPLORATION, LANDSCAPE ANALYSIS, CONSERVATION AND PUBLIC PRESENTATION

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Our object in this paper is to discuss air-photographic work by official, academic and private-sector bodies in Wales over the past thirty years (Wales is the rocky western part of the United Kingdom to which the gentler landscapes of central England are attached). Our aim is to show how differing objectives, organisations and individuals, working together over a considerable period of time, can have an important influence on the integration of aerial techniques into the everyday conduct

Figure 1. Wales as part of the British Isles.



of a country's archaeological research, conservation and public presentation. The emphasis is on the inter-relationship between organisations and work-programmes over time, rather than the technical means through which the work is carried out. The key message is the need to find ways of achieving broad-ranging objectives which for one reason or another cannot be delivered through single institutions alone.

Firstly it is necessary to introduce the 'players' in what at times over the past three decades has seemed like a rather stately dance. The principal participants are:

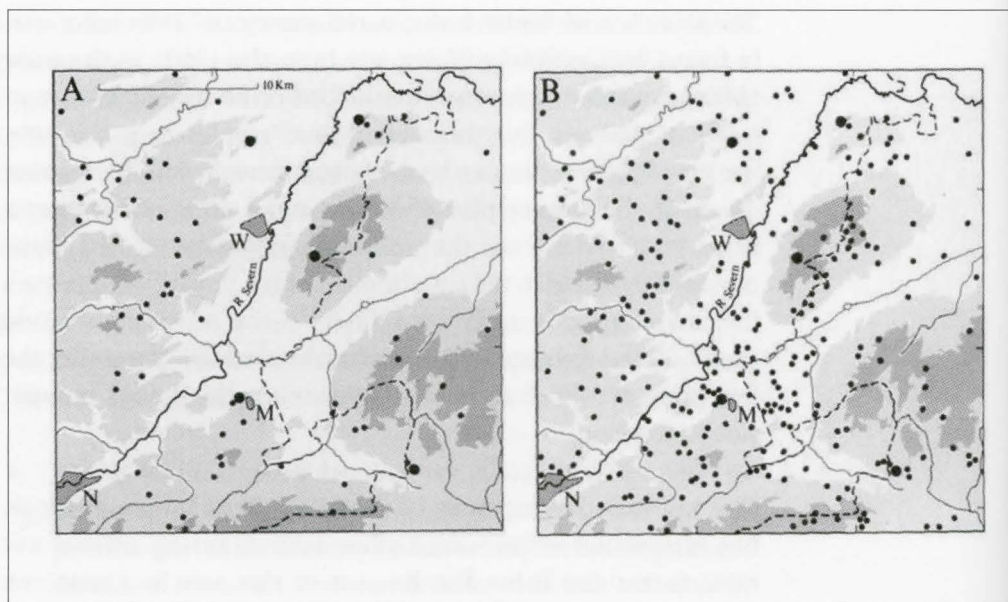
- ***Cadw: Welsh Historic Monuments.*** A section of the national government of Wales which deals with the protection and presentation of the country's most valued archaeological and historical resources. For convenience this title will also be used for earlier state-funded organisations in Wales which served broadly similar purposes.
- ***The Royal Commission on the Ancient and Historical Monuments of Wales,*** known for short as 'the Royal Commission' or simply 'the Commission'. This is a publicly funded body, notionally at one remove from government but almost entirely dependent on public funds. It is the official body of archaeological survey and record in Wales, matching broadly similar organisations in England and Scotland.
- ***Four relatively small University Departments*** in various parts of Wales, carrying out independent research as well as teaching. Their research, however, has often been focused outside rather than inside Wales.
- ***Four independent Archaeological Trusts,*** providing a broad 'regional' service for archaeological records, development-control, conservation and project work of various kinds. The Trusts draw on both public and commercial funding.
- Contributions of various kinds are also made by Local Authorities, national and local museums, commercial archaeological firms, amenity societies, voluntary groups and private individuals.

The initiation of 'home-based' aerial survey in Wales, after early forays by Cambridge University from the 1950s to the early 1970s, depended very much on the 'out-of-hours' enthusiasm of a few individuals. But their 'work-time' employment in Cadw, the Royal Commission and two of the archaeological Trusts were crucial in the development of limited aerial survey programmes in parts of Wales from the mid-1970s onwards. In 1986 these moves culminated in the appointment of the Royal Commission's first 'investigator in aerial photography' (Chris Musson), a decade after a similar development in Scotland and twenty years after the formation of a small air photography unit in the Royal Commission in England.

The gradual development of aerial work in Wales, through the interaction of various bodies with differing official remits, forms the focus for the rest of this article. Questions of organisation, finance and 'who does what' are seen as major influences on attempts to study, conserve and present the historic environment in the particular conditions of Wales. Comparable but inevitably different relationships are bound to apply in other regions and other countries. The lesson from Wales is that these relationships, whatever they may be, must be mobilised in a flexible way, sometimes over a substantial period of time, to achieve objectives which command general support but which no single institution can bring to fruition on its own.

Example 1: exploration, analysis and follow-up research

Our first example concerns aerial exploration by archaeologists themselves through oblique air photography, using industry-standard cameras and readily available light aircraft. No sophisticated technology is involved, though GPS navigation and digital cameras have increased the efficiency of the work in recent years. Improvements in technology have also aided subsequent photo-interpretation, mapping and record creation through the use of desktop computers and inexpensive software designed specifically for transcribing information from oblique as well as vertical air photographs.



On the central Borderland of Wales this kind of exploratory air survey was carried out mainly by the local archaeological Trust in the 1970s and 1980s, the resulting cropmark discoveries transforming previous concepts about the density and distribution of settlement in the local landscape during the Iron Age and the succeeding Romano-British period (Figure 2). What appeared from surviving earthwork evidence to be a pattern of defended hilltop settlements (or 'hill-forts'), with relatively little occupation on the lower slopes and in the valleys below, became within a decade and a half a densely populated landscape of hilltop, hill-slope and lowland settlements, not very different in many respects from the rural landscape of the present day.

All this could be mapped and documented for inclusion in the regional Trust's 'sites and monuments record' as well as for onward transmission to the national archive in the Royal Commission. Newly-discovered sites could be quickly incorporated into the local planning process which (now, but less so then) requires all potentially 'sensitive' development proposals to be subjected to archaeological and environmental assessment before their ap-

Figure 2. 'Small enclosures' of the Iron Age and Romano-British period on the Borderland between England and Wales. On the left as mapped from surviving earthwork evidence, on the right with the extra information provided by two decades of cropmark exploration. The previously 'empty' valleys are shown in white, the higher land shaded. © Crown Copyright Reserved, RCAHMW.

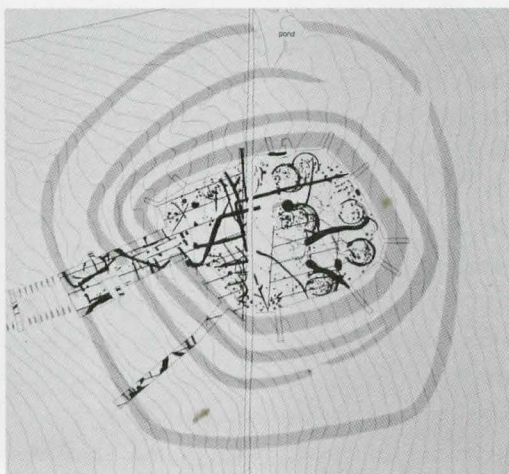
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proval (or refusal) by the local planning authority. But cropmarks, of themselves, reveal little about the function and dating of the discovered sites, save for conjectures based on excavations or artefactual evidence from elsewhere. Of course this is not a problem that applies only to aerial evidence – archaeology, whether using aerial or ground-based observations, is by its very nature a study which deals with partial rather than total survival of physical traces of the past.

In the early 1980s one of the more complex settlements on the Welsh Borderland came under threat of destruction by ploughing, over which there is as yet virtually no legal control in Britain. Total excavation (Figure 3) was placed in hand through the regional archaeological Trust, using funding from Cadw in its role as protector of the historic environment ('rescue' work was at that time funded by the state but the costs are now met largely by the developers themselves following the establishment in Britain of the principle that 'the polluter pays'). The excavation revealed much about the dating, function and development of the settlement during the later Iron Age and the Romano-British period, allowing more informed speculations about other cropmark and earthwork sites and their inter-relationships in the emerging landscape of the region. The archaeological Trust then took the

Figure 3. Collfryn settlement, aerial view and excavation plan.

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initiative in proposing a structured programme of surface collection and small-scale excavation on a *number* of settlement sites so as to provide basic dating – and hopefully functional evidence – across a representative range of sites. After much discussion the project was accepted by Cadw for limited funding and was put into effect in the mid-1980s.

The results, however, were disappointing, for a variety of reasons. Cadw, for instance, in its 'protective' role, required the work to be essentially non-destructive, simply examining the *surface* of any intact archaeological deposits encountered below the disturbed plough-soil. Limited excavations across enclosure ditches were allowed, and a few potentially helpful radiocarbon samples were obtained. But virtually no pottery or other datable artefacts came to light, apart from Roman material from (later) occupation of some of the sites. This part of Wales, in the pre-Roman Iron Age, is virtually a-ceramic, a fact which severely limits the effectiveness of surface collection. At that time, unfortunately, geophysical prospection was considered an expensive, time-consuming and specialist means of investigation, and was not used in the field-work programme. Overall, the results were felt to be disappointing, perhaps predictably so in the known or suspected conditions of the area. Further funding for the project was not forthcoming.

Further to the south-west in Wales, from the 1980s until the present day, a previously unsuspected landscape of ditched enclosures, of various shapes and sizes, has been progressively revealed through aerial survey on a broad plateau north of the coastal town of Cardigan. The aerial exploration was carried out first by the regional archaeological Trust for that area and then by the Royal Commission. Again questions of dating and function became matters of increasing concern in the attempt to understand the increasingly distinctive landscape (or landscapes?) that the enclosures represented. For several years the local Trust and others therefore urged Cadw to fund a programme of research on the area. But 'research', as such, is not mentioned in the legal framework through which Cadw operates, so for a considerable period of time nothing happened. There was a growing conscious-

Figure 4.
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ness, however, of the need to provide *some* kind of protection for these newly discovered sites, and perhaps for cropmark sites in general. Cadw had, from the early 1990s, been developing a programme of pan-Wales surveys, carried out by the archaeological Trusts through desktop studies and field visits, to assess particular classes of monuments for selective protection through the legal process. Eventually, 'defended rural settlements' found their place within this programme. The door was then unlocked for a Cadw-funded project of integrated field survey, sample excavation and geophysical prospection, to gain information which might allow a small number of these cropmark sites to be selected for protection as being of 'national importance'.

By the time this four-year project began in 2004 (Figure 4) geophysical survey, using a variety of instruments, had become an almost routine form of non-destructive investigation in Britain.

Figure 4.
Air photography,
geophysics and
excavation in combined
use within the
'cropmark enclosures'
project near Cardigan
in south-west Wales.
© Dyfed Archaeological
Trust.

Four-year project of field survey,
sample excavation and geophysical
survey on a number of sites in the area



Each season of work has therefore involved both sample excavation and geophysical survey on and around selected sites, with positive results which do not need elaboration here. The point is that, following the initial discoveries from the air, the impetus for the next stage of landscape analysis came not from the university sphere, nor indeed from any research imperative as such, but from the need to understand the character and state of preservation of the sites so as to justify their selective preservation through the legal process. Paradoxically, there has never been a problem in providing legal protection for Neolithic or Roman sites known only from cropmark evidence. It is worth mentioning in passing that an English university has been involved in this project, principally by providing students to assist in the excavation work and geophysical survey. Through their involvement in the project the students, along with others participants from around the world, have come to appreciate the 'aerial' nature of the original discoveries, along with the complementary contributions of excavation, geophysics, field survey and legal processes in an integrated process of research and conservation.

Example 2: aerial monitoring of legally protected sites in Wales

In the mid-1980s Cadw initiated an innovative programme of aerial monitoring of legally protected sites in Wales, covering about 2400 sites at that time but 3500 or more now (Figure 5). Systematic oblique air photography was carried out in the first instance by the archaeological Trusts, whose staff thereby became familiar with the usefulness of aerial photography in various aspects of their work. More recently the bulk of the monitoring has been carried out by the Royal Commission through its own aerial archaeologist (Toby Driver, who took over the post on Chris Musson's retirement in 1997). Approximately half of the Commission's 60-hour annual flying programme is now spent on monitoring work, the photographs progressively enriching the pictorial and interpretative record for the country's most important heritage sites, from the Neolithic to the remains of industry, war and urban life.



Figure 5. Aerial monitoring of legally protected sites in Wales. The photograph shows a series of dark, linear features, likely cropmarks or archaeological remains, running diagonally across a green field. The top right corner of the image is partially cut off by the page edge.



Figure 5. Two 'monitoring' photographs of Carew Castle, in south-west Wales. The earthworks in front of the castle are well illustrated in the left-hand image. Cropmarks in the right-hand image, taken a few months later at the height of a summer drought, reveal the multiple ditches of an earlier promontory fort, probably of the pre-Roman Iron Age. © Crown Copyright reserved, RCAHMW.

The photographs, critically for Cadw, provide its staff with readily intelligible images for discussion with landowners, tenant farmers and others about the sympathetic management and conservation of the sites in their care or on their land. The detailed photographic record, and hence the characterisation of the sites and their possibly changing land-use, is supplemented year by year. The photographs are widely used in Cadw's highly-praised guide-books and analytical works, as well as in a host of other publications for specialists and (more importantly perhaps) for the general public. The monitoring work, which can form part of any flight throughout the year, provides a framework of assured returns from each individual sortie. At any time during a flight, however, attention can be turned from monument monitoring to other aspects such as exploratory survey, excavations in progress, industrial or townscape recording or landscape characterisation. In Britain this focus on multiple targets is described as a *portfolio*

approach, making each hour of flying more productive than any form of single-subject air photography. Similar monitoring work is now done selectively in England, where there have also been experiments with detailed low-level photography of legally protected sites to identify actual or potential damage from ploughing or other agricultural activities.

Example 3: air photo interpretation, mapping and field survey

In England a programme of air-photo mapping at 1:10,000 scale, first by high-quality manual transcription and more recently by computer-aided methods, has been in progress since the early 1990s. Over this time a team of around twelve photo-interpretters and mappers has so far covered just over a third of England's land-mass, adding vast numbers of previously unrecorded sites to the national archive. The resulting information is passed in the form of digital maps and accompanying text-records to Local Authority archaeologists for use in development-control and conservation work.

In Wales, with far smaller resources, air-photo mapping has been directed at more specific targets, initially through grants from the Royal Commission to the archaeological Trusts, for mapping cropmark evidence in particular areas or of particular site types. More recently the Royal Commission itself, through the part-time work of a single member of staff (Tom Pert, who later worked on the PDA project noted in the final part of this discussion) has been mapping *upland* areas prior to their rapid survey by teams of field surveyors provided by the regional Trusts or commercial archaeological firms. The upland mapping projects are variable in the number of 'new' sites which they reveal but they have proved highly effective in providing a skeleton framework of archaeological features which the ground-based surveyors can then check, elaborate and add to in the field (see Example 4 below).

The down-side of the decision to concentrate on the uplands is that some *lowland* areas, where cropmarks provide the only evidence of otherwise invisible sites or landscapes, remain only par-

tially mapped and analysed. But difficult choices have to be made when financial resources are limited. The decision has a certain logic, and highly productive walk-over survey of these areas, under the title of the Uplands Initiative, have been in progress through Cadw and more recently the Royal Commission since the late 1980s. The problem of the lowland areas, however, remains unresolved. The computer-aided mapping of individual cropmark or earthwork discoveries is now routine in the both the Royal Commission and the archaeological Trusts, but there is a regrettable backlog of un-mapped cropmark information from the 1970s to 1990s. The comprehensive examination of *vertical* photography for lowland areas, from 1940s onwards, also still remains to be tackled. There may be a role here for university students, at both undergraduate and postgraduate levels, but little has yet been achieved along these lines.

Example 4: public presentation

In recent decades in Britain there has been a general acceptance that archaeological information gathered at public expense belongs to the public whose taxes (or military and mapping authorities) facilitated its collection. The information, including (with rare exceptions) the location and character of the sites, should therefore be made widely available and not treated as the private property of specialists, whether archaeologists or otherwise. Hence the readily accessible air-photo and other archives of English Heritage and the Royal Commissions in Scotland and Wales, as well as the parallel records created and made available at regional level in Wales by the archaeological Trusts. Since the partial devolution of domestic government to the National Assembly of Wales in 1999 two keynotes of public policy have been social inclusion and open access for all. Over time these have added moral support and limited financial assistance to initiatives by official bodies and local groups aimed at making the physical traces of the past more intellectually and physically accessible to the community as a whole. Some archaeologists, of course, have seen this as a 'dumbing down' of their esoteric art. Others have seized on the opportunity, arguing that if we do not carry the public with us we can hardly complain if, through their elected politicians,

they refuse to give us the increasing amounts of money that we so often seek (but so often fail to get!).

Much of Cadw's work is concerned with public presentation of the monuments in its care, but paradoxically it did not until very recently have a dedicated Education Officer. The archaeological Trusts have long encouraged and cooperated with local groups whose aim is to increase the understanding, presentation and conservation of heritage features in their areas. There has been a strong push, too, to make the accumulated archaeological records, at both national and regional level, directly accessible to the general public through the Internet. This builds on the early ambition of the four archaeological Trusts to make their combined records available as an Extended National Database (or END). In the late 1970s and early 1980s this proved beyond the technical and financial resources of the Trusts. But the concept has remained alive and all of the Trusts, along with Cadw, the national and local museums, the Royal Commission and other bodies are now engaged in an initiative to make their various records available over the internet through a single historic environment portal.

Another initiative has been the development by the Royal Commissions in Scotland and Wales of a system for internal web-based access to their ever-growing heritage archives (the system is called SWISH, or Shared Web Information Services for the Heritage). For the general public this partnership manifests itself in Wales as a free, web-based, application called Coflein (*memory-line* in Welsh). Through text-based or map-based searching this provides access to information on a growing archive of more than 72,000 archaeological sites, monuments, buildings and maritime features, along with an index of drawings, manuscripts and photographs held by the Royal Commission. Thousands of digital images (including air photographs) are also available, along with detailed reports in the form of pdf files. Through this system it may soon be possible to make available all newly acquired digital air photographs, along with their related text records, very shortly after their acquisition.

The Royal Commission has also been developing 'remote sensing in reverse', aimed at delivering heritage information in the field through the use of mobile handsets. These moves began with experiments to see how mobile GIS software, deployed on PDA devices, could benefit the organisation's own field surveyors. The combination of GPS-enabled handsets and air photo mapping data removed the need for windswept or rain-soaked field surveyors to struggle with paper maps and hard-copy air photographs. Instead, the system guided them accurately to already-mapped archaeological features that might otherwise have been very difficult to find. Use of the PDA also allowed far more information to be accessed in the field, including digital versions of databases, maps of various scales and ages, and both vertical and ortho-rectified oblique air photographs.

These internal developments suggested the possibility of making similar information available to the general public as they walked about town or countryside. The Royal Commission, through a partnership with outside groups and a local high school, was able to assemble grants for the development of a so-called 'e-trail' around Ruthin, a small historic town in north-east Wales. The aims were:

- To deliver heritage information in a new and innovative way to a wider audience.
- To introduce students to the fundamentals of GIS, GPS and mobile technology.
- To enable students to develop measurable skills for specific educational targets.
- To develop understanding on the delivery of heritage information to mobile devices.

At Ruthin (Figure 6) members of the public are loaned PDAs by the local Record Office for use as they wander the streets. The PDA displays the user's position in real-time and highlights buildings for which historical information is available. The user simply taps on the PDA screen with a stylus and the device links through to a Coflein web page giving information about the chosen building. From here there are links to related images, from historic en-

Delivery of Coflein information to remote PDA



gravings to twentieth-century postcards and recent architectural records created by the Royal Commission. Many of the images, including air photographs, show hidden parts of the town, so that even local residents can gain a new perspective on its buildings, layout and development over time.

Students at the town's high school were involved in the selection of suitable images and were trained in the use of GIS and photo editing, along with the creation of web pages which could then be incorporated into the e-trail. They were highly enthusiastic about the use of both the PDAs and GIS. The school was able to buy additional PDAs and GIS software at an educational discount. The availability of national mapping databases has also prompted the school's teachers to think about wider applications for this kind of equipment and software.

*Figure 6. The e-trail being demonstrated at Ruthin, with a selection of screens delivered remotely from the Royal Commission archive.
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The Royal Commission has more recently been perfecting a further phase of development, to provide a wider range of information, including audio and video playback, for the contrasting historical, archaeological and physical landscapes of a wide-spreading World Heritage Site and a Roman legionary fortress in South Wales. These initiatives, conducted in partnership with the Royal Commission in Scotland, will hopefully advance the long-term aim of achieving wireless delivery of heritage data in Wales, including air photographs and related records, to mobile phones and PDAs without the need for expensive specialist software (see Pert T 2008, *History in your Hands: using mobile devices in heritage interpretation*. Obtainable via www.rcahmw.ac.uk).

Final thoughts

This last example shows how technological developments, especially those focused on an organisation's own particular objectives, can sometimes help to achieve things which we could only dream of in the past. But in a very real sense the key element in making any kind of progress is cooperation between organisations whose individual purposes may be different or circumscribed in one way or another. The process requires goodwill, time and perseverance. It involves the constant search for ways in which work or funding from one organisation or source can be broadened or elaborated by another, working to a different brief. Progress will almost always be slow and will not always lead precisely to where we want to go, if only because – individually – we often want to arrive at slightly different places.

Have we been successful in Wales? And perhaps in Britain generally? In the public service, for information-provision, conservation work and an irreducible residue of rescue archaeology we are inclined to give a qualified 'yes'. But our university teaching of aerial and remote-sensing archaeology, with a few notable exceptions, is weak. Moreover, in Britain as a whole the meagre engagement of university staff and students in free-ranging research contrasts strongly with the active (in some cases almost exclusive) involvement of universities in remote-sensing archaeology and landscape research in other parts of Europe.

Where we can get to, of course, depends on where we are starting from, where we *think* we want to go, what means we have of getting there, and how much help we receive from fellow travellers along the way. There is rarely a single answer. The capacity to explore different possibilities, over an extended period of time, must surely be a keyword in any part of Europe, as it has been in Wales, for aerial archaeology and other activities, over the past three decades.