

CHAPTER 3 ACTION OF WINDS

After studying this chapter, students should be able to:

- identify and describe the processes of wind erosion.
- describe the features and mode of formation of erosional landforms such as inselberg, rock pedestal, Zeugen, Messa and butt, etc.
- describe the features of wind deposition.

3.1 Wind

About a third of the land surface of the globe experiences desert or semi-desert conditions, including the polar and sub-polar lands which are sometimes called “cold deserts”. The basic factors responsible for the existence of a desert is aridity, insufficient rainfall often less than 127mm (5 inches), coming at most irregular period, coupled with very high temperatures ($31^{\circ}\text{C}/87.8^{\circ}\text{F}$ on the average) and a rapid rate of evaporation, are the chief causes of aridity. Denudation through the processes of weathering (mechanical and chemical), wind action and the work of running water have combined to produce a desert landscape that is varied and distinctive.

3.1 Processes of Wind Erosion

The erosive power of the wind involves a triple process namely:

- (i) Abrasion (ii) Attrition (iii) Deflation

(1) Abrasion: This is the sand-blasting of rock surfaces by winds when they hurl sand particles against them. The sand-blast effect results in rock surfaces being scratched, polished and worn away. Abrasion is most effective at or near the base of rocks, where eddies or wind blasting effect is more pronounced.

- (2) **Attrition:** This occurs when wind-borne materials in motion roll against one another and the rock surfaces they meet, thereby producing a characteristic rounded sand grain or 'millet seed'. This forms the dominant and constituent materials of extensive sand deserts.
- (3) **Deflation:** Deflation involves the lifting and blowing away of unconsolidated or loose materials from the ground surface. The finest material is carried away as dust-storm, while heavier material in the form of sand grains are swept along in sand storm.

Features of Wind Erosion

The combined effects of abrasion, attrition and deflation give rise to characteristic features namely:

1. **Inselbergs:** They are isolated residual hills, ridge or small mountain rising abruptly from the level ground. They are typical of many arid and semi-arid landscapes. Examples include northern Nigeria, western Australia and the Kalahari desert. They are characterized by very steep slopes and rounded tops. They are composed of granite or gneiss and are relics of original plateau which has been almost entirely eroded away by water or wind. The remains are hard and resistant rocks. Inselbergs are irregular in shape with alternate horizontal layers of hard and soft rock.

Mode of Formation

- They are formed from the remains of an original Plateau which has been eroded away by water or wind.
- It may also be formed through the process of scarp retreat. Example: Gwariland in Abuja in Northern Nigeria, Makeni region of Sierra Leone.

2. **Rock Pedestals:** They are formed by sand blasting effect of winds which wears back the softer layers, creating grooves and hollows in the rock surfaces, carving them into fantastic and grotesque-looking pillars. The characteristic mushroom blocks, undercut at the base where friction is greatest are known as gour in the Sahara fig. They are irregular in shape with alternate horizontal layers of hard and soft rocks.

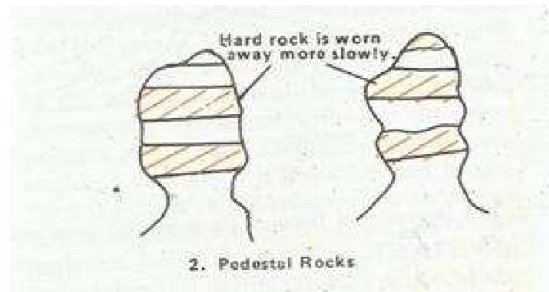


Fig. 3.1: Rock Pedestals

3. **Yardangs:** They are desert landscape features which are characterized by ridges and furrows which results from differential erosion.

Mode of formation: They are formed when hard and soft rocks in vertical bands are aligned in the direction of the prevailing wind. Wind abrasion erodes the softer rocks into long narrow corridors, separating the steep-sided ridges of hard rocks called Yardang: They are found in the Atacama Desert. It has a height rising to about 8.15m (25.50 feet) and in central Asia.

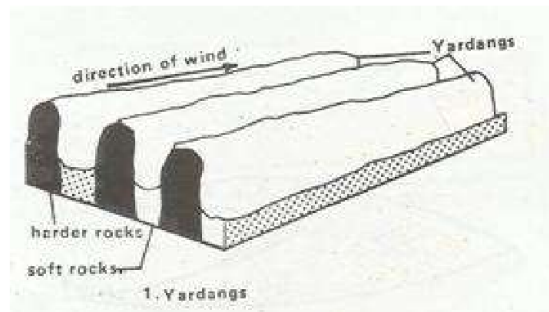


Fig. 3.2: Yardangs

4. **Zeugen:** These are tabular masses which have a layer of hard horizontal rocks lying above a soft one.

Mode of formation: Mechanical weathering along the joints breaks the rock into the hard cap where a surface layer of hard rock is underlain by a layer of soft rock, thereby having a ridge and furrow landscape.

- Wind abrasion and its sculpturing effect wears them into a weird-looking 'ridge and furrow' landscape.
- Wind abrasion further 'eats' into the underlying softer rock layer so that layer-deep furrows are developed.
- Hard rocks then stand above the furrow as ridges called Zeugen which stand prominently at 30m (100ft) or more above the surrounding level.

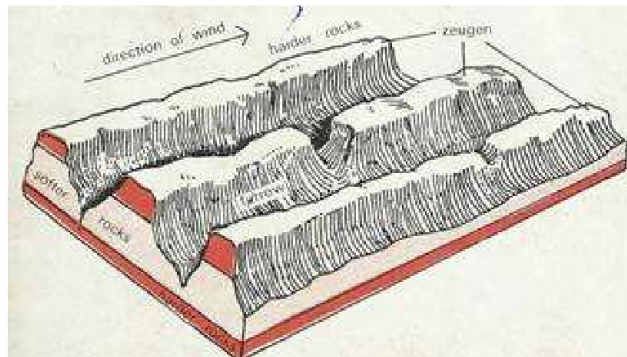


Fig.3.3: Zeugen

5. **Mesas and Buttes:** Mesas is an isolated flat, table-like land mass with very steep sides that is smaller in area than a plateau. They are plateaus that have been eroded into large islands by wind and water. As water and wind erode the Mesas, it shrinks in size and becomes a butte. An eroded butte is called a fin and an eroded fin is also called a spine.

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

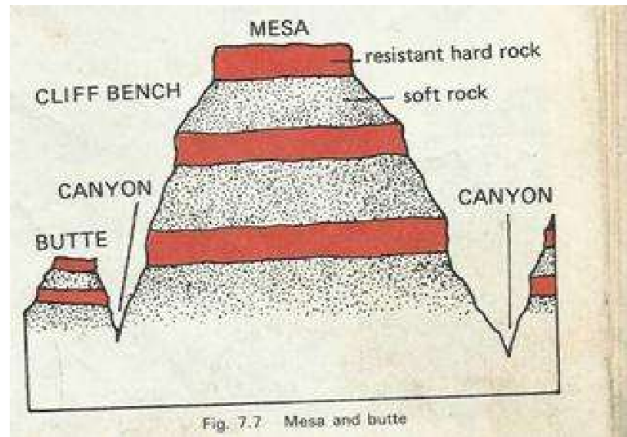


Fig. 3.4: Mass and Buttle

6. **Ventifacts or Dreikanter:** They are pebbles faceted by sand-blasting. Individual pieces of rock, broken off by mechanical weathering, but too heavy to be moved by the wind, are worn on the windward side, and are known as ventifacts.

A ventifact with three wind-faceted surfaces, is called a dreikanter. The surfaces of pebbles may be so wind-polished as to form a 'deserts pavement' or 'desert mosaic'.

7. **Deflation Hollows:** This can be formed when winds lower the ground by blowing away loose materials, thereby forming small depressions or hollow by eddying through the action of winds on minor faulting which wears weaker rocks until the water table is reached. As a result, water seeps out forming oases or swamps. Examples include: Faiyum Depression in Egypt which lies 40m below the sea- level.

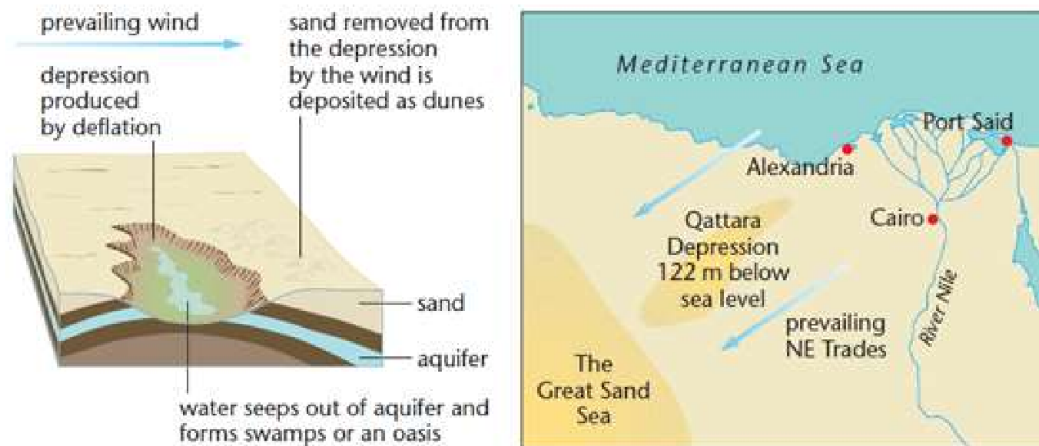


Fig. 3.5: Formation of deflation hollows

Land Forms of Wind Deposition

The load carried by the wind depends on the size of the material, and on the strength of the wind. The finest dust-like grains may be moved right out of the desert area, at a distance of about 3700km (2300miles) before they are finally deposited. The dust from the Sahara Desert is sometimes blown across the Mediterranean to fall as 'blood rain' in Italy or on the glaciers of Switzerland. The heavier ones may simply be re-sorted within the deserts themselves.

Many factors account for the various depositional forms. The nature of the surface over which the sand is moved such as deep sand, bare rock, presence of an obstacle- (a rock, a thorny shrub) or an area of pebbles which may exercise a frictional drag is important. Also the direction and strength of the dominant winds, the presence of vegetation e.g Nile valley, and of ground water reaching the surface, may exert considerable control on the movement and deposition of sand.

Features of Wind Deposition

1. **Dunes:** Dunes are accumulation of hills of sand of varying shape and extent caused by the movement of winds. When dunes are constantly in

motion, they are called active or live dunes, while inactive or fixed dunes when they are rooted with vegetation. Dunes are mostly found in Erg and Sandy deserts. Due to their difference in shape, size and alignment, they have been classified as 'star dunes', 'hairpin dunes', sword dunes, smoking dunes, 'pyramid dunes', parabolic blowout dune and transverse dune. Two most common types of dunes include: (a) barchans (b) selfs.

- (a) **Barchans:** These are crescent or moon shaped dunes which may occur individually or in groups. They are live dunes which occur transversely to the wind, their 'horns' trailed out in the direction towards which it is blowing. They are commonly found in the deserts of Turkistan and in the Sahara.

Mode of Formation: Barchans usually develop from the accumulation of sand caused by small obstructions such as rock or a piece of vegetation.

- As they occurs transverse to the prevailing wind, their horns thin out and become lower in the direction of the wind due to the reduced frictional force of the winds around the edges.
- The leeward side is steep and concave, while the windward side is convex and gently sloping.
- As the accumulated sand is driven up by the prevailing wind, the windward side on reaching the crest, slips down the leeward so that the dune advances. This varies from 8m (25 feet) a year for the high dunes measuring up to 30m (100 feet) high to 15m (50 feet).

Barchans are more prone to migration which may encroach on an oasis, burying several palm trees or houses. This can be prevented by planting long-rooted, sand-holding trees and grasses. When several barchans coalesce into a line or irregular ridges, it becomes difficult to cross.

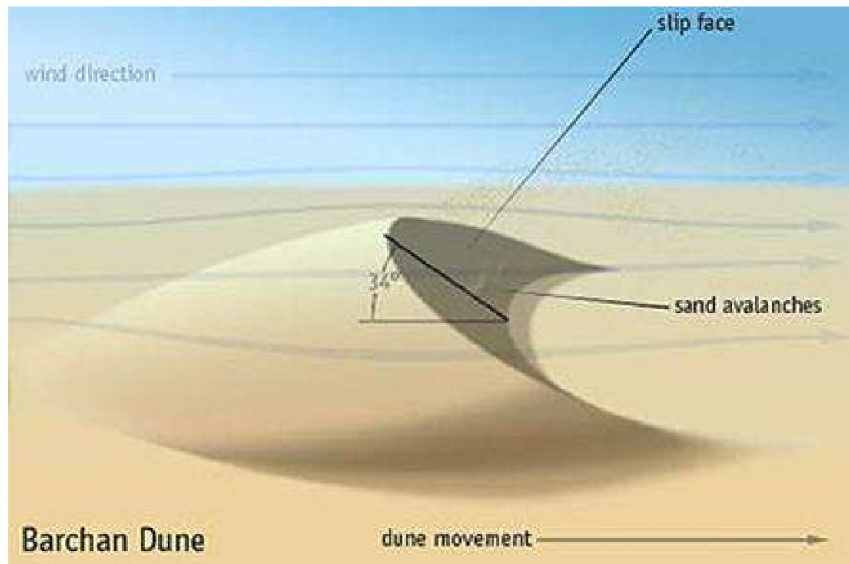


Fig. 3.6 Barchan

- (b) **Seifs or longitudinal dunes:** These are long ridge –shaped dunes which lies in the direction of the prevailing winds. They have steep side and lies parallel to each other. They may be over 100m long.

Mode of Formation: Seifs may be formed by the coalescence of a line of barchans as the prevailing winds and other cross winds blow at right angles.

- The tails swept off the tails of former barchans, are later gathered together for the seif dunes.
- The dominant wind blows straight along the depressions between the dunes lines keeping them clear of sand while eddies help to build up the sides of the dunes.

Examples include the Sahara desert which covers parts of Egypt and Libya, Namib Desert and Northeastern Nigeria sand ripples and ridges.

- (c) **Loess:** These are fine wind-borne or dust materials deposited beyond the limits of the deserts or neighbouring lands. It is a sheet of yellow, friable, porous materials covering nearly 650,000 sq.km with a depth of 90-300m.

It is a fine loam, rich in lime, very coherent and extremely porous. It is so soft that roads constructed through a loess region sink easily and their walls rise steeply. Examples include China, France, Germany, U.S.A.

Importance of Loess:

- (1) They have caves which serve as houses.
 - (2) They are usually very fertile hence encourage agricultural development.
 - (3) They are fine loam, rich in lime.
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- (a) **Sand Ripple:** There are small-scale mound-like features found in between sand dunes. Their height is usually not more than a few centimeters. They are formed by the process of saltation on dry sand surfaces.
 - (b) **Sand ridges:** They are mound-like features, larger in size than ripples which is composed of coarse sand particles, and occur at regular intervals.

Landforms Due to Action of Water in the Desert

Rains do not often fall in true hot deserts but it does occur at times; in semi-desert margins with a mean annual rainfall of 12-25cm (5-10mm). These areas experience a few torrential but short-lived downpours. These short-lived torrents, known as flash-floods, carry loads of solid matter, the product of desert weathering, which may turn into mud-flows. At the mouth of the valley or foot of the hill slope where the gradient eases, the stream is divided into channels forming an alluvial cone or dry delta.

A bajada is a gently undulating sloping surface formed when a number of alluvial cones coalesce along the edge of a depression. When succeeded by an expanse of sand and mud sheet in the centre, it becomes a swamp or temporary salt lake.

Wadis are striking features of a rock desert; their walls, which is steep and craggy rise abruptly from the floors, mainly because of the concentrated vertical erosion by powerful, but short-lived torrents. A prominent Wadi in Africa is the Sahara el-Arabiya in Eastern Egypt. Some desert streams are fed by melting snow of the distant mountains outside the deserts and rivers flow as exotic streams. Water carves out steep walls, which rise, abruptly from the stream bed. In Algeria, such gorges are termed Chebka.

The pediment is an erosional plain formed at the base of the surrounding mountain scarps.

Desert Landscapes

Desert landscapes, in addition to these various features which have been discussed, can be summarized into five distinctive types:

1. The true sand desert, known as the erg in the Sahara and the Koum in Turkestan, consists of vast, almost horizontal sand sheets, with regular dune-lines or an undulating sand-sea e.g the Colan Scio sand sea in Libya.
2. The rocky desert, or the Hemada, which consists of a bare rock surface of which wind had swept clear of sand, and is diversified by Zeugen and Yardang.
3. The stony desert, where horizontal sheets of smoothly angular gravel cover the surface. In Algeria it is called Reg, and Seviv in Libya and Egypt.
4. The area of desert plateau, crossed by Canyon –like valleys of exotic rivers deriving their water from beyond the desert to lands, with steep plateau –edges, mesas and buttes.
5. The Mountain desert with their harsh, serrated outlines, their steep, craggy faces cut into by Wadis, and the action of wind that shows sharp irregular edges. Examples include peaks of Tibesti Alaggar, ranges of central Sahara, and the Sinai mountain of Western Arabia.

Summary

1. Winds though not the most effective agent of erosion, transport and deposition, is more efficient in arid and dry regions that are devoid of vegetation.
2. Wind erosion is carried out by the following processes: deflation, attrition and abrasion.
3. Landforms of wind erosion include rock pedestals, zeugens, yardangs, deflation hollows, ventifacts and dreikanter.
4. Landforms of wind deposition include sand dunes such as barchans, self, and loess.
5. Landforms due to water action in desert include: wadi, pediment, bajada, playas, etc.
6. Types of desert landscape include rocky desert or Hamada, sandy or e.g. mountain deserts, etc.

Objective Questions

1. Rock pedestals are most likely to be found in:
(A) regions where river erosion has taken place. (B) areas where wind abrasion has modified rock of differing resistance. (C) regions where wave hydraulic action has taken place. (D) arid areas where wind deflation has scooped out the earth surface. (E) regions where a river has deposited a large load of sediments (SSCE 1990).
2. A rock pedestal is a feature of
(A) water erosion (B) coastal erosion (C) marine erosion (D) wind erosion (E) volcanic region (SSCE 1992)
3. Which of the following is a feature of erosion in arid regions?
(A) caldera (B) Barchan (C) Yardang (D) Pedestals (E) outwash plain
4. Yardangs are best described as
(A) Long narrow hollow of sand lying parallel to the direction of the prevailing winds. (B) Deserts landscape features which are characterized

by ridges and furrows caused by erosion. (C) Sand blasting effect of winds. (D) Soft rocks that are aligned by the road. (E) Tabular masses which have a layer of hard horizontal rocks.

5. A steep-side feature with bands of alternate hard and soft rock aligned in the direction of the prevailing wind is
(A) Mesa (B) Zeugen (C) Yardang (D) butte
6. In the desert region the most prominent agent of erosion is
(A) Thunderstorms (B) Rainfall (C) Rivers (D) Wind
7. Vent facts are products of
(A) Sand-blasting (B) Wind abrasion (C) Sheet erosion (D) Wind depression
8. Wind erosion is most common in
(A) arid areas (B) rainforest (C) coastal areas (D) river courses
9. Steep sided and often dry valleys in the desert are called
(A) Wadis (B) Hamada (C) Mesa (D) Reg
10. Abrasion, attrition and deflation are processes of
(A) River erosion (B) Coastal erosion (C) Wind erosion (D) Glacier erosion

Essay Questions

1. With the aid of diagrams, describe the characteristic and mode of formation of any two of the following (A) Rock pedestals (B) Yardang (C) Mesa
2. (A) explain the processes of wind erosion
(B) With the aid of a diagram, describe the features of a Barchan dune (WASSCE 2011)
3. Attempt a simple classification of deserts justify your basis of classification of deserts bringing out their distinct differences in appearance and outstands features.
4. Differentiate between the following

5. (A) Zeugen and Yardangs (B) Mesa and Yardangs (D) Barchan and Seif (D) Bajadas and pediments
6. Define with reference to examples what these terms mean.
(A) Erg landscape (B) Loess deposits (C) Rock pedestals (D) Flash floods.