LESSON 5: GEOMORPHOLOGY I (TOPOGRAPHY)

Key Concepts

In this lesson we will focus on summarising what you need to know about:

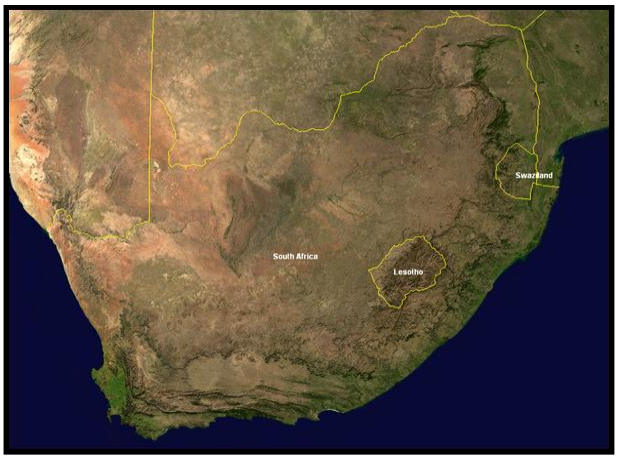
- Topography associated with Horizontally Layered Rocks
- Topography associated with Inclined/Tilted Rock Strata
- Topography associated with Massive Igneous Rocks

X-Planation

Topography Associated with Horizontally Layered Rocks

Characteristics and processes associated with the development of Hilly Landscapes

In areas where the climate is arid there is not enough water for sheet-wash to occur. Water will run unevenly down slopes eroding gullies in certain places. The slopes are therefore rugged and uneven. There is little chemical weathering and soils are thin.



Characteristics and processes associated with the development of Basaltic Landscapes

In areas where the horizontal strata are formed from lava flows, basaltic plateaus will form. Rivers will cut into joints and cracks forming steep cliffs and deep valleys called gorges

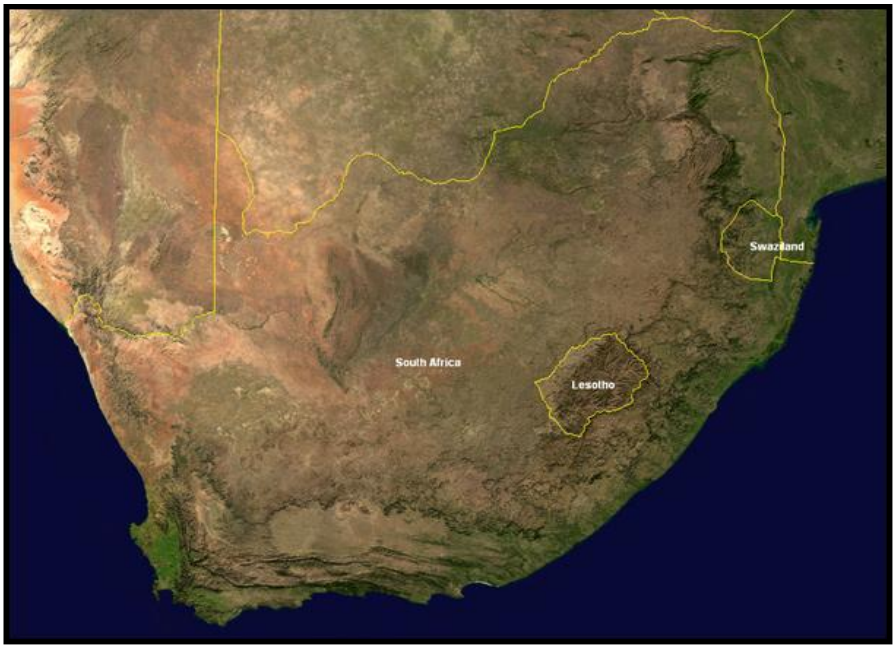
A term applied to those basaltic lavas that occur as vast composite accumulations of horizontal or sub horizontal flows, which, erupted in rapid succession over great areas, have at times flooded sectors of the Earth's surface on a regional scale

They are generally believed to be the product of fissure eruptions. One or a succession of high-temperature basaltic lava flows from fissure eruptions which accumulate to form a plateau. Also known as flood basalt

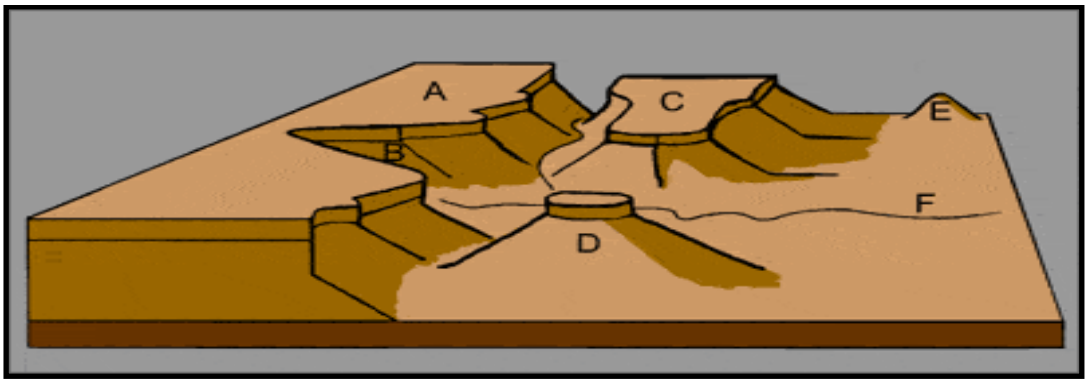
Characteristics and processes associated with the development of Canyon Landscapes

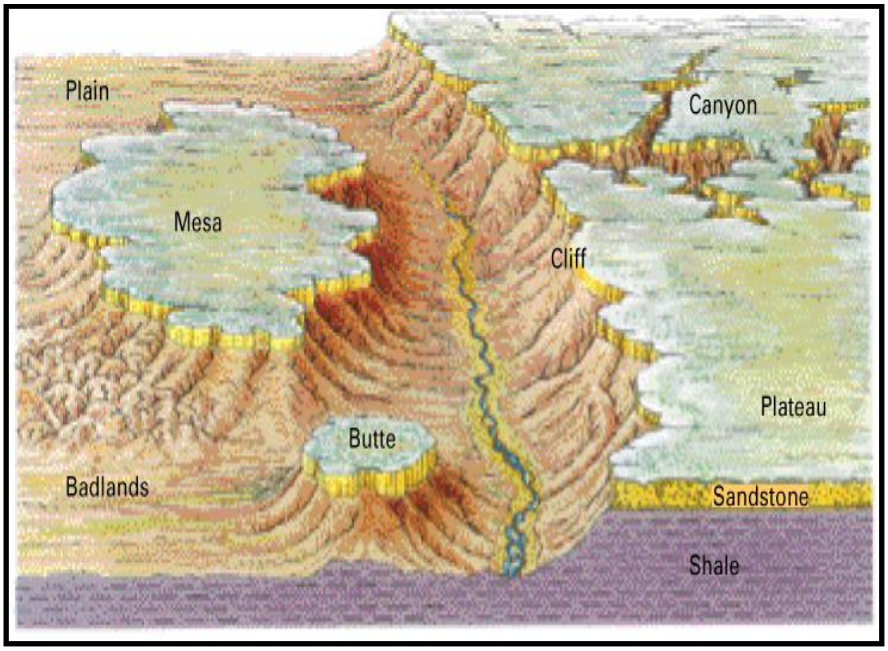
Canyon landscapes develop where horizontal strata have varying resistance to erosion

Examples of canyons in South Africa include the Fish River Canyon and Blyde River Canyon. Canyon landscapes are characterised by deep valleys and uneven slopes



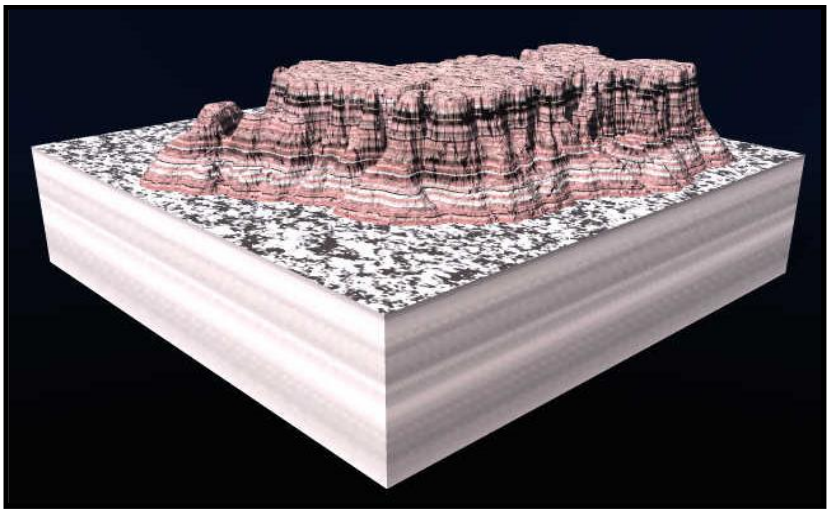
Characteristics and processes associated with the development of Karoo Landscapes





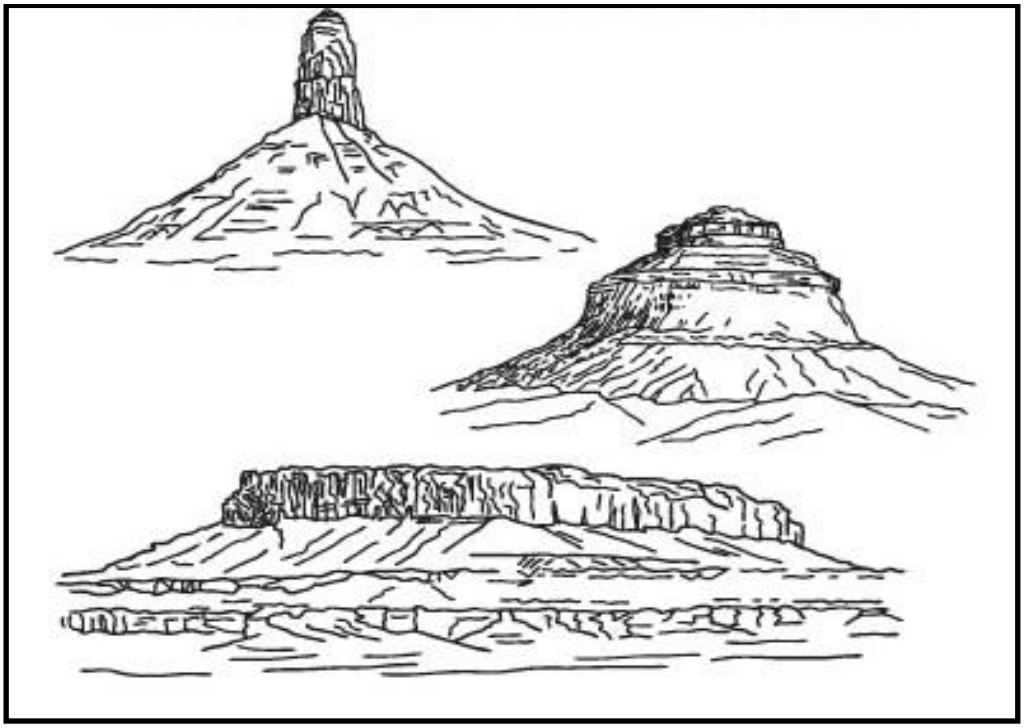
Mesa:

- A mesa is an isolated, flat-topped hill or mountain with steep sides that is smaller in area than a plateau.



Butte:

- A butte is also a flat-topped hill with steep sides, though smaller in area than a mesa.



Horizontal Layers on Topographical Maps

The Concept of Scarp Retreat and Back Wasting

Slopes eroding back parallel to their original position; common in dry climates where there is very little surface water runoff; also known as back wasting.

Utilization of Horizontally Layered Landscapes

Canyon landscapes are not attractive for settlement and agriculture. The wide valleys of these landscapes also make the construction of infrastructure quite difficult.

The Karoo landscape is arid and not generally suited for agriculture or settlement. The area is, however, used successfully for sheep farming.

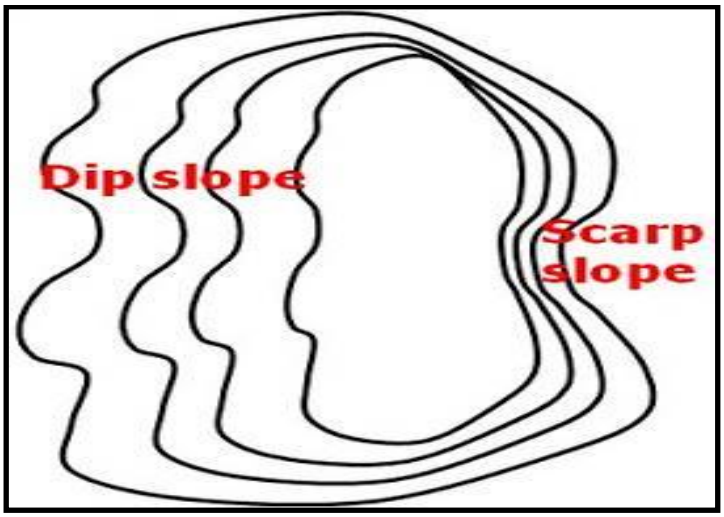
Topography Associated with Inclined / Tilted Rock Strata

What is Inclined Rock Strata

- Asymmetrical ridge according to the angle of a dip slope

Characteristics and processes associated with the development of Scarp and Dip Slopes

- It occurs when strata is subjected to stress (either compression, tension, volcanic intrusion or tectonic movement) and they become tilted relative to their original (horizontal) position.
- Faulting or folding causes the strata to be tilted.
- The beds may be inclined in any direction with the angle of the dip slope between 0º to 90º.
- Inclined strata has TWO slopes; a dip and scarp slope.

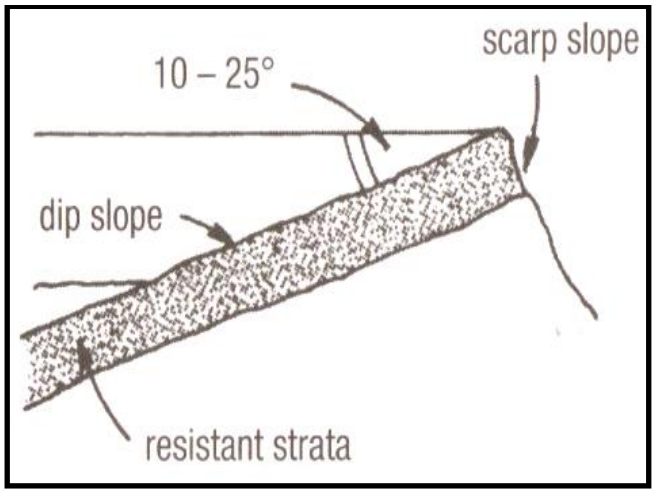


Dip Slope	Scarp Slope
• A natural/gradual slope on the surface of the ground which is parallel to the dip of the underlying strata. **OR** • A side on which hard layers dip and has a gentle slope. • It has a GENTLE SLOPE and a RESISTANT ROCK LAYER.	• A long steep slope or cliff at the edge of a ridge/ plateau. • It has a STEEP SLOPE and a SOFTER ROCK LAYER.

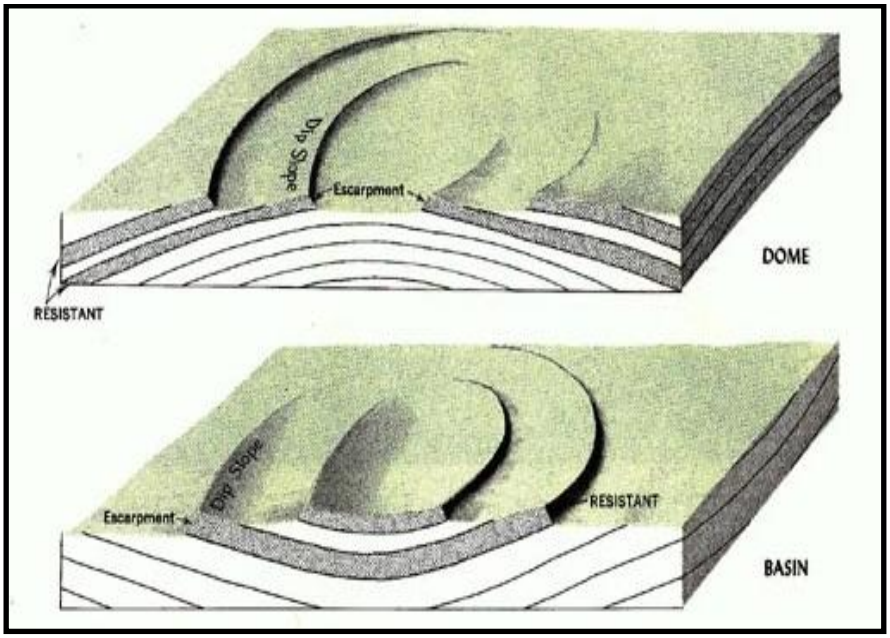
Characteristics and processes associated with the development of Cuesta, Homoclinal Ridge and Hogsback Ridge

- When the strata is weathered, asymmetrical ridges called homoclinal ridges are formed .
- Homoclinal ridges are where the underlying strata is tilted in the same direction and has a uniform dip angle. (rock strata dipping in one direction).
- Homoclinal ridges are classified according to the angle of the dip slope.
- There are THREE types of homoclinal ridges, namely:
  - cuesta
  - homoclinal ridge and
  - hogsback ridge

Cuesta

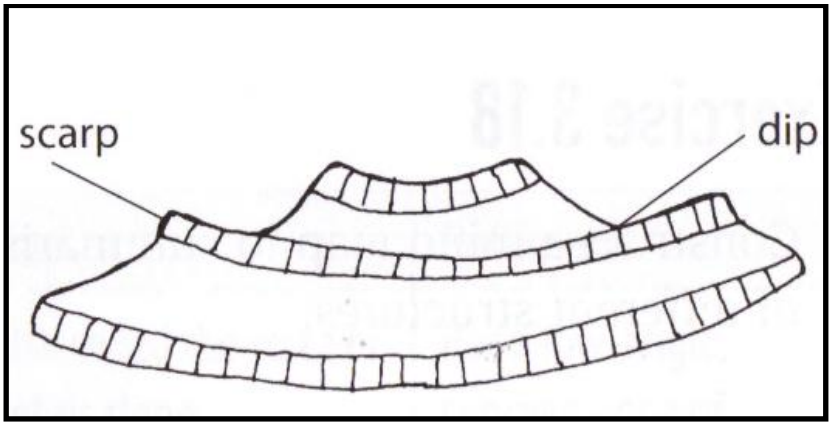


- A ridge with a gentle dip slope and a steep scarp slope.
- The angle of the dip slope is 10º – 25º to the horizontal.
- The dip slope does have fertile soil and is usually used for forestry.
- Example: Magaliesberg Mountain in Gauteng



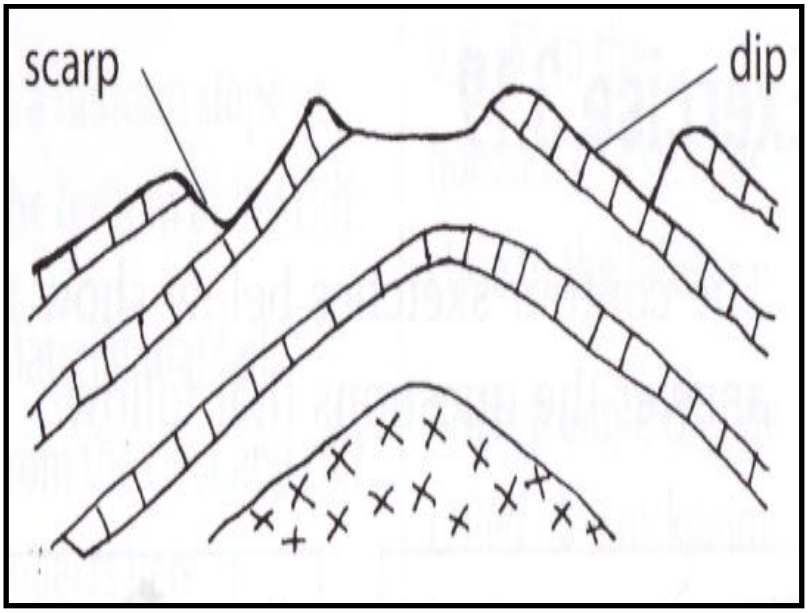
Cuesta Basins

- Cuesta basins are formed as a result of volcanic intrusions of a lopolith.
- The scarp slope faces downward, and the dip slope is directed inward.
- These hold artesian wells and can form oil traps.



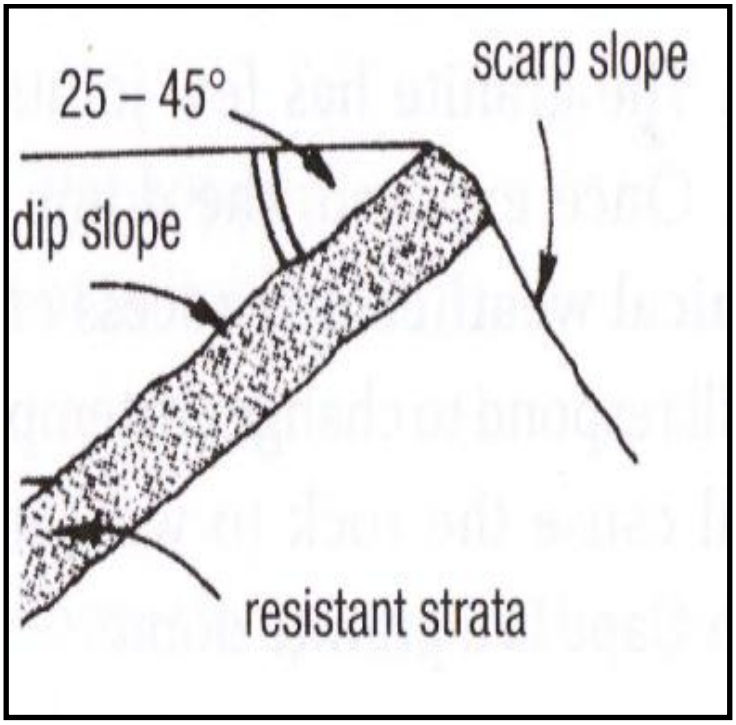
Cuesta Dome

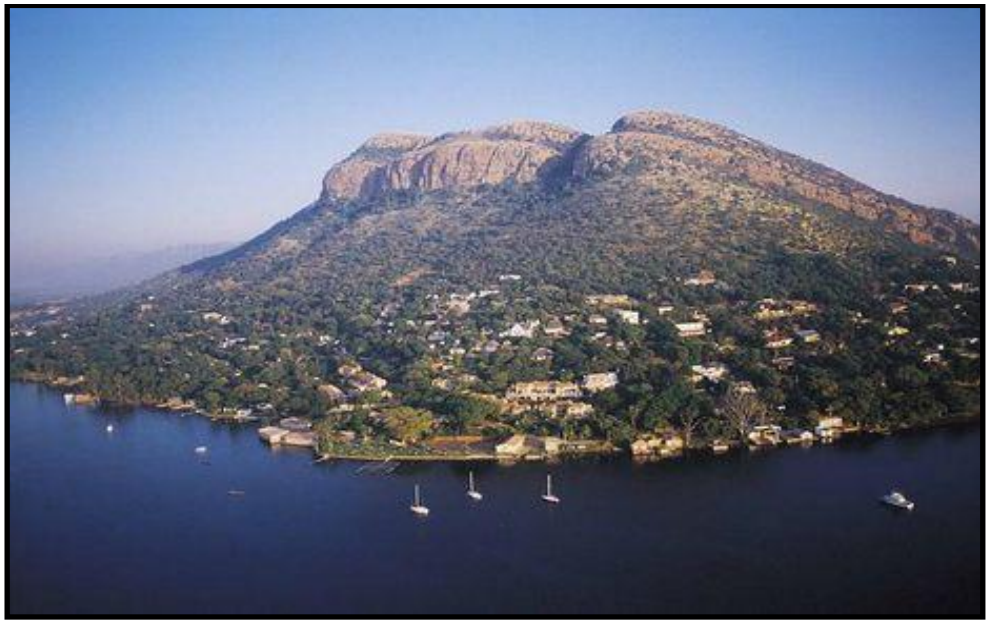
- Cuesta domes are formed as a result of volcanic intrusions of a batholith and lacollith.
- The scarp slope faces inward, and dip slopes faces outward.



Homoclinal Ridge

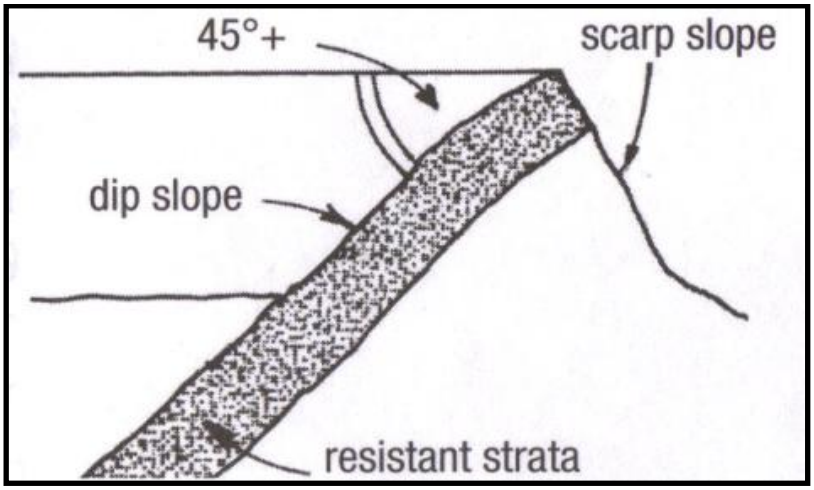
- The angle of the dip slope lies 25º – 45º to the horizontal.
- Rivers cut poorts through the ridges.
- Drainage is normally trellis patterned.
- Example: Magaliesberg near Pretoria and Hex River Mountains in Western Cape.





Hogsback

- The angle of the dip slope is more than 45º to the horizontal.
- There is very little difference in the gradient of the scarp and dip slopes.
- Example: in Eastern Cape



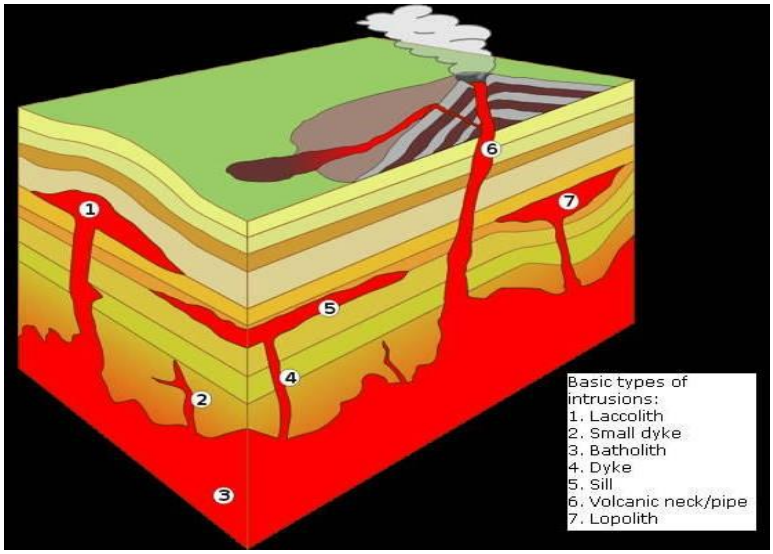
Utilisation of Inclined Strata by Humans

- Cuestas
  1. are used for farming
  2. are used for forestry
- Hogsbacks
  1. For recreation – e.g. mountain climbing
  2. For protection during war

Topography Associated with Massive Igneous Rocks

What are Massive Igneous Rocks?

Massive igneous rocks are not stratified. They solidified at depth as a great compact mass and cooling was therefore slow. Because of this slow cooling process, there was sufficient time for large crystals to develop. These large masses can assume a variety of forms, namely, batholiths, laccoliths, lopoliths, dykes and sills as well as tors.



Batholiths

The largest of the dome-shaped intrusive forms is a batholiths. It reaches down to such great depths, increasing in size deeper down, that it seems to have no lower limit. Even the exposed part at the Earth's surface often extends over several thousand square kilometres.

Laccoliths

The laccolith is much smaller than batholiths. It is also formed by the erosion of magma amongst other strata, e.g. between sedimentary layers of rock. The overlying layers have to be removed before the laccoliths itself is visible.

Lopolith

Lopoliths are formed in much the same way as laccoliths, but the sedimentary strata between which magma has intruded have been unable to bear the weight. The floor has collapsed to form a shallow, saucer-shaped intrusive form.

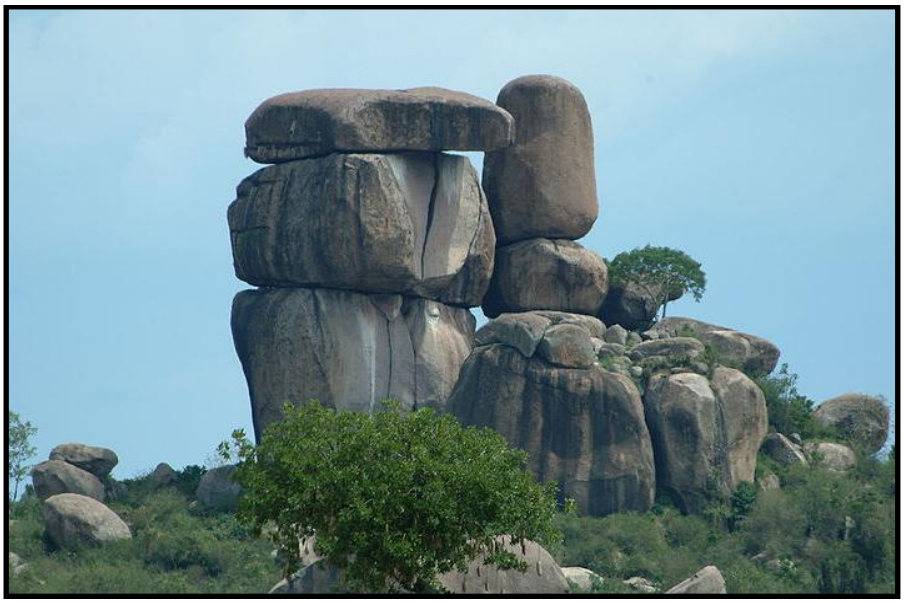
Dykes and Sills

Dykes and sills can be the same material from the same source. Dykes find and fill vertical structural weaknesses. If they find a weaker horizontal plane, they fill that too, forming a sill.

- A dyke is an intrusion into an opening cross-cutting fissure, shouldering aside other pre-existing layers or bodies of rock.
- A sill is a tabular sheet intrusion that has been intruded between older layers of sedimentary rock, beds of volcanic lava.

Granite Domes

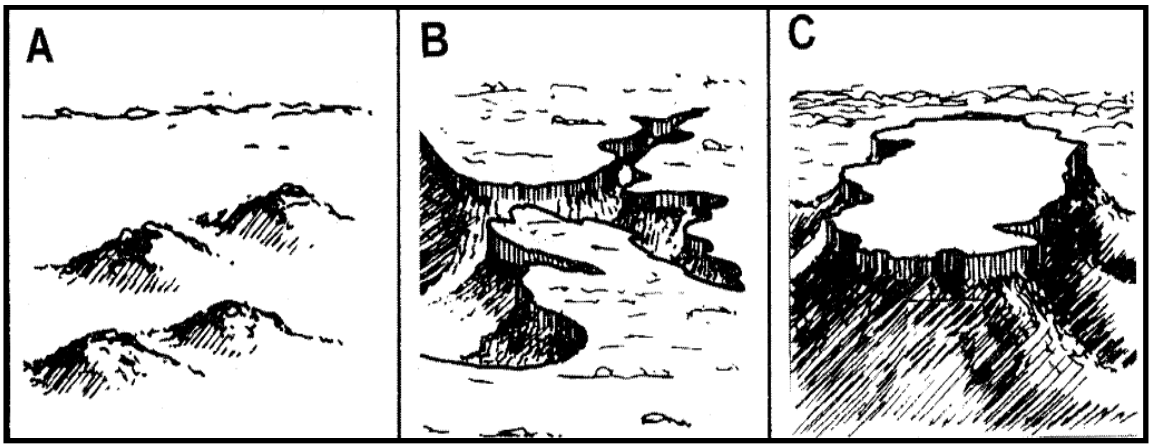
Tors



X-ample Questions

Question 1

Refer to the FIGURE showing topography associated with horizontally layered rocks. The 3 diagrams are not arranged in the correct order of development.



1.1 Arrange the THREE diagrams in the correct order of development by writing the letters that appear on the diagrams in the correct order. (3 x 2) (6)

1.2 The utilization of these types of landscapes, especially B, is limited. Explain the reason for this. (1 x 2) (2)

1.3 Which one of the diagrams illustrates a typical Karoo landscape? (1 x 2) (2)

1.4 Identify the landform in the diagram mentioned in QUESTION 1.3 that is typically found in the Karoo landscape. (1 x 2) (2)

Question 2

Refer to the figure below, a photograph showing an example of inclined rock strata.

2.1 Explain how rocks are bent in this type of landscape. (1 x 2) (2)

2.2 Identify the type of Cuesta evident in the photograph. (1 x 2) (2)

2.3 Give a reason for your answer. (1 x 2) (2)

2.4 State the TWO types of slopes generally associated with inclined rocks. (2 x 2) (4)

2.5 Draw a diagram to distinguish between these TWO types of slopes. (2 x 2) (4)

Question 3

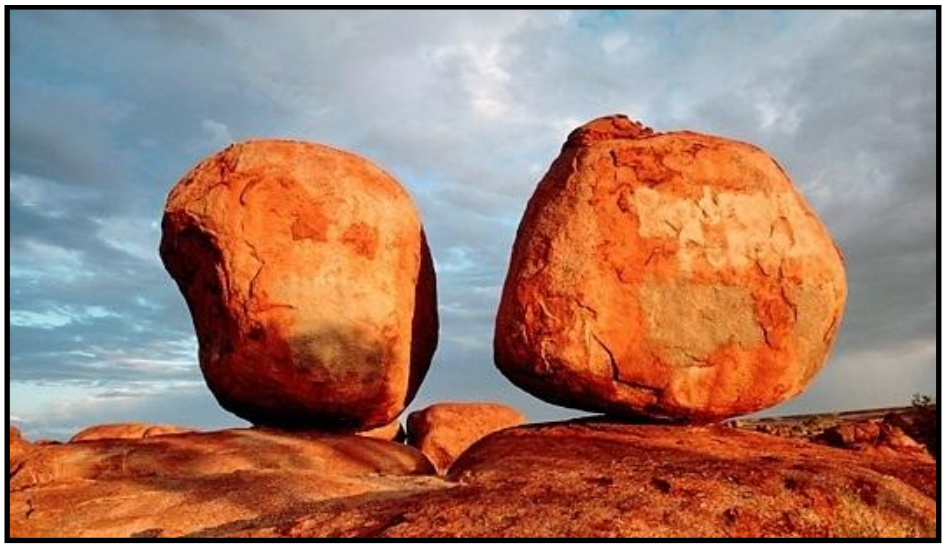
Refer to the figure below, showing various intrusive rock bodies. Use the diagram to complete the table by matching the terms in column A with the definitions in column B.

Write only the number and the correct answer. (5 x 2) (10)

Column A	**Column B**
3.1 Batholith	A. A horizontal rock formed as magma spread between layers
3.2 Laccolith	B. A wall like intrusion that cuts almost vertically across existing strata
3.3 Lopolith	C. Magma intrudes between sedimentary layers. The layer underneath cannot support the weight and sinks downwards creating a saucer shaped intrusion.
3.4 Dyke	D. A mushroom shaped intrusion that pushes the overlying strata upwards
3.5 Sill	E. The largest of all intrusive forms.

Question 4

Refer to the figure below showing topography associated with massive igneous rocks.



4.1 Identify the landform evident in the picture. (1 x 2) (2)

4.2 Describe the landform that you have identified in QUESTION 4.1. (1 x 2) (2)

4.3 Write a paragraph (approximately 8 lines) in which you explain the formation of the landform identified in QUESTION 4.1. (4 x 2) (8)

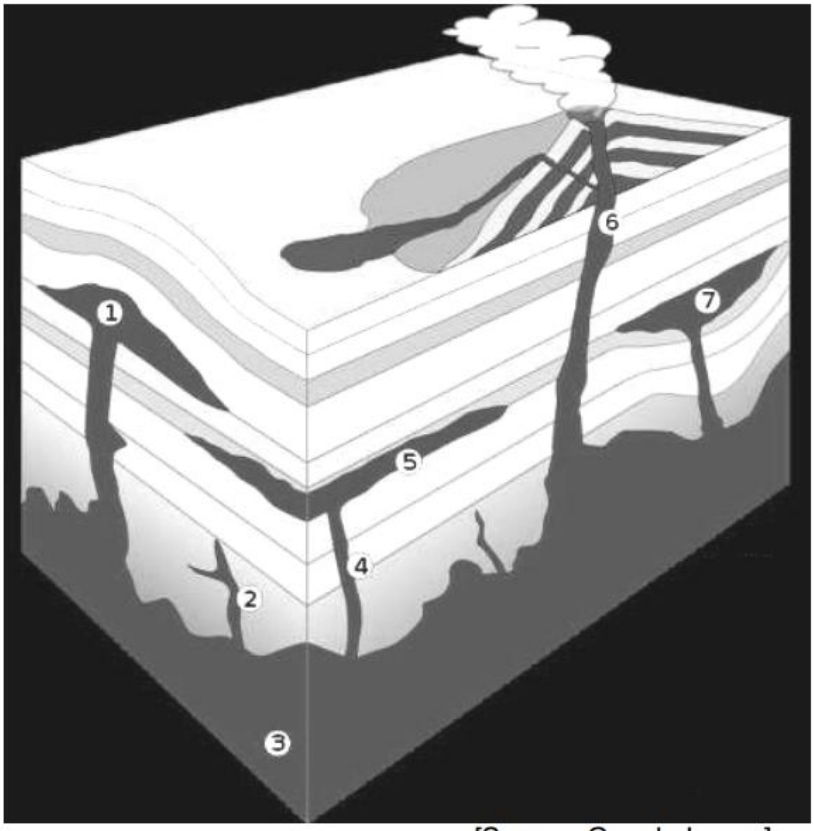
X-ercise Questions

Question 1

(Adapted from Gr 11 Exemplar, DBE, Paper 1, Question 1.2)

Refer to FIGURE 1 showing igneous intrusions and answer the questions that follow.

FIGURE 1: IGNEOUS LANDFORMS



[Source: Google Image]

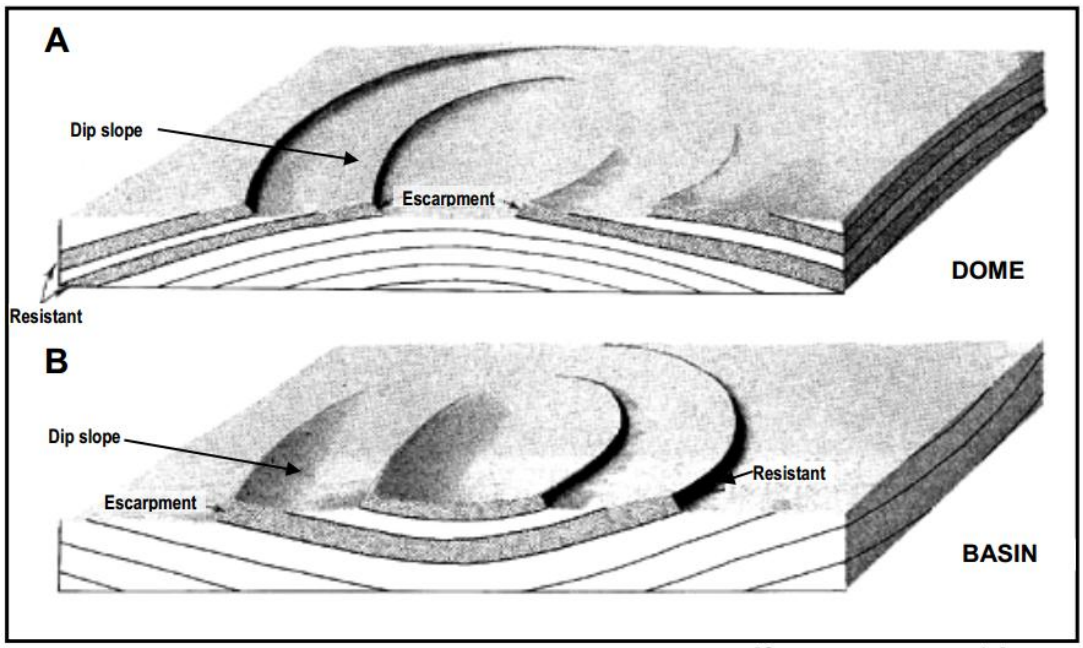
1.1	Name the largest igneous intrusion labelled 3.	(1 x 2) (2)
1.2	Label igneous intrusions 1, 2 and 7.	(3 x 2) (6)
1.3	Which landform would develop if 1 is exposed to the Earth's surface?	(1 x 2) (2)

Question 2

(Adapted from Gr 11 Exemplar, DBE, Paper 1, Question 1.6)

Refer to FIGURE 2 showing cuestas and answer the questions that follow.

FIGURE 2: CUESTAS



[Source: geo.msu.edu]

2.1 What is a cuesta? (1 x 2) (2)

2.2 Describe the difference in the formation of cuestas in diagrams A and B. (2 x 2) (4)

2.3 Describe the difference between the dip slope and the scarp slope of a cuesta. (2 x 2) (4)

2.4 Discuss how humans can use cuestas. (2 x 2) (4)

Question 3

(Adapted from Gr 11 Exemplar, DBE, Paper 1, Question 2.5)

Refer to FIGURE 3 showing two landforms that develop in succession to one another.

FIGURE 3: LANDFORMS RESULTING FROM IGNEOUS FORMATIONS

3.1 Identify landforms A and B. (2 x 2) (4)

3.2 Name the underlying igneous intrusion from which both these landforms developed. (1 x 2) (2)

3.3 Briefly explain why landform A assumes a rounded shape. (3 x 2) (6)

3.4 Write a short paragraph in which you explain how landform B develops. (6 x 2) (12)

Solutions to X-ercise Questions

Question 1

(Adapted from Gr 11 Exemplar, DBE, Paper 1, Question 1.2)

1.1 batholith

1.2 1 - laccolith
2 - dyke
7 - lopolith

1.3 dome

Question 2

(Adapted from Gr 11 Exemplar, DBE, Paper 1, Question 1.6)

2.1 A ridge that develop in tilted sedimentary rock characterised by a gentle slope and a steep slope

2.2 A forms when the rock strata in the centre are pushed upward
B forms when the rock strata in the centre are pushed downward

2.3 Dip slope is gentle
Scarp slope is steep

2.4 Farming takes place in the cuesta valleys situated between the ridges, as the flat surface is covered in fertile soil
Where cuesta basins form, artesian wells, which are sources of groundwater, are found
These basins can also form oil traps
These ridges are of strategic importance, as they can protect settlements on the cuesta valley floors during times of war
The ridges form excellent lookout points
Many outdoor activities are concentrated in these landscaping e.g. hang gliding and hot air ballooning

Question 3

(Adapted from Gr 11 Exemplar, DBE, Paper 1, Question 2.5)

3.1 A - dome
B - tor/rock castle

3.2 Batholith/Laccolith

3.3 Exposed batholith/laccolith subjected to exfoliation
Surface heats up quicker than inside
Outer layers flake/peel off
Rounded dome remains

3.4 Cooling below the Earth's contracted, leaving many, mainly vertical cracks in granite
These allowed water circulation to great depths, which both chemically and mechanically changed the rock surrounding the cracks
Differential weathering takes place
As the granite became exposed, the released pressure resulted in horizontal bedding planes developing in the rock
Further chemical weathering by circulating water, and later by acidic rainwater, caused more weathering along the lines of these joints
Erosion, most likely by river action, washed away all the weathered rock
It would leave the more resistant core rocks behind