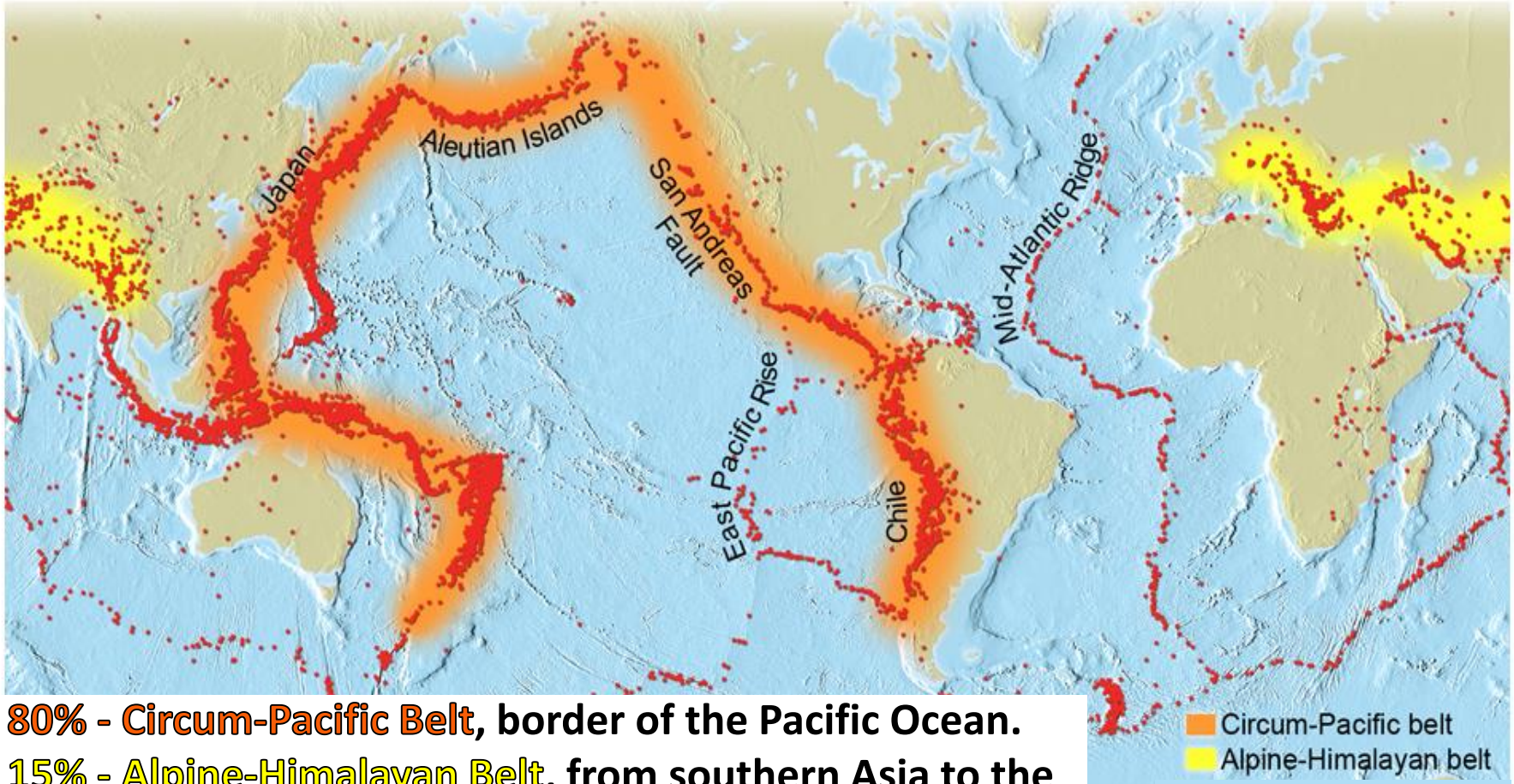
Earthquakes around the world mostly happen near tectonic plate boundaries



80% - Circum-Pacific Belt, border of the Pacific Ocean.

15% - Alpine-Himalayan Belt, from southern Asia to the Mediterranean region.

5% - parts of the Arctic, Atlantic, and Indian Oceans. Antarctica and Australia experience the least amount of earthquake activity then any other areas of the world.

Graph shows 15,000 larger magnitude (>5) earthquakes over 10-year period.

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!): one unit of magnitude increase corresponds to ~10-fold increase in intensity and ~30-fold increase in energy.**
- **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 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 +

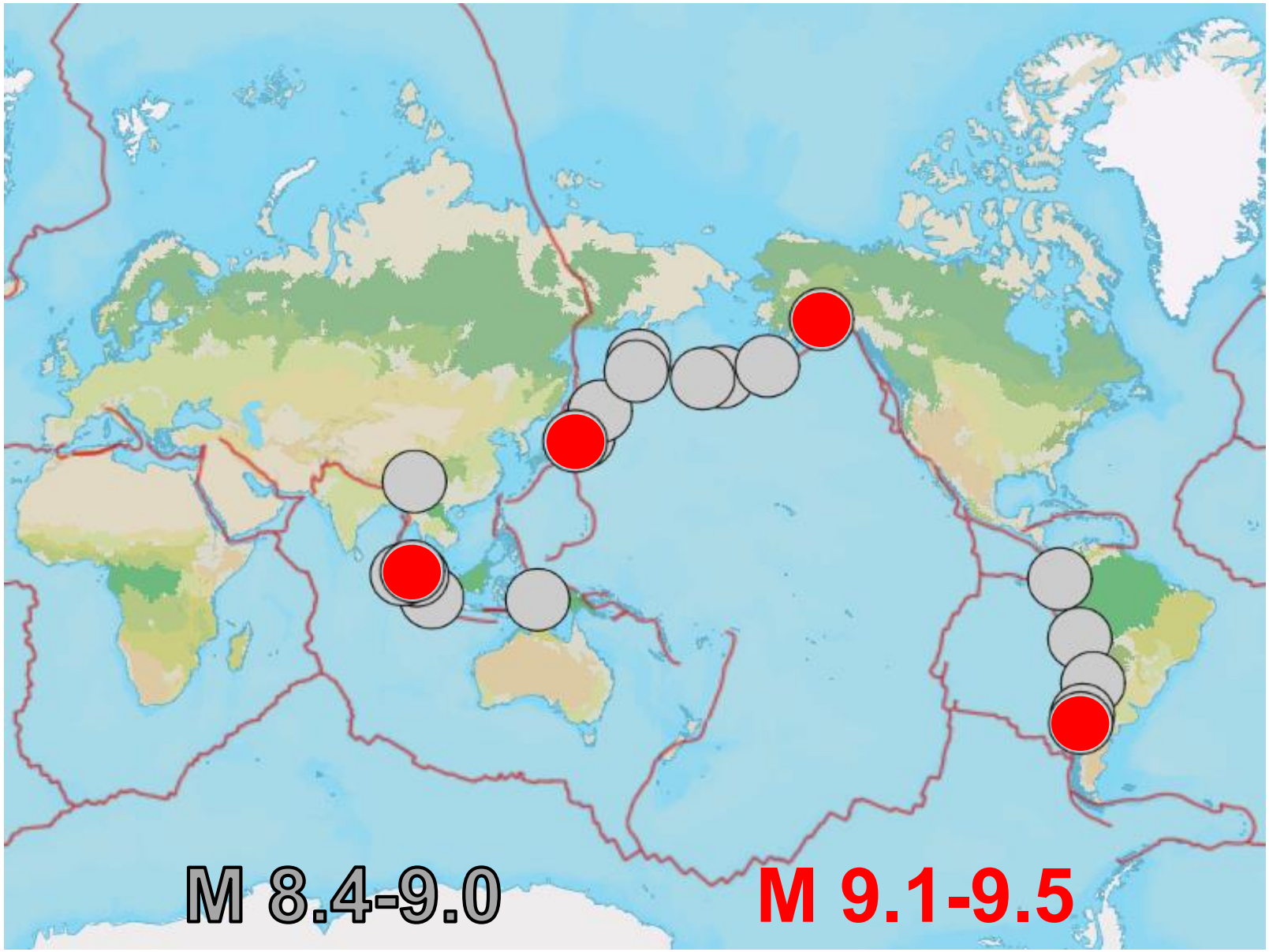
Earthquake Magnitude and Energy Equivalence

Earthquake Magnitude	Energy Released* (Millions of Ergs)	Approximate Energy Equivalence
0	630,000	1 pound of explosives
1	20,000,000	
2	630,000,000	Energy of lightning bolt
3	20,000,000,000	
4	630,000,000,000	1000 pounds of explosives
5	20,000,000,000,000	
6	630,000,000,000,000	1946 Bikini atomic bomb test 1994 Northridge Earthquake
7	20,000,000,000,000,000	1989 Loma Prieta Earthquake
8	630,000,000,000,000,000	1906 San Francisco Earthquake
9	20,000,000,000,000,000,000	1980 Eruption of Mount St. Helens 1964 Alaskan Earthquake 1960 Chilean Earthquake
10	630,000,000,000,000,000,000	Annual U.S. energy consumption

barely felt

One unit of magnitude increase corresponds to ~10-fold increase in intensity and ~30-fold increase in energy.

20 Largest Earthquakes Worldwide



Greatest Earthquakes Ever Recorded

1. (M 9.5) 22 May 1960 – Great Chilean Earthquake, Valdivia, Chile:

   most powerful earthquake ever recorded; lasted ~10 min; triggered tsunami which reached Hawaii and Japan; 3000-5000 dead.

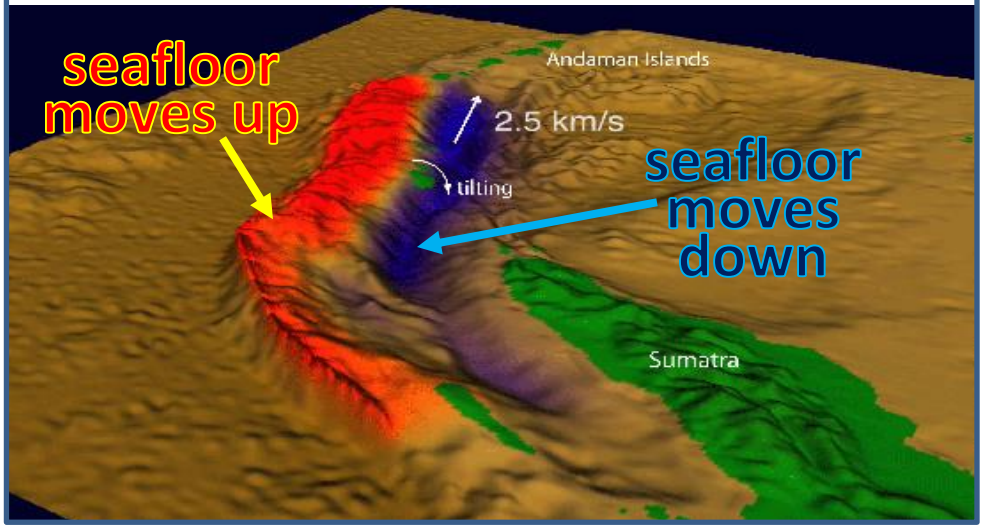
2. (M 9.2) 27 March 1964 – Great Alaskan Earthquake (aka Good Friday earthquake), Prince William Sound, AK:

   lasted ~4.5 min; tsunami, soil liquefaction; 128 dead.

Greatest Earthquakes Ever Recorded

3. (M 9.1) 26 December 2004 – Indian Ocean Earthquake (aka Sumatra-Andaman earthquake) off the west coast of Sumatra:

shaking lasted ~8 min; surface wave oscillations exceeded 1 cm everywhere on Earth; the longest ever fault rupture of 1600 km triggered tsunami waves (up to 30 m high reaching as far as 2 km inland in Indonesia); killed 230,000 people in 14 countries.



4. (M 9.1) 11 March 2011 – Great East Japan Earthquake (aka Tohoku earthquake) off the west coast of Japan:

lasted ~6 min; tsunami waves (up to 40 m high, travelled as far as 10 km inland); the disaster caused partial meltdown at Fukushima Daiichi Nuclear Power Plant; 15,800 dead.

How *common* are earthquakes?

- **It is estimated that around 500,000 earthquakes occur each year, detectable with current instrumentation.**
- **About 100,000 of these can be felt (*ground shaking* during a moderate to large earthquake typically lasts about *10 to 30 seconds*).**
- **Minor earthquakes occur nearly constantly around the world; larger earthquakes occur less frequently.**
- **While most earthquakes are caused by movement of the Earth's tectonic plates, the following human activities can also produce earthquakes:**
  - **storing large amounts of water behind a dam**
  - **drilling and injecting liquid into wells**
  - **coal mining and oil drilling/fracking**

Yesterday's Worldwide Earthquakes (M>3)

Oldest quakes are shown in yellow, more recent in red.