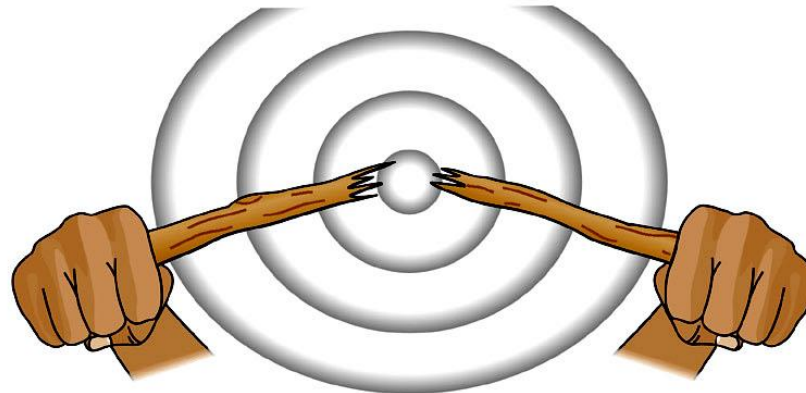
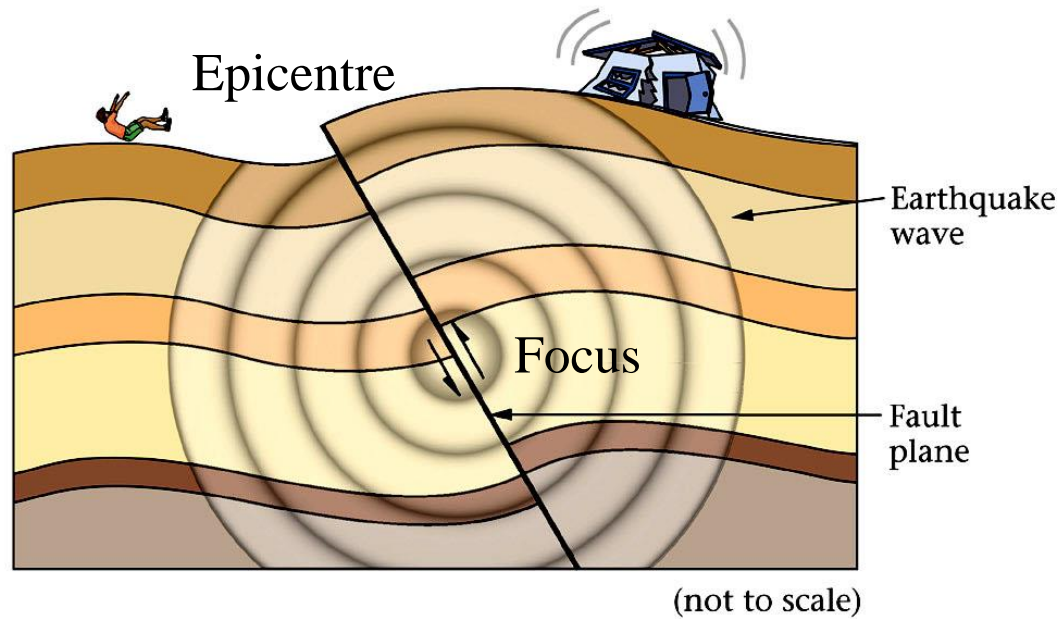
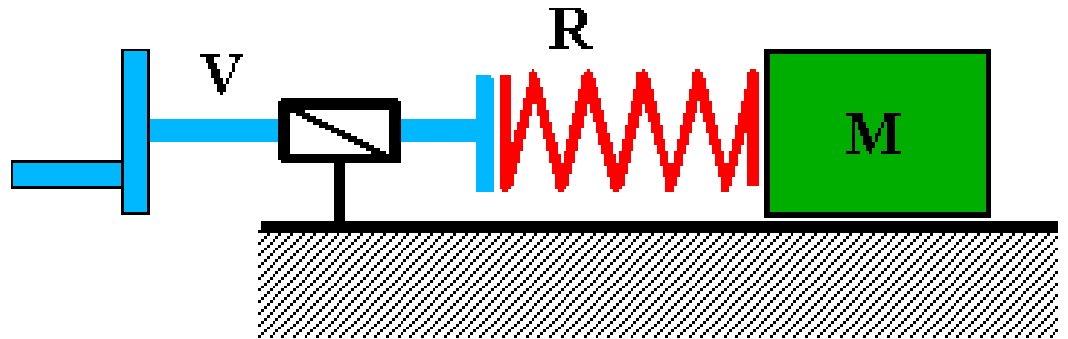
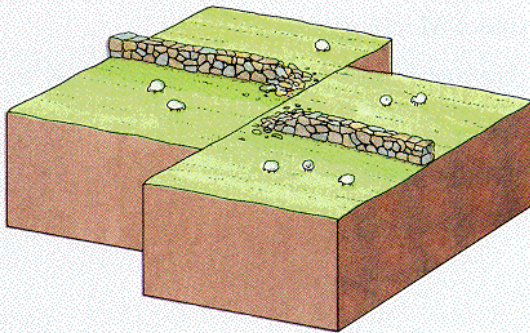
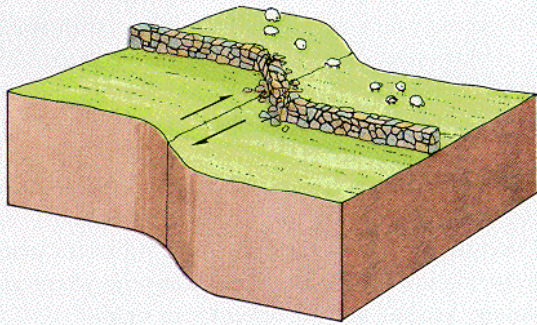
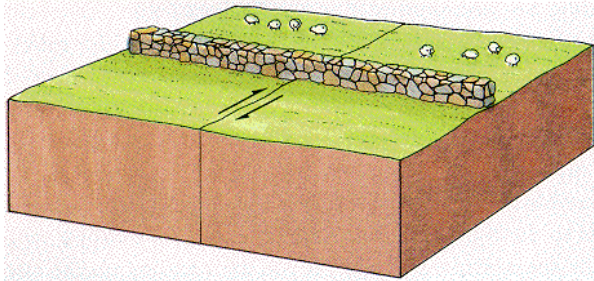


# Earthquakes and the internal structure of the Earth



# Elastic Rebound Theory of Earthquakes



# Compressional or P Waves

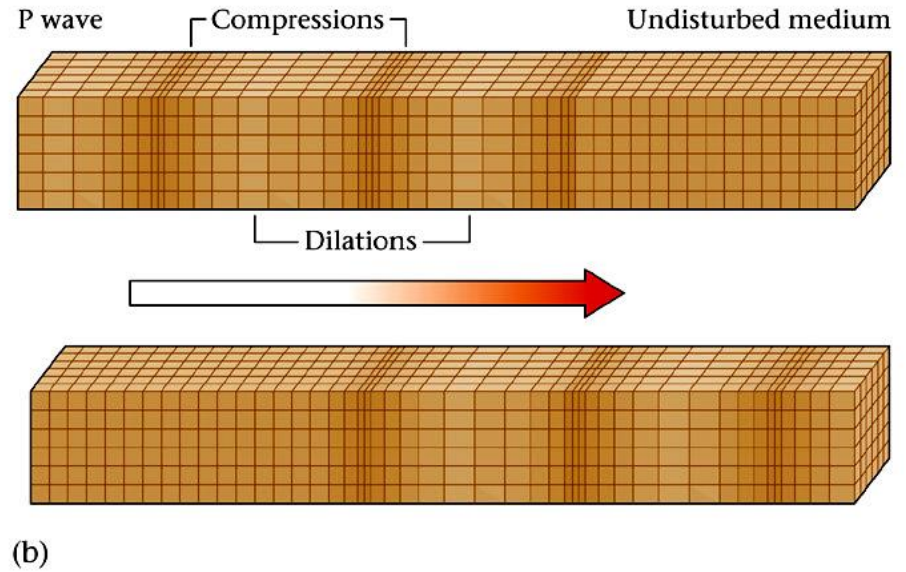
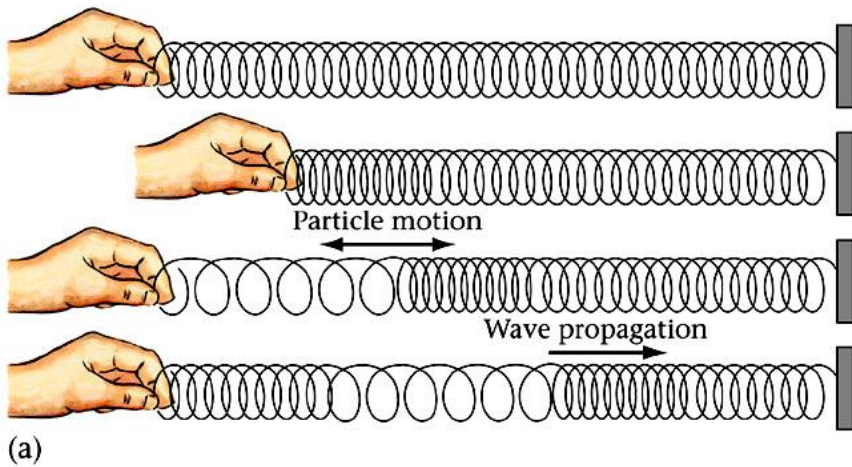
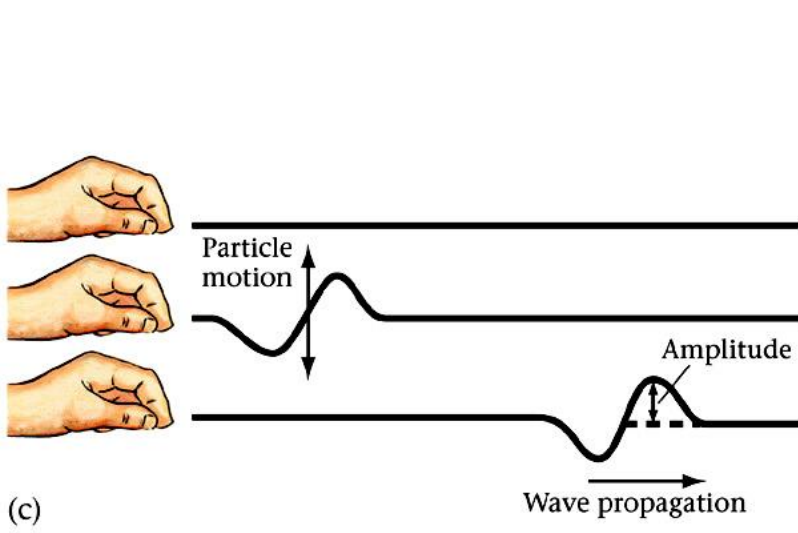
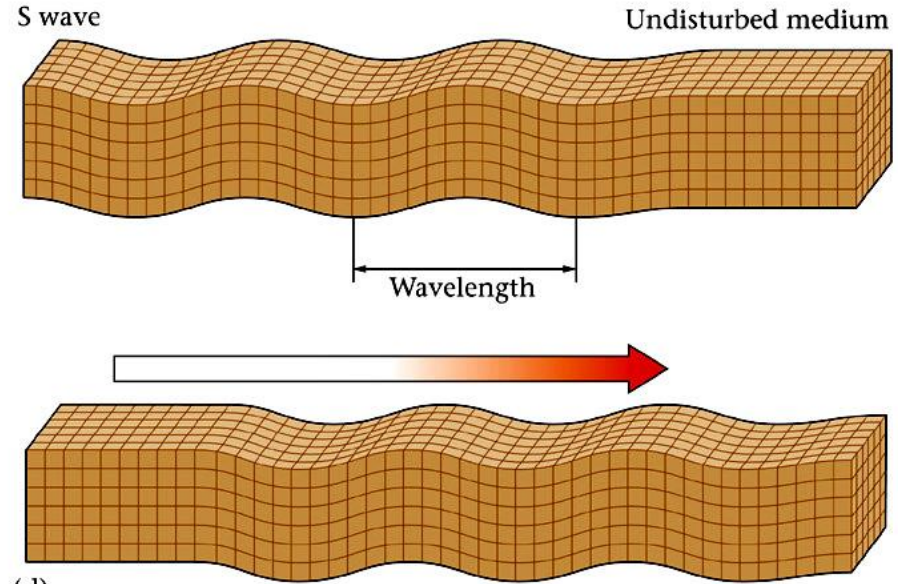


FIGURE 10.12

# Shear or S Waves



(c)



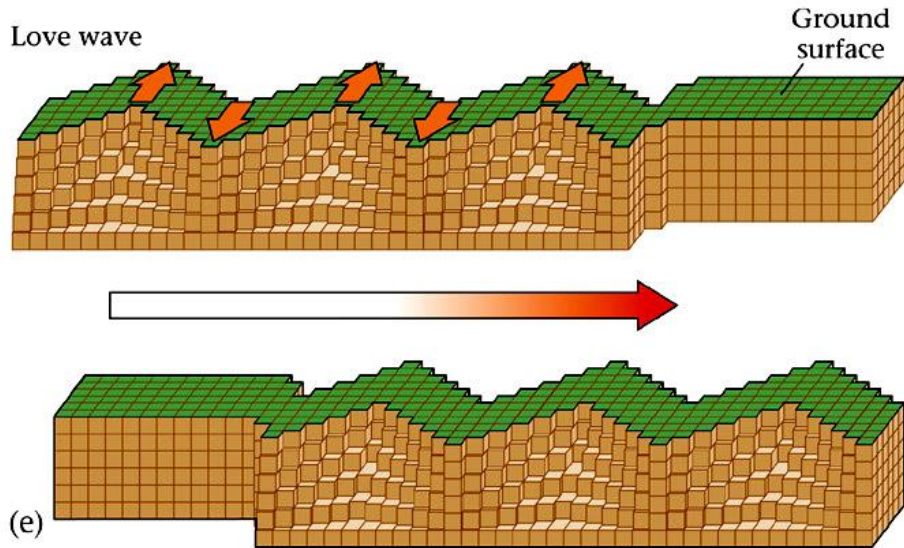
(d)

FIGURE 10.12



# Surface Waves

## Love Waves



## Raleigh Waves

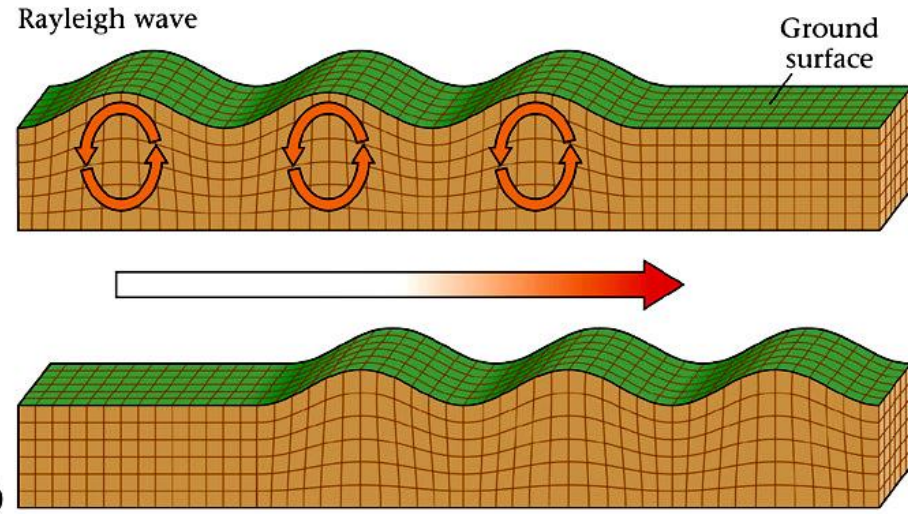


FIGURE 10.12

# Seismographs

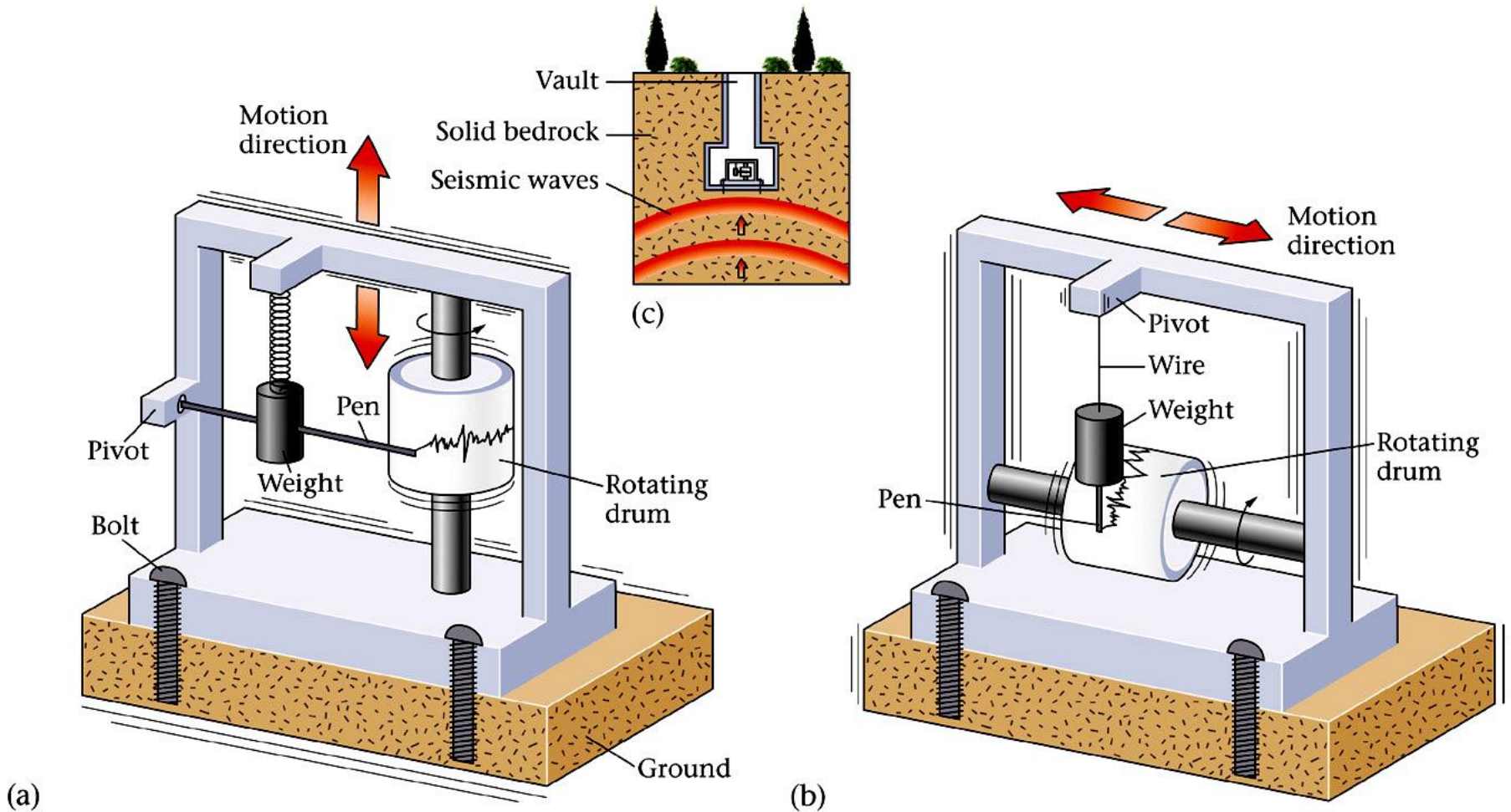


FIGURE 10.13

# Modern Seismograph

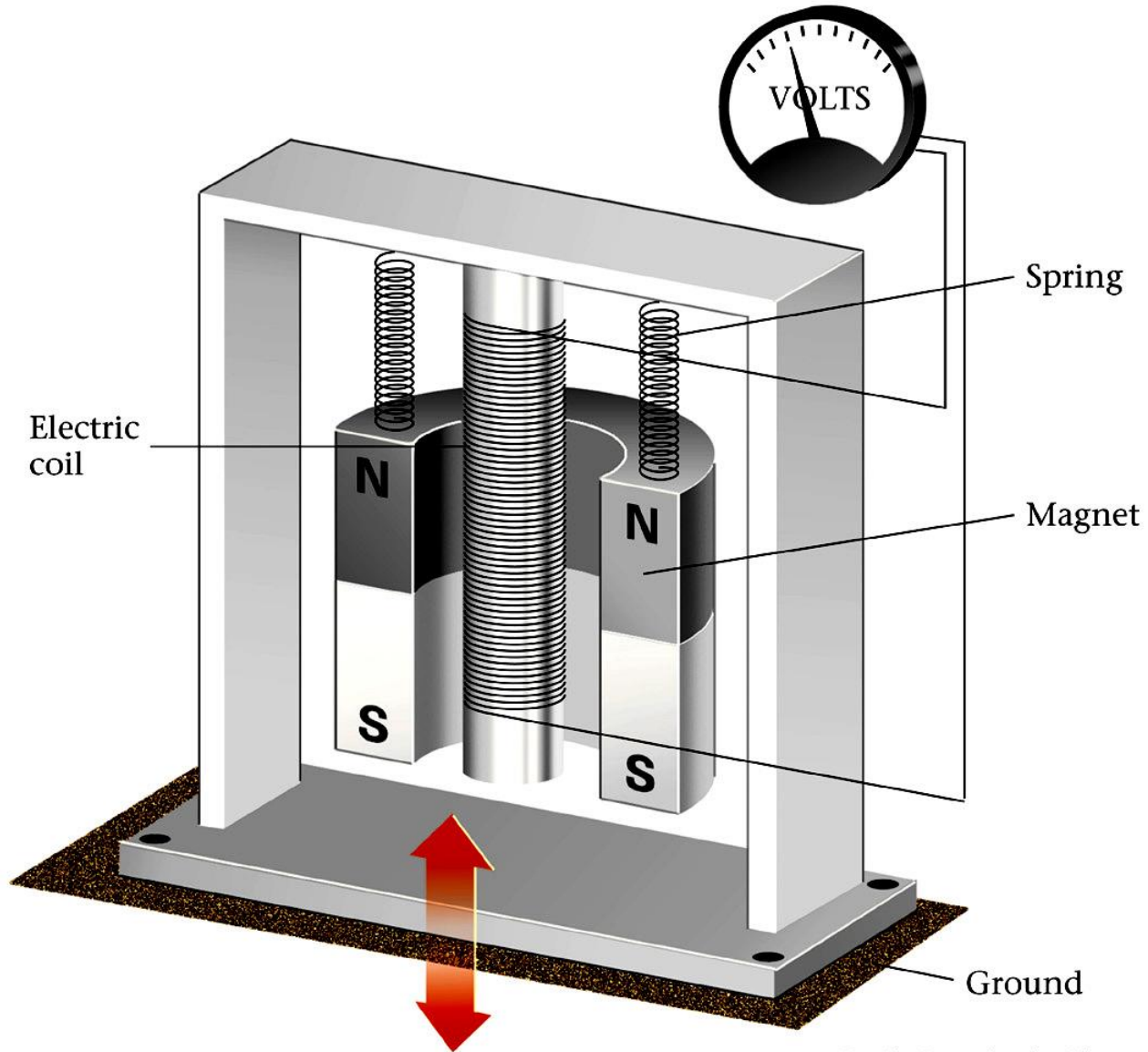


FIGURE 10.15



# Seismogram

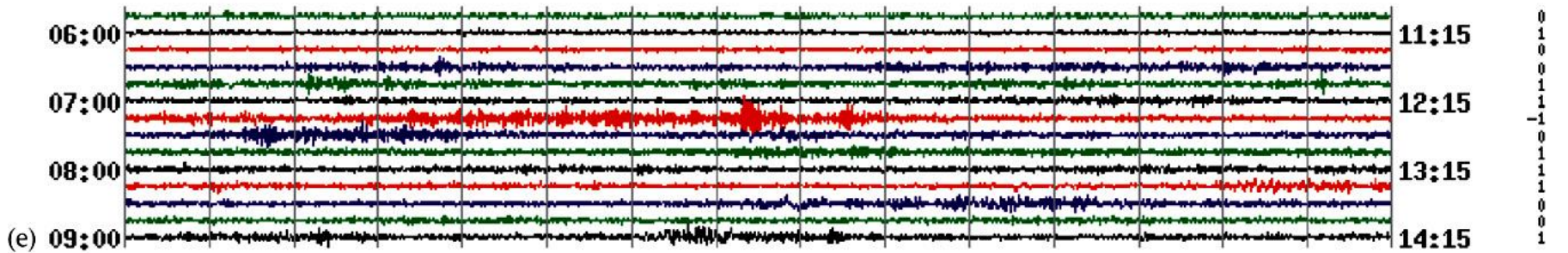
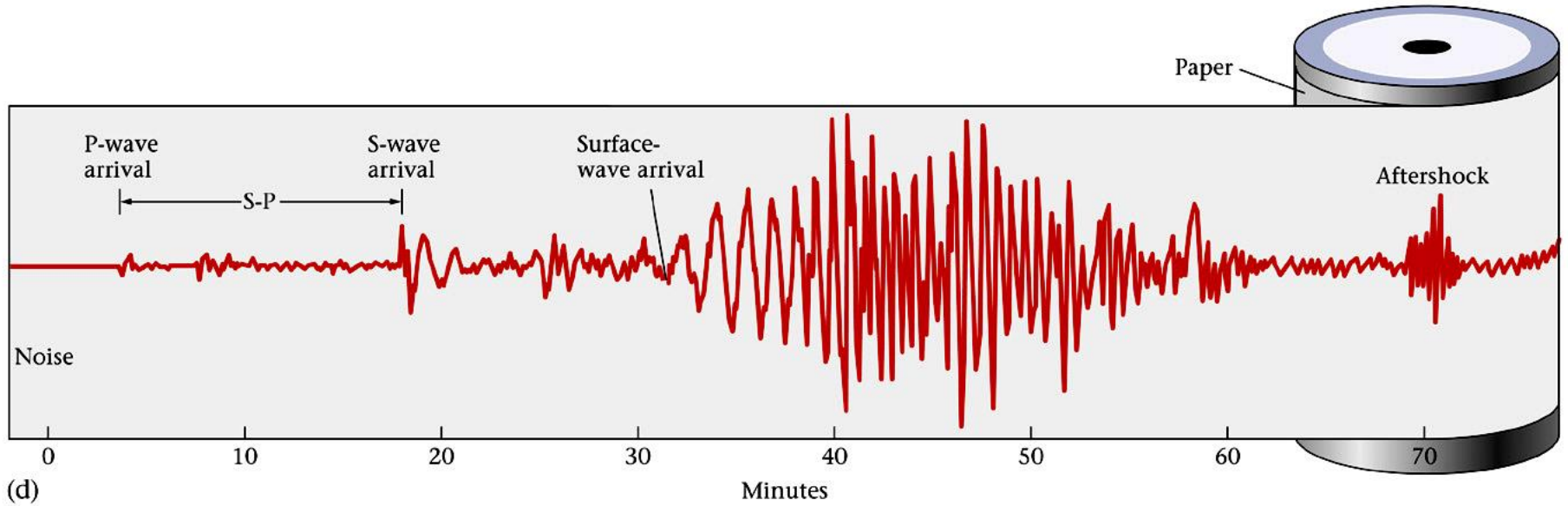


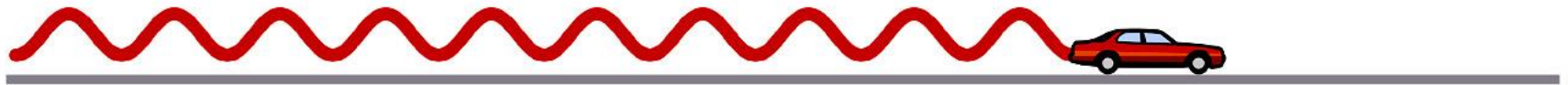
FIGURE 10.14



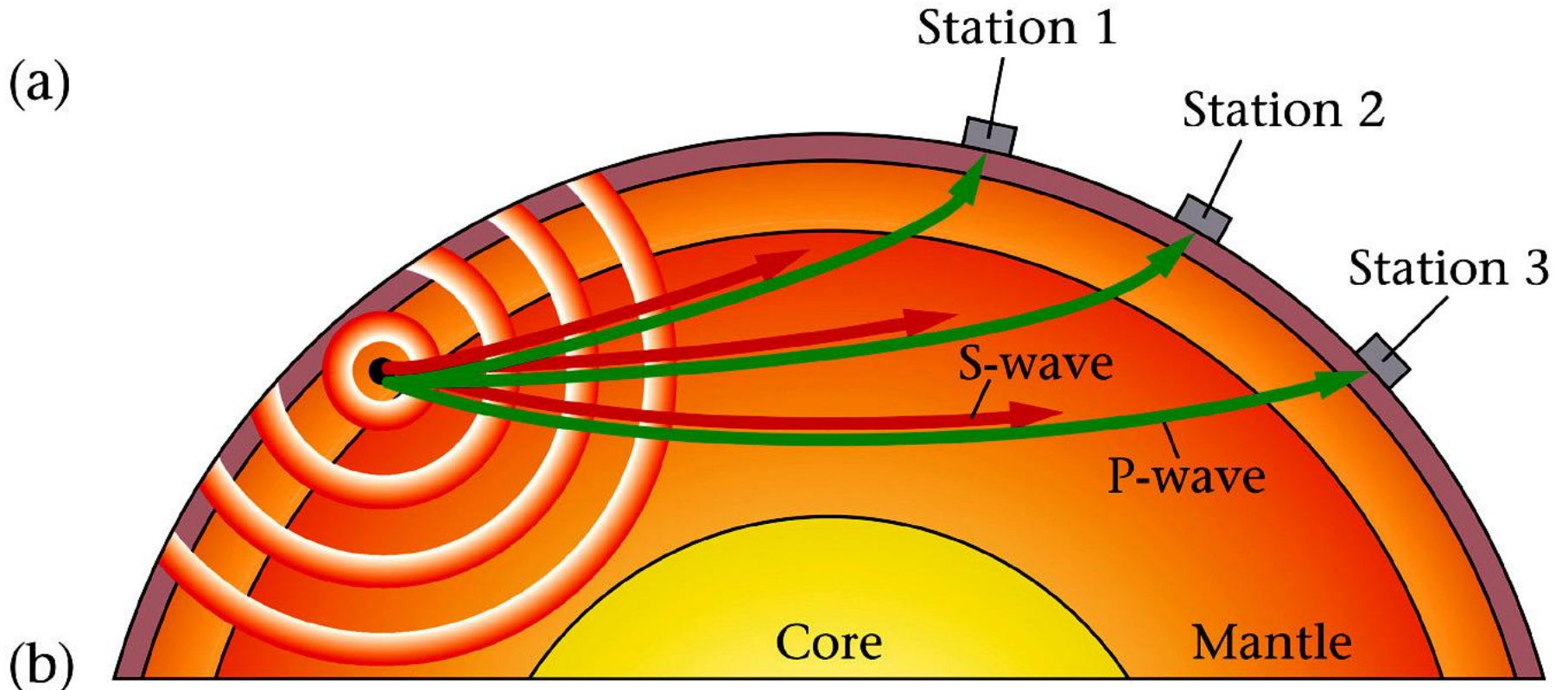
P-wave



S-wave

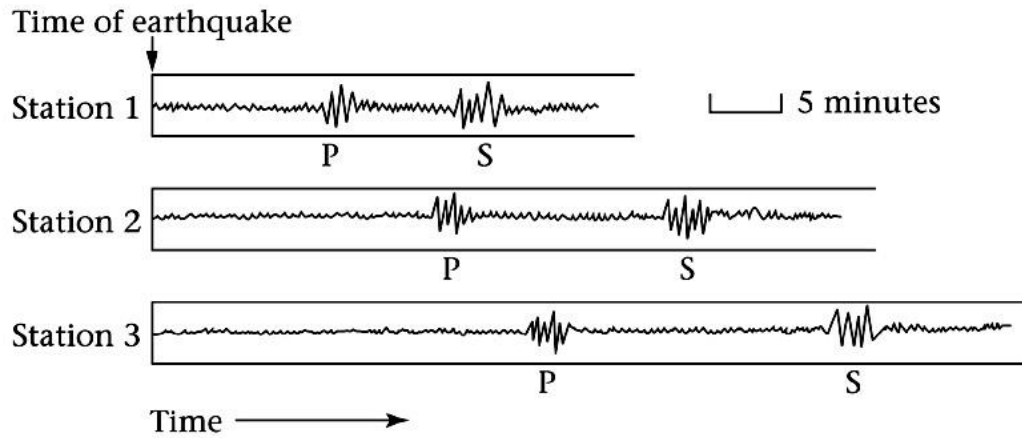


(a)

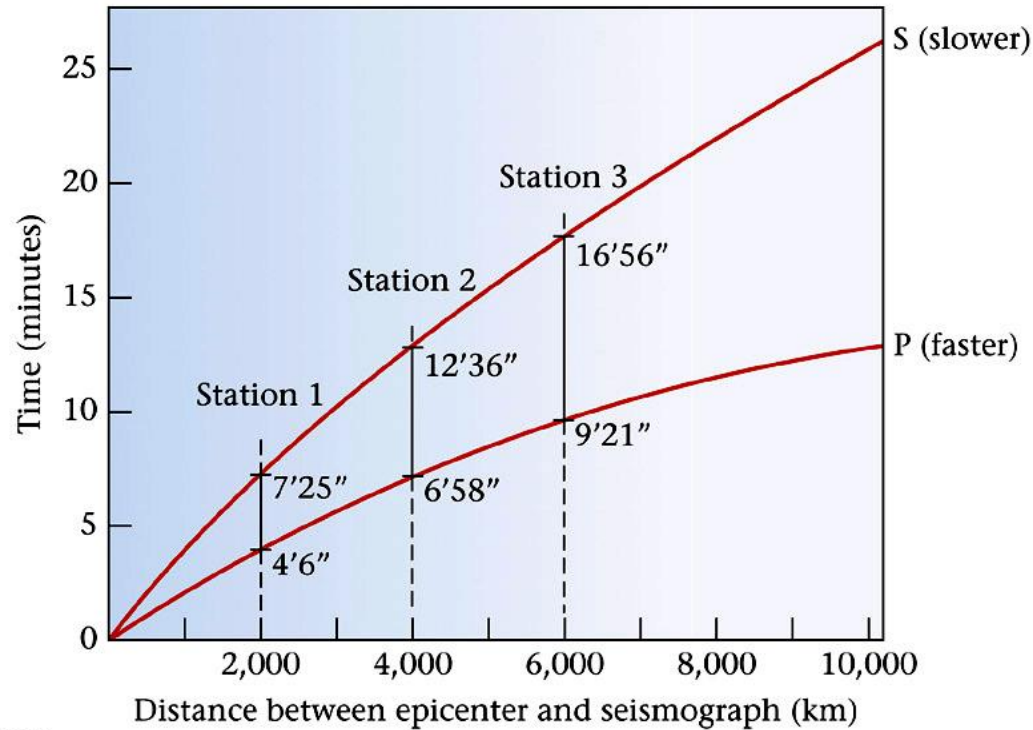


(b)

FIGURE 10.16

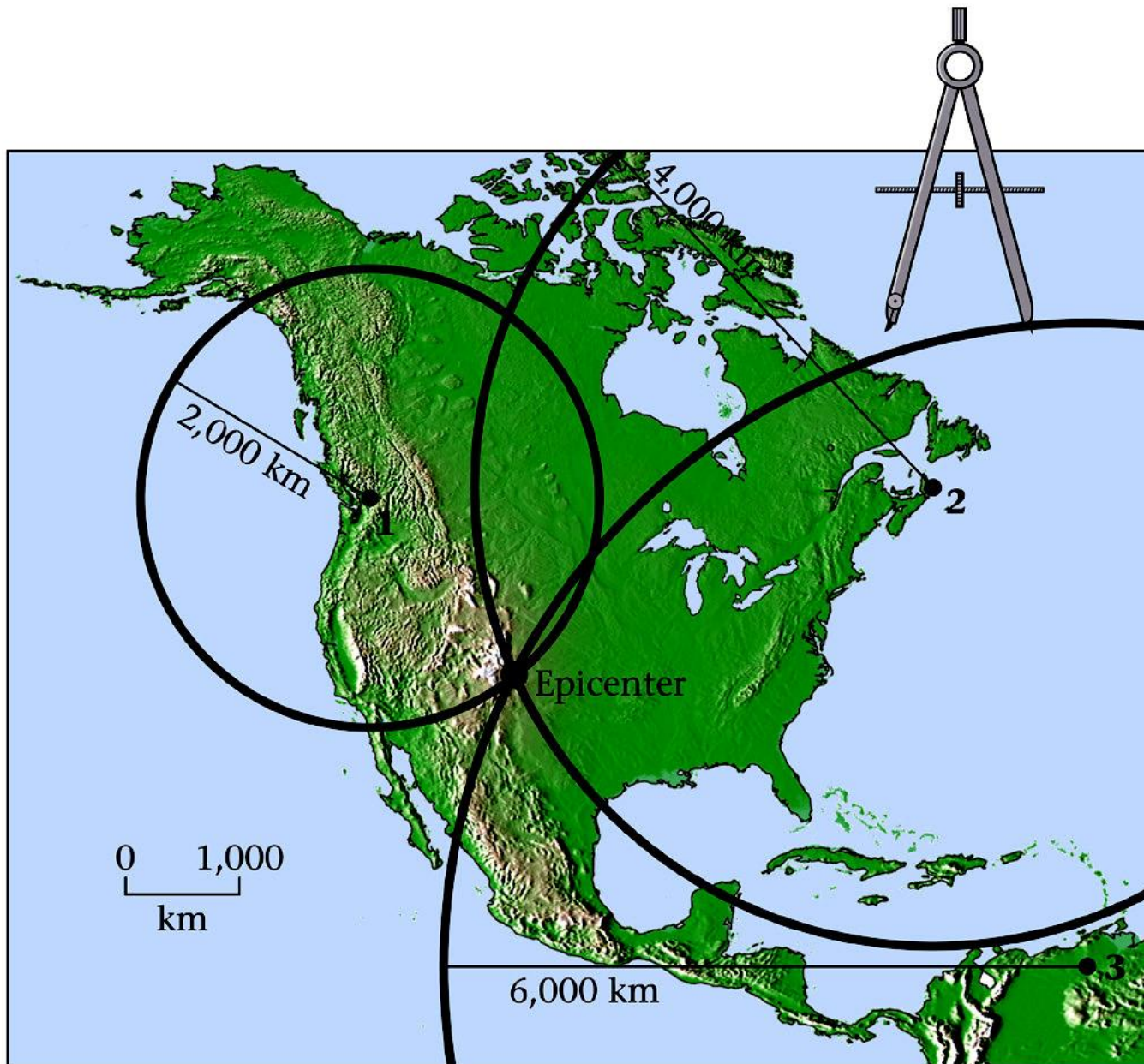


(c)



(d)

FIGURE 10.16



(e)

FIGURE 10.16



# Richter Scale

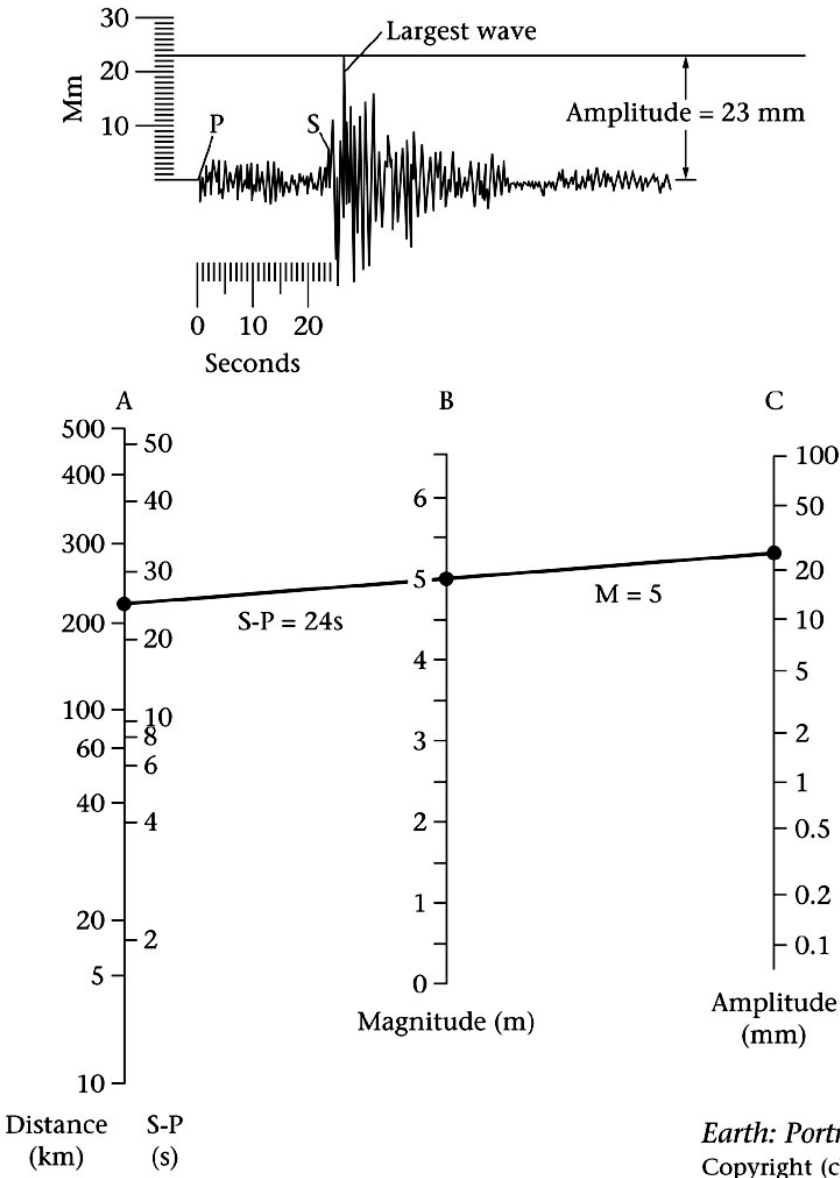


FIGURE 10.18

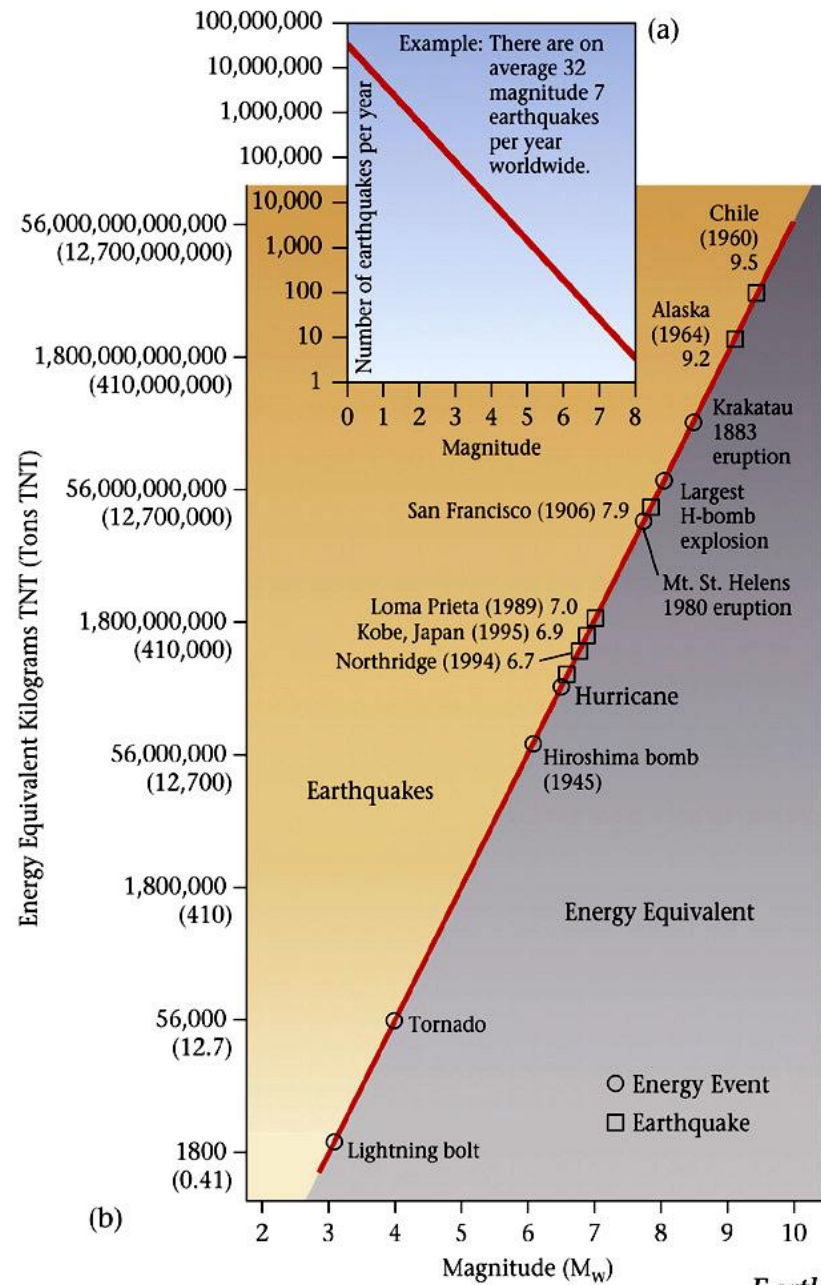


FIGURE 10.19

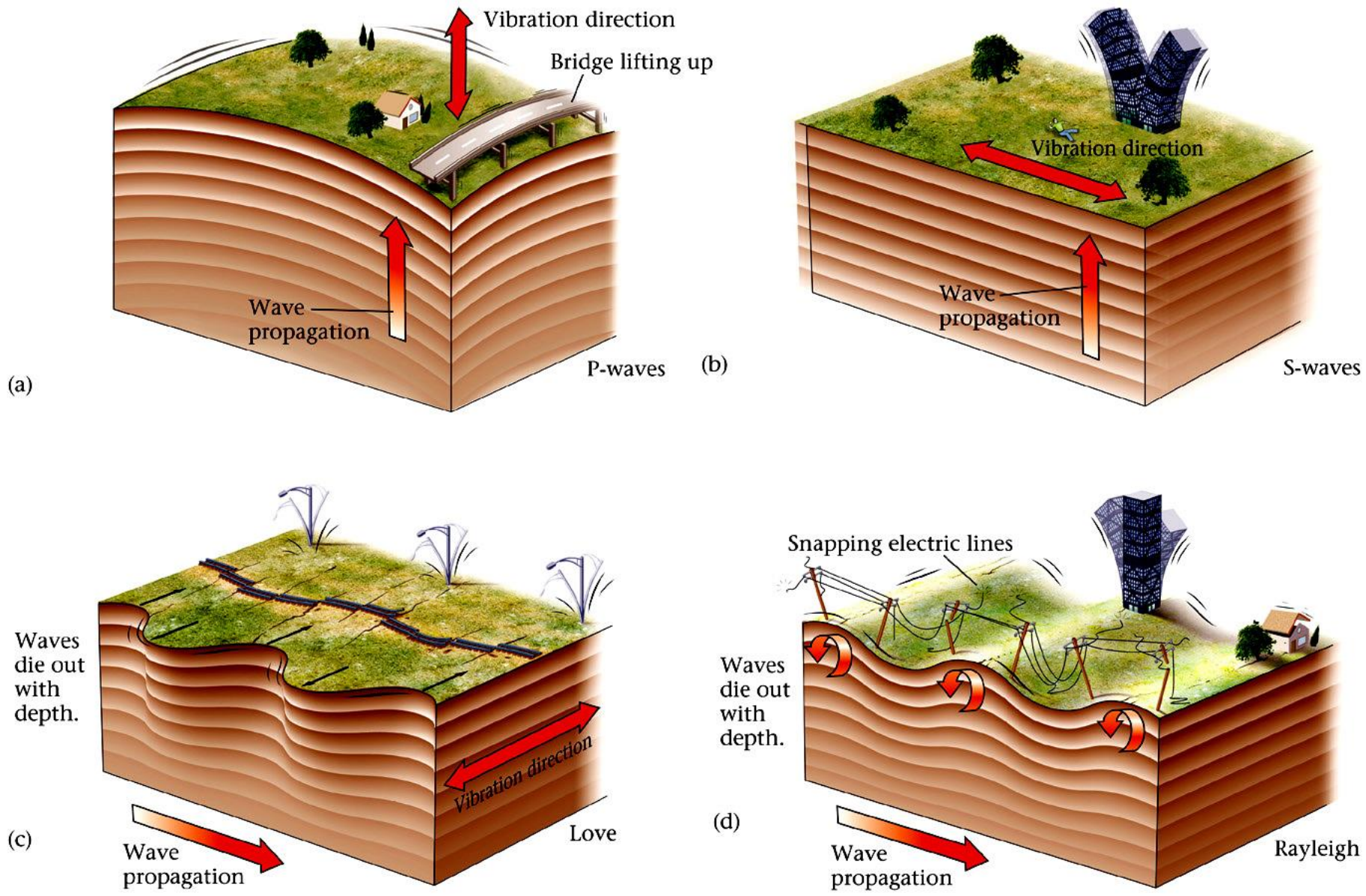


FIGURE 10.27





(b)

FIGURE 10.23





(c)

FIGURE 10.29





(e)

FIGURE 10.29

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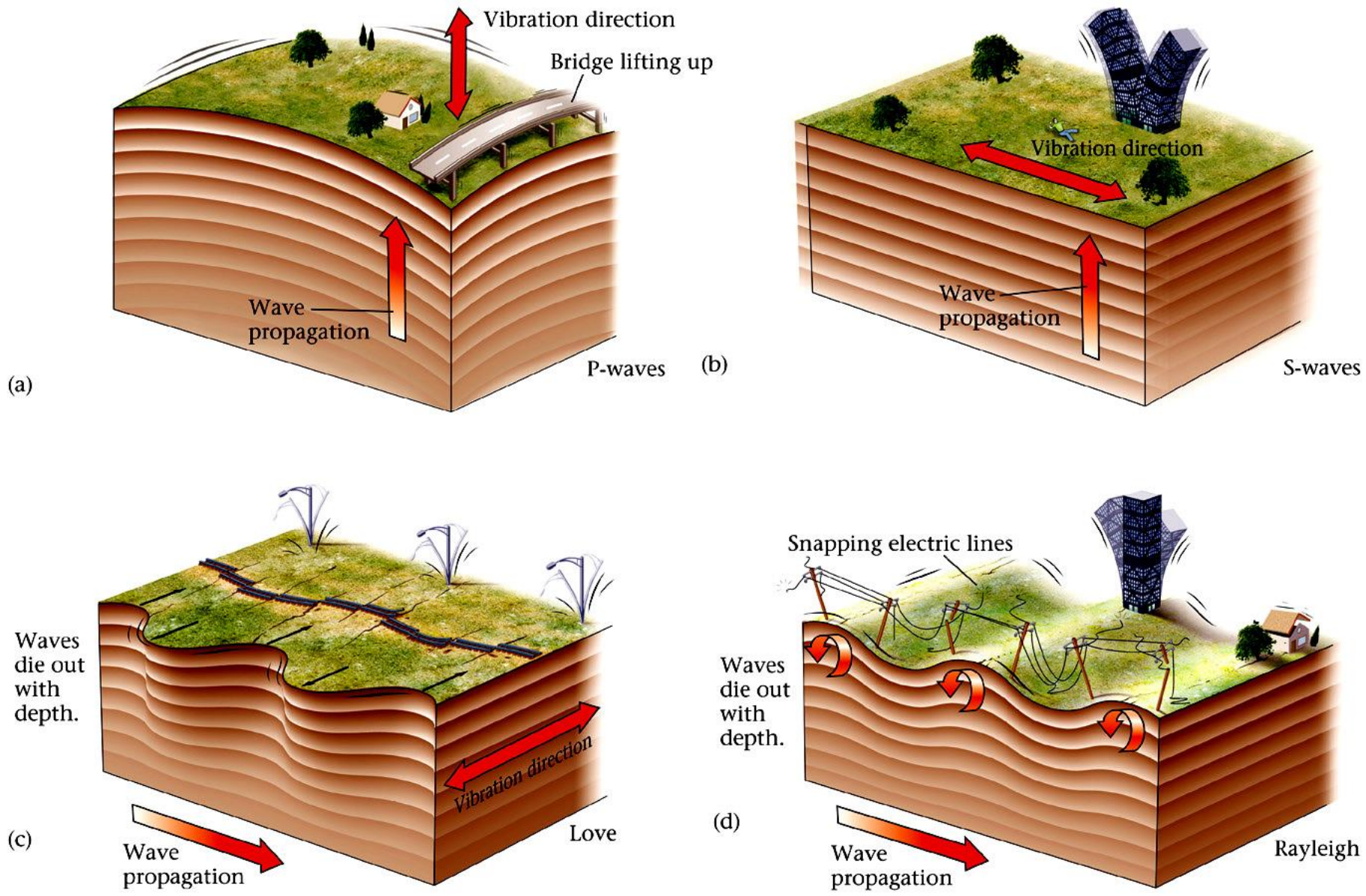


FIGURE 10.27





FIGURE 10.33

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# The San Francisco Earthquake of 1906





# The San Andreas Fault

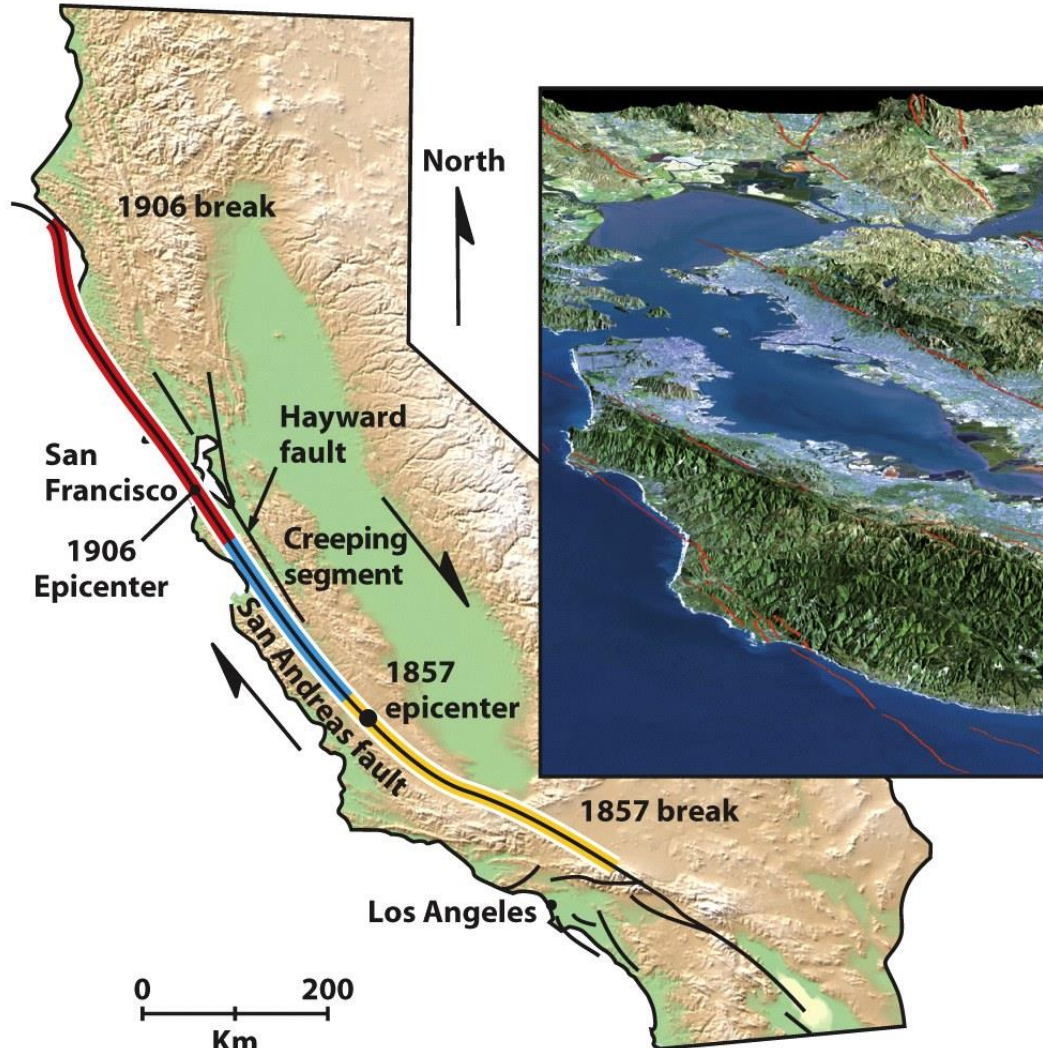
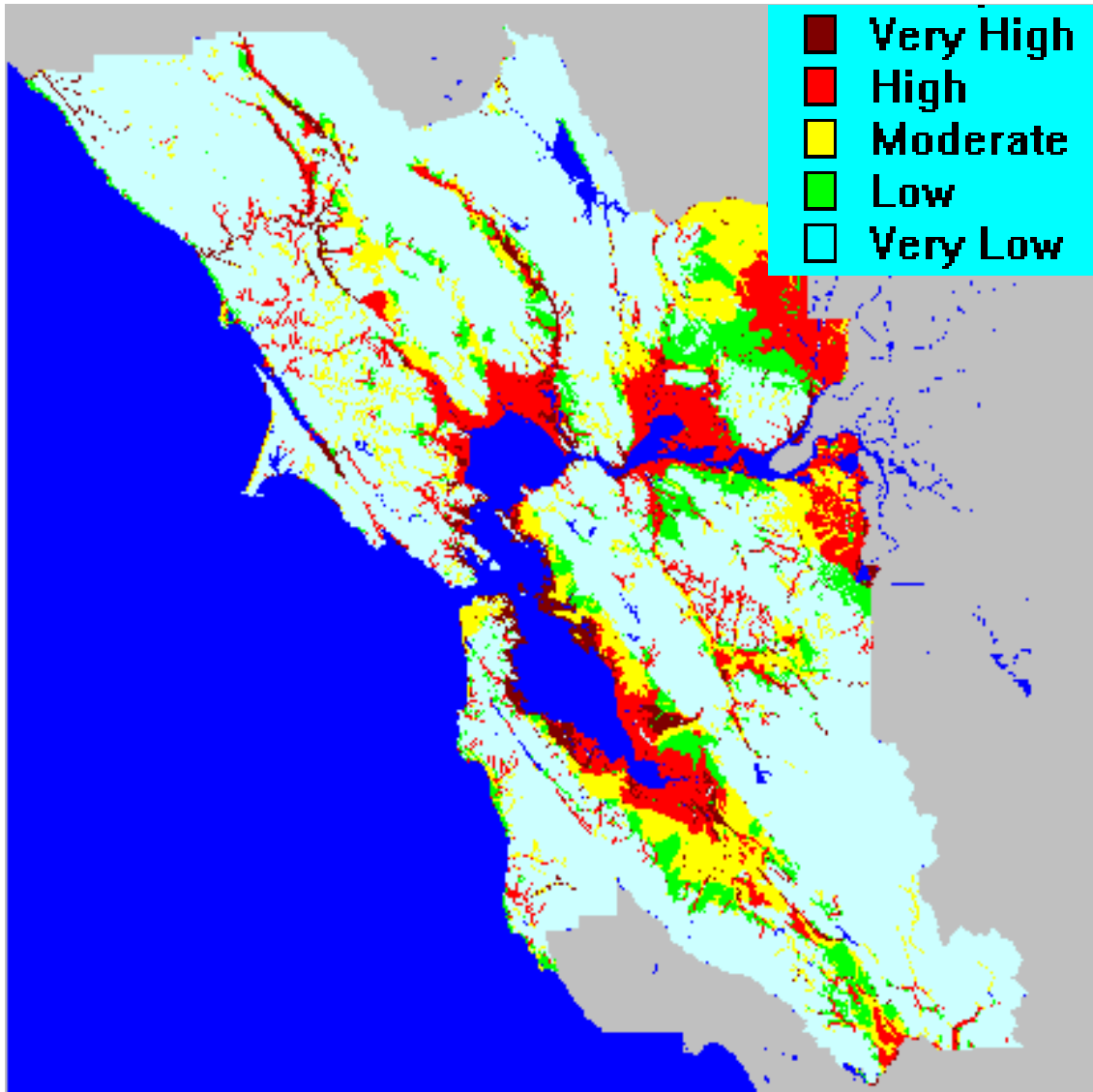


Figure 10-25ab Earth: Portrait of a Planet 3/e  
Photo: U.S. Geological Survey

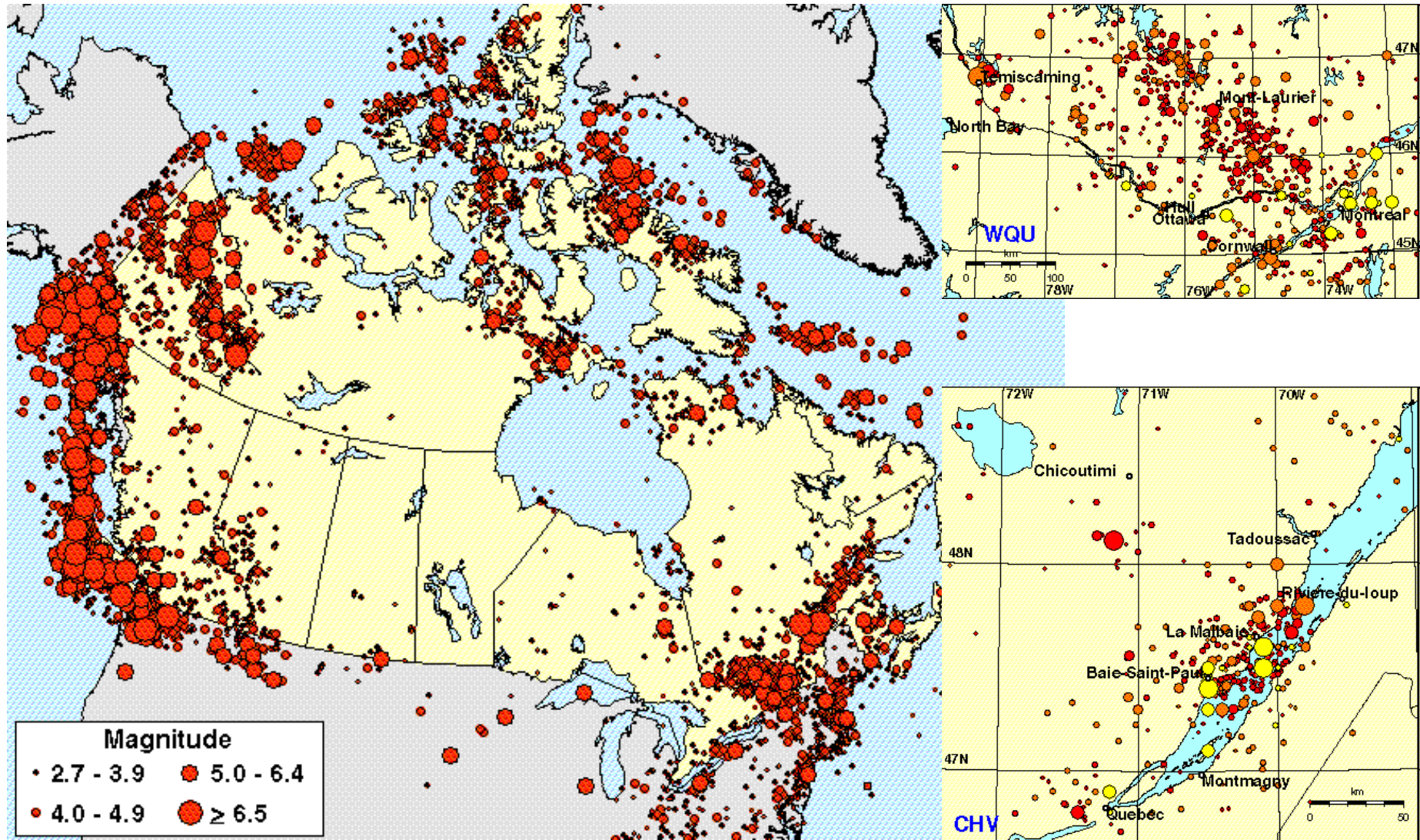
# Earthquake-induced liquefaction and San Francisco



Earthquake-induced shaking turns water-saturated but otherwise solid ground into a slurry of sand/soil plus liquid

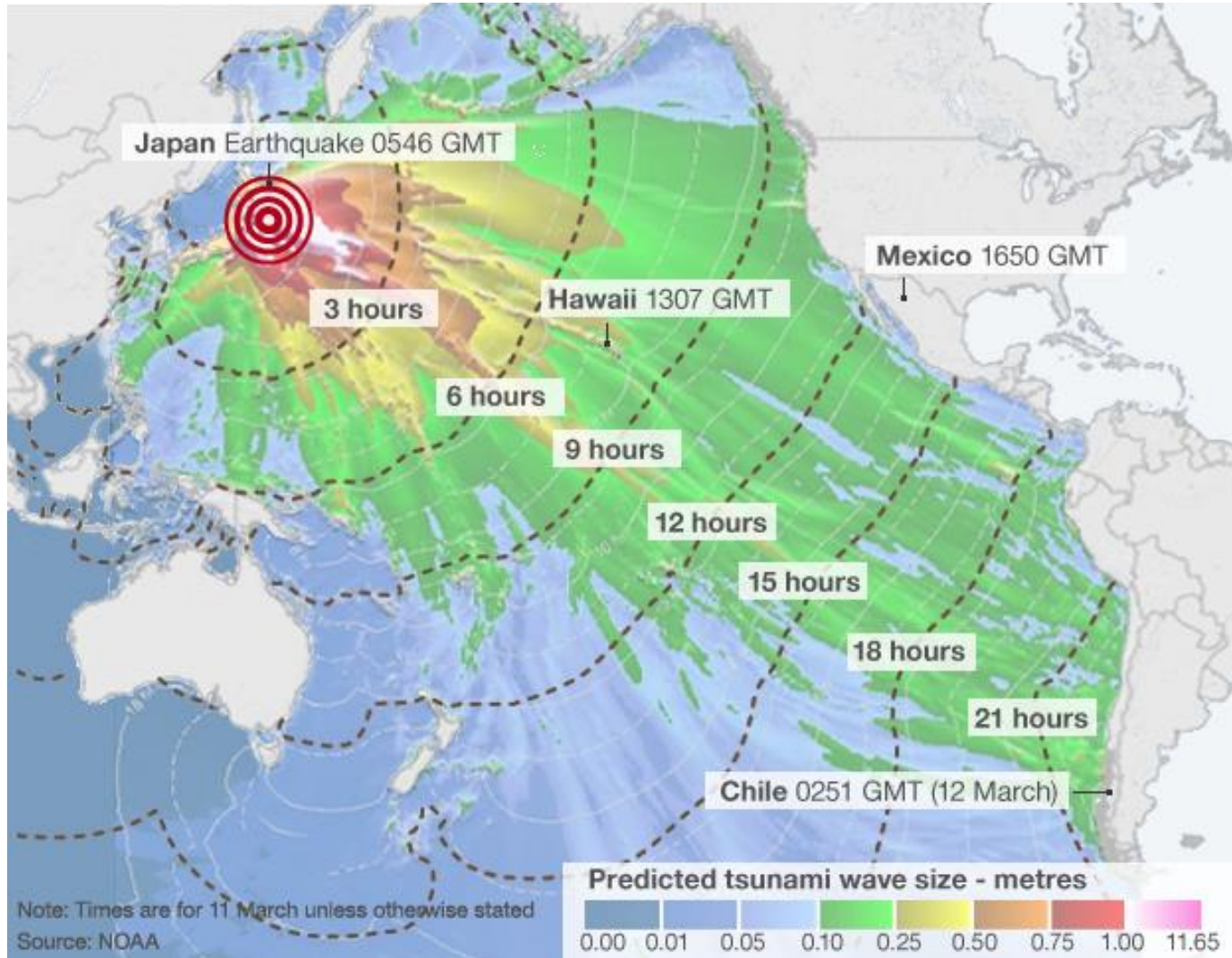


# Seismic Map of Canada





# Japanese Earthquake (Magnitude 9) and Tsunami March 14<sup>th</sup> 2011



# Japanese Tsunami March 14<sup>th</sup> 2011





# The Devastation





# The Fukushima Nuclear Disaster



# The Boxing Day Tsunami

## Banda Aceh 26-12-2004





# Tsunami Wave



# Tsunami waves approach Phuket, Thailand two hours after the Banda Aceh earthquake





# Tsunami waves approach Phuket, Thailand



# Tsunami wave strikes coastal city





# Inundation





# Devastation



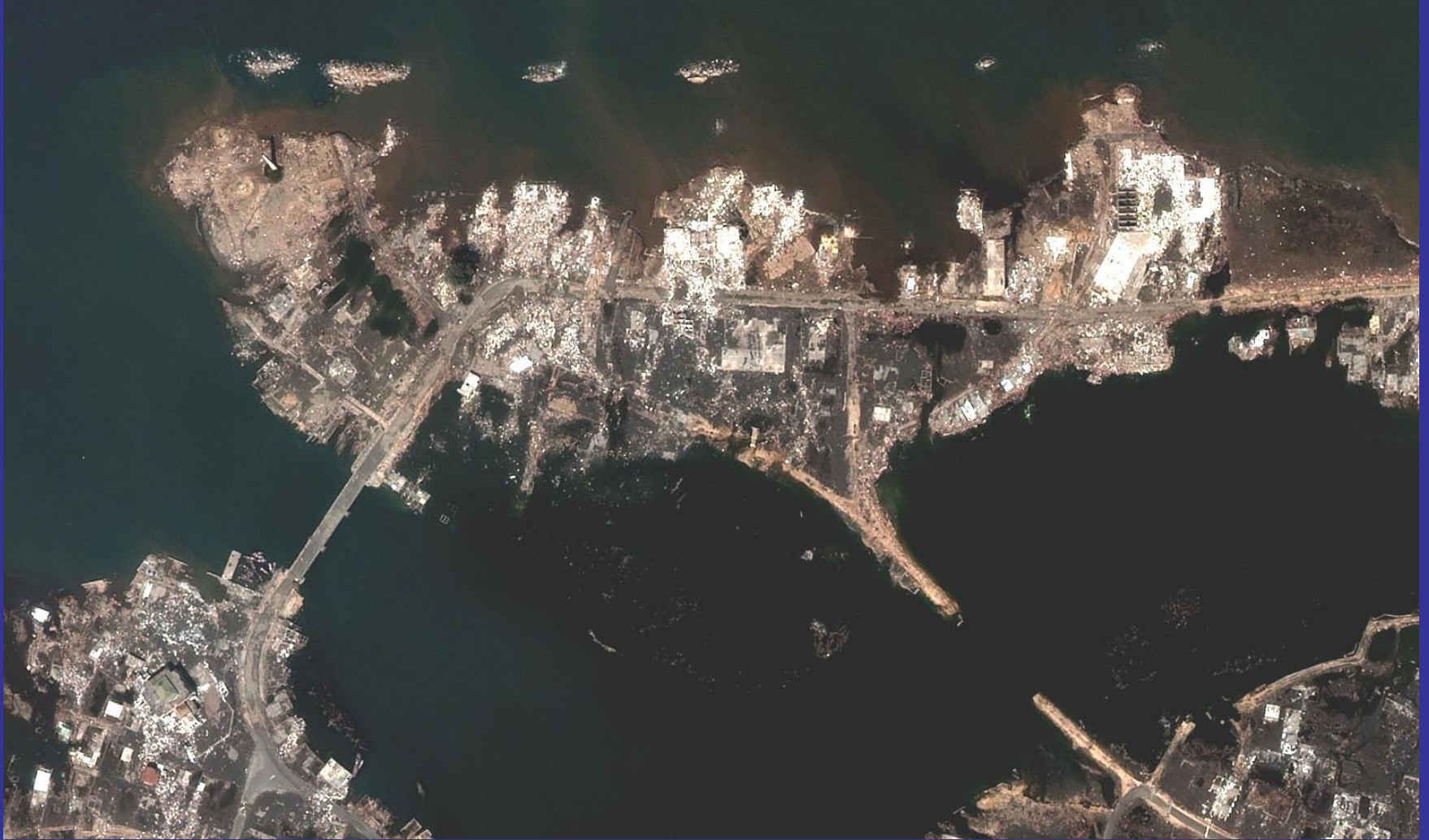


# Banda Aceh before the Tsunami



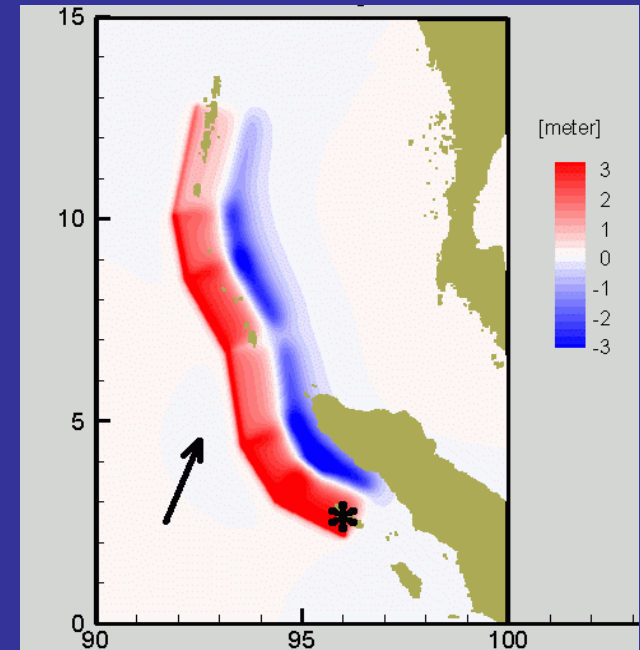
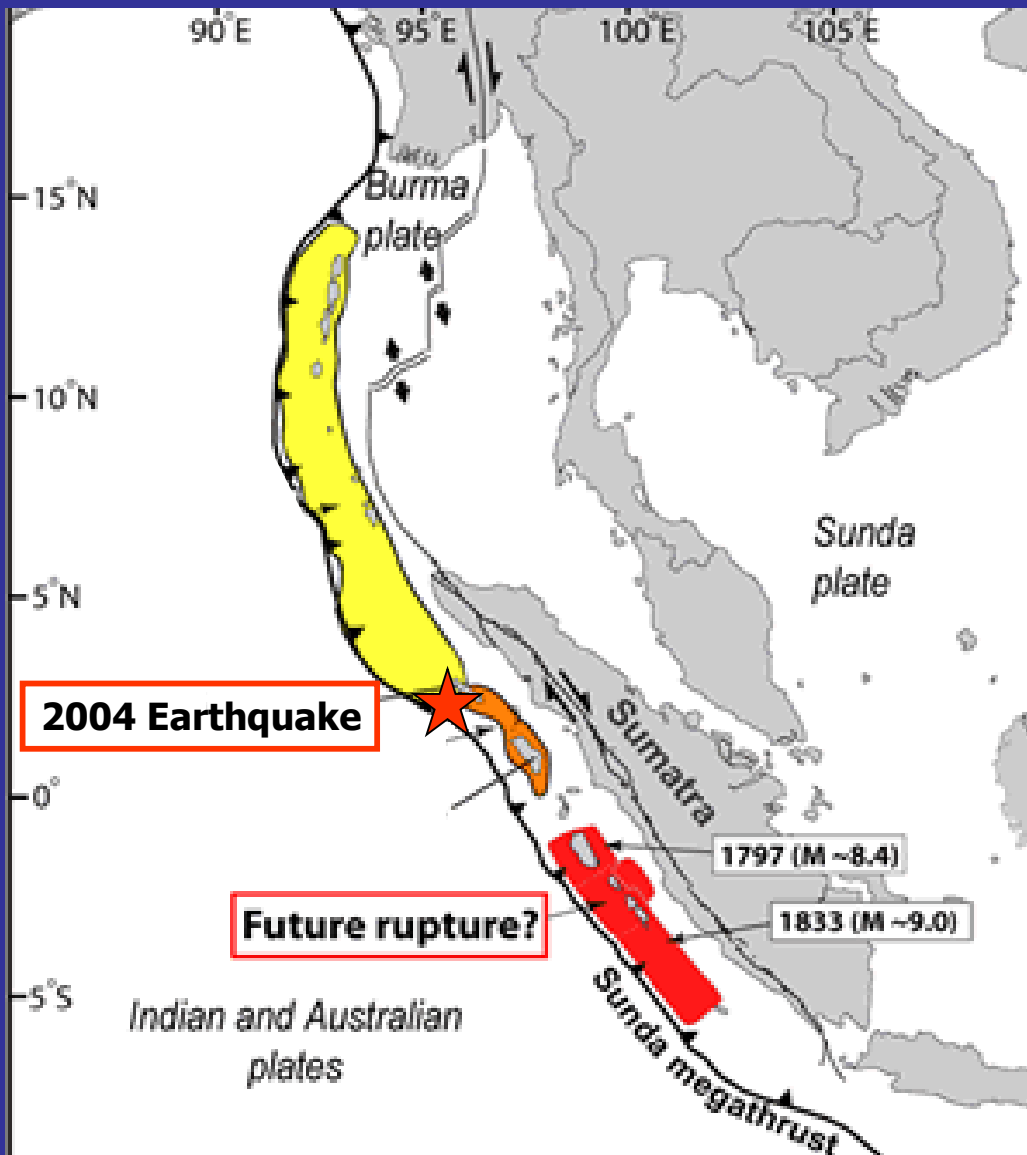


# Banda Aceh after the Tsunami



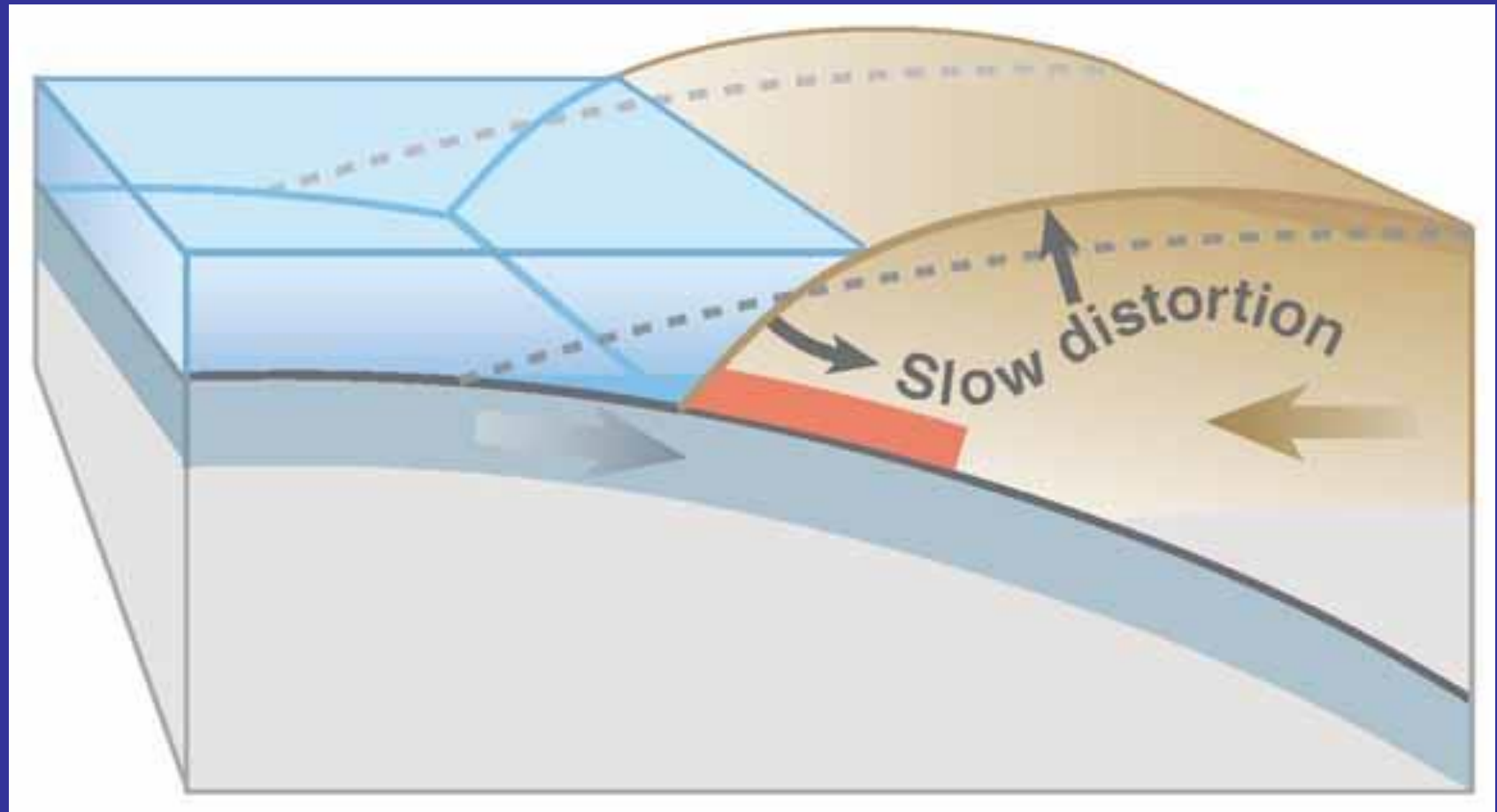


# Subduction and the Banda Aceh Earthquake



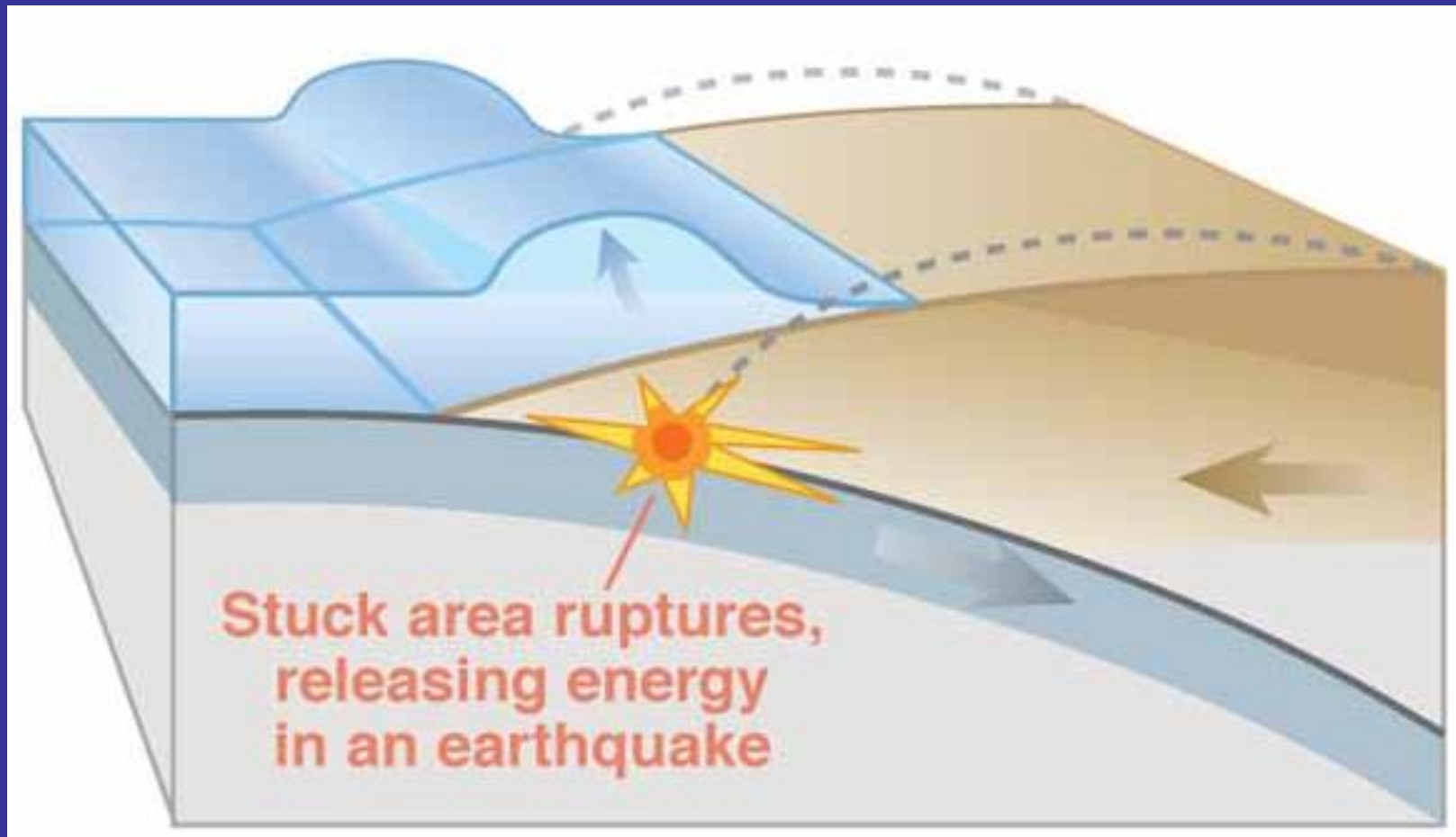
Seafloor displacement (m)

# Tsunami generation – initiated by subduction of oceanic plate





# Earthquake generates Tsunami



# Tsunami Wave Characteristics

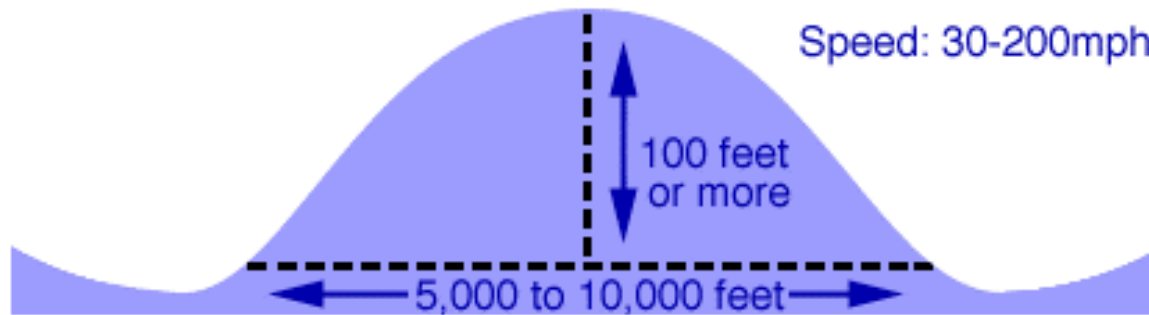
Tsunami in deep ocean

Speed: 450-650mph



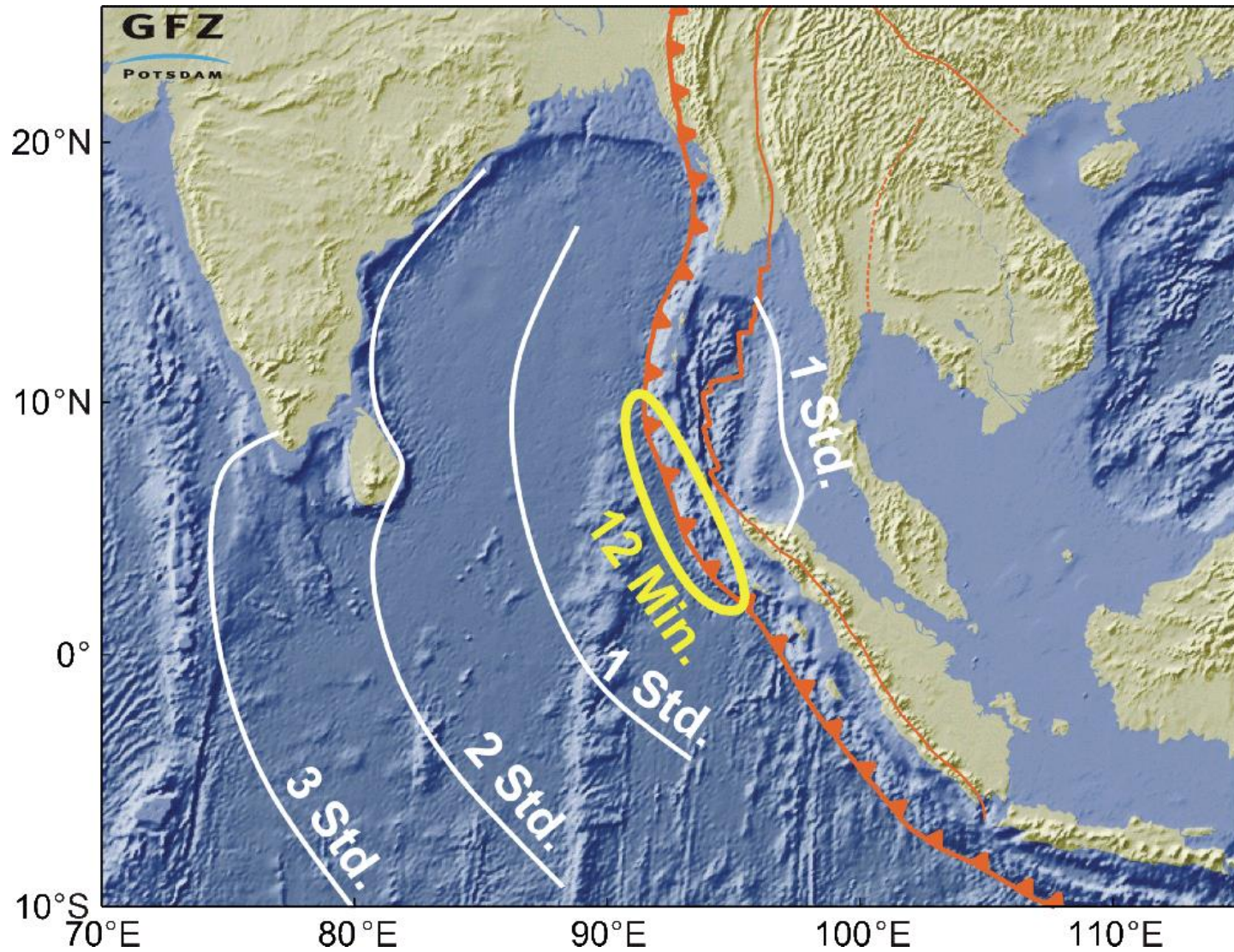
Tsunami approaching shore

Speed: 30-200mph

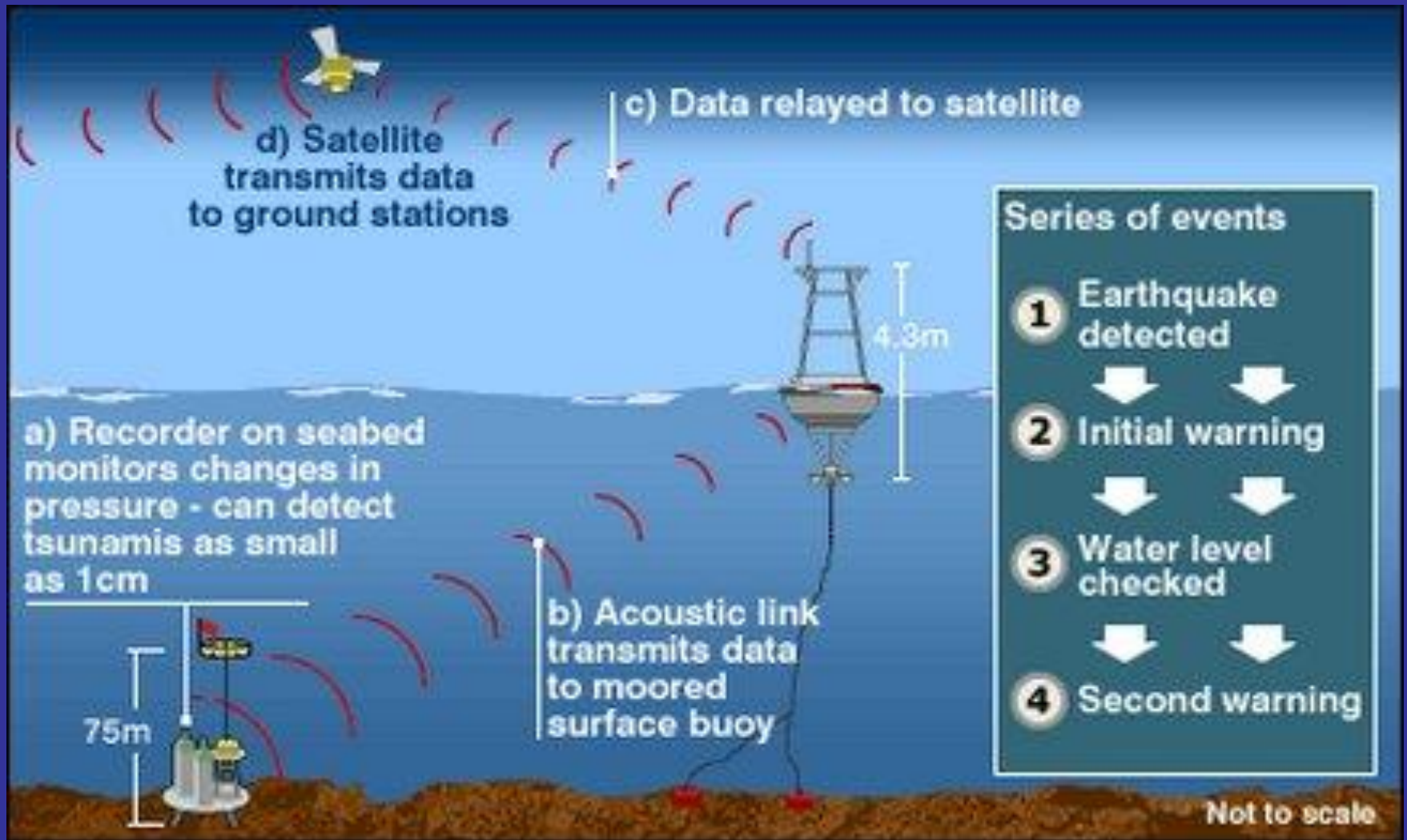




# Tsunami travel time

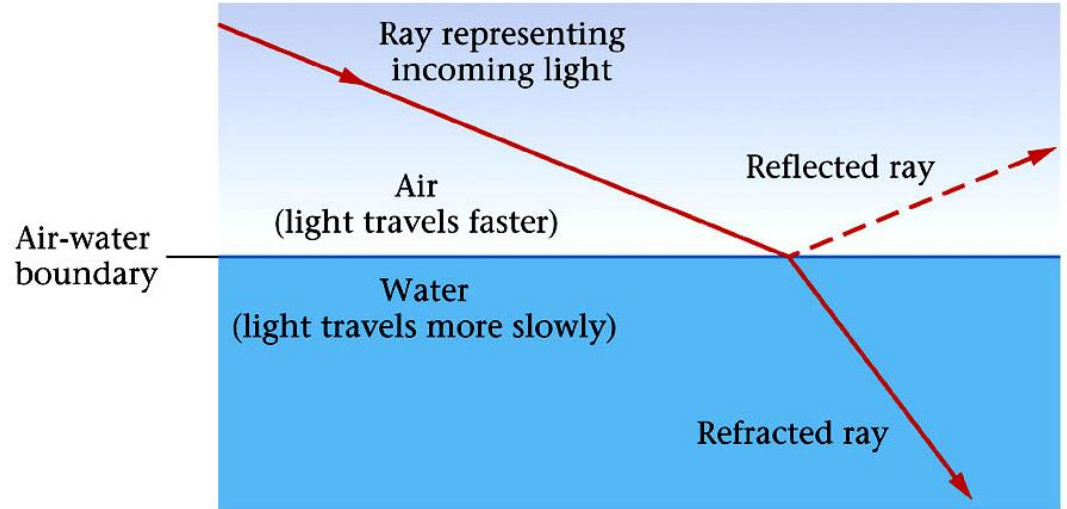


# Tsunami Early Warning System

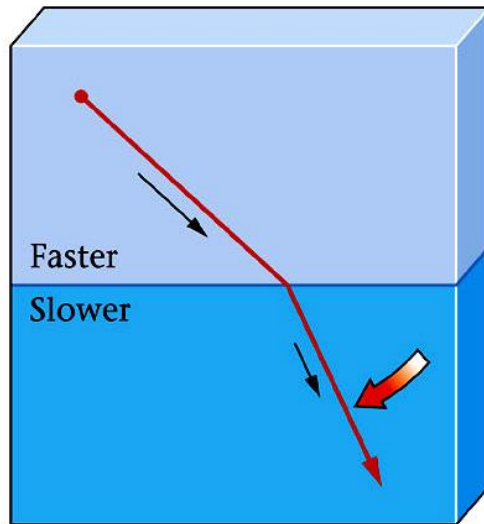




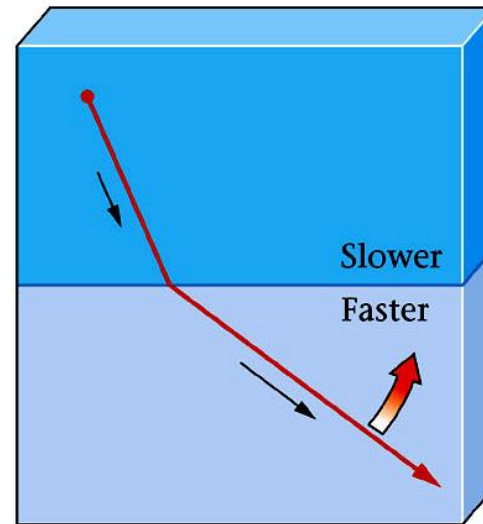
# Refraction



(a)



(b)

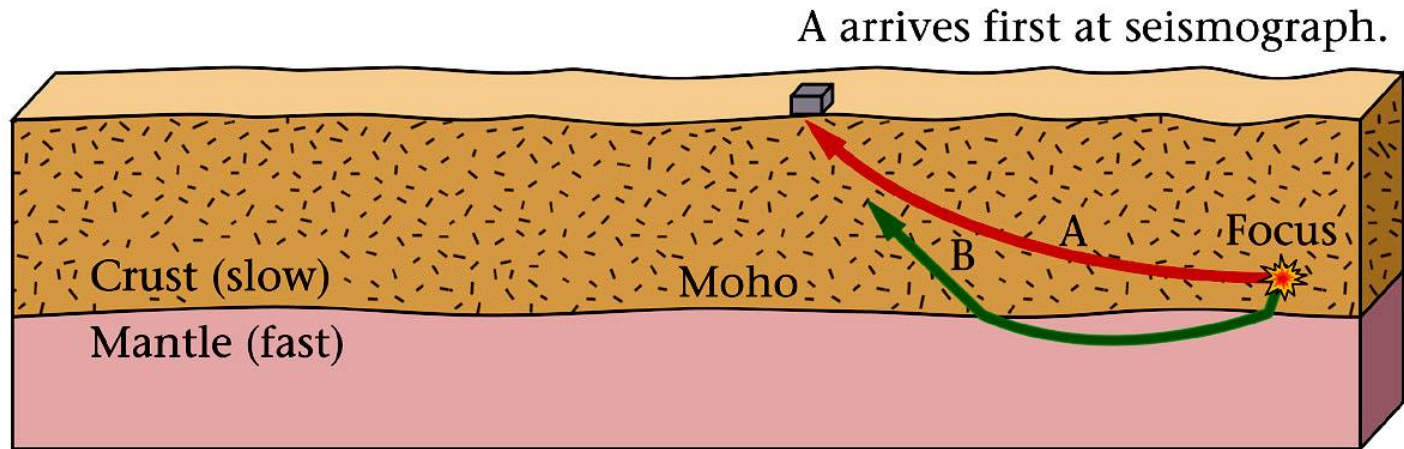


(c)

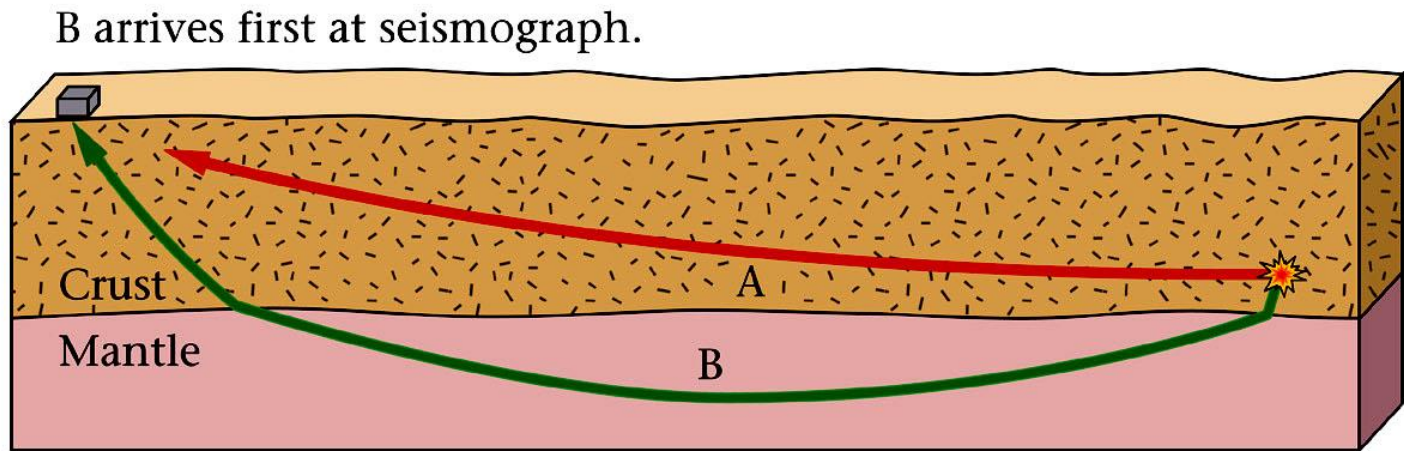
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FIGURE C.5

# Seismic Refraction



(a)

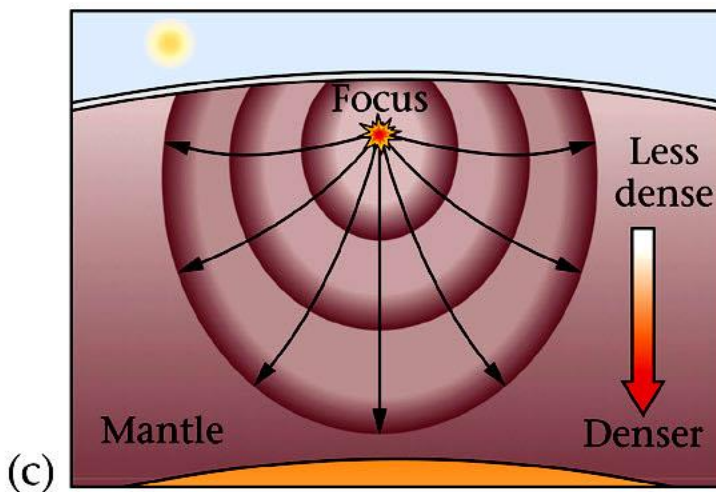
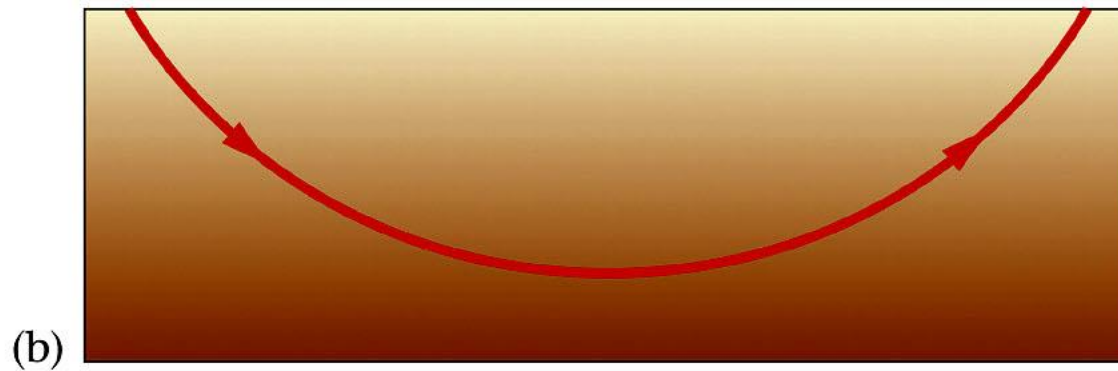
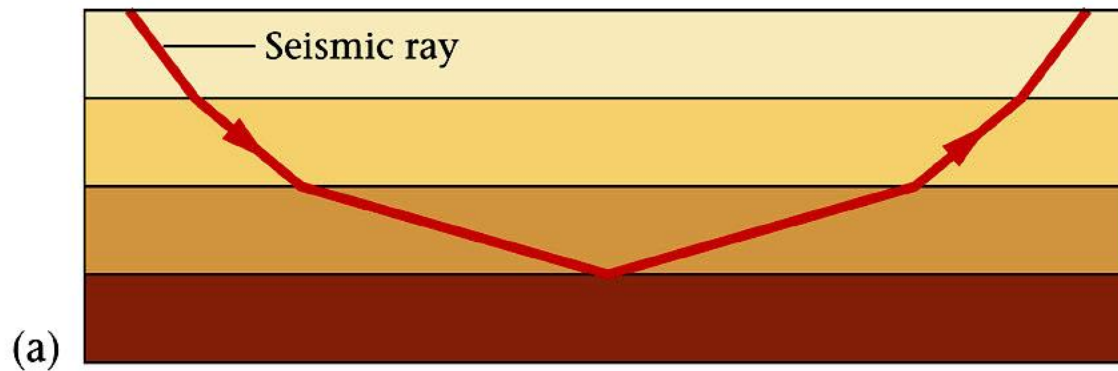


(b)

← Velocity in crust  
← Velocity in mantle

FIGURE C.6

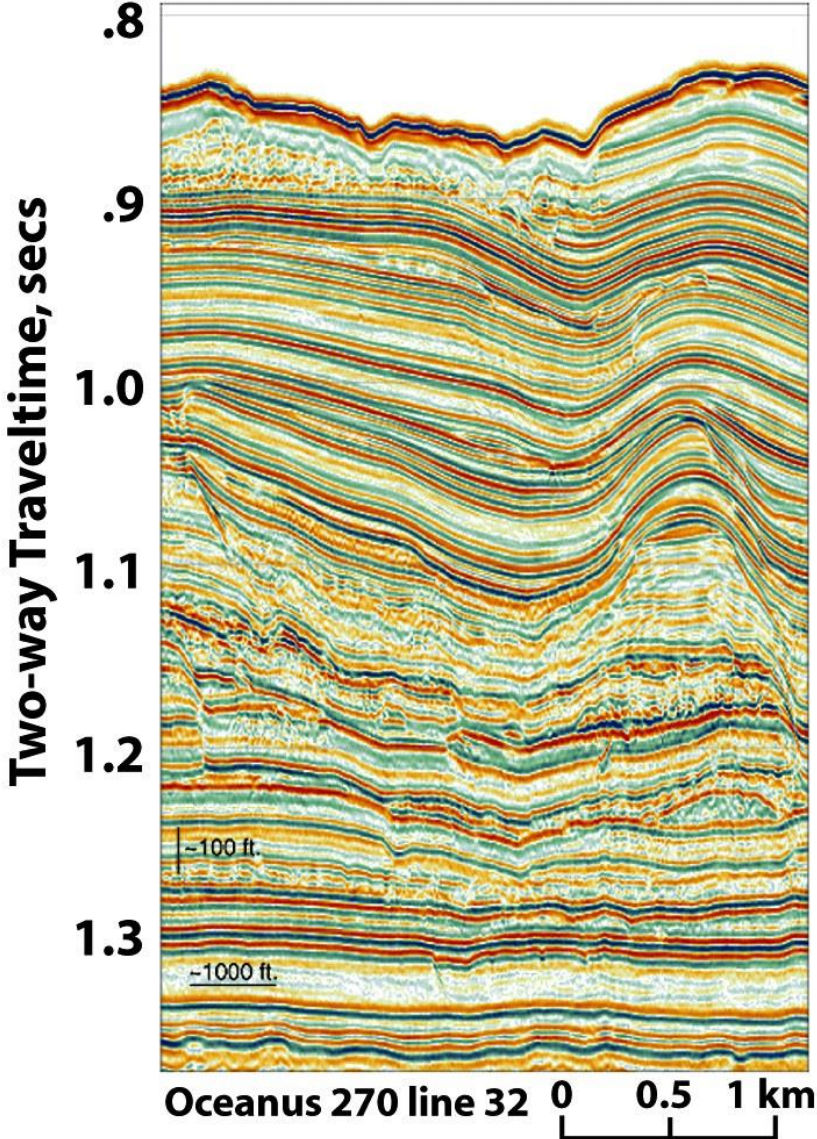




Curved rays in a mantle whose density increases gradually with depth

FIGURE C.8

# Seismic mapping





# Internal structure of the Earth

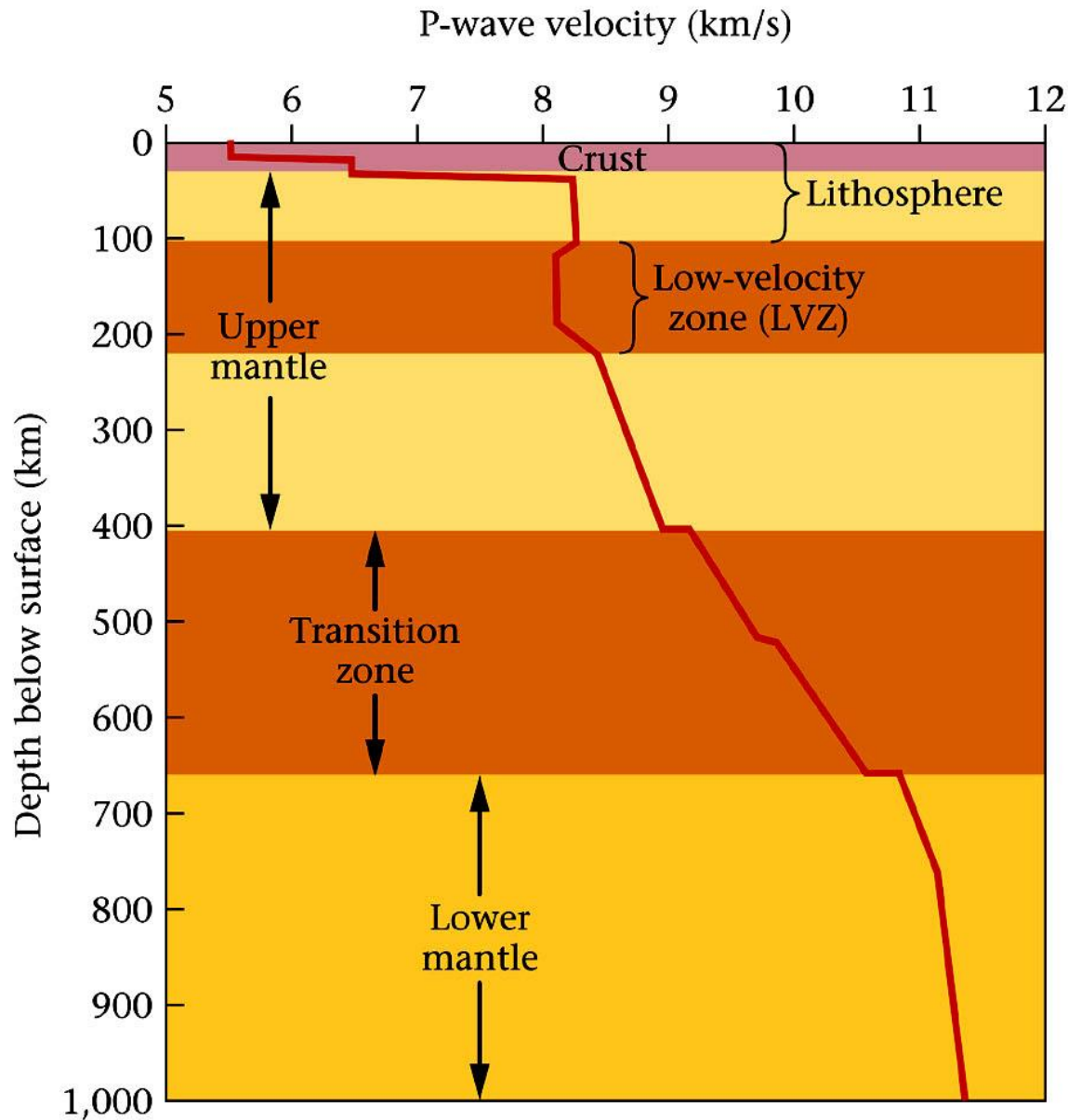


FIGURE C.7

# Internal structure of the Earth

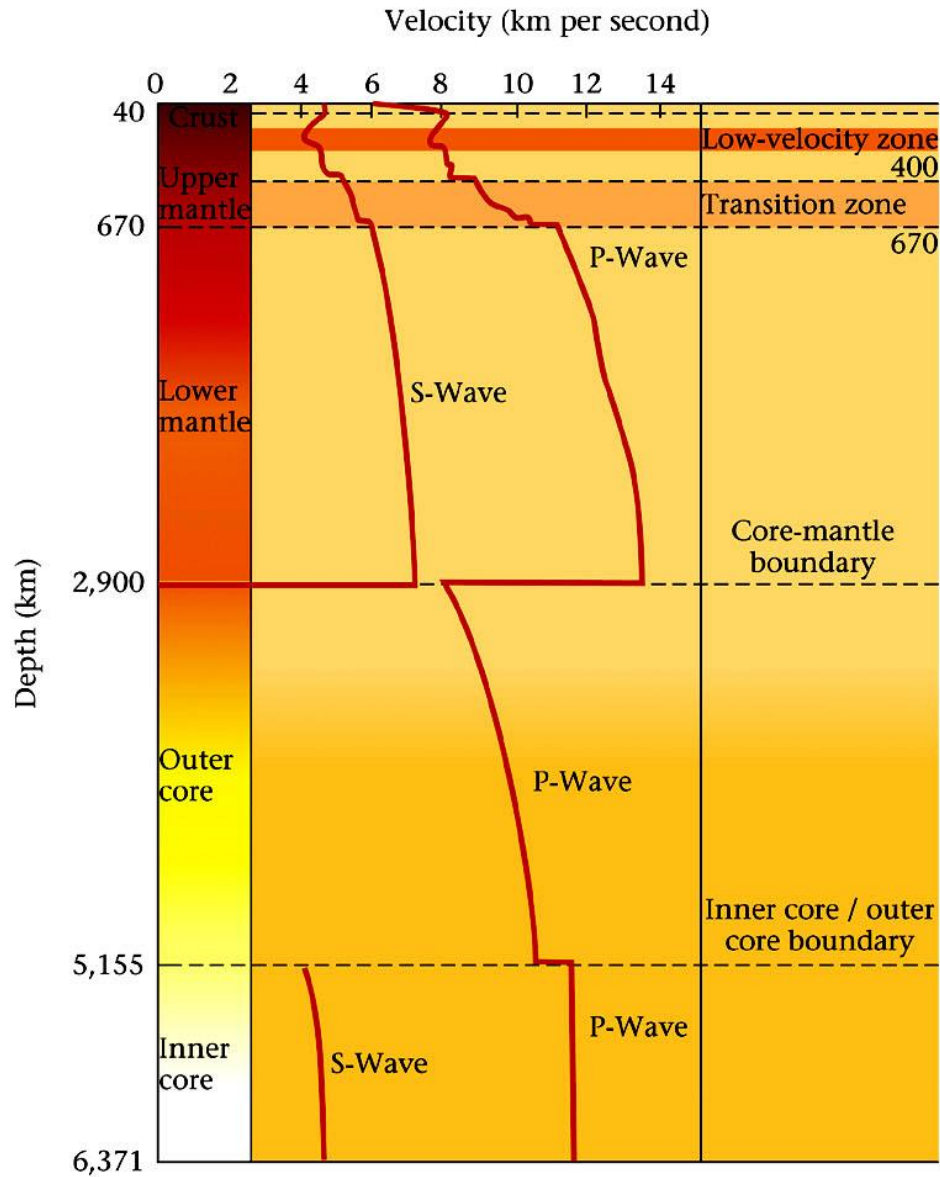


FIGURE C.14



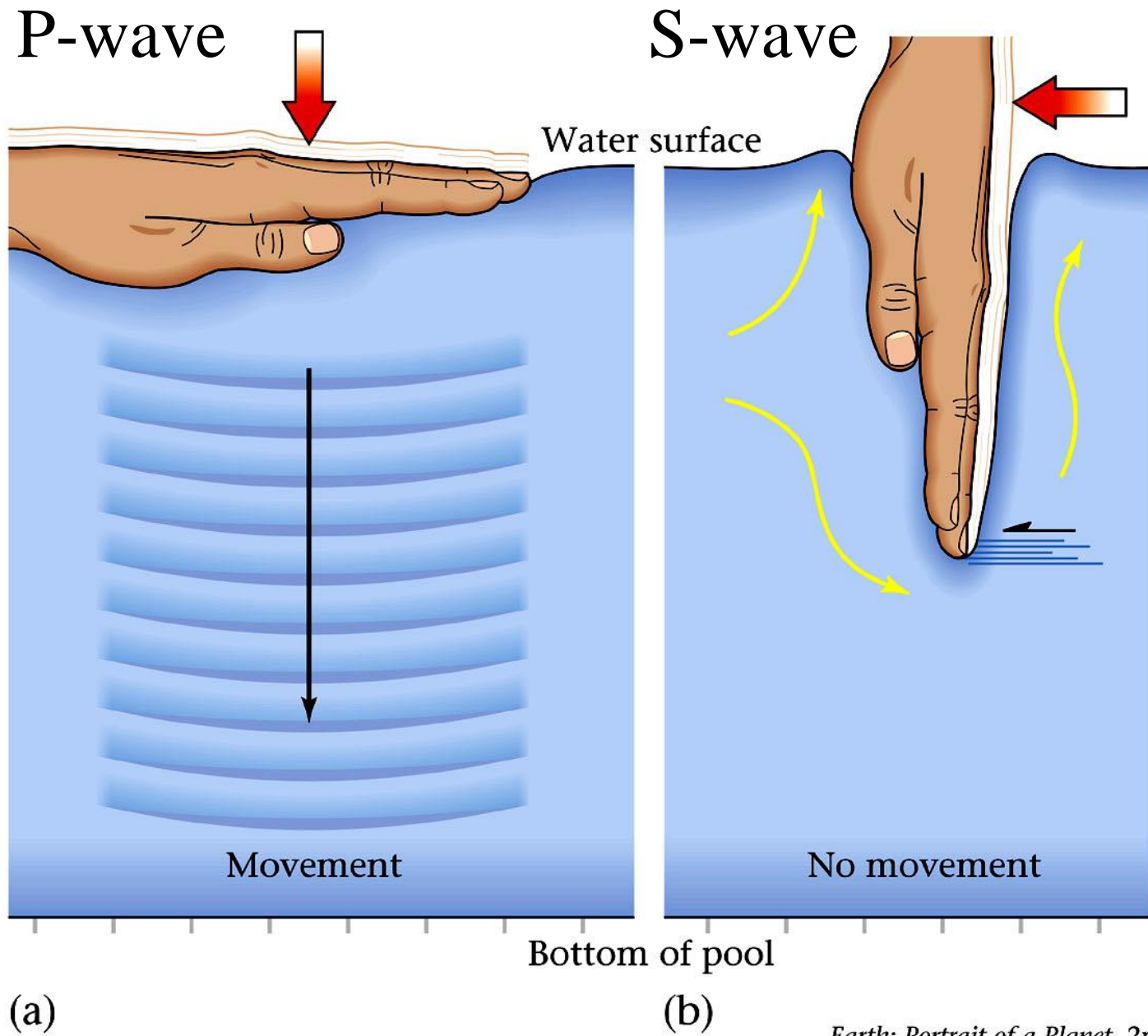


FIGURE C.4

# Evidence for a liquid core: P-wave behaviour

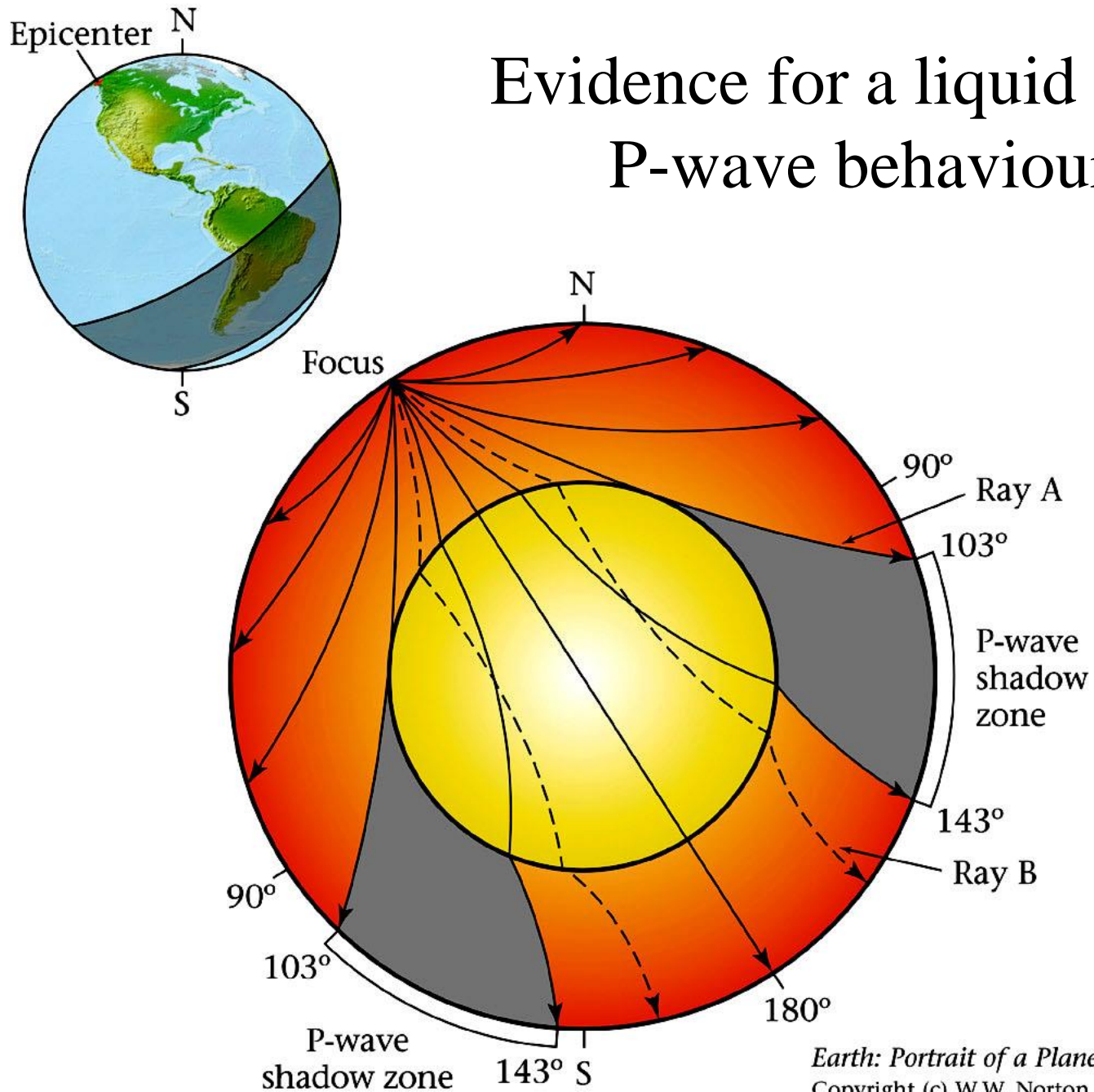
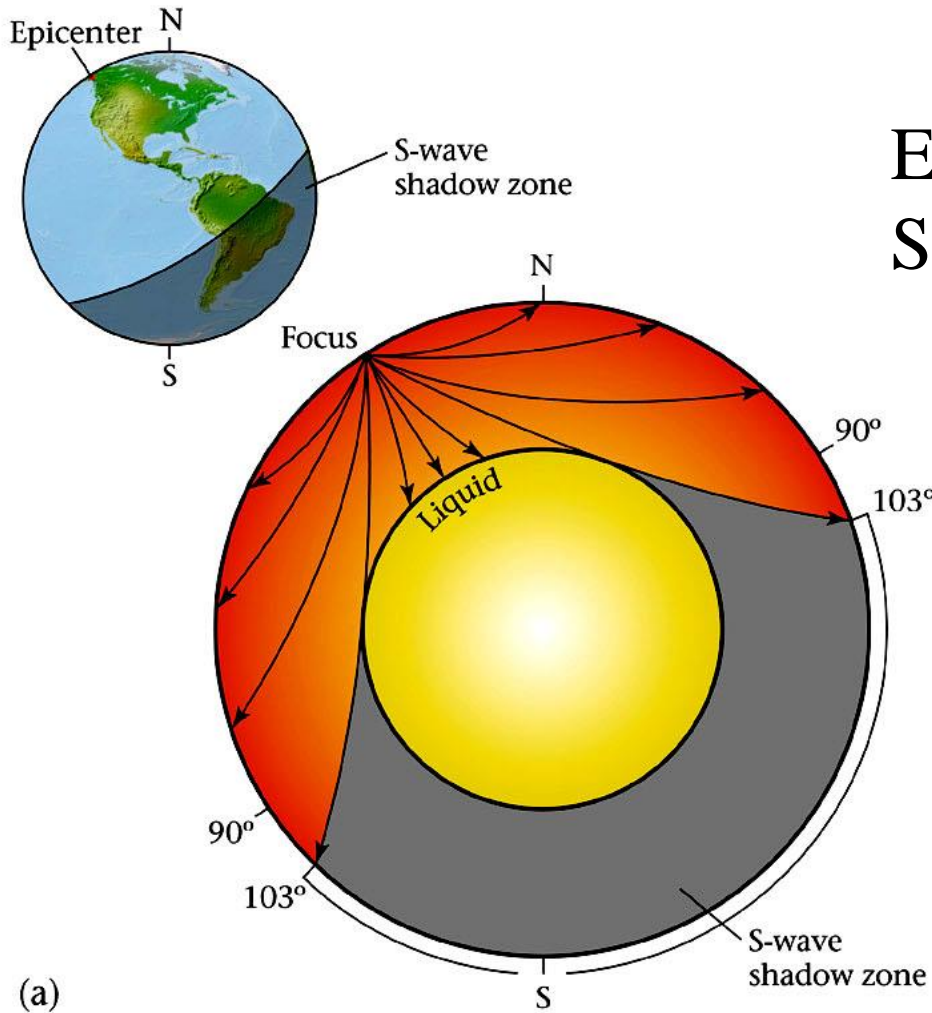


FIGURE C.9

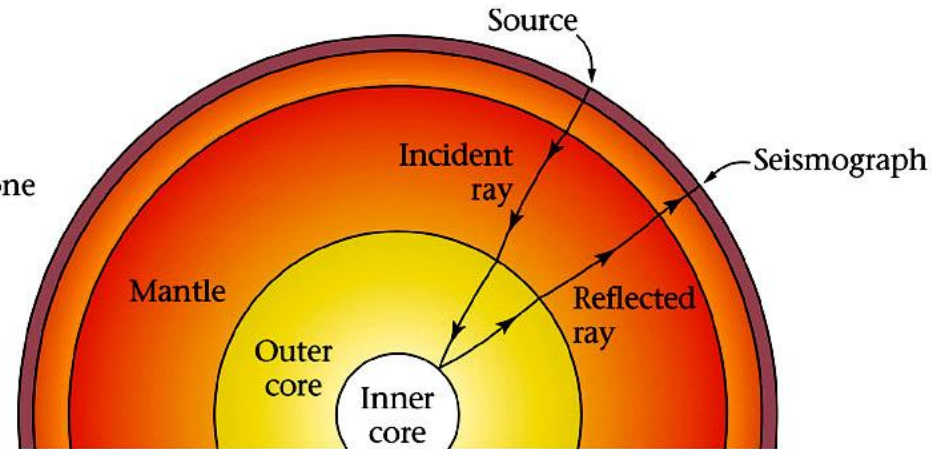




Evidence for a liquid core:  
S-wave behaviour

Seismic reflection:  
a solid inner core

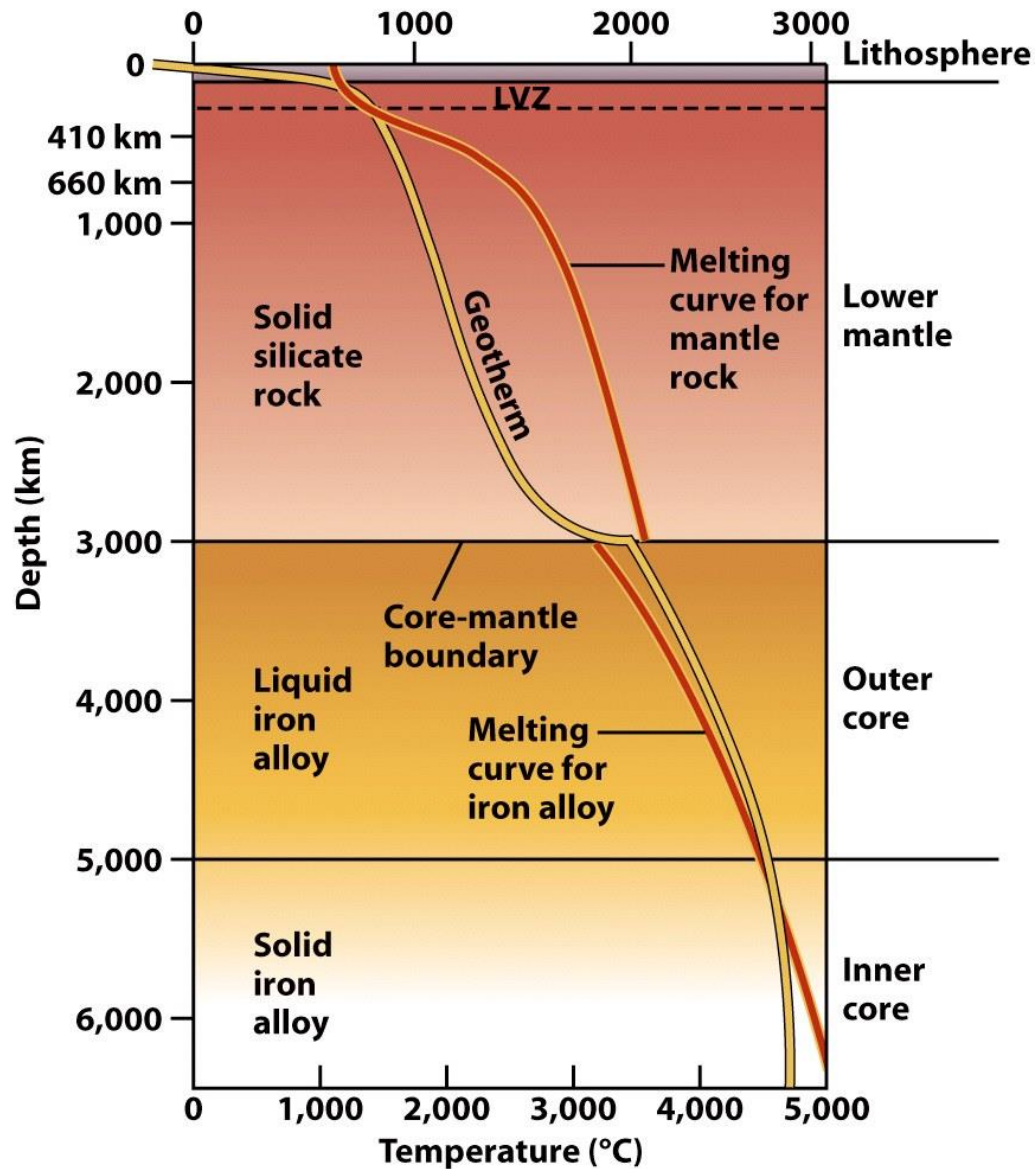
(a)



(b)

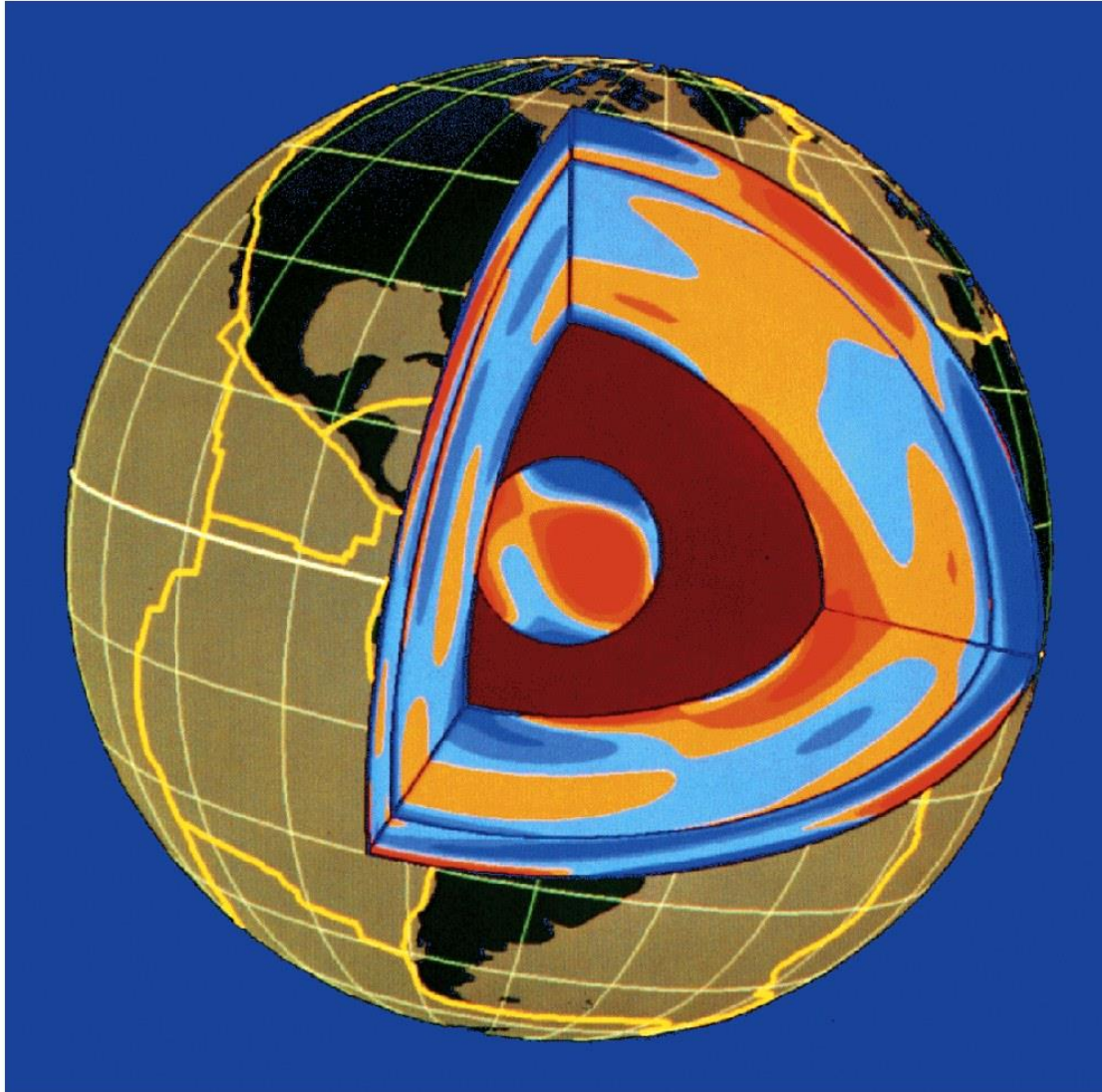
FIGURE C.10

# Geotherm and melting curve





# Seismic velocity model of Earth



Red = slow  
Blue = fast

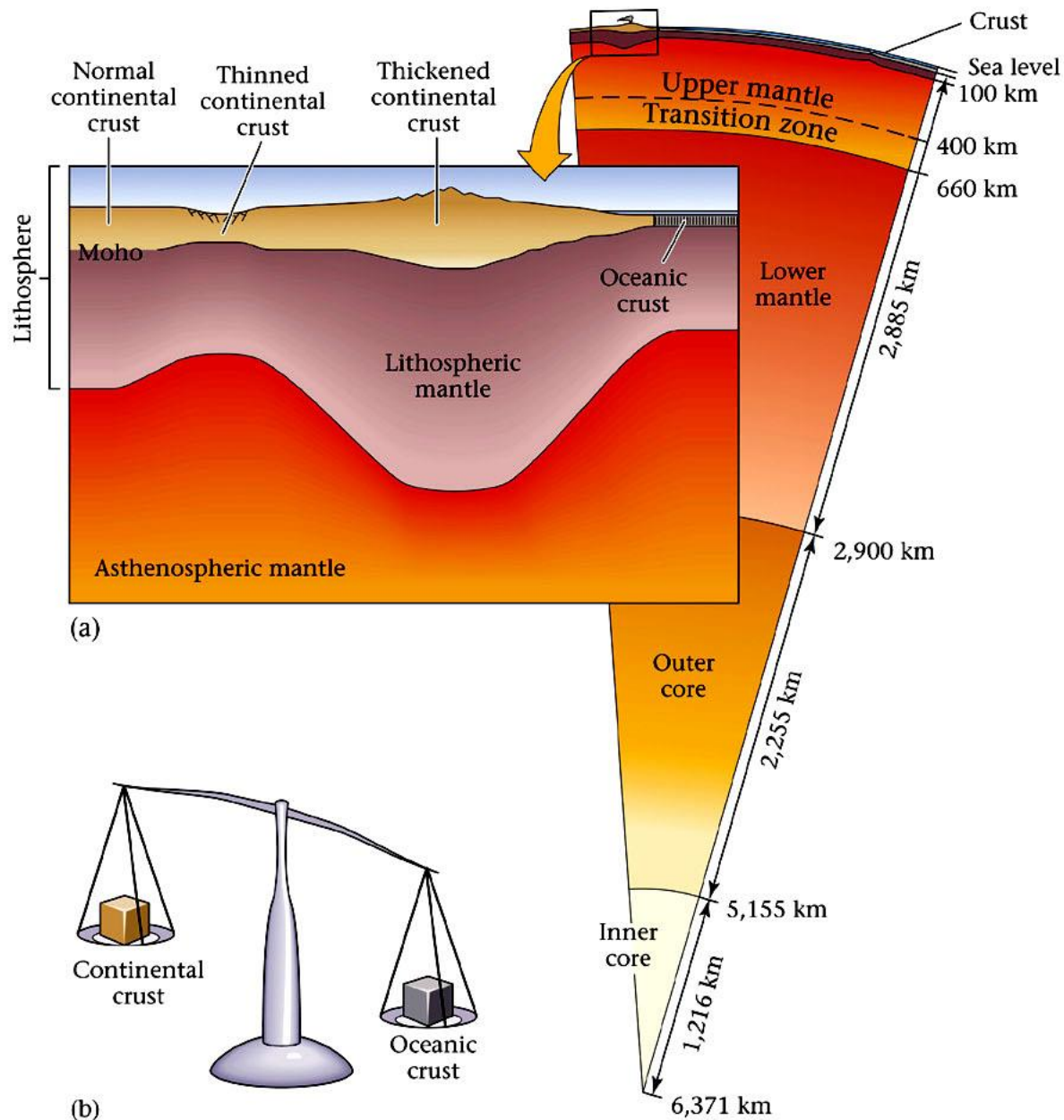


FIGURE 2.14