Introduction to the HYDROSPHERE II

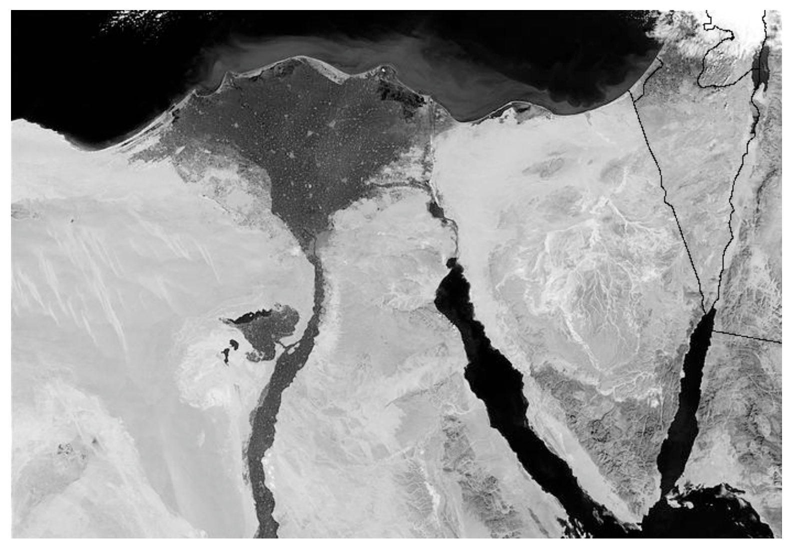
Review

- In the last lecture, I talked about how rivers modify the land they pass over by:
  - Erosion
    - Cutting new channels
    - Leaving features such as *oxbow lakes*
  - Depositing *alluvium* in features such as
    - Natural levees
    - Point bars

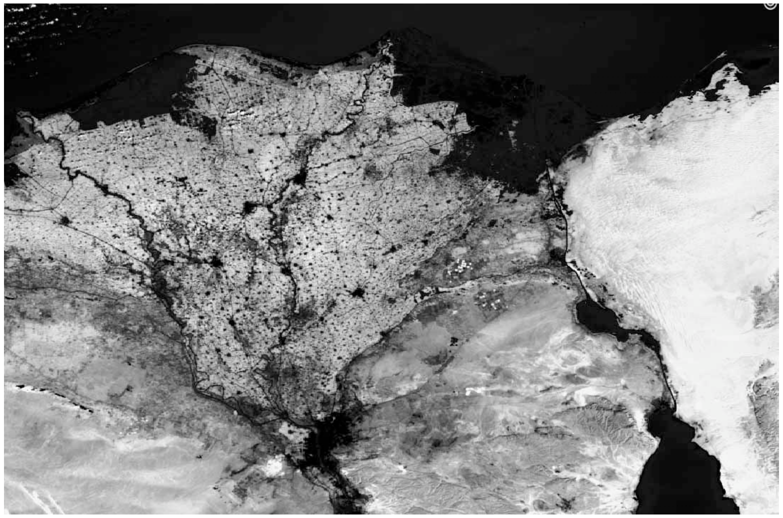
Deltas

- River current velocity drops rapidly as the river enters a lake or the ocean, causing large amounts of sediment to settle out of the water, forming a *delta*
- Deltas usually contain multiple channels carrying water away from the main channel; these are *distributaries*.
  - Distributaries shift position if left to themselves, causing headaches for people who build in or navigate through deltas. . .

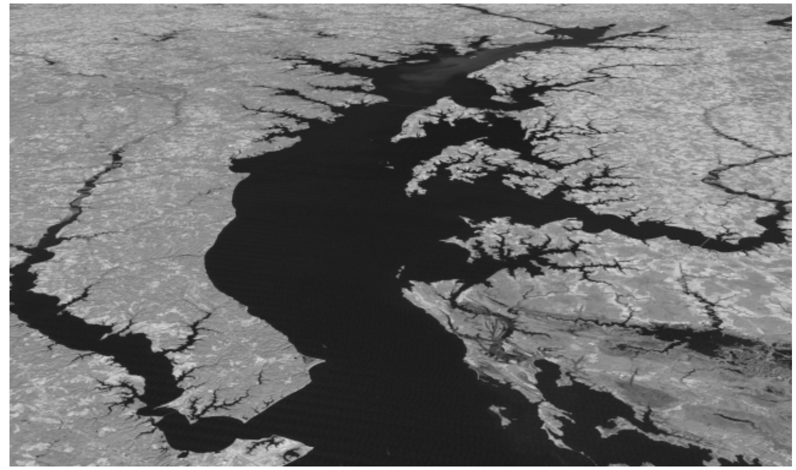
The Nile River mouth was called *delta* by the Greeks because of its triangular shape—hence the name. . .



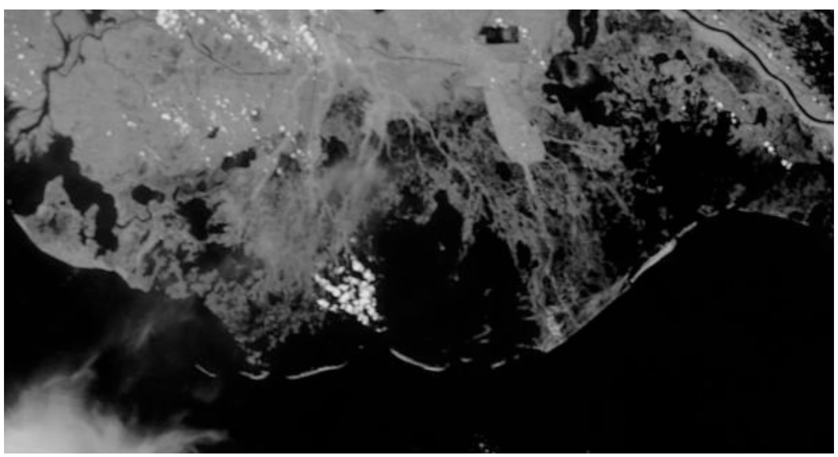
This false-color satellite view shows the distributaries better. (The black blob at the base of the delta is the city of Cairo.)



In times and regions where sea level has recently gone up. and/ or land elevation has dropped, there may be no delta visible; instead, the ocean moves into the lower floodplain, and we get a *drowned river valley*, such as Chesapeake Bay



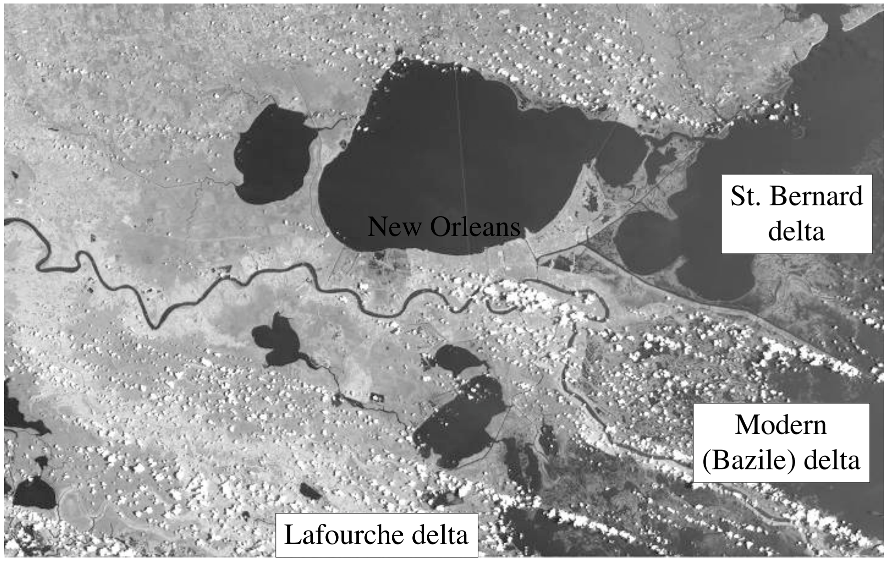
Abandoned deltas (such as the old Lafourche Delta of the Missisippi River) are reshaped by ocean waves and currents into long, narrow *barrier islands*, also known as *cheniers*.



Changing Channels

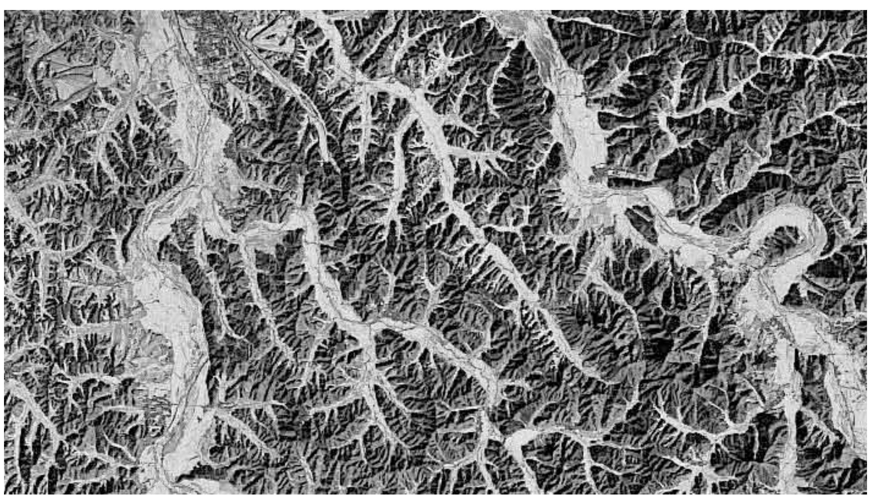
- Near its mouth, as a river's gradient approaches zero, the river begins to drop sediment, forming a delta. . .
- This can lead to the river changing its course
  - If a river's current channel is being built up higher by sediment deposition, eventually, if the river can break out of its channel it will start taking a new channel.

Parts of three deltas in the New Orleans area

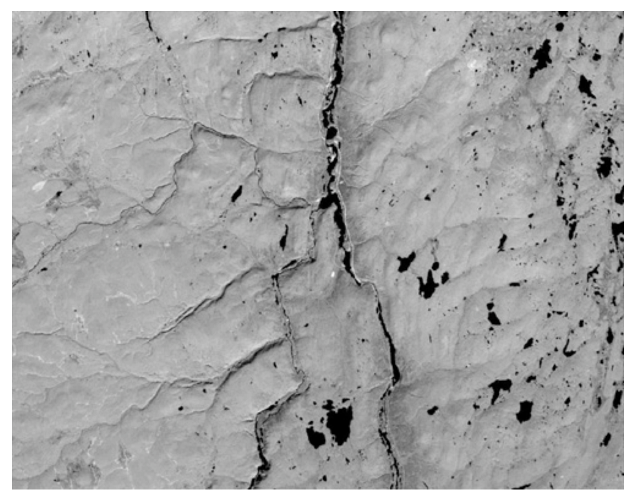


What's currently keeping the Mississippi River from changing channels is the Army Corps of Engineers' Old River Control System at Pointe Coupee, Louisiana.

Dendritic drainage (Manchuria, China)



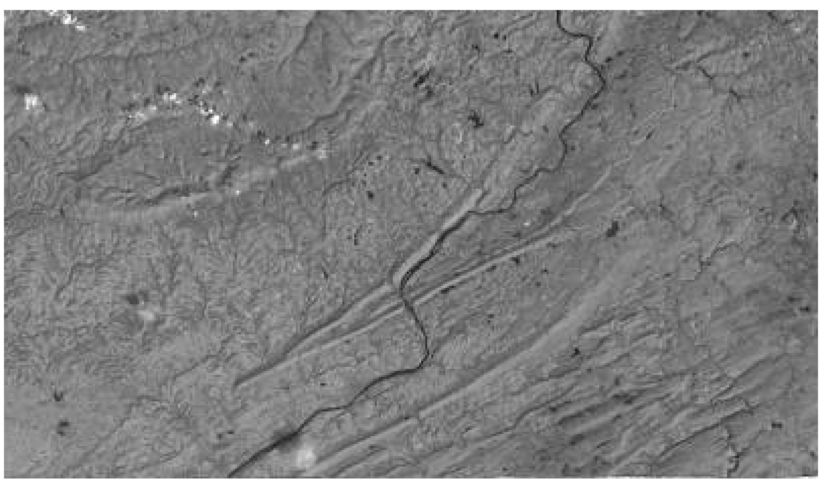
Rectangular drainage (Estonia)



Radial drainage (Mt. Rainier, Washington)

Trellis drainage (Ouachita Mts.)

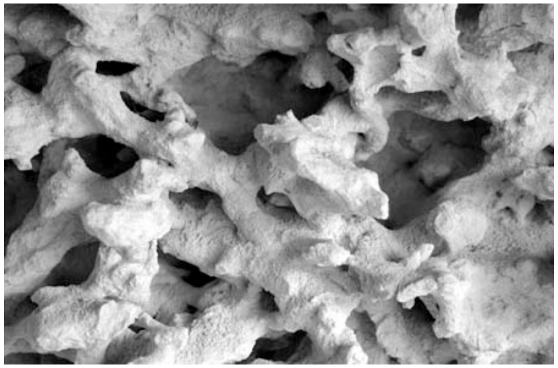
Trellis drainage, and a *water gap* where a river has cut through an elongated mountain (Appalachian Mts.)



Very Quick Notes on Groundwater

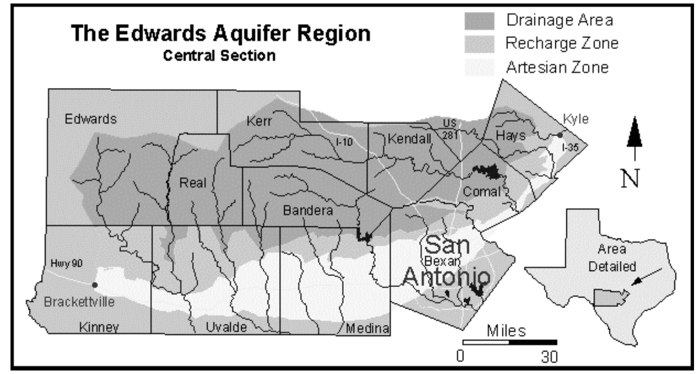
- Groundwater makes up 94% of the Earth's fresh water that is easily available to humans.
- Groundwater provides drinking water for 50% of the US population
  - It's also crucial for agriculture, especially in areas where rainfall is too low or irregular—40% of irrigation water is groundwater

Groundwater comes from rain or snowmelt that soaks into the ground and enters a porous rock body called an *aquifer*.

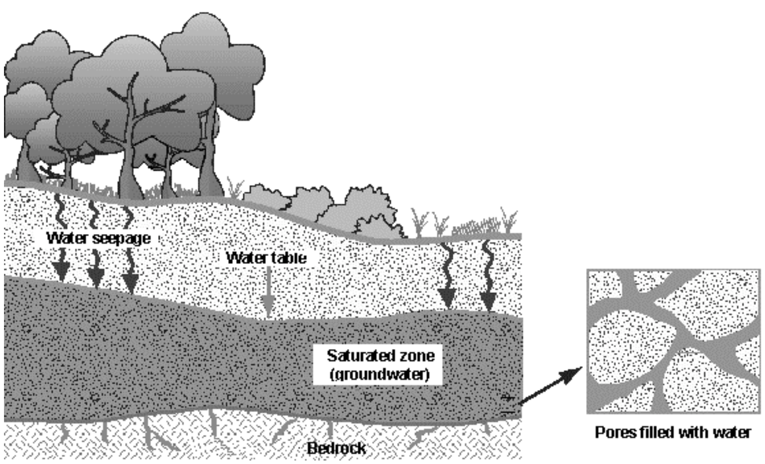


This porous and fractured limestone in central Texas makes up the large Edwards Aquifer, main water source for Austin and San Antonio

The region where rainfall will flow into an aquifer is its *recharge area* (shown in light blue on this map).



Water percolates through soil and rock until it reaches the *zone of saturation* (all the spaces in the rock are filled with water). The top of this zone is known as the *water table*.



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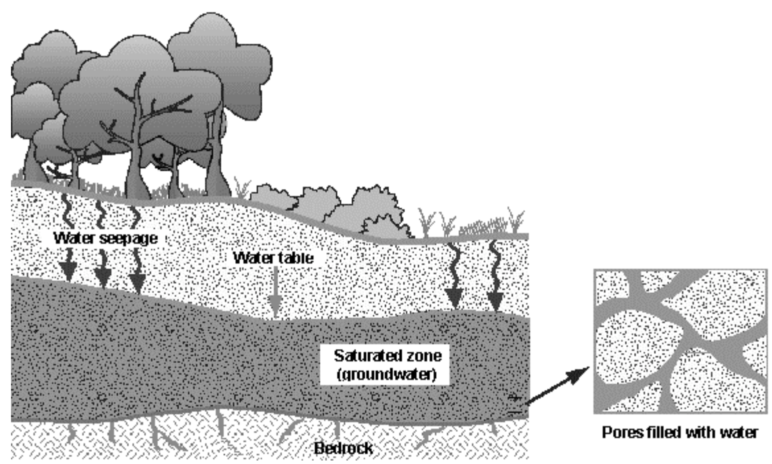
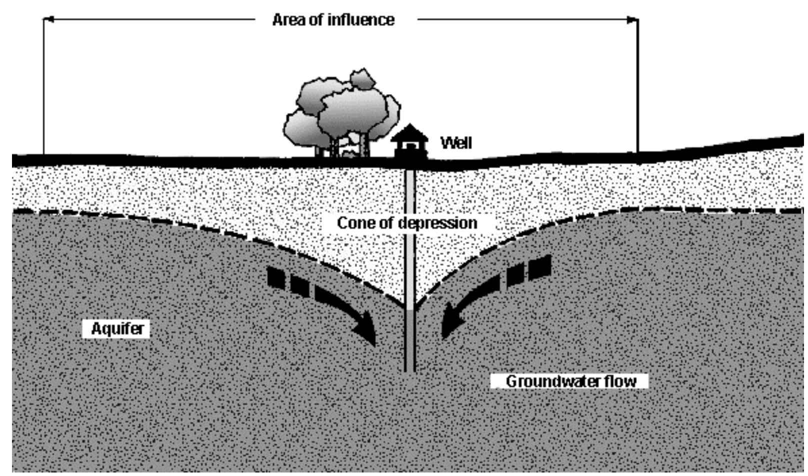


In limestone-rich areas, groundwater dissolves the limestone, producing a type of terrain known as *karst*: irregular terrain with caverns and sinkholes, but few large aboveground rivers or lakes

Karst areas, such as central Florida, may be a beautiful place to visit. . .

. . . but you might not want to live there!

Pumping water out of an aquifer creates a *cone of depression* around the well. . . which creates a problem if two wells are close enough that their cones overlap. . .



Pumping groundwater faster than precipitation can recharge it can result in *subsidence*—gradual sinking of the land (nine meters in fifty-two years, in the San Joaquin Valley of California. . .)

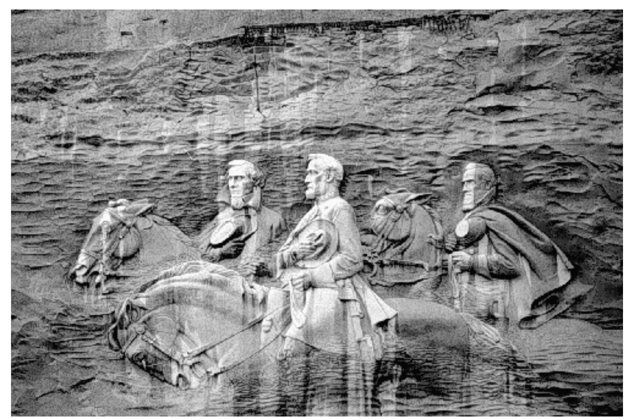
Subsidence can cause the land to crack, as has long been happening in places such as Arizona. . . which is not really good for, say, the suburban subdivisions built on it!

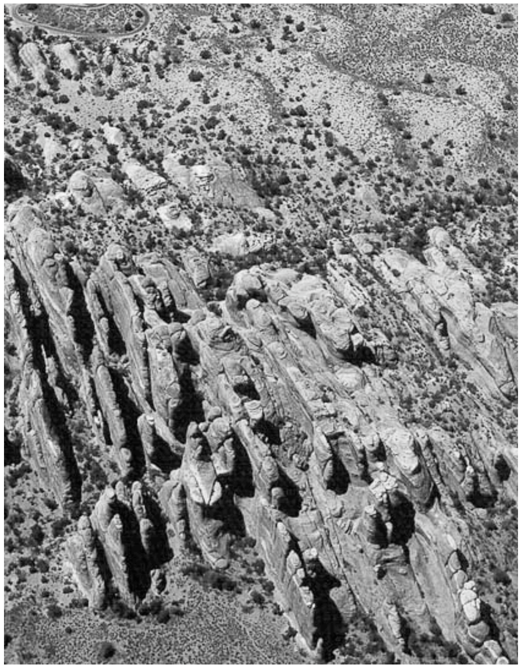
Sediment fissures from grounwater "mining" east of Phoenix. Compaction causes the ground to crack at bedrock sills. TMcG

Weathering

- Breakdown of rocks at the surface of the Earth
  – Mechanical: the physical breakdown of rock
  – Chemical: chemical decomposition of rocks and minerals

Stone Mountain Park, near Atlanta, Georgia: the discoloration is an example of *chemical weathering*.





Aerial view of Arches National Park, where mechanical weathering along parallel joints is creating fins of rock. . .

Mechanical weathering may be helped by jointing within the rock. For example: When large masses of granite are exposed, they're released from pressure by the overlying rock. This causes them to split apart into sheets, a process known as *exfoliation*.

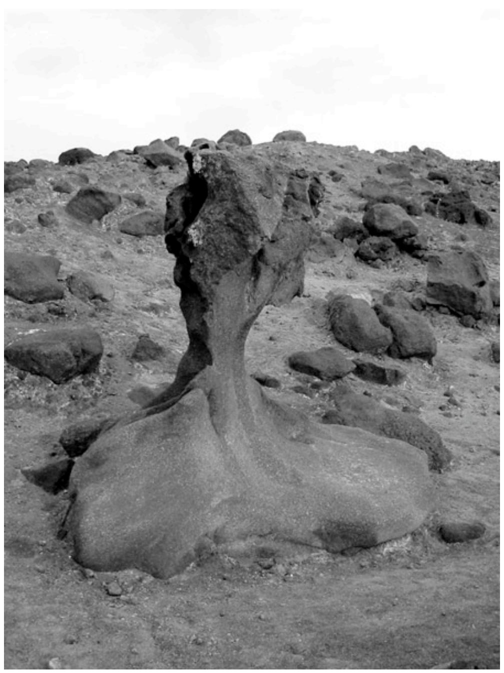
Half Dome, in Yosemite National Park, California, is an example of an *exfoliation dome*.

When water penetrates into cracks and freezes, it expands, widening cracks and breaking rocks apart—a process called *frost wedging*.

This and other types of erosion form regions of eroded rock fragments known as *talus*.

Erosion

- Transport of small particles from one place to another
- Usually, water flow is the means of erosion



You *can* get erosion caused by wind, or rather by windblown dust. . . which sculpted Mushroom Rock in Death Valley, California (a fine example of a *ventifact*). . .

. . . but most erosion is ultimately caused by the action of water.

Even in deserts, occasional flash floods erode rocks and carry sediment, forming "delta"-like mounds of alluvium at the mouths of canyons, called *alluvial fans*.

Which nicely seques into our next slide. . .

Mass Wasting

- Transfer of rock and soil down a slope under the force of gravity
- Three basic types
  - *Fall:* freefall of detached pieces of material
  - *Slide:* slab of coherent material moves down a surface
  - *Flow:* downward movement of viscous fluid

This mudflow in Pomona, California, is a fine example of mass wasting. . .

. . . as was the rockfall in 1903 at Frank, Alberta, Canada: 40 million cubic yards of rock in two minutes. . .

. . and this one in 1995, that took out a road in Colorado!

Slumping, seen here in the Black Hills of South Dakota, is a considerably slower process. Slabs of material break along a curved surface and move downwards.

Slowest of all is *creep*—it may be measured in millimeters per year, but give it enough time and it'll do things like this (near Marathon, Texas). Or go look at the outcrop behind the Marketplace Grill in Conway: that'll show an excellent example of soil creep.

Soil that's perpetually waterlogged may flow downhill in "tongues" or "lobes", a process called *solifluction* (seen here in Alaska).