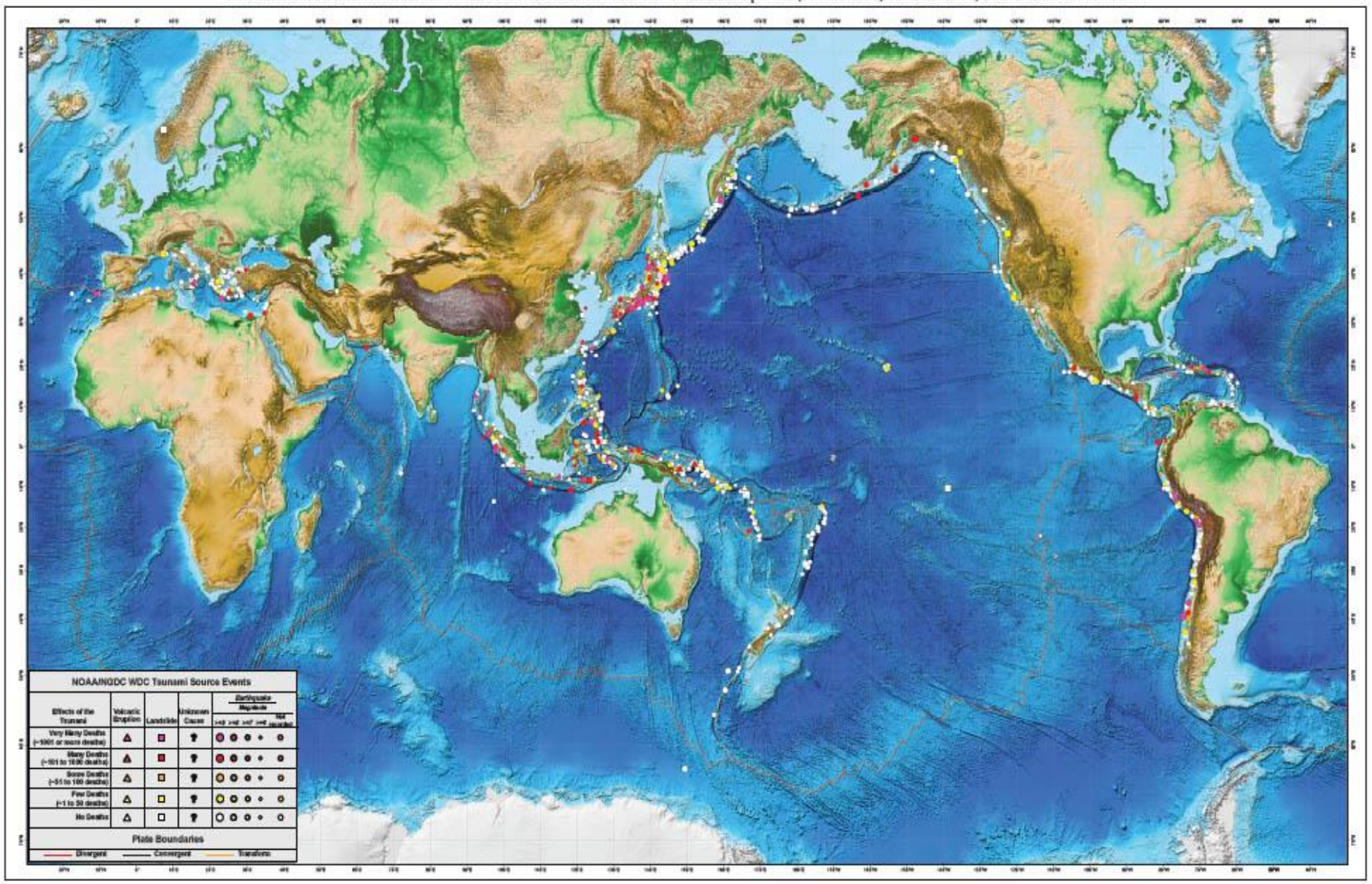
Tunami

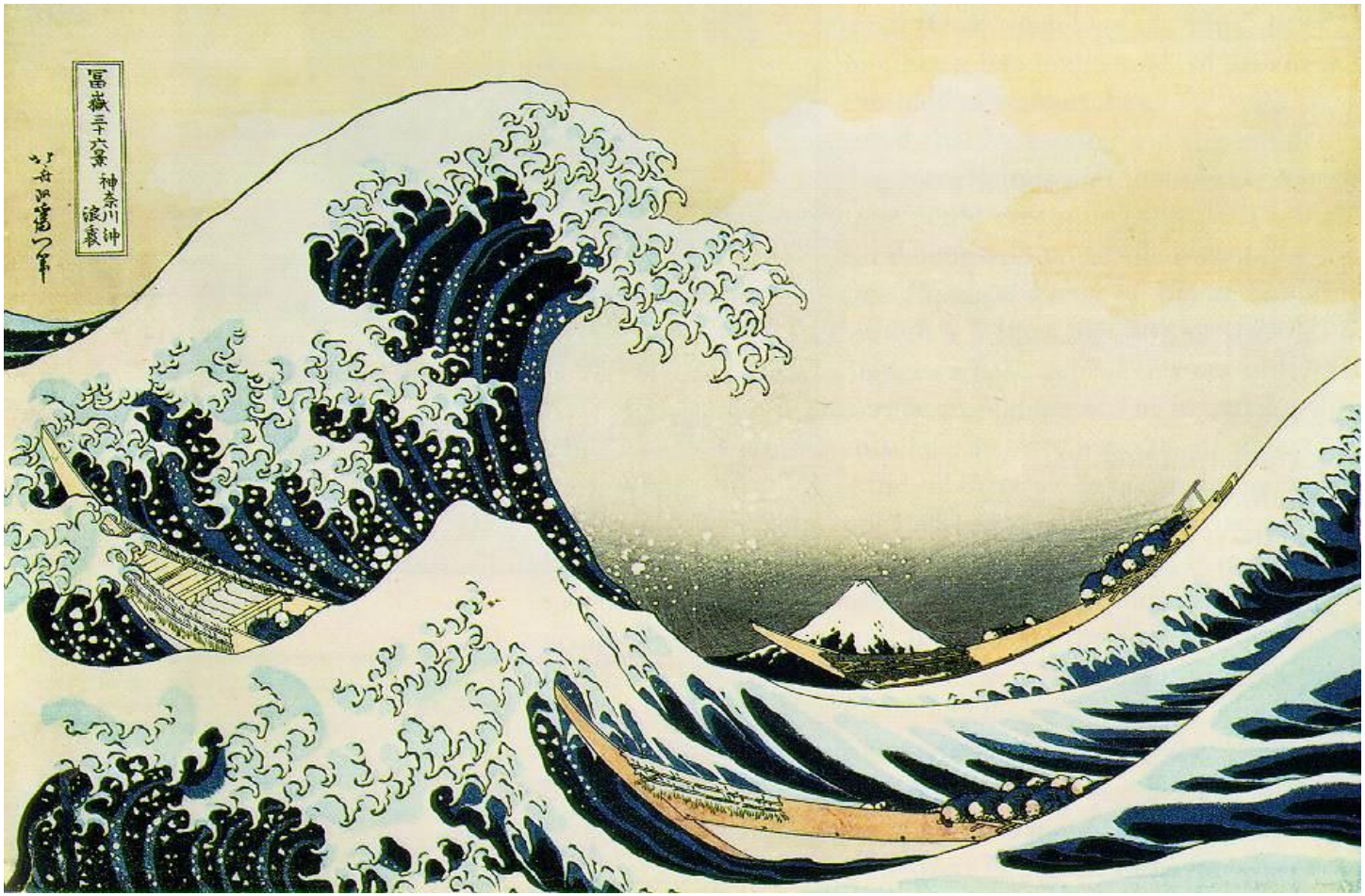
Tsunami, Japan, 2011



Global Tsunami

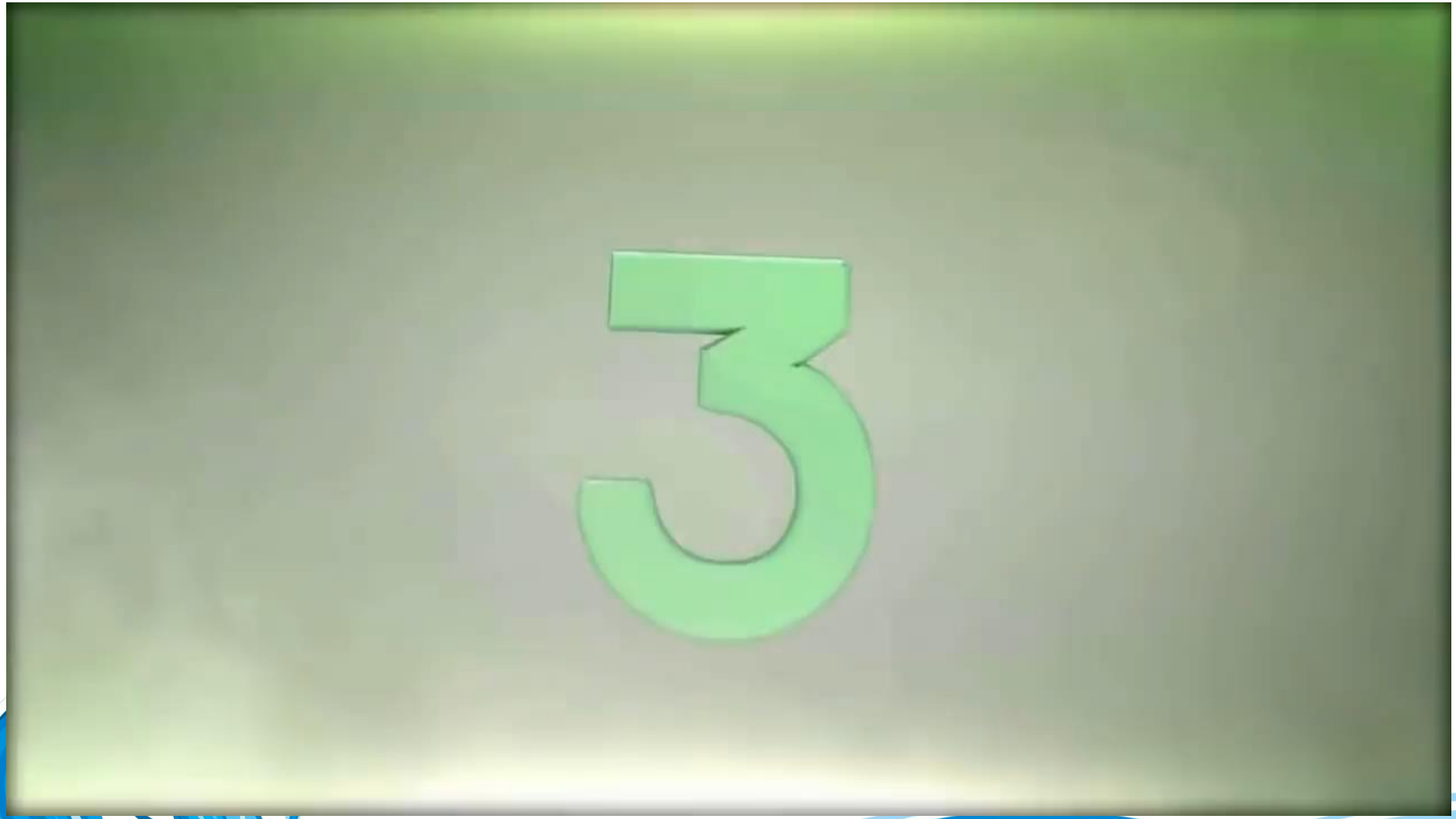
Tsunami: Japanese name for "**harbor waves**"
because the waves rise highest where they are focused into bays or harbors

Not "tidal waves"; have nothing to do with tides



Danger signals may include a rapid **rise** or **fall of sea level**

2004 Sumatra Tsunami at India



海啸 – 2004 Sumatra Tsunami at Indonesia

2004 Sumatra Tsunami at Sumatra

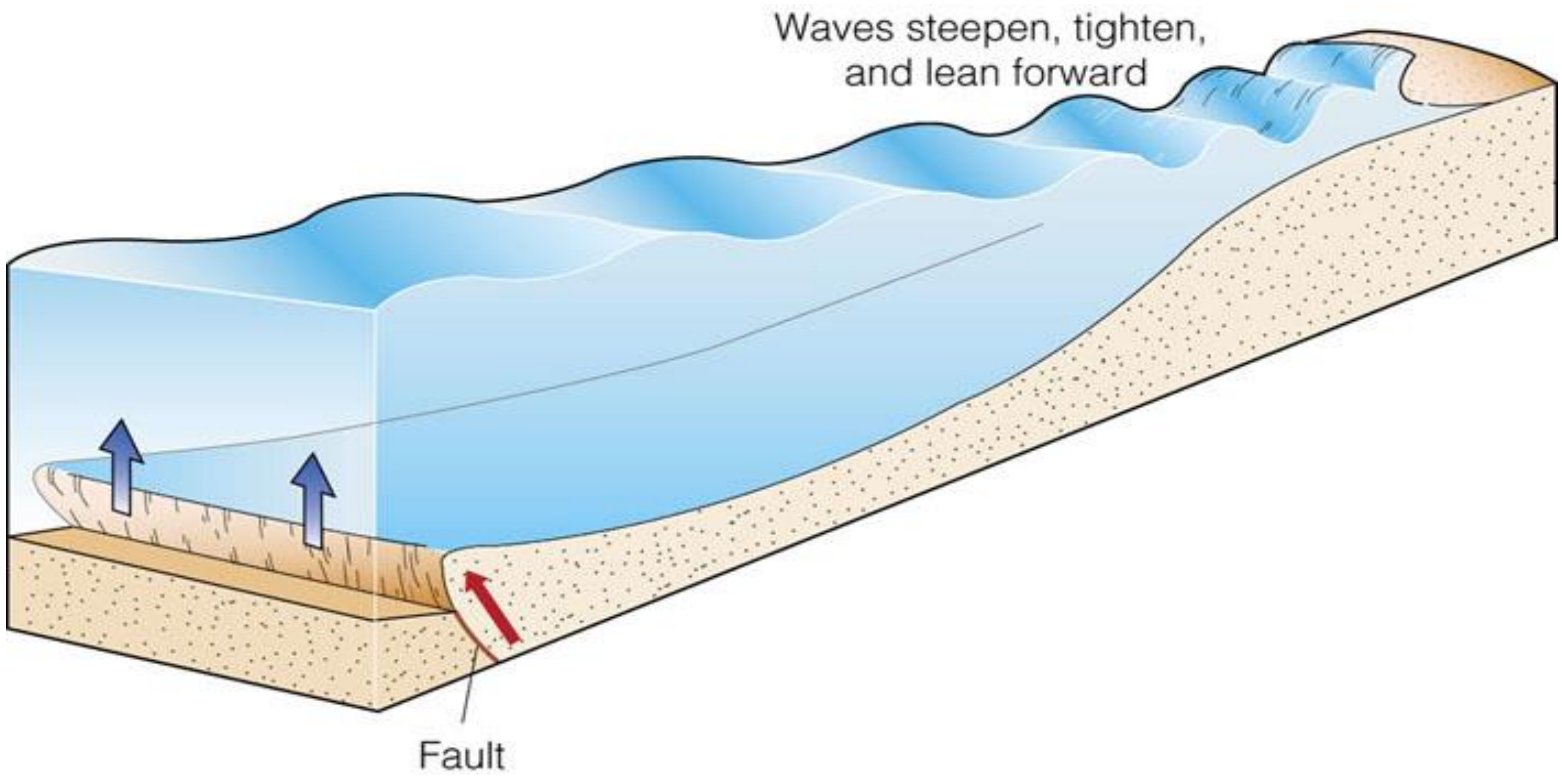
Formation of tsunami


NHK

Caused by **large, sudden displacement of water**

(A)Tsunami from **undersea earthquakes**

Tsunami are also called "**seismic sea waves**" because most of them are generated by **shallow-focus underwater earthquakes**

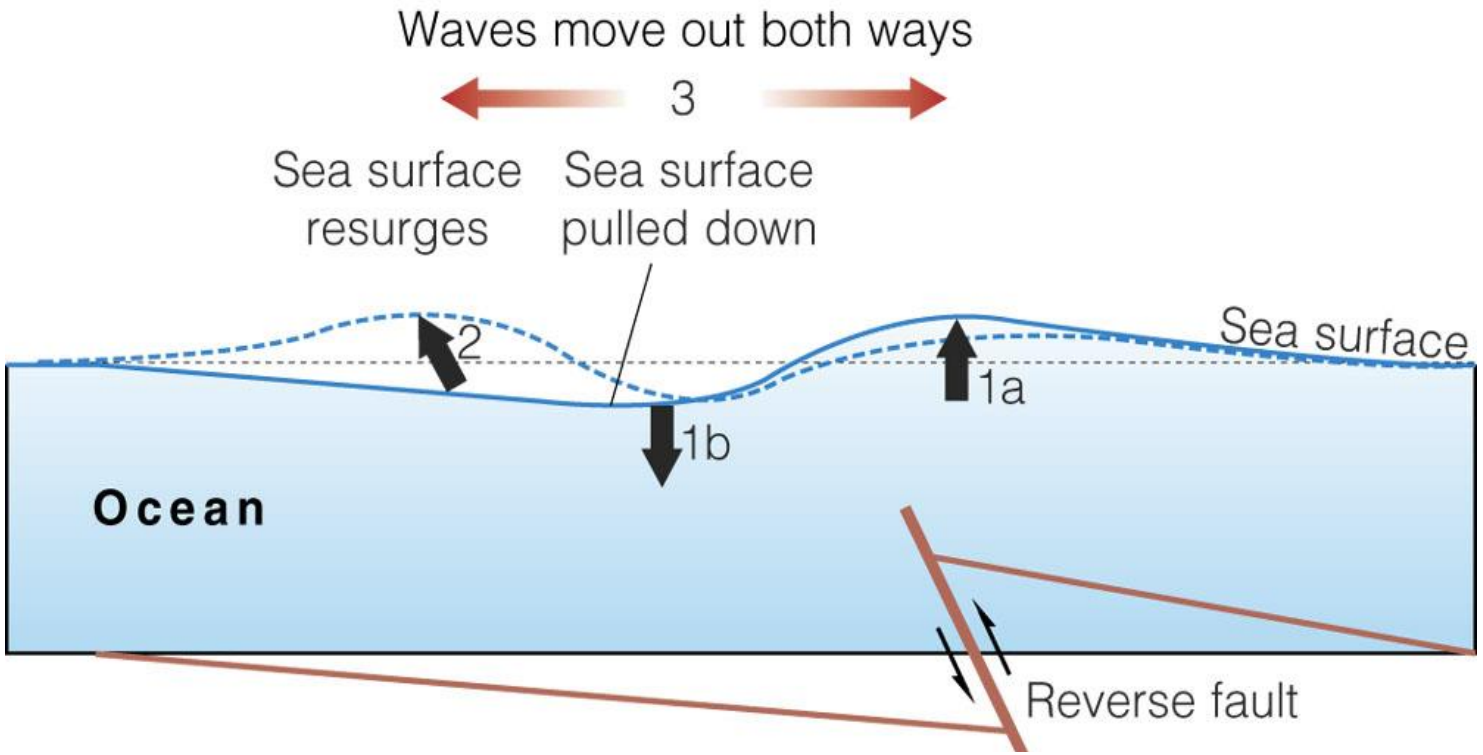


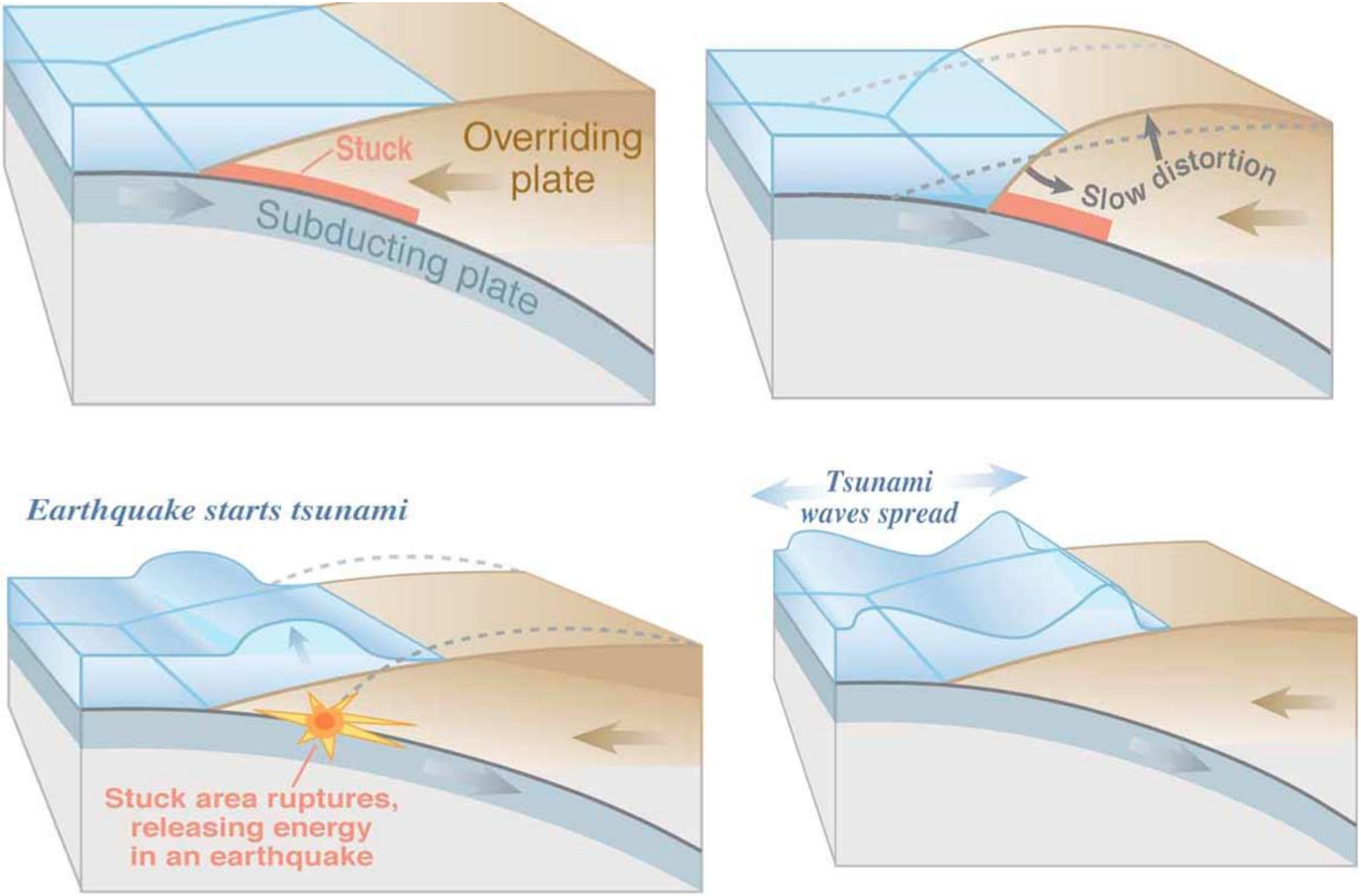
Displacement of ocean floor

Mostly on a **reverse fault** at **<u>subduction zone</u>**

Occasionally on a **normal fault**

Strike-slip earthquakes rarely generate tsunami because they do not displace much water

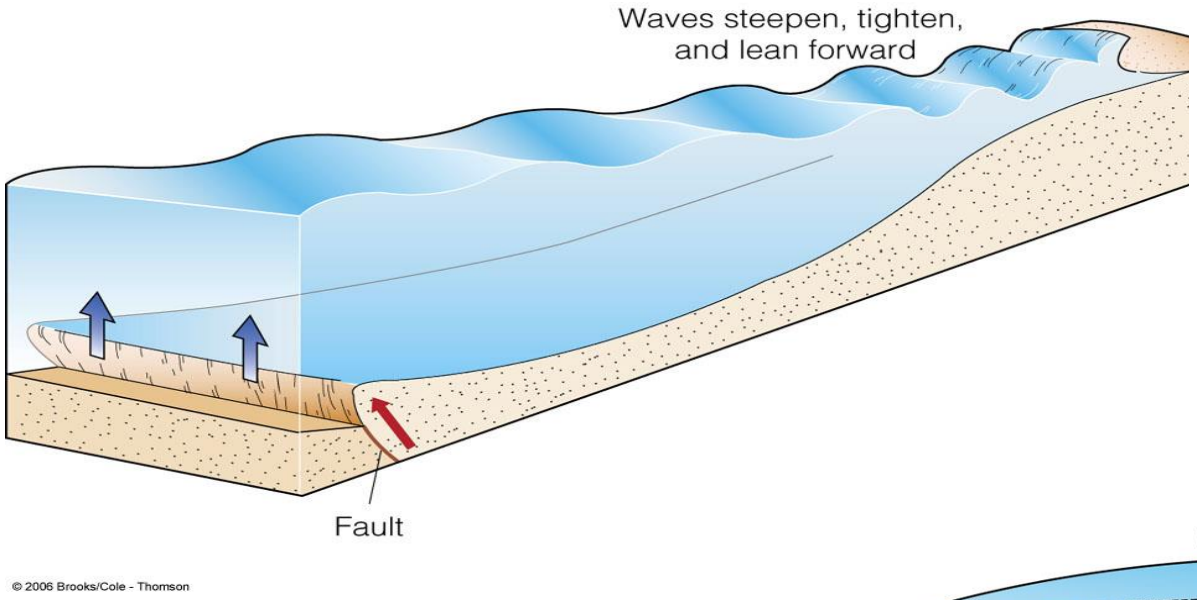


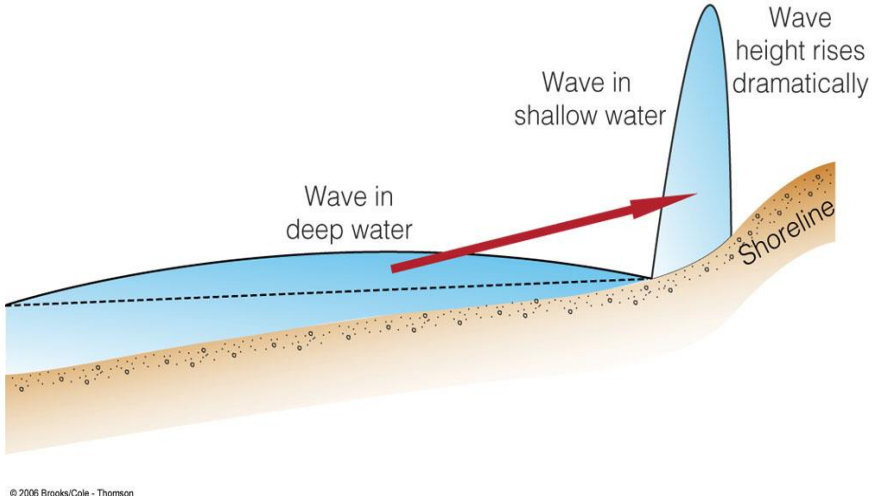


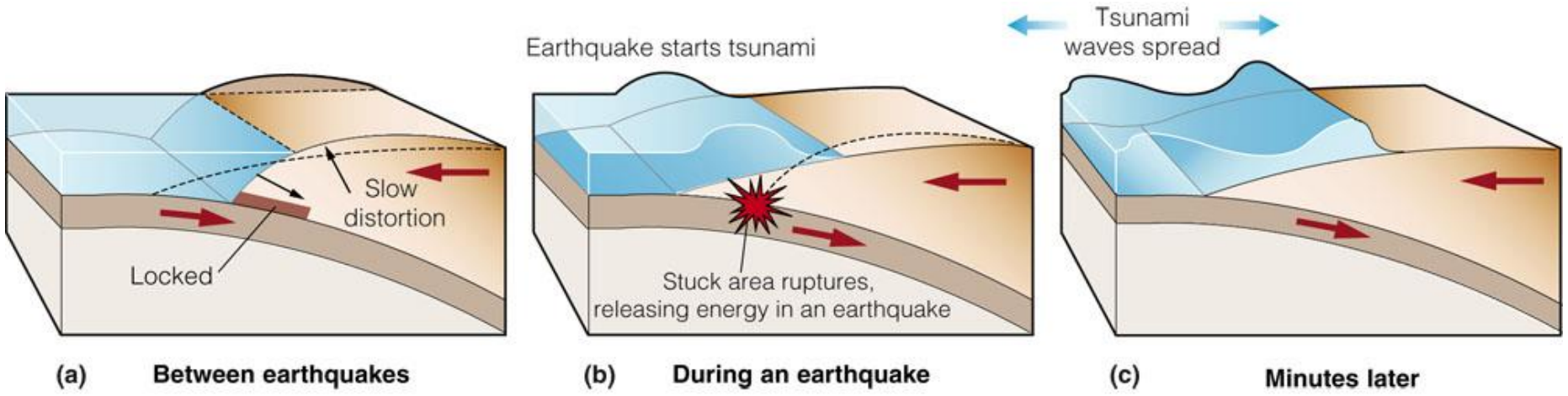
Tsunami caused by thrust fault rupture at subduction zone

Velocity and Wave Height of Tsunami

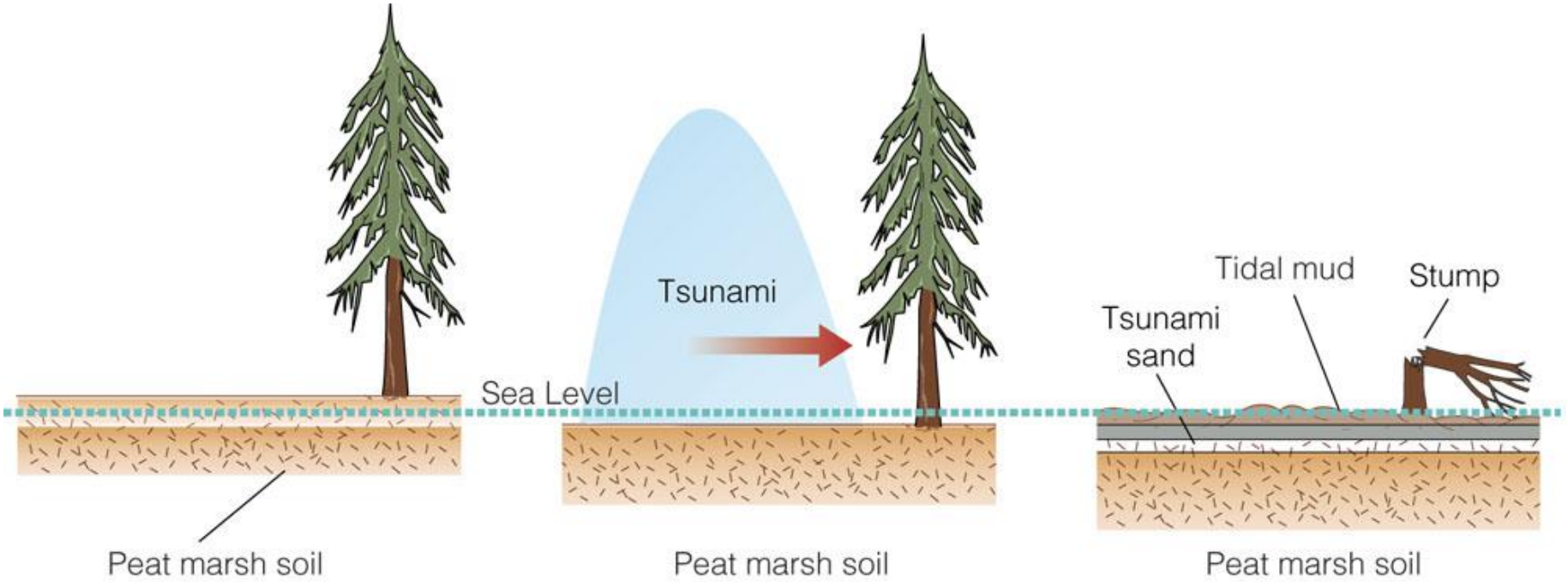
	deep ocean	near shore
Speed	**up to ~ 800 km/hr**	**~ 100km/hr or slower**
Height	**low**	**~ 6 times of those at deep water**

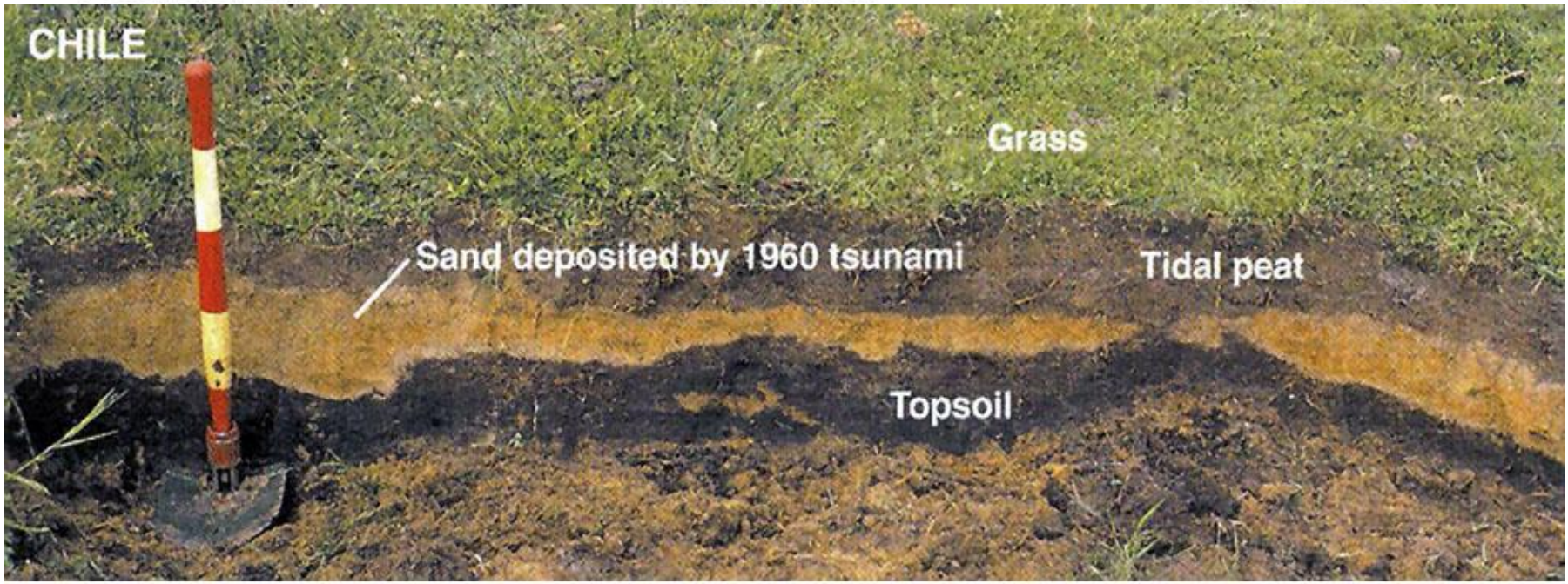






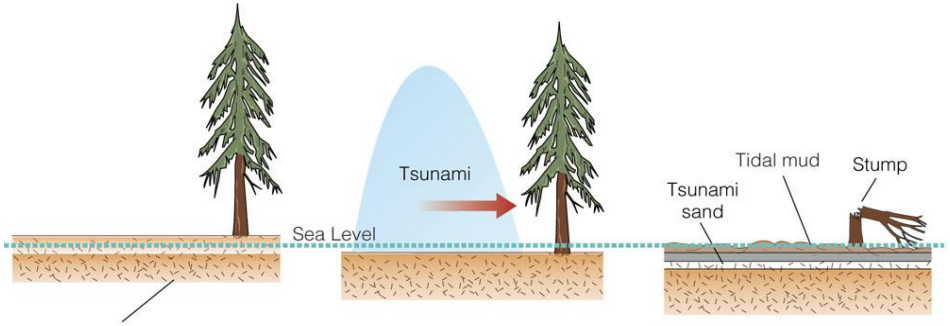
Alaska coastal area flooded when the coastal bulge collapsed after the earthquake





Tsunami in the Pacific Northwest

Evidence- **stumps of ancient trees felled by tsunami**



"Ghost Forest", Washington

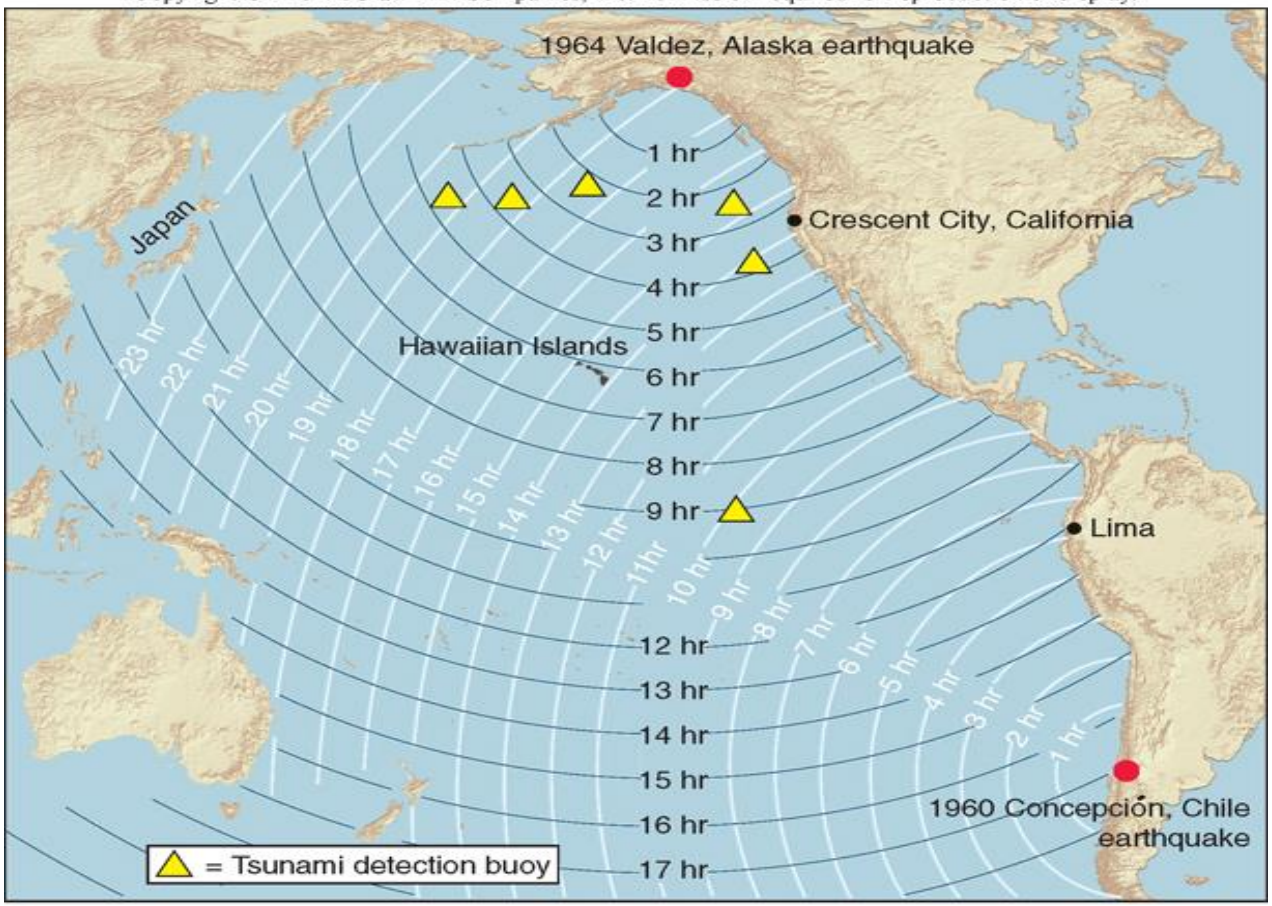
Neskowin, Oregon

Chile Tsunami (1960, Mw = 9.5 EQ)

Subduction of **Nazca Plate** beneath **South American Plate**

Alaska Tsunami (1964, Mw = 9.2 EQ)

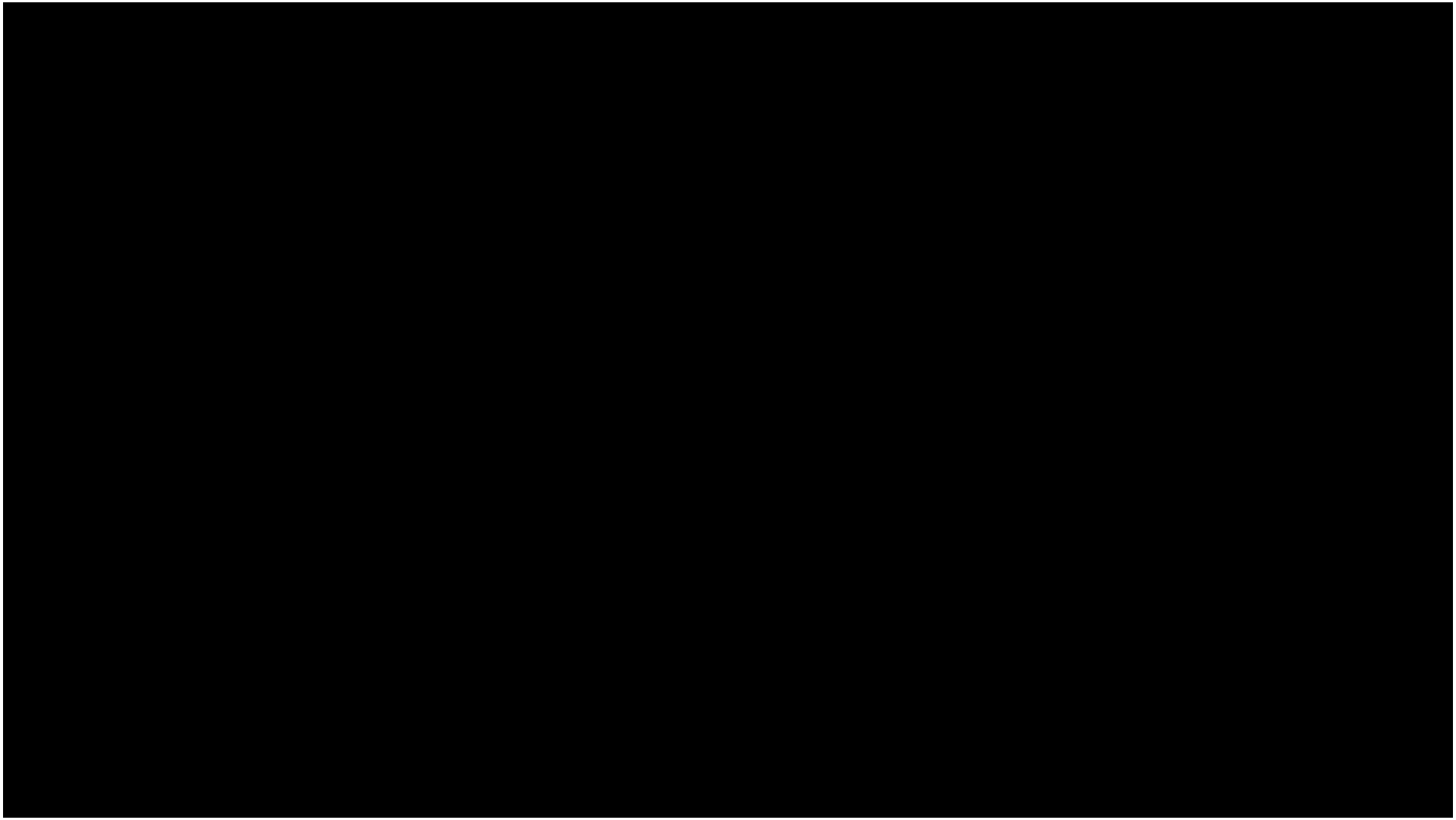
Subduction of **Pacific Plate** beneath **N American Plate**



A

From NOAA

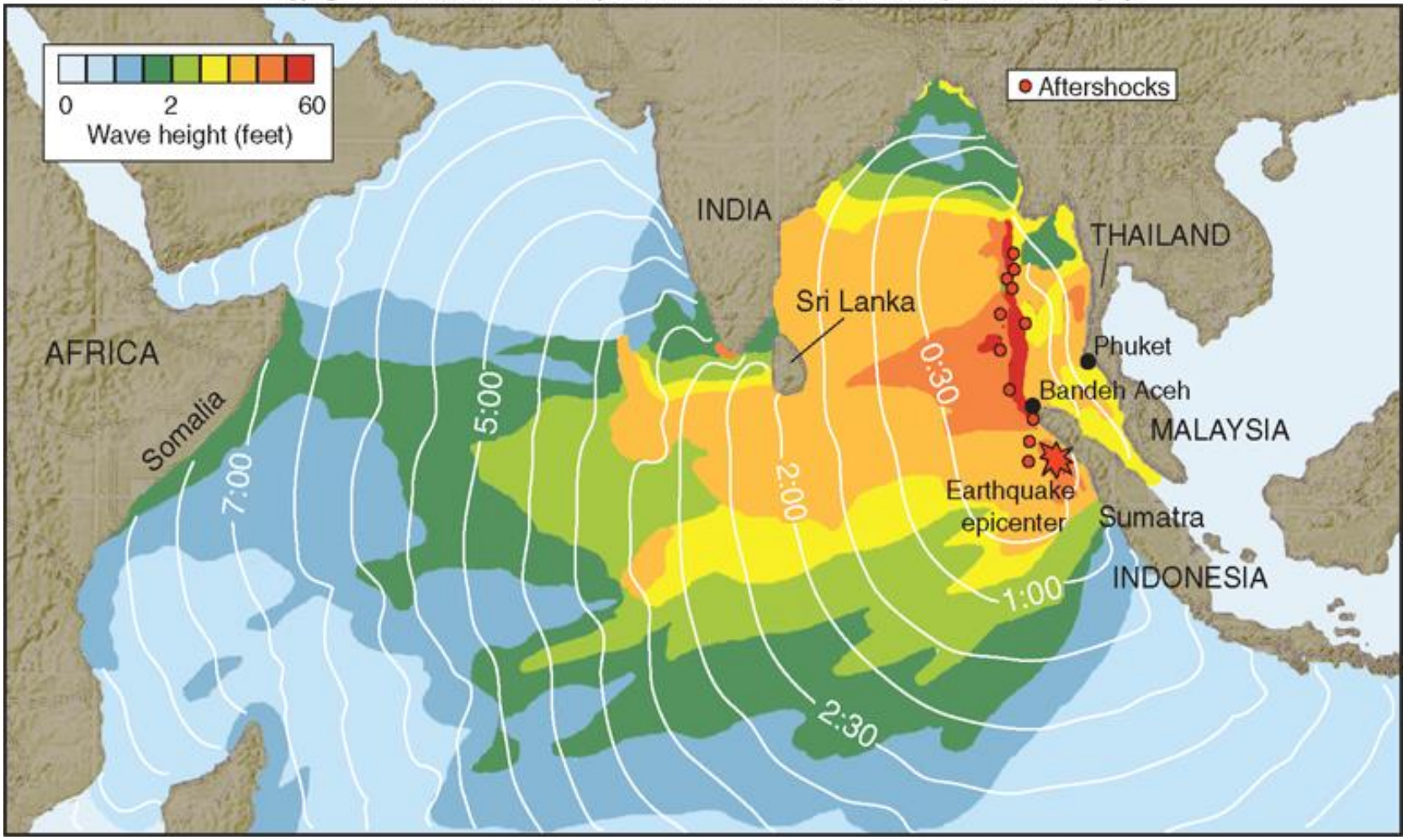
Magnitude 9.2: The 1964 Great Alaska Earthquake

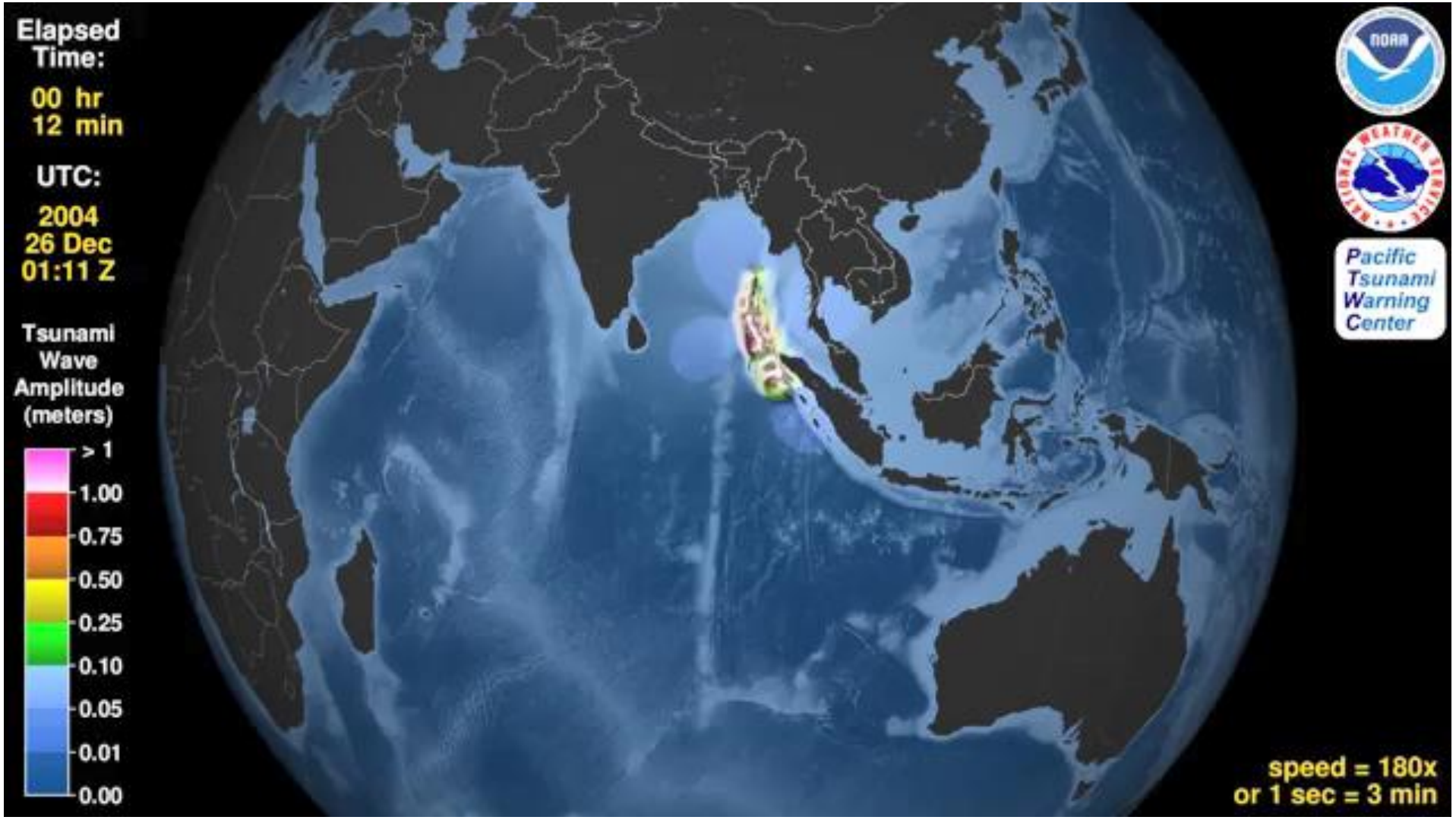


Sumatra Tsunami

(12/26/2004, Mw = 9.15 earthquake)

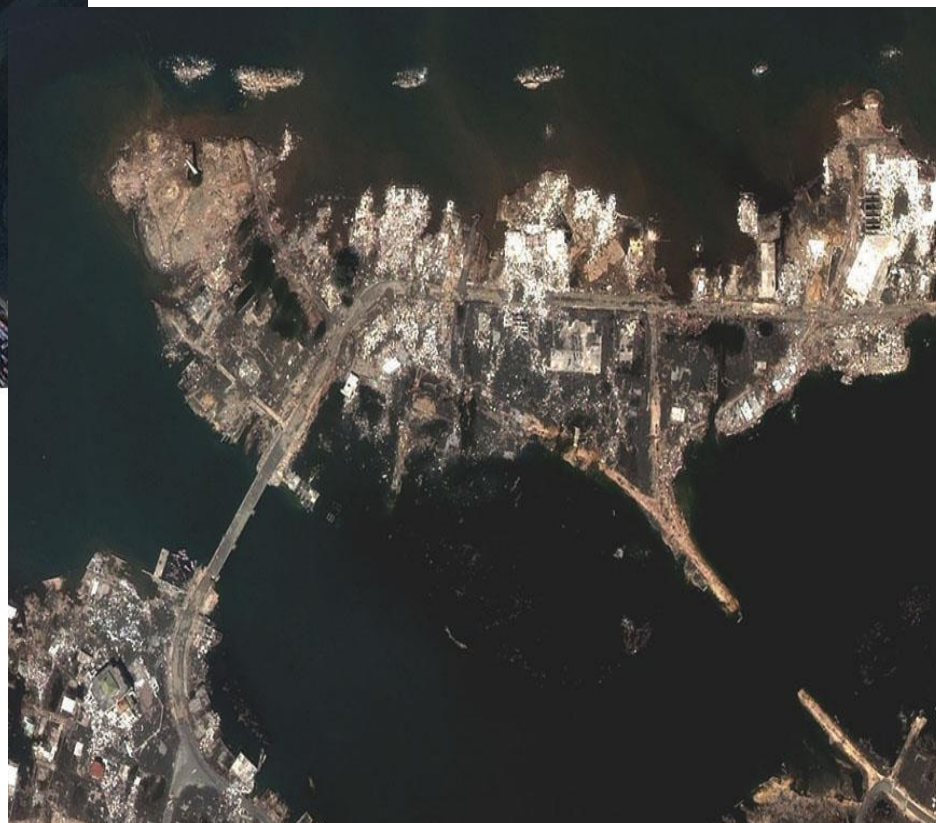
Subduction of **Indian Plate** beneath **Burma Plate**




Elapsed Time:
00 hr 12 min
UTC:
2004 26 Dec 01:11 Z
Tsunami Wave Amplitude (meters)
> 1
1.00
0.75
0.50
0.25
0.10
0.05
0.01
0.00
Pacific Tsunami Warning Center
speed = 180x
or 1 sec = 3 min

The northern part of Banda Aceh, Sumatra before the tsunami

The same area on December 28, 2004, after the tsunami



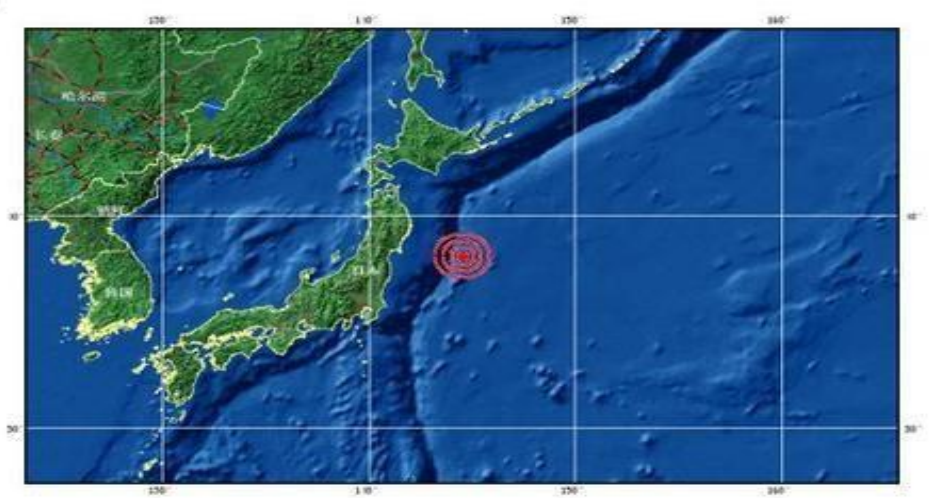
3/11/2011 - Tohoku, Japan
(M = 9.0)

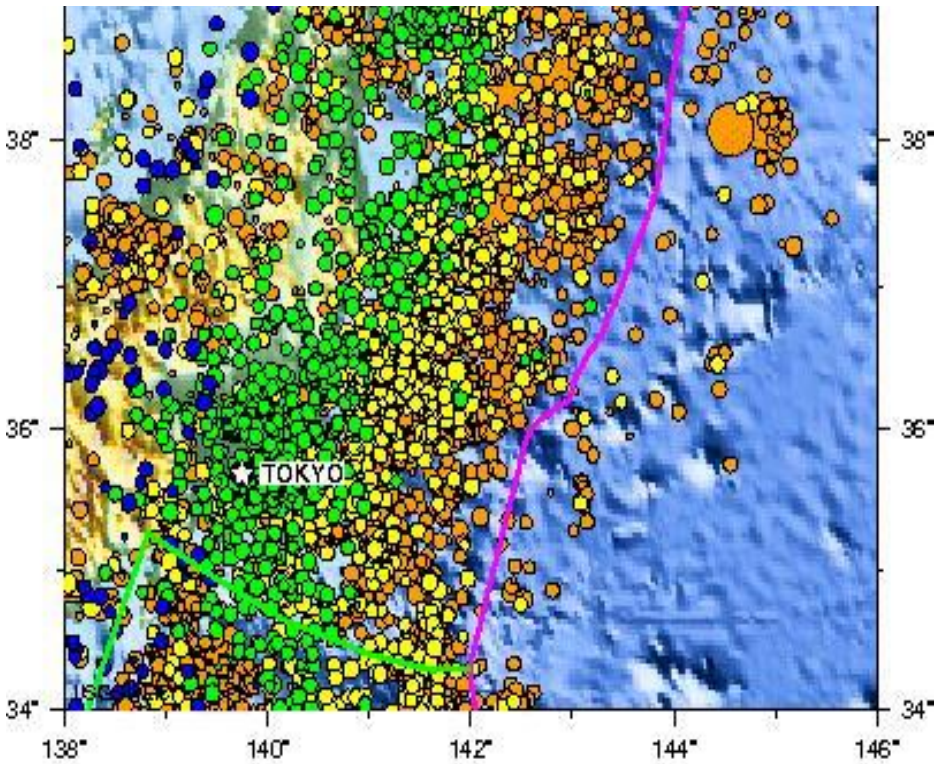
Subduction

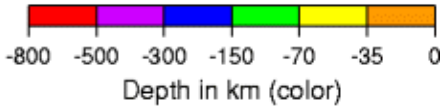
Pacific Plate

beneath

North America Plate





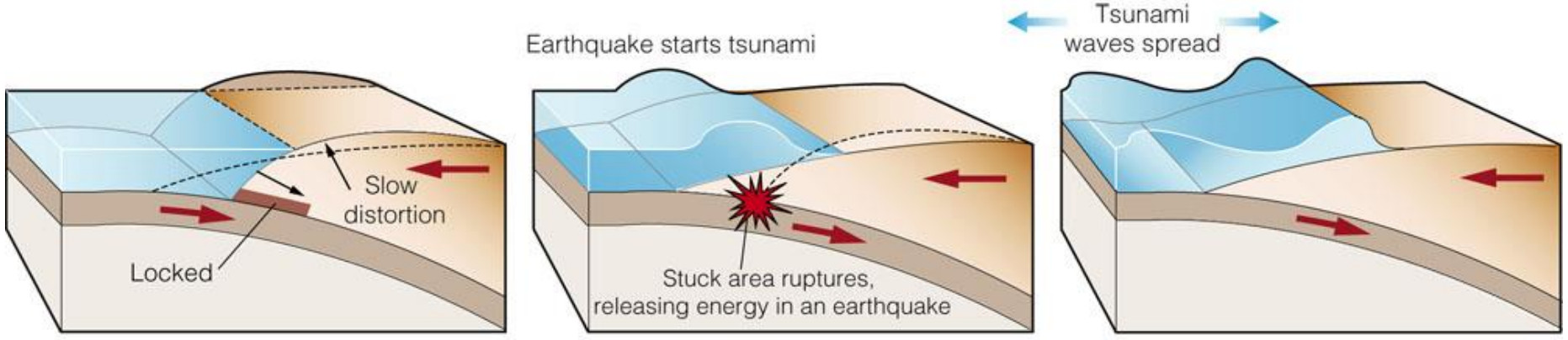


NEAR EAST COAST OF HONSHU, JAPAN

2011 03 11 05:46:23 UTC 38.32N 142.36E Depth: 24.4 km

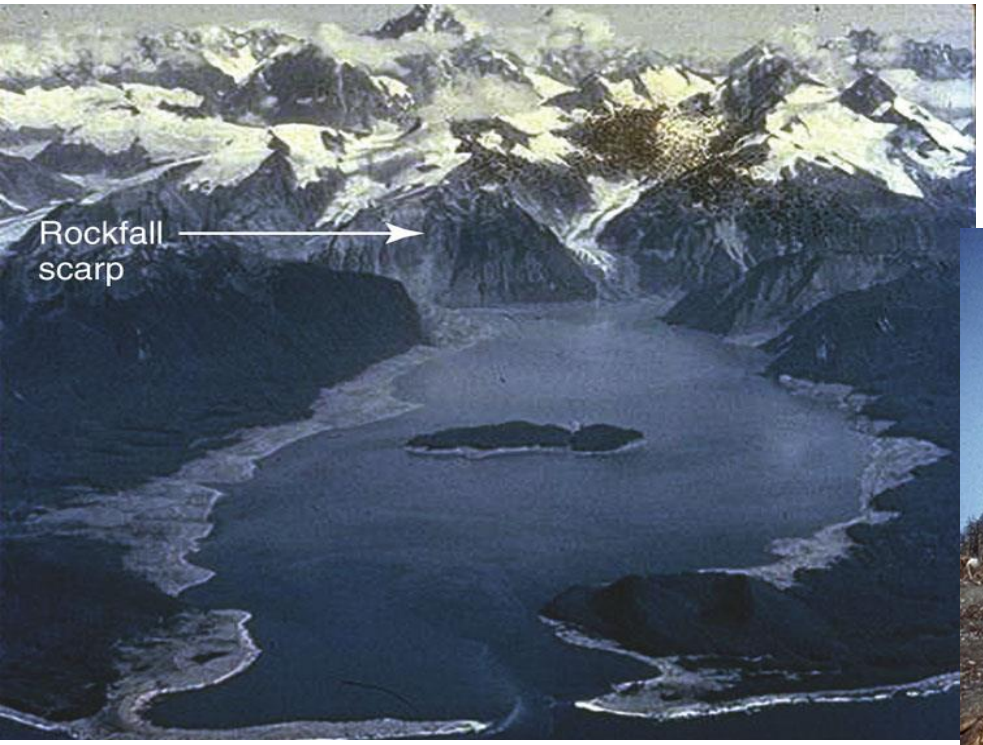
Seismicity 1990 to Present

2011 Tsunami, Japan



(B) Tsunami from **Landslides/Rock Falls into ocean**

e.g., Lituya Bay, Alaska; Glacier Bay, Alaska



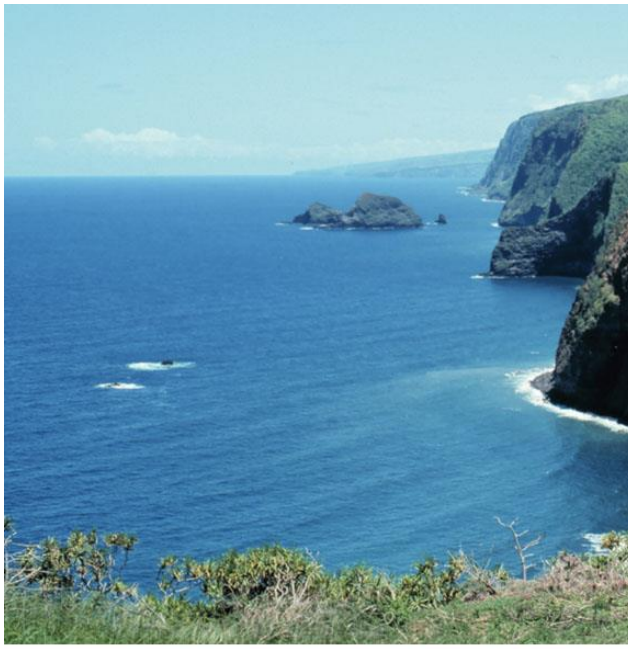
Tsunami damages at a ridge 524 meters above the bay

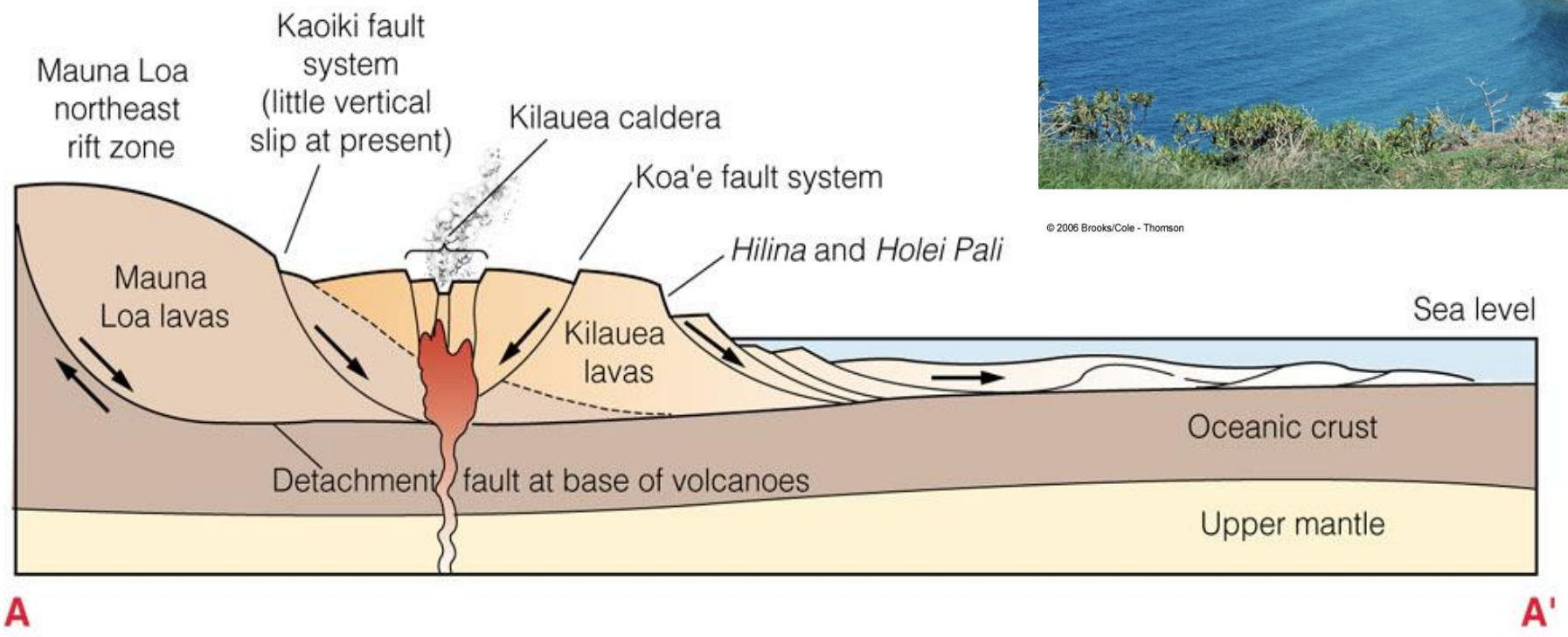
(C) Tsunami from **Volcano Flank Collapses** into ocean

e.g., **Hawaii**

-- rare events; average recurrence interval
~ 100,000 years.

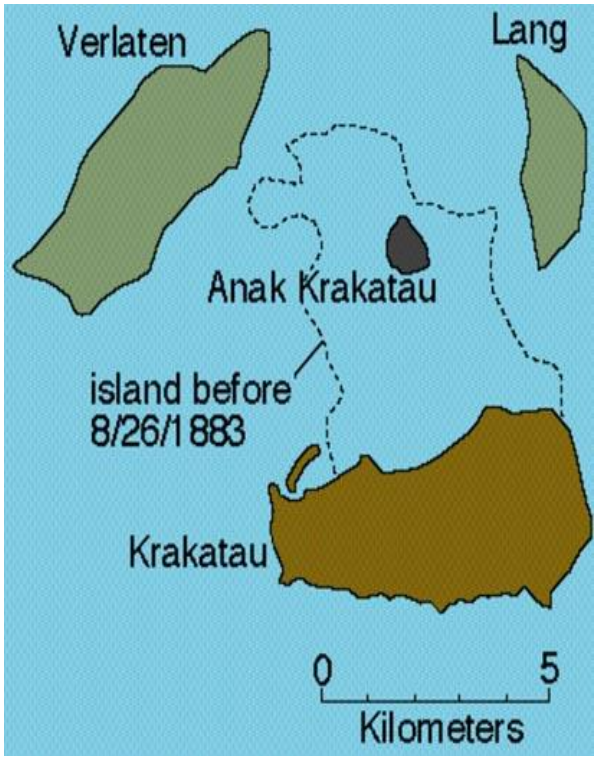
-- most recent event in Hawaii
: ~120, 000 years ago

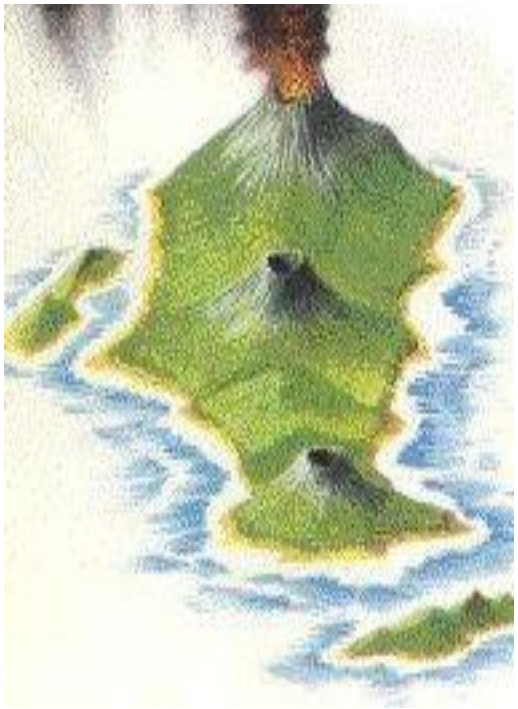


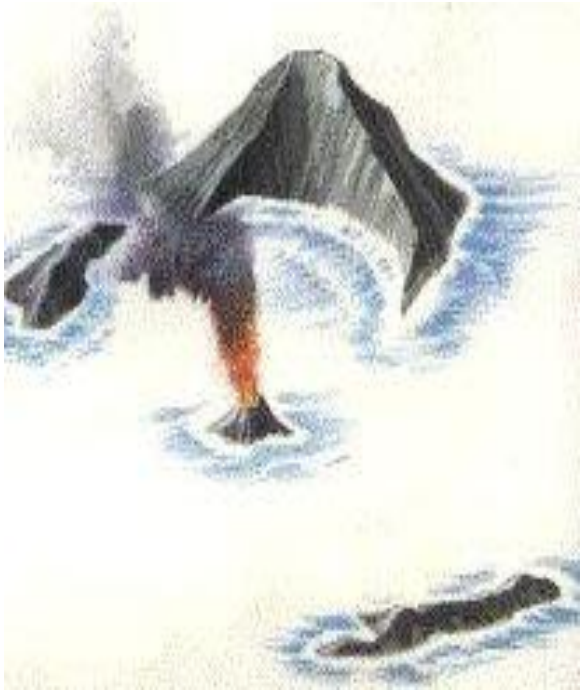


(D) Tsunami from **explosive submarine volcanic eruptions**, or **large amount of ash flows into ocean**

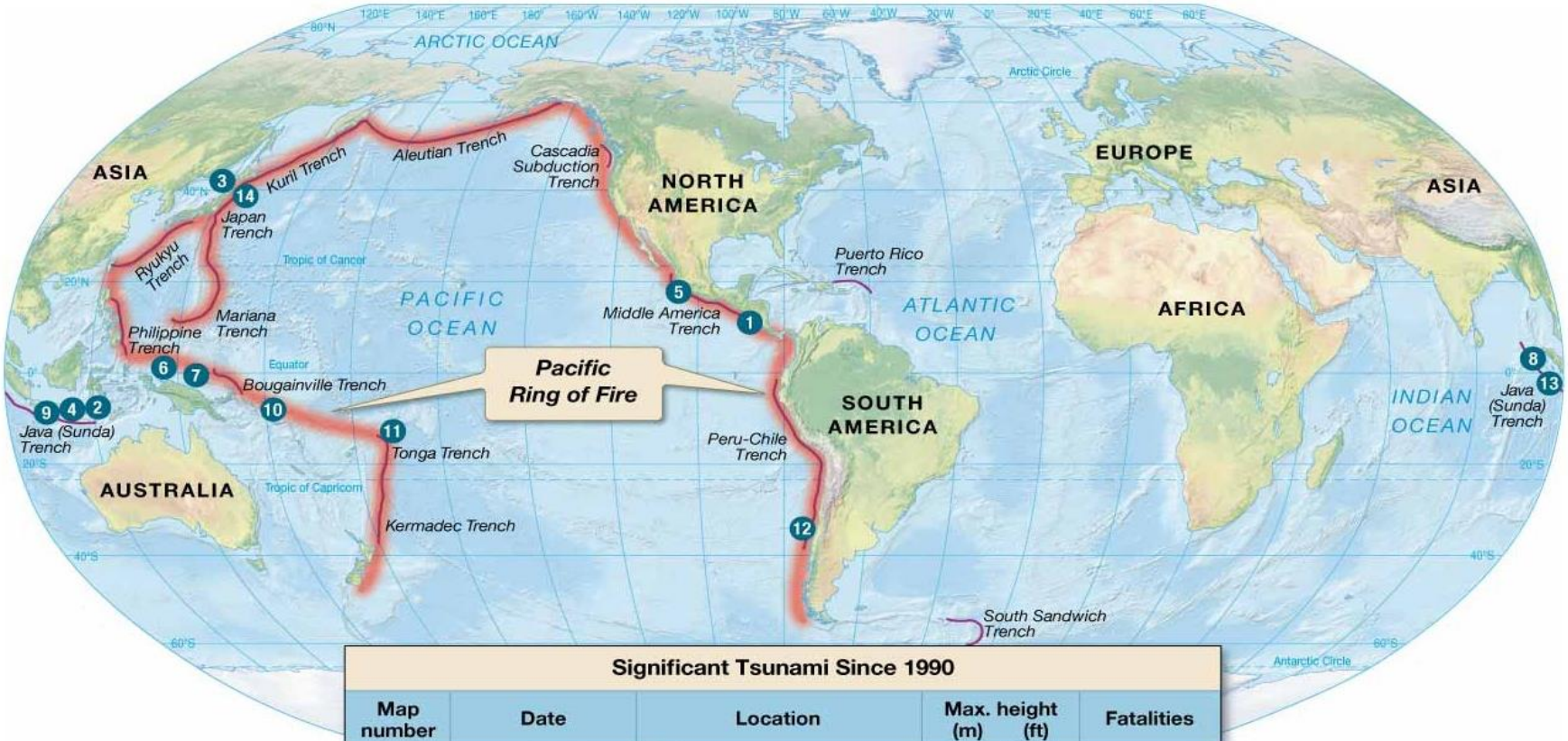
e.g., Krakatau, Indonesia, 1883







Historical Large Tsunami

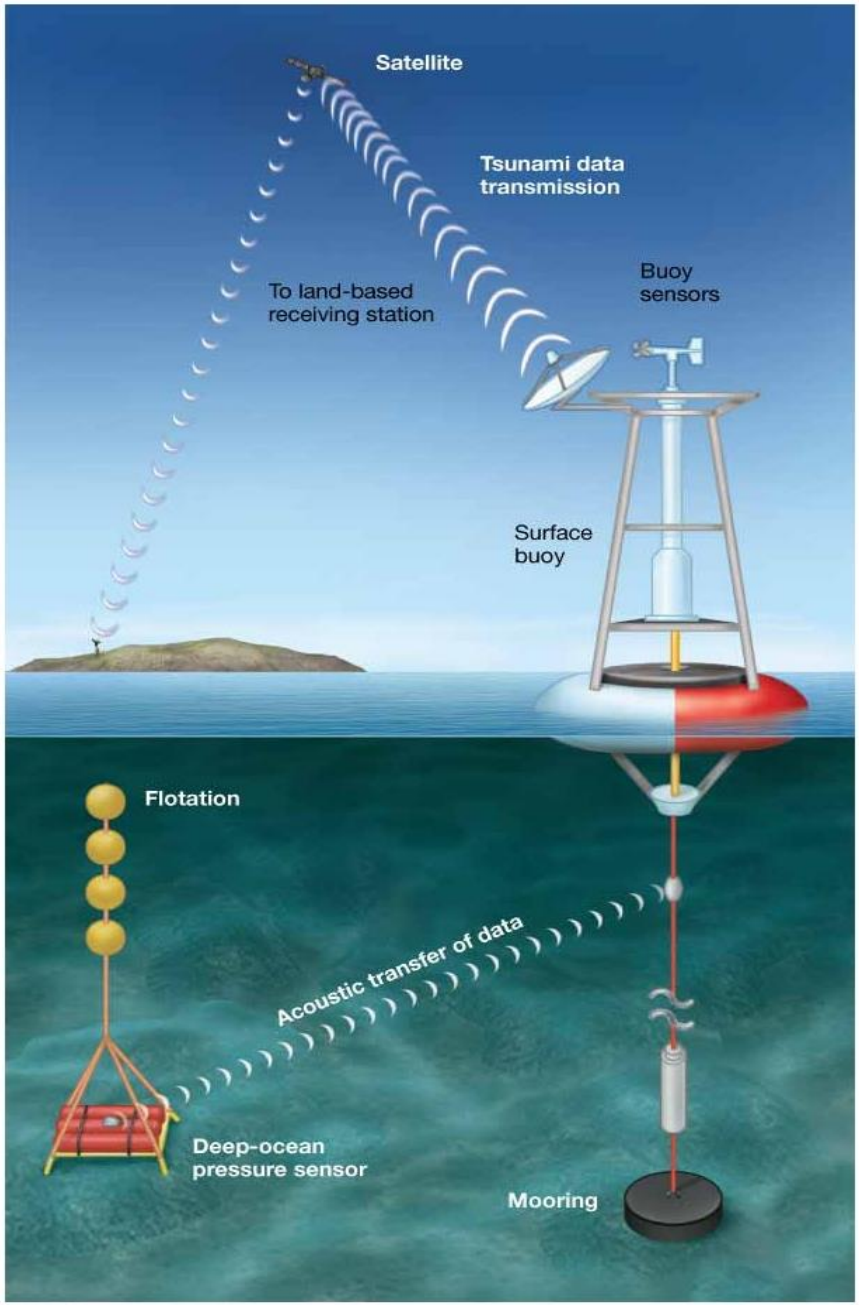


Significant Tsunami Since 1990

Map number	Date	Location	Max. height (m)	Max. height (ft)	Fatalities
1	Sep. 2, 1992	Nicaragua	10	33	170
2	Dec. 12, 1992	Flores Island, Indonesia	26	85	>1,000
3	Jul. 12, 1993	Okushiri, Japan	31	102	239
4	Jun. 2, 1994	East Java, Indonesia	14	46	238
5	Oct. 9, 1995	Jalisco, Mexico	11	36	1
6	Feb. 17, 1996	Irian Jaya, Indonesia	8	26	161
7	Jul. 17, 1998	Papua New Guinea	15	49	>2,200
8	Dec. 26, 2004	Sumatra, Indonesia	35	115	300,000
9	Jul. 17, 2006	Central Java, Indonesia	3	10	668
10	Apr. 1, 2007	Solomon Islands	5	16	52
11	Sep. 29, 2009	Samoa	14	46	189
12	Feb. 27, 2010	Chile	3	10	550
13	Oct. 25, 2010	Pagai Island, Indonesia	3	10	435
14	Mar. 11, 2011	Tohoku, Japan	40	131	19,508

Tsunami Warning System

- Pacific Tsunami Warning Center (PTWC) – Honolulu, HI
  - Uses seismic wave recordings to forecast tsunami
- Deep Ocean Assessment and Reporting of Tsunami (DART)
  - System of buoys
  - Detects pulse of tsunami passing



Video: Tsunami Basics