MODULE 1: The Earth

- Origin, Age and Internal structure of the Earth; Materials of Earth; Earth as a closed system. Geomorphology - Weathering of rocks and its engineering considerations; Geological work of wind and running water.

The work of wind

Much of the Earth's solar energy is gained between the tropics and lost at the poles, resulting in a system of global winds which are indirectly responsible for much erosion. They create waves on the oceans which attack the continental coastlines and carry water vapour from the oceans to fall as rain and snow on land to support the rivers and glaciers of the world. The direct effect of wind on land is greatly reduced by vegetation and thus it is bare ground that is most influenced by this agent of erosion.

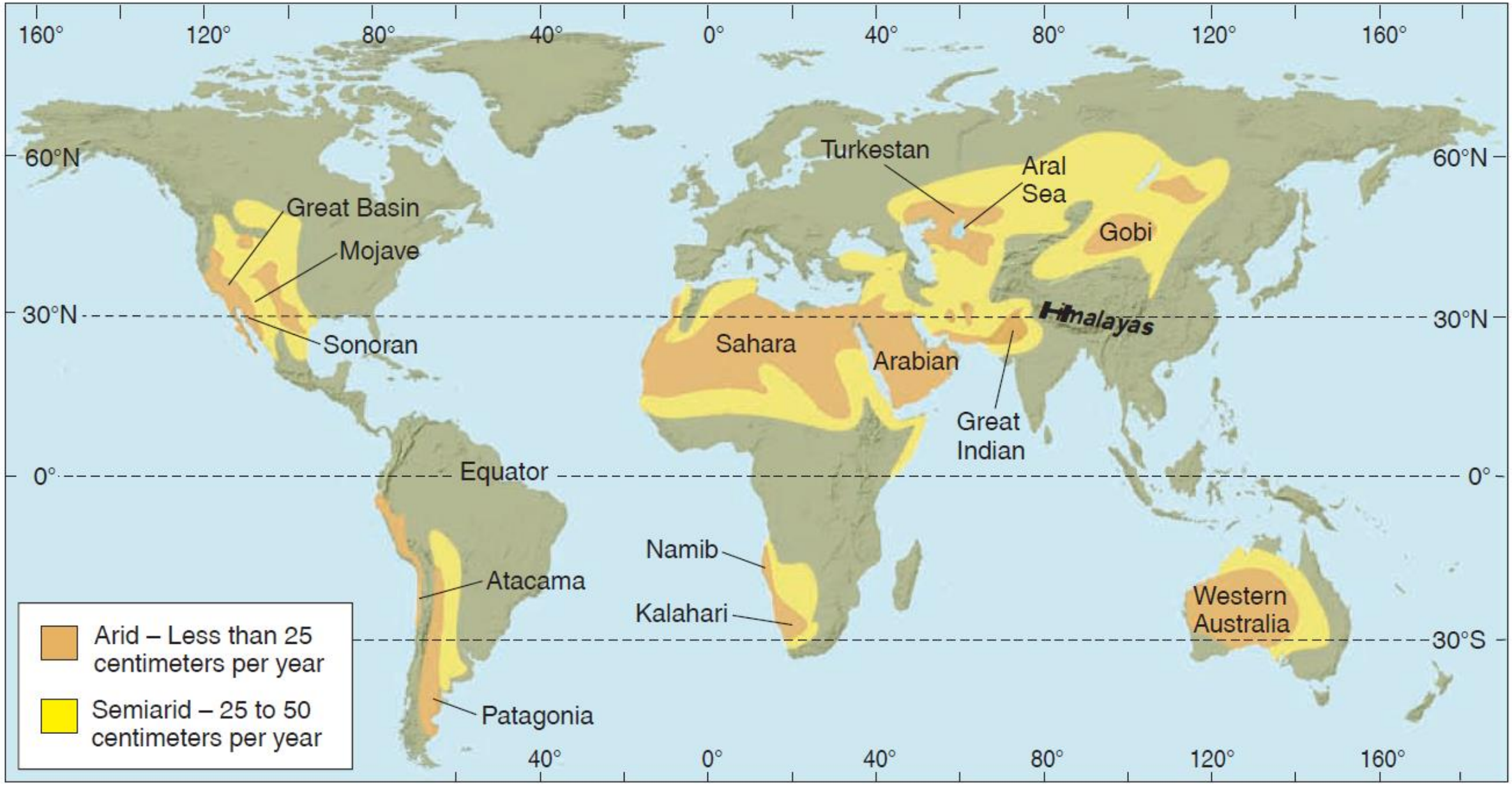


FIGURE 18.3

World distribution of nonpolar deserts. Most deserts lie in two bands near 30°N and 30°S. *Map adapted from U.S. Department of Agriculture*

Transportation of Sediment by Wind

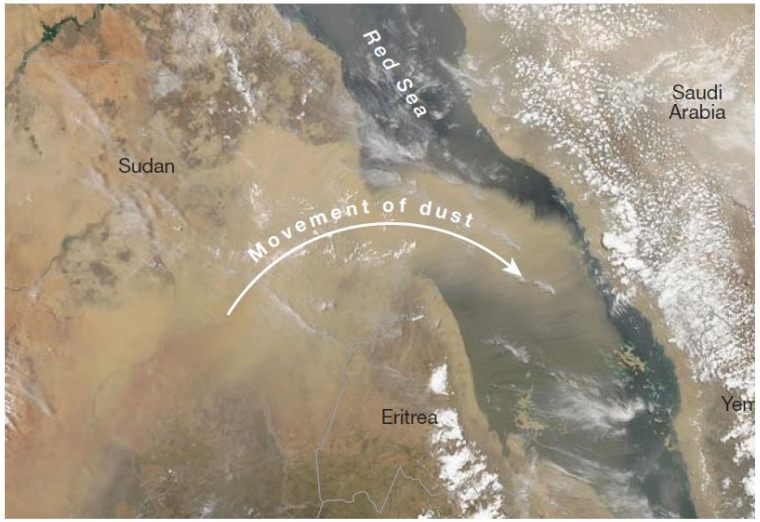
Moving air, like moving water, is turbulent and able to pick up loose debris and transport it to other locations.

- Bed Load
- Suspended Load

FIGURE 12.12 Two examples of suspended load. **A.** Dust blackens the sky on May 21, 1937, near Elkhart, Kansas. It was because of storms like this that portions of the Great Plains were called the Dust Bowl in the 1930s. *(Photo reproduced from the collection of the Library of Congress)* **B.** This satellite image shows thick plumes of dust from the Sahara Desert blowing across the Red Sea on June 30, 2009. Such dust storms are common in arid North Africa. In fact, this region is the largest dust source in the world. Satellites are excellent tools for studying the transport of dust on a global scale. They show us that dust storms can cover huge areas and that dust can be transported great distances. *(NASA)*

A.

B.



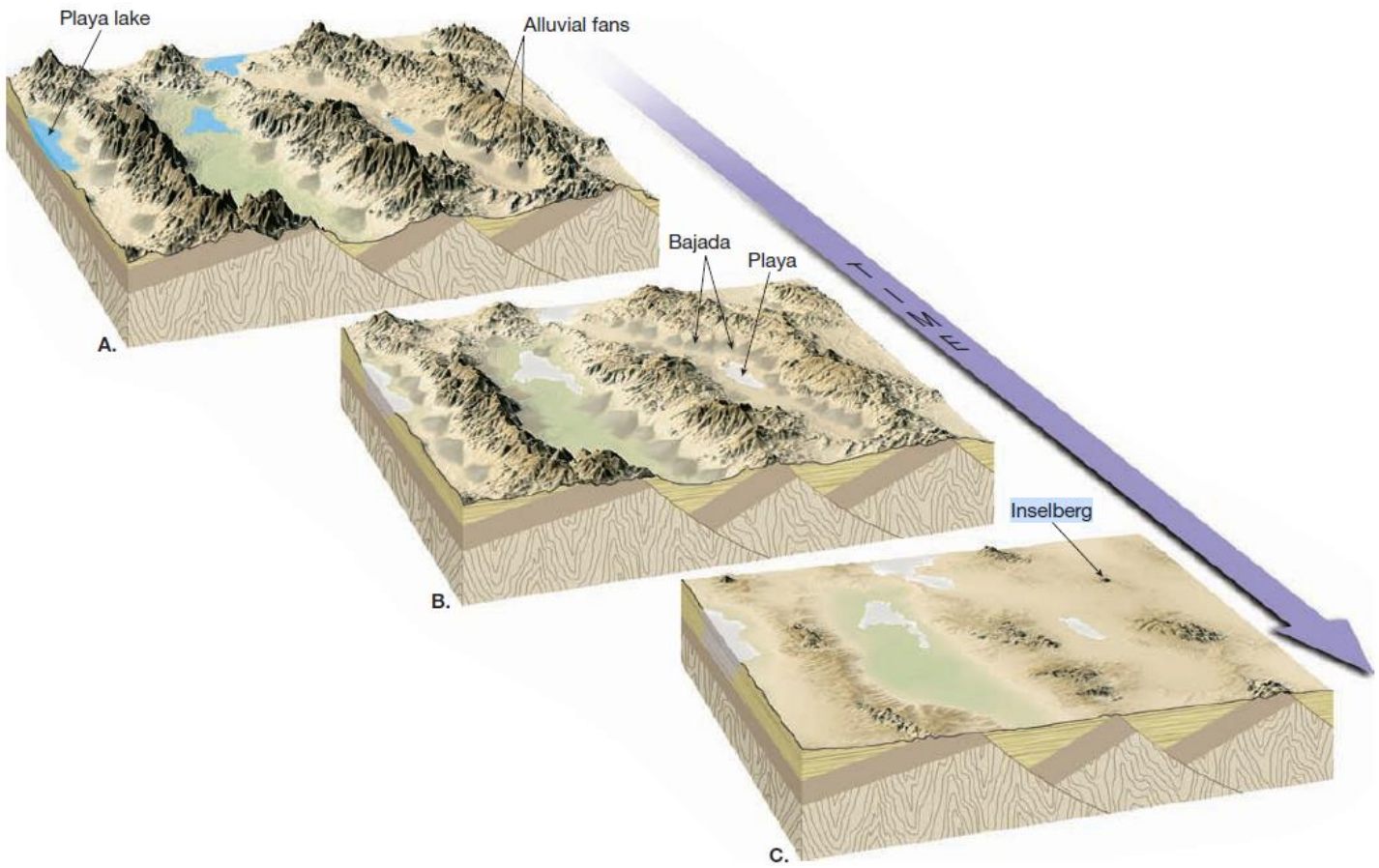
Wind Erosion

Wind erosion is more effective in arid lands than in humid areas because in humid regions moisture binds particles together and vegetation anchors the soil.

The work of denudation by wind is seen most prominently in regions that have a hot, dry climate.

Blowing over weathered surfaces it removes small loose particles of dry and decayed rock, both in deserts and in more temperate regions. In dry desert areas sand of even grade is carried near the ground. Dust particles, however, are blown to greater heights in large quantities, giving rise to repeated dust storms. Most deserts have a rocky floor and any rock surfaces standing above the level of the floor are abraded by the blown sand. The surfaces are smoothed, sharp comers are rounded, and softer bands of rock become more deeply etched than harder layers. These features are typically seen in rocks that have been subjected to wind erosion over a period of time.

Larger masses of rock standing above the floor of the desert are undercut by eddying sand near the ground (to heights of little more than a metre), giving characteristic 'mushroom-shaped' rocks with a narrowed base.



Deflation and Blowouts

One way that wind erodes is by deflation**,** the lifting and removal of loose material.

The removal of clay, silt, and sand particles from the land surface by wind is called **deflation.** If the sediment at the land surface is made up only of fine particles, the erosion of these particles by the wind can lower the land surface substantially.

A **blowout** is a depression on the land surface caused by wind erosion (figure 18.18*A*). A *pillar,* or erosional remnant of the former land, may be left at the center of a blowout.

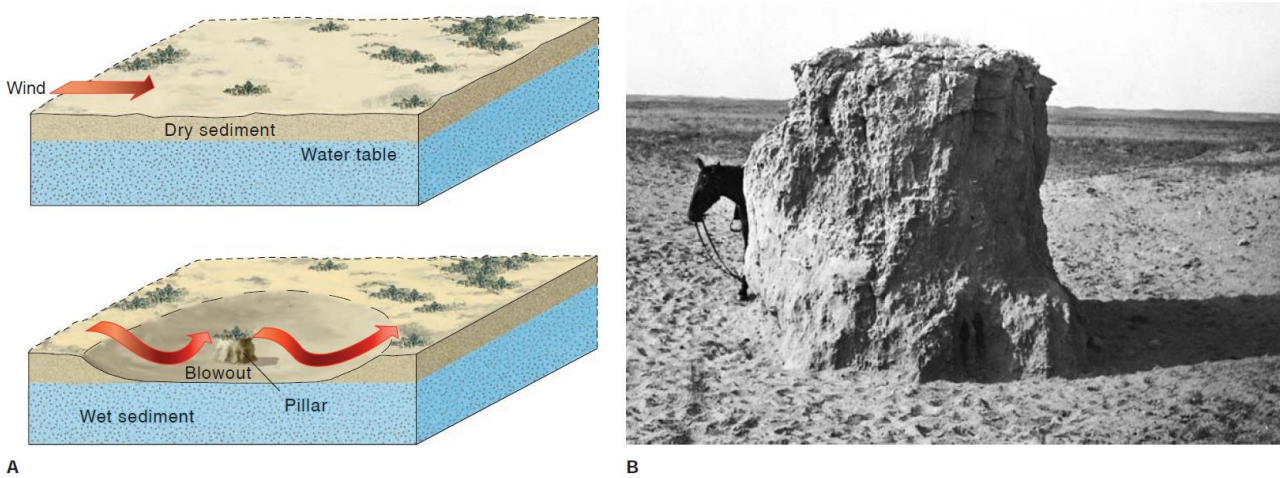


FIGURE 18.18

(*A*) Deflation by wind erosion can form a blowout in loose, dry sediment. Deflation stops at the water table. A pillar, or erosional remnant, may be found in the center of a blowout. (*B*) Large blowout near Harrison, Nebraska. Pillar top is the original level of land before wind erosion lowered the land surface by more than 3 meters. The pillar is the erosional remnant at the center of the blowout. *Photo by N. H. Darton, U.S. Geological Survey*

Ventifacts and Yardangs

Like glaciers and streams, wind also erodes by abrasion**.** In dry regions as well as along some beaches, windblown sand cuts and polishes exposed rock surfaces. Abrasion sometimes creates interestingly shaped stones called ventifacts(FIGURE 12.16A). In addition to ventifacts, wind erosion is responsible for creating much larger features, called yardangs (from the Turkistani word *yar* meaning “steep bank”).

A yardang is a streamlined, wind-sculpted landform that is oriented parallel to the prevailing wind (FIGURE 12.16B). Individual yardangs are generally small features that stand less than 5 meters (16 feet) high and no more than about 10 meters (32 feet) long. Because the sandblasting effect of wind is greatest near the ground, these abraded bedrock remnants are usually narrower at their base.

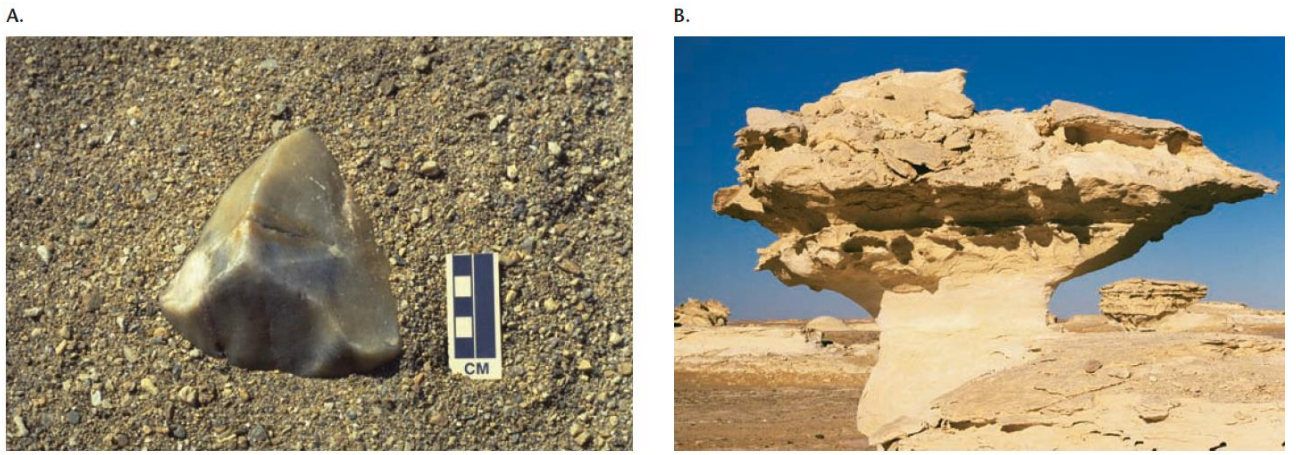


FIGURE 12.16 **A.** Ventifacts are rocks that are polished and shaped by sandblasting. *(Photo by Richard M. Busch)* **B.** Yardangs are usually small, wind-sculpted landforms that are aligned parallel with the wind. *(Photo by Peter M. Wilson/CORBIS)*

Wind Deposits

As is the case with running water, wind drops its load of sediment when its velocity falls and the energy available for transport diminishes.

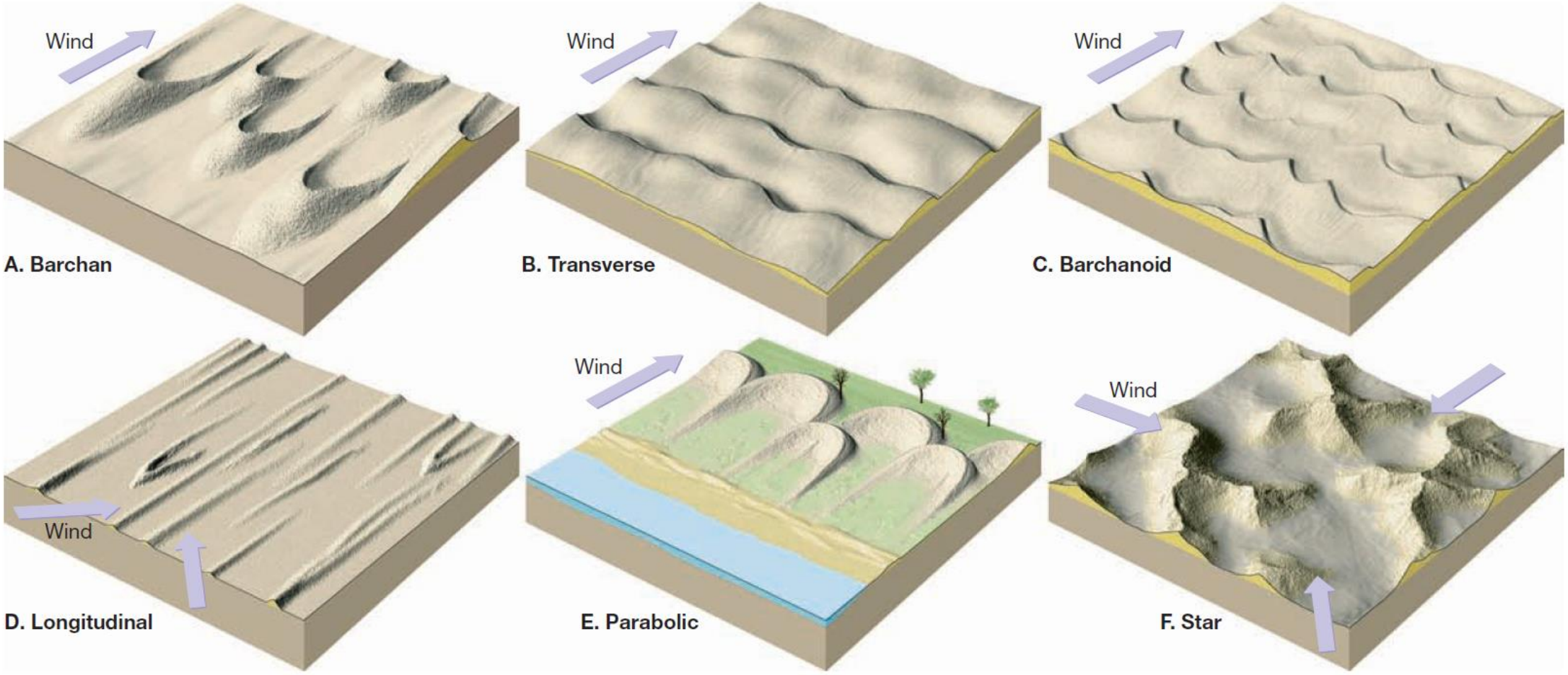
Wind deposits are of two distinctive types:

(1) dunes, and

(2) loess,

Types of Sand Dunes

FIGURE 12.19 Sand dune types. **A.** Barchan dunes. **B.** Transverse dunes. **C.** Barchanoid dunes. **D.** Longitudinal dunes. **E.** Parabolic dunes. **F.** Star dunes.



Loess (Silt) Deposits

In some parts of the world the surface topography is mantled with deposits of windblown silt, called loess. Over thousands of years dust storms deposited this material.

Loess is a deposit of wind-blown silt and clay composed of unweathered, angular grains of quartz, feldspar, and other minerals weakly cemented by calcite.