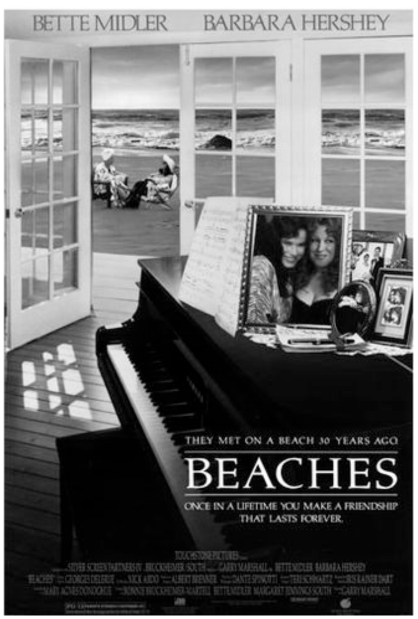
Beaches

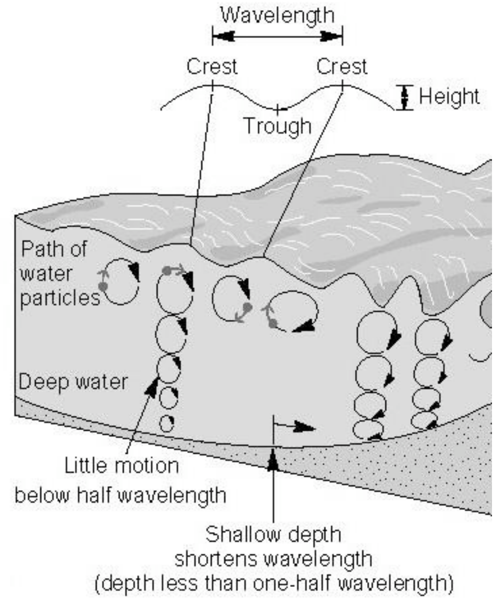
by MC Doc W



Ahh, we love beaches. . . and we love to live by the beaches. . .

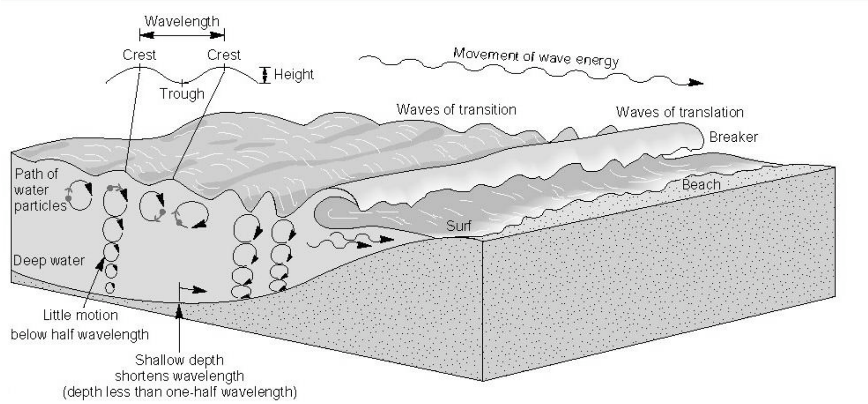
Problems arise, of course, when people build on or near beaches without quite understanding what they're in for. . .

Let's start by looking at waves. . .



Waves move, but the molecules of water don't—they simply go around in *circular orbital motion*. At a depth greater than 1/2 wavelength, a depth called *wave base*, there is little water motion.

But when the ocean is shallower than wave base, the bottom begins to interfere with wave motion. . . waves slow down. . . they "pile up" on shore, and grow higher and higher. . . and eventually the high waves collapse forward, and the wave breaks.



Remember that for any wave, *speed* = *wavelength* X *frequency*, or in other words *speed* = *wavelength* / *period* (period = time between one wave and the next). Slowing waves down must cause the wavelength to decrease, so the waves get closer. . . water can't be compressed, so the waves must get higher. . . and when wave height is greater than 1/7 of wavelength, we get this:

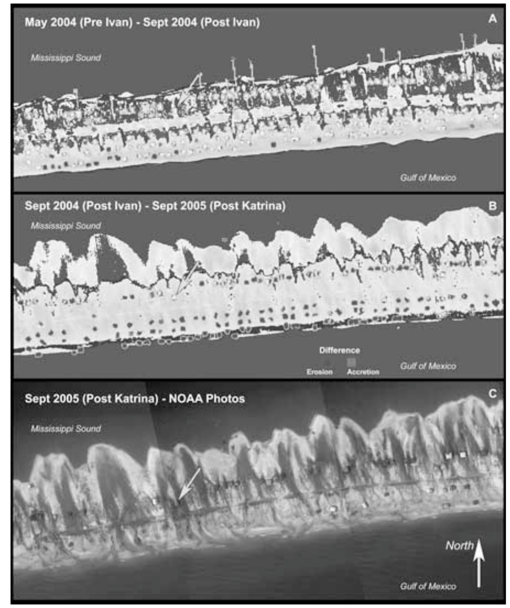
Strong waves may strike rocks with a pressure of 2000 pounds per square foot (OK, OK, 10,000 kg/m^2). . .

Waves are deflected towards *headlands*, where erosion is strongest; sand builds up in *pocket beaches* between headlands.

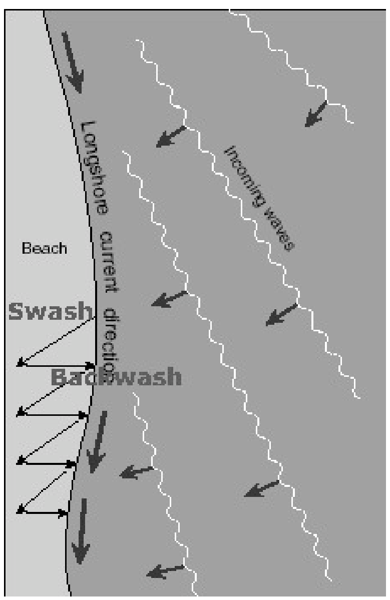
This is enough to break rocks. . . and rock fragments in the water often *abrade* rocks further. This is one major source of beach sand (rivers are the other).

Given time, waves will cut a *wave-cut terrace* in rocky coastlines. (Broad Bench, Kimmeridge, south England)

Current wave-cut terrace, cliff, and old terrace (from a time when sea level was higher) at Big Sur, California.

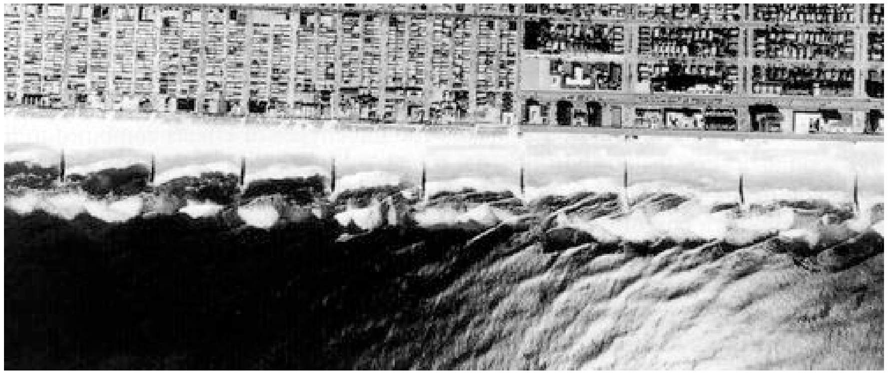


NASA imagery showing the effects of Hurricanes Ivan and Katrina on Dauphin Island off the Louisiana Gulf Coast. Waves have caused "rollover" of sand from the seaward side of the island to the landward side.



Waves striking at an angle to a beach, and then retreating perpendicular to the beach, move sand grains in a zig-zag pattern along the beach: *longshore transport*. This also sets up *longshore currents* running parallel to the shoreline. The problem arrives when longshore transport threatens precious beachfront real estate. . .

Aerial shot of a *groinfield*—a series of groins—from Chesapeake Bay, Maryland. Which way is longshore transport going?



Another image of a groinfield. Notice the direction that the waves are coming in (lower right of the photo), and how that relates to the way the groins are trapping sand.

Jetties are built to keep harbors and shipping channels open, but they are similar in other respects to groins. Notice sand buildup to the left of the channel, and sand loss on the right, here in Florida.

Breakwaters, built parallel to the coast, also stop longshore transport, as you see in this photo of Santa Monica, California. . .

Photo: C. Sudderth/ OP Gazette
Aerial shot clearly shows effects of silt buildup behind Venice breakwater a few miles south of Santa Monica

Just down the coast, the breakwater at Venice Beach, California has created a sizable sandbar, and blocked sand from moving farther along. (Notice the groin in the distance. . .)

When a small island is close to the main coast, it can act as a natural breakwater and cause sand buildup, creating a sandbar-like pile of sediment called a *tombolo*.

Seawalls defend property from destruction by deflecting wave energy back to the ocean. . .

The downside is that waves normally expend their energy as they move across a beach—but not if they bounce off a seawall! Seawalls accelerate wave erosion of beaches.

Beach nourishment simply involves adding large quantities of sand to a beach (often dredged from the seafloor). The pictures show Miami, Florida before (top) and after (bottom) beach nourishment between 1976 and 1981.