

TWO KEYS FOR THE HISTORICAL INTERPRETATION OF AERIAL PHOTOGRAPHS*

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The techniques and practices associated with the exploitation of aerial photography in the study of air archaeology and historical geography were pioneered during World War I by German and British scholars. Many individuals contributed to the succeeding development and perfection of methods, based upon experience in the field, during the next fifty years. O. G. S. Crawford, a leading British pioneer in this area, codified the techniques of prehistorical interpretation when he devised a simple but most effective grouping of site attributes in two cornerstone publications.¹ The familiar categories of shadow-sites and shine marks, soil-sites, and crop-sites serve as foundational departure points for the archaeologist, anthropologist, and historical geographer working over either vertical or oblique photographs. The full range of what can be achieved from photography in terms of ingenious techniques working upon obscure data is splendidly illustrated by John Bradford in his *Ancient Landscapes*.² This much of technique and interpreted data is, therefore, secure, essential, and difficult to improve upon.

The very rapid expansion of the usage of aerial photography in a wide number of fields and according to a bewildering variety of techniques is a development of the last 25 years. The photo interpretation key has been evolved to aid in the basic tasks of recognizing and identifying objects which appear on the photos, and two justifications for the development and use of keys have been agreed upon.³ They may serve as valuable short cuts in interpretation especially if highly trained personnel are not available, and they assist greatly in the training of photo interpreters. It would seem that a third justification for the photo key might reside in the need to process the large volume of photography available today for the initial isolation of features which, by reason of their susceptibility to easy destruction, are rapidly passing from the visible scene. It is with this latter requirement foremost in mind that the following two photo interpretation keys are advanced as being suitable for usage by historical geographers.

TYPES OF KEYS

The photo interpreter endeavors to identify objects by employing processes of selection and of elimination. He can tell either what something is, or he can identify and reject something which it is not. Both

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¹ O. G. S. Crawford, "Air-Survey and Archaeology," *Ordnance Survey Professional Paper*, n.s. No. 7, (1924), 39 pp., and "Air-Photography for Archaeologists," *Ordnance Survey Professional Paper*, n.s. No. 12, (1929), 44 pp.

² John Bradford, *Ancient Landscapes: Studies in Field Archaeology*. London: George Bell, 1957, 297 pp.

³ Interdepartmental Committee on Air Surveys, Department of Mines and Technical Surveys, *Proceedings of a Seminar on Air Interpretation in the Development of Canada*, (Ottawa), 1964, Pt. 4, pp. 38-40.

approaches work better if they are broken down into a number of intermediate steps of decision-making. A key provides an orderly arrangement for such decisive steps. If the key is illustrated with single or stereo photography, the identification process is made even more accurate and dependable.

The selective type of key illustrates and describes classes of phenomena, and the interpreter must select the closest fit for his particular specimen.⁴ The amount of detail which can be handled by means of this type of key is restricted, but it is easier to prepare, and it has the added advantage of treating the subject as a whole.

Elimination keys, on the other hand, proceed step by step through an array of possible identifications, and here the interpreter must discard all incorrect choices.⁵ A refinement of the elimination key occurs when a dichotomous format is employed. Choices are then paired throughout a series of characteristic-categories which become more and more restricted at each division point until the ultimate choice of alternatives is reached. The most familiar dichotomous device in the realm of the geographer is the botanist's taxonomic key.

The advantage of the dichotomous key is that one works from general toward more particular characteristics, and thereby the way through a mass of detail is more easily found. Choices are almost always limited to two alternatives because this tends to reduce confusion and ambiguity. If an incorrect choice is made, the hope is that it will be quickly recognized when the succeeding criteria of choice do not fit the specimen at hand.

Design of a suitable key is a matter of balancing the desired ends against the level of ability of the interpreter. If a key is to be used by experienced interpreters, it is possible to impart a higher degree of complexity both in its subject matter and in the degree of refinement of its selection criteria. One must, therefore, first measure the man and then the range of phenomena. Both simple and complex keys are needed, for no one key will do all jobs incidental to the historical interpretation of photographs.

As will be seen below, the geometric properties of features of historical interest will be stressed here. Recent experience with small-scale satellite photography indicates that, detectability and ground resolution parameters notwithstanding, the ground-feature geometric properties of linearity and focality show up amazingly well.⁶ In addition, association analysis which is the study of features in both their areal arrangement and context is basically predicated upon a *Gestalt* which is in large measure geometric.⁷

In order to illustrate two types of keys which can be designed as well as to indicate the incidental problems in their usage, the following

⁴ American Society of Photogrammetry, *Manual of Photographic Interpretation*, Washington: American Society of Photogrammetry, 1960, p. 112.

⁵ *Ibid.*

⁶ U.S., House of Representatives, Select Committee on Astronautics and Space Exhibition, *Space Handbook: Astronautics and Its Applications*, 86th Cong., 1st Sess. 1959, House Document No. 86, pp. 173-174.

⁷ American Society of Photogrammetry, *op. cit.*, pp. 104-105.

proto-types are discussed here. It should be noted that ideally these examples would be illustrated with annotated photography, preferably stereoscopic pairs of pictures.

THE SELECTIVE KEY (KEY 1)

The first device is a Selective Key, and its operation is illustrated by reference to a particularly choice area in Wiltshire county, England. (Figure 1.) Five categories have been set up according to basically geometric criteria to assist in the simple, initial identification of historic objects on aerial photographs. The geometric properties were chosen because pattern, outline, inter-relationships in space, and spatial overlaps are all readily spotted on aerial photographs even at very small scales. In the key itself the categories are listed in order of their seeming prominence on a photograph. The assemblage of features included within each category is enumerated, and illustrative examples are included from Figure 1 in lieu of photographs.

Aerial features which constitute the "grain" or overall pattern of a land surface will consist here of historical man-made aspects of agricultural, forestry, artificial water body, and expansive settlement elements. In the territory illustrated here, such features will consist of so-called "Celtic Fields" and lynchets. With respect to these two groups of things it should be noted that both the time of day of the photography and the season of the year will be essential parameters for successful interpretation.

KEY 1: A SELECTIVE KEY FOR THE HISTORICAL INTERPRETATION OF AERIAL PHOTOGRAPHERS

<i>Category</i>	<i>Assemblage of Features and Illustrations</i>
1. AREAL FEATURES—	"Grain" or pattern of the land surface, consisting here mostly of agricultural features. <i>e.g.</i> , Celtic Fields, Lynchets.
2. LINEAR FEATURES—	Travelling earthworks, boundaries, alignments, and transportation lines. <i>e.g.</i> , Roman Road, Wansdyke, the Old Bath Road, the Kennet and Avon Canal.
3. FOCAL FEATURES—	Ritual centers, settlements, habitation complexes, and communications junctions. <i>e.g.</i> , the Avebury Complex, Windmill Hill.
4. POINT FEATURES—	A great range of possibilities, including monuments, small enclosures, and isolated buildings. <i>e.g.</i> , Silbury Hill, Knap Hill Fort.
5. COMPLEX FEATURES—	Overlaps in position or in usage characterize these, and usually reflect origins at different times. Includes overlapping land uses, and military or political frontiers. <i>e.g.</i> , overlap (a) between Roman Road and Ridgeway, and (b) Roman Road and Wansdyke; the Avebury Circle, occupied since Bronze Age.

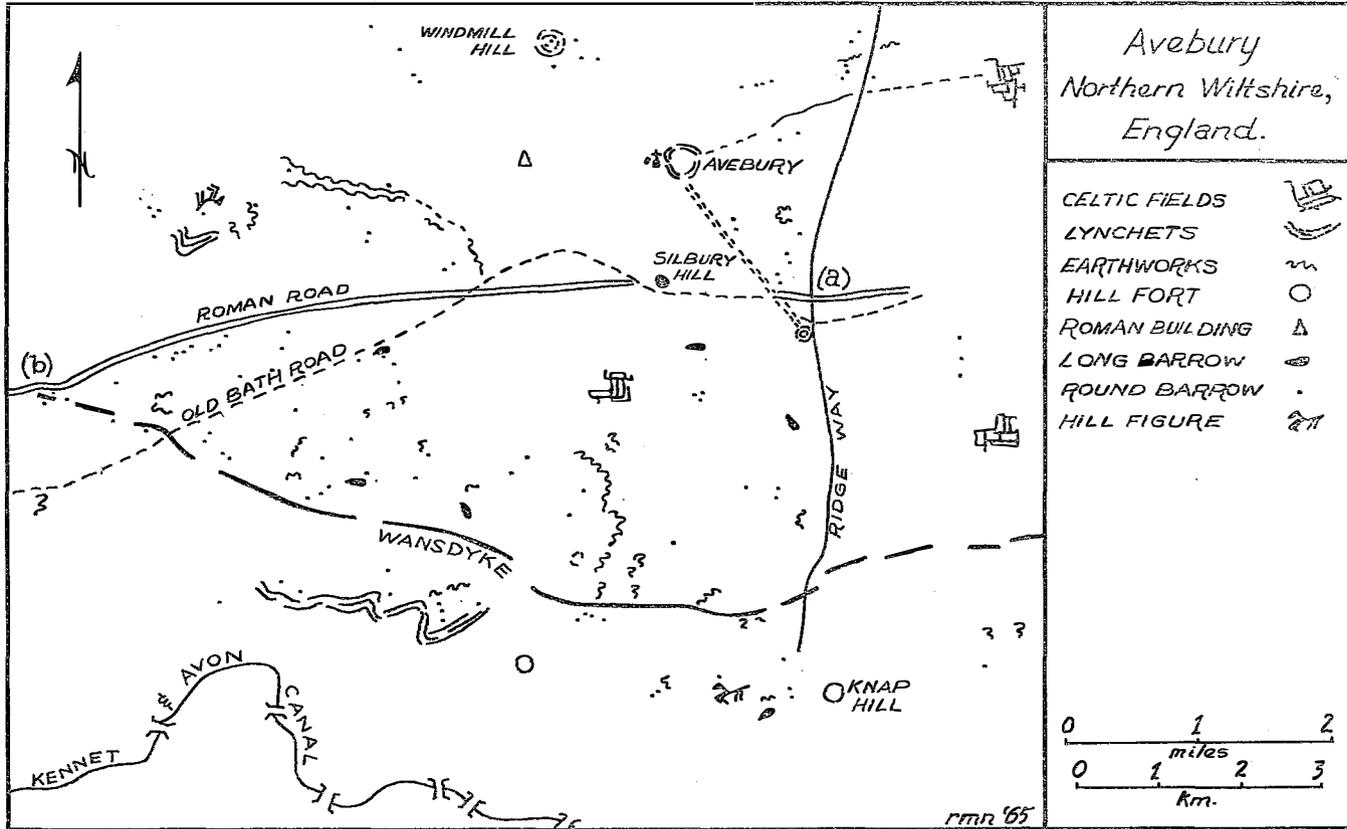


Figure 1

Although not nearly as extensive in areal coverage, linear features are remarkably visible upon photography of even the smallest scales. The more regular the linearity and the longer its extent the more easily visible will the feature be. As cited in the key itself, the travelling earthwork of Wansdyke stands out most clearly by reason of its size and favorable configuration for the casting of shadows. Both the old Roman Road and the much later Old Bath Road are intermediate in visibility. The Kennet and Avon Canal, a monument to the more recent historic vogue in navigational construction, would emerge more clearly if reference were made to the road network which leads to and crosses this feature but which is not depicted on Figure 1.

Congeries of visual clues help in the identification of focal features. A concentration of elements about a center, such as characterizes Avebury, or the funneling of trackage about a habitation site, now alas no longer visible about Windmill Hill, tend to draw the eye of the interpreter to a prime focus.

Point features frequently require photography of high ground resolution characteristic before they can be recognized. In Wiltshire the great abundance of sizeable burial mounds, which cast good shadows at the proper time of day, would not be overlooked. A hill fort such as that on Knap Hill would also be relatively visible by reason of the shadows it cast. The white horse hill figure just to the west of the fort would tend to show up as a tonal difference between the exposed white chalk of the feature and the surrounding grass.

With respect to the analysis of complex features, it would appear that the more one knew about the area under interpretation the better would be the chances of identification. The overlap of linear features at point (a) for instance could be seen, but the significance of this overlap could not be ascertained from the photography alone. However, the relative sequence of construction could be ascertained if details of construction and peculiarities of mutual interrelations were visible upon the print.

The chief problem faced in the design of a Selective Key is making certain that all of the possible classes or categories of phenomena have been included without excessive subdivisoning or ambiguous compartmentalization. An additional perplexity arises when one attempts to analyze the functioning of the phenomena; it is quite obvious that a Bronze Age Trackway would look and operate quite differently from either a Roman Road or a 17th century coach route. The limitations imposed by ethnocentric conditioning in the interpreter have been partially avoided through the use of gross geometric characteristics as the main criteria of identification. It is assumed that the recognition of significant geometrical features is independent of cultural bias. However, it is well recognized that the mental set of the interpreter is one of the five bases for object identification.⁸ Last to be mentioned among the short-comings of this key is that it reveals nothing about absolute chronologies. However, the relative se-

⁸ A. P. A. Vink, "Some Thoughts on Photo-Intepretation," *Publications of the International Training Centre for Aerial Survey, Series B, Number 25*, Delft: I.T.C., 1964, p. 9.

quencing of events and features can sometimes be revealed through the close study of overlaps and displacements among surface objects.

THE DICHOTOMOUS ELIMINATION KEY (KEY 2)

The following sample key for the recognition and identification of ancient fields in Britain has been constructed upon the basis of three premises.⁹ First, the essential decision for the user is supposed to be a simple "either . . . or" type of choice. Secondly, the progression in the scheme of the key is from the general, easily identified characteristics of the objects to the more highly specific details. Lastly, the emphasis has been placed upon the basic features of size, shape, and interrelationships, all geometric properties. (See Figure 2.) For purposes of simple illustration the relevant but highly complex details of overlap and semi-obliteration brought about by time and alternative usages have been set aside.

Two additional areas of omission in this key must be explained. Again in order to maintain a simplicity of illustration, the necessary but far from unanimous units of measure characterizing each feature were left out. It is quite clear that mathematical values would have to be assigned before the interpretation of size or shape differences would be entirely meaningful. For the same reason the dozen or so other features of ancient agricultural land use, many of which are debatable both as to terminology and identification, were not included.¹⁰

Figure 2 is an attempt to depict in a visual manner the objects and their shapes as defined within Key 2.

The first choice which the interpreter must make is with respect to the Size of the enclosed agricultural field unit. If the feature is large, that is on the order of several acres, then he assumes that he is dealing with a prehistoric cattle ranch, pastoral enclosure, or landed estate as defined by visible boundaries. If the size of the enclosed area is small, by contrast, then he moves to the next branch of the key, Branch (II).

Small size of field features then requires an assessment of areal Shape. Irregularity as indicated in Figure 2, Branch (A) leads to a subordinate branching which is predicated upon whether this irregularity is rectilinear or long and narrow. If the interpreter opts for the former category, then he may assume that he is dealing with corn fields of Neolithic or Bronze Age varieties. On the other hand, lynchet features and terraces would be irregular but also long and narrow areas.

When, however, feature Shapes are regular, then the person using this key follows the branch which descends from Branch (B) in the dia-

⁹ The importance of the study of "agrarian archaeology" is suggested in Institut Pedagique National, *Archaéologie Aérienne et techniques complémentaires*. Paris: I. P. N., 1963, p. 72.

¹⁰ The omitted field types would include such things as transversely divided strips, embanked enclosures, cultivation banks, cultivation terraces, "Medieval fields", and Roman *per scamna et strigas* systems. The terminology for the field systems in Key 2 was drawn from H. C. Bowen, *Ancient Fields*, London, British Assoc. for Adv. of Sci., 1961, 80 pp., and E. Cecil Curwen, "Air Photography and Economic History: the Evolution of the Cornfield," *Economic History Society*, Pamphlet No. 2, 1929, 31 pp.

KEY 2: A DICHOTOMOUS ELIMINATION KEY FOR THE INTERPRETATION OF ENCLOSED FEATURES OF ANCIENT BRITISH FIELD TYPES.

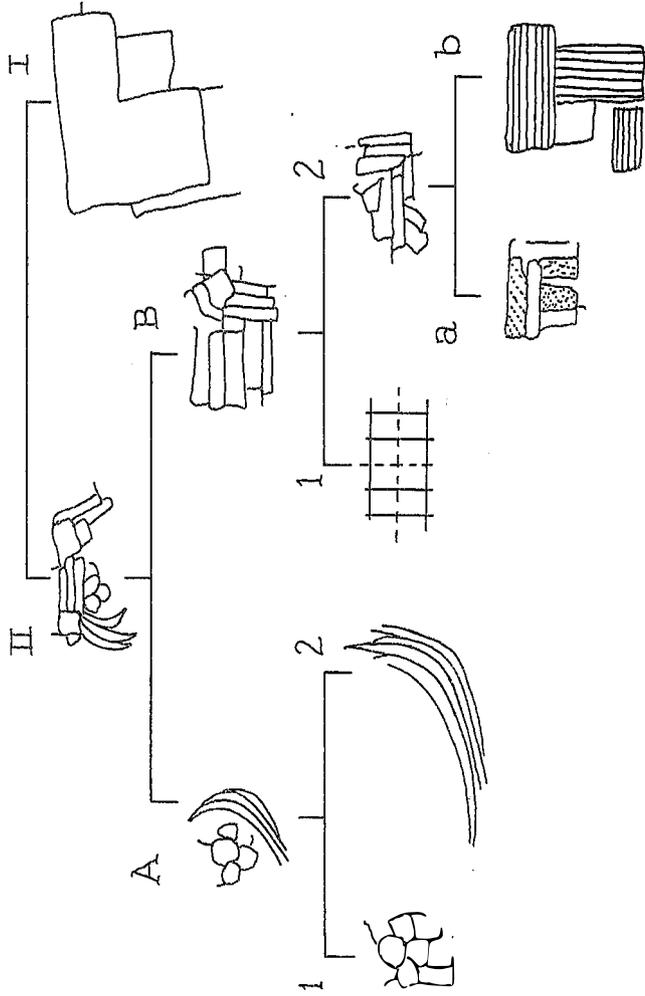
- I. SIZE of Enclosed Area large agricultural enclosures such as ranch boundaries, cattle corrals, pastoral enclosures, and estate boundaries.

 - II. SIZE of Enclosed Area small
 - A. SHAPE of Area irregular
 - 1. Irregular but rectilinear corn plots of Neolithic and Bronze Age.
 - 2. Irregular but long and narrow strip-lynchets, lynchets, terraces.
 - B. SHAPE of Area regular
 - 1. PATTERN or Relationship with other Enclosures highly regular Roman fields, *e.g.*, centuriation.
 - 2. PATTERN or Relationship with other Enclosures irregular
 - a) CULTIVATION MARKS absent, although may have slight scratching marks of cultivation, usually 2 sets crisscross Celtic Fields.
 - b) CULTIVATION MARKS present, banks and hollows or ridge and furrow in elongated strips bundled into rectangular groupings Ridge and Furrow.
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gram. His next criterion is that of Pattern or Shape relationship with respect to the adjacent field features. A highly regular field Pattern, within the confines of the area and samples cited here, would suggest Roman centuriation to the interpreter. An irregular field Pattern would cause him to descend from Branch (2) to the final bifurcation of the key.

Small Size, regular Shape, irregular Pattern, and the photo-reader is faced with a final decision based upon the absence or presence of Cultivation Marks over the surface of the field areas under photo study. Ridge and Furrow tends to show up very well in any of the traditional site attribute categories mentioned above if prolonged deep plowing has

Illustration of a Dichotomous Elimination Key for Interpretation of Ancient Field Types.



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Figure 2

not been practiced. The *ard*, supposedly the cultivation implement of the Celtic Fields, leaves very slight if even detectable surface cultivation marks.

The unsolved problems relevant to Key 2 would be, first of all, the oversimplification which is inherent in this present device. There are many other features of ancient agricultural land use which have not been included here. In addition, the categories of existing features as well as their several sets of identifying characteristics are not agreed upon yet by all students of ancient fields. If quantitative criteria relative to size and shape were added to the Key, its operability would be correspondingly enhanced. Lastly, this particular Key is useful for the interpretation of photography only from Britain. A key for the identification of types of German or Andean ancient fields would have to be quite different.

CONCLUSIONS

Even so obscure a subject as the development and usage of keys for air photo interpretation has enjoyed an impressive but perhaps unreasonable vogue. Within the pages of *Photogrammetric Engineering* between the years 1952 and 1958 there appeared a total of 16 articles on the subject of P.I. Keys. In 1955 a Symposium on keys produced alone ten of these articles. The usefulness of keys for the establishment of interpretative short-cuts and as aids in the training of interpreters has already been mentioned. However, cautionary voices have sounded the warning that the key is not a substitute for the well-trained and knowledgeable interpreter.¹¹

With respect to an assessment of the utility of photo keys within the fields of air archaeology and historical geography, three contrasting opinions can be cited. J. K. St Joseph, Director of the Committee for Aerial Photography at Cambridge and dean of present efforts in air archaeology in Britain by reason of his energetic field work and publication schedule, expressed doubts as to the usefulness of keys in the interpretation of historical landscapes.¹² His stand was based upon the facts that very many special cases exist among historic features and that categories tend so to grade one into another. The diversity of features to be handled, when added to the experience characteristic of mature interpreters, would tend in the end to limit the usefulness of such keys to basic instructional levels and for highly generalized initial surveys.

Kirk H. Stone, long a worker with air photography as related to rural settlement analysis, occupies a middle position regarding the usefulness of keys for historical studies.¹³ The development of the dichotomous key for many applications has reached a point of surfeit, but the need for historical keys is great presumably because fewer of these exist.

Robert N. Colwell, who has concerned himself over a long period with the precise exploitation of air photography especially in applications to forestry, was enthusiastic about the future for keys of the type illustrated

¹¹ Interdepartmental Committee on Air Surveys, Department of Mines and Technical Surveys, *op. cit.*, pp. 38-40.

¹² J. K. St. Joseph, personal communication, April 1964.

¹³ Kirk H. Stone, personal communication, May 1965.

here.¹⁴ The existence of a large reservoir of archaeological sites which are now coming more and more under the impartial eye of the aerial camera provides the student with a mounting interpretative work-load. A second argument for the usefulness of such keys resides in the fact that so many historical sites are in current and pressing danger of destruction. Hence, there exists the acute need for site identification and evaluation as guides for subsequent site reservation or rescue excavations.

A compromise position relative to the value of keys for historical interpretation of aerial photography might be phrased as follows.¹⁵ In this day of voluminous satellite photography of increasingly higher quality and with a gathering interest in the geographic exploitation of remote sensing systems, P.I. keys designed specifically for the analysis and identification of historic landscape features are needed. The eventuality that large volumes of photography will of necessity be screened by interpreters not trained in the facts and viewpoints of air archaeology and historical geography argues for the acceptability of even simplified keys. The related possibility of programing keys in order that guidance might be provided to a dispassionate data processing mechanism responsible for photo interpretation probably lies within current technological capabilities.

Within this small compass it has not been possible to provide more than a slight suggestion of the intriguing possibilities offered by the design of photo interpretation keys suitable for the historical study of landscapes by means of airborne sensors. The photo key by itself cannot do the entire job, of course. In the hands of an interpreter who is experienced in both interpretation and field work, and who employs skillfully the concept of the convergence of evidence, the photo key can help to shed new light upon the exploration of the "archives of the earth".¹⁶

¹⁴ Robert N. Colwell, personal communication, May 1964.

¹⁵ Robert H. Alexander, "Geographic Data from Space," *The Professional Geographer*, Vol. XVI, No. 6, November 1964, pp. 4-5.

¹⁶ Paul Chombart de Lauwe, ed., *La Découverte Aérienne du Monde*, Paris, Horizons de France, 1948, p. 98.