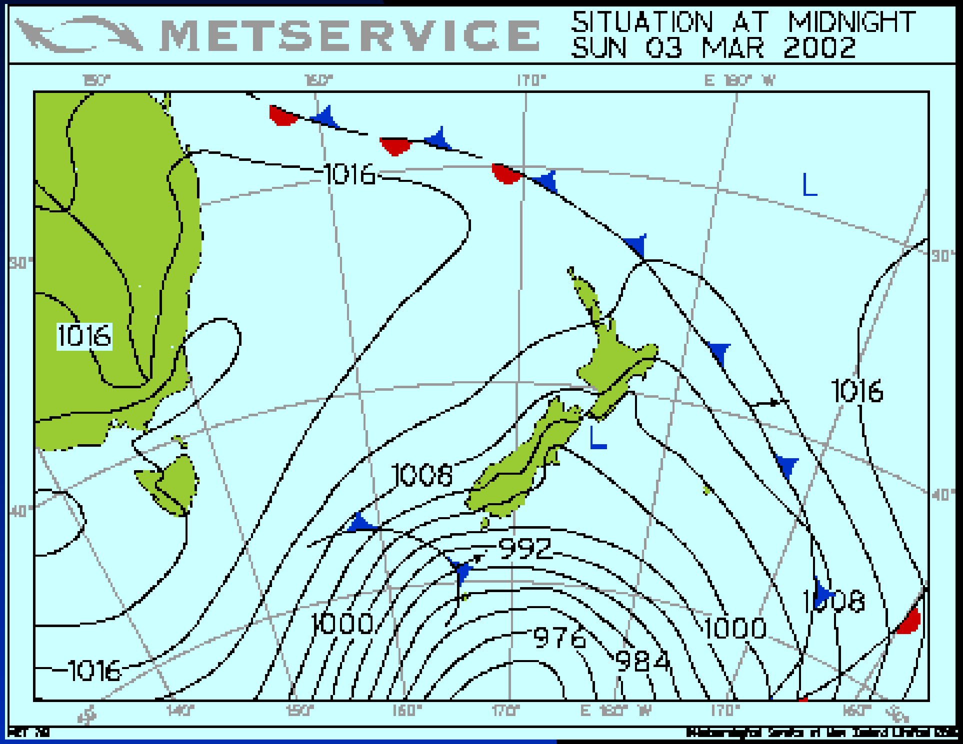
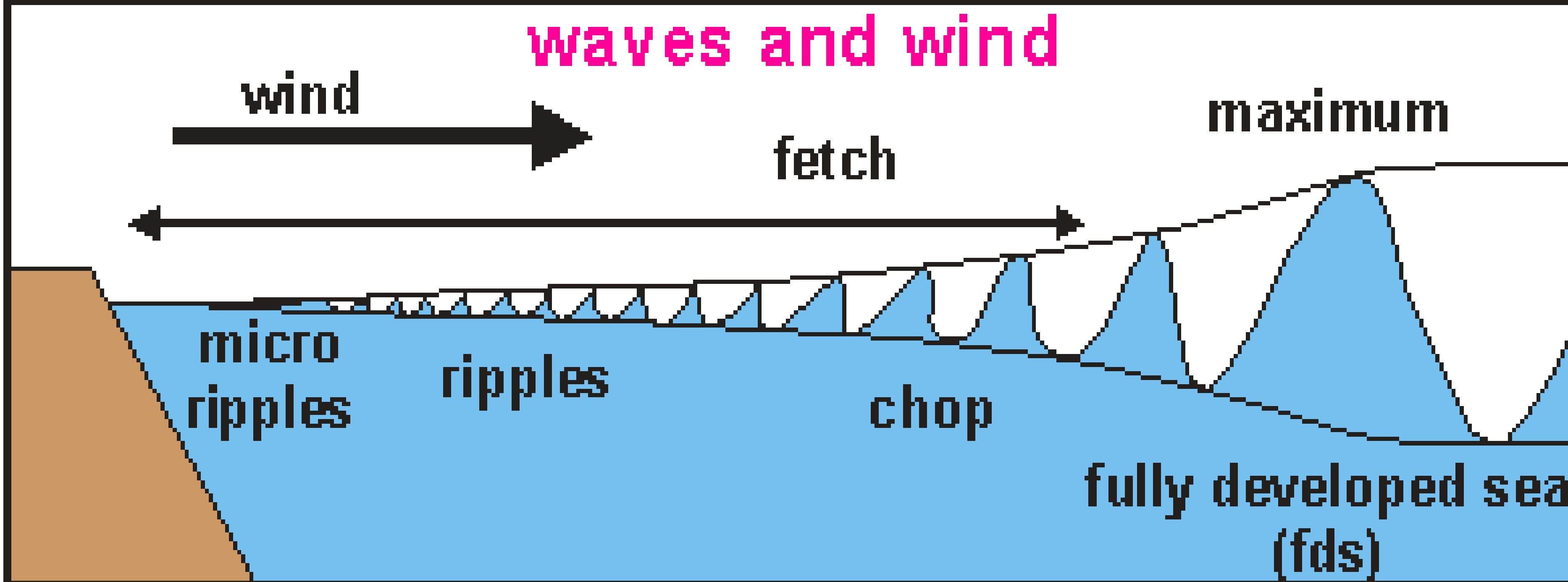
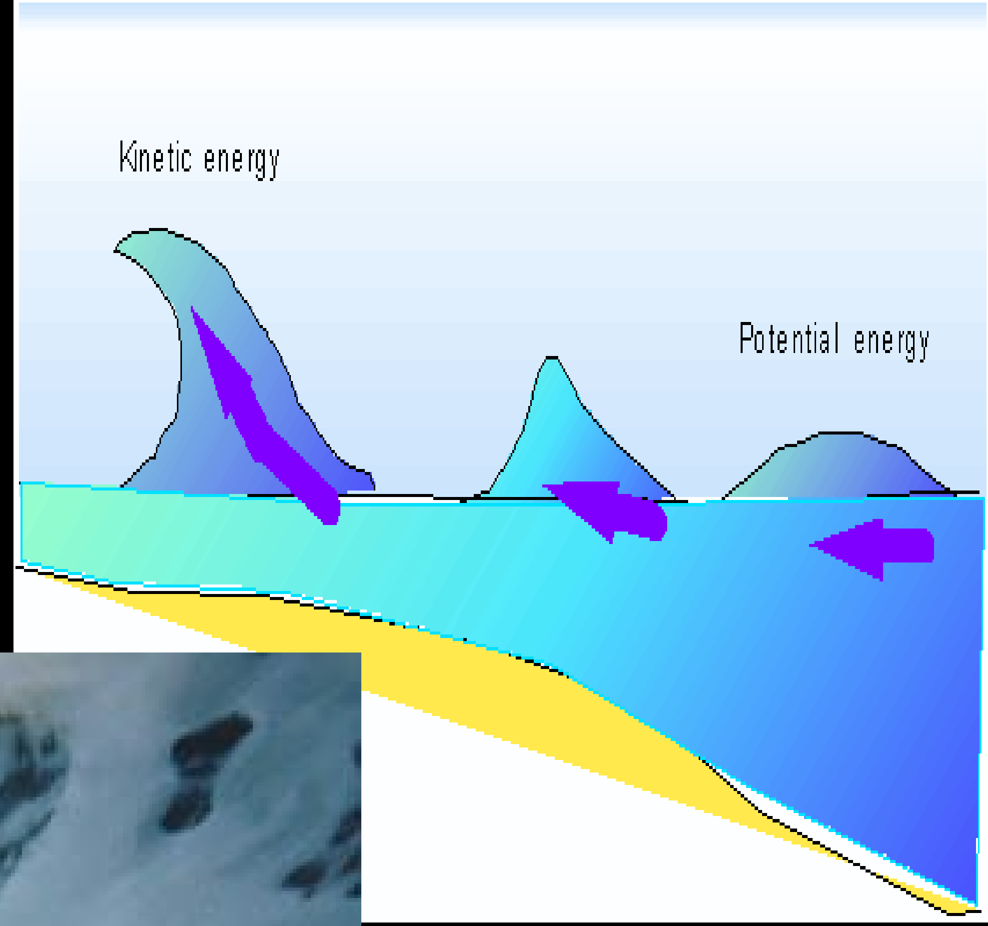
WAVES



- Waves, either on the ocean or on a lake, are created as the wind blows over the water, turning particles of water in circles. Imagine the force of a breaking wave as accumulated wind energy near the water's surface. Each particle of water transmits energy to the next.
- Wave size depends on how hard the wind blows, and how long it blows in one direction (scientists call this "fetch"). As waves move, each particle of water stays in roughly the same area.



As waves develop, they offer more surface area for the wind to press against (wind stress). Depending on both fetch and time, the size of the waves increases quadratically to a maximum. The energy imparted to the sea increases with the fourth power of the wind speed! As waves develop, they become more rounded and longer and they travel faster. Their maximum size is reached when they travel almost as fast as the wind. A 60 knot storm lasting for 10 hours makes 15m high waves in open water.


Kinetic energy
Potential energy

How waves break

- As the seafloor becomes less deep near the coast, it drags on the wave and slows it down. This compresses the distance between wave crests and increases the height. Finally, the top of the wave falls down, or breaks.

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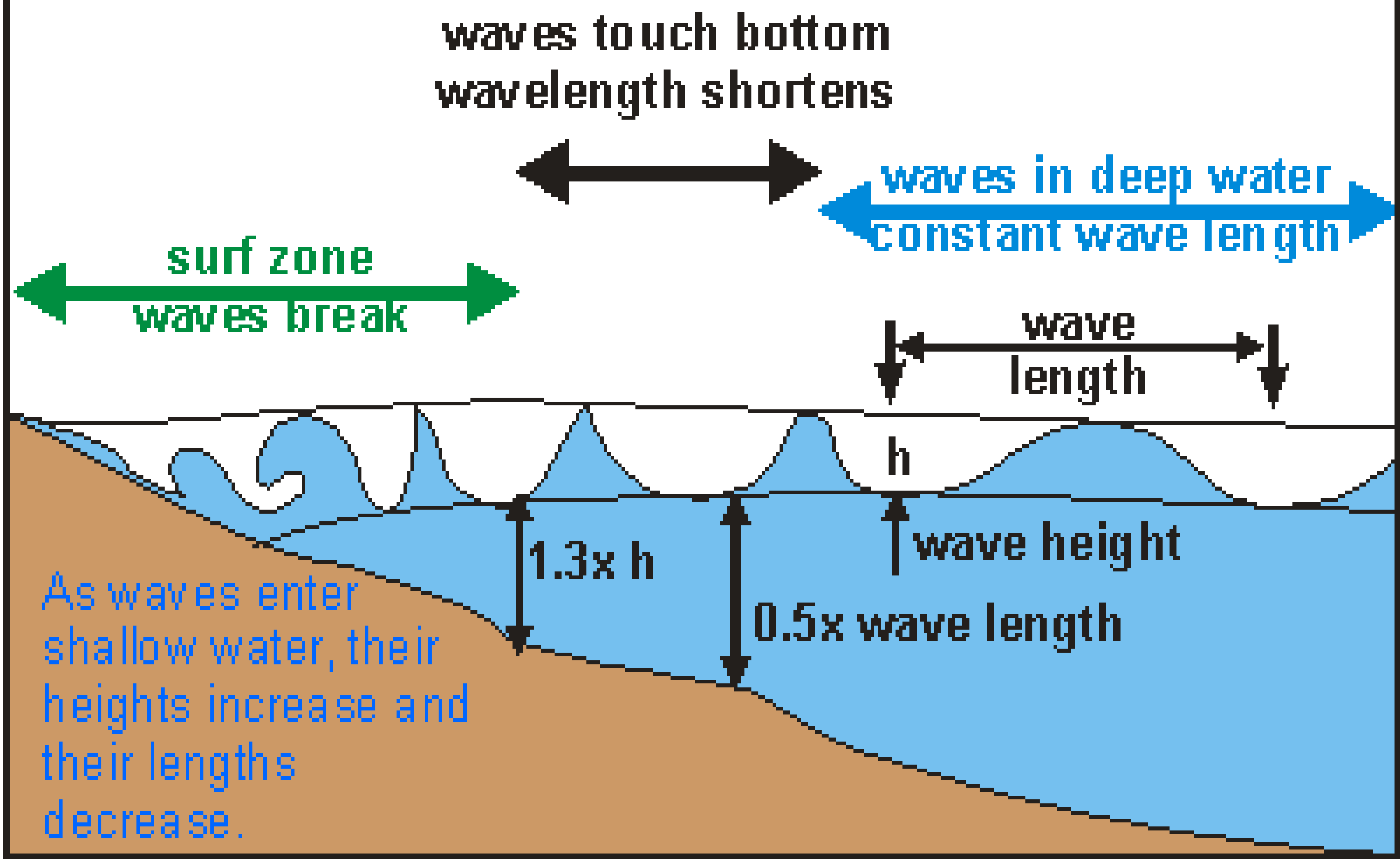
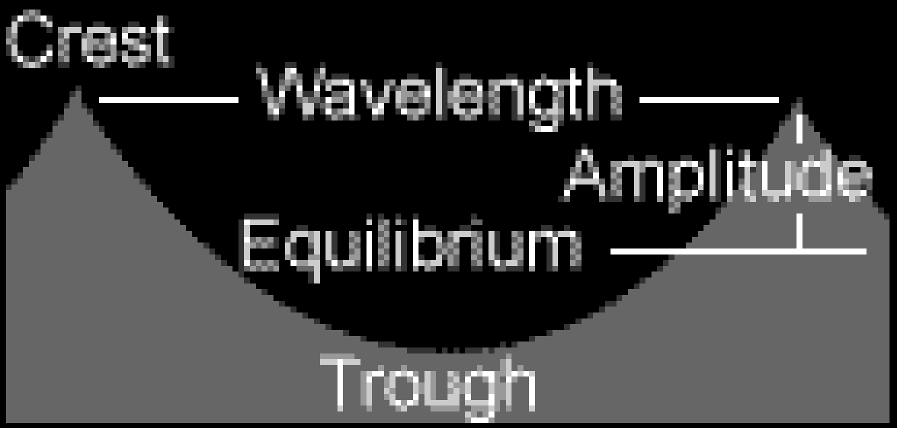
waves entering shallow water



Measuring waves

- A wave's amplitude is the distance between equilibrium and a crest, or equilibrium and a trough. The distance between wave crests is called wavelength. The longer the wavelength, the faster a wave moves.



Ninety Mile Beach
Wavelength decreases as waves enter shallow Water

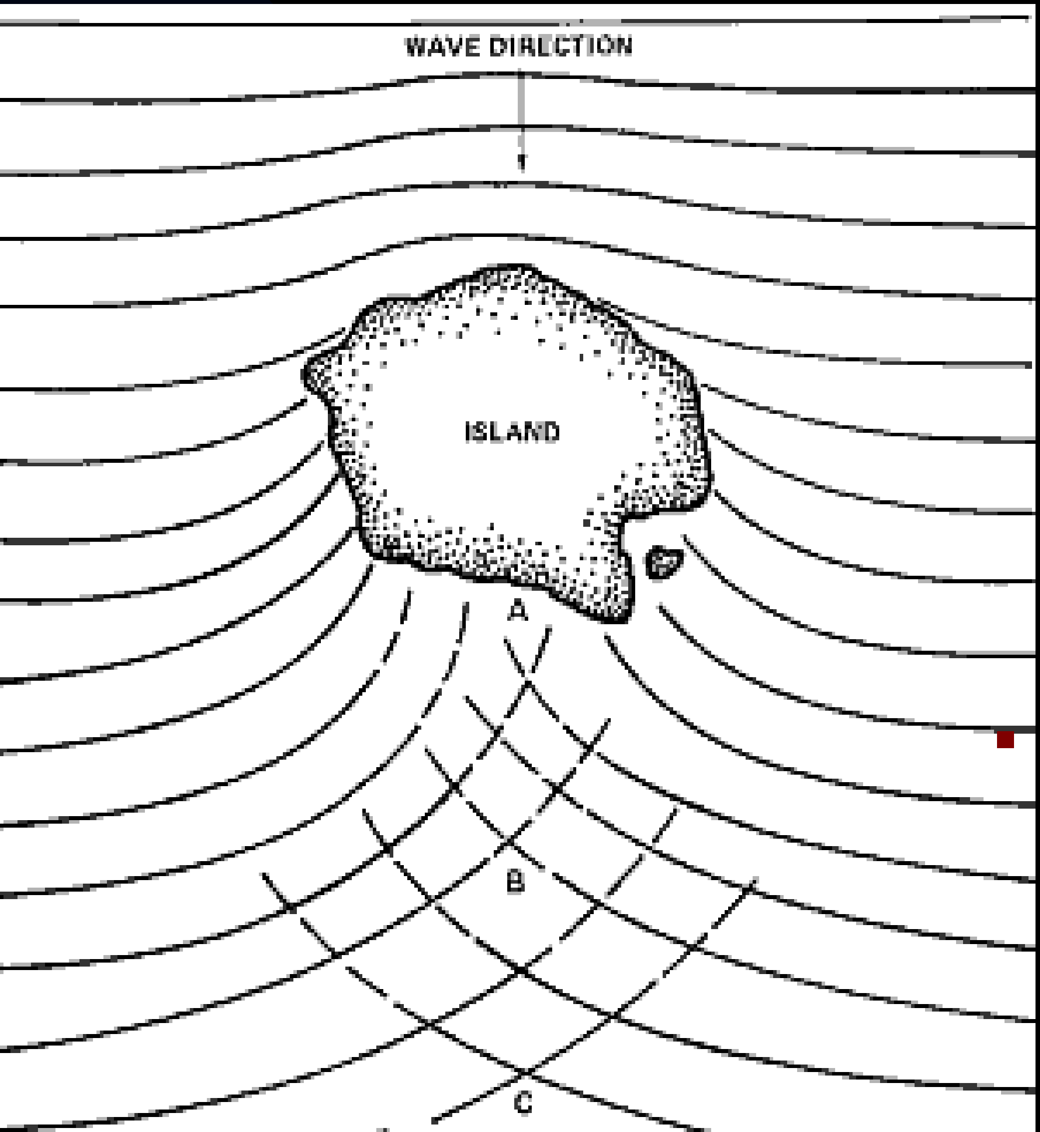

© Tim McKENNA

Whangamata Bar

Breaker Bay Wellington

Taupo Bay Northland

Refraction



- This drawing shows how waves are bent around an island which should be at least 2-3 wave lengths wide in order to offer some shelter. It causes immediately in the lee of the island (A) a wave shadow zone but further out to sea a confusing sea (B) of interfering but weakened waves which at some point (C) focuses the almost full wave energy from two directions, resulting in unpredictable and dangerous seas.

- Recent research has shown that underwater sand banks can act as wave lenses, refracting the waves and focussing them some distance farther. It may suddenly accelerate coastal erosion in localised places along the coast.

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The wave equation

$V = f x \lambda$

- V=velocity metre/sec
- F=frequency Hertz HZ
- Λ=wavelength metre

Frequency

- This is the number of waves that pass a point every second.
- Measured in Hertz.
- Radio waves have a frequency of 98.6Khz or 98600 waves are sent out every second.
- Sea waves can have a frequeny of 1 wave every 30 seconds.

Waves travel in ‘sets’

- People first began to discover why waves appear in sets when they built a wave tank which launched an absolutely regular train of waves out of a little wave-making machine at one end of the tank.
- Trouble was, when this train of waves into making the tank and the machine absolutely precise and regular. reached the other end, it was no longer regular. It had organized itself into tiny litle "sets". Hey! said the engineers. Our wave machine must not be working smoothly. So they put a lot of effort But no go .. the wave trains *still* organized themselves into sets, no matter how carefully and uniformly they were launched.
- So the engineers sat down and studied the equations that govern wave motion. They found that certain (very tiny and usually neglected) nonlinear terms in the equations of motion of deepwater waves act to transfer energy (very slowly) from the leading and trailing edge of a set of waves, toward the center waves. Thus the central waves get bigger at the expense of leading and trailing waves.
- As a result, even if the wind is blowing absolutely uniformly, waves will still organize their energy into sets. This organization happens slowly, which is why local windswells are less-well-organized than swells that have propagated thousands of miles. The mathematical name of the nonlinear interaction that creates sets in water waves is the "Benjamin-Feir Instability".


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- **Tsunamis** are long-period waves, meaning wave crests are far apart (sometimes hundreds of miles). Tsunamis can move as fast as 400 mph, an energy that carries them great distances. The amplitude, or height of the waves, is usually 3 feet or less.

- As the seafloor becomes less deep, it drags on the wave and slows it down. This compresses the distance between wave crests and increases the height. A tsunami commonly grows to more than 30 feet tall and can reach as high as 100. Effects range from a series of breaking waves to surging tides to a barely imperceptible rise in water levels.