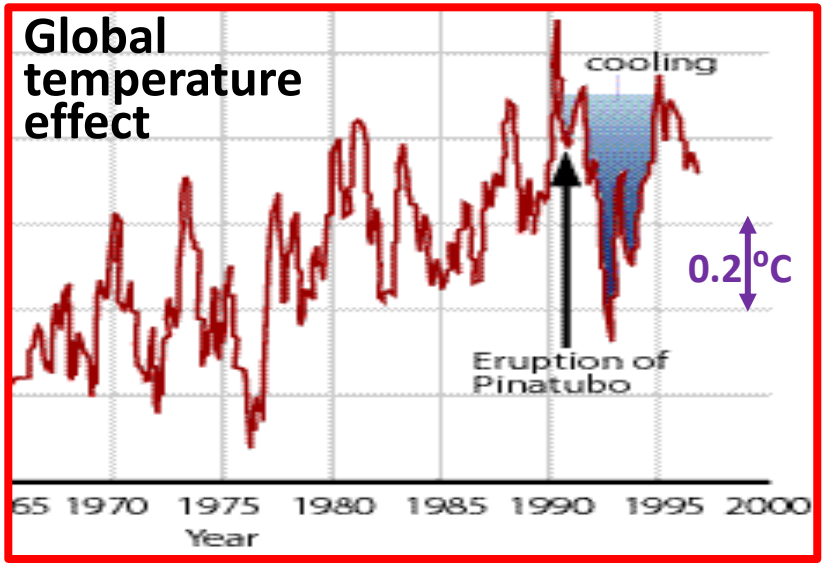
Volcanoes and Climate

Mt. Tambora, Indonesia •

Largest observed eruption in *recorded* history; 1816 "Year Without Summer"



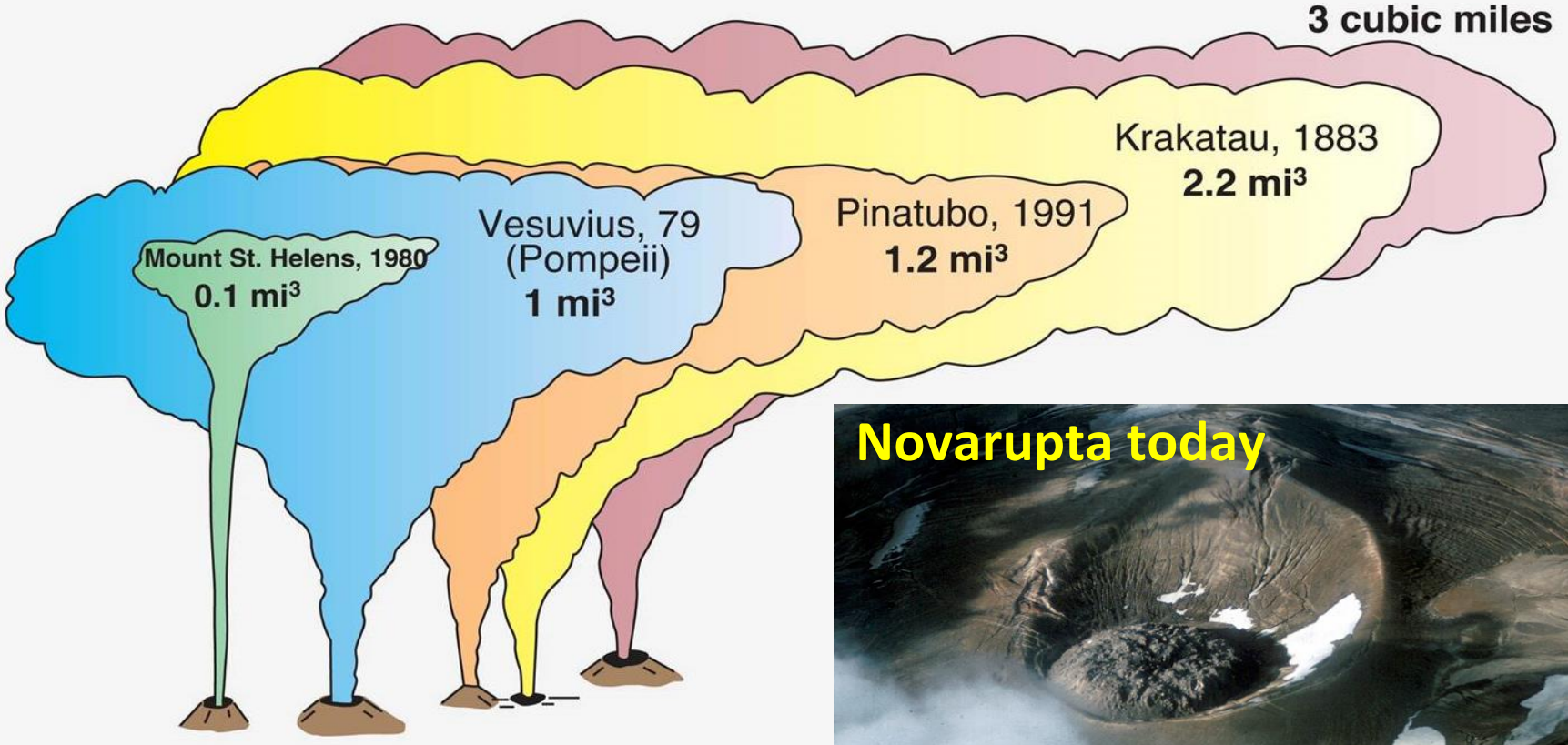
• Mt. Pinatubo, Philippines

Second largest eruption of the 20th century, June 1991.

The Most Powerful Volcanic Eruption of the 20th Century

Went almost unnoticed - people in Juneau, Alaska, about 750 miles from the volcano, heard the sound of the blast – *over one hour after* it occurred.

•NOVARUPTA
Alaska 1912



Dangerous volcanoes are constantly being monitored by volcanologists using the following methods:

- **Measuring slope**
  - bulges may form with magma pushing up.
- **Measuring volcanic gases**
  - outflow of volcanic gases (*sulfur dioxide, carbon dioxide*) may precede eruption.
- **Measuring temperature from orbit**
  - monitoring changes in temperature over time.
- **Measuring small quakes**
  - increase in number & intensity before eruption.

Earthquakes

What is an earthquake?

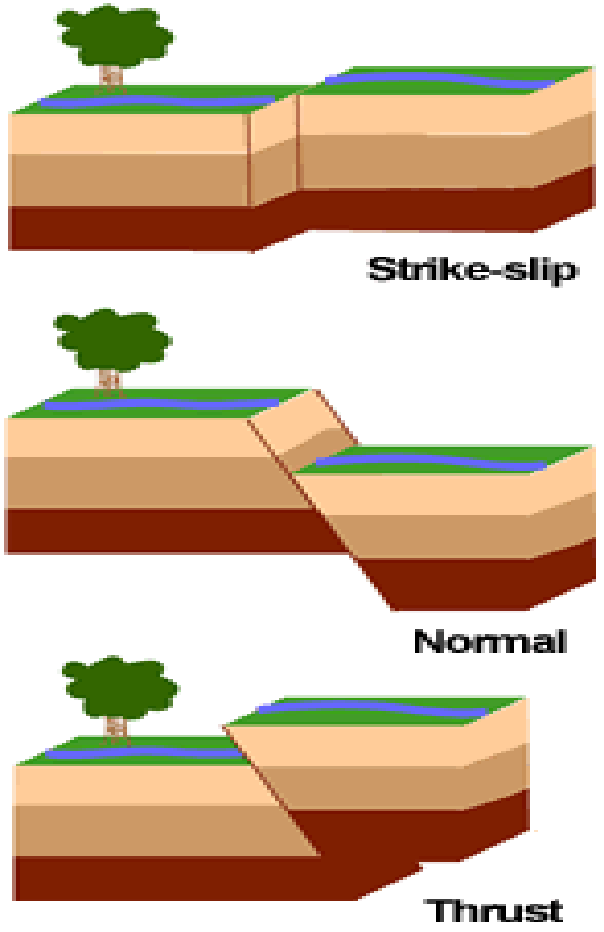
Earthquake is the vibration (shaking) and/or displacement of the ground produced by the sudden release of energy.

- **Rocks under *stress* accumulate *strain energy* over time.**
- **Stress results from tectonic plate movement, magmatic or volcanic activity.**
- **When stress exceeds strength of rocks, rock breaks and slips.**
- **Rock slippage/rupture occurs at the weakest point *(fault)*.**
- **Strain energy is released as seismic waves.**

Geological Faults

Earthquakes most often occur along existing faults: planar fractures in a volume of rock, across which there has been significant displacement as a result of prior movement.

- **Strike-slip faults are vertical (or nearly vertical) fractures where the blocks have mostly moved horizontally.**
- **If the rock mass above an *inclined fault* moves down, the fault is termed normal, whereas if the rock above the fault moves up, the fault is termed thrust.**
- **Faults are found alone or in clusters, creating a fault zone.**



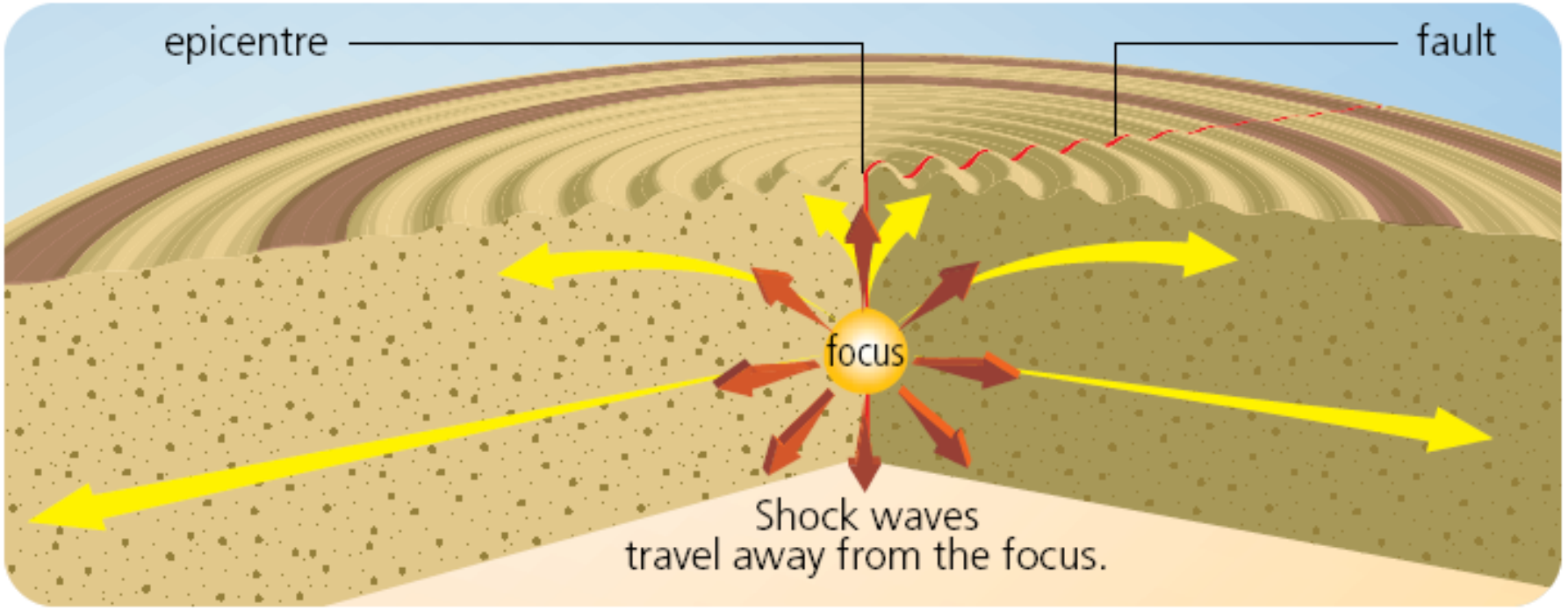
What can faults look like?

Normal

Strike-slip

←Thrust

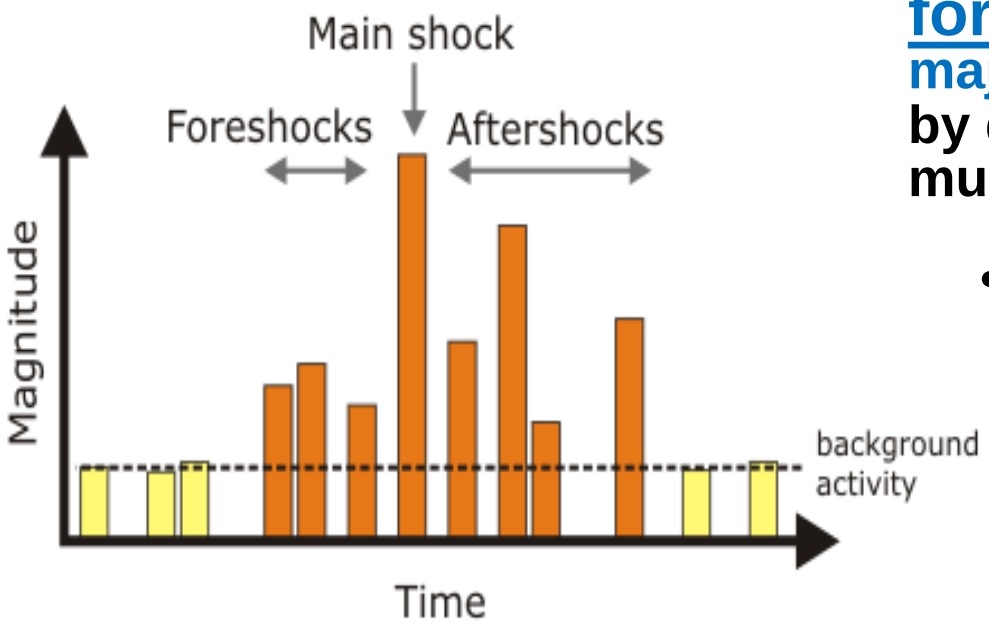
Focus and Epicenter



- **Focus – point <u>inside</u> the Earth <u>where an earthquake begins</u> (*point of initial rupture*). The majority of tectonic earthquakes originate in depths not exceeding tens of kilometers.**
- **Epicenter – point <u>on the surface</u> of the Earth <u>directly above the focus</u> where the shaking is usually felt most strongly.**

Foreshocks and Aftershocks

Earthquakes often occur as a sequence rather than individual events:



- **Small earthquakes, called foreshocks, often precede a major earthquake (main shock) by days or, in some cases, by as much as several years.**
- **Adjustments of crust (redistribution of stress on the fault) that follow a major earthquake often generate smaller quakes in the same area called aftershocks.**
- ***Bigger* earthquakes often have *more and larger* aftershocks and the sequences can last for years.**
- **Earthquake swarms are sequences of earthquakes striking in a specific area within a short period of time in which no single earthquake has notably higher magnitudes than the other.**

Measuring Earthquakes

Two measurements that describe the "power" or "strength" of an earthquake are:

Mercalli scale

- **Intensity – a measure of the degree of shaking at a given locale based on the amount of damage.**

Richter scale

- **Magnitude – estimates the amount of energy released at the source of the earthquake:**

- **Magnitude is a *logarithmic* scale (not linear!)**
- **Magnitude 2 or lower earthquakes cannot be felt by humans.**
- **Magnitude 7 and over potentially cause serious damage over larger areas, depending on their depth.**
- **The largest earthquakes in historic times have been of magnitude slightly over 9, although there is no limit to the possible magnitude.**

Modified Mercalli Scale vs. Richter Scale

Intensity category	Effects	Magnitude scale
I. Instrumental	Not felt	1-2
II. Just perceptible	Felt by only a few people, especially on upper floors of tall buildings	3
III. Slight	Felt by people lying down, seated on a hard surface, or in the upper stories of tall buildings	3.5
IV. Perceptible	Felt indoors by many, by few outside; dishes and windows rattle	4
V. Rather strong	Generally felt by everyone; sleeping people may be awakened	4.5
VI. Strong	Trees sway, chandeliers swing, bells ring, some damage from falling objects	5
VII. Very strong	General alarm; walls and plaster crack	5.5
VIII. Destructive	Felt in moving vehicles; chimneys collapse; poorly constructed buildings seriously damaged	6
IX. Ruinous	Some houses collapse; pipes break	6.5
X. Disastrous	Obvious ground cracks; railroad tracks bent; some landslides on steep hillsides	7
XI. Very disastrous	Few buildings survive; bridges damaged or destroyed; all services interrupted (electrical, water, sewage, railroad); severe landslides	7.5
XII. Catastrophic	Total destruction; objects thrown into the air; river courses and topography altered	8 +