

# Chapter 16

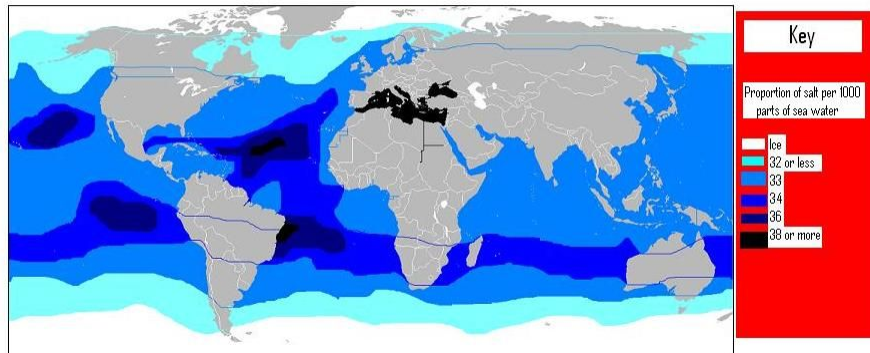
Oceans, Coastal Systems, and Wind  
Processes

# Salinity

**Salinity** is the saltiness or amount of salt dissolved in a body of water .

- Usually measured in dissolved solids per volume

## Salinity of the Oceans



Salinity is an important factor in determining many aspects of the [chemistry](#) of natural waters and of [biological](#) processes within it, and is a [thermodynamic state variable](#) that, along with [temperature](#) and [pressure](#), governs physical characteristics like the [density](#) and [heat capacity](#) of the water.

## Brackish

**Brackish water** - water that has more salinity than fresh water, but not as much as seawater.

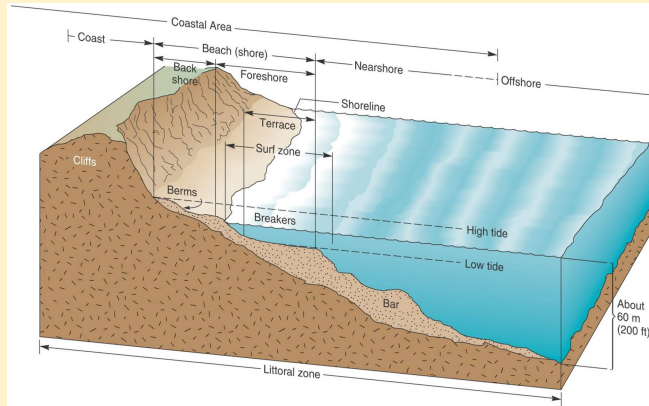
- It may result from mixing of seawater with fresh water, as in estuaries, or it may occur in brackish fossil aquifers.



- **Brine** - term applied to water that exceeds the average of 35% salinity
- *Example:* Sargasso Sea (38%) and the Persian Gulf (40%)

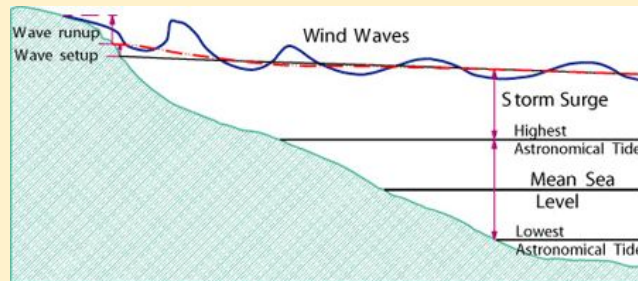
# Coastal Environment

- **Littoral zone** - extends from the highest water mark, which is rarely inundated, to shoreline areas that are permanently submerged.



## Mean Sea Level

**Mean sea level (MSL)** - a value based on average tidal levels recorded hourly at a given site over many years



Currently the U.S. MSL is calculated at 40 locations

Rising sea levels are a problem - just a 1 foot rise would cause shorelines worldwide to move inland an average of 30 m (100 ft)

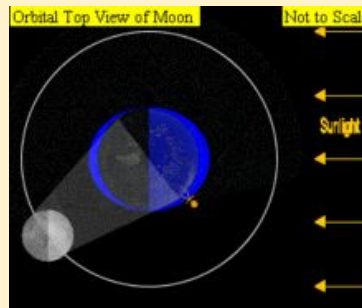
inundating about 20,000 km<sup>2</sup> of and along No. American coastlines - trillions of dollars in economic losses

## Tide

**Tides** are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the Moon and the Sun and the rotation of Earth.

- Complex - occur twice daily

**Fig. 16.6**



Important for human activities including navigation, fishing, and recreation

## Tide Changes

Tide changes proceed via the following stages:

- Sea level rises over several hours, covering the intertidal zone; **flood tide**.
- The water rises to its highest level, reaching **high tide**.
- Sea level falls over several hours, revealing the intertidal zone; **ebb tide**.
- The water stops falling, reaching **low tide**.

**Fig. 16.7**

## Spring/Neap Tide

- **Spring tides** result in high waters that are higher than average, low waters that are lower than average, with stronger tidal currents than average.
  - when the moon is full or new
- **Neap tides** result in less-extreme tidal conditions. There is about a seven-day interval between springs and neaps.
  - when the moon is in its first-quarter or third-quarter

**Fig. 16.6**



## Wave

- **Waves** - undulations of water
- They result from the wind blowing over a fluid surface.
- Storms generate large wave trains.



Waves in the oceans can travel thousands of miles before reaching land. Wind waves on Earth range in size from small ripples, to waves over 100 ft (30 m) high.

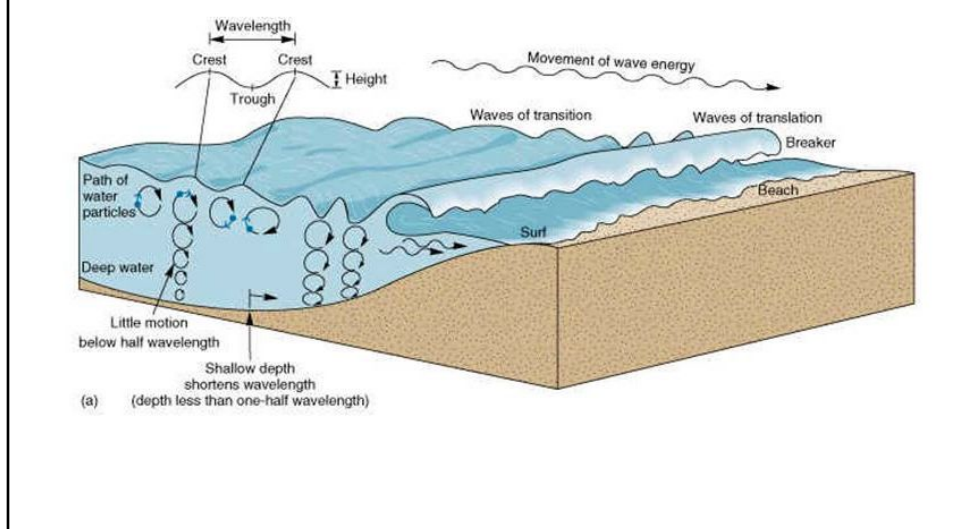
## Swell

**Swell** - a smooth, rounded wave - usually in regular patterns - the mature undulations of the open ocean.

- As these swells, and the energy they contain leave the generating region, they can range from small ripples to very large flat-crested waves.
- It's not the water that is moving - but the water molecules are transferring energy to each other in simple cyclical undulations.

**Fig. 16.9 b & c**

## Wave Formation & Breakers



**Read p. 466 - top left**

**Fig. 16.9 b & c - breakers & rip current**

In times past, when ocean navigation was relatively rudimentary, a line of breaking waves was a crucial indicator that a boat was bearing down upon an island or reef. This was especially the case when sailing in darkness, in which the highly visible line of froth caused by breaking waves could be the only such indicator. In such cases the line of breakers was charted and named as a "breaker".

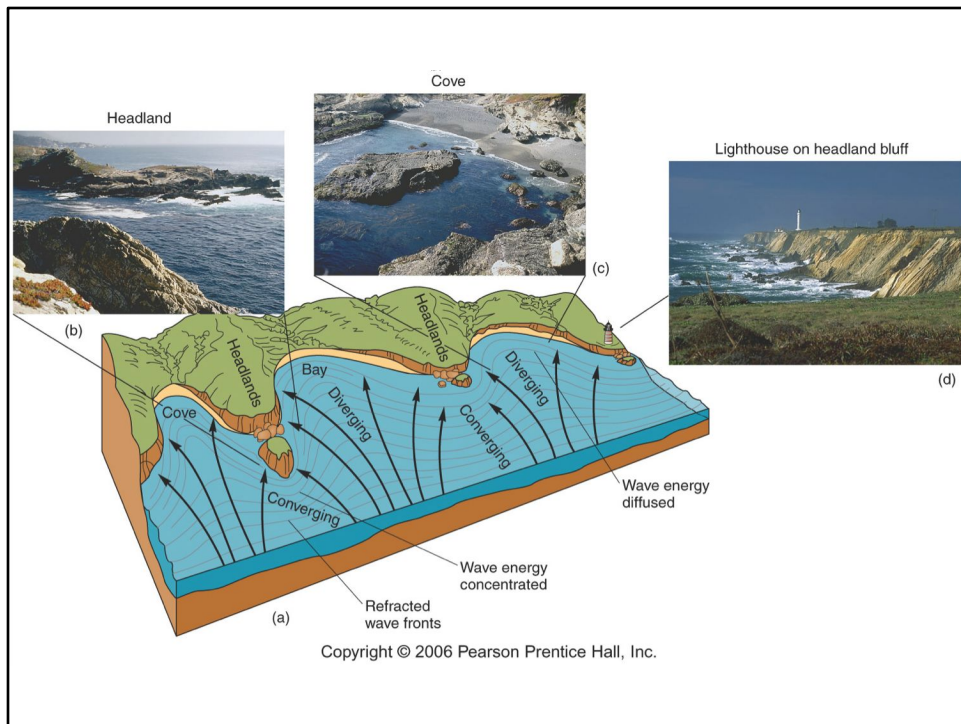
In phase wave trains can lead to monstrous waves.

Out of phase (peaks and troughs don't line up) will dampen their wave energy

## Wave Refraction

Wave action tends to “straighten” a coast line.

- **Refraction** - when waves approach an irregular coastline, the underwater topography refracts, or bends, waves around headlands (protruding landforms made of resistant rock)
  - the refracted energy becomes focused around the headlands and dissipates in the coves or bays between headlands

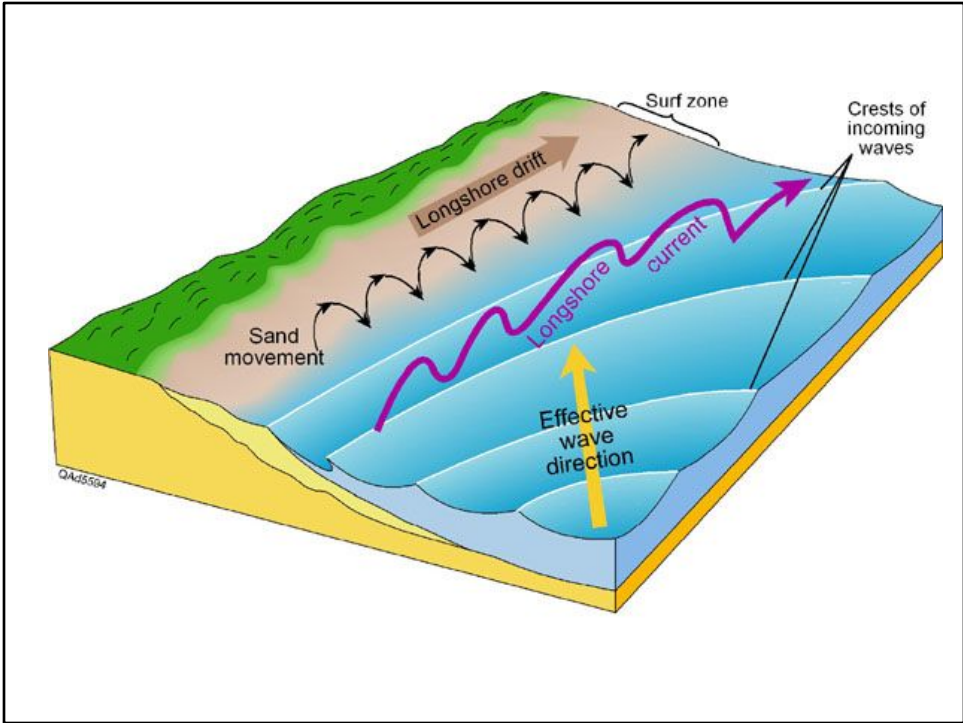


Headlands receive the brunt of the wave attack along a coastline. Long term effect of straightening the coast line

## Longshore Current

Waves usually approach a coast at a slight angle.

- **Longshore current** - is generated only in the surf zone - incoming waves hit the coast and ripple back a bit from the shoreline - the sediment churned up is transported along a coast parallel to the shoreline by successive waves
  - **Beach drift** is simply the sediment moved by the longshore current.
  - **Littoral drift** - term for the combined actions of the longshore current and beach drift.



## Tsunami

**Tsunami** - a series of waves caused by the displacement of a large volume of water, generally in an ocean or a large lake.

- Have nothing to do with the tides - “tidal wave” is incorrect
- Generated by undersea (and coastal) landslides, earthquakes, submarine volcanic eruptions, and meteorite impacts on the ocean

**Fig. 16.12**

Tsunami means “harbor wave” in Japanese because of the devastating impacts they have on harbors





Bottom left - 2004 - Thailand **Fig. 16.12**

Others - March 2011 - Japan **pp. 470-471 Focus Study**

## Wave-Cut Platform

- A **wave-cut platform**, coastal benches, or wave-cut benches is a horizontal bench in the tidal zone area - often found at the base of a sea cliff, extending from the foot of a sea cliff out into the sea - *created by the erosion of waves*.
  - Wave-cut platforms are often most obvious at low tide when they become visible as huge areas of flat rock.

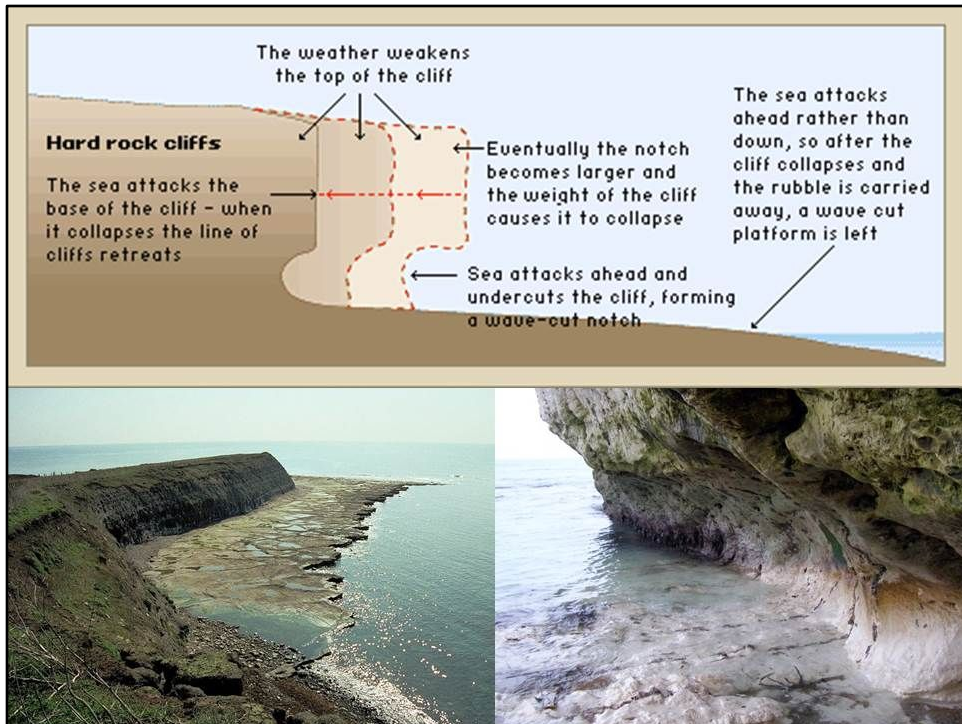


Fig. 16.13

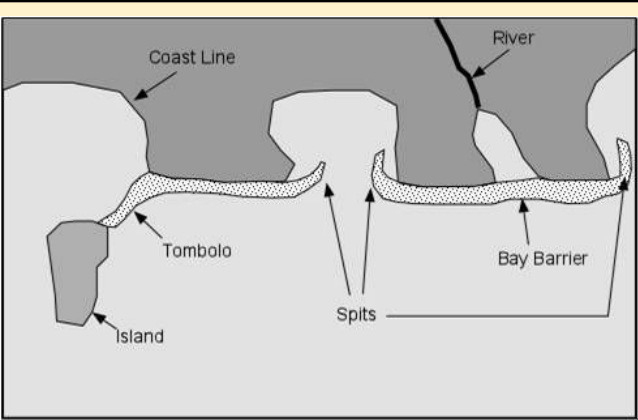
## Barrier Spit / Bay Barrier

- **Barrier spits** - depositional formations caused by the lateral movement of water along a shoreline known as littoral drift - sometimes partially crossing or blocking the mouth of a bay
- **Bay barrier** - when a spit completely cuts off a bay from the ocean



## Lagoon / Tombolo

- **Lagoon** - a shallow saltwater body of water separated from the ocean by bay barriers, barrier islands, or reefs.
- **Tombolo** - occurs when sediment deposits connect the shoreline with an offshore island or sea stack.
  - Once attached, the island is then known as a tied island.
  - Several islands tied together by bars which rise above the water level are called a tombolo cluster.



**Fig. 16.14**



## Beach

**Beach** - a relatively narrow strip along a coast where sediment is reworked and deposited by waves and currents

- Sediment temporarily resides on the beach while in active transit along the shore.

## Barrier Beach / Barrier Island

- **Barrier Beach** or shoal - long narrow depositional features, generally made of sand, that form roughly parallel to the coast
- **Barrier Island** - barrier beaches that become broader and more extensive

**Fig. 16.17**

**Fig. 16.18**



**Should you build on either of these?**



## Coral

Not all coastlines are formed by purely physical processes..... some are formed by biological processes.

- **Corals** are marine invertebrates. They typically live in compact colonies of many identical individual *polyps*.
  - The group includes the important reef builders that inhabit tropical oceans and secrete calcium carbonate to form a hard external skeleton.

**Fig. 16.19** - living coral formations

### **Fig. 16.20** - How atolls form from volcanic islands

Coral bleaching - a significant problem - colorful coral reefs turn stark white as they expel their nutrient-supplying algae and “starve”

Don't really know why, but scientists are tracking it worldwide - possible causes include local pollution, diseases, sedimentation, changes in ocean salinity, and increasing ocean acidity.

## Coastal Wetlands - I

**Mangrove swamp** -in tropical and subtropical regions, sediment accumulation on coastlines provide site for mangroves, shrubs, palms, and ferns that grow in these intertidal areas

- Very tolerant of in coastal saline or brackish water.  
The term is also used for tropical coastal
- Mangrove roots are generally visible above the waterline.
- Below the waterline, the roots provide a habitat for a multitude of specialized life forms

**Fig. 16.23**

Some coastal area have sediments rich in trapped organic matter and as a result have great biological productivity

## Coastal Wetlands - II

**Salt marsh** - is a coastal ecosystem in the upper coastal intertidal zone between land and open salt water or brackish water that is regularly flooded by the tides.

- It is dominated by dense stands of salt-tolerant plants such as herbs, grasses, or low shrubs



## Wind Processes

The geomorphic changes of wind can most easily be seen at coastal and desert environments.

Moving air is fluid, like water, and like moving water, causes erosion and deposition.

- **Eolian** - sand or rock material carried or arranged by the wind.

## Eolian Transport of Dust and Sand

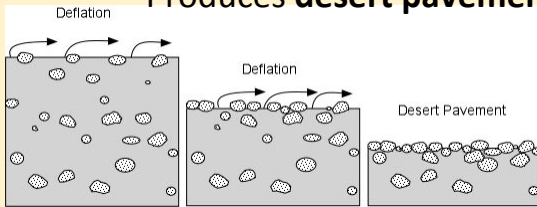
- Suspension - particles literally lifted and carried by the wind
- **Saltation** - sediment picked up and bounced along the surface
- **Surface creep** - process in which larger sand grains are moved along the ground surface by impact of other grains in saltation.

**Fig. 16.25**

## Deflation/Abrasion

**Deflation:** the removal of loose, fine-grained particles by the turbulent action of the wind.

- Produces **desert pavement**



**Abrasion:** the wearing down of surfaces by the grinding action and *sandblasting* by windborne particles



Desert pavement

## Ventifact

**Ventifact** - a rock that has been abraded, pitted, etched, grooved, or polished by wind-driven sand or ice crystals.



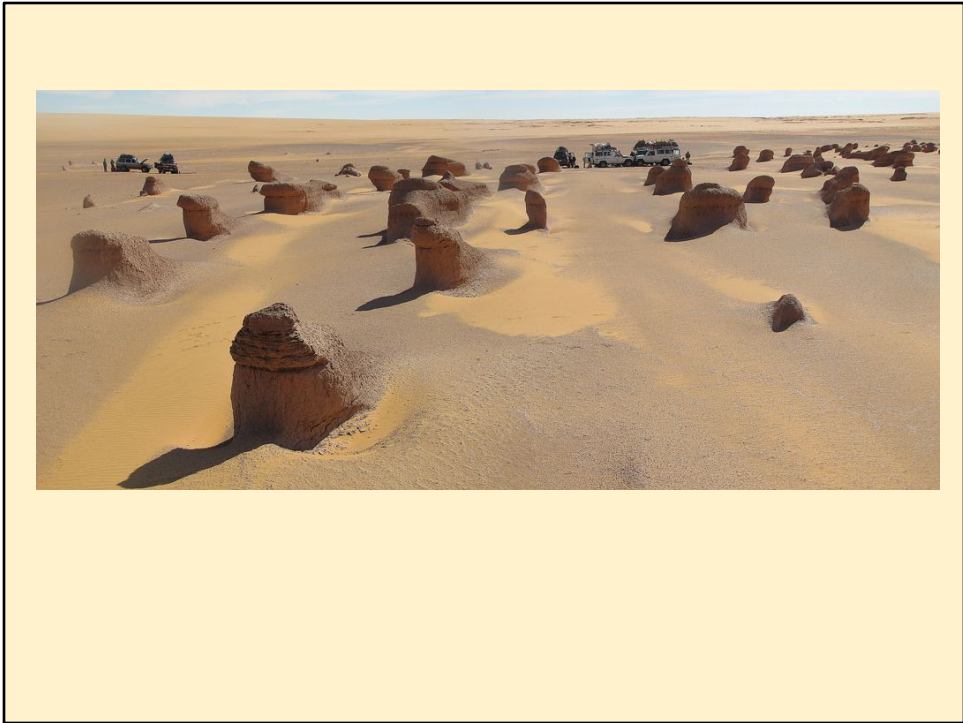
# Yardang

**Yardang** - large scale deflation and abrasion of multiple rock structures in a landscape

- alignments parallel to the most effective wind direction
- produce distinctive, elongated formations



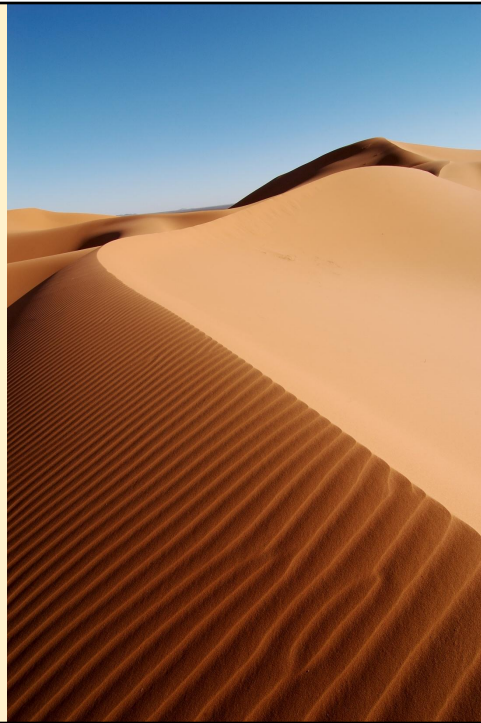




## Dune

**Dune** - a hill of loose sand built by wind

- transient
- longer on the windward side where the sand is pushed up the dune and have a shorter "slip face" in the lee of the wind.
- Extensive area of dunes is an **erg**, or **sand sea**



## Types of Dunes - I

- **Barchan** - crescent shaped dune with “horns”  
pointed downwind
  - wind consistently coming from one direction
- **Transverse** - long, slightly sinuous dune
  - forms perpendicular (at right angles) to the wind direction



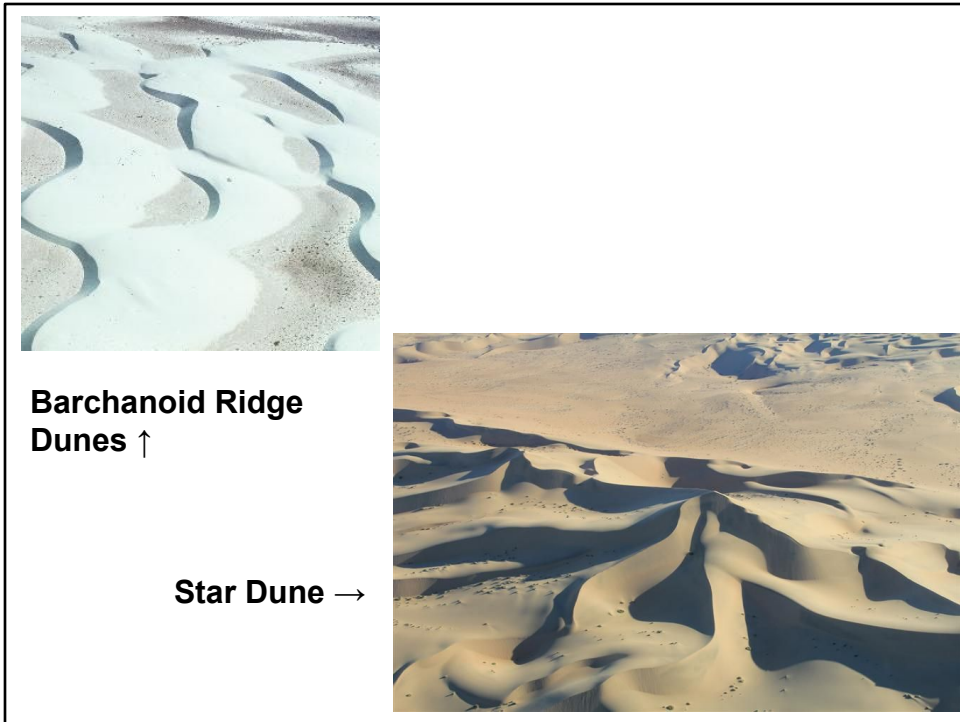
**Barchan dunes** ↑

**Transverse** →



## Types of Dunes - II

- **Barchanoid ridge** - wavy, asymmetrical dune formed from coalesced barchan dunes
  - form perpendicular to wind direction
- **Star dune** - pyramidal shaped with three or more sinuous, radiating arms extending outward from a central peak
  - results from effective winds shifting in all directions

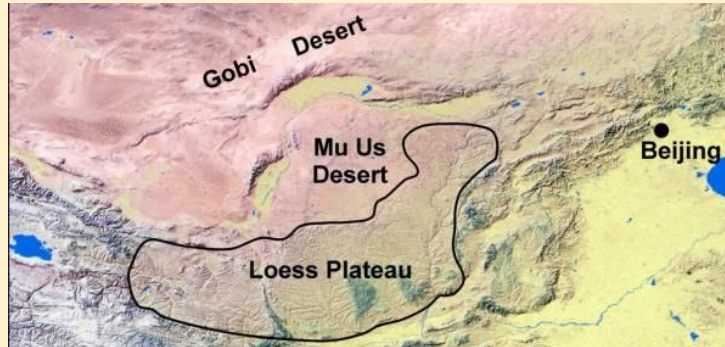


Dunes can also become “stationary” - when plant growth stabilizes them over time, and even lithified

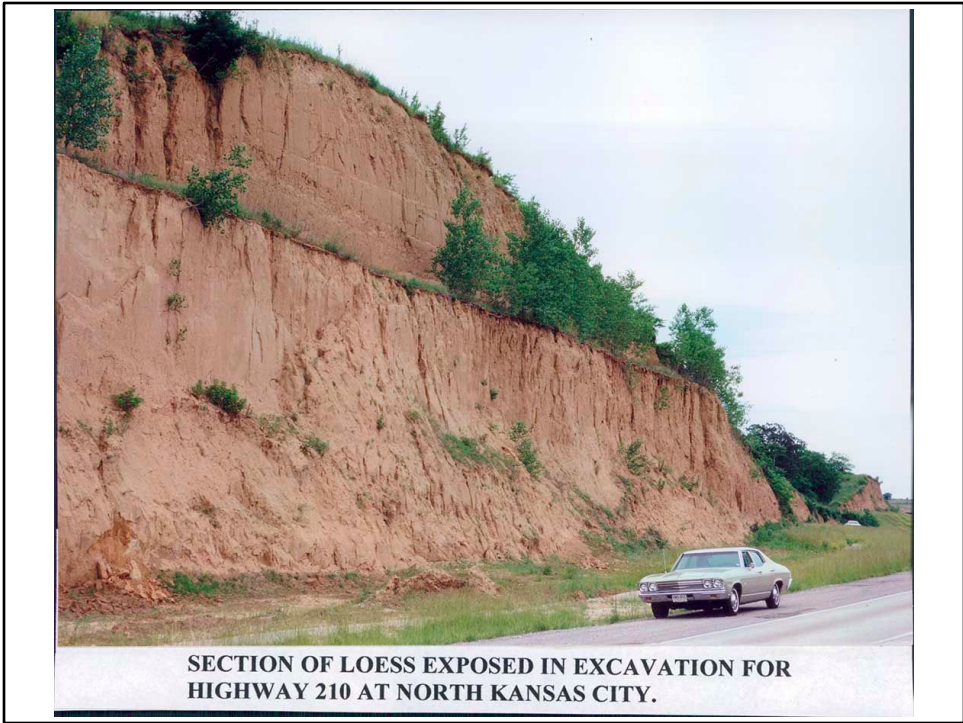
# Loess

**Loess** - large quantities of fine-grained clays and silts left as glacial deposits

- subsequently blown by the wind great distances and redeposited as a generally unstratified, homogeneous blanket of material covering existing landscapes



Pronounced "luss"



**SECTION OF LOESS EXPOSED IN EXCAVATION FOR  
HIGHWAY 210 AT NORTH KANSAS CITY.**