*Air Photo Interpretation Procedures**†*

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AIR PHOTO interpretation is a way of using research material. The technique is valuable in research primarily as procedure when air photos are employed with other source materials. Yet, study of the literature of air photo interpretation reveals a serious absence of procedures.[1] Numerous references are available on the photographic characteristics of features, that is, on the recognition of objects or the clues to *what* is seen. However, there are few publications on how to interpret—the very heart of the technique—and air photo interpretation has remained unnecessarily mystical as a result.

Some standardization of interpretational procedures is possible in spite of the variety of objectives of research involving air photos. Thus, suggestions for standardization are made in this paper in order to aid beginning interpreters, to provoke study and extension by those more experienced, and to remind all researchers of the value of publishing procedures of study with the final results. The recommendations are made with the assumption that source materials are used with the photographs but that sources are somewhat limited and, therefore, that some general questions can be answered only by analysis of the air photos. It is further assumed that once the interpreter has employed the procedures and has noted differences between elements of the photographed landscape he will proceed with the explanation of these differences, a stage more dependent upon knowledge of the content of a field of study rather than upon a technique.

The foundation of procedure is mental discipline. So it is in air photo interpretation that the primary tools are the brain and at least one eye. Other equipment is secondary. However, the need for mental discipline often is overlooked because of the adjustments necessary to the unfamiliar viewpoints of the oblique and vertical photos, of the apparent desirability of much of the "photo interpretation equipment" available, and of an unconscious desire to learn about everything in a landscape because part of the great mixture seen on mosaics or photos is recognizable immediately. Thus, the hardest part of air photo interpretation is getting started efficiently, a step based on four general procedures.

GENERAL PROCEDURES

1) *Interpretation should be done in a methodical way.* An air photo is a record of the natural mixture of the physical and cultural elements of a landscape. To prevent initial confusion and discouragement by this mixture, and to insure completeness of analysis, nine basic steps of interpretation have been suggested previously.[2] They have proved to be useful in geographic research and teaching. Especially valuable in preventing confusion is the technique of interpreting only

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[1] Stone, K. H., "A Selected Bibliography for Geographic Instruction and Research by Air Photo Interpretation," PHOTOGRAMMETRIC ENGINEERING, v. XX, 1954, p. 561–565.

[2] Stone, K. H., "Aerial Photographic Interpretation of Natural Vegetation in the Anchorage Area, Alaska," *Geographical Review*, v. XXXVIII, 1948, p. 466.

one topic at a time. For example, all that is needed regarding transportation should be interpreted before proceeding to the topic of drainage. It is true that the interpretation of one topic aids another. Such aid is apparent as an interpreter proceeds from topic to topic, particularly if it is in the order listed and described below.

Some research requires description or mapping of all of an area. However, unless full coverage is demonstrably essential, interpretation by the sampling procedure is highly recommended. With the use of other source material researchers usually should be able to select areas, strips, lines, or spots and to place them in representative, mechanical, or random locations before interpretation is begun. Certainly research with air photos should not be assumed to require complete analysis of an area any more than if that area is analyzed by large-scale maps or detailed statistical data.

2) *Interpretation should be made from the general items to the specific.* Or, we may say from the small-scale to the large-scale considerations, whether or not generalizations are to be the end product of the analysis. The first view of the photos should be with the naked eyes and of the smallest scale coverage available, such as photo indices, mosaics, and smaller scale verticals and obliques. By this step are discovered broad regional patterns which are too subtle to be seen on single photos as well as the discontinuous patterns which must be viewed over large areas to observe any continuity at all. After the naked eye study, examination of the smaller scale verticals with a mirror stereoscope, without binoculars, will be a natural step toward more detail. The study of large-scale vertical coverage is more effective when done last for here detail is the only thing apparent. In particular is this true when pocket stereoscopes are used because the diameter of the effective area seen directly beneath the two-power lenses is less than three inches, and that beneath the four-power lenses is less than one and one-half inches.

In general, there is too great a tendency for photo interpreters to become lost in detail, and too little effort to conquer the tendency; the prevention, and more efficient interpretation, is by working from the general characteristics toward the specific ones of each topic interpreted.

3) *Interpretation should be done from the known to the unknown features.* Just as we "screen" the photos a topic at a time, so should we establish early what is clearly recognizable from other source materials and previous experience. Generally there is little need to methodically identify a feature on a photo when an available map or report already identifies it. For encouragement and efficient interpretation it is valuable to establish rather soon in the research what parts of a topic are recognizable on a photo. These items must then be verified by comparison with source materials, by examination of the photo pattern, and by measurement of the object to determine its size (particularly necessary with respect to cultural features). What is absolutely identifiable on the coverage is then available for comparison with the unknown features; this comparison of known with unknown is very basic procedure.

Then two thought-provoking questions must be applied rigorously to the unknown. Is it a part of or directly related to the topic being analyzed? If the answer is in the negative the item should be skipped immediately. If there is doubt or if the answer is in the affirmative, identification should be sought. Any possible identification must then be recognized as only a possibility by repetition of the second question: what else could it be? This question must be posed many times until identification is certain or until the number of possibilities is as limited as it can be. It is this last question which is one of the more

difficult to apply in air photo interpretation, but which is one of the more valuable techniques to prevent assumptions.

4) *The photography should be analyzed for its photographic qualities alone.* Most commercial photography taken in peace time is of high quality. Occasionally, however, there are variations in photographic characteristics which are purposeful or accidental and which cause minor problems in interpretation. When interpreting military photography, major problems may arise because the photographing, development, and printing often are done under trying and imperfect conditions, particularly those of combat. Clouds may hinder observation of the ground; static streaks or scratches may simulate the works of man, spots from drops of fluid may be distracting; objects may be slightly blurred; or scales may vary. Nevertheless, this type of photography is available for large parts of the world and should be used whenever at all possible.[3]

Topical Procedures

Application of the general procedures to the topical is seen in the suggested order of interpretation of topics. This is: transportation, drainage, surface configuration, vegetation, agriculture, rural non-agriculture, and urban features. Specialized topics, such as military features, should be added at the end. Such an order is effective because it leads an interpreter methodically and, usually, from the better known to the less well known, as well as from the general to the more specific features.

Most persons feel generally familiar with land transportation. Thus, beginning with such things as are recognizable from every-day experience, immediately builds confidence. In addition, features are located which are basic to most research. Also, because transport lines are usually functions of the places they connect, an interpreter is prompted to begin with small-scale photos so as to see in one view the places connected and the connecting links. Then, it is logical to proceed to drainage which is often confused with transportation because both features commonly are linear, close together (as in a valley), and similar in size and photographic tone.[4]

Determination of the drainage pattern is fundamental for interpretation of surface configuration which may logically follow. An understanding of both drainage and surface configuration is needed for the interpretation of vegetation; and because all three topics usually have wide-area patterns of distribution, an interpreter is led by this order to begin with the smallest scale photos available.

Crops are logically next because they are similar photographically to natural vegetation, and they and other agricultural uses of land often are distributed in close relationship to the topics previously noted. This leaves the non-agricultural rural uses of the land, several of which are like the intensive land uses found in cities. This increased intensity of use introduces a need for larger scale

[3] Stone, K. H., World Air Photo Coverage, 1953, Photogrammetric Engineering, v. XX, 1954, p. 605–610.

[4] The significance of photographic tone in interpretation probably has been overemphasized. Tone is the result of the reflective properties of an object, not necessarily its color. And the reflective property is dependent upon the position of the object with respect to the sun as well as its density. Bodies of water, for example, may have all the tonal values from white to black on a single photo, because of changes of the angle of reflection of sunlight to the camera, of shallowness of the water, or of motion of the water, or of the amount of sediment in the water. Further, the tonal values are relative to each other rather than constant for an object, because the tones are partially a result of the exposure, development, and resolution of the film, as well as the proximity on the ground of objects and, therefore, the scale of the photography.

photos. Even with these, however, it has been found that the closeness of objects, and the unfamiliarity of such things as roof features and factory layouts, makes these last two topics least well known and, therefore, best interpreted after other experience and by elimination. Then, when this order or another of topical listing has been adopted, the interpreter needs particular topical procedures, similar to the examples that follow.

TRANSPORTATION FEATURES

Scales of 1/70,000–1/30,000[5]

a. Outline areas with and without any kind of transportation lines.
b. Mark the locations of the major and minor foci of transportation lines.
c. Separate the more direct and less direct lines between major foci.

Scales of 1/30,000–1/10,000

d. For the more direct lines, determine the kind of vehicle on each.
e. For the more direct lines, determine generally what is at the ends of the lines (e.g., city, water body, industry).
f. For the more direct lines, determine generally what is at the ends of the lines which are tributary to them.
g. For each more direct line, note its location with respect to the centers and types of foci, to the land between the foci (e.g., direct or indirect routes, continuous or discontinuous appearance), to the angle of junctions with tributaries, and to the general distribution of buildings and other centers of human activity.
h. For the less direct transportation lines between major foci repeat d–g above.

Scales larger than 1/10,000

j. For the transportation lines between minor foci and other centers of human activity, repeat d–g above.
k. Determine specific characteristics of individual transportation lines and their associated features (e.g., width, function of adjoining structures).

DRAINAGE FEATURES

Scales of 1/70,000–1/30,000

a. Outline the general areas of permanent water bodies (ocean, lakes, and rivers), seasonal water bodies, no apparent surface drainage, and underground drainage).
b. Outline ocean shorelines, larger permanent lakes, and trunks of major rivers.
c. Determine general direction(s) of flow of water.
d. Outline general areas with respect to types of drainage patterns (e.g., dendritic, trellis, karst).

[5] The three scale classes suggested in this paper are arbitrary determinations from research experience. The divisions are the same for every topic for purposes of convenience. The smaller limit of 1/70,000 is used because air photos usually are not made with smaller scales, and if so their usefulness is likely to be limited. Further, the placing of steps under these scale classes means that it is more efficient interpretation procedure to take them in the order given, and with the scales noted if such coverage is available. If not, several of the steps can be taken with photos in other scale classes and careful interpretation.

Scales of 1/30,000–1/10,000

e. Outline and classify ocean shorelines.
f. Outline the major tributaries and minor streams.
g. Prepare profiles of the characteristics of the major valleys and ridges.
h. Mark departures from the general distribution pattern of water bodies or courses, and of sudden changes in direction of flow.
j. Mark features on water bodies (e.g., waves, ice, logs, boats).

Scales larger than 1/10,000

k. Outline minor tributaries and distributaries.
l. Mark locations of artificial drainage features (e.g., dam, drainage ditch, tiles area, river straightening).
m. Mark locations of differences in photographic tone and texture of water in various drainage features.
n. Determine specific characteristics, particularly with respect to associated topics, such as transportation on water bodies or land.

SURFACE CONFIGURATION FEATURES

Scales of 1/70,000–1/30,000

a. Outline the major drainage divides between lakes and major rivers.
b. Outline the areas of lower elevations (valley bottoms and lowlands adjacent to major water bodies).
c. Outline areas on the basis of length of slopes.
d. Outline in general the probable unglaciated and glaciated areas.

Scales of 1/30,000–1/10,000[6]

e. Outline the minor drainage divides.
f. Outline the parts of the area with respect to the amount of land in slopes and flat.
g. Outline the parts of the area on the basis of steepness of slopes.
h. Outline areas of rock outcrop.
j. For unglaciated parts:
   1. Outline areas on basis of general rock type (e.g., igneous, sedimentary, metamorphic).
   2. Outline areas on basis of structural characteristics.
   3. Determine general characteristics of specific landforms and geologic structures (e.g., dip, strike).
k. For glaciated areas:
   1. Outline probable areas of mountain and continental glaciation.
   2. Outline areas of glacial erosion and glacial deposition.
   3. Determine direction of glacial movement.
   4. Determine general thickness of glacial drift.
   5. Determine general characteristics of specific landforms.

Scales larger than 1/10,000

Determine detailed characteristics of specific landforms and geologic structures.

[6] Of particular value in this scale class is Ray, R. G., "Photogeologic Procedures in Geologic Interpretation and Mapping, Preliminary Report, U. S. Geological Survey, Washington, 1955, although the report was prepared from research with photos having scales both larger and smaller than 1/30,000.

NATURAL VEGETATION FEATURES

Scales of 1/70,000–1/30,000

a. Outline bare areas and areas with natural vegetation.
b. Outline areas of natural vegetation on the basis of those apparently used used by people or animals, and those not used by people or animals.
c. Outline areas of forest, brush, and grass (excluding cultivated grass).
d. Note the distribution of forest, brush, and grass in relation to drainage and surface configuration.
e. For forests:
    1. Outline areas of evergreen and deciduous trees.
    2. Outline areas on basis of significant differences in tree height.
    3. Outline areas on basis of significant densities of stands.
    4. Outline areas on basis of differences in photographic texture of stands.
    5. Outline areas on basis of differences in photographic tone of stands.
    6. Outline areas on basis of the shape of stands (e.g., linear, partially rectangular, irregular).
    7. Outline areas on basis of repeating patterns of combinations of distributions, height, photographic texture and tone, and shape of stand.[7]
    8. Outline areas of associations (e.g., oak-hickory, birch-beech-maple).
    9. Outline areas of genera (e.g., spruce, poplar).
    10. Determine general characteristics of undergrowth.
f. For brush:
    1–7. Same as for forests 2–8.
g. For grass:
    1–6. Same as for forests 2–7.

Scales of 1/30,000–1/10,000

h. Outline areas which appear recently changed from a naturally vegetated state (by clearing, by burning, or by disease).
j. Outline areas of species of trees.
k. Outline areas of associations of brush and grass.

Scales larger than 1/10,000

l. Determine detailed characteristics of individual trees (e.g., volume of lumber, amount of growth).
m. Outline areas of species of brush and grass.

AGRICULTURAL FEATURES

Scales of 1/70,000–1/30,000

a. Outline areas of cultivated land.
b. Outline areas of fenced uncultivated land.
c. Outline areas of unfenced, uncultivated land which is probably used by animals.
d. Outline farmsteads and note general pattern of distribution (e.g., agglomerated, dispersed).
e. Outline general areas of extensive and intensive agriculture.

[7] It is particularly advisable that beginning interpreters with no botanical experience be encouraged at first to classify vegetation on the basis of only the combined photographed characteristics, and then to learn and use the common and Latin names of the association and genera as a separate stage of identification.

Scales of 1/30,000–1/10,000

f. Note location of farms in relation to transportation lines, drainage features, surface configuration, and natural vegetation.
g. Outline areas of commercial and subsistence agriculture.
h. If commercial crop agriculture, determine probable number of major crops and whether single-or multiple-cropping in growing season.
j. If commercial animal agriculture, determine type of specialty (e.g., meat, milk, wool).
k. Determine specific land uses in areas of extensive agriculture.

Scales larger than 1/10,000

l. Detemine specific crops in areas of intensive agriculture.
m. Determine specific uses of buildings in farmsteads (e.g., grain storage, implement shed, animal barn).
n Determine specific use of rural agricultural buildings and structures not in farmsteads (e.g., windmill, corral).

RURAL NON-AGRICULTURAL FEATURES

Scales of 1/70,000–1/30,000

a. Outline areas of transportation by type (e.g., railroad, canal, road).
b. Outline built-up portions of villages.
c. Mark locations of rural industry (e.g., hydroelectric plant, gravel pit, mine)
d. Mark locations of rural institutions (e.g., hospital, prison, home for the aged).
e. Locate and identify type of recreational areas (e.g., skiing, golf, boating).

Scales of 1/30,000–1/10,000

f. Locate and identify rural public and semi-public buildings (e.g., school, meeting hall, church).
g. Mark locations of rural commercial buildings (e.g., store, roadside stand, gasoline station).
h. Locate probable non-farm residential buildings.
j. Identify types of rural industry (c above).
k. Identify types of rural institutions (d above)
l. Outline and identify areas of various land use in villages (e.g., commercial, industrial, residential).

Scales larger than 1/10,000[8]

m. Determine specific building use in villages
n. Identify the more significant functional parts of industries within and outside of villages (e.g., power unit, processing buildings, storage of finished product).
o. Identify use of rural commercial buildings (g above).
p. Determine specific characteristics of rural nonagricultural features.

[8] The apparent necessity of very large-scale photos for rural analyses is likely to be an automatic indication of the need for more study of other source materials, for more field observation, and perhaps large-scale mapping on a sample basis.

URBAN FEATURES

Scales of 1/70,000–1/30,000

a. Outline total built-up area with urban characteristics.
b. Outline the major transportation lines going through the city.
c. Outline the major transportation lines going into or out of, but not through the city.
d. Outline the major physical characteristics of the total built-up area and adjoining land (e.g., drainage, surface configuration, natural vegetation).

Scales of 1/30,000–1/10,000

e. Separate total built-up area into urban and suburban parts.
f. Outline the kinds of transportational areas in the city (e.g., railroad yard, port district, canal area).
g. Outline minor transportation lines through and only into or out of the city.
h. Outline areas of warehouses and open storage adjacent to the transportation lines.
j. Outline main heavy industrial areas by interpreting along major transportation lines toward the center of the city.[9]
k. Outline the main commercial areas by interpreting toward the center of the city along major and minor transportation lines and particularly at transport junctions.
l. Outline recreational areas.
m. Outline cemeteries.
n. Outline residential areas along and between main transportation lines.
o. Outline areas of the city with respect to selected characteristics (e.g., age, street pattern, elevation, multiple residence).

Scales larger than 1/10,000

p. Outline the kinds of internal transportation routes (e.g., street car, small barge canal).
q. Mark the locations of and identify individual structures and installations (e.g., school, railroad classification yard "hump," sewage disposal plant, heavy industrial factory).

HEAVY INDUSTRIAL FACTORIES

Scale of 1/70,000–1/30,000

a. Outline major and minor transportation lines in the area of heavy industry (Urban j above).
b. Divide each area of heavy industry into individual factories or groups of buildings and structures.

Scales of 1/30,000–1/10,000

c. Outline storage units of raw materials by interpreting along major transportation lines into each factory.
d. Outline the units supplying power and heat by interpreting along the major transportation lines into each factory.

[9] Many of the old cities of Europe and the Far East have a much more complex areal mixture of functions than the newer cities of the Americas and Europe. Nevertheless, the attempt to outline areas of similar use, before identifying individual building uses, is valuable for understanding the urban patterns.

e. Outline the storage units of finished products by interpreting along transportation lines going out of each factory.
f. Designate the general direction of flow of processing from raw material units to finished product units in each factory.

Scales larger than 1/10,000

g. Outline the various kinds of internal transportation lines (e.g., railroad, pipeline, electric line).
h. Identify specific raw materials.
j. Identify specific power and heat units and distribution lines of power and heat.
k. Identify specific finished products.
l. Outline specific flow of processing from raw materials to finished products.
m. Identify specific stage of processing in individual buildings.
n. Identify industry associated with each main factory (e.g., shipbuilding with steel fabrication, chemical production with petroleum refining.

MILITARY FEATURES

Military features need to be recognized as such to prevent loss of time during peace-time interpretation of defense areas or with war-time photography. Often military activity is characterized by light tones of disturbed soil in patterned or patternless lines and spots, the obvious abnormal patterns of camouflage, or the presence of bombs or bomb bursts on the coverage. Such features need be observed only long enough to establish their military classification and lack of significance to most peace-time objectives of interpretation. If, however, photography is being analyzed for military purposes, the procedures for identification need to be prepared on the bases of kinds of weapons, vehicles, and defensive or offensive operations involved in the area of coverage.

Air Photo Interpretation Keys

An air photo interpretation key is a systematic listing of the observable distinguishing characteristics of an element of a landscape. In general, such a key is prepared to make possible the rapid recognition of a feature photographed. The key is procedural if it is used by a selective process that progresses from alternative general characteristics to alternative specific ones (such as, dendrological classifications in forestry by dichotomous listings). However, such aids to procedure are limited in number and availability.

It is unlikely that the future of air photo interpretation procedures depends on the production of more interpretation keys. In fact, keys may have been overemphasized already. Furthermore, keys have limitations. To use many of those available requires far more than average knowledge of the content of a field of study, making the key of primary value to only its inventor. Standardization of key forms is difficult because various analyses require different and variously arranged facts. Terms like photographic texture are difficult to subdivide for detailed description. Also, keys often are useful only for specific photography. For example, a vegetated area may vary greatly in photographic tone, texture, and stereoscopic appearance with changes in scale, photographic time (diurnal and seasonal), shadows on the photos, and photographic quality (exposure, development, resolution, and lens quality). Or, the same cultural feature may appear quite differently in two areas because of cultural differences of the people concerned.

Thus, enthusiastic and unlimited production of air photo interpretation keys for existing world coverage is a nearly endless task, if not one of questionable value. It is likely to be more efficient to postpone making new keys until the need for specific ones is demonstrated for specific projects.

Air photo interpretation is a technique belonging to all fields of study. The procedures are similar to those of map interpretation, language translation, statistical manipulation, and field observation. Also, successful air photo interpretation is based upon the use of all available source materials, photographic and non-photographic. Therefore, the value of the technique may be overemphasized thereby doing it an injustice, in our enthusiasm to classify researchers as "photo—ists(ers)"; such analysts use other techniques and source materials and the term is the equivalent of calling a person a "hammer-carpenter." Too, there is hardly any such person as an "air photo interpreter," unless temporarily for educational or administrative purposes, because no one proposes to use just air photos, nor do many people suggest by such a title that they can identify everything seen on any coverage of the world.

It follows that the way to interpret air photos is simple in general terms. Work is carried on methodically from the general to the specific items, and from the known to the unknown features, in view of the photographic qualities available. Then we analyze topically. Thus, the more specific procedures are likely to come in the future from topical specialists (such as, geographers, city planners, geologists, foresters) who interpret air photos with breadth and depth of topical content, as well as other source materials and techniques.

*Problems in Comparing Photo Interpretation Research Results from Different Studies**

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ABSTRACT: *Quantitative data are increasingly becoming available in photo interpretation research. The task of evaluating these data for a particular study in view of other similar studies and the making of a comparative evaluation of the results, runs into problems. The author presents an example and offers suggestions to research workers in the field of photo interpretation so that research results can be compared with other similar studies.*

THE PROBLEM

IN THE past twenty years great progress has been made in all fields of photo interpretation. During this period investigators have collected data to study

* A contribution of Commission VII, Photographic Interpretation, International Society of Photogrammetry.