Chapter 8*

AERIAL PHOTO INTERPRETATION

8.1 INTRODUCTION

Aerial photographs provide an overview of both the regional conditions and local site features. Since aerial photographs are generally available for most parts of the world, the aerial photo interpretation may provide very useful information at virtually no cost. Examination of stereopairs under a stereoscope enables the interpretation of geological and geomorphological features. Geological information such as recognition of rock types and their distribution, as well as bedding, jointing, and fault zones, may supplement the study of regional conditions with particular reference to the feasibility of the engineering structures. The study of landforms provides information on the geological history of the area. Even where the ground surface is obscured by dense vegetation, the nature of cover may reflect the the nature of the underlying rocks and landslide activity. If aerial photographs are available for an area over a period of time, it may help in identifying the extent of recent mass wasting processes. The inferences obtained from the aerial photograph are often checked at important locations by field investigations.

8.2 ELEMENTS OF AERIAL PHOTO INTERPRETATION

The important elements of aerial photo interpretation are i) topography, ii) drainage, iii) gray tone, iv) erosion, v) vegetation, and vi) miscellaneous features resulting from man-made activities on the landscape (Keser 1979). All these patterns are not always well expressed on a given photograph as the expression varies with the nature of the photograph and its scale.

8.2.1 *Topography*

The study of topographic characteristics, such as relief, size, and surface configurations, helps to identify the landforms. The boundary characteristics are observed in the plan view in order to assess the nature of the landforms. These landform characteristics may be:

- **terraced,** e.g., fluvial, glaciofluvial, and marine terraces
- **ridged,** e.g., lateral moraines,
- **lobate,** e.g, mass movements, especially flows and spreads,
- **conical,** e.g., fans and talus cones, and
- **linear,** e.g., streams.

8.2.2 *Drainage*

Drainage patterns refer to the spatial arrangement of stream channels and show a close relationship to lithology, structure, and the geological history of the area. The basic drainage patterns (Fig. 8.1) are:

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* Figures and Tables without credit lines in this Chapter are compiled by the author.

- **dendritic** - a drainage pattern having a branch-like form with an acute angle between tributaries and mainstreams - inference: homogeneous crystalline or flat-layered sedimentary rock; homogeneous soil texture;

- **rectangular** - a drainage pattern having a right-angled system of streams with abrupt bends - inference: intersecting joints and faults;

- **parallel** - a drainage pattern in which the streams and tributaries are nearly parallel - inference: tilted rocks with parallel faults and joints; lava flows; alluvial aprons.

- **trellis** - a drainage pattern having short parallel tributaries joining the long streams flowing parallel for the most part to the regional strike - inference: parallel folds in strata of varying resistances; parallel faults;

- **radial** - a drainage pattern having streams radiating from a central area like spokes on a wheel - inference: dome-shaped intrusions; and

- **annular** - a drainage pattern having ring-like tributaries - inference: volcanic craters; rocks of different erosional resistance in a domed structure.

8.2.3 *Gray Tone*

Gray tone is basically the result of reflected light from terrains of soil and vegetation cover and varies between absolute black and absolute white. Gray tone is considered in contexts of the following elements:

- **tone variation** is due to inherent colour differences of various units, e.g., gabbro and basalt-black colour, granite and sandstone -light black; sand and gravels-white to light gray;

- **tone uniformity** indicates the nature of distribution of the material both laterally and vertically;

  e.g., uniform - coarse, well-drained material such as coarse alluvium and fans,
  mottled - due to changes in soil texture and moisture,
  banded - sedimentary rocks consisting of dark and light strata, e.g., alternating shale-sandstone beds; and

- **boundary sharpness** is identified by the nature of variation of the tones;
  e.g., sharp - abrupt change of contrasting rock types,
  gradual - textural changes of clayey materials.

8.2.4. *Erosion*

Erosional features are produced as a result of the interaction of erosional agents and the nature of the geologic materials. Some of the well-known erosional features are gullies and landslides. Figures 8.2, 8.3, 8.4, and 8.5 show the resultant slope geometrics when resistant and non-resistant beds of the hill slopes are subjected to surface erosion.

8.2.5 *Vegetation*

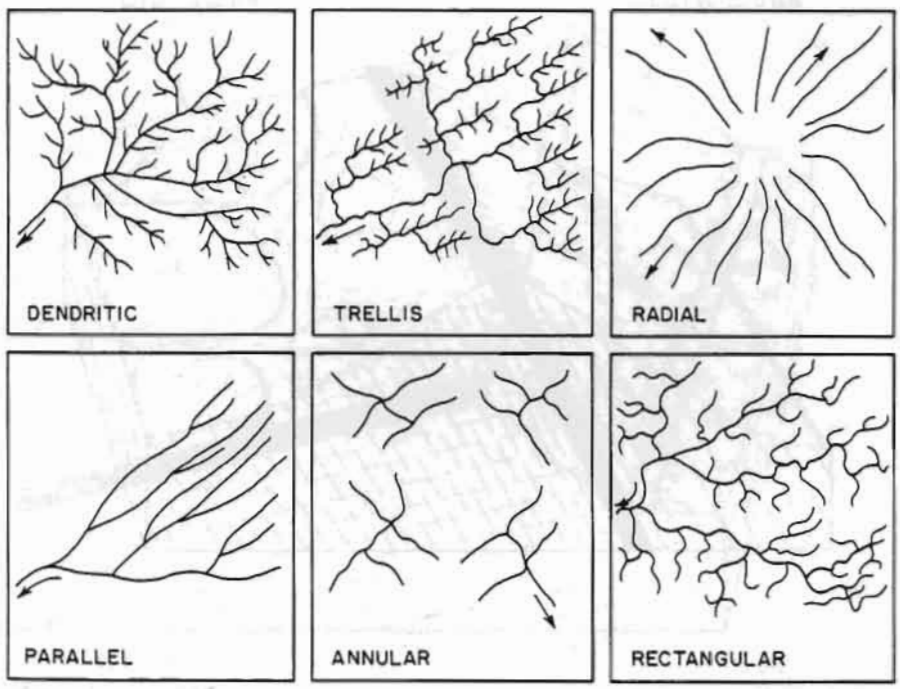
Proper identification and evaluation of vegetation require a good knowledge of the vegetation patterns of the area as well as the regional geological setting. The distribution of vegetation is affected by soil, slope, and relief. Identification of vegetation pattern involves the evaluation of elements such as tone, texture, shape, and size. The general factors affecting tone have already been discussed under 'Gray Tone'. Texture is the orderly arrangement of tone patterns. The shape and size of the species are often important although they may vary with age.

8.2.6 *Miscellaneous Features*

In both forested and non-forested areas man-made features may reflect characteristic changes in the landscape. Some features, such as dams, channels, roads, and industrial developments, can be easily identified on the photographs.

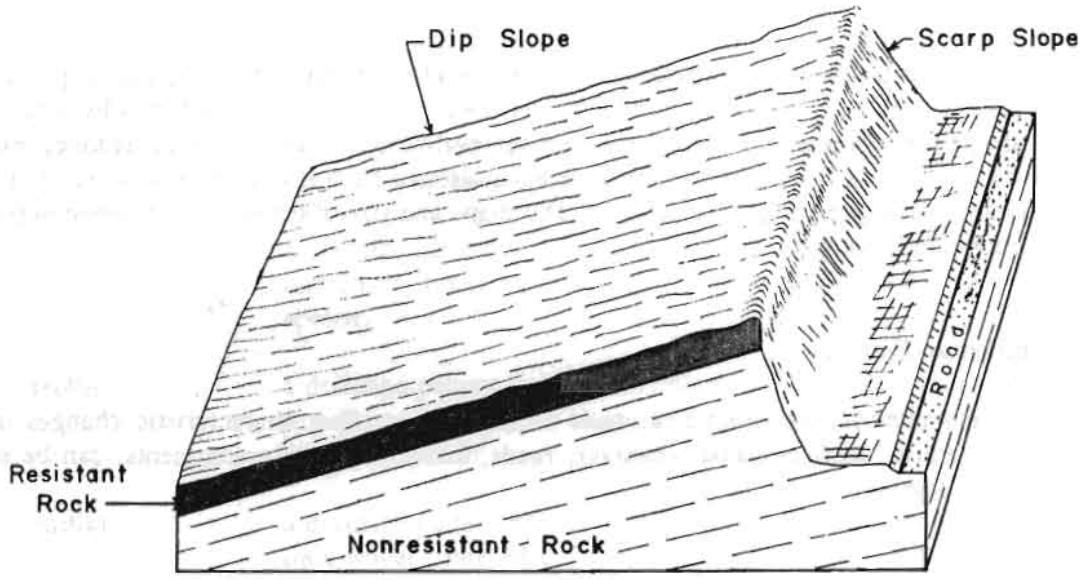
8.3. INTERPRETATION OF ROCK TYPES

The interpretation of rock types involves a careful evaluation of the various identifiable elements of photointerpretation described above. In areas where the overlying surficial material is deep or the surface covered with dense forest, the interpretation may be difficult. Tables 8.1, 8.2, and 8.3 provide the nature of photo features generally associated with igneous, metamorphic, and sedimentary rocks.



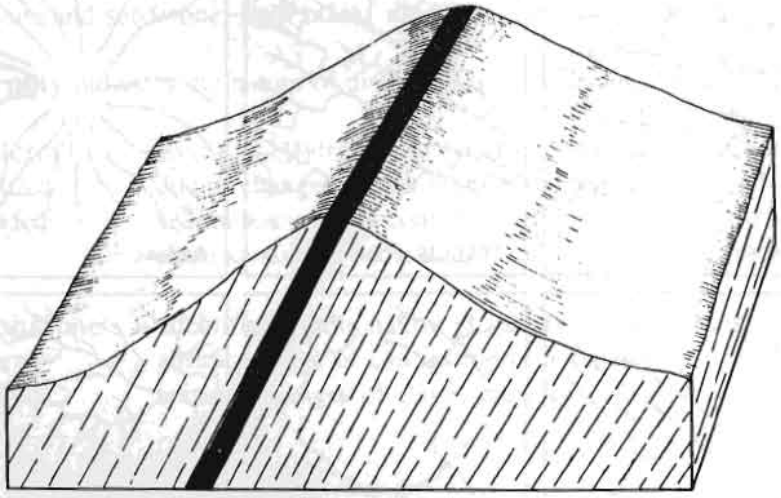
Source: Keser 1976

Fig. 8.1 Basic drainage patterns



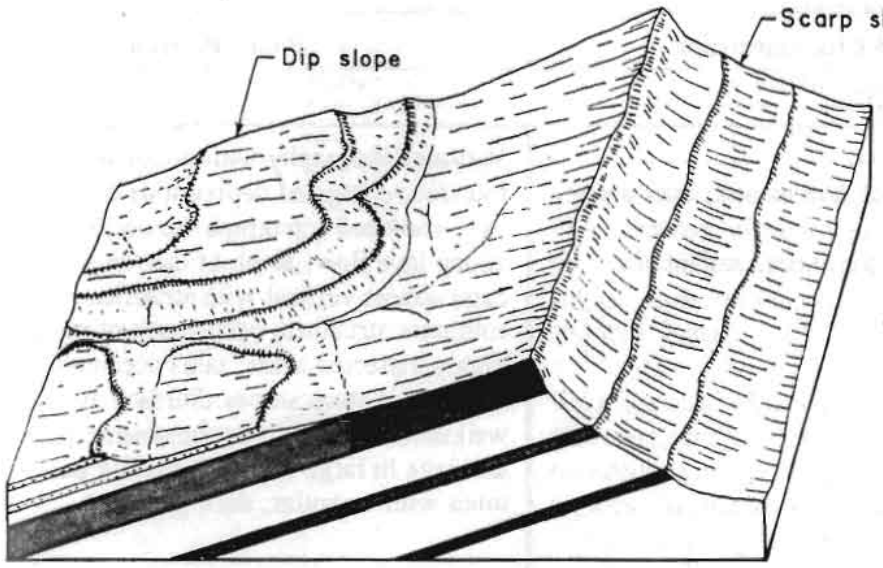
Source: Modified from Miller 1962

Fig. 8.2 Dip slope and scarp slope represented by resistant rock on top non-resistant rock



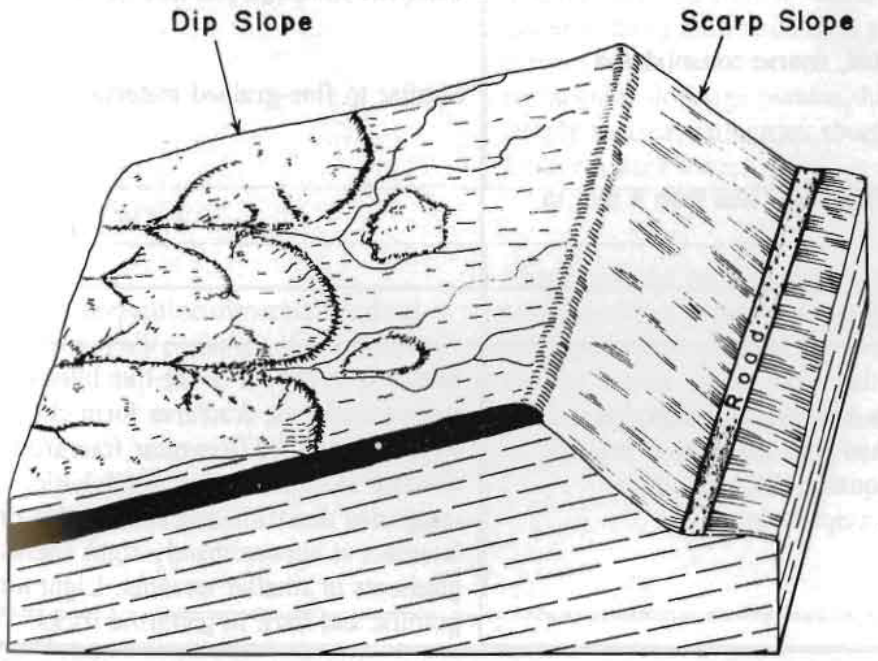
Source: Modified from Miller 1962

Fig. 8.3 Steeply dipping resistant and non-resistant beds without distinct dip slopes and scarp slope



Source: Modified from Miller 1962

Fig. 8.4 Interbedding of resistant and non-resistant strata with dip and scarp slopes



Source: Modified from Miller 1962

Fig. 8.5 Dip slope drainage pattern in soft rock on top of hard rock

Table 8.1. Identification of igneous rocks

Type and Characteristics	Photo Pattern
EXTRUSIVE ROCKS:	
Lava and related rocks: very fine-grained (grains seen only under microscope) major minerals: quartz, feldspar, mica, pyroxene, amphibole	Varying topography with minor irregularities; rounded, elongated depressions common; rope-like, scalloped topography towards terminus of young lava flow; slope of canyon walls (river cuts) almost vertical with stratification and columnar structure; occurrence of mesas in highly dissected areas; talus accumulation at the base of steep slopes. Surface drainage not well developed and may be absent; parallel drainage in large areas. Generally dull, dark tones with irregular, dark patches.
	Lack of drainage - white tone.
Ash: uncemented, fine pyroclastic fragments	Rough dissected topography - uniform, dense, dendritic drainage pattern; variable tone.
Breccia: highly angular, coarse consolidated fragments	Similar to fine-grained material.
Tuff: compacted fragments less than 4 mm in diameter	
INTRUSIVE ROCKS:	
Plutonic rocks: medium to coarse-grained (grains distinguished with naked eye) major minerals: quartz, feldspar, mica, pyroxene, amphibole	Massive, rounded, dome-like hills with fairly steep sideslopes; fractures form choppysurface with minor relief (irregular fracture patterns); absence of stratification and foliation. Well-integrated dendritic and rectangular lines intersect at approximately right angles; high gradients in smaller streams. Light tones in granitic and dark in gabbroic rocks.

Source: Keser 1976

Table 8.2 Identification of metamorphic rocks

Type and Characteristics	Photo Pattern
FOLIATED ROCKS:	
Gneissic: coarse-grained alternating bands of granular and micaceous minerals	Sub-parallel, steep-sided, sharp-crested ridges. Fine-textured, angular dendritic drainage pattern; tributaries join main trunk at near right angles. Uniform light tones or alternating light and dark bands.
Schistose: medium to coarse-grained micaceous minerals dominant	Well dissected topography; humid regions - moderate relief, ridges are usually smooth and rounded; in arid, subarctic and glaciated regions - scattered, irregular banding (foliation). Long, steep, closely- spaced, sub-parallel gullies and ravines common; contorted drainage pattern in some areas. Contour farming and terracing common. Uniform light or banded tones.
Slate: fine-grained; well-developed fissility	Uniform size, comparatively small, randomly distributed hills; similar lateral and height dimensions to numerous hills produces a distinctive airphoto pattern. Fine-textured rectangular drainage pattern -highly developed; deeply incised; numerous short, steep gullies. Uniform dark tones.
NON-FOLIATED ROCKS:	
Serpentinite: contains serpentine minerals; derived from previous existing olivine and pyroxene	Sharp contrast with bordering rock types; sinuous ridges connect conically-shaped hills; scalloped ridge outlines; smoothly, rounded convex slopes. Short steep gullies. Light tone ('creamy') often has soft mohair-like sheen.

Source: Keser 1976

Table. 8.3 Identification of sedimentary rocks

Type and Characteristics	Photo Pattern
MASSIVE ROCKS	
Limestone: fine to medium-textured, cemented dominant mineral - calcite	Commonly hummocky surface expression in glaciated terrain; karst topography may not have developed; few valleys - steep, nearly vertical sides with flat floor. Few streams with many short, steep tributaries; sinkhole depressions, often ponds or swamps with swallowhole drainage pattern. Humid regions -vegetated except in sinkholes. Arid regions - vegetated in sinkhole depressions. Light gray tone overall, broken by tone changes in sinks; erosion scars appear as short, light streaks on hillsides.
THIN BEDDED ROCKS:	
Shale: indurated and consolidated clays and silts; impervious, fine-textured classified for the impurity that is dominant (argillaceous, siliceous)	Humid regions - rounded hills. Arid regions - rough topography with steep to vertical sideslopes on hills. Well developed, fine, dendritic drainage pattern. Humid regions - mottled light and dark tones. Arid regions - uniform light tone (with banding in the rock).
INTERBEDDED ROCKS:	
Flat-lying: alternating layers with differing resistances to erosion Tilted: alternating layers with differing resistances to erosion	Faint (thin beds) to well-defined, stepped (structural benches and terraces) contour breaks on sideslopes; hilltops are at same general elevation. Dendritic drainage pattern; may be rectangular if cap rock is jointed; more intense drainage with many gullies - thicker beds; less intense drainage with few gullies - thinner beds. Banding along contours, with more distinctive banding in thicker beds. Alternating light and dark bands. Series of straight, nearly parallel ridges (escarpments), forms include cuestas and hogbacks. Definite trellis drainage pattern. Parallel light and dark bands.
THICK BEDDED TO MASSIVE ROCKS:	
Flat-lying (sandstone): fine to coarse-grained principal constituents: quartz, feldspar, rock fragments, silt and clay cemented together; classified according to cementing agent (calcareous, ferruginous, siliceous)	Arid regions - rugged topography with deep valleys, isolated hills with banding evident. Humid regions - rolling to hilly topography with bold massive hills and steep slopes. Widely-spaced rectangular pattern - few gullies. Arid regions - short, dark, straight lines indicate joint pattern. Humid regions - light tone.
Tilted: as in THIN BEDDED	AS IN THIN BEDDED.

Source: Keser 1976