Chapter 4: "Principles of Visual Landform Identification & Evaluation" Part 1 out of 4

Introduction:

The principle terrain characteristics that can be estimated by means of visual image interpretation are:

1. Bedrock type,
2. Landform,
3. Soil texture,
4. Site drainage conditions,
5. Susceptibility of flooding, &
6. Depth of unconsolidated material over bedrock.

Other characteristics, such as slope of the land surface, can also be estimated, but they might require stereo image viewing.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Soil Characteristics:

- Soil consists of combination of solid particles (gravel, sand, silt, & clay), water, & air.
- Soil could be residual soils, transported soils, organic soil, or a combination of them.
- Soils have characteristics drainage conditions that depends on; surface runoff, soil permeability & internal soil drainage conditions.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Land Use Suitability Evaluation:

Four factors that can affect the land use suitability for urban & suburban uses:

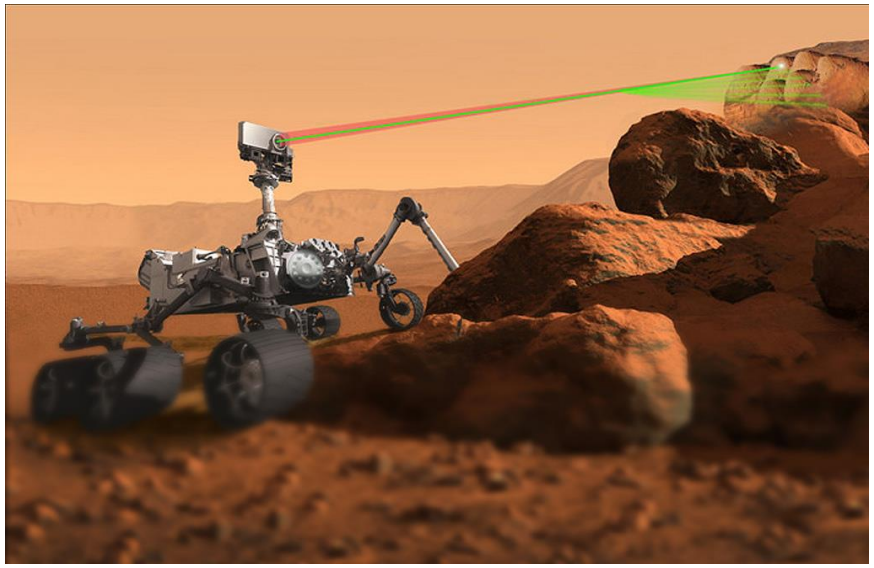
- *Topographic characteristics of an area,*
- *Soil texture & drainage conditions,*
- *Depth to bedrock, &*
- *Slope stability.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Elements of Image Interpretation for Landform Identification & Evaluation:

Image interpretation is based on a systematic observation & evaluation of 5-key elements that are studies stereoscopically:

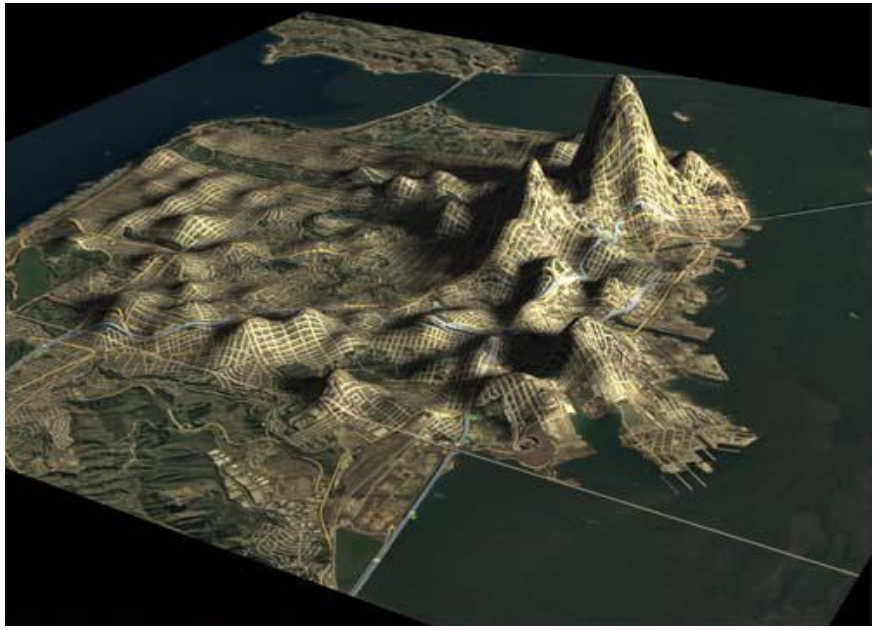
- *Topography,*
- *Drainage pattern & texture,*
- *Erosion,*
- *Image tone &*
- *Vegetation & land use.*



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

***Elements of Image Interpretation for Landform Identification & Evaluation:* (continue)**

Topography; each landform & bedrock type has its own characteristic topographic form that has typical size & shape.



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Elements of Image Interpretation for Landform Identification & Evaluation: (continue)

Drainage pattern & texture; there are six common drainage patterns:

- Dendritic drainage pattern,
- Rectangular drainage pattern,
- Trellis drainage pattern,
- Radial drainage pattern,
- Centripetal drainage pattern, &
- Deranged drainage pattern.

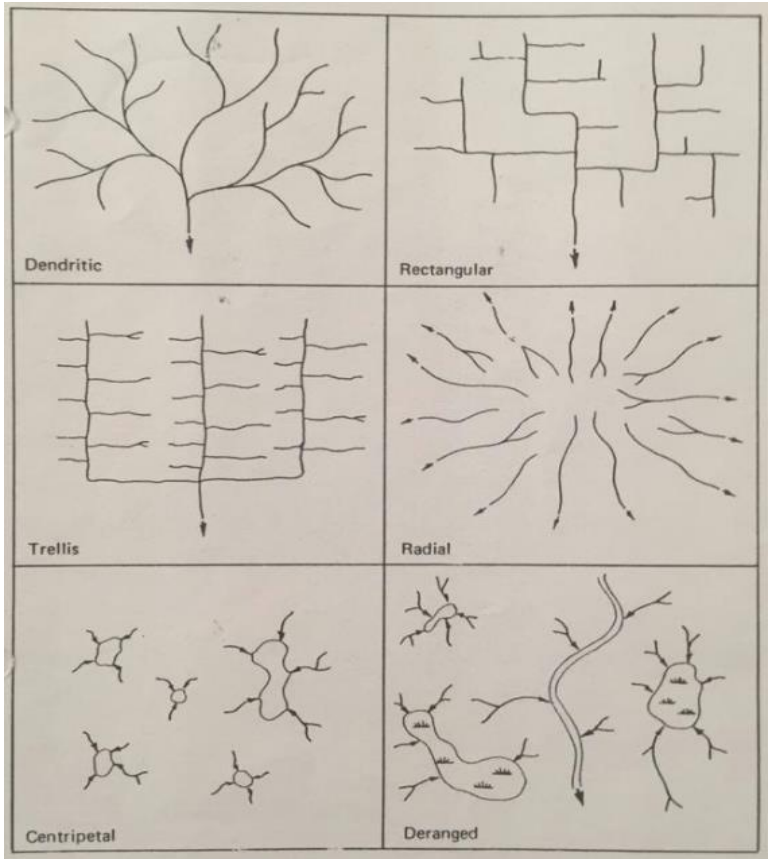


FIGURE 4.2 Six basic drainage patterns.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Elements of Image Interpretation for Landform Identification & Evaluation: (continue)

Drainage pattern & texture;

Similarly, there are two drainage textures:

- Course-textured drainage pattern, developed at hard massive rocks.
- Fine-textured patterns, occurs at soft easily eroded rocks.

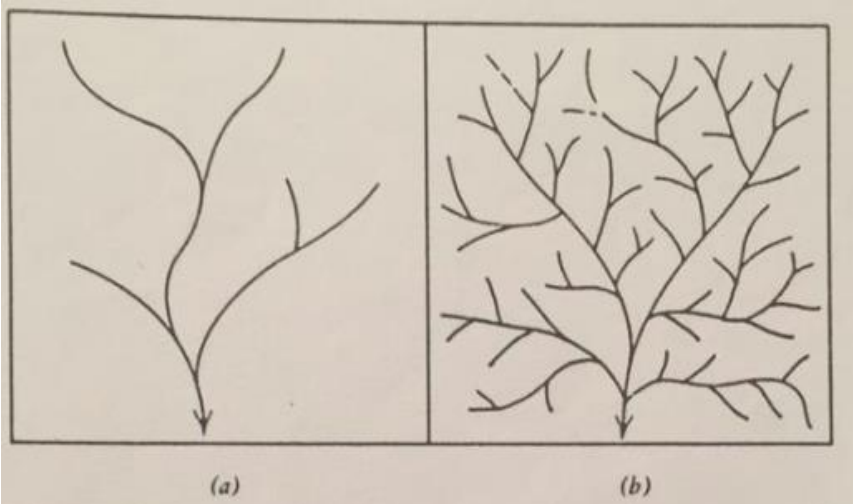


FIGURE 4.3 Illustrative drainage patterns. *(a)* Coarse-textured dendritic pattern. *(b)* Fine-textured dendritic pattern.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Elements of Image Interpretation for Landform Identification & Evaluation: (continue)

Erosion; result from the erosion of unconsolidated materials by runoff, gullies are the smallest drainage features that can be seen on aerial photographs.

Three common gullies shapes:

- *Short V-shape cross-sectioned gullies tend to develop in sand & gravel,*
- *U-shape cross-sectioned gullies tend to develop in a silty soils,*
- *long-gullies with gently rounded cross-sectioned tend to develop in silty & clay soils.*

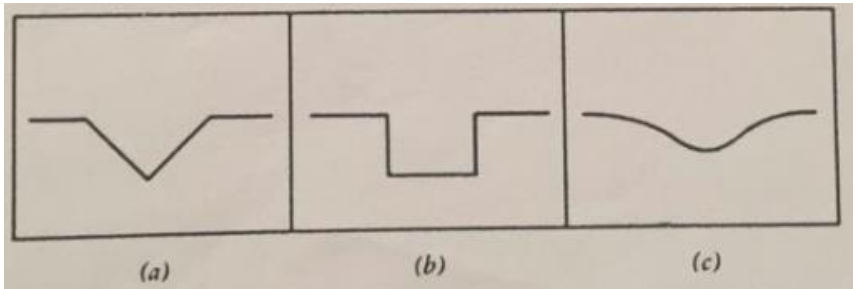


FIGURE 4.4 Illustrative gully cross sections. (a) Sand and gravel.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Elements of Image Interpretation for Landform Identification & Evaluation: (continue)

Image Tone; refers to the relative brightness or color of objects in an image.

Vegetation & land use; differences in vegetation often indicate differences in terrain conditions.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Elements of Image Interpretation for Landform Identification & Evaluation: (continue)

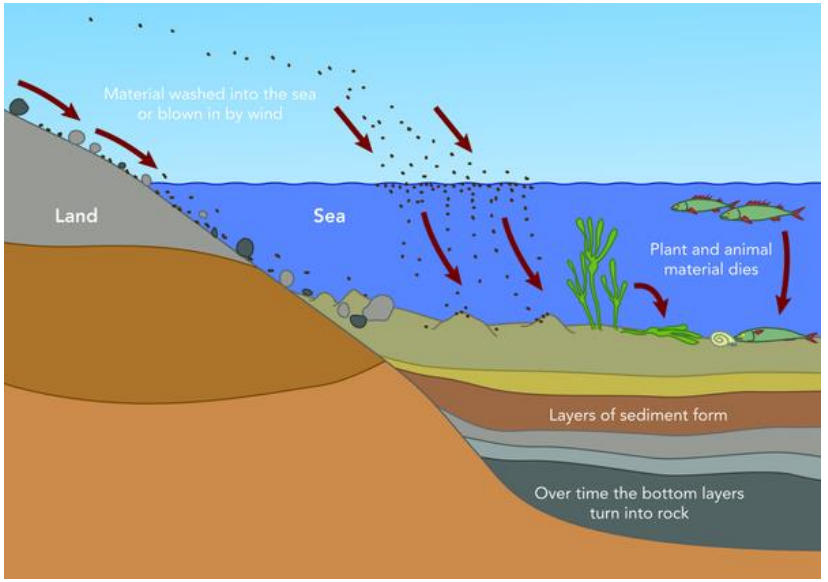
Final Note;

One should take in consideration is that areas that resave 50 cm or more rainfall per year will be considered as humid climates. In the contrary areas that resave less than that will be considered as arid climate.

Chapter 4: "Principles of Visual Landform Identification & Evaluation" Part 2 out of 4

Sedimentary Rocks:

- *Formed by the consolidation of layers of sediments that have settled out of water or air.*
- *Extend over approximately 75% of the earth surface.*



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

***Sedimentary Rocks:* (continue)**

Principal sedimentary rock characteristics are;

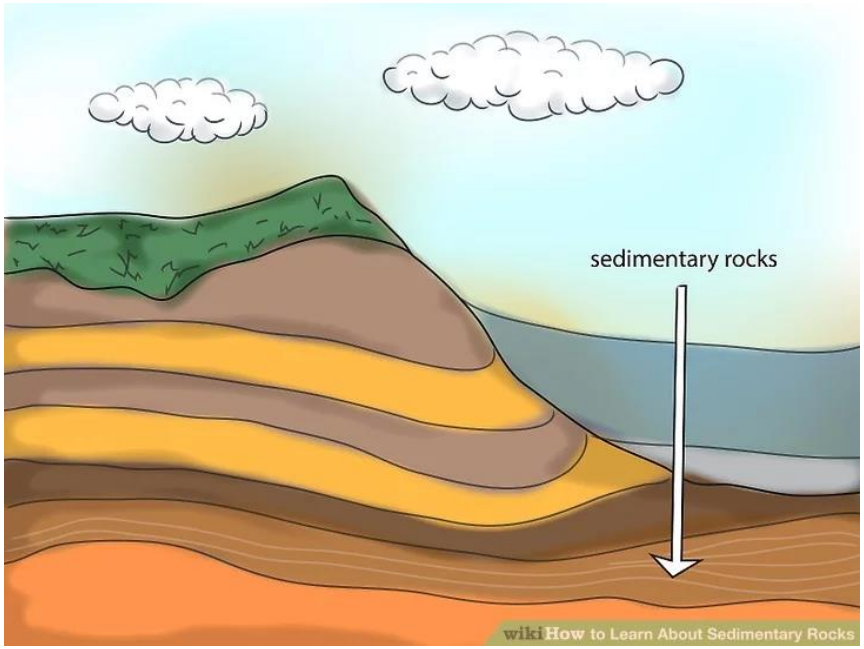
- *Bedding, ranging in thickness from a few millimeters to many meters,*
- *Jointing, primarily perpendicular to bedding plans, &*
- *Resistance to erosion.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: *(continue)*

Principal sedimentary rock types are;

- *Sandstone,*
- *Shale, &*
- *Limestone.*



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: (continue)

Sandstone:

- Commonly occur in beds a few meters thick interbedded with shale &/or limestone,
- Prominent on images,
- Jointing is prominent, with jointing system of 2 or 3 dominant directions, &
- Commonly undeveloped because of a combination of their typically rugged topography & shallow depths to bedrocks.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

***Sedimentary Rocks:* (continue)**

Image Identification of Horizontally Bedded *Sandstone*

(1) **Topography:** Bold, massive, relatively flat-topped hills with nearly vertical or very steep hillsides.

(2) **Drainage:** Corse-textured, joint controlled, modified dendritic pattern.

(3) **Erosion:** Few gullies, V-shaped in residual soil.

(4) **Image tone:** generally light toned due to excellent internal drainage.

(5) **Vegetation & Land Use:** Sparse vegetation in arid areas. Commonly forested in humid areas.

(6) **Other:** Sandstone is sometimes mistakenly identified as granite.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: (continue)

Shale:

- Bedding is typically 1 to 20 cm in thickness,
- Bedding is not always visible on aerial & space images,
- The affect of jointing is not always strong enough to alter the surface,
- Resistance to erosion is low, &
- water drainage & depth to bedrock conditions may limit residential development.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

***Sedimentary Rocks:* (continue)**

Image Identification of Horizontally Bedded *Shale*

(1) **Topography:** Minutely dissected terrain with steep side slopes resulting from rapid surface runoff in arid climates. Gently to moderately sloping softly rounded hills in humid climates.

(2) **Drainage:** Dendritic pattern with gently curving steams. Fine-textured in arid climates, medium to fine textured in humid climates.

(3) **Erosion:** Gullies in residual soil have gently rounded cross sections.

(4) **Image tone:** generally dark toned.

(5) **Vegetation & Land Use:** Usually barren in arid areas & intensively cultivated or heavily forested in humid areas.

(6) **Other:** Shale is sometimes mistakenly identified as loess.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: (continue)

Limestone:

- Limestone consists mainly of calcium carbonate, a water soluble material,
- Bedding & jointing are generally not prominent on images,
- The ground surface of soluble limestone is typically dotted with thousand of sinkholes, &
- Limestone can cause problems in constructions because of sinkholes, depth of soil, & soil structure.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

***Sedimentary Rocks:* (continue)**

Image Identification of Horizontally Bedded *Soluble limestone* in humid climates

(1) **Topography:** Gently rolling surface broken by roughly circular sinkholes that are typically 3 to 15 meter in depth & 5 to 50 meter in diameter.

(2) **Drainage:** Centripetal drainage into individual sinkholes.

(3) **Erosion:** Gullies with gently rounded cross sections developed in fine-textured residual soil.

(4) **Image tone:** Mottled toned due to extensive sinkholes development.

(5) **Vegetation & Land Use:** Typically farmed except for sinkholes.

(6) **Other:** Dolomite limestone is more difficult to identify because it generally well drained & has subtle sinkholes.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: (continue)

Interbedded Sedimentary Rocks:

- Rock formations with alternating layers of different sedimentary rock types,
- Appearance of the resulting terrain depends on the thickness of the beds & their altitude,
- Two types; horizontal or tilted formation.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: *(continue)*

Image Identification of Horizontally Bedded Interbedded Sedimentary Rocks

(1) **Topography:** With thickness of 10 meter or more, a distinct stair-stepped terrain is clear on the image.

(2) **Drainage:** Typically dendritic drainage.

(3) **Erosion:** Varies with residual soil type.

(4) **Image tone:** Differences in image tone appear as contours in hillsides.

(5) **Vegetation & Land Use:** Tonal differences may be caroused by differences in vegetation over different rock types.

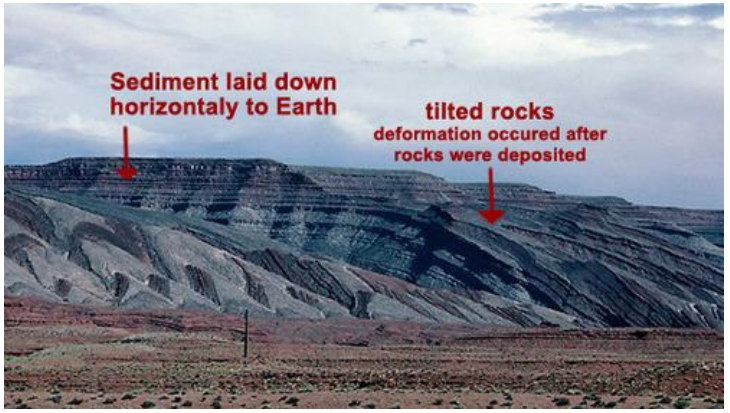
(6) **Other:** Horizontal bedded sandstone over shale is sometimes mistakenly identified as flood basalt over shale.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: (continue)

Tilted Sedimentary Rocks:

- Sedimentary rocks that have been folded or warped from their original horizontal bedding planes,
- Tilted sedimentary rocks can form linear ridges & valleys that can run parallel for many kilometers, &
- When axes are plunging, ridges curve in a zigzag fashion,

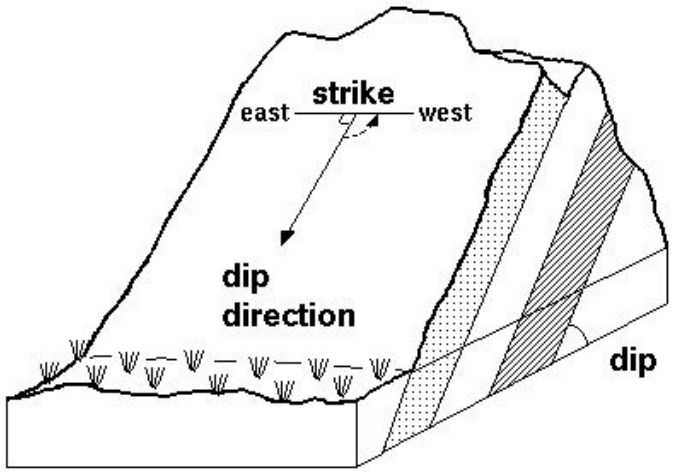


Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Sedimentary Rocks: (continue)

Tilted Sedimentary Rocks:

- The term strike & dip are used to indicate the direction & amount of inclination of tilted sedimentary beds,
- A horizontal line along the beds gives the direction of strike, &
- The amount of dip is the inclination of the beds from horizontal measured along the direction of dip.



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

***Sedimentary Rocks:* (continue)**

Image Identification of Tilted Interbedded Sedimentary Rocks

(1) **Topography:** A series of straight or curving ridges.

(2) **Drainage:** A trellis drainage pattern with major streams running along valley bottoms & secondary streams flowing down dip.

(3) **Erosion:** Varies with residual soil type.

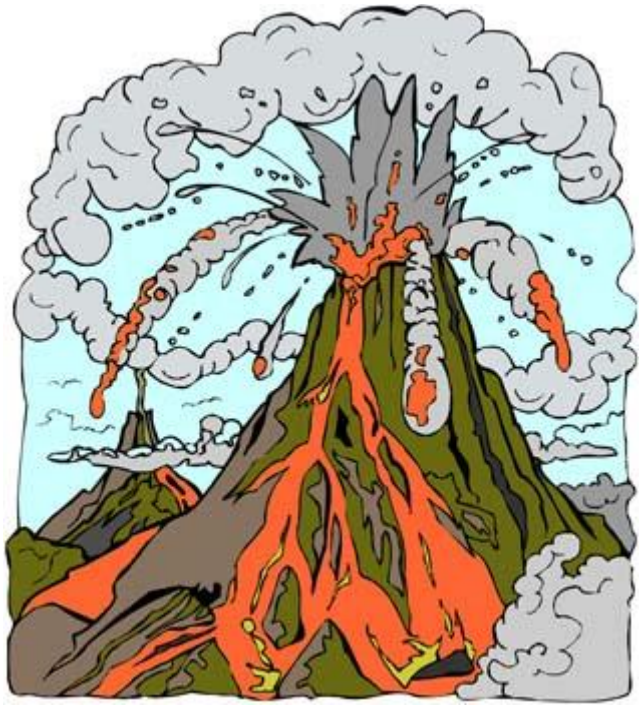
(4) **Image tone:** Varies with rock type.

(5) **Vegetation & Land Use:** A typical occurrence for tilted sedimentary rocks in a humid area would be forested sandstone ridges & farmed shale valleys.

Chapter 4: "Principles of Visual Landform Identification & Evaluation" Part 3 out of 4

Igneous Rocks:

- *Formed by the cooling & solidification of magma,*
- *Igneous rocks are divided into two groups;*
  - *Intrusive igneous rocks, formed when the magma does not reach the earth's surface & solidified in cavities or cracks. The out coming rocks are dense strong & free of cavities, &*
  - *Extrusive igneous rocks, formed when magma reaches the ground surface, occur as various volcanic forms, including various types of lava flows, cones, & ash deposits.*

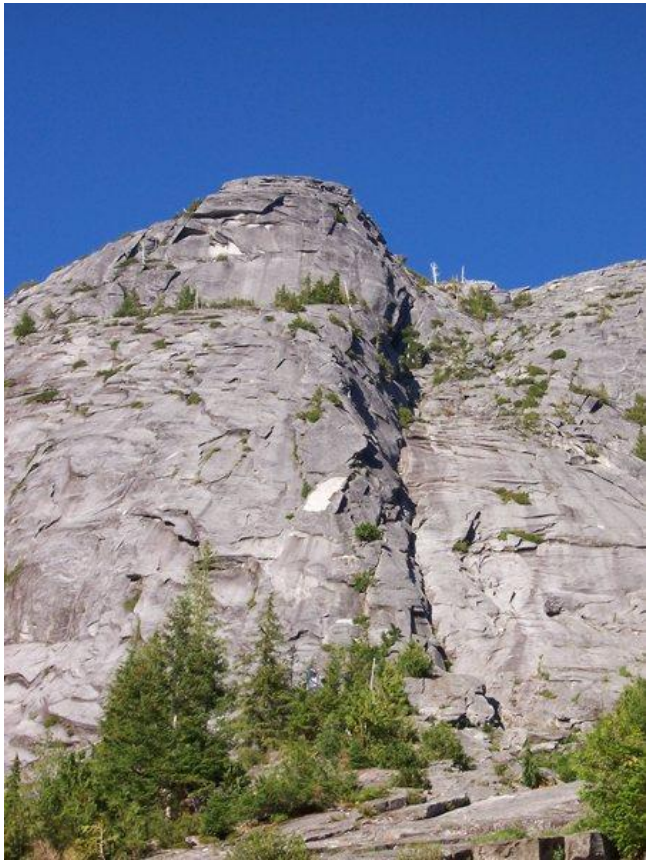


Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Intrusive Igneous Rocks; Granitic Rocks:

- *Commonly occur in large masses in which the magma has cooled very slowly & solidified into large crystals. The out coming rocks are dense strong & free of cavities,*
- *Granitic rocks are course-grained, light-colored, unbedded formations, &*
- *Often strongly fractured into a series of irregularly oriented joints,*

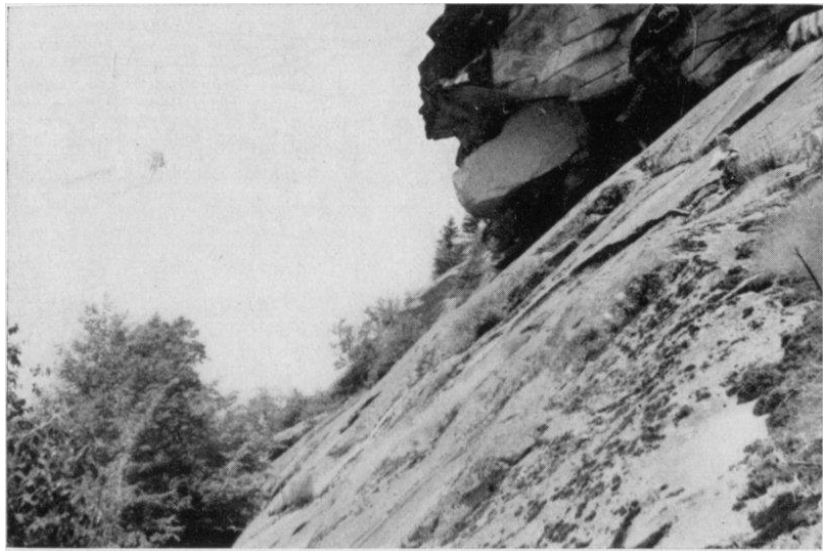


Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Intrusive Igneous Rocks; Granitic Rocks: (continue)

- *A high resistance to erosion; however, as they weather they tend to break in sheets through exfoliation, &*
- *Not well suited to urban development because of a combination of rugged topography, shallow depths to bedrocks, & poor water supply.*



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Image Identification of Granitic Rocks

(1) **Topography:** Massive, rounded, unbedded domelike hills with variable summit elevations & steep side slopes. Often strongly jointed with an irregular pattern.

(2) **Drainage:** Corse-textured dendritic pattern with streams tendency to curve around the base of domelike hills. Secondary drainage channels form along joints.

(3) **Erosion:** Few gullies, except in areas of deeper residual soil.

(4) **Image tone:** Light toned due to light rocks color.

(5) **Vegetation & Land Use:** Sparse vegetation in arid areas. Often forested with some bare rock outcrops in humid climates.

(6) **Other:** Granitic rocks are sometimes mistakenly identified as horizontally bedded Sandstone.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

The principal differences in image identification of granitic rocks versus sandstone can be summarized as follows;

	Granite	Sandstone
1 - Evidences of bedding	None.	Bedded.
2 – Topography	Variable summit,	Forms plateaus.
	Rounded cliffs,	Vertical cliffs.
	Rounded micro-features.	Blocky micro-features.
3 - Joint pattern	Irregular joint pattern.	Joint system consisting of 2 or 3 principal directions.
4-Drainage pattern	Dendritic	Rectangular

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Extrusive Ignores Rocks:

- *Consist mainly of lava flows & pyroclastic materials,*
- *Solidification of molten rocks that issued from volcanic cones or fissures form the lava flows,*
- *The form of lava flows depends on the viscosity of the flowing lava &*
- *Viscosity of the lava increases as the percentage of silica & alumina increases,*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Extrusive Ignores Rocks: (continue)

- *Tree types of lava flows, Depends on the viscosity of the lava:*
  - *Basaltic lavas are the least viscous with 65% silica & alumina,*
  - *Andesitic lavas are more viscous, with 75% silica & alumina, &*
  - *Rhyolitic lavas are the most viscous, with 85% silica & alumina.*
- *Pyroclastic materials, such as cinder & ash were ejected from volcanic vents.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Extrusive Ignores Rocks: (continue)

- *Several basic volcanic forms are recognized. These forms can be divided into two main groups:*
  - *Strata volcanoes; steep-sided, cone-shaped volcanoes, composed of alternating layers of lava & pyroclastic materials, &*
  - *Shield volcanoes; broad, gently sloping 4-10% volcanoes cones built of overlapping basaltic lava follows.*
  - *Caldera; a large cauldron-like hollow that forms shortly after the emptying of a magma chamber/reservoir in a volcanic eruption.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Image Identification of Lava Flows, (Excluding Flood Basalt)
(1) **Topography:** A series of tongue like formation that may overlap & interbedded. Viscous lavas form thick flows with prominent steep edges. Fluid lavas form thin flows that are usually less than 15 meters.
(2) **Drainage & Erosion:** Lava flows are well drained internally & there is seldom a well developed drainage pattern or gullies.
(3) **Image tone:** The color of unweathered unvegetated lava is dark incase of basalt, & moderate for andesitic & light for rhyolite. Recent unvgetated flows are darker than weathered vegetated flows.
(4) **Vegetation & Land Use:** Recent flows are seldom farmed or developed.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Flood Basalt:

- *Consists of large-scale eruptions of very fluid basalt that build broad nearly level plains,*
- *Individual flows are typically 15 to 30 meter thick, sometimes thicker,*
- *Flood basalt deposits typically exhibit columnar jointing typically six-sided half to one meter wide, &*
- *Flood basalt deposits are well drained internally because of the strong columnar jointing.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

Image Identification of Flood Basalt

(1) **Topography:** Nearly leveled surface often cut by major streams that form deep valleys.

(2) **Drainage:** Very few, if any, surface streams because of the excellent internal drainage.

(3) **Erosion:** Gullies generally not prominent.

(4) **Image tone:** Basalt rock has a dark tone, especially along valleys walls.

(5) **Vegetation:** The ground surface often has some vegetation especially when a soil cover is present.

(6) **Land Use:** Flood basalt with a soil cover is often farmed in areas near streams where the land can be irrigated.

(7) **Other features:** Landslides are often found along flood basalt cliff, especially where streams undercut the base of the slopes.

(8) **Other:** Flood basalt plateaus are sometimes mistakenly identified as Sandstone capped plateaus.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Igneous Rocks: (continue)

The principal differences in image identification of flood basalt plateaus versus sandstone capped plateaus can be summarized as follows;

	Flood Basalt Plateaus	Sandstone Capped Plateaus
1 - Tone	Dark-toned.	Light-toned.
2 – Rock jointing	Columnar jointing. Cliff edges have a serrated appearance.	Joint system consisting of 2 or 3 principal directions. Canyon & cliff edges.
3 - Drainage	Principally internal drainage.	Has a law density modified dendratic pattern.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Metamorphic Rocks:

- *Formed from preexisting sedimentary or iguanas rocks due principally to heat & pressure,*
- *Minimum condition for metamorphic change are estimated at temperatures in excess of 100 celsius along with a pressure equal to that found at 3 kilometers below the earth's surface, &*
- *Maximum conditions are estimated to be a temperature of 800oc & a pressure equal to that found at 35 kilometers below the earth's surface.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation" Part 4 out of 4

Aeolian Deposits:

- *Created by the deposition of unconsolidated materials by the wind, &*
- *The main Aeolian deposits are sand dunes loess.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Aeolian Deposits: (continue)

Sand Dunes:

- *Sand dunes are hills of windblown sand,*
- *Found where there is;*
  - *A source of sand,*
  - *A strong enough wind to erode & transport sand sized particles, &*
  - *A land surface to deposit the sand.*
- *Sand grains are transported by bouncing & rolling, generally within half to one meter above the ground surface.*

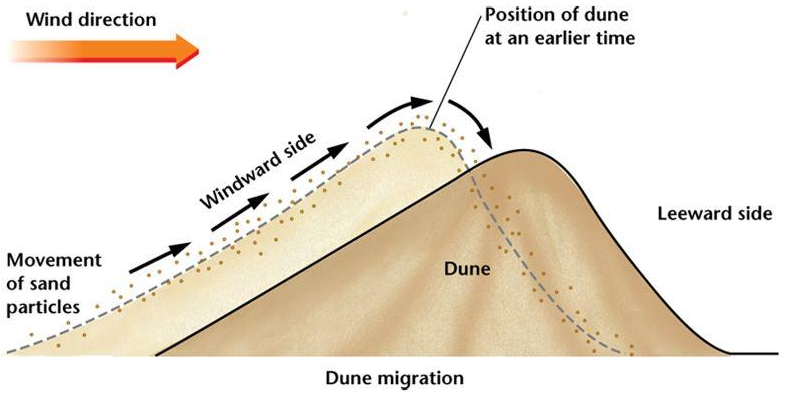
Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Aeolian Deposits: (continue)

Sand Dunes: (continue)

- *Windward slope of 5 to 10, & 30 to 34 degrees on the leeward slope, &*
- *Unless stabilized by vegetation, sand dunes tend to move by less than 30 meter a year downwind.*

Wind Deposition-dune formation



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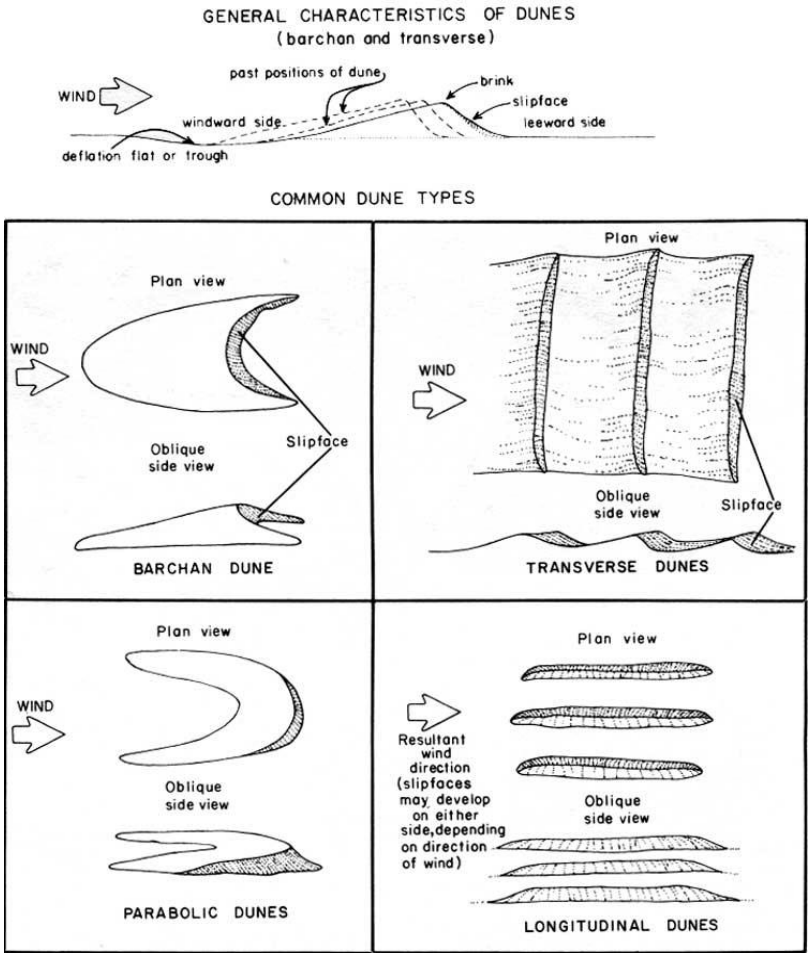
Aeolian Deposits: (continue)

Sand Dunes: (continue)

- *Sand dunes vary in shape, depending on the quantity & particle size of the sand, the strength & direction of the wind, & the vegetation conditions, &*
- *Basic sand dunes shapes;*
  - *Transverse sand dunes,*
  - *Barchans sand dunes,*
  - *parabolic sand dunes, &*
  - *longitudinal sand dunes.*



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Aeolian Deposits: (continue)

Sand Dunes: (continue)

- *Transverse sand dunes;*
  - *Tend to form in areas with a large supply of sand & little vegetation, &*
  - *Often cover large areas & develop a wave-like perpendicular to the direction of the wind.*

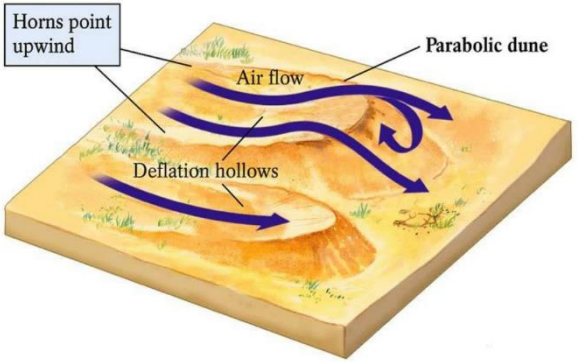
- *Barchans dunes;*
  - *Crescent-shaped dunes,*
  - *Tend to form in areas where there is a limited amount of sand & little vegetation, &*
  - *The tips of the dunes point downwind.*

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

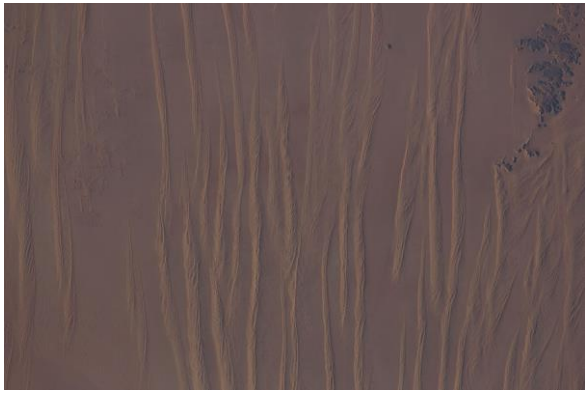
Aeolian Deposits: (continue)

Sand Dunes: (continue)

- *Parabolic sand dunes;*
  - *Have a crescent shape with long horns pointed into the wind, &*
  - *Formed where vegetation anchors portions of the horns, allowing the center to migrate.*



- *Longitudinal sand dunes;*
  - *long, nearly straight ridges of sand that form parallel to the direction of the wind, &*
  - *Symmetrical with a width several times the height.*



Sand dunes are generally unfavorable locations for urban development due to the possibility of blowing sand & migrating dunes.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Aeolian Deposits: (continue)

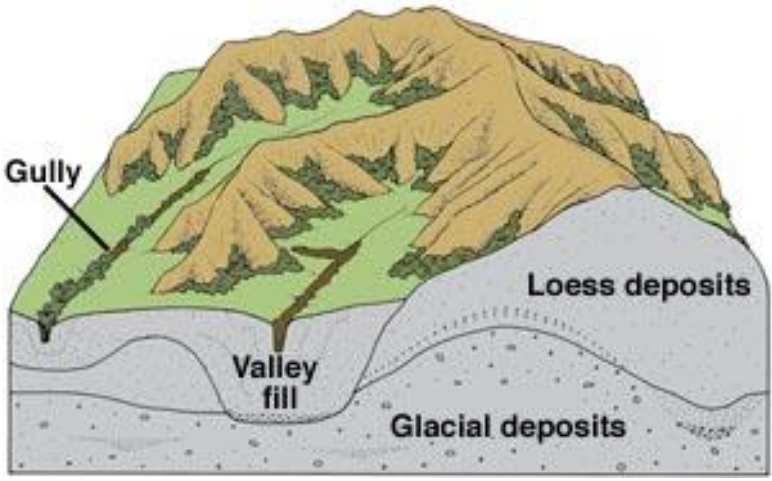
Image Identification of Sand Dunes
(1) **Topography:** As described.
(2) **Drainage:** Excellent internal drainage.
(3) **Erosion:** Frequent wind erosion.
(4) **Image tone:** Very light on B&W films.
(5) **Vegetation & Land Use:** Stabilized dunes often have a grass or shrub cover.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Aeolian Deposits: (continue)

Loess:

- *Consists of unconsolidated silt-sized (60 to 70)% windborne deposits with little amount of fine sand & clay,*
- *Loess soils are well drained in their natural stats,*
- *Easily eroded by moving water, &*
- *It has a relatively low density compared to other soils.*



Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Aeolian Deposits: (continue)

Loess: (continue)

- Loess has been called "collapsible" material because it may undergo excessive settlement when;
  - Moisture content increases,
  - When under a heavy vertical load,
  - When under vibration,
  - Or a combination of them.
- Great care must be taken when development of loess areas, &
- Special considerations must be given to the unusual slope stability characteristics of loess.

Chapter 4: "Principles of Visual Landform Identification & Evaluation"

Aeolian Deposits: (continue)

Image Identification of loess
(1) **Topography:** Thick undissected loess deposits roughly parallel crests some 500 to 1,000 meter apart.
(2) **Drainage & Erosion:** The overall drainage pattern is typically a modified denetric pattern. Gullies are U-shaped.
(3) **Image tone:** Light tone because of the good internal soil drainage.
(4) **Vegetation & Land Use:** Typically farmed except on steeper slopes or in low rainfall areas.

End *of* Chapter 4