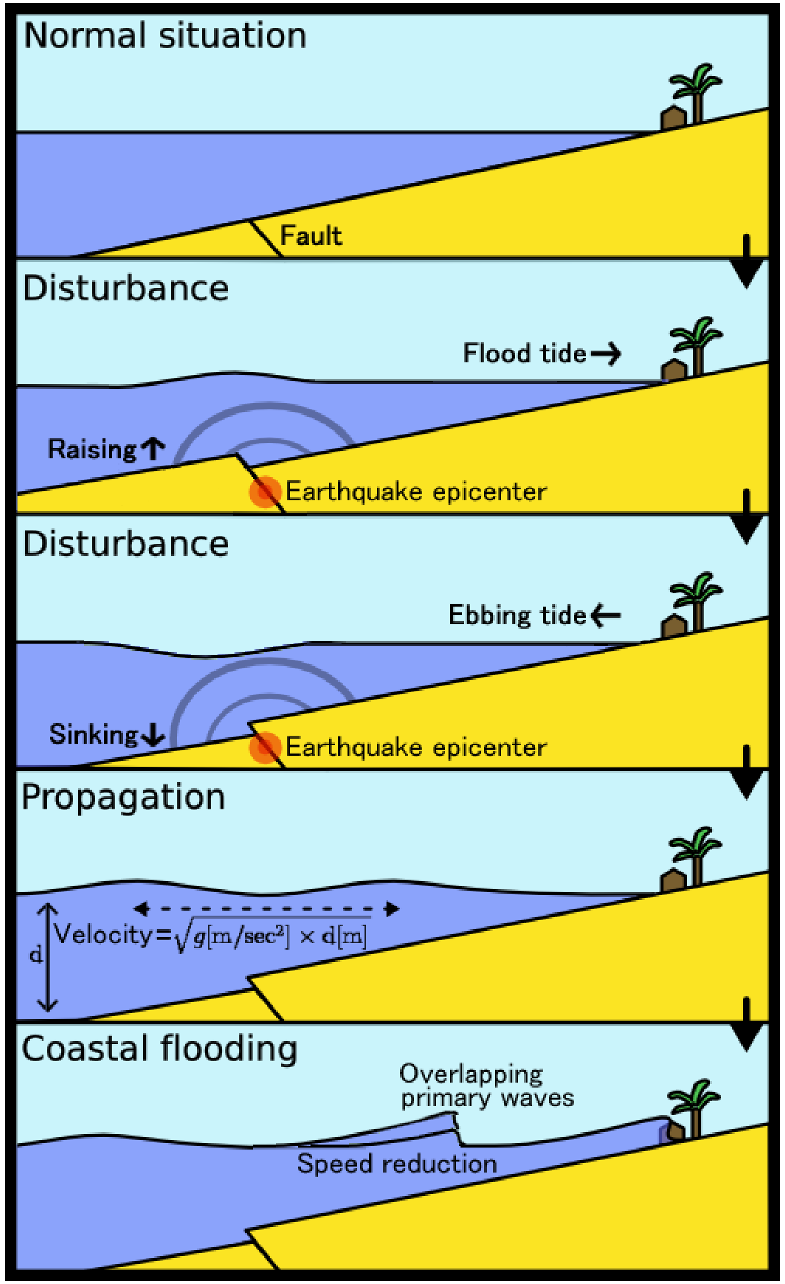
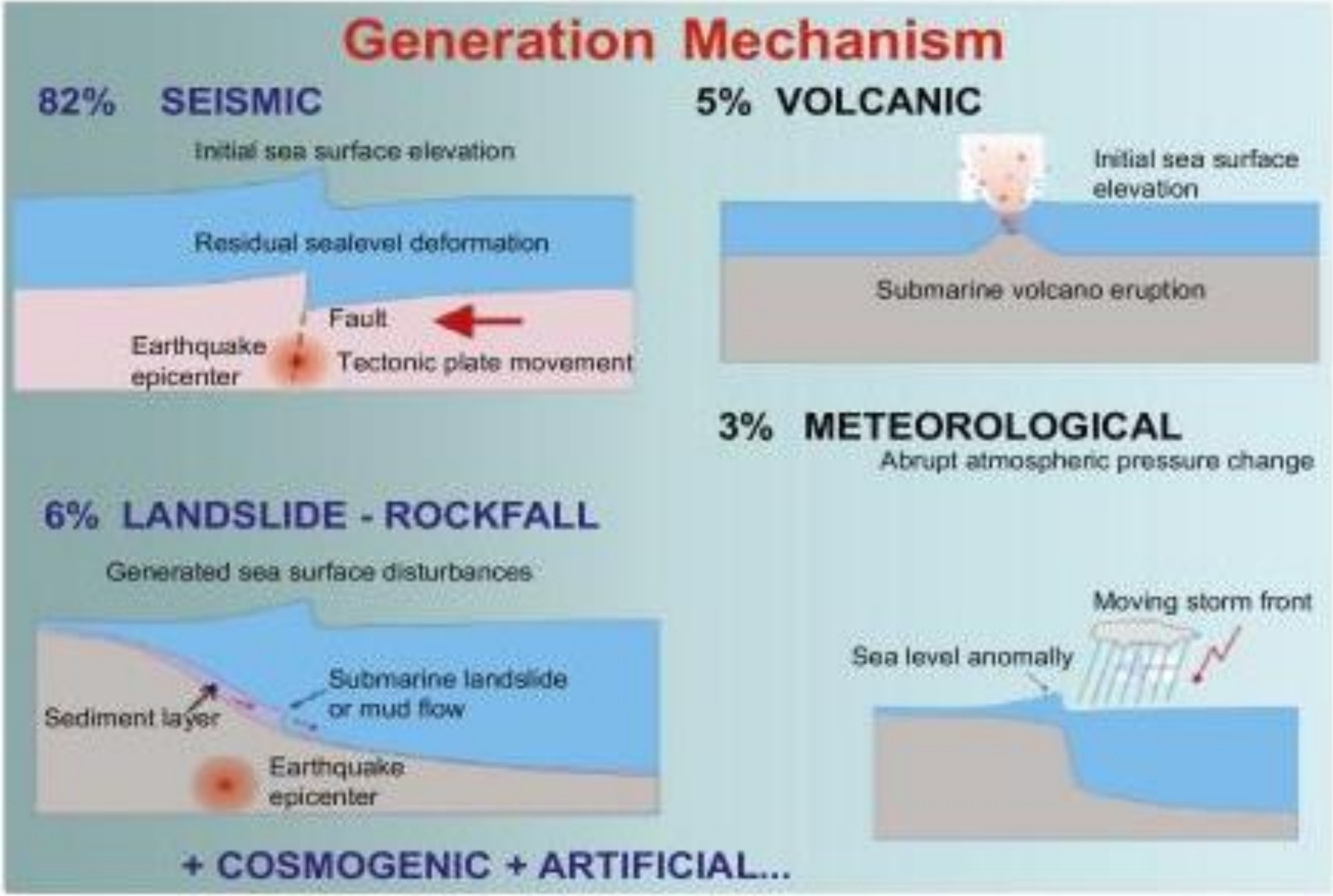
Fuentes

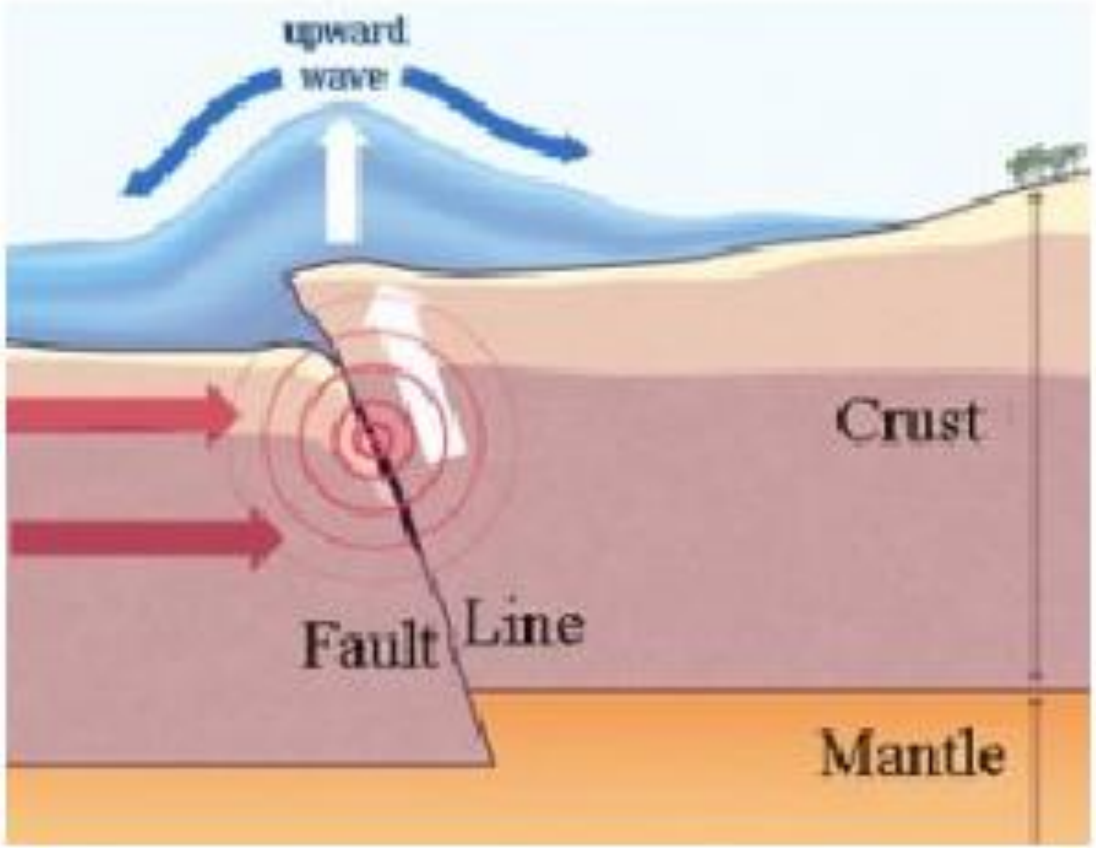
Recordando…



Normal situation
Fault
Disturbance
Flood tide
Raising
Earthquake epicenter
Disturbance
Ebbing tide
Sinking
Earthquake epicenter
Propagation
d
Velocity=$\sqrt{g[\mathrm{m/sec^2}] \times d[\mathrm{m}]}$
Coastal flooding
Overlapping
primary waves
Speed reduction

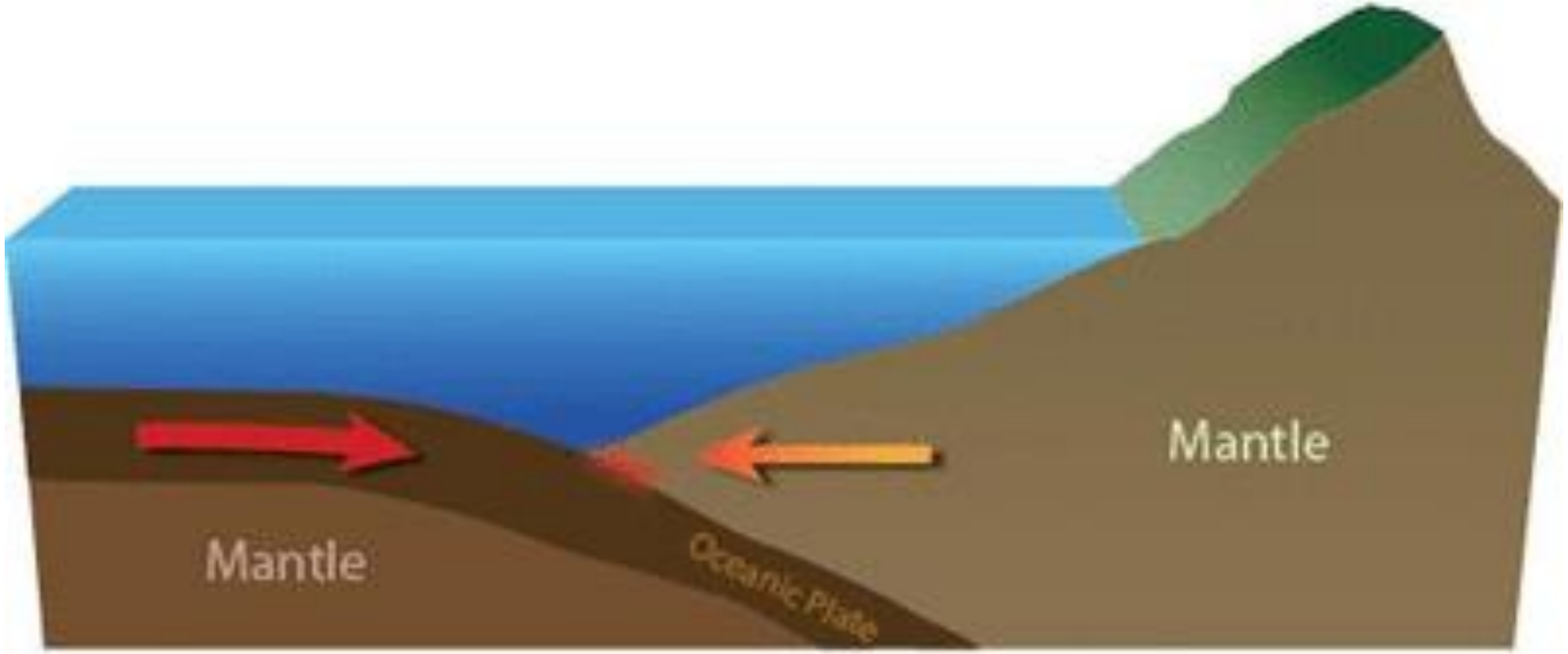

Generation Mechanism
82% SEISMIC
Initial sea surface elevation
Residual sealevel deformation
Fault
Earthquake epicenter
Tectonic plate movement
5% VOLCANIC
Initial sea surface elevation
Submarine volcano eruption
3% METEOROLOGICAL
Abrupt atmospheric pressure change
Moving storm front
Sea level anomally
6% LANDSLIDE - ROCKFALL
Generated sea surface disturbances
Submarine landslide or mud flow
Sediment layer
Earthquake epicenter
+ COSMOGENIC + ARTIFICIAL...

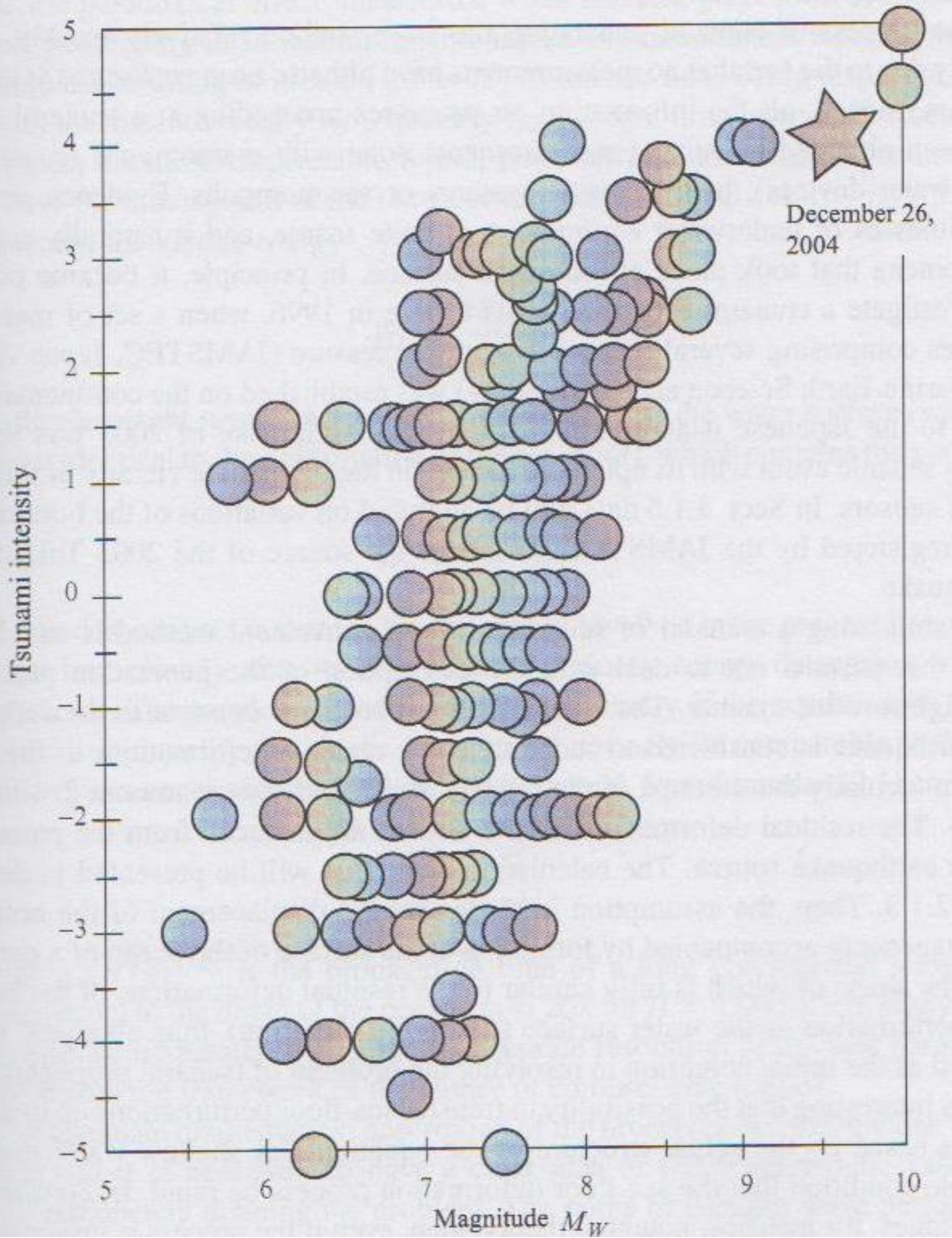
Terremotos



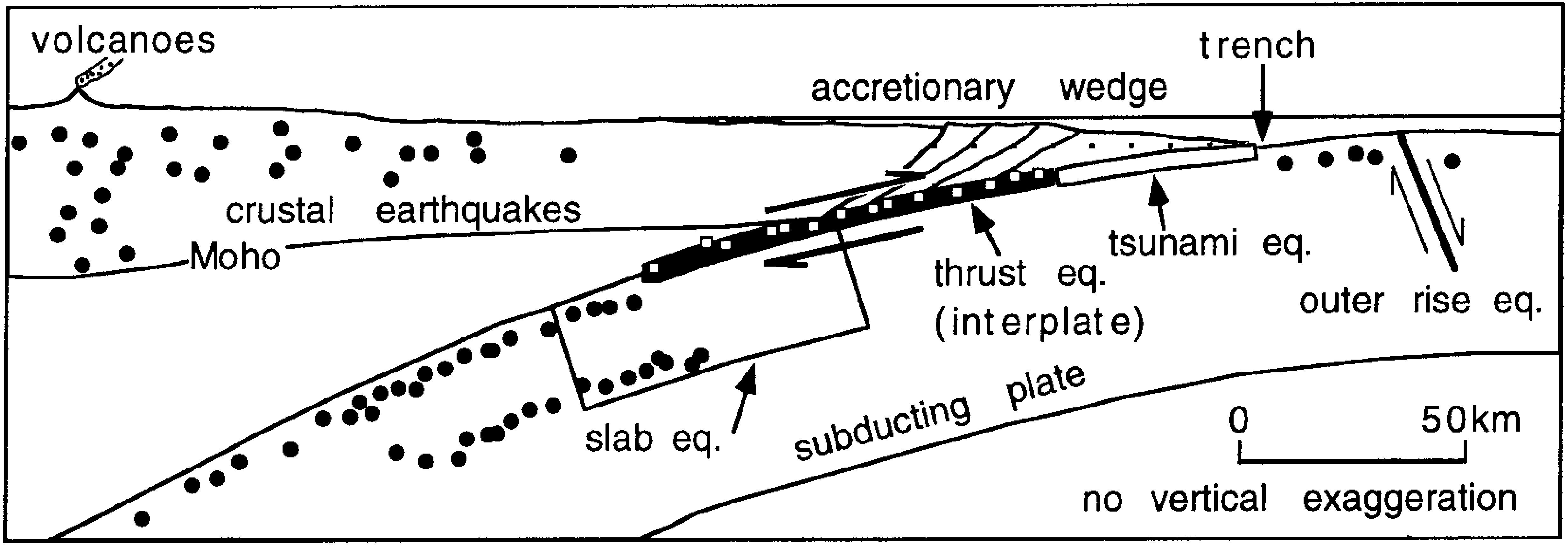
Date	Country	Location	Magnitude
May 22, 1960	Chile	Central Chile	9.5
March 28, 1964	USA	Prince William Sound, AK	9.2
March 09, 1957	USA	Andreanof Islands, AK	9.1
November 04, 1952	Russia	Kamchatka	9
December 26, 2004	Indonesia	Off western coast of Sumatra	9
January 31, 1906	Ecuador	Off coast	8.8
February 27, 2010	Chile	Off southern coast	8.8
June 15, 1911	Japan	Ryukyu Islands	8.7
February 04, 1965	USA	Rat Islands, Aleutian Islands, AK	8.7
March 28, 2005	Indonesia	Indonesia	8.7
November 11, 1922	Chile	N. Chile	8.5
February 01, 1938	Indonesia	Banda sea	8.5
October 13, 1963	Russia	S. Kuril Islands	8.5
March 02, 1933	Japan	Sanriku	8.4
June 23, 2001	Peru	S. Peru	8.4
September 12, 2007	Indonesia	Sumatra	8.4
June 25, 1904	Russia	Kamchatka Peninsula, Russia	8.3
June 26, 1917	Samoa	Samoa Islands	8.3
August 15, 1918	Philippines	Celebes sea	8.3
April 30, 1919	Tonga	Tonga Islands	8.3
February 03, 1923	Russia	Kamchatka	8.3
April 14, 1924	Philippines	E. Mindanao Island	8.3
January 24, 1948	Philippines	Sulu sea	8.3
July 10, 1958	USA	SE. Alaska, AK	8.3
November 06, 1958	Russia	S. Kuril Islands	8.3

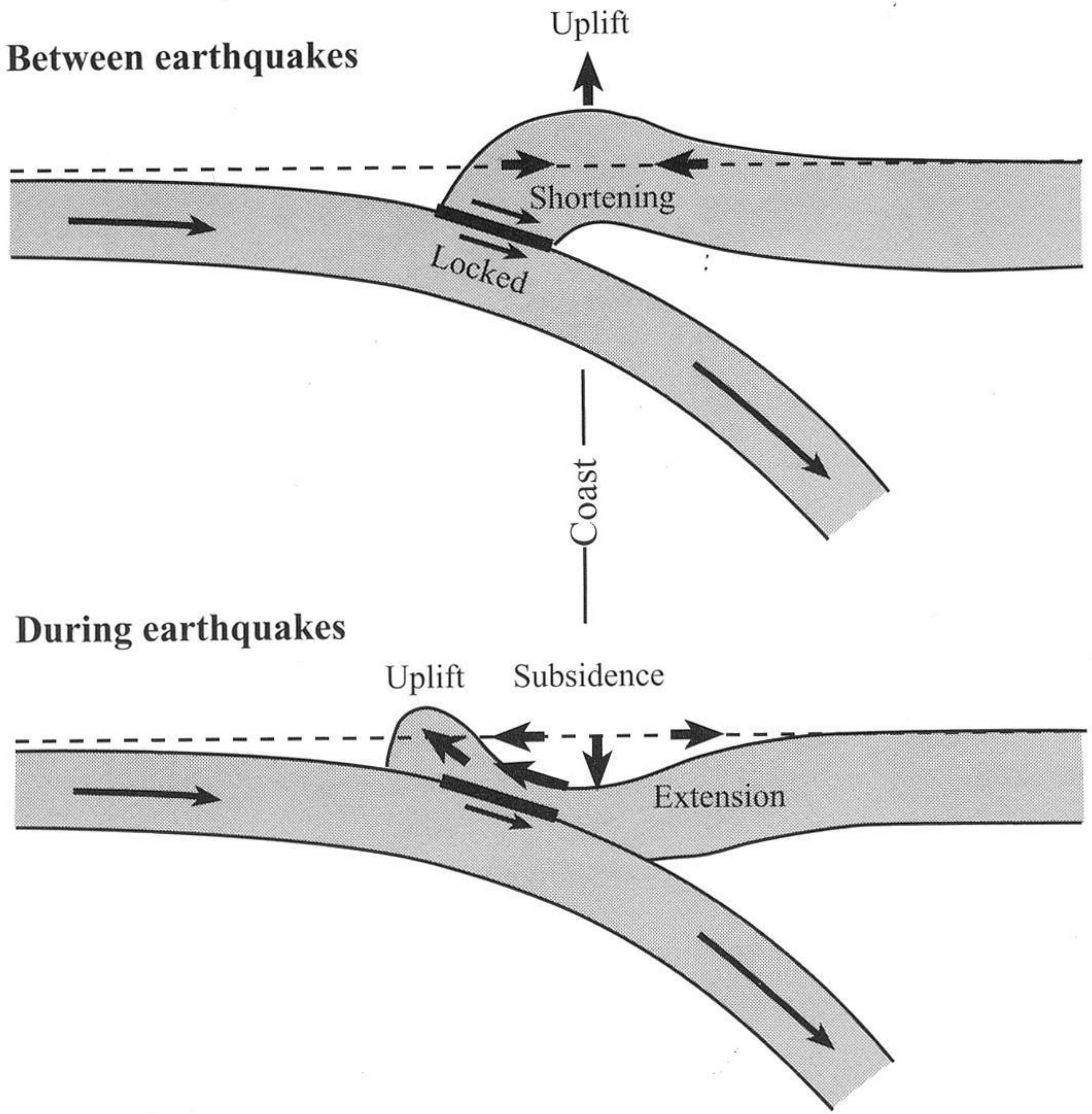
Date	Country	Location	Magnitude
October 04, 1994	Russia	S. Kuril Islands	8.3
September 25, 2003	Japan	Hokkaido Island	8.3
November 15, 2006	Russia	S. Kuril Islands	8.3
August 17, 1906	Chile	Central Chile	8.2
September 07, 1918	Russia	S. Kuril Islands	8.2
November 10, 1938	USA	Shumagin Islands, AK	8.2
April 06, 1943	Chile	Central Chile	8.2
May 04, 1959	Russia	Kamchatka	8.2
May 16, 1968	Japan	Off east coast of Honshu Island	8.2
August 11, 1969	Russia	S. Kuril Islands	8.2
February 17, 1996	Indonesia	Irian Jaya	8.2
September 14, 1906	Papua New Guinea	Solomon Sea	8.1
April 14, 1907	Mexico	S. Mexico	8.1
June 03, 1932	Mexico	Central Mexico	8.1
December 07, 1944	Japan	Off southeast coast of Kii Peninsula	8.1
April 01, 1946	USA	Unimak Island, AK	8.1
August 04, 1946	Dominican Republic	Northeastern coast	8.1
December 20, 1946	Japan	Honshu: S coast	8.1
August 22, 1949	Canada	British Columbia	8.1
March 04, 1952	Japan	SE. Hokkaido Island	8.1
October 17, 1966	Peru	Central Peru	8.1
January 01, 1967	Solomon Islands	Solomon Islands	8.1
October 03, 1974	Peru	Central Peru	8.1
August 16, 1976	Philippines	Moro Gulf	8.1
April 21, 1977	Solomon Islands	Solomon Islands	8.1

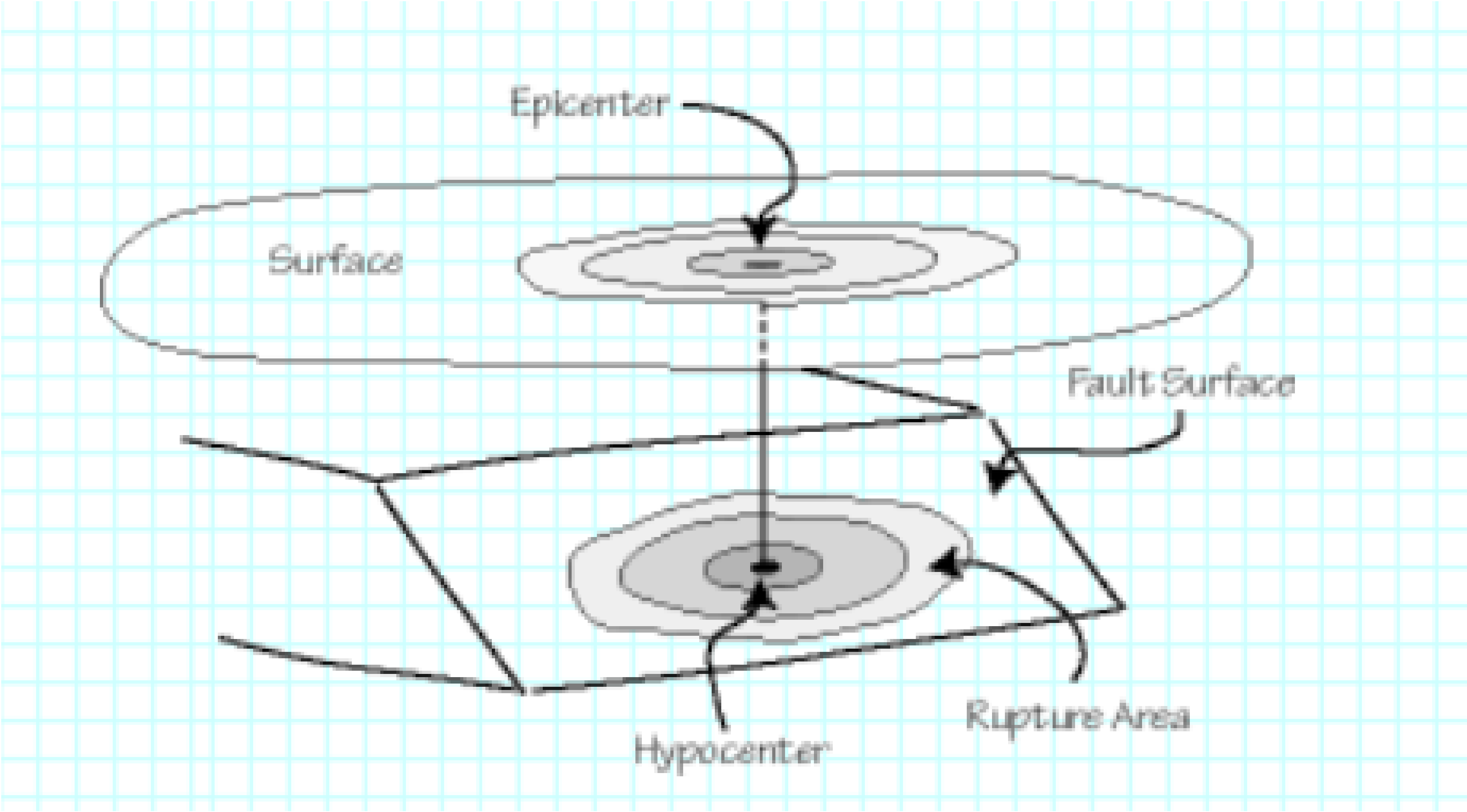

Mantle
Mantle
Oceanic Plate



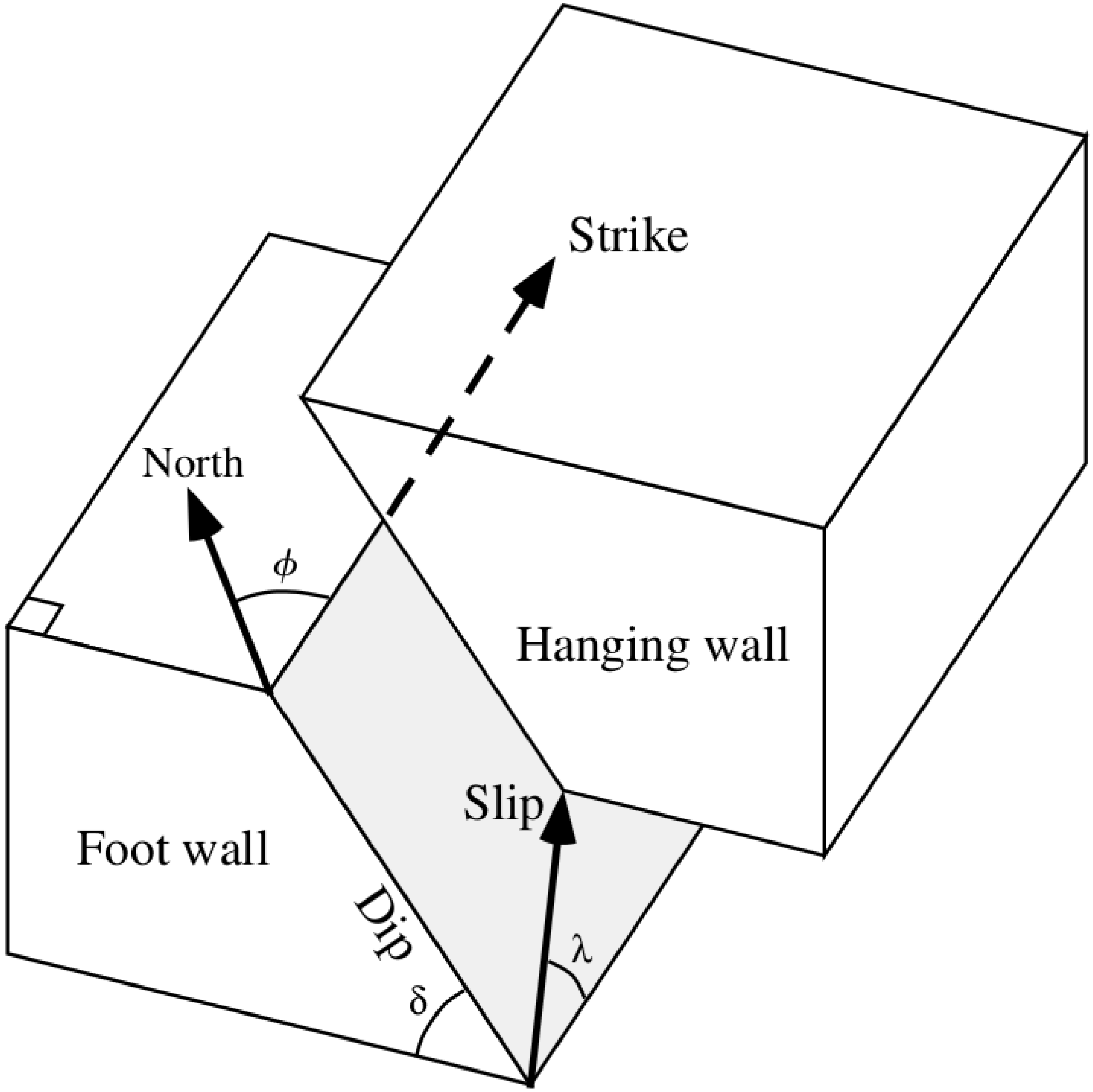
Tsunami intensity
5
4
3
2
1
0
−1
−2
−3
−4
−5
Magnitude M_W
5
6
7
8
9
10
December 26, 2004


volcanoes
trench
accretionary wedge
crustal earthquakes
Moho
tsunami eq.
thrust eq.
(interplate)
outer rise eq.
slab eq.
subducting plate
0
50km
no vertical exaggeration


Between earthquakes
Uplift
Shortening
Locked
Coast
During earthquakes
Uplift
Subsidence
Extension

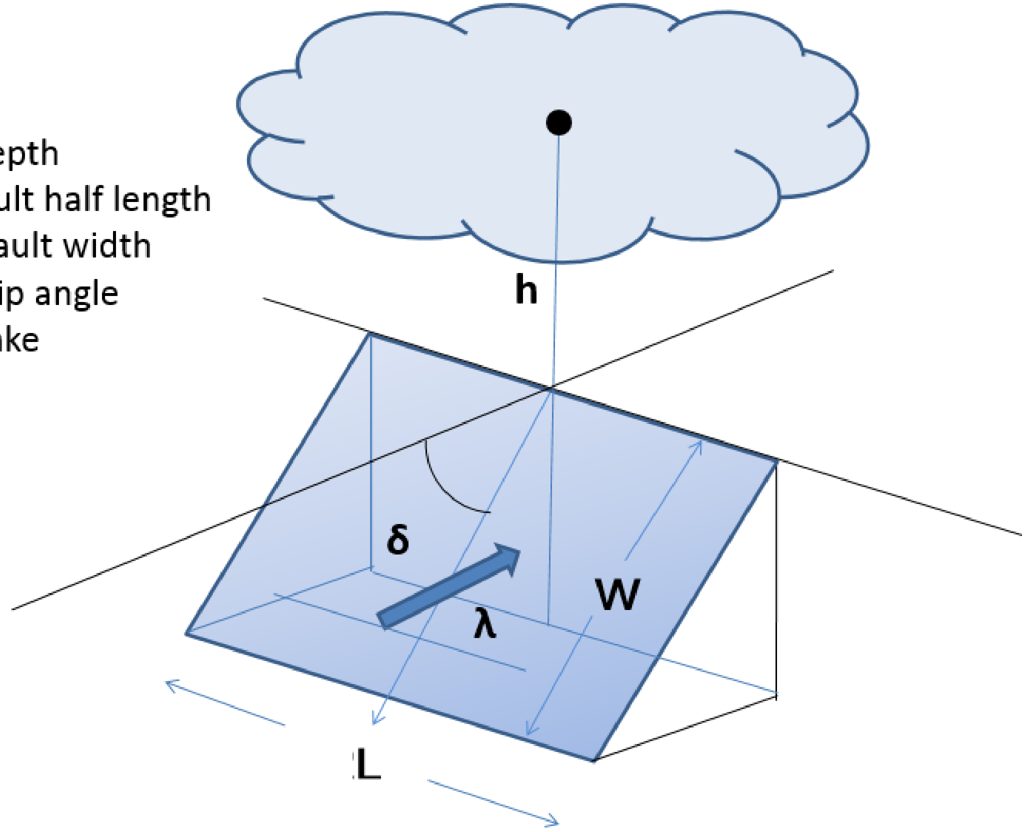


Epicenter
Surface
Fault Surface
Rupture Area
Hypocenter



Fault geometry and a slip on the fault

h: depth
L: fault half length
W: fault width
δ: dip angle
λ: rake

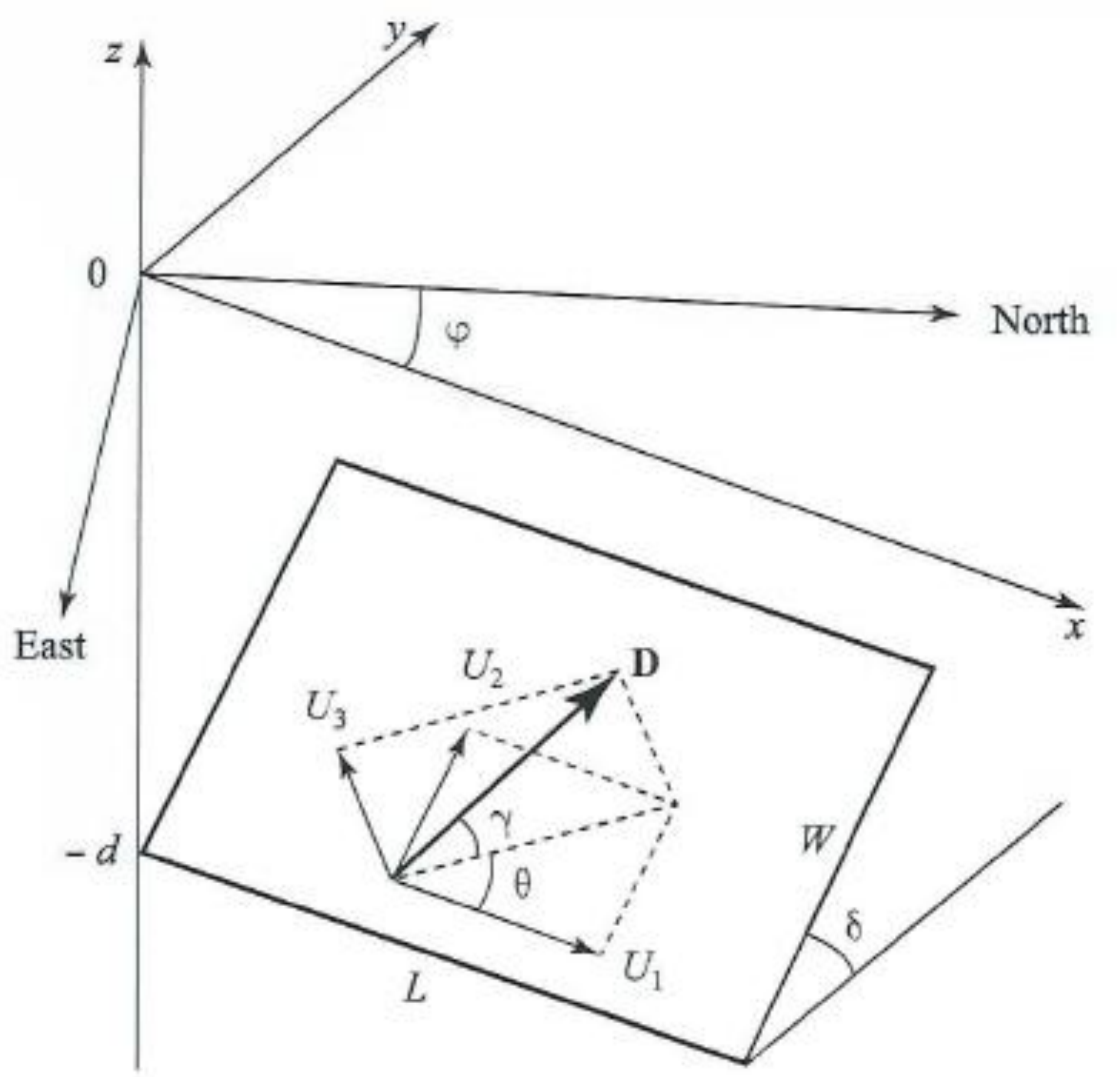


Okada, 1985

$$U_1 = |\vec{D}| \cos(\gamma) \cos(\theta)$$

$$U_2 = |\vec{D}| \cos(\gamma) \sin(\theta)$$

$$U_3 = |\vec{D}| \sin(\gamma)$$



Okada, 1985

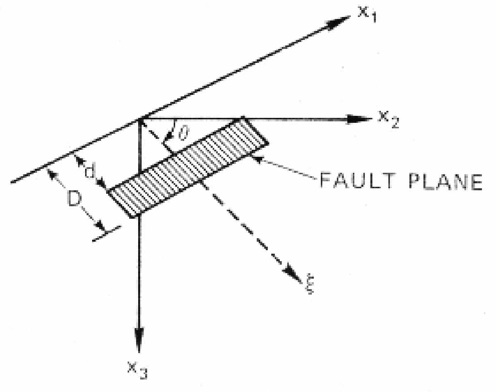
(1) Displacements

For strike-slip

$$\begin{cases} u_x = -\dfrac{U_1}{2\pi}\left[\dfrac{\xi q}{R(R+\eta)} + \tan^{-1}\dfrac{\xi\eta}{qR} + I_1 \sin\delta\right]\Big\| \\ u_y = -\dfrac{U_1}{2\pi}\left[\dfrac{\tilde{y} q}{R(R+\eta)} + \dfrac{q\cos\delta}{R+\eta} + I_2 \sin\delta\right]\Big\| \\ u_z = -\dfrac{U_1}{2\pi}\left[\dfrac{\tilde{d} q}{R(R+\eta)} + \dfrac{q\sin\delta}{R+\eta} + I_4 \sin\delta\right]\Big\| . \end{cases}$$

For dip-slip

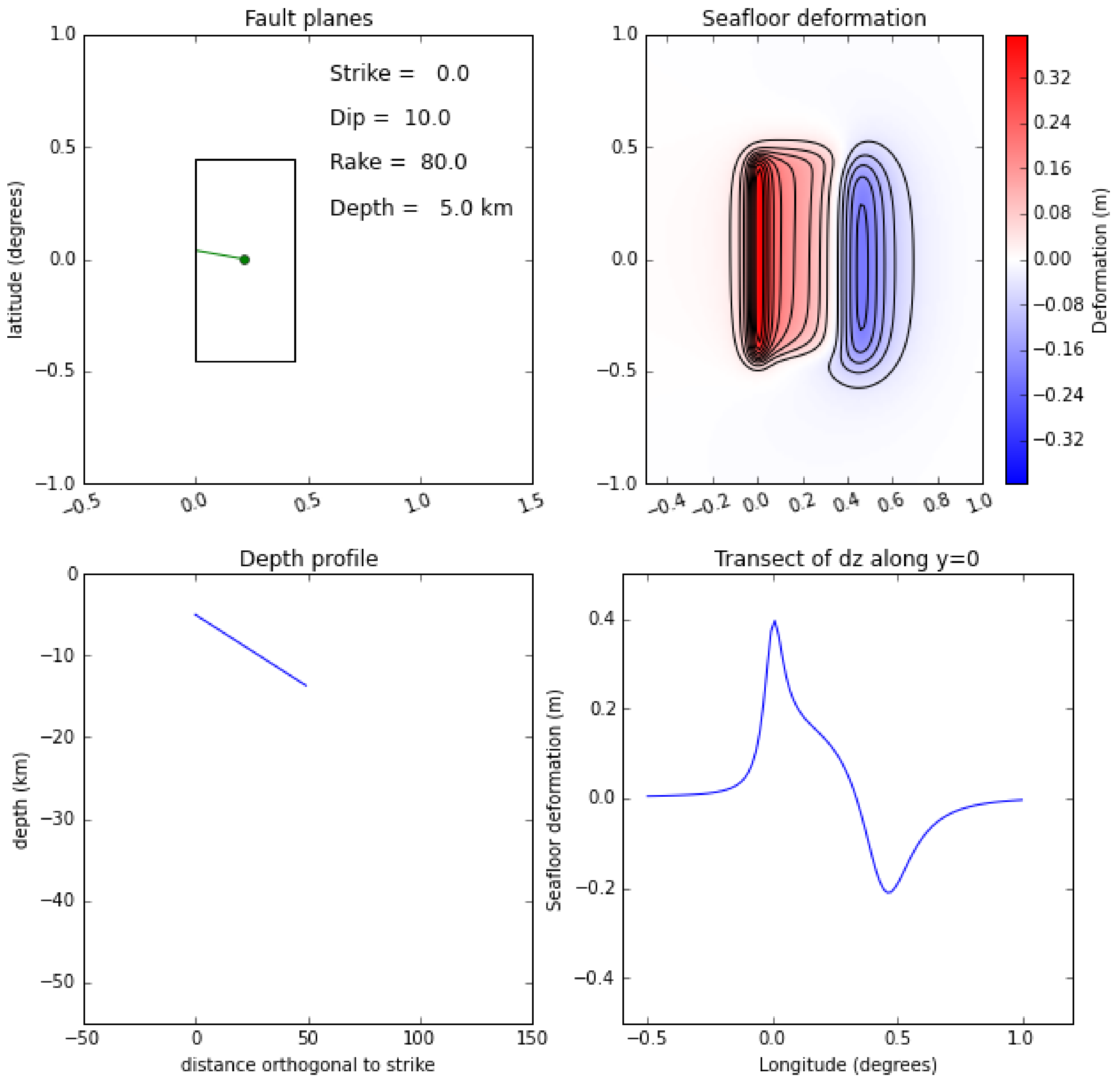
$$\begin{cases} u_x = -\dfrac{U_2}{2\pi}\left[\dfrac{q}{R} - I_3 \sin\delta\cos\delta\right]\Big\| \\ u_y = -\dfrac{U_2}{2\pi}\left[\dfrac{\tilde{y} q}{R(R+\xi)} + \cos\delta\tan^{-1}\dfrac{\xi\eta}{qR} - I_1 \sin\delta\cos\delta\right]\Big\| \\ u_z = -\dfrac{U_2}{2\pi}\left[\dfrac{\tilde{d} q}{R(R+\xi)} + \sin\delta\tan^{-1}\dfrac{\xi\eta}{qR} - I_5 \sin\delta\cos\delta\right]\Big\| . \end{cases}$$



where

$$\begin{cases} I_1 = \dfrac{\mu}{\lambda+\mu}\left[\dfrac{-1}{\cos\delta}\dfrac{\xi}{R+\tilde{d}}\right] - \dfrac{\sin\delta}{\cos\delta} I_5 \\ I_2 = \dfrac{\mu}{\lambda+\mu}[-\ln(R+\eta)] - I_3 \\ I_3 = \dfrac{\mu}{\lambda+\mu}\left[\dfrac{1}{\cos\delta}\dfrac{\tilde{y}}{R+\tilde{d}} - \ln(R+\eta)\right] + \dfrac{\sin\delta}{\cos\delta} I_4 \\ I_4 = \dfrac{\mu}{\lambda+\mu}\dfrac{1}{\cos\delta}[\ln(R+\tilde{d}) - \sin\delta\ln(R+\eta)] \\ I_5 = \dfrac{\mu}{\lambda+\mu}\dfrac{2}{\cos\delta}\tan^{-1}\dfrac{\eta(X+q\cos\delta)+X(R+X)\sin\delta}{\xi(R+X)\cos\delta} \end{cases}$$

Okada, 1985

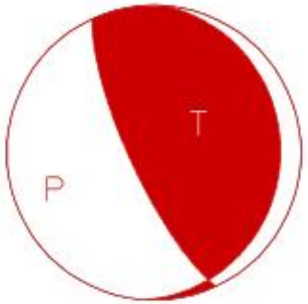


Fault planes
Strike = 0.0
Dip = 10.0
Rake = 80.0
Depth = 5.0 km
latitude (degrees)
Seafloor deformation
Deformation (m)
Depth profile
depth (km)
distance orthogonal to strike
Transect of dz along y=0
Seafloor deformation (m)
Longitude (degrees)

EXAMPLE: VALPARAISO, CHILE

17 AUGUST 1906

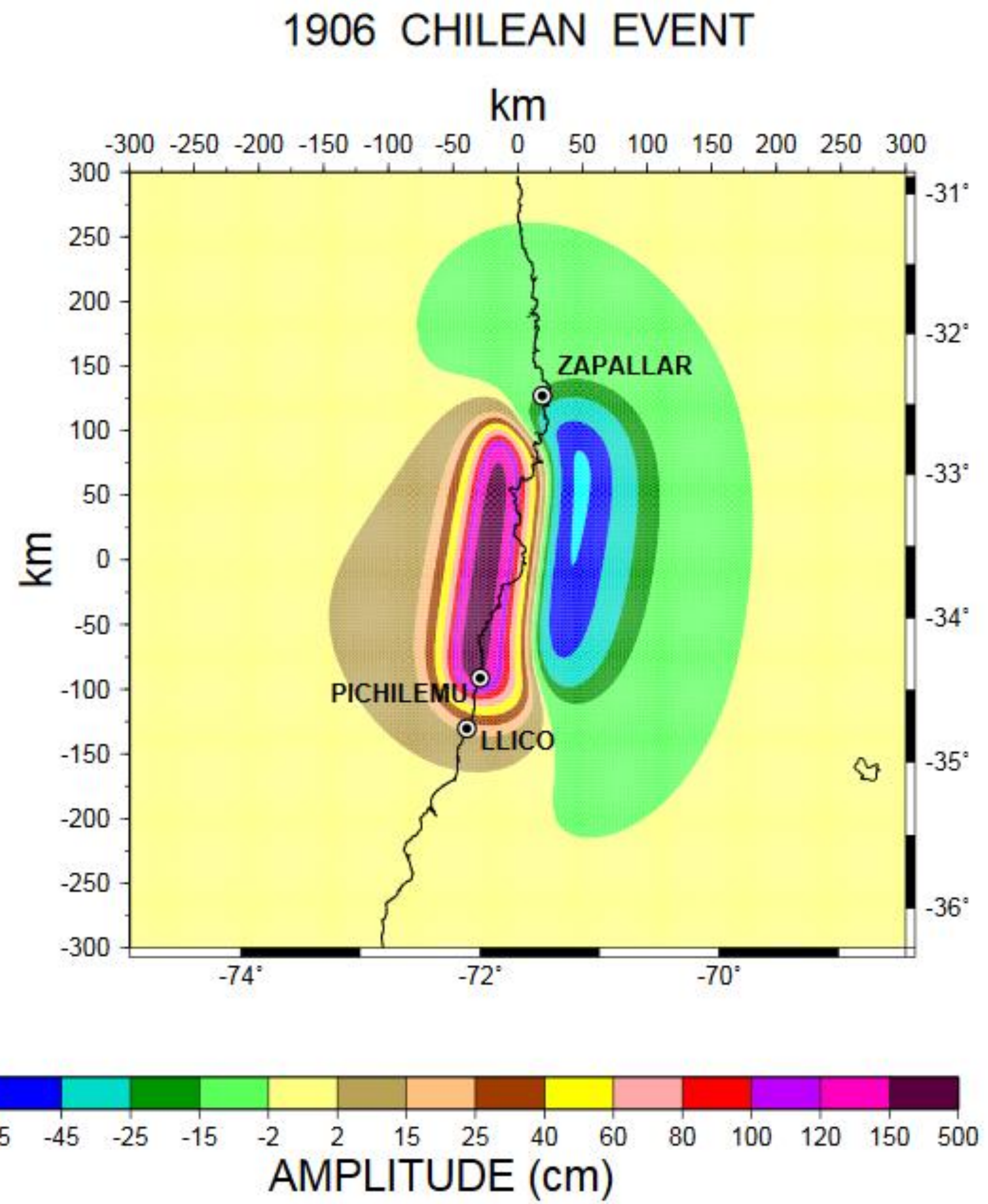
$M_0 = 2.8 \times 10^{28}$ **dyn-cm**



$\varphi_f = 3°;\ \delta = 15°;\ \lambda = 117°$

$L_F = 200$ **km**; $W = 75$**km**;

$\Delta u = 5.3$ **m**



[*Okal*, 2005]