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2 ***Chapter 19 – Deserts & Winds***

3 **Distribution and Causes of Dry Lands**

- What Is Meant by *Dry*?
  - A dry climate is one where yearly precipitation is not as great as the potential for evaporation
  - Dry regions cover 30 percent of Earth's land surface
  - Two water-deficient climatic types are commonly recognized
    - Desert (or arid) regions, and
    - Steppe (or semiarid) regions
- Desertification: the persistent degradation of dry-land ecosystems—desert-like conditions are expanding worldwide

4 **Dry Climates**

5 **Distribution and Causes of Dry Lands**

- Subtropical Deserts and Steppes
  - Lie between the Tropics of Cancer and Capricorn
    - Virtually unbroken desert environment stretching for more than 9300 kilometers
  - Subsiding air masses
    - The basic cause of bands of arid and semi-arid areas
    - Regions of high pressure (sinking air that is compressed and warmed)
      - Few chances for cloud formation and precipitation

6 **Subtropical Deserts**

7 **Distribution and Causes of Dry Lands**

- Subtropical Deserts and Steppes
  - West Coast Subtropical Deserts
    - Cold ocean current cools air and prevents it from rising
      - Few chances for cloud formation and precipitation
      - Often foggy areas
        - » Atacama Desert, South America
        - » Namib Desert, south-western Africa

8 **Distribution and Causes of Dry Lands**

- Middle-Latitude Deserts and Steppes
  - Sheltered in deep interiors of large landmasses
    - Far-removed from ocean moisture
      - Gobi Desert, central Asia
  - Mountain barriers
    - As prevailing winds meet mountains, the air is forced to ascend where it rises, expands and cools, producing clouds and precipitation
    - Air flowing over the leeward side of the mountain is dry and forms a rainshadow
      - Coast Ranges, Sierra Nevada and Cascades, North America

9 **Rain Shadow Deserts**

10 **Precipitation in Washington**

11 **Geologic Processes in Arid Climates**

- Weathering
  - Chemical weathering processes not as prominent
  - Mechanical weathering more prominent
  - Some chemical weathering does occur over long spans of time
    - Produces clay, thin soils, and oxidation of iron-rich sediments

12 **Geologic Processes in Arid Climates**

- The Role of Water
  - Water still plays an important role in shaping dry landscapes
  - Most streambeds are dry most of the time

- Ephemeral streams (intermittent streams) only carry water in response to specific periods of rainfall
  - –May only flow a few days or hours a year
- When rain falls, it is too much to soak in and most of it flows as runoff into the streambeds
  - –Desert floods arrive suddenly and subside quickly

13 **Ephemeral Stream**

14 **Geologic Processes in Arid Climates**

- Different names are used for ephemeral streams in various regions
  - – *Wash* and *arroyo* (western United States)
  - – *Wadi* (Arabia and North Africa)
  - – *Donga* (South America)
  - – *Nullah* (India)

15 **Wadi in North Africa**

16 **Geologic Processes in Arid Climates**

- The Role of Water
  - – Some permanent streams do cross arid regions
    - Originate *outside* the desert in well-watered mountains
    - Must contain enough water to compensate for loss from evaporation in arid region
      - –Example: Colorado and Nile Rivers
  - – While infrequent, running water does *most* of the erosional work in deserts

17 **Basin and Range: The Evolution of a Desert Landscape**

- Arid regions typically have interior drainage because the intermittent streams do not flow to the ocean
  - – *Basin and Range* province has basins, local base levels, so erosion occurs without reference to the ocean
- Landscape evolution
  - – Uplift of mountains
  - – Running water erodes and transports materials to the basin

18 **Landscape Evolution in the Basin and Range**

19 **Basin and Range: The Evolution of a Desert Landscape**

- Landscape Evolution
  - – Sediment-laden rivers from sporadic rains deposit debris at the mouth of a canyon
    - Runoff spreads out over gentler slopes and quickly loses velocity
    - This fan-shaped sediment deposit is called an alluvial fan
      - –Coarsest material deposited first
    - A bajada forms from the coalescing of multiple fans

20 **Bajada**

21 **Basin and Range: The Evolution of a Desert Landscape**

- Landscape Evolution
  - – During heavy rainfall, streams flow across the bajada to form a shallow, short-lived playa lake
    - The dry, flat lake bed left after the water evaporates is called a playa
  - – Continued erosion diminishes the mountains to a few isolated bedrock knobs called inselbergs

22 **Playa in Death Valley**

23 **Death Valley**

24 **Transportation of Sediment by Wind**

- Differs from that of running water in two ways:
  - – Wind is lower density and less capable of picking up and transporting coarse materials
  - – Wind is not confined to channels and can spread sediment over large areas

25 **Transportation of Sediment by Wind**

- Bed Load
  - The bed load is carried by wind close to the surface
    - Consists mostly of sand grains
    - Sand moves across the surface in a process called saltation (by bumping and skipping)
  - Height of the bed load rarely exceeds one meter above the surface, generally no higher than 0.5 meters

26 **Transporting Sand**

27 **Transportation of Sediment by Wind**

- Suspended Load
  - The suspended load is carried high into the atmosphere
    - Consists mostly of silt-sized particles
      - Surface area must be high compared to weight
      - Example: flat clay particles
    - Hard to move fine particles unless they have been disturbed on the surface
      - Example: a clay road with and without a car driving over it
    - The suspended load can be transported far distances
      - Dust from the Sahara can reach the Caribbean

28 **Wind's Suspended Load**

29 **Wind Erosion**

- Compared with glaciers and running water, wind is an insignificant erosional agent
  - More effective in arid regions
    - Dryness and scant vegetation are important for wind to be effective at eroding
      - Example: Dust Bowl in 1930s

30 **Wind Erosion**

- Deflation and Blowouts
  - Deflation is the lifting and removal of loose material
    - Hard to notice because the entire surface is being lowered
      - During the Dust Bowl, vast areas were lowered by one meter in a few years
  - Deflation also produces blowouts (shallow depressions)
    - Can range from small dimples to depressions that are 50 meters deep and several kilometers across

31 **Blowouts**

32 **Wind Erosion**

- Desert Pavement
  - Many deserts have a veneer of pebbles and cobble called desert pavement
  - Forms from an initial surface of coarse pebbles
    - Fine, windblown grains are trapped between the pebbles
    - Gravity and infiltrating rainwater move the fine sediments beneath the cobbles

33 **Desert Pavement**

34 **Formation of Desert Pavement**

35 **Wind Erosion**

- Ventifacts and Yardangs
  - Wind also erodes by abrasion (scraping)
    - Windblown sand *cuts and polishes* rock surfaces
    - Creates interestingly shaped stones called ventifacts
  - Wind also creates streamlined landforms oriented parallel to the prevailing wind direction called yardangs

36 **Shaped by the Wind**

37 **Wind Deposits**

- Two types of depositional landforms are created by wind
  - Dunes
    - mounds and ridges of sand from the wind's bed load

- Loess
  - extensive blankets of silt once carried in suspension

38 **Wind Deposits**

- Sand Deposits
  - Sand will accumulate wherever an obstruction blocks wind flow, creating a dune
    - Dunes often form around a clump of vegetation or rocks
    - Most dunes have an *asymmetrical profile*
      - Windward slope is gently inclined and the steeper leeward slope is called the slip face
        - The slip face typically maintains an angle of 34 degree (the angle of repose for sand)

39 **White Sands National Monument**

40 **Wind Deposits**

- Sand Deposits
  - As sand is deposited on the slip face, layers form *inclined to prevailing wind direction*, creating cross bedding
  - Moving sand can be troublesome for permanent structures like roads and buildings

41 **Cross Bedding**

42 **Moving Sands**

43 **Wind Deposits**

- Types of Sand Dunes
  - Dunes are classified into six basic types *based on their size and shape*
  - Barchan dunes are solitary sand dunes shaped like crescents
    - Form where sand supplies are limited and the surface is flat, hard, and lacking vegetation
  - Transverse dunes are a series of long ridges oriented at right angles to prevailing winds
    - Form where sand is plentiful and vegetation is sparse
      - Most coastal beach dunes are transverse dunes
  - Barchanoid dunes are a intermediate form of dune between barchan and transverse dunes

44 **Wind Deposits**

- Types of Sand Dunes
  - Longitudinal dunes form parallel to prevailing winds where sand supplies are moderate
  - Parabolic dunes form when vegetation partially covers the sand
  - Star dunes are isolated hills of sand that develop when wind directions are variable

45 **Types of Sand Dunes**

46 **Wind Deposits**

- Loess (Silt) Deposits
  - Windblown silt deposits
  - Material is deposited by storms over thousands of years
    - Sources of sediments come from deserts and glacial outwash deposits
      - Loess in China originates from desert basins in central Asia
      - Loess in the United States and Europe is the product of glacial material

47 **Loess**

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