Aerial Photography and Manual Image Rectification

*a Short Guide*

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What is Aerial Survey?

Aerial photography has been an invaluable source of non invasive and large scale survey of the UK for nearly a century. The large number of photographs taken during and immediately after the Second World War are a valuable resource in themselves and since then, we have had the flying archaeologists in light aircraft and even helicopters. They have flown both in search of new monuments and cropmarks, as well as recording the landscape as a whole, putting monuments into a spatial relationship with the topography and other monuments.

The times and seasons of flying would depend on the type of feature that was to be prospected or recorded; cropmarks show during certain times during the growth of a crop, parchmarks only show in hot dry weather, while light dustings of snow, or low sun in winter may show up low profile sites. Upstanding structures or landscapes would require conditions that favoured their particular photography (for example, exotic coniferous planting in designed landscapes would show up easier in winter when the rest of the trees were bare). Soilmark sites will only show up in recently ploughed areas, where the ground is turned over.

It is a common misconception that once an area has been flown, it requires no further flights. A cropmark or parch mark may only appear in one season and be invisible the next 10 years depending on the specific conditions that are present during that particular flight in that season, on that day at that time with that crop.

There are two main types of photograph:

**Vertical**
These are often taken from a fixed camera mounted on a military or professional aerial survey plane. The aircraft will fly at a fixed height and produce a near plan view for production of a photograph at a certain scale (often 1:10,000 or 1:25,000). There are often two photographs taken and these are used as a stereoscopic pair, which can be viewed through a stereoscope produce the impression of a 3D image. This form of photography is often concerned with recording the present landscape, or in the case of the WWII photographs, searching for military targets. They do however often capture sites as well, and can be very useful in locating sites. Vertical photography does allow the large-scale mapping of landscapes (including areas of past human activity) which is as useful as the site centred photography that characterises oblique photography.

**Oblique**
These are the most common form of monument photograph, where a handheld camera is used to record a site that is being flown over. This results in an angled shot of the site, though it is usually taken at a lower altitude and targeted directly on the site from various directions, thus providing more detail than vertical photographs. Many photographs can even be achieved from elevated locations such as hills, or the tops of buildings.

The National Heritage organisations also have teams that deal with aerial photography on a national scale, both commissioning new flights and collating and
rectifying existing resources. It is a shame that this useful resource is under funded, but in this period of time where the rural landscape is being developed at an ever-increasing rate, it is essential that this form of large-scale prospecting be given the importance it deserves.

Other cheaper forms of Aerial photography that have been established and found to be of great use are Kite Flown Cameras, Remote Controlled model aircraft and of course Microlights. They all allow a greater number of flights and coverage, as well as allowing amateurs and local groups to get involved. To do this however, the following concepts and aims should appreciated.

This guide is intended as a quick start to understanding and using aerial photographs, the useful links at the end will lead you to more detailed and specialist resources, should you wish to take this further.

**Cropmark and Parch mark Sites**

The definition of a cropmark site is just as it sounds visible signs of buried features within a sown crop in a field. The sub surface archaeology causes variation in the growth of the overlying crop. Variations in the moisture retention of the buried ditch fills or walls cause observable difference in the growth and or colour of the vegetation, which is best observed in large homogenous crop areas, such as fields of arable crops.

Above ditches or humic rich areas, the crops will grow quicker and higher than the surrounding plant, due to the additional water and nutrients (positive cropmark), while walls, roads and features that are more compact will not retain the moisture as well, resulting in the crops growing slower or shorter (negative cropmark). The period when cropmarks are visible is short, as it depends on the growing crop, usually in the high summer of July or August.

As the name suggests parch marks appear during periods of extended heat and little or no rain. It is the underlying archaeology that determines the degree of parching, with the first areas exhibiting drought being directly over features such as walls, roads or cobbled areas, that have retained the least amount of moisture. It is possible to see these marks clearly on grass as well as crops, though the window of opportunity to view and identify these sites is only during a period of particularly hot weather. (1976 was a good year for cropmarks, a bad year for farmers!).

It may be geological or recent works rather than ancient human activity that is evident in the cropmark, so interpretation is essential. Ancient streambeds, geological cracks in the bedrock or modern pipelines will show up as linear features. People have been fooled by the circles formed by animals feeding from a bale of hay for example. Time and experience will aid interpretation, but if in doubt, say so.
**Soilmark Sites**

Another form of feature visible from the air is the soilmark site. This type of site is the actual features themselves, rather than the ghostly depiction in the overlying vegetation. When an area is deep ploughed, or has been stripped of topsoil, the underlying features are exposed and differences in the colour of these in relation to the natural subsoil. Often, areas of human activity produce a large amount of ‘dark soils’ so that you may be able to make out dark areas in fields that may represent sub surface activity. Building rubble, dark ditch fills or even ploughed out barrows will all show up, though only for the shortest of periods when the topsoil is freshly turned. The best time to spot these is during the winter when the farmer has freshly ploughed the fields. In some cases the effect can even be seen from any elevated position. It is also sadly evidence that the underlying archaeology is being damaged by continual agricultural activity.

Remembered that you may be looking at geological rather than archaeological elements in the landscape – A site must be interpreted correctly or it should be recorded as a possible rather than definite site.

**Low profile Sites**

A low profile site is actually still visible on the ground, though it may be imperceptible, with low bumps and humps being the only sign of buried features. They will usually only survive in areas that have not been subject to arable ploughing and levelling, so upland sites are the most common to view in this way, or deserted village sites that have been given over to pasture for centuries. These sites are also startling to view vertical aerial photos under a stereoscope, where the exaggerated vertical scale makes the earthwork leap out of the photograph.

Good clear light is required to see these monuments best and the low raking sunlight in the mornings and evenings of the winter is perfect as it provides a marked contrast between the highlights and shadows. For larger earthworks, it is also possible to see the banks and hollows after a light dusting of snow, though once again, all the conditions must be just right to capture these images.

Hillforts, Deserted Medieval Villages, Rig and Furrow, relic field system boundaries are all examples of monuments that become clearer after this form of photographic recording.

**Rectification**

After you have flown, photographed and identified your sites, whether cropmark or monument, it is important to know where exactly they are, or they are just photographs with only half the information that could be taken from them. Location, shape and size can be extracted from the photograph, as long as enough
recognisable features are present. The features could be corners of fences, buildings, road junctions, or any recognisable element that also appears on a map.

There are three simple methods of rectification, where you take the raw data of the photograph and translate it to a scaled map, from which much more information can be taken. This guide does not describe other methods, such as softcopy photogrammetry, parallax or stereo pair elevation mapping, but concentrates on those that are readily accessible to all.

a. Paper Strip Method of rectification

This method is best for linear features and requires a **minimum** of three recognisable points on the oblique photograph, though it is better if you have a minimum of four. Mark each point with a number (1,2,3,4……etc) and mark the same points on the map (1:10,000 as a maximum scale).

With lines drawn from point 1 to the others (see below) – draw further lines to the end points and corner of the linear feature. Now place the 'paper strip' on the image, as shown and mark the points where the lines intersect the paper, remembering to mark which line is which.
Now move to the map, lay the strip on the same radial pattern and move the paper until the 'known point marks match up. You can then mark the 'unknown points’ onto the plan and draw faint lines (red dotted lines above), from the origin through the marks to create a radial pattern for the unknown points.

Repeat the previous step with the other radial series. (see above) You could of course repeat this process three or four times if you mark more radial origins. In this case, we are only using two point origins.

You can now project lines from the radial origins and through the new points you have now marked and where they intersect is the rectified point.
It really is that simple, though this method cannot deal with complex or curved features and for that, we will have to use a modified version of the Mobius Network. In this example we will locate the enclosed farm in the centre of this aerial photograph.
**b. Mobius Network**

This method of rectification is much better for complicated cropmarks and curved features. It is slightly more time consuming, but the results are worth it, especially if you are out in the field, away from any form of technological rectification.

You will need a photograph that has visible and recognisable points (4 in total, which surround the feature you wish to rectify, and a plan that shows the same features as the photograph. As before, mark the points 1, 2, 3 & 4. (For this version of mobius rectification, they must form a rough square.) Draw lines to between each point, measure the length and then divide by 10, now mark these points along the line. Repeat on each line and then join the dots to form a grid pattern.

Repeat the entire procedure on the map of the area and you are ready to begin. This method does suit near vertical photographs better as to use obliques you will have to consider perspective. The more oblique the more distortion from perspective, this is good for a field rectification, and should be accurate to +/- 2m if you take care.
Once you have the two images with the grids superimposed, it is a simple case of ‘tracing/copying’ the photo image across to the map, just like the children’s drawing books where one picture is traced across to a blank grid.

A reference to another form of Mobius network rectification can be found in Evans, B.M. and Malta, L., Acquisition of 35 mm. oblique photographs for stereoscopic analysis and measurement, Photogrammetric Engineering and Remote Sensing 50, 1581-90, (1984).

This guide is to help you rectify aerial photographs using the minimum of technology, there are several commercial software programmes that can complete complex rectification calculations (check the links to see some examples). It should be remembered that rectifying an image is one thing, but recognising features, interpreting them and utilising the rectified images takes practice and training.

For more information of Aerial Photography in archaeology, BAJR recommends contacting Aerial Archaeology Research Group (AARG).
Useful web resources

Aerial Archaeology Research Group (AARG)
http://aarg.univie.ac.at/

Archaeological Prospection Resources
Department of Archaeological Sciences
http://www.bradford.ac.uk/acad/archsci/subject/archpros/archp_nf.php

Bonn Archaeological Software Package (BASP) with Air Photo
http://www.uni-koeln.de/~al001/basp.html

Aerial Archaeology - Beginners' Book list
http://aarg.univie.ac.at/bibliography/list/beginners.html

TerraServer-USA – A site to show what is possible with Aerial Photos
http://aarg.univie.ac.at/bibliography/list/beginners.html

Digital Grove - Desktop Mapping Gateway
http://www.digitalgrove.net/rectification.htm

Aerial Archaeology in Wales - RCAHMW
http://www.rcahmw.org.uk/aerial/

Aerial Survey - English Heritage

Aerial Archaeology – French site with definitions and explanations
http://www.archaero.com/archeo31.html

AHDS - Archiving Aerial Photography and Remote Sensing Data: A Guide to Good Practice
http://ads.ahds.ac.uk/project/goodguides/apandrs/

Baker Aerial Archaeology
http://www.nmia.com/~jaybird/AANewsletter/TableOfContents.html

BBC History – explain Aerial Archaeology – by Dave MacLeod
http://www.bbc.co.uk/history/archaeology/time_flyers_03.shtml

Google Maps – including satellite image (some up to 2m resolution)
http://maps.google.co.uk