USGS

Introduction to the Mojave National Preserve

Physiography

Weather Data

General Mojave Geologic History

Changing Climates & Ancient Lakes

Weathering & Erosion

Carbonate Rocks & Landforms

Granitic Rocks & Landforms

Volcanic Rocks & Landforms

Faults & Active Tectonics

Pediments & Alluvial Fans

Stream Channel Development

Stream Terraces

Stream Terraces and Older Surfaces

Stream terraces form when streams carve downward into their floodplains, leaving discontinuous remnants of older floodplain surfaces as step-like benches along the sides of the valley. Stream terraces are common throughout the Western United States. In the context of this discussion on the Mojave region, older *surfaces* represent flattened areas (plateaus, mesa, uplands areas, hillside benches) that are stable or isolated, neither experiencing significant rates of sediment buildup (aggradation) or down cutting by erosion. These older surfaces may have no clear or obvious connection to a more modern drainage system in a particular area. Terraces and older surfaces preserve or display unique characteristic soil profiles or weathering characteristics because of their long-standing isolation from stream erosion.

Many factors influence why streams episodically carve into their floodplains, forming stream terraces. Because stream terraces are typically widely distributed along steams throughout a region, changing climatic conditions are likely a most important contributing factor to their formation. Streams broadened their floodplains when sediment supplies are high and down cutting by stream erosion is abated. In cool, wet periods, plants typically cover the landscape, and hence sediment supply is low; enhanced moisture increases stream flows, and streams draining mountainous regions will cut downward. During dry periods, plants don't provide enough cover to prevent intense erosion during infrequent storms. As a result, high sediment yields may result in the backfilling of stream channels. This natural feedback system is much more complex than this because many other processes occur simultaneously. Under cooler, wetter conditions during an ice age, soil development and weathering processes proceed faster due to more frequent wetting and drying, more freeze-thaw cycles, and increased biological activity (particularly root penetration). Soils formed during extended wet periods can be released as sediments once the groundcover is removed during drought conditions, especially by wildfire followed by a rainstorm.

Climate is also a factor in the development of *caliche* (calcium-carbonate-rich crusts or soils that form in desert conditions). In North America, caliche is found in arid or semiarid regions of the western states. In many places in the Mojave region these calium-carbonate-rich crusts form a resistant caprock along stream terraces.

& Older Surfaces

Mojave River

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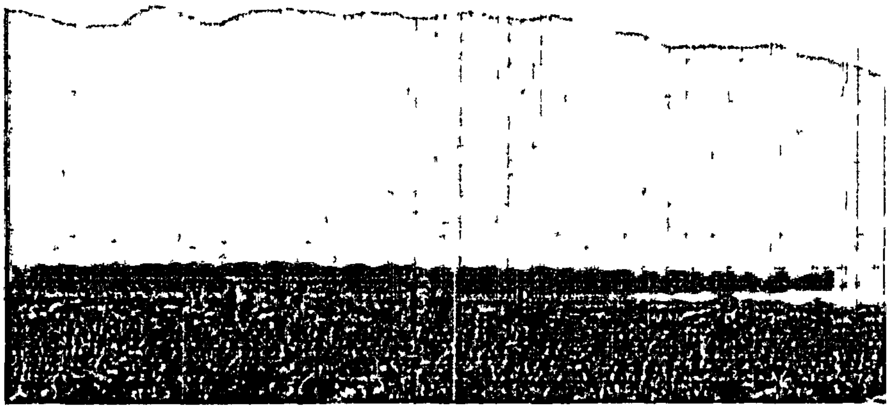
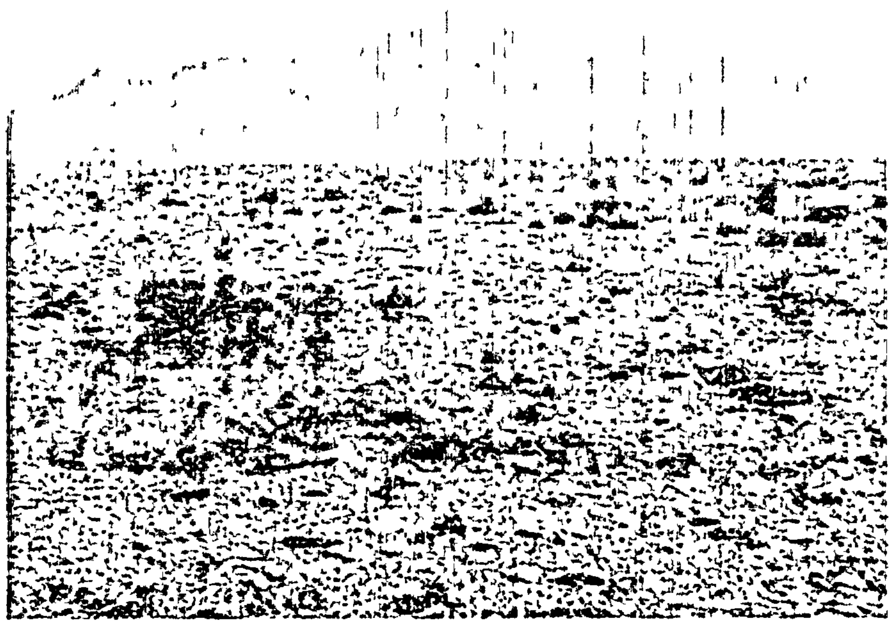
Caliche-cemented gravels (pale zone topped by a ledge) form the resistant cap rock of older Pleistocene terrace surfaces along the sides of the modern wash. In the distance, the surface of an older quaternary alluvial fan is preserved intact (partly due to a resistant caliche bed preserved at the surface). The high core of the Providence Mountains in the distance consists mostly of Paleozoic limestone and dolomite rock formations; these rocks provide calcium carbonate to the alluvium and enhance caliche development.

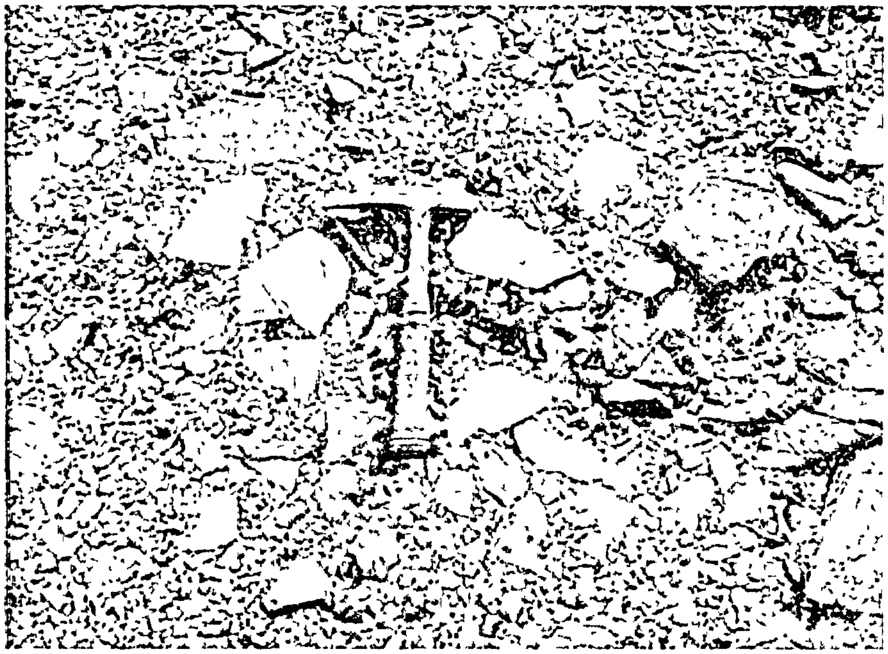
A boulder of the caliche-cemented gravel has been eroded and re-deposited.. It displays rock fragments similar to the modern stream gravels surrounding it.



Morning sunlight highlights the incised remnants of an older (Pleistocene or Pliocene) alluvial fan along the mountain front of the Granite Mountains. The smoother modern (Holocene) alluvial fan surface stands out in the foreground (in mountain shadows). The incised and eroded condition of this fan suggests different possibilities.



A desert pavement (a surface gravel deposit of tightly packed pebbles, layered just one pebble thick and generally devoid of vegetation) is abundant on Pleistocene-age surfaces, particularly in the mid-fan regions. Pavements such as this occur in areas where the stream flow is restricted to relatively stable channels nearby. Note how little relief exists on this alluvial fan surface on the eastern flank of the Providence Mountains.



A close-up view of a desert pavement shows that gaps between rock fragments are small or rarely visible (hiding the accumulated dust underneath). Wind and episodic rains keep the surface free of dust, and plants have a difficult time becoming established due to lack of soil. The surface temperature difference between night and day during the summer may range over 100 degrees Fahrenheit. This daily temperature difference may play a role in the formation of these pediment surfaces. Most of the rock fragments shown here are dolomite and limestone.

Continue to the *Mojave River* page...

USGS Western Earth Surface Processes Team
The URL is http://deserts.wr.usgs.gov/mojave/
For more information contact:WESP Team Webmasters.
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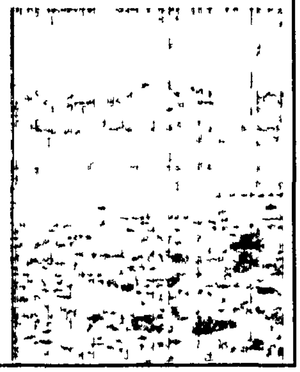
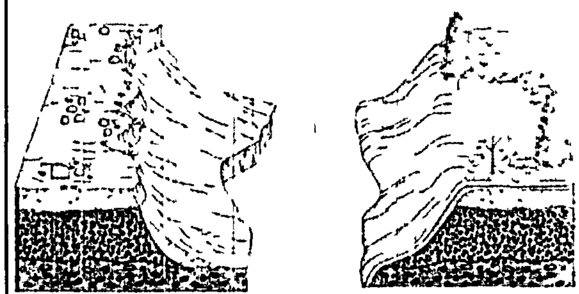
We have "trees in our minds." Desert looks different because every rock and depression is visible rather than covered up.



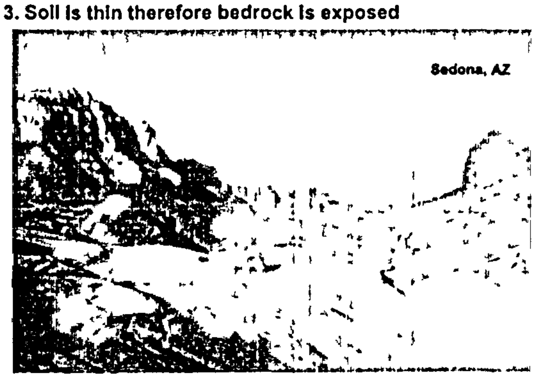
Factors in shaping arid lands
1. Weathering
   primarily physical → angular landforms + debris



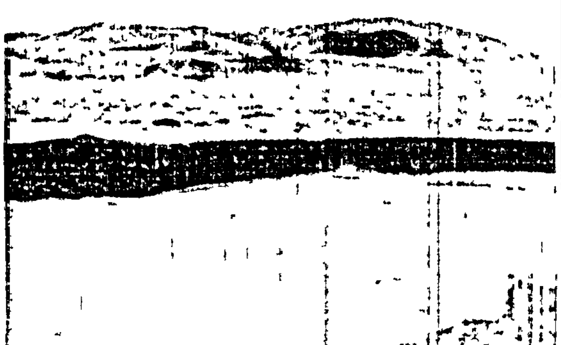
Factors in shaping arid lands
2. "Creep" is uncommon
   land surface is not "smoothed" by soil creep

Sedona, AZ

Factors in shaping arid lands
3. Soil is thin therefore bedrock is exposed



Factors in shaping arid lands
4 Surfaces are impermeable therefore runoff is rapid



Factors in shaping arid lands
5. Sand may be present → shifting sand forms

Monahans TX

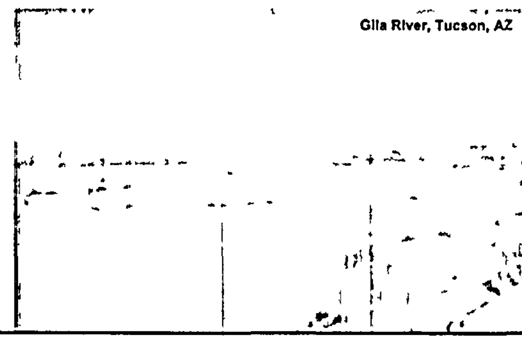
Factors in shaping arid lands

6 Rainfall intense but infrequent → severe erosion

Factors in shaping arid lands

7. Drainage

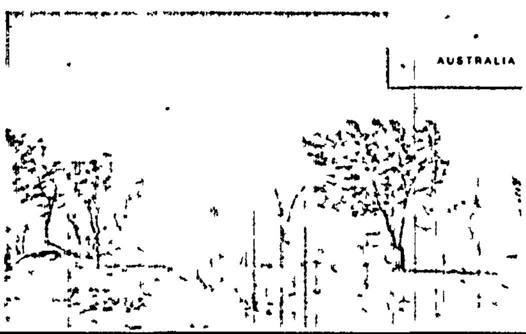
intermittent streams → intermittent transport



Factors in shaping arid lands

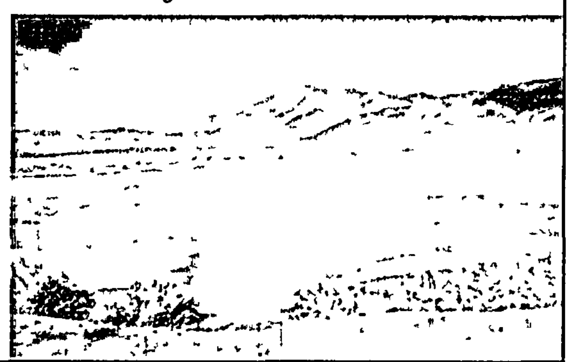
8 Wind is common due to surface heating

can be effective agent of gradation in dry areas



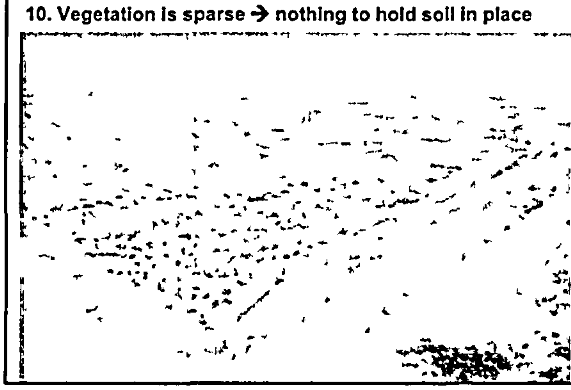
Factors in shaping arid lands

9 Interior drainage to closed basins is common



Factors in shaping arid lands

10. Vegetation is sparse → nothing to hold soil in place



Water as an agent of gradation in the desert

Most desert landforms actually made by water

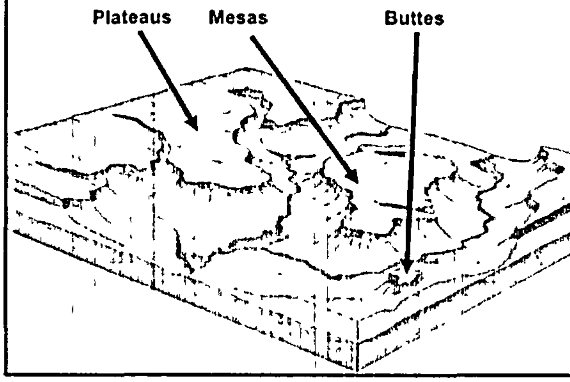
- rainfall intense
- surface impermeable
- runoff rapid
- vegetation sparse

} erosion severe

Desert erosional features associated with water

stream channels

Desert erosional features associated with water

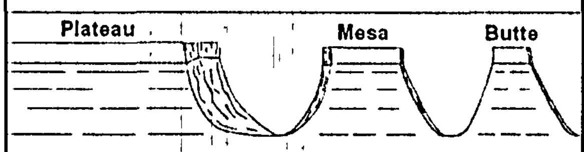


Desert erosional features associated with water

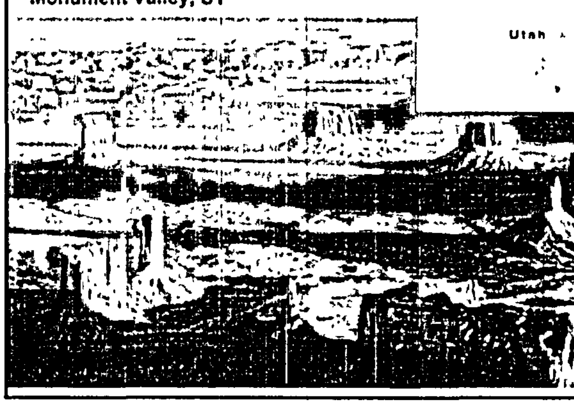
Plateau: width > height

Mesa: width ≈ height

Butte: width < height



Monument Valley, UT



Desert erosional features associated with water

Badlands: erosion too fast for vegetation to take hold

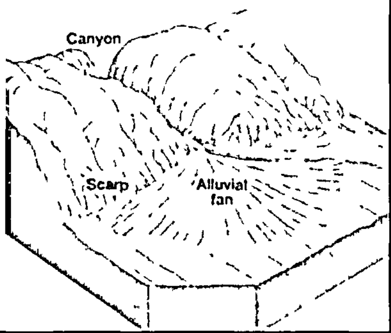
Badlands N P., SD

"Exotic" streams cross desert but have headwaters elsewhere.

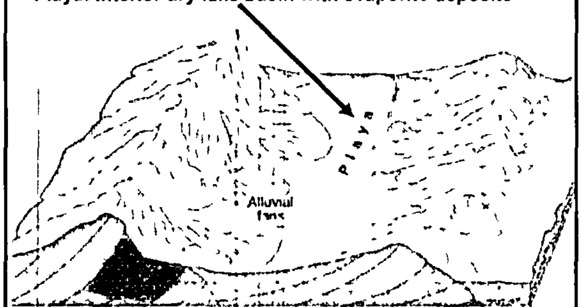
Examples: Nile Riv

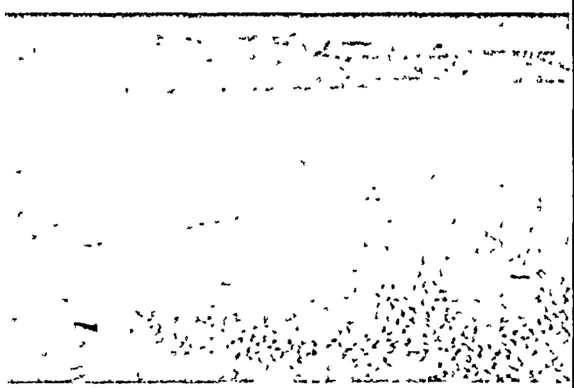
Colorado River

Desert depositional features associated with water
Alluvial fans & bajadas (two or more fans that overlap)

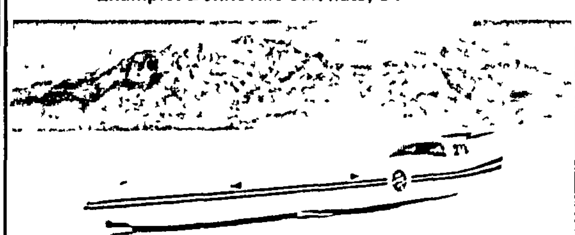


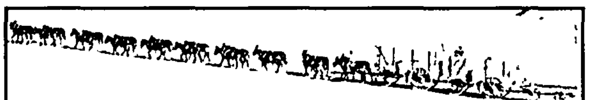
Desert depositional features associated with water
Playa: Interior dry lake basin with evaporite deposits



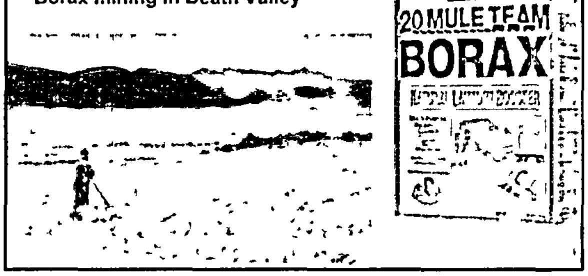


Evaporites build up in playas
Example: Bonneville salt flats, UT

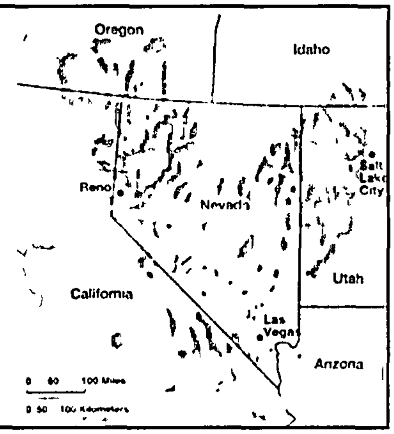




Another example of evaporites:
Borax mining in Death Valley



Some features in arid lands were built when water was abundant during last glacial period.



Wind as a gradational agent → eolian (aeolian) features

Less competent than water

cannot carry as heavy an object

Can have high capacity

Only effective in dry areas

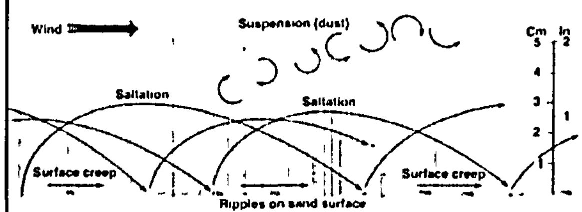
Wind's load

Suspended load = clay and silt sized particles

can be carried out of basin

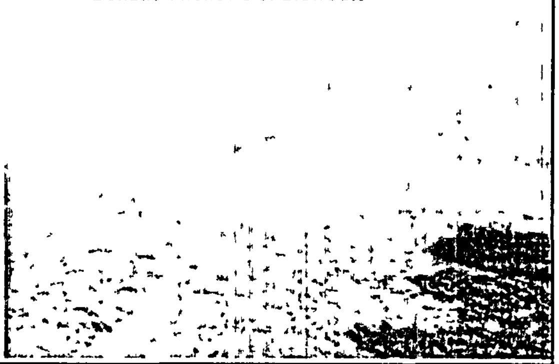
Bedload = sand dragged or "bounced along"

stays in basin → dunes



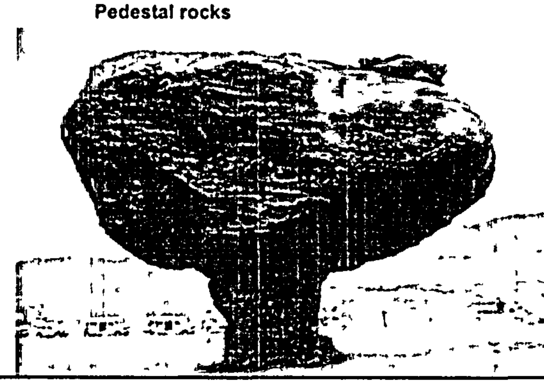
Eolian erosional features

Deflation hollows or blowouts



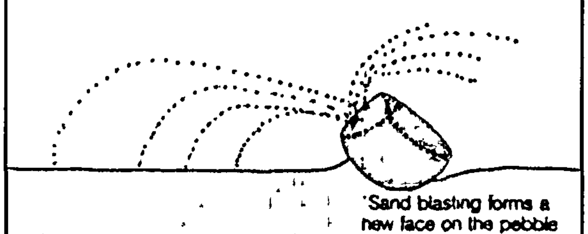
Eolian erosional features

Pedestal rocks



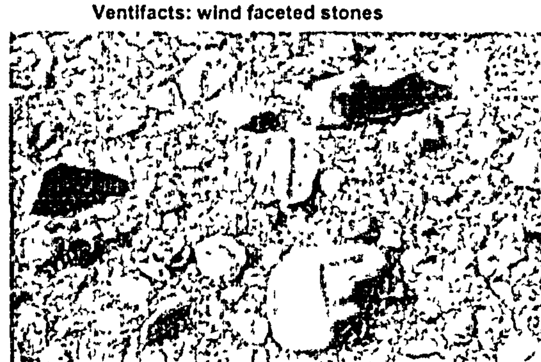
Eolian erosional features

Ventifacts: wind faceted stones

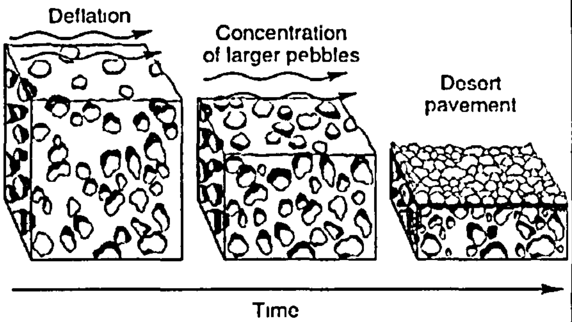


Eolian erosional features

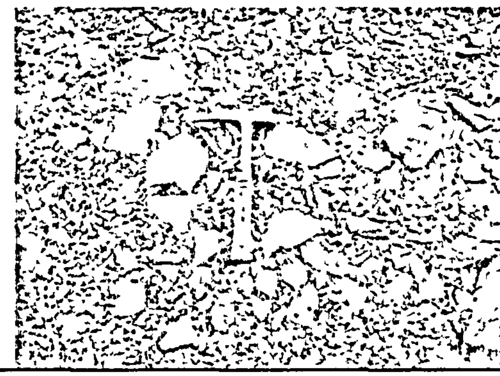
Ventifacts: wind faceted stones



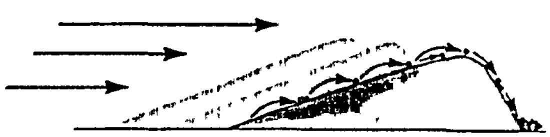
Eolian erosional features
Desert pavement



Desert pavement



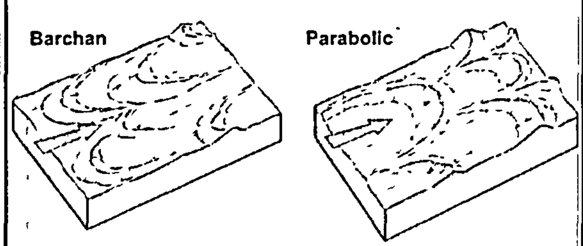
Eolian depositional features
Dunes from coarser material near source



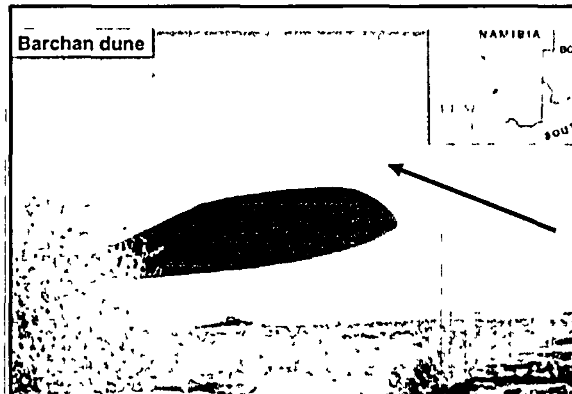
Most deserts do not have significant dune fields

Shape of dunes is determined by
- wind speed
- wind direction
- sand supply
- vegetation

Eolian depositional features: dunes
moderate winds, moderate sand supply

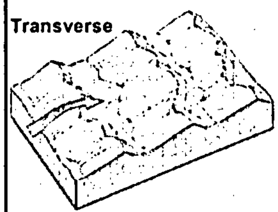


Barchan dune

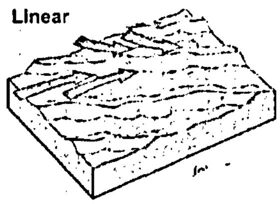


Eolian depositional features: dunes
Strong winds

Transverse



Linear

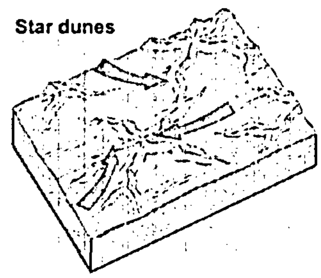


Unlimited sand

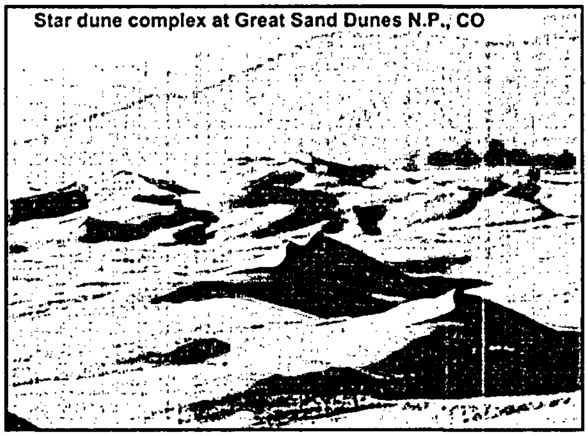
Limited sand

Eolian depositional features: dunes
Multidirectional winds

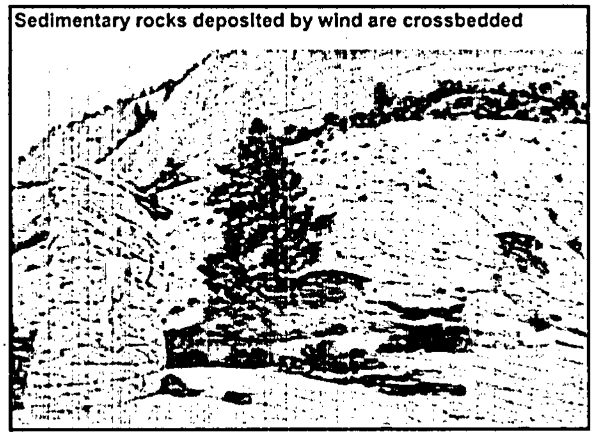
Star dunes



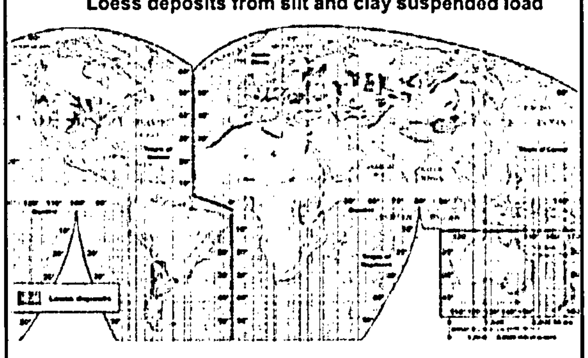
Star dune complex at Great Sand Dunes N.P., CO

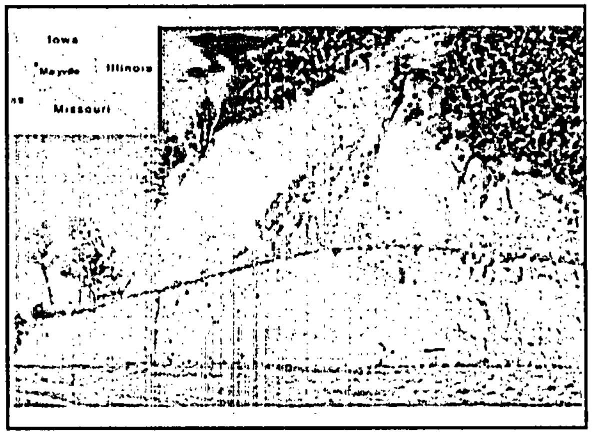


Sedimentary rocks deposited by wind are crossbedded



Eolian depositional features
Loess deposits from silt and clay suspended load





Loess plateau in China