LECTURE 6

USE AND INTERPRETATION OF AERIAL PHOTOGRAPHS – I

6.0 INTRODUCTION

As we have already discussed in Lecture 1 (section 1.4), aerial photographs are important in the interpretation of the geology of a given project area. Aerial photographs refer to photos taken from the air with a camera pointing vertically downwards at the time of exposure. These photographs provide a three dimensional overall view of the ground at almost any scale demanded by the user.

In this lecture, you will learn the important uses of aerial photographs. You will be introduced to the nature and characteristic features of aerial photographs. You will learn not only how to use stereoscopes – the equipment used to aid in the study of aerial photographs – but also how the tone and relief features of a photograph assist in the interpretation of the geology of a given terrain.

6.1 OBJECTIVES

Objectives

At the end of this lecture you should be able to:

(a). Outline uses of aerial photographs

(b). Describe important features of aerial photographs

(c). Describe the concept of stereoscopy and the optical system of mirror stereoscopes.

(d). Explain how the stereoscope can be used to interpret the geology of a given region using tone and relief variation features.

(e). Identify lineaments in aerial photograph

6.2 IMPORTANCE OF AERIAL PHOTOGRAPHS

Aerial photographs provide a three dimensional overall view of the ground at almost any scale demanded by the user. This property makes aerial photographs to be of great value for the following activities.

(i) Topographical mapping

(ii) Regional geological mapping

(iii) Regional soil mapping

(iv) Forestry Resources

(v) Land use studies

(vi) Military intelligence

(vii) Archaeology and civil engineering studies

Aerial photographs are taken from the air with a camera pointing vertically downwards at the time of exposure. Other types of aerial photographs include:

(i) high oblique

(ii) low oblique (both taken by a tilted camera).

6.3 NATURE OF AERIAL PHOTOGRAPHS

Aerial photographs are characterised by several features and these are illustrated in the diagram below (Fig. 6.1) and described in subsequent section.

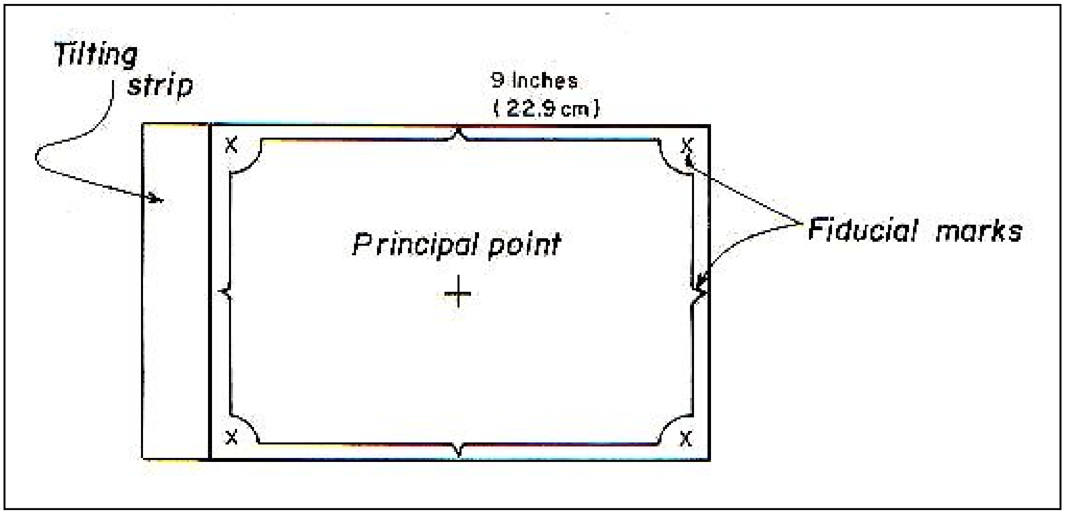

Fig. 6.1 Common features in aerial photographs.

6.3.1 Fiducial Marks

The fiducial marks, which are center points indicated on the corners or edges of the photographs (see Fig 6.1), are imprints of index marks that are rigidly connected with the camera lens. One of their purposes is to define the position of the principal point (Fig 6.1). If straight lines are drawn between opposite fiducial marks they intersect at the principal point. The fiducial marks can be of various designs. They are located either in the corners or along the edges of the photographs.

6.3.2 Principal Points

A principal point refers to the geometric center of the aerial photograph (Fig. 6.1). This is the foot of the perpendicular from the interior perspective centre to the plane of the photograph. It is often referred as the **center point**.

Each photograph should have recorded on it the following features:

(i) flight number and path number if any

(ii) flying height of plane

(iii) focal length of the camera lens

(iv) date of photography

(v) country represented

List importance features usually recorded in aerial photographs

6.3.3 Laps and Stereo-modal

Aerial photographs are taken to give an **over-lap** of often 60% (see Fig. 6.2), such that when the resulting two adjoining photos are inspected using a stereoscope, they give an apparently solid modal of the ground. The observed solid modal of the ground inspected is known as the **stereo modal**. An overlap of 60% is preferred for adjoining photos taken along the same flight line. In this overlap, every point on the ground is represented on at least 2 consecutive photographs.

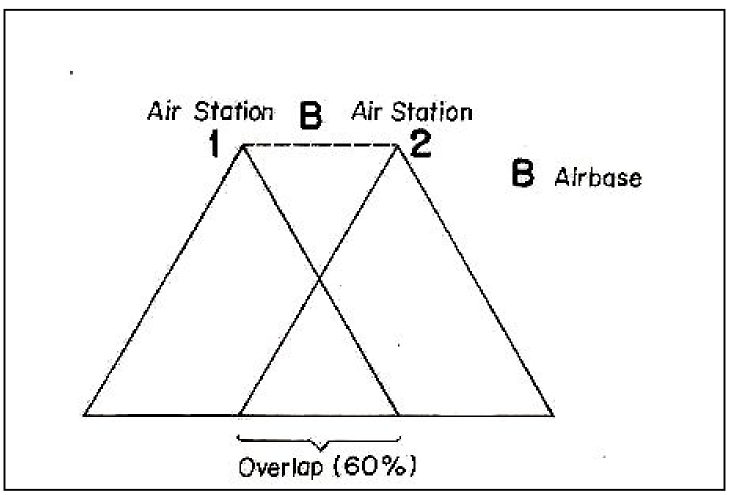

Fig. 6.2. Aerial photograph taken with an overlap of 60%.

In the diagram (Fig. 6.2), B – is the air base i.e. the distance between air stations. This controls the size of the overlap. On the other hand, a side-lap of about 30% is preferred (see Fig. 6.3) for photos taken along parallel flight lines when a large block of ground is photographed.

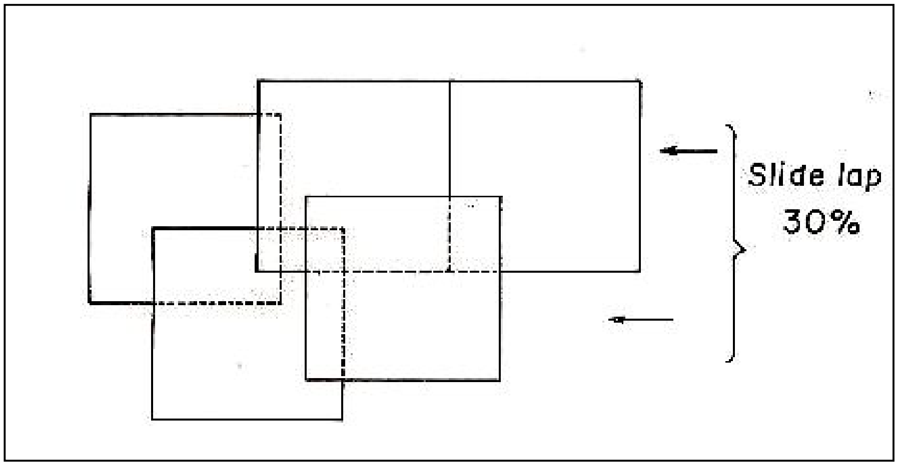

Fig. 6.3 Aerial photography taken with a side-lap of 30%.

6.3.4 Scales of Photographs

Although the many different users of aerial photographs do not require the same type of photography, the optimum scales for photo geological work is usually as follows:

(i) 1:20,000 - for detailed work

(ii) 1:40,000 - for regional work

(iii) 1:50,000 } for rapid reconnaissance work
(iv) 1:80,000 }

It is known that in very small scales (1:80,000 or smaller), not only are many structures overlooked, but also the notation of the prints becomes difficult. In large-scale prints (e.g., 1:10,000 or larger) photo geological interpretation can be very difficult.

6.4 STEREOSCOPY AND STEREOSCOPES

Stereoscopy is a three dimensional perception obtained with the aid of a stereoscope equipment. The act of perception is a mental process: the mind invents a modal to fit the data that it has been provided. This is what happens in stereoscopy. A three-dimensional interpretation of the area covered by aerial photographs is perceived with the help of stereoscopes. In order to get a stereoscopic vision of a certain area, most geologists use either:

(i) Pocket stereoscopes (Fig. 6.4) or

(ii) A mirror stereoscope (Fig. 6.5) – normally kept in the office.

Pocket stereoscope

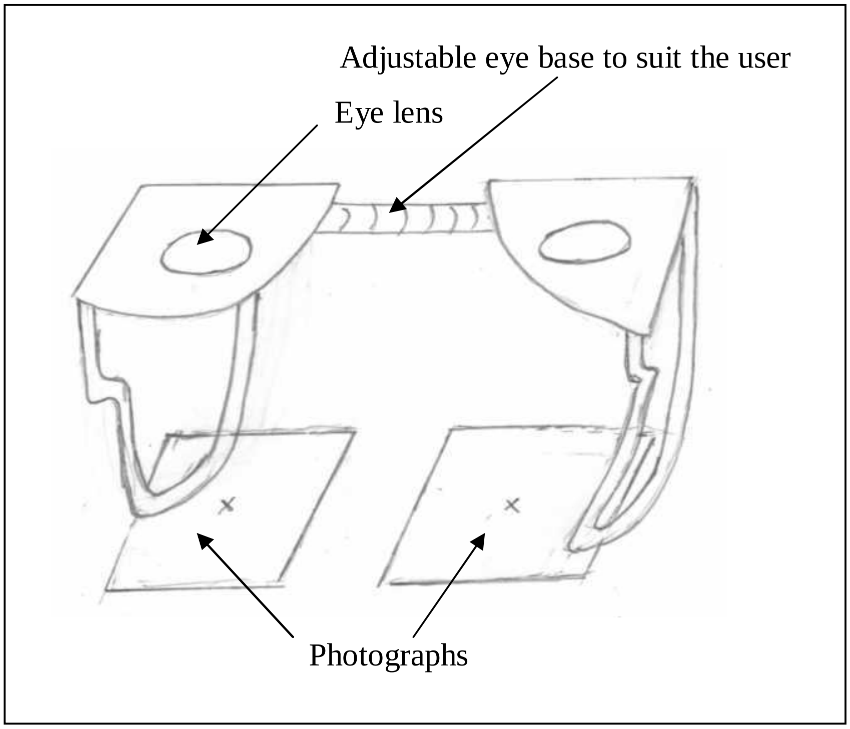

Fig. 6.4 -Simple sketch of pocket stereoscopes – 2 lenses

A pocket stereoscope (Fig. 6.4) consists of two eye lenses with an adjustable eye base to suit the user, and two metallic stands.

Mirror Stereoscope

The optical system for mirror stereoscopes is illustrated in Fig. 6.5. In the large mirror stereoscopes, light rays from photographs are reflected first by large surface silvered mirrors set at 45^o to the horizontal and again by small surface silvered mirrors set parallel to the large ones. After reflection by the small mirrors, the rays are parallel again to their original direction (i.e., were vertical) and are separated by a distance determined by the separation of the small mirrors. The separation of the photographs is either adjustable or preset to approximate the eye base of the average observer. From the optical system described above, it can also be noted that the separation of the photographs when they are set for stereoscopic viewing is determined by the separation of the large mirrors.

Mirror Stereoscope

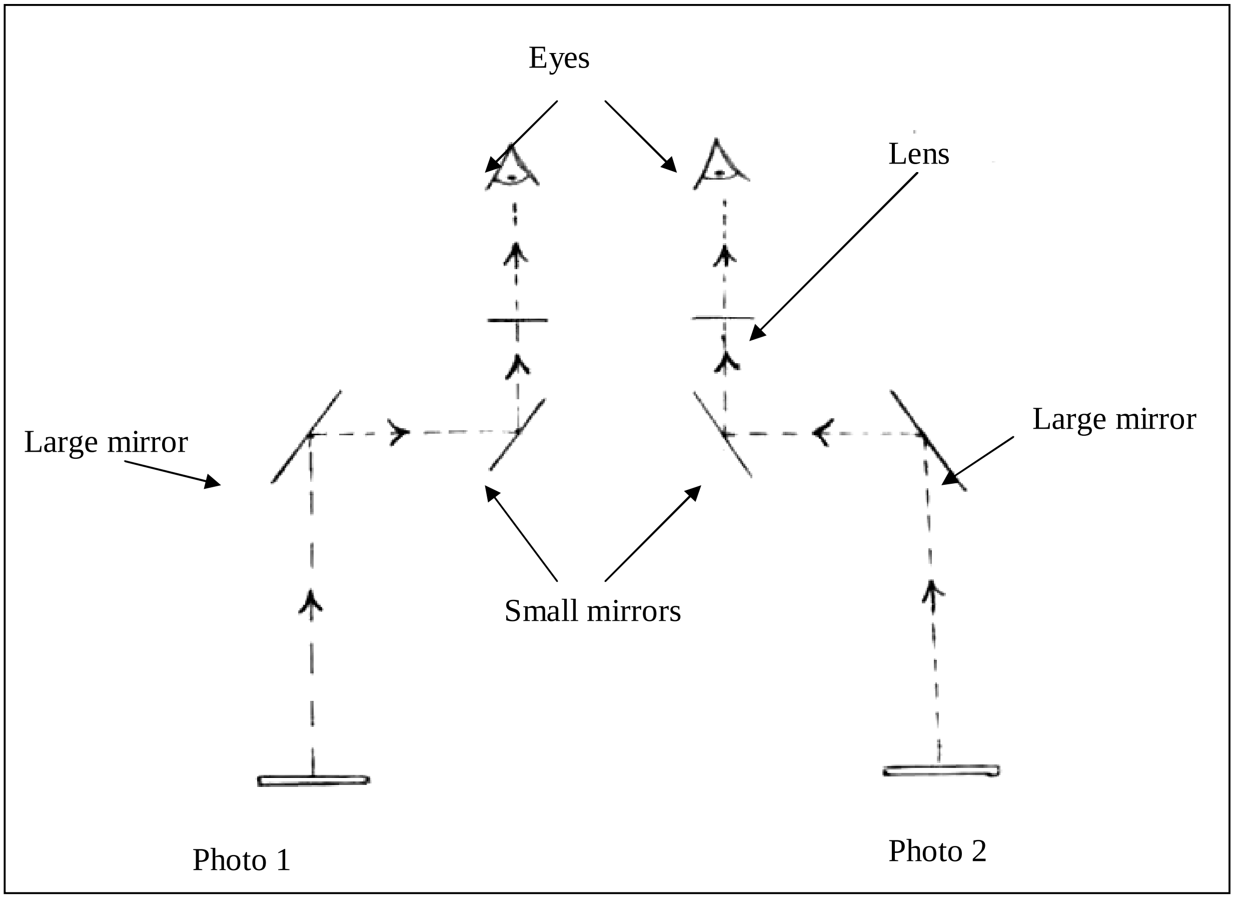

Fig. 6.5 –A sketch diagram showing the optical system of mirror stereoscopes

6.5 GENERAL INTERPRETATION OF GEOLOGY USING STEREOSCOPES

The information on a single black and white photograph is recorded largely by variations on **tone**. Another interpretive criterion besides tone is the **relief** of the stereo model. Hence, many data can be represented to the viewer by a combination of **relief and tonal variations** than any of these criteria separately. Tone and relief factors will be explained in the following section.

Field- and photo-geological mapping differ in the sense that the latter has two stages of interpretation whereas the former has only one. This is because the photo-geologist first has to interpret in the aerial photographs the under-mentioned geological data before going to the actual field area. This interpretation involves the following features:

(i) Land forms

(ii) Man-made lines

(iii) Structurally controlled lines

(iv) Vegetation

(v) Rock outcrop boundaries

(vi) Rock outcrop texture etc.

After the photo-geologist has interpreted the above features, he then relates them to geological structures and lithology observed in the given project area. A field mapper on the other hand (one who deduces data directly in the field) only sees landforms and outcrops directly. Thus he has only one stage of interpretation.

6.6 RELIEF AND TONE

Relief on a stereo modal indicates ***relative resistance of rocks to erosion*** for example a peridotite dyke intruding different rock units may portray a ***negative relief*** feature in one rock unit but a ***positive*** feature in another unit. In addition more resistance rock units may form ridges or hills (positive relief) and the more easily erodable ones may form sections of negative relief (see Fig. 6.6).

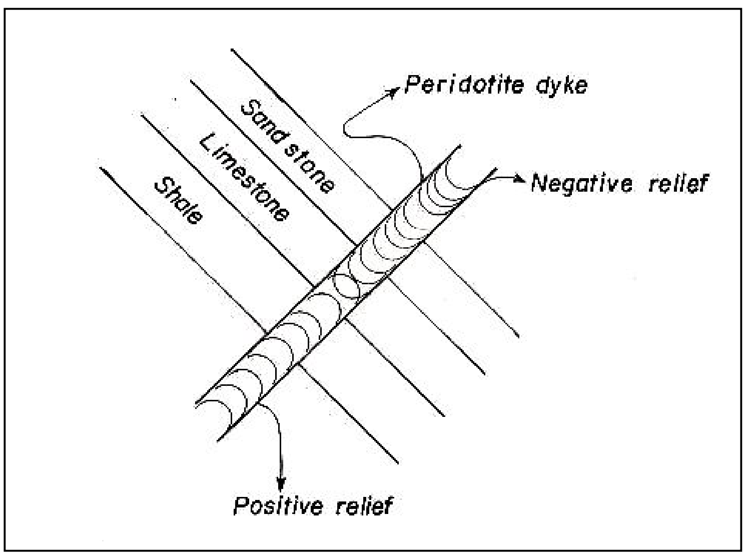

Fig. 6.6. Positive and Negative relief features.

Tone is the quality of the photograph in terms of brightness, darkness etc. On any particular print, the relative tonal values of features are important in photo-geological interpretation.

ACTIVITY

Using a suitable illustration, distinguish "relief" and "tone" as used in aerial photography.

The tone in a photograph can be affected by:

- Nature of the rock photographed
- Light conditions
- Characteristics of the film
- Influences of filters, and
- Effects of processing

However, the following are important features to note about the tone of geological interpretations:

(i) The tone of the photograph image of an intrusion is related to its composition. The more basic intrusions produce the darker tones.

(ii) Among the bedded rocks, chalk, limestone, sandstones, and quartz–schist tend to photograph in a light tone. The other types of rocks of intermediate mineral composition may photograph as follows:

- mudstones
- shales
- slates
- micaceous – schists

} photograph in intermediate tones

While rocks of basic (mafic) mineral compositions e.g., amphibolites and gabbros usually photograph in dark tones.

List factors that can affect the photographic tone of geological materials.

The photographic appearance of rocks is affected by the following factors:

(i) Climate
(ii) Vegetation cover
(iii) Soil cover
(iv) Absolute rate of erosion
(v) Relative rate of erosion of the rocks compared with that of the surrounding country rock
(vi) Colour and reflectivity
(vii) Its composition
(viii) Physical characteristics
(ix) Depth of erosion
(x) Structure
(xi) Texture
(xii) Factor inherent in types of photography and the conditions under which the photograph was obtained.

6.7 LINEAMENT

A lineament is any line on an aerial photograph that is structurally controlled and for photo geologic purposes includes any alignment of separate images such as: stream beds; trees and vegetation such as bushes. The term can also be applied to beds, lithological horizons, mineral banding, veins, faults, unconformities, joints and weak boundaries. However, man-made and human activity features such as:

railways;
roads ;
paths;
animal tracks and
field boundaries

are not included in the term lineament

ACTIVITY

(a). Study relevant aerial photographs and make repeated comparisons of the stereo models with the ground observations.

(b). Compare good quality geological maps of other areas with relevant aerial photographs.

6.8 Summary

SUMMARY

In this lecture we noted that aerial photographs provide a three dimensional overall view of the ground, and that this property makes them to be of great value for topographical mapping, regional geological mapping, regional soil mapping, forestry resources, land use studies, military intelligence, and archaeology and civil engineering studies among others. Among the important features recorded in aerial photographs include the flight and path number, flying height of the plane, focal length of the camera lens, date of photography, and the country represented.

We also noted that aerial photographs are taken to give an ***over-lap or side lap*** of 60% and 30% respectively. Such overlaps ensures that when two adjoining photos are inspected using a stereoscope, they give an apparently solid modal of the ground. A stereoscope assists in obtaining a three-dimensional interpretation of the area covered by aerial photographs.

The information on a single black and white photograph is recorded largely by a combination of ***relief*** and ***tona***l variations. ***Relief*** on a stereo modal indicates relative resistance of rocks to erosion. On the other hand, we noted that ***tone*** is the quality of the photograph in terms of brightness and darkness. The tone of the photograph image of a geologic intrusion is related to its composition. The more basic (or mafic) intrusions produce the darker tones and the more acidic rock types (or felsic) such as chalk, limestone, sandstones, and quartz–schist tend to photograph in a light tone.

Finally we learned that a lineament is any line on an aerial photograph that is structurally controlled and for photo geologic purposes includes any alignment of separate images such as: stream beds, trees and vegetation. The term can also be applied to beds, lithological horizons, mineral banding, veins, faults, unconformities, joints and weak boundaries. However, it was made clear that man-made and human activity features such as railways; roads, paths, animal tracks and field boundaries are not included in the term lineament.

6.9 References

REFERENCES

Montgomery, C.W. 1989. Environmental Geology. 2nd Edition. Wm. C. Brown Publishers, Dubuque, Iowa. 476pp.