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GEOLOGY
Paper: Remote Sensing and GIS
Module: Photogeology: Visual Interpretation of Aerial Photographs

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1. Introduction

Interpretation of various features on aerial photograph is called as photogeology (Dirik, 2005). An aerial photograph is the image of the earth surface taken from the air with the help of a camera pointing downward.

2. Types of aerial photographs

The aerial photographs can be classified on the basis of: Optical axis position, scale and film used.

1.1 On the basis of position of optical axis aerial photographs are classified into following three categories:

- Vertical photographs
- Low oblique photographs
- High oblique photographs

a) Vertical photographs: While capturing the aerial photograph, two different axes are generated from lens centre of camera. Where one axis is towards the ground plane and other one is toward the photo plane. A perpendicular line formed from the lens centre of camera to the ground plane is called as vertical axis and plump line, which is formed from the lens centre towards the photo plane, is called as photographic or optical axis. These two axes may also coincide with each other if photo plane and ground plane kept parallel to each other. The photograph obtained is vertical aerial photograph (Fig. 1).

As aircraft flies over the curved surface of the earth, so it is not easy task to achieve perfect parallelism between the two planes. Therefore photographic axis deviates from the vertical axis. If the deviation is within the range of plus or minus 3 degree then it is called as near vertical photograph otherwise photograph with more than 3 degree of unintentional deviation is called as tilted photograph. Vertical photograph covered small area and horizon does not appear in vertical photographs.

- b) **Low oblique photograph:** If there is an intentional error in the capturing of aerial photograph and if deviation lies between 15 degree to 30 degree in the axis of camera than the captured photograph is low oblique photograph. These photographs are generally used in reconnaissance surveys.

In low oblique photographs horizon appear and they cover relatively larger area then the vertical photographs.

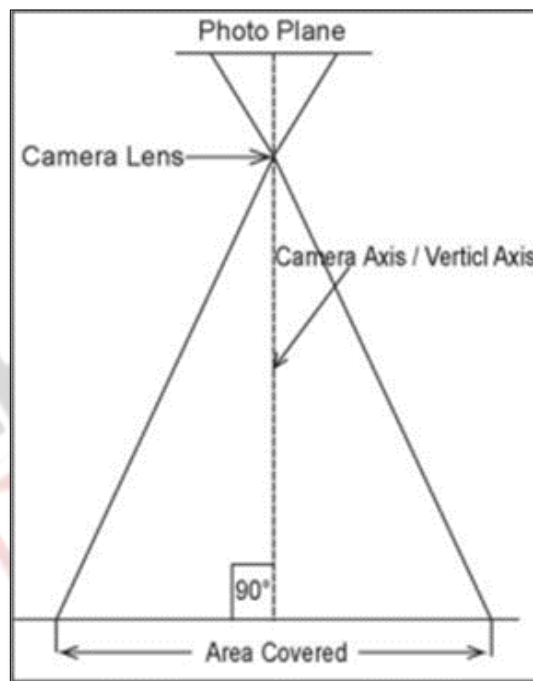


Fig. 1

(Source: *Global security.org*)

- c) **High oblique photograph:** If intentional deviation is about 60 degree from the vertical axis than the obtained photograph is called as high oblique photograph. These are also used in reconnaissance surveys. Horizon appears in high oblique photographs also and they covered largest area.

1.2 Classification of aerial photographs based on scales:

There are three type of aerial photographs based on the scale. They are:

- Small scale photographs
- Medium scale photographs
- Large scale photographs

- a) **Small-scale photographs:** If photograph is taken with scale i.e. less than 1:30,000 of representative fraction (RF). It is called as small-scale photographs. These photographs covered large area with less information of ground features.
- b) **Medium scale photographs:** If scale of photograph lies between RF of 1:15,000 and 1:30,000 than it is called medium scale photograph. These photograph cover relatively less area and show more detailed information about features on the ground than the small-scale photograph.
- c) **Large-scale photographs:** Scale of large-scale photograph is more than 1:15,000. It means it covers small area and show most detailed information about the features existing on the ground surface.

1.3 Types of aerial photograph on the basis of film used

There are three types of aerial photographs on the basis of film used in the photography.

- Panchromatic black and white photographs
 - Coloured photographs
- a) **Panchromatic black and white photographs:** Minus blue filter used in the black and white photographs which eliminates the scattering effect of the haze so produce the good quality of aerial photograph with high resolution. These photographs are used for mapping purpose.
- b) **Coloured photographs:** These photographs have some advantage over the panchromatic photograph, as it is easy to detect features in coloured tone than the different shades of grey. Coloured photograph are mainly used in studies like forestry and pollution studies.

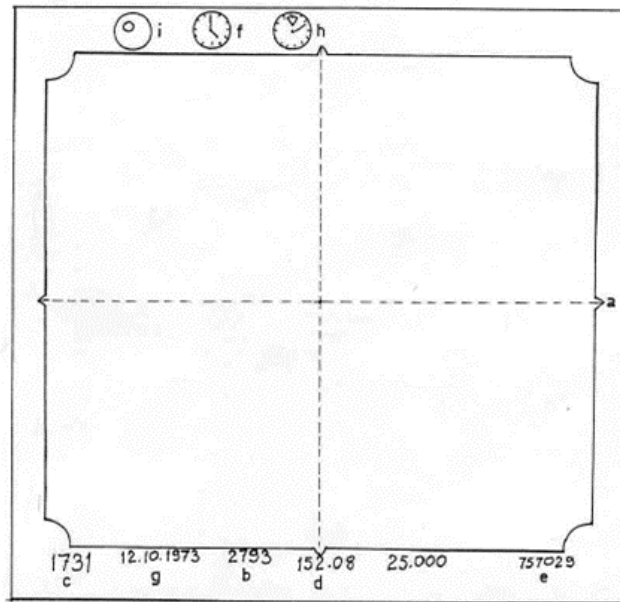
3. Printed information on aerial photographs

Figure 2 showing all the information present on the aerial photograph.

- a) **Fiducal (collimation) mark:** Fiducal mark or fiducal centre are used to identify the principal point on the photograph. Geometric centre of a

photograph is called as principal point. When two lines joining opposite fiducial points intersect at a point, this point of intersection is called as principal point. There is 60% overlap of aerial photograph to the adjacent photograph. Therefore, principal point of one photograph also lies on the adjacent photographs. These points are called as 'conjugate principal point' or 'transferred principal point'. Therefore, every photograph has one principal point and one conjugate point.

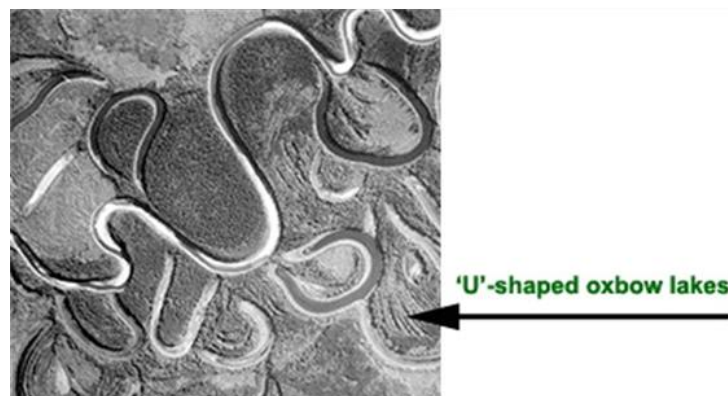
- b) **Serial number:** There is a number on all photographs of same strip along the flight line is called as serial number. At the end of each flight plan serial number are recorded.
- c) **Film (or photograph) number:** Separate number is given to photographs taken from airplane is called as film number.
- d) **Focal length (or principal distance) 'f':** The distance between the lens of camera and film used is called as focal length denote by 'f'. Standard focal length of modern camera is 152mm.
- e) **Camera number:** A number is given to the camera, which is used to take the photograph. It is automatically printed on the photograph.
- f) **Clock:** To determine the speed of the aircraft time interval of two successive aircraft is used. Time when picture is taken is shown by clock.
- g) **Date:** Day, month and year are also displayed on the aerial photograph under the column of date.
- h) **Altimeter:** It gives the detail of height of aircraft from mean sea level from which photograph is captured.
- i) **Spirit level:** Tilt of photograph is shown by spirit level.


Fig. 2

4. Basic elements of photo interpretation

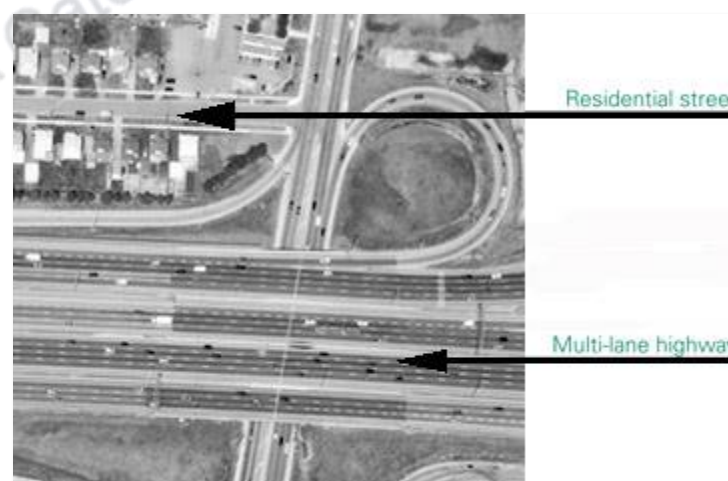
Following are the basic elements used for the identification of features on photographs and for photo interpretation.

4.1 Shape: General form, structure, or outline of an object is called as shape. It is an important tool for photo interpretation. Urban or agriculture features have straight edge shape, whereas forest and other natural features have irregular shape. The shapes of objects on photographs are vertical view of the objects. It is sometimes very difficult to identify elements on ground from their vertical view. Shape of any objects act as a tool in identification of structure, composition and function of the objects. For example, an interpreter of industrial studies is not able to tell about the function of building by just seeing its front door, but with the help of vertical view of the object, he can tell more about its function on the basis of shape of the building. By seeing figure 3, oxbow lakes and meandering rivers are easily identified.


Fig. 3

(Source: www.nrcan.gc.ca)

4.2 Size: Scale of the photograph determines the size of objects on the photographs. Assessment of absolute size of the objects and their relative size to other object aids in photo interpretation. For instance, it helps in determining if the object is small pond or a large lake. It also helps in differentiating smaller roads from larger highways, and also helps in distinguishing between smaller tributaries from large river. By quick estimation of size of the object can drive to interpretation to a suitable result easily. For instance, if an interpreter had to identify land use zones, and if there is an area with a number of buildings in it, large buildings like factories or warehouses can be commercial property, while smaller buildings can be of residential use. Residential street and multi-lane highway can be easily demarcated on figure 4.


Fig. 4

(Source: www.nrcan.gc.ca)

4.3 Shadows: Size and shape of any object can be assumed by their shadow.

Therefore, it is also useful in interpretation. It can give a clue related to the profile and relative height of an object or targets that helps in easier identification of objects. It is also very useful most particularly in radar imagery for identification of topography and landforms on the earth surface. However, some useful information is also lost because of shadows as objects are very less detectable in the area of influence of shadow. High rise building in figure 5 can be identified by seeing its large shadow in top of the image in its right hand side and low rise buildings are seen in bottom left part of the image.

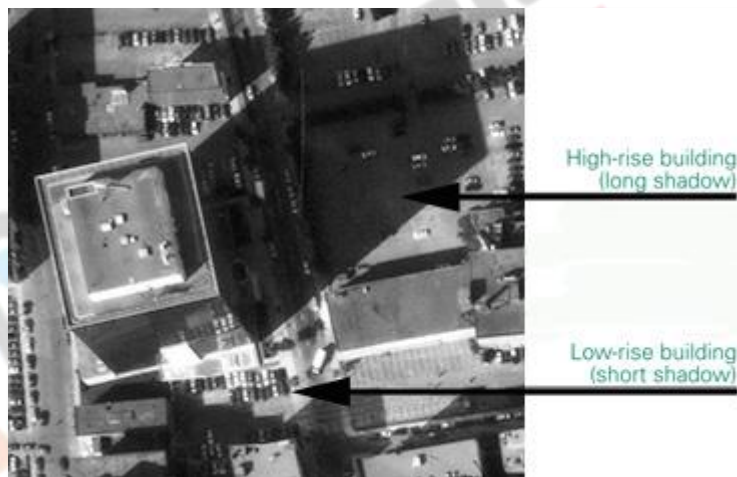


Fig. 5

(Source: www.nrcan.gc.ca)

4.4 Tone: Relative whiteness and blackness of the photograph is referred as tone and it is the outcome of the reflectance of light by an object. In black and white photograph, tone is used as fundamental tool for photo interpretation. There are many factors, which influence the tones of photographic images. These factors are angle of sun, number of wave reflected by the object etc. Smooth surface reflect more light so they appear light in tone on photograph, for instance a black asphalt road appear light in tone. Tonal variation is used in variation field like soil scientist used it for soil classification; the foresters used it to differentiate hardwood

from coniferous forest and geologist for mapping of minerals, lithology and classification of rocks. Light tone is sand and dark tone is water can be easily differentiated in figure 6.

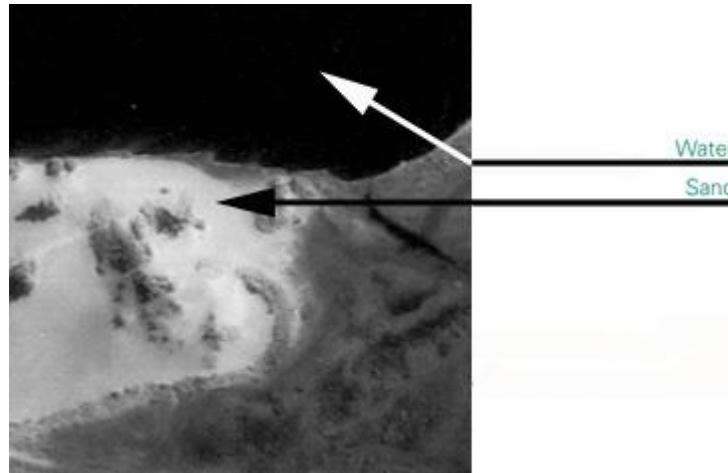


Fig. 6

(Source: www.nrcan.gc.ca)

4.5 Colour: When any object reflects light in a particular wavelength they are showing different shades of colour. For instance, naturally, vegetation appears green because they reflect a larger part of green light than the other colour like blue or red. Colour is an important tool for photo interpretation because, it is easier for humans to differentiate different colour than different shades of grey. So in coloured photograph greater amount of information can be extracted than the panchromatic photograph. False colour composition (FCC) developed during World War II is very useful for the study of conditions of plants, distribution of vegetation, drainage delineation and assessment of soil-moisture.

4.6 Texture: Texture is defined in terms of “smoothness” and “roughness”. The amount of change in photograph causes smoothness or roughness. Object, which has less variation, appears smooth and object, which has more variation, appears rough. Generally smoother surface has lighter tone in the photograph. Rough texture like tall grasses and shrubs are of dark tone. For example, features like grass, cemented features and water appear

smooth, while canopy covers of forest appear rough. Texture of forest appears rough and texture of calm water is smooth as shown in figure 7.



Fig. 7

(Source: www.nrcan.gc.ca)

4.7 Patterns: Pattern is an important clue for identification of features. Smallest and significant patterns can be captured with the help of aerial photograph. There can be some natural and some cultural pattern and some are resulted because of interaction of man and nature. Pattern is nothing but spatial arrangement of phenomena on the earth surface. This spatial arrangement is used in the identification of objects. For example, unmanaged area of trees have random pattern whereas orchard are evenly spaced arrangement of trees. Natural forest, plantation and open field can be identified in figure 8 on the basis of their pattern.

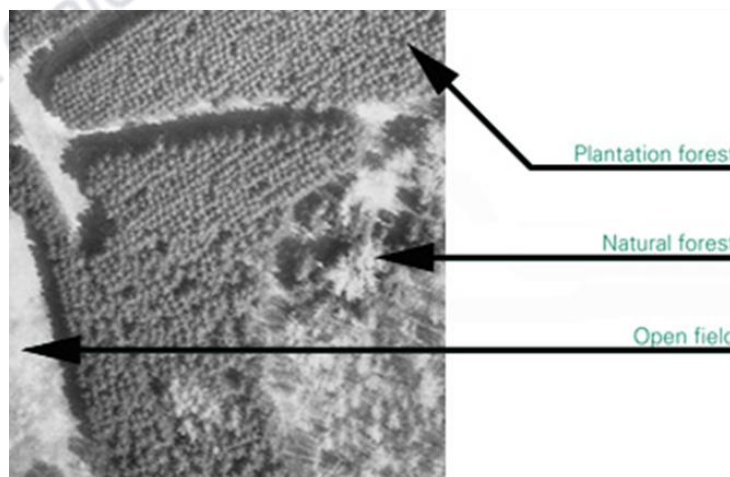


Fig. 8

(Source: www.nrcan.gc.ca)

4.8 Relationship/association: Some type of association always exists between some groups of objects. The background of an object can endow with handy information about the object. For example, in the setting of single-family housing it is not permissible to have a nuclear power plant. Green area in urban environment must be a park or a cemetery. Wetlands may be located next to rivers, lakes, or estuaries. Commercial centers will likely be situated along major roads, railroads, or waterways. In figure 9, one can easily identify railway track along the coast, dry dock and ship along the coast and the railway track and water harbour along the railway tracks and along the ship.

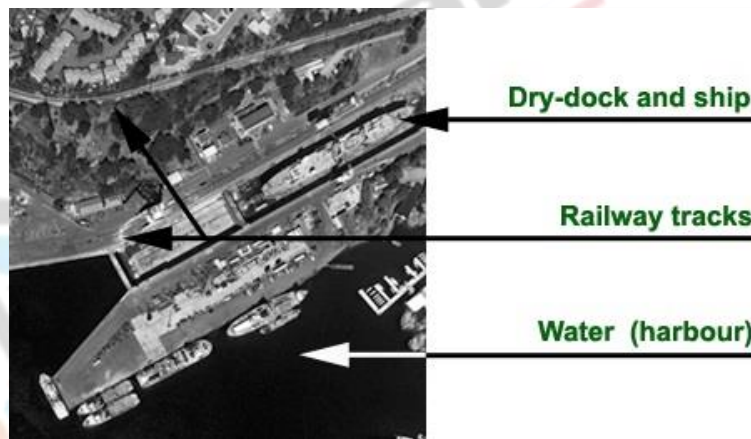


Fig. 9

(Source: www.nrcan.gc.ca)

4. Application of aerial photography

There are various application of aerial photography. They are as follows:

4.1 Disaster Risk Reduction & Prevention: Adverse impacts of the hazards and related disasters can be completely overcome with the help of aerial photograph. They also help in the formation of systematic efforts for the analysis and management of the factors responsible for the disasters. For example, in prevention of disasters like landslides, overflowing rivers during heavy rainfall periods, wildfires during heat waves periods an aerial photograph can help in constant visualization and updating the

current situation and accordingly preventive measures can be taken. Example: Deforestation is the main cause behind many landslides or avalanches. Therefore, phenomena like deforestation on hill slope and construction on risky zones can be visualized with the help of aerial photographs. So local administration and decision makers can regulate and stop further deforestation and construction.

4.2 Protection of the Natural Environment - Nature and Wildlife:

Conservation of natural environment is the burning issue and continuous records of situation and records of over time change are the greatest benefits provided by the utilization of aerial photographs in planning. It is some time also used in making awareness about some natural phenomena among local people. For example, periodical change in glaciers over the mountain can be seen with the help of aerial photograph taken over a period of time in the same season. For the management of wildlife sanctuary also it can be used.

4.3 Engineering & Urban Planning: For small-scale mapping in urban area and land use application planners, developers and engineers mostly used high-resolution aerial photographs. Combination of information collected from aerial photographs and GIS (Geographical Information System) analysis, planning and evaluation of ongoing plans and engineering becomes easier.



Fig. 10

http://www.rsgis.hu/images/stories/BG_6.jpg

For example, in cadastral mapping, aerial photographs are used and these maps are crucial and provide the base for various other mapping projects, which are necessary in planning of many public services. Besides this, it is also used in estimation of cost of construction and strategic planning.

4.4 Agriculture & Precision Agriculture: In agriculture, aerial Photographs facilitate more precise interventions and techniques. Management of farming based on the observation and response of intra-field variation is known as precision farming or precision agriculture. Quick, accurate and precise data related to each field in a continuous fashion is possible with the help of aerial photograph and information technology like GPS (Global Position System).

For instance top view of agriculture field provide information about real crop growth, crop affected by pests and can reduce the input cost involved in traditional method of agriculture. Nevertheless applying the right amount of inputs in right time and at right place give optimum result in crop production and also good for the quality of soil and helps in recharge of ground water, so consequently helps in whole crop cycle.

4.5 Journalism: Recently, in the practice of investigation and reporting of events use of aerial photograph has increased. They provide a geographical idea of a position. It can be used in the case of civil unrest. Utilization of aerial photograph may reduce the danger for journalists.

4.6 Surveillance and Monitoring System: Aerial photograph is also used to complement satellite image for verification in application like earth monitoring. Aerial photographs are also used in the surveillance of huge private property, frontiers and national boundaries and maritime boundary domains. Beside this, aerial photographs also used to update the information on regular basis in existing surveillance system.

4.7 Tourism: Private and government enterprises related to the tourism services used aerial photographs currently for making attractive

presentation and proposal strategies. Aerial photographs are also used by resorts, hotels, property owners, tour guides and travel agents to acquire and provide proper and full information to tourist about their desired location.

5. Summary

All visible features of the earth surface can be recorded in aerial photograph. However, it is hard to identify features in the aerial photograph by common man. An interpreter should have prior information and knowledge about elements of photo interpretation. Photo interpretation is nothing but a process of viewing, studying and collecting the knowledge and information about various natural and man-made features on the surface of the earth. Shape, size, tone, texture, shadow, pattern, colour and association are the important elements of photo interpretation. It can be an excellent data source for spatial data related to Earth's environment.

Frequently Asked Questions-

- Q1. Write the type of aerial photograph?
- Q2. What is fiducial point of aerial photograph?
- Q3. Write the advantage of aerial photographs over the ground based observation?
- Q4. What is the procedure of capturing the aerial photograph?
- Q5. What are the applications of aerial photograph?

Multiple-choice questions-

1. Horizon appears in which of the following aerial photographs
 - a. Vertical
 - b. Near-vertical
 - c. Low-oblique
 - d. High-oblique

2. Nadir and the principle points coincide in which of the following aerial photographs
 - a. Vertical
 - b. Near-vertical
 - c. Low-oblique
 - d. High-oblique

3. In aerial photographs which type of the following projections is used
 - a. Parallel
 - b. Orthogonal
 - c. Central
 - d. None of the above

Suggested Readings:

1. Ali, Syed Ahmad (1982), Photogeology and geomorphology of Parsoli–Bichor syncline, Chitrogarh District, Rajasthan, India. pp. 37–63.
2. Rampal, K. K. (1999), Handbook of Aerial Photography and Interpretation, Concept Publishing Company. ISBN: 8170225418.