Deserts and Wind

I. Introduction

A. Landscape evolution in arid and semi-arid regions of the earth can take on a distinctive characteristic of their own.

1. low annual precipitation,
2. distinctive floral/faunal habitation,
    a. sparse vegetative cover
    b. high erosion potential
3. Physical weathering dominant
4. ephemeral (seasonal) erosion / deposition processes

B. Definition/Characteristics of Deserts

1. Dry Climate: Rate Evaporation > Rate of Precipitation
    a. Arid climate: <10 to 15 inches/year (Desert Regime)
    b. Semi-arid: 10-25 inches/year (Steppe Regime)
    c. "flashy" high-intensity, short duration rainfall events
    d. wind and water as erosive agents
        (1) water still most effective agent
    e. cold vs. hot deserts
    f. poor soil development, low humic content
    g. drainage: ephemeral, dry river beds
    h. internal drainage, dry lake beds common

2. Causal Factors of Dryness:

    a. Latitudinal Effects of Global Surface Heating/Global
        (1) Result of semi-permanent high pressure systems
        (2) high level temperature inversions
            (a) e.g. Sahara Desert of Africa

        (3) Global Subtropical Desert Belt
            (a) persistent dry / arid air
            (b) 20-30 degrees N. and S. of Equator

        (4) Polar Deserts
            (a) Cold, dry air
            (b) persistent, dry, high-pressure systems
                i) e.g. Antarctica

    b. Orographic/Rain Shadow Effects: on leeward sides of high mountain ranges or in remote continental interiors, precipitation is concentrated on upwind side of mountains, water condenses as air rises over mountains, leaving dry air moving over leeward side, creating desert conditions.

        (1) interior of Pacific Northwest, Mohave desert of California.
    c. Coastal Dryness

(1) Cold marine water offshore
(2) Promotes cold, dry air above
(a) e.g. Peru / Chile

II. Fluvial Processes in Desert/Arid Regions:

A. High erosion and runoff in dry, sparsely vegetated areas
1. rain splash, sheetwash, rilling and flashflooding is common
2. streams rapidly become choked with sediment during concentrated flow/flood events.
3. Drainage basins tend to be closed (i.e. not through flowing) with internal drainage and basin sedimentation.

B. Desert Hydrography

1. Dominated by ephemeral streams: streams which only flow during seasonal or storm events. Most of the time these drainages exist as dry washes aka arroyos or wadis.

2. Exotic streams = perennial streams that flow year round through the desert, but these are relatively rare and sustained by water with headlands outside of the desert region in a more humid environment.

a. The Nile river

3. Lake Basins: perennial lakes uncommon in desert, but dry lake beds are quite common, and associated with the closed nature of drainage basins.

a. Playa lakes- dry lake beds, are epemeral in nature and may periodically contain water, subsequently subject to high evaporation rates

b. Salt flats: playa lakes in which the water contains an appreciable amount of dissolved salts, upon evaporation the salts precipitate on the lake floor.

c. Pluvial Lakes: perennial lakes found in some desert areas (e.g. Great Salt Lake, Pyramid Lake of Nevada) that are remnants of larger lake bodies that formed in past, more humid climates of the Pleistocene.

C. Fluvial Erosional Desert Landscape Features

1. Differential Erosion- the differential erodibility of different rock types under desert-fluvial conditions. (e.g. quartz sandstone is more resistant than shale to weathering).

2. Butte/Mesa Desert Topography: a result of differential erosion with resistant cap rocks holding up topographic features.

a. Butte- round/oval shaped, flat topped topographic feature
b. Mesa- elongated/table like, flat-topped topographic feature

3. Inselbergs- isolated, resistant rock masses that stand high in relief to surrounding topography. Erosionally resistant rock mass, that stands in relief as more easily eroded material is striped/eroded from the surrounding landscape.

4. Pediments- gently inclined ramp that extends outward from a mountain front, found along the lower slopes of mountains in desert regions. Formed by erosion of mountain fronts.

5. Badland Topography- intricately rilled and barren terrain in arid regions. An extensive network of convoluted rills and gullies forming a "badland" topography.

D. Fluvial Deposition in Arid Landscapes: eroded debris is commonly deposited in form of talus slopes and alluvial deposits on valley floors.

1. Depositional Sites

a. Piedmont Zone- "foot of the mountains"- the zone at base of desert mountain ranges that forms the site of fluvial depostions from mountain canyons.

b. Alluvial Fans: fan-shaped deposit of alluvial debris as mountain stream drainages empty onto the piedmont area.

c. Bajada- coalescing alluvial fans from adjacent mountain canyons forming a "fan apron" along the mountain front.

d. Intermontane Basins:
(1) Playa lake deposits
(2) Alluvial deposits
(3) Aeolian Deposits: i.e. dune development
(4) Bolsons - closed, internal drainage basins
(a) no through flow / outlet of rivers / streams

2. Arroyo - ephemeral (comes and goes), seasonal streams of the southwest
a. dry washes
b. flash-flood prone
c. Arroyo Cycles -
(1) episodic infilling with sediment alternating with erosional incision

III. Eolian Processes: The Work of Wind

A. General

1. Introductory statement: desert winds readily move sediment in sparse vegetative regimes, but the size fraction is generally limited to clays, silts, and fine sand.
2. "Aeolian" processes- are those related to wind (greek root of wind).

B. Aeolian Erosion Processes:

1. Deflation- general movement of loose particles by shear force in suspension or by rolling along ground surface.
    a. Blow outs: selected areas subject to selective deflation of finer grain-size fractions

2. Abrasion- i.e. sandblasting effect eroding and setting additional sediment into motion.
    a. Rock pitting, etching, faceting, and polishing.
    b. Ventifacts- polished and abraded stones on desert floor.
    c. Desert Pavement- a layer of coarse gravel and boulders left stranded on desert floor as wind selectively deflates finer grain sizes out of area.

        (1) desert varnish- a dark shiny coating consisting ofiron and maganese oxides coating desert pavement.

C. Aeolian Transportation:

1. Bedload: coarse sand moved along ground surface through saltation process.
2. Suspension Load: finer sand, silt, and clay particles carried above the ground surface in air turbulence.
    a. Sand Storms/Dust Storms: sediment in suspension anywhere from several inches to several feet, to 100's of feet above ground surface.

D. Aeolian Deposition: deposition at sites of decreased wind energy

1. Sand Dunes: mounded piles of windblown sand deposited on desert floor. May be found in extensive dune fields, on playas, or on bedrock surfaces.

    a. Ergs- "sea of sand", a large sand dune complex perhaps covering 10's to 100's of square miles.

    b. Dune Morphology

        (1) Classic Dune Profile: gently sloping stoss side (up wind side) of 10-15 degrees, crest or top of dune, and steeply inclined (32-25 degrees) leeward side or "slipface".

            (a) Slipface- steep leeward side of dune,
            (b) Sand generally saltates up stoss side, and is deposited on leeward side at slip face in the dune shadow. Avalanching common on slipface forming high angle cross-bedding.

E. Sand Dune Types: classification based on shape and pattern of dunes

1. Barchan Dunes: solitary crescent shaped dunes with their tips pointing downwind (i.e. horns point downwind). Steep leeward slipface on on concave side of dune.

2. Transverse Dunes: essentially a series of interconnected barchan dunes connected by a sinuous crest. Crest oriented transverse to wind direction, found in areas of greater sand supply than barchan dunes, with strong unidirectional winds.

3. Longitudinal Dunes or Seifs- elongated ridges of sand in which the dune crest is oriented parallel to the wind direction.

    a. thought to be associated with modest sand supplies but with 2 dominant wind directions within 90 degrees of one another.

4. Parabolic- similar to barchans but in opposite orientation--crescent-shaped dunes with steep lee side on convex portion, with horns pointing upwind.

    a. Found in areas where vegetative growth anchors the dunes with subsequent blowout of stoss-side central portions.

F. Loess- wind-blown silt, generally lacks stratification, with great cohesion within depositional unit.

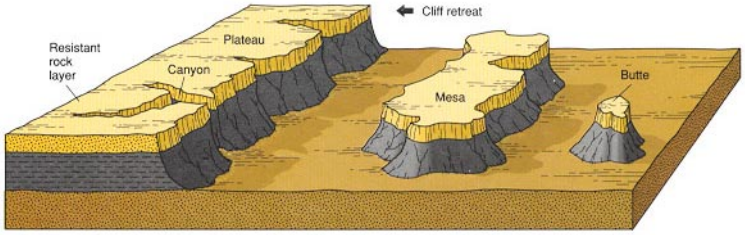
1. often found at edges of desert basins or on margins of glacial outwash areas.

IV. Desertification / Climate Change

A. Desertification
1. Environmental transformation of arable land into dry land
    a. high erosion potential
    b. destruction of delicate arid-climate vegetation

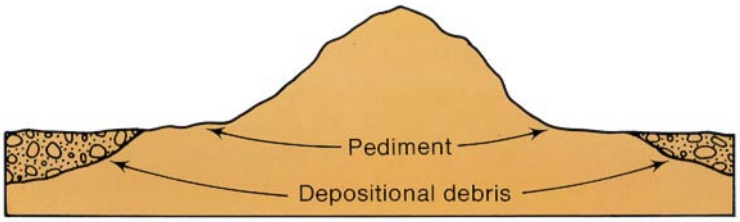
2. Man Induced
    a. Landuse
        (1) overgrazing
        (2) excessive water use
            (a) groundwater
            (b) surface water
                i) irrigation

3. Climate Induced
    a. Global Warming / Global Climate Cycles



Mountain Erosion in Arid Climate

A pediment is an erosional surface usually found in the piedmont zone of a desert mountain range T66



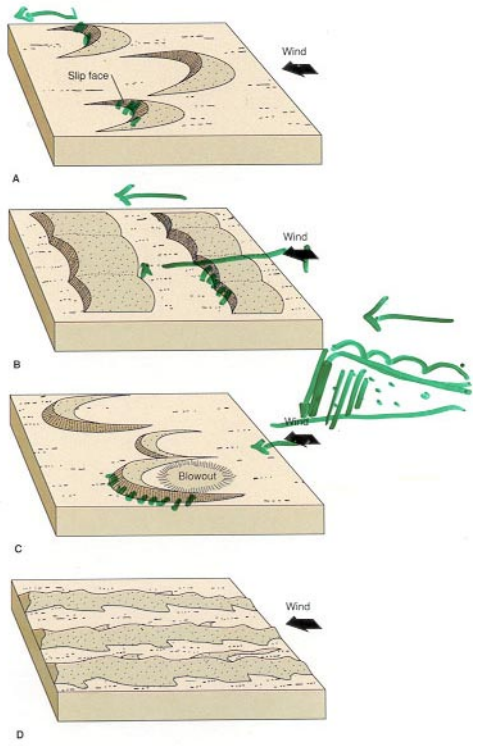
Eolian / Wind Processes in Deserts

Barchan

Transverse

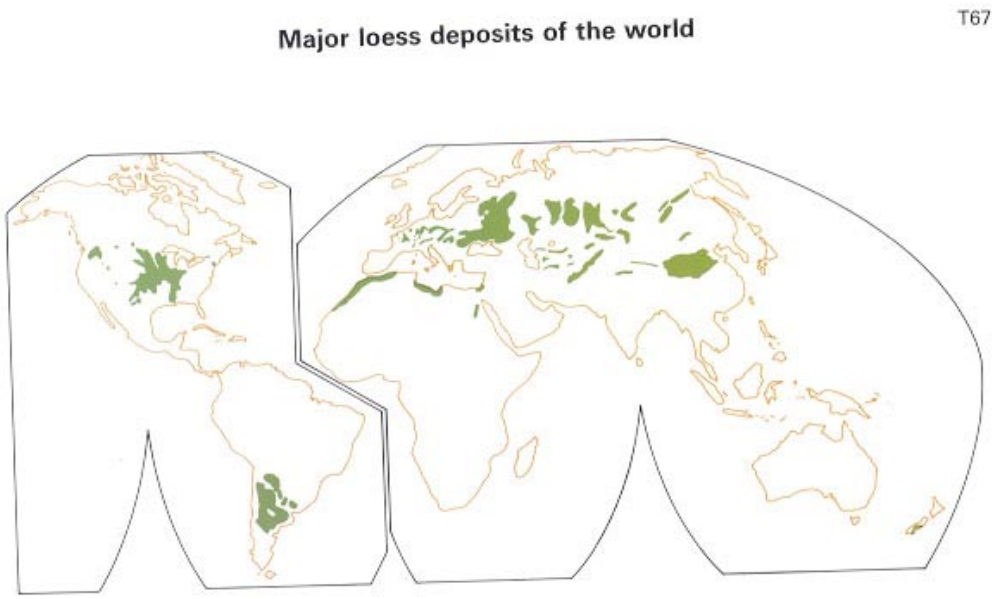
Parabolic

Longitudinal / Seif



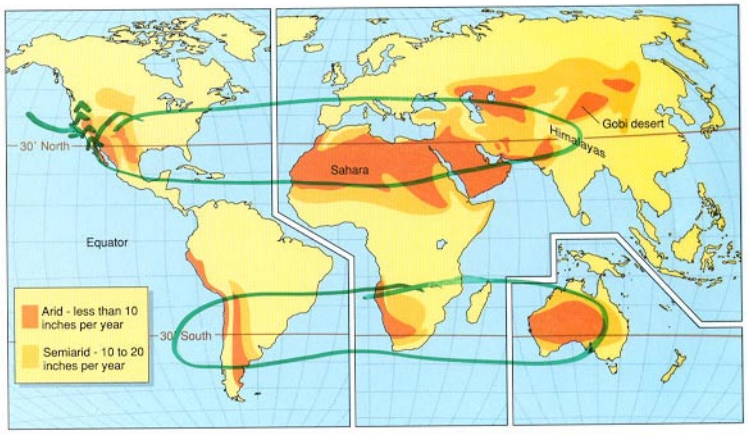
Dune Types

Dune Profile / Wind Direction

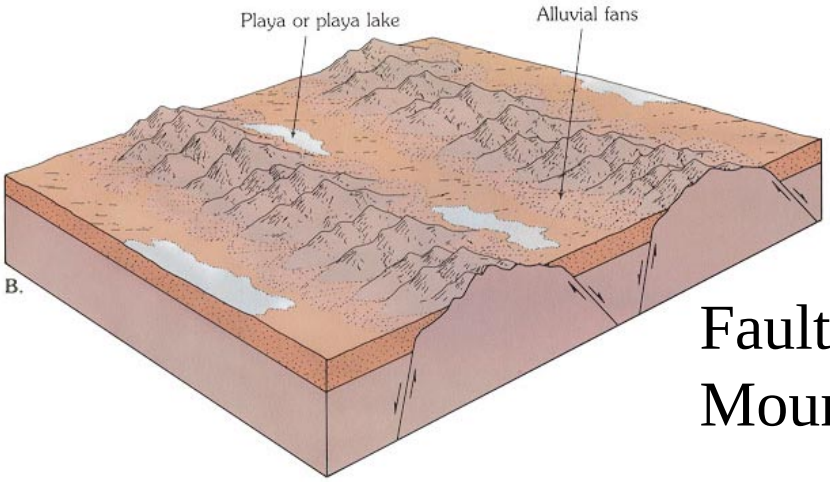


Loess = wind blown silt

Global Distribution of Deserts



Closed Drainage



Fault-Block Mountains

Landscape Erosion in Basin and Range