Earthquakes :
Quick Summary

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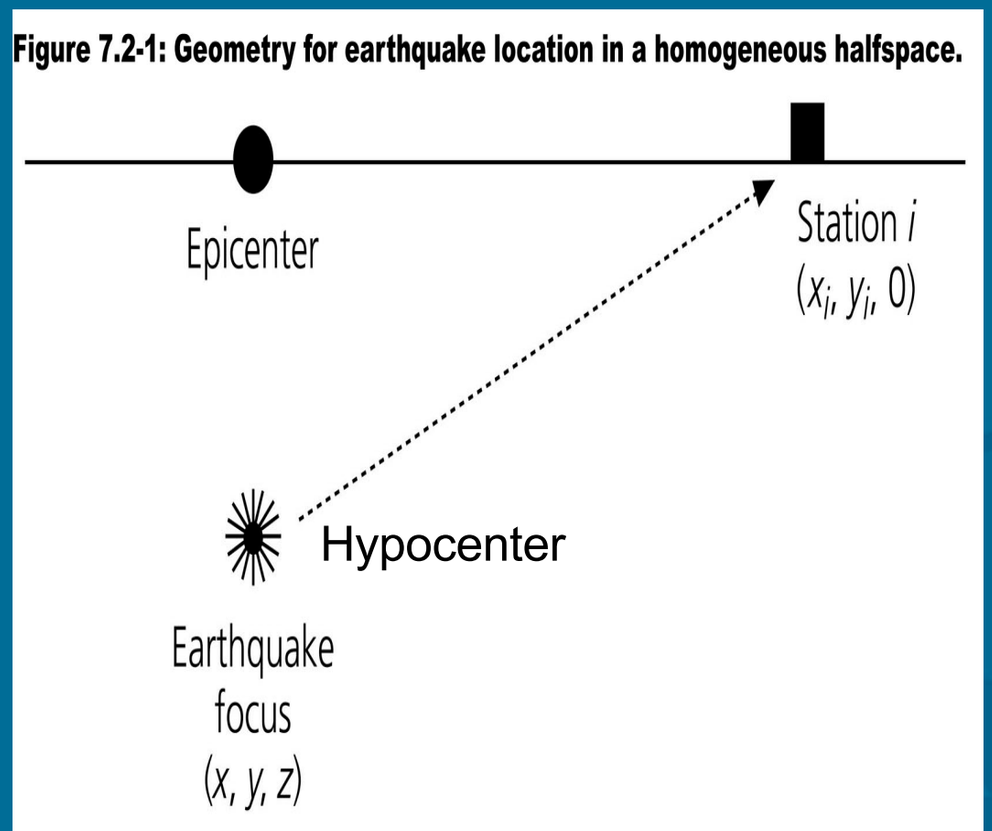
Earthquake Nomenclature and Classification

Earthquake Nomenclature

Described by Time (t) and Location (x,y,z)

Hypocenter (Focus):
Origin Time,
Latitude, Longitude,
Depth
Location in Earth where energy in the rock being strained is released

Epicenter:
Latitude, Longitude
Point on Earth's surface directly above Hypocenter



EARTHQUAKE CLASSIFICATION - SIZE

MAGNITUDE	CLASSIFICATION
$M \geq 9.0$	Gigantic (? new term)
$M \geq 8.0$	Great Earthquake
$7.0 \geq M < 8.0$	Major / Large Earthquake
$5.0 \geq M < 7.0$	Moderate Earthquake
$3.0 \geq M < 5.0$	Small Earthquake
$1.0 \geq M < 3.0$	Microearthquake
$M < 1.0$	Ultra Microearthquake

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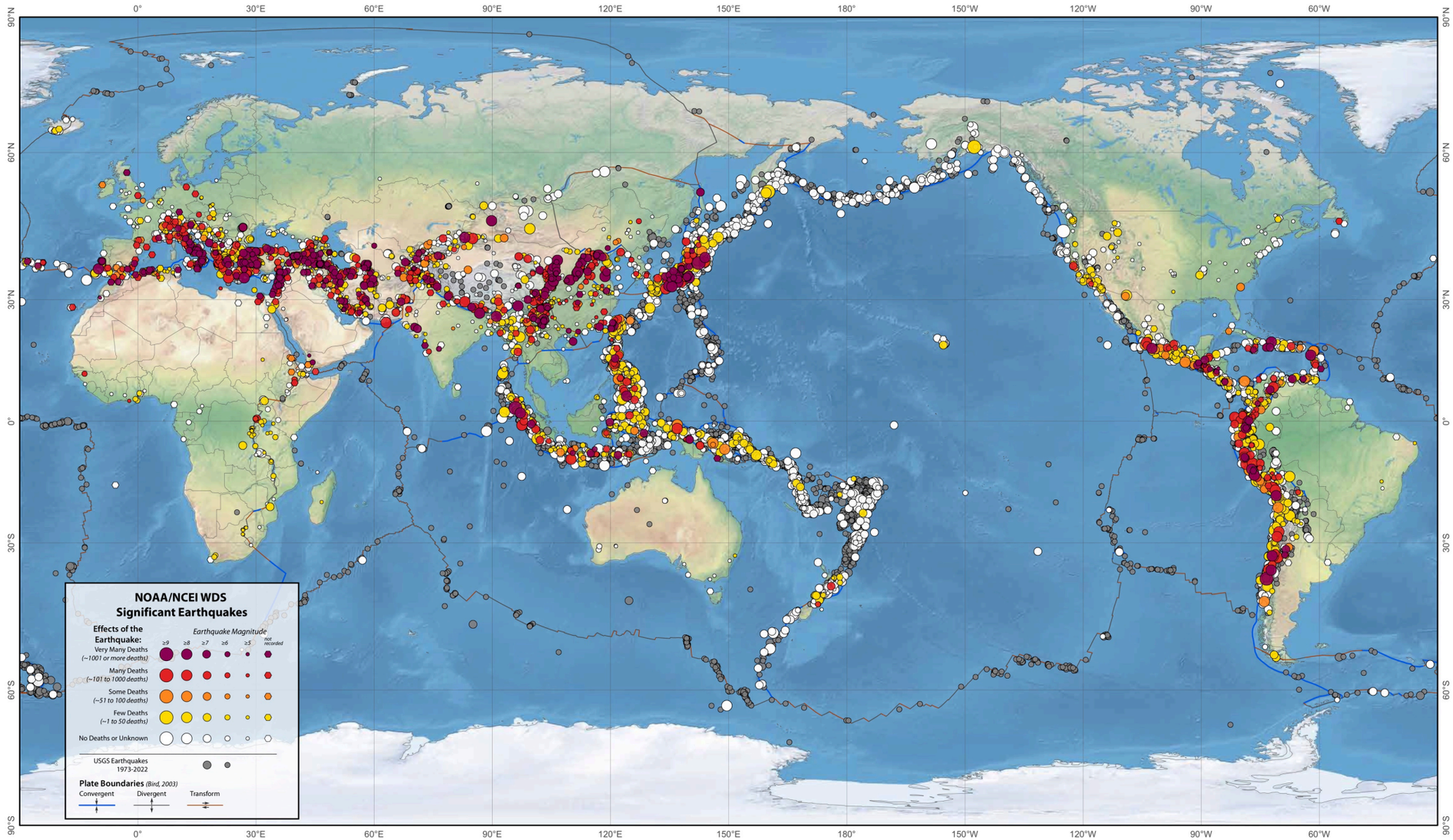
Hagiwara, 1964

Magnitude	Earthquake Effects	Est Nbr / Year
2.5 or less	Usually not felt, but can be recorded by seismograph.	**900,000**
2.5 to 5.4 (Small (3-5) to Moderate (5-6)	Often felt, but only causes minor damage.	**30,000**
5.5 to 6.0 (Moderate)	Slight damage to buildings and other structures.	**500**
6.1 to 6.9 (Strong)	May cause a lot of damage in very populated areas.	**100**
7.0 to 7.9 (Major)	Major earthquake. Serious damage.	**20**
8.0 or greater (Great)	Great earthquake. Can totally destroy communities near the epicenter.	**1 every 5-10 years**

Significant Earthquakes 2150 B.C. to A.D. 2022



Patterson Cylindrical Projection

Symbol drawing order: more deaths on top of fewer deaths;
smaller magnitude earthquakes on top of larger magnitude earthquakes.

March 2022

EQ CLASSIFICATION – DISTANCE MEASURED

- Teleseismic Earthquake > 1000 km
- Regional Earthquake > 500 km
- Local Earthquake < 500 km

EQ CLASSIFICATION – TIME

- Foreshocks
- Main shock
- Aftershocks
- Earthquake Swarm

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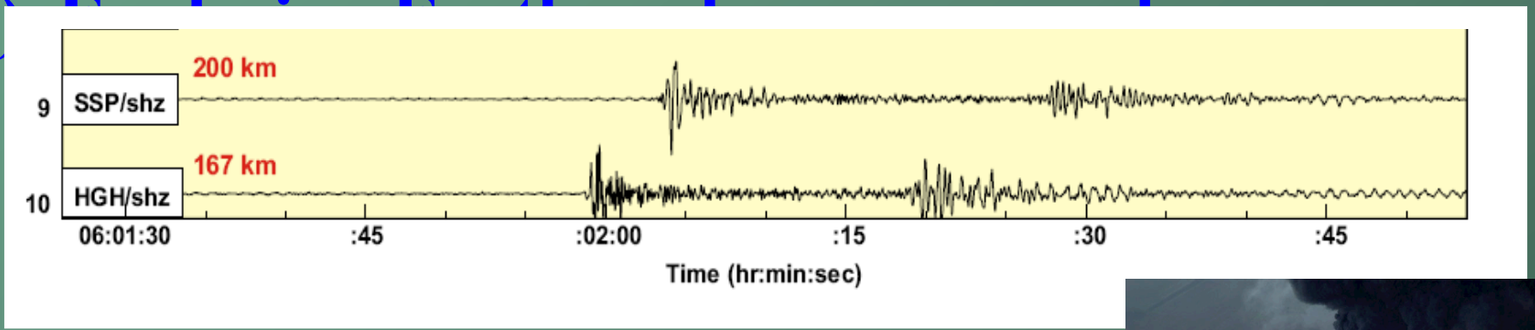
EQ CLASSIFICATION - CAUSES

1) Tectonic Earthquake – MOST COMMON (FAULTS)
2) Volcanic Earthquake – magma movement, eruptions
3) Collapse Earthquake – cave collapse, rock fall
4) [illegible]



BGS recordings of an explosion at an oil storage depot near London Dec 16, 2005.
Equivalent to M2.4 earthquake

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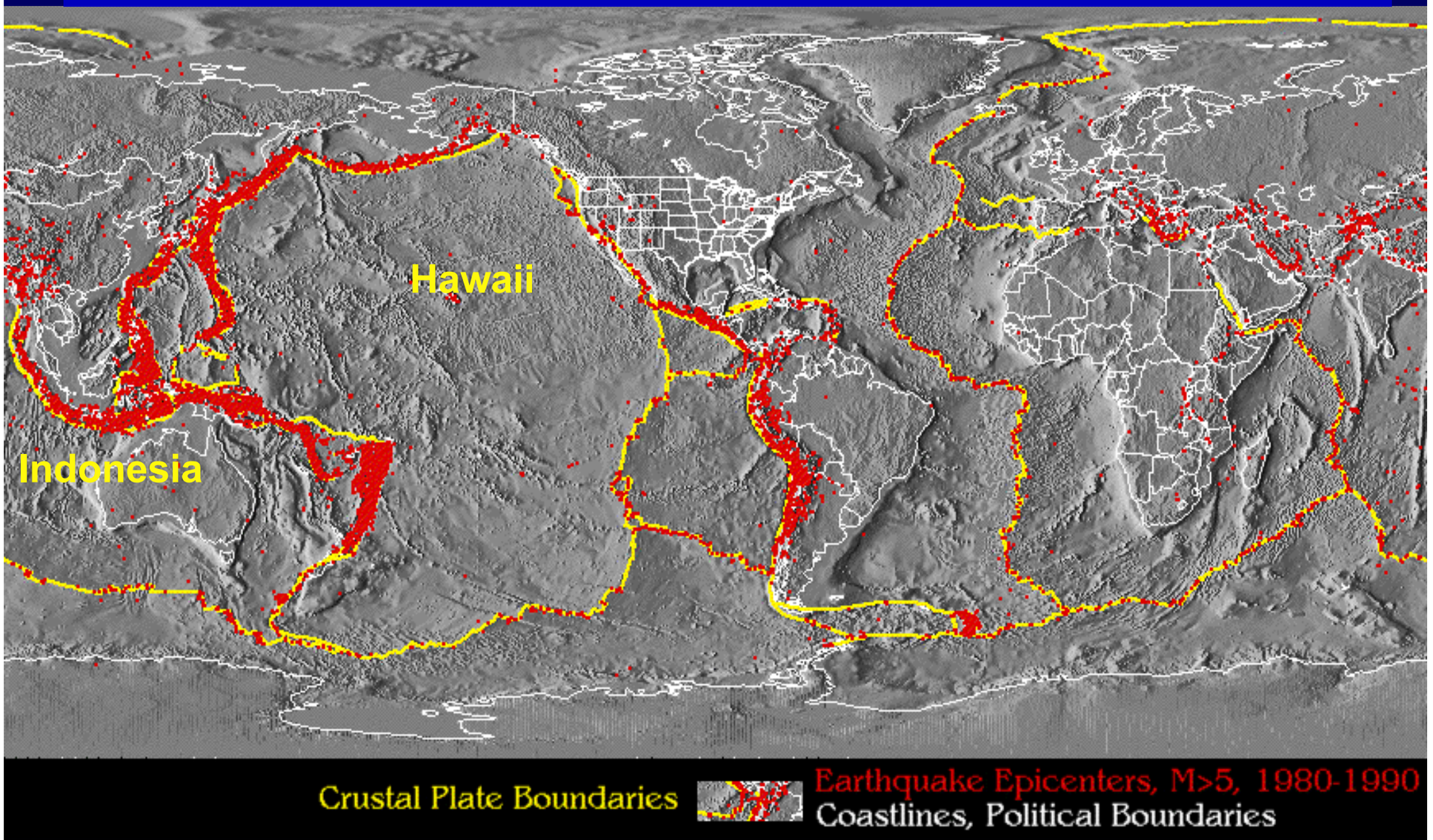
Faulting

Earthquakes delineate Crustal Plate boundaries



Types of Earthquake Faulting - Tectonic

- Normal fault
- Thrust or reverse fault
- Lateral slip or strike-slip fault

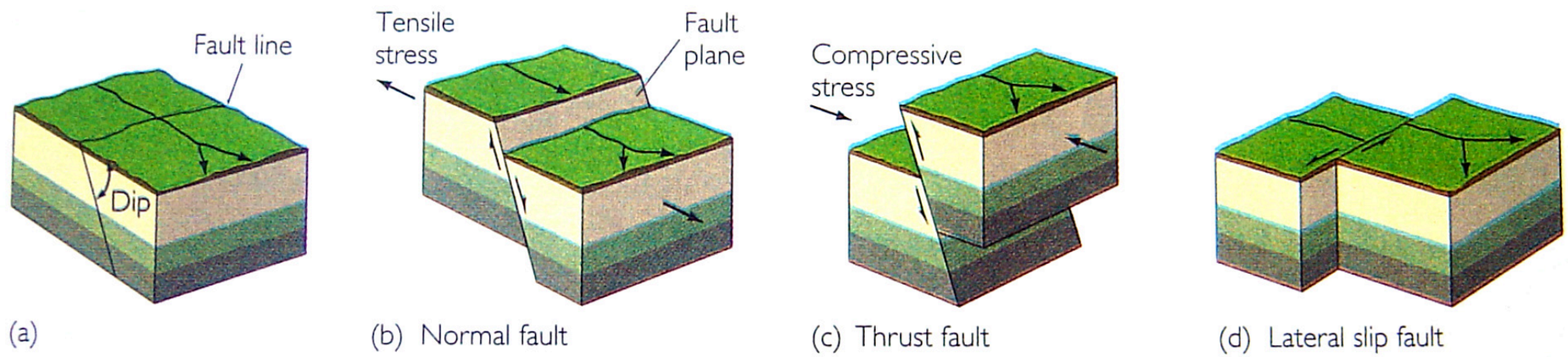
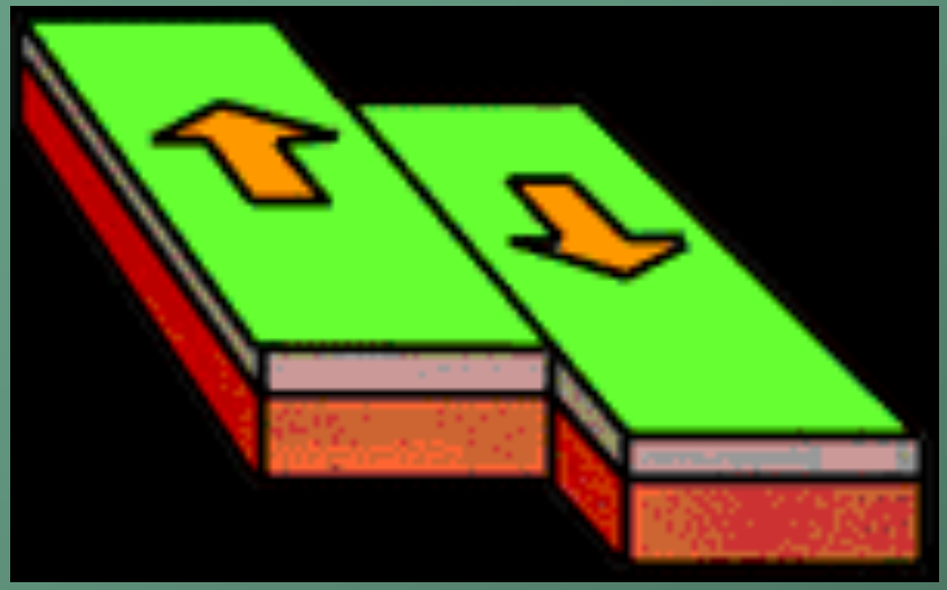


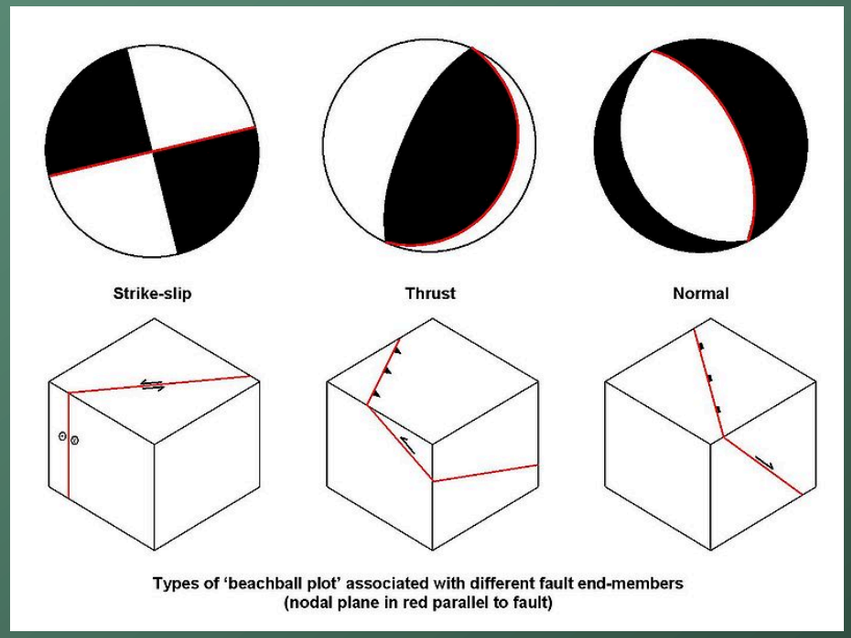
FIGURE 18.12 The three main types of fault movements that initiate earthquakes, and the stresses that cause them: (a) situation before movement takes place; (b) normal fault due to tensile stress; (c) thrust (or reverse) fault due to compressive stress; (d) lateral slip (or strike-slip) fault due to shearing stress.

Normal fault Regime

Thrust fault Regime



Strike-slip fault Regime



Types of 'beachball plot' associated with different fault end-members
(nodal plane in red parallel to fault)

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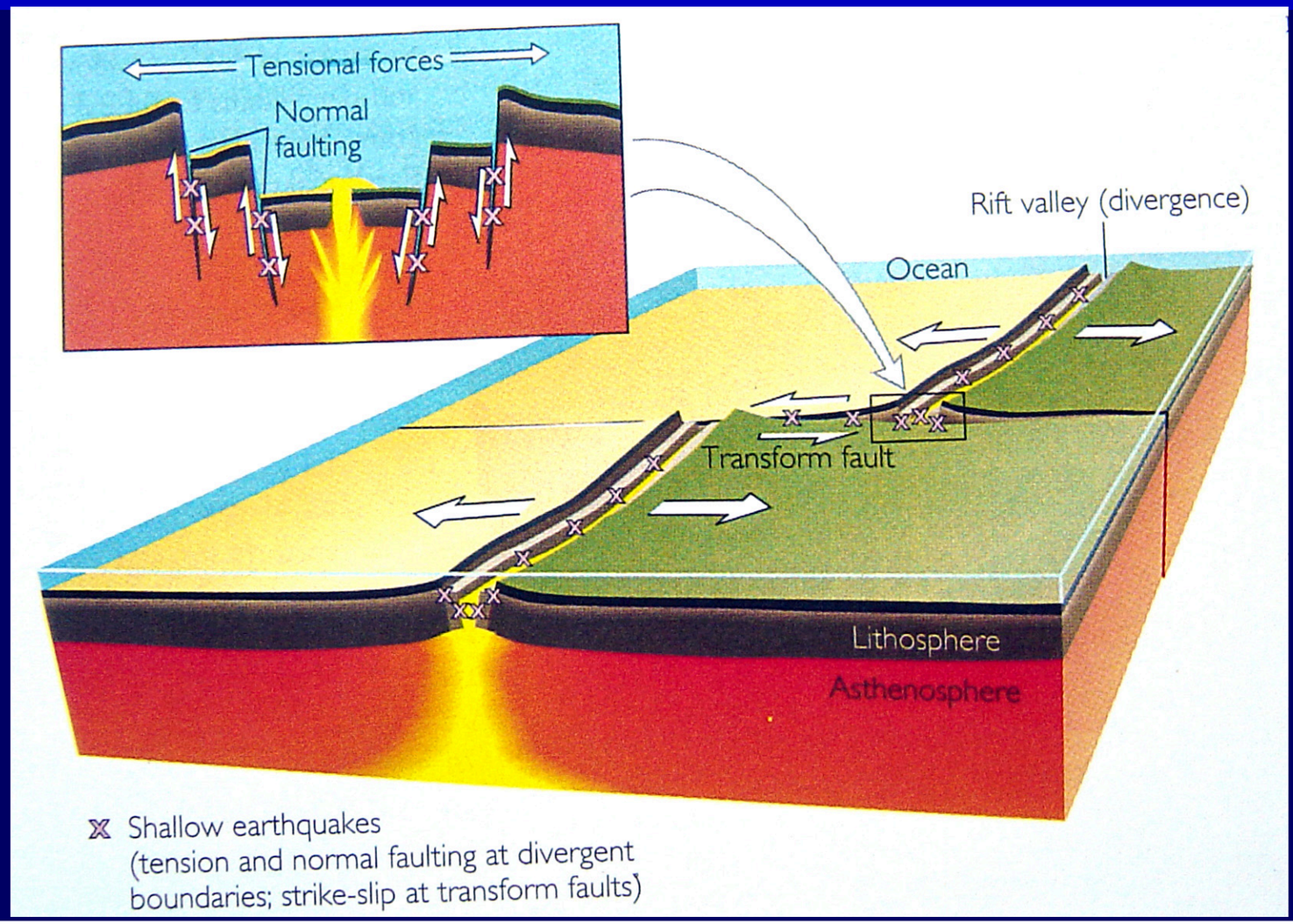
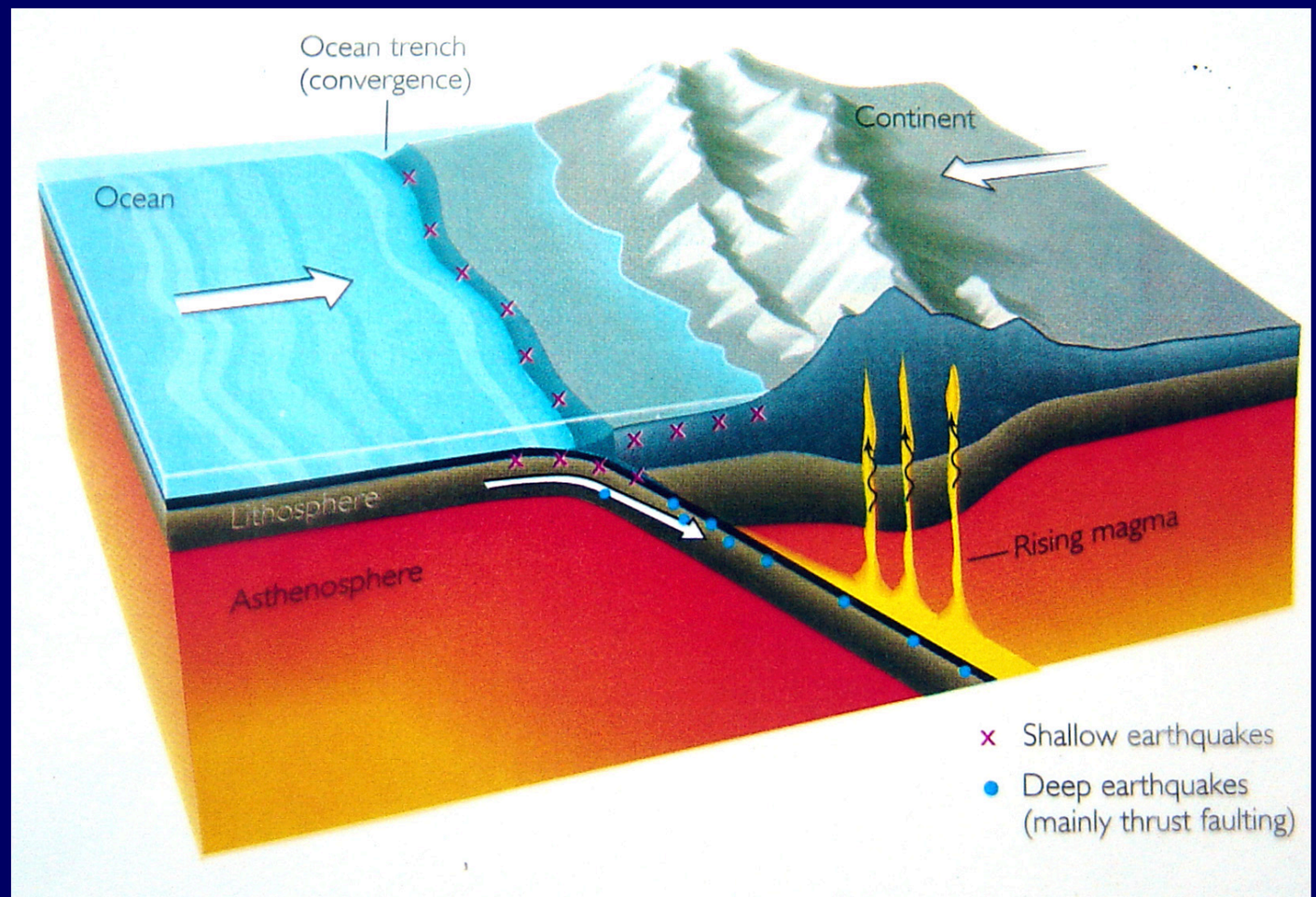
Tectonic Earthquakes at Plate Boundaries

- Normal faulting at mid-ocean ridges
- Strike-slip faulting along transform faults

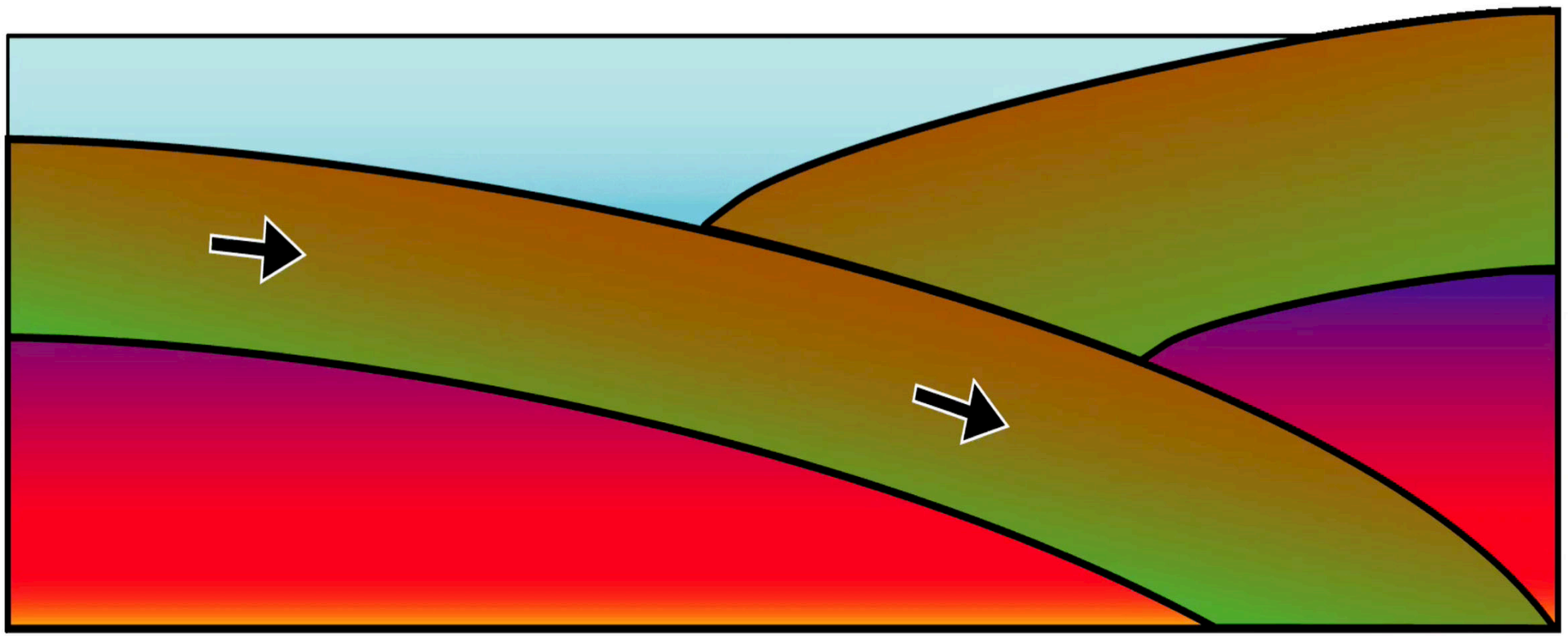


Tectonic Earthquakes at Plate Boundaries

- Thrust earthquakes at subduction zones
- Volcanic island arcs built above subducting plate

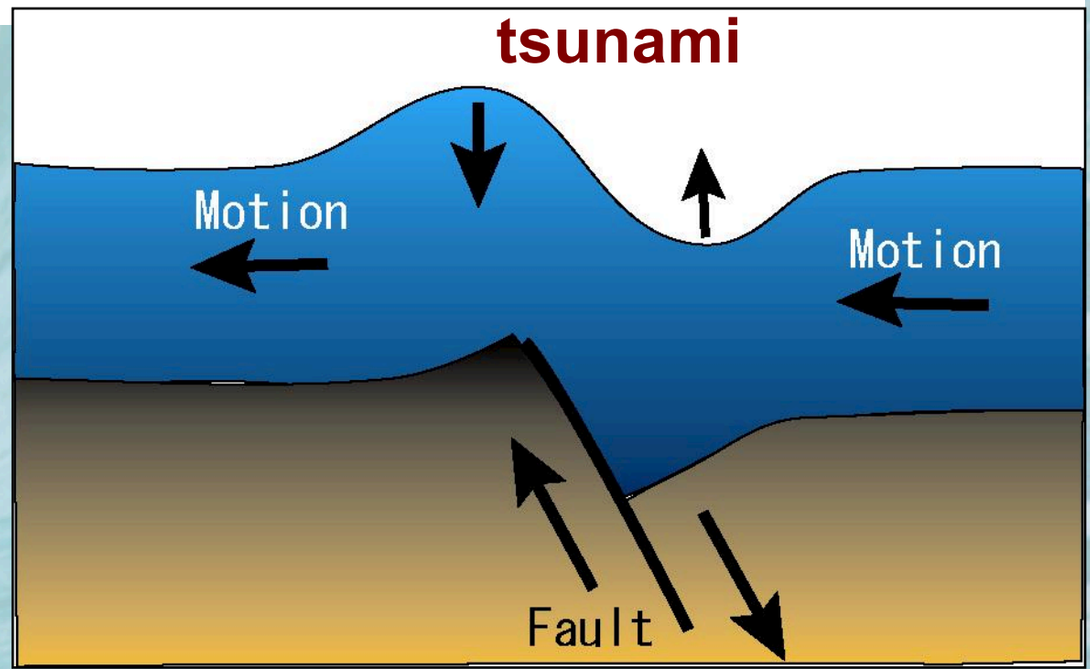


Most Tsunamis are caused by Shallow, Large Earthquakes beneath the Seafloor



Great Earthquakes (M>8.0)

- Shake for a long time (10s sec to 2-3 min)
- Rupture for 10 to 100s miles
- Move the earth up and down
- => Ocean up and down
- => Generate tsunami



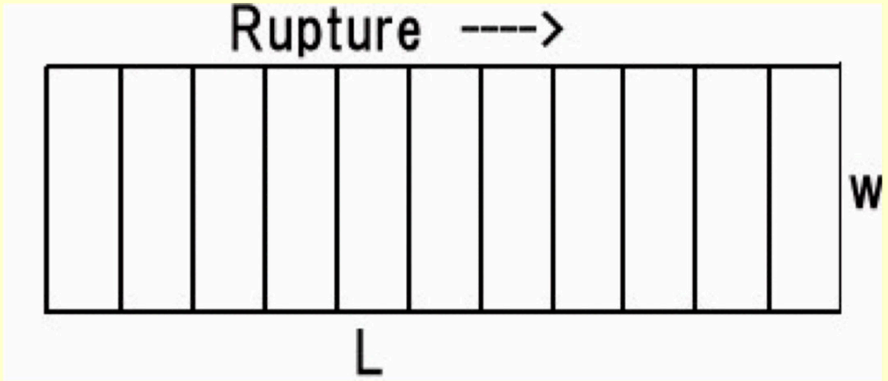
Earthquake Rupture complexity

Great Earthquakes

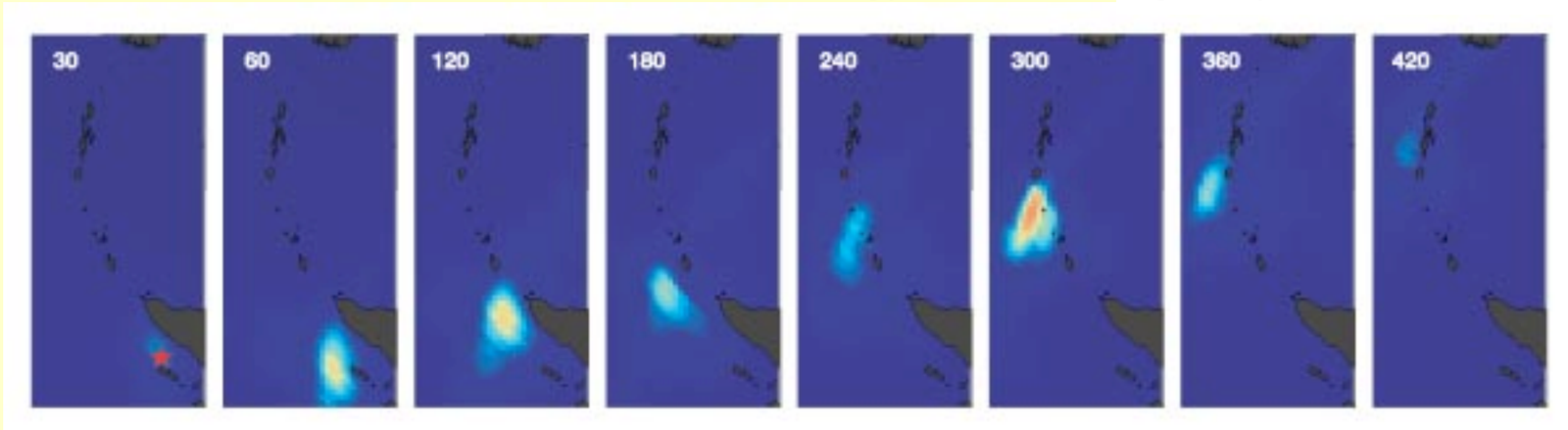
- Shake for a long time (10s sec to 2-3 minutes)
- Rupture for 10 to 100s miles

2004 Sumatra earthquake

Haskell Line Source
Dislocation Source



Energy Release imaged by Japan HINET Array



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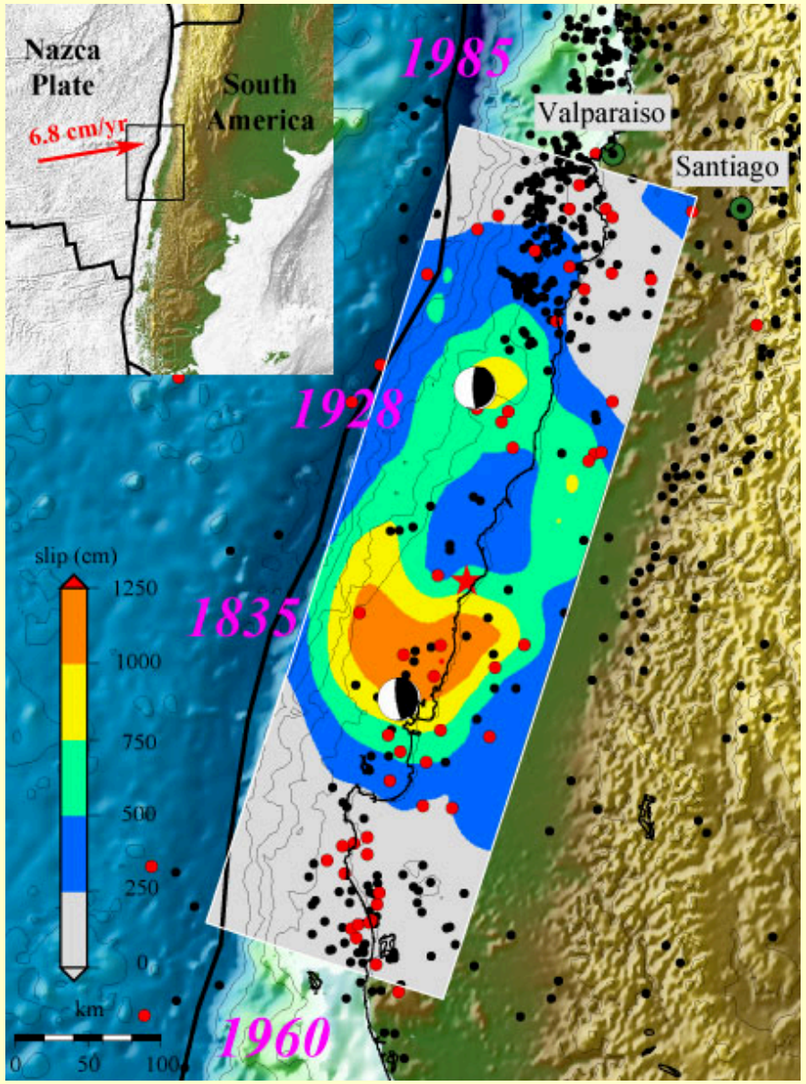
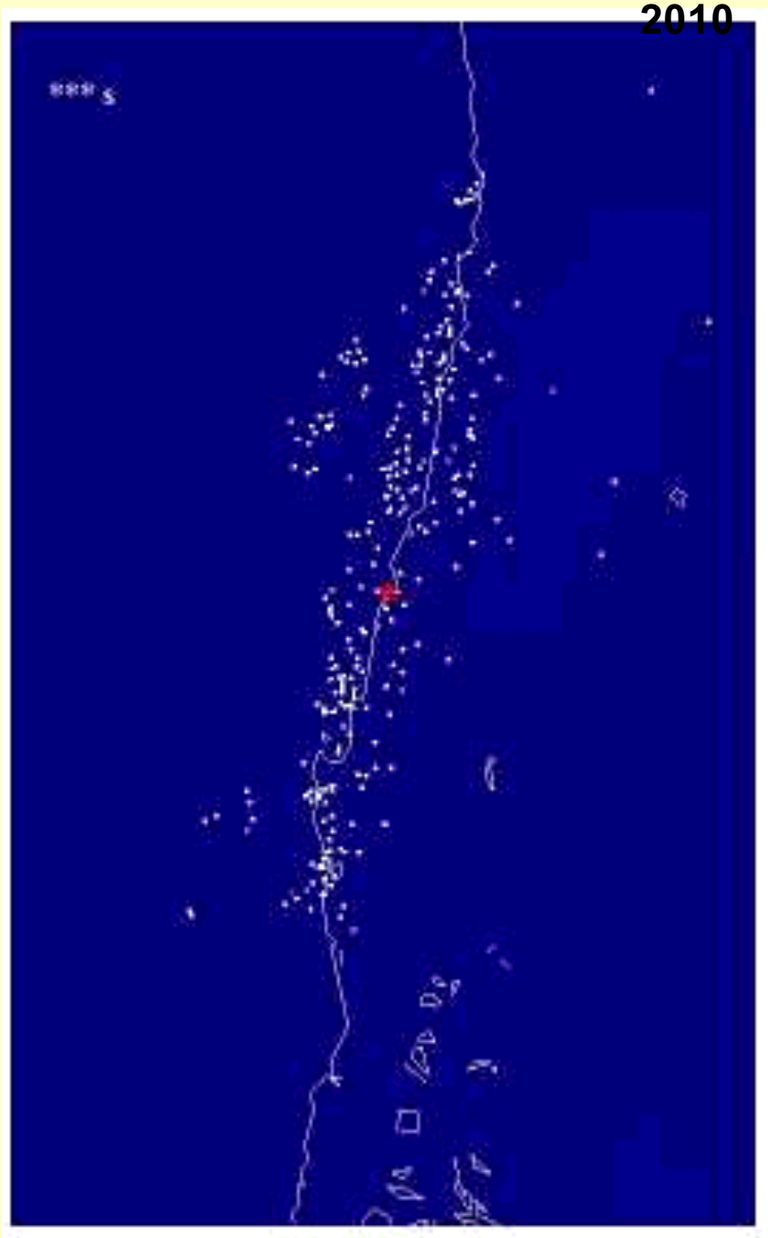
Ishii et al., 2005

2010 Chile earthquake



Energy Release imaged by Japan HINET Array, Ishii et al, 2010



Preliminary slip model of the Feb 27, 2010 Mw 8.9 Maule, Chile Earthquake
G Shao, X Li, Q Liu, X Zhao, T Yano, Chen Ji, UCSB

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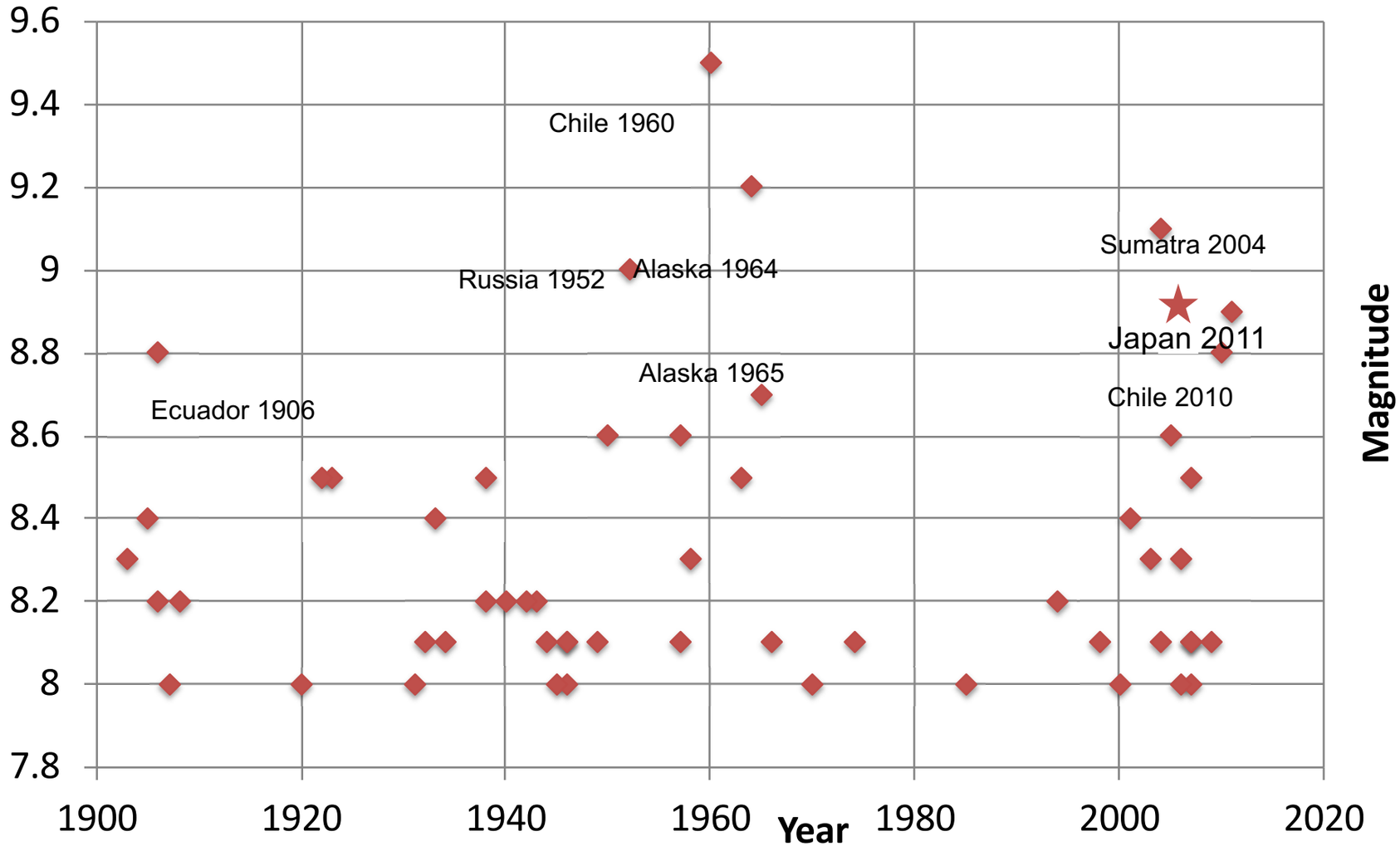
Great (M>8) Earthquakes since 1900 (avg 2.1/yr)



R. Butler, 2011

Thank You

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