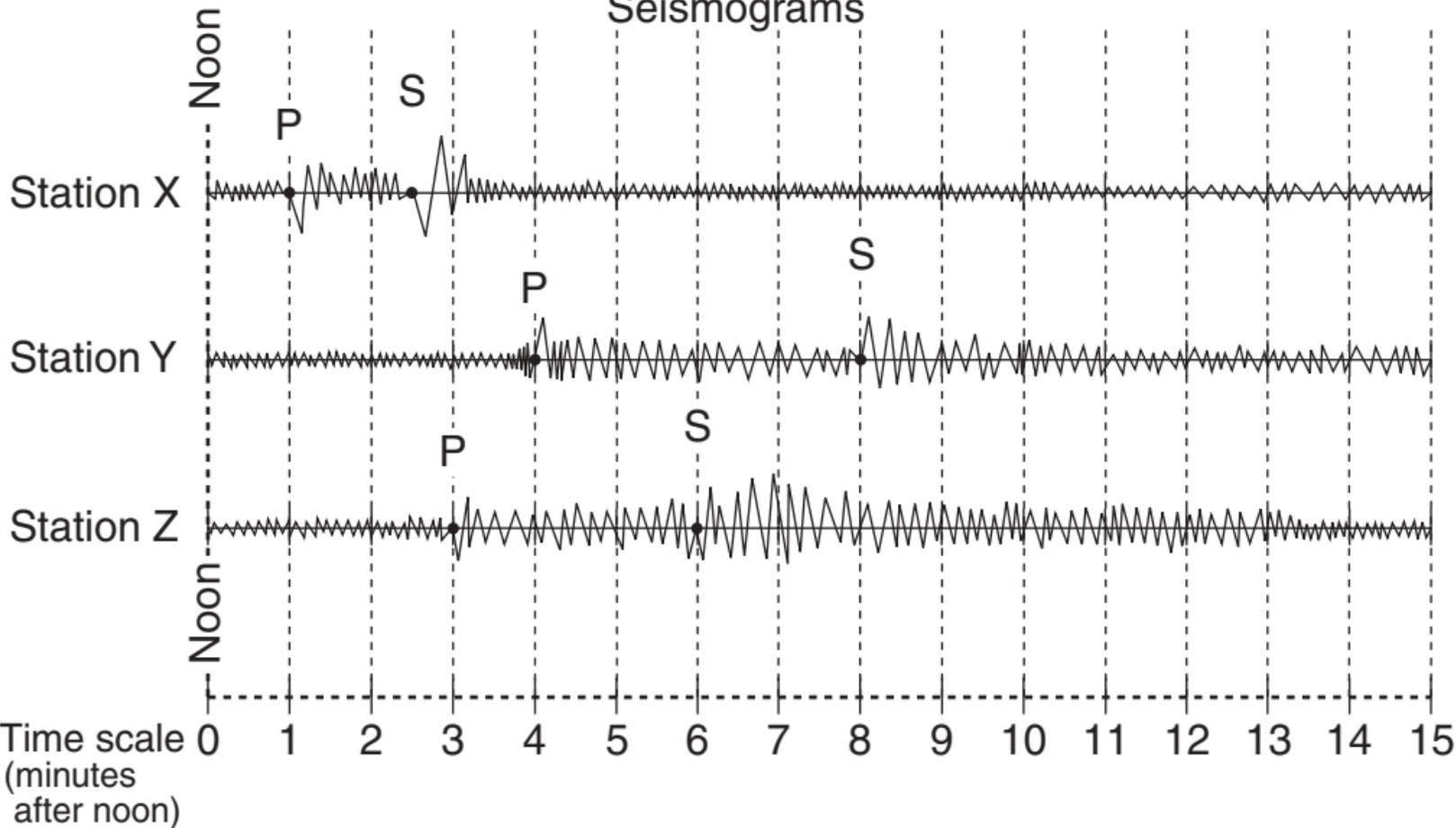
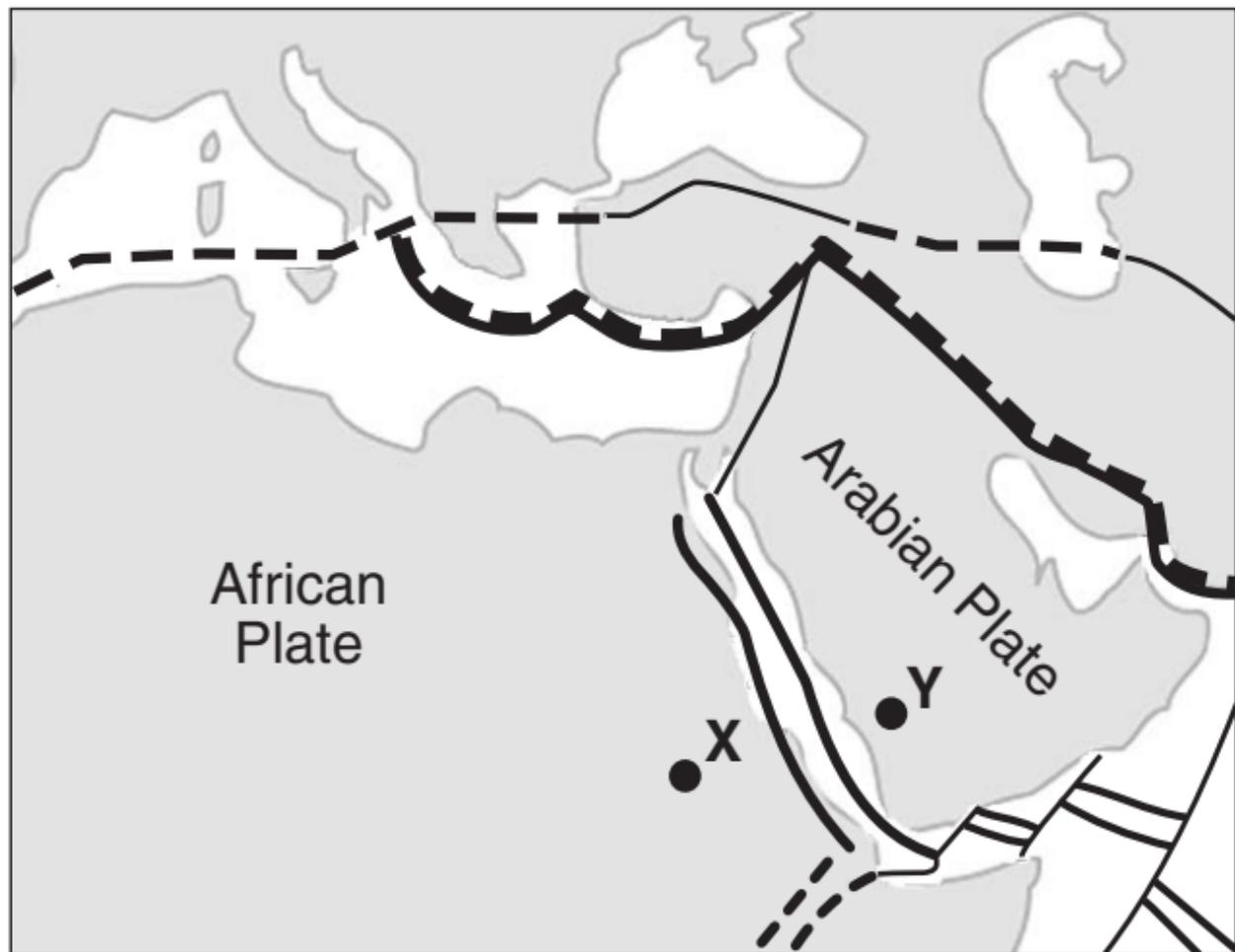


Seismograms

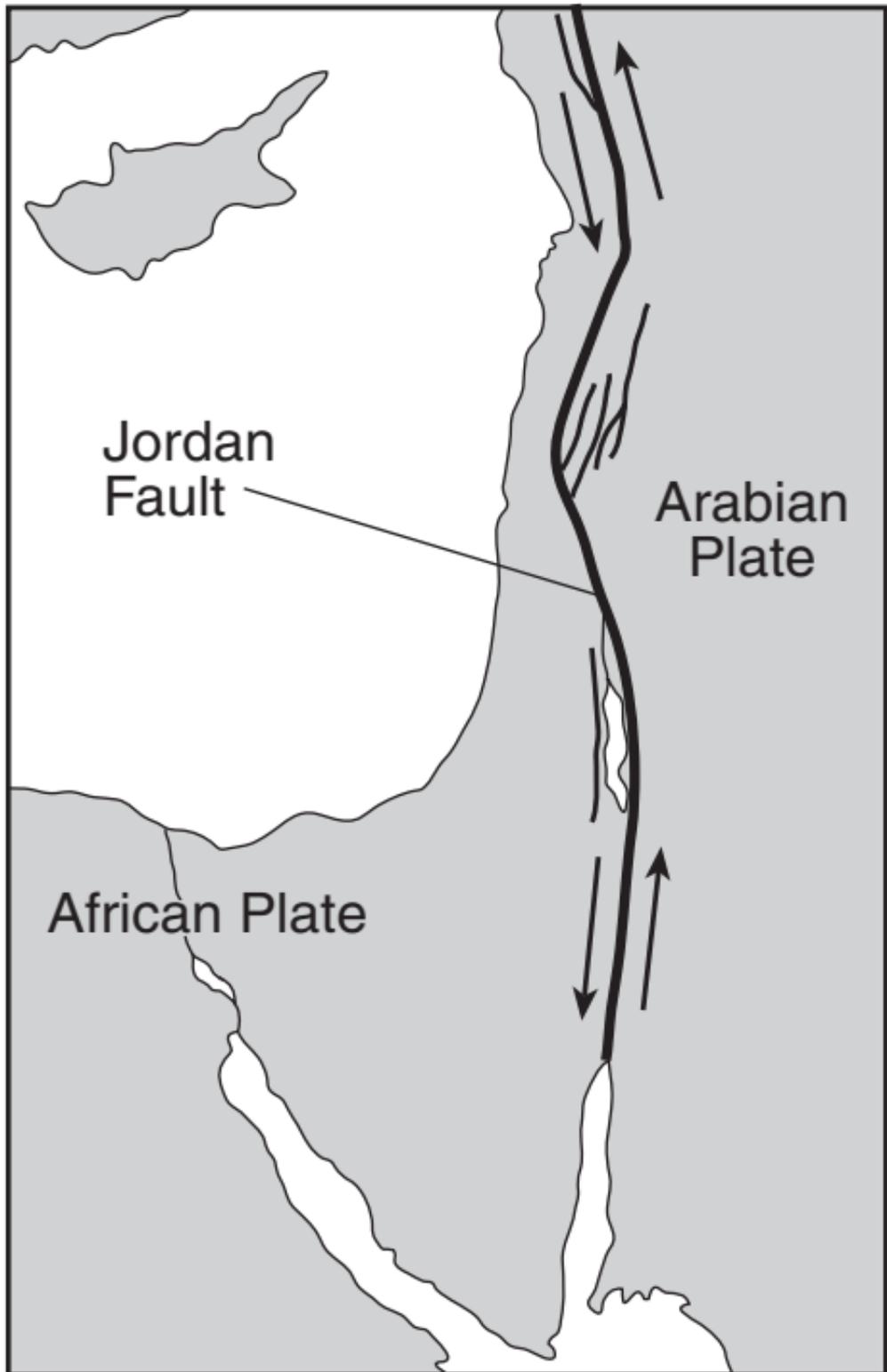


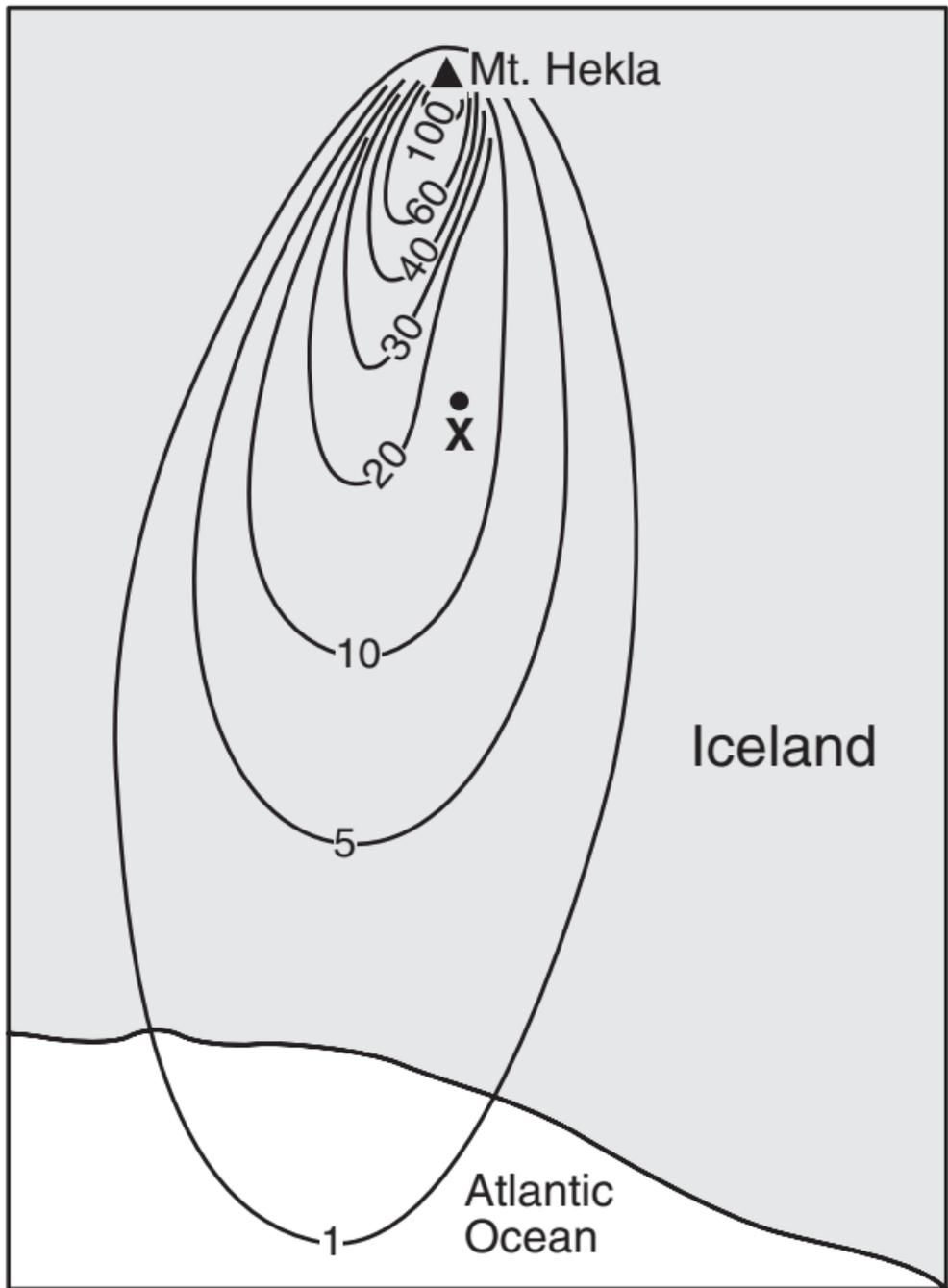


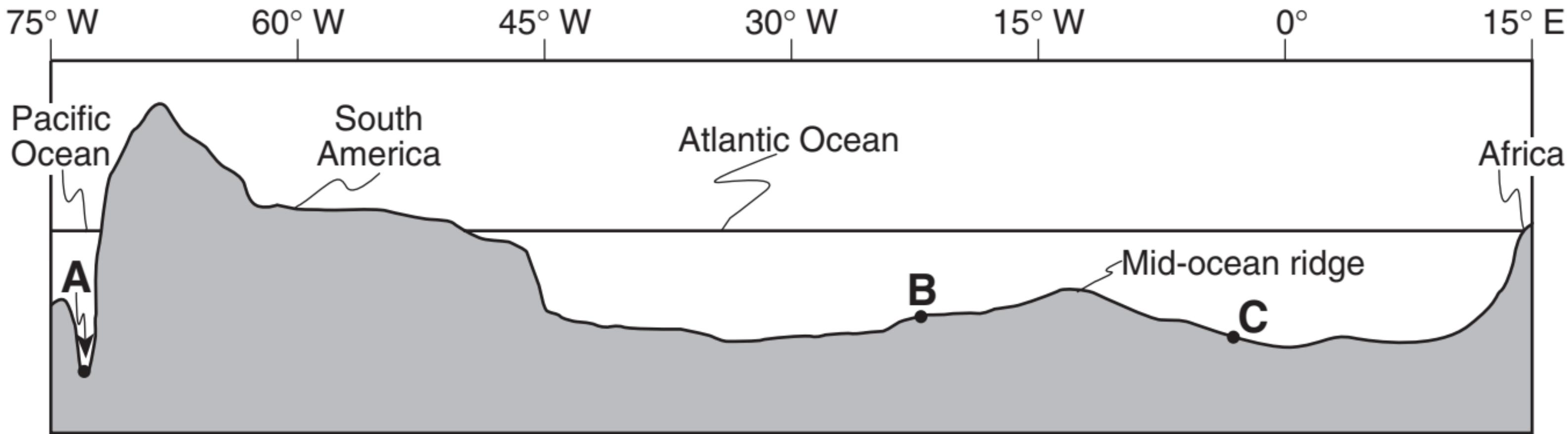
Jordan
Fault

Arabian
Plate

African
Plate

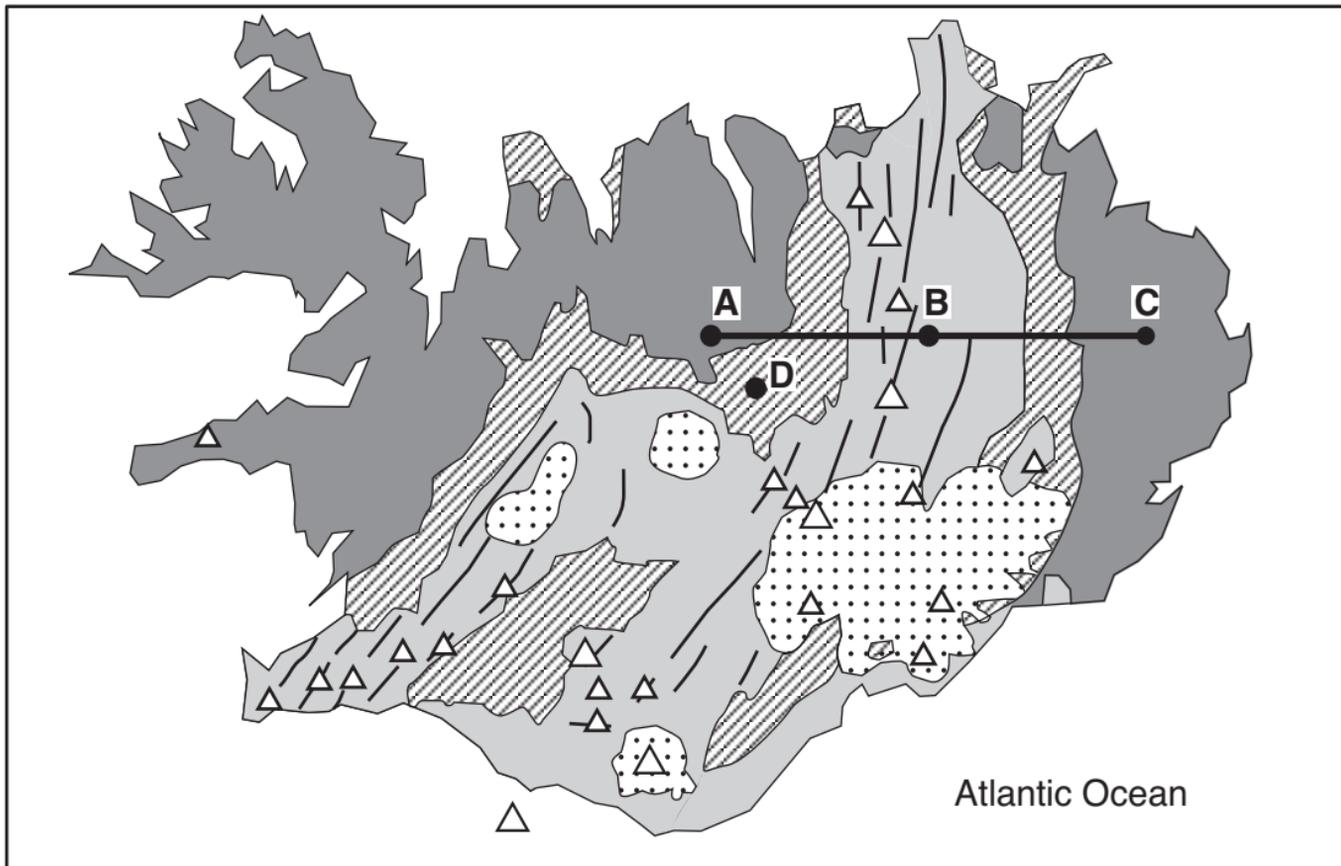


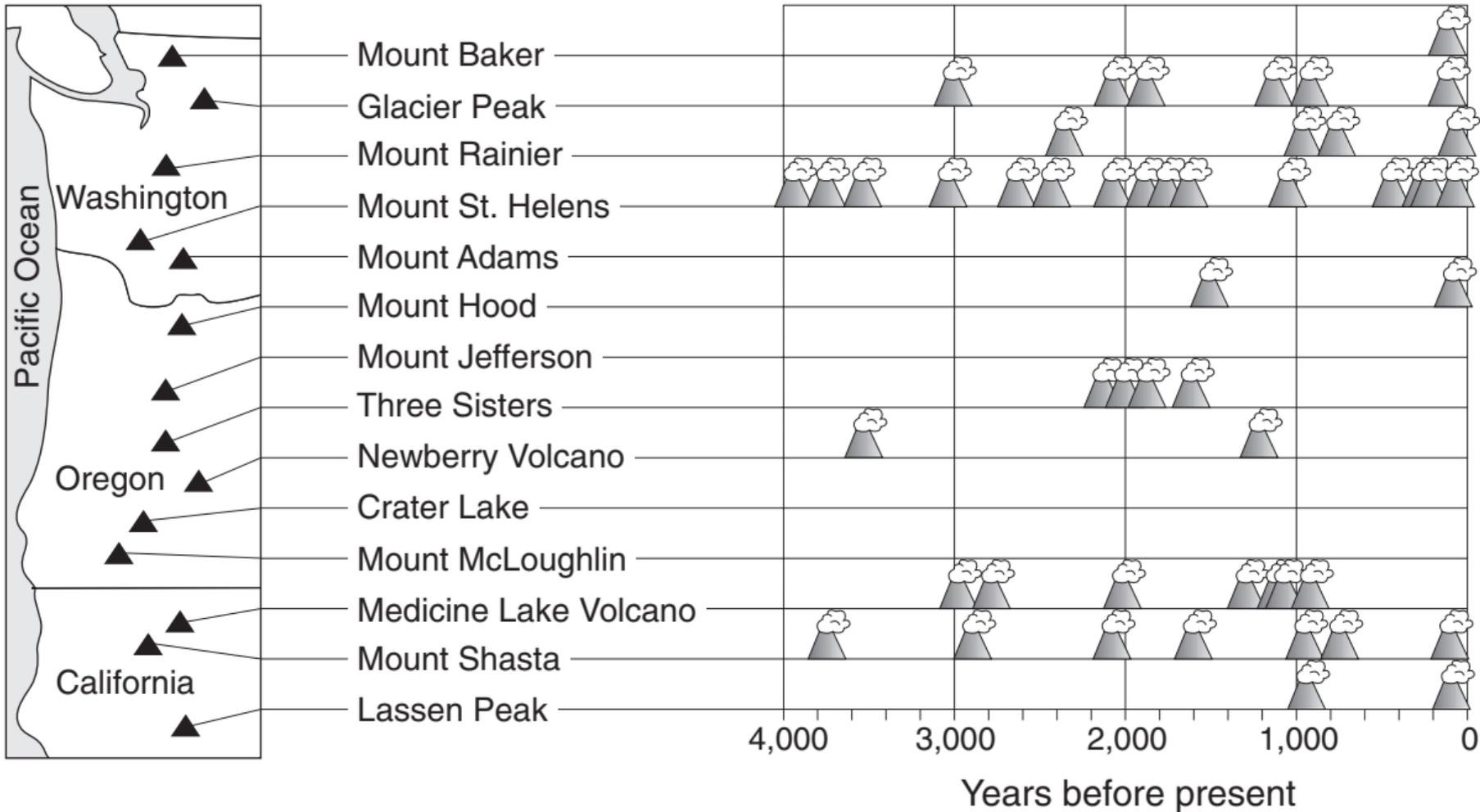




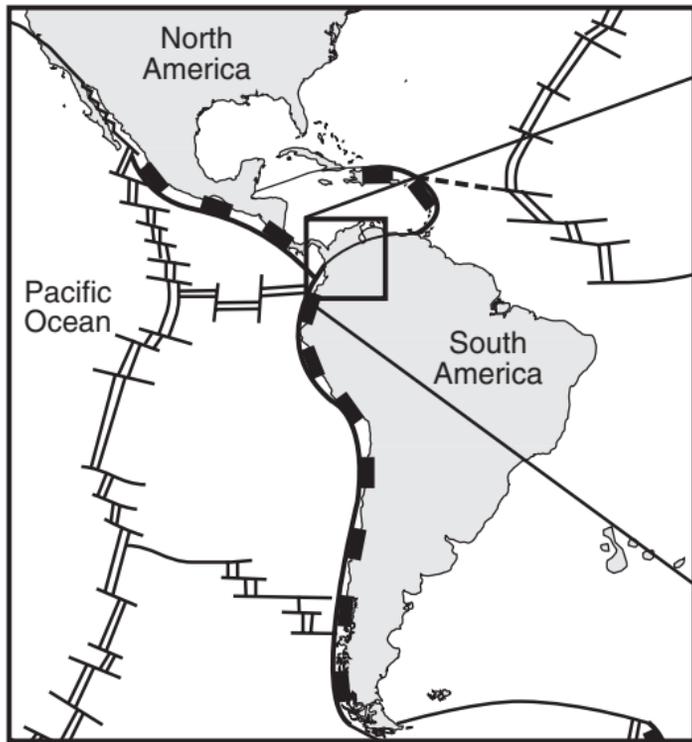
(Not drawn to scale)

Generalized Bedrock Map of Iceland

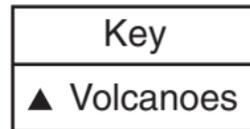
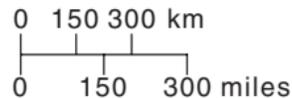


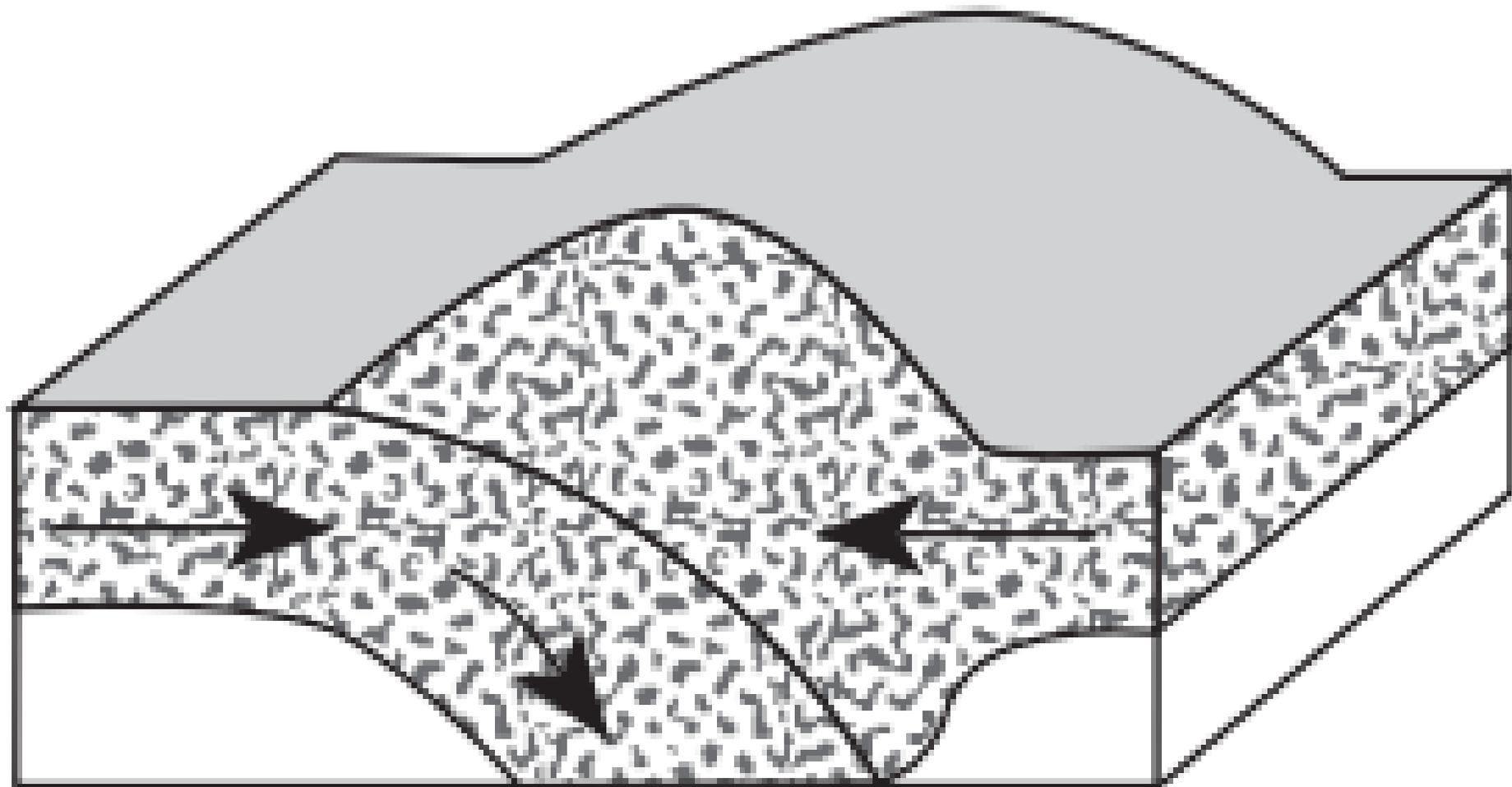


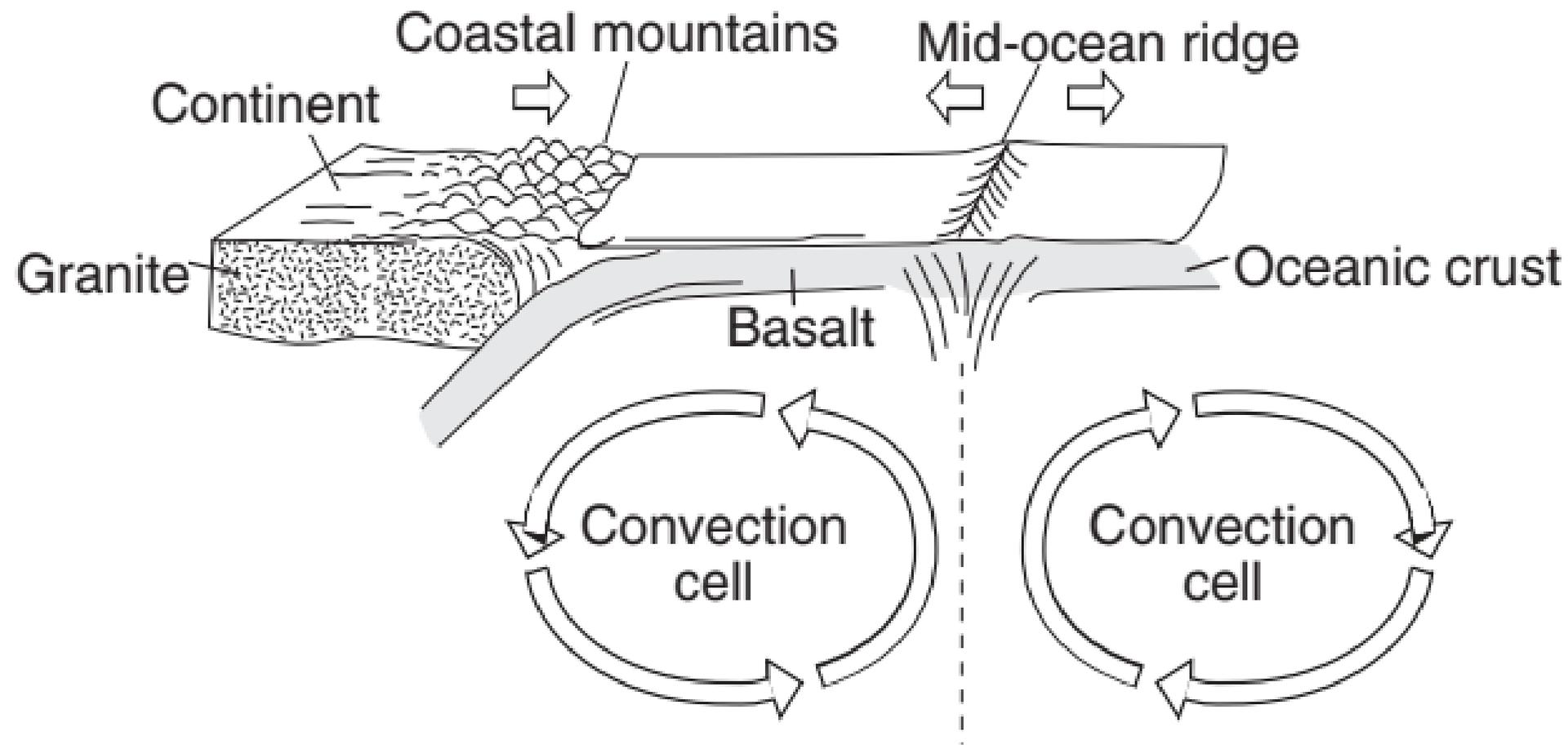
Locator Plate Map

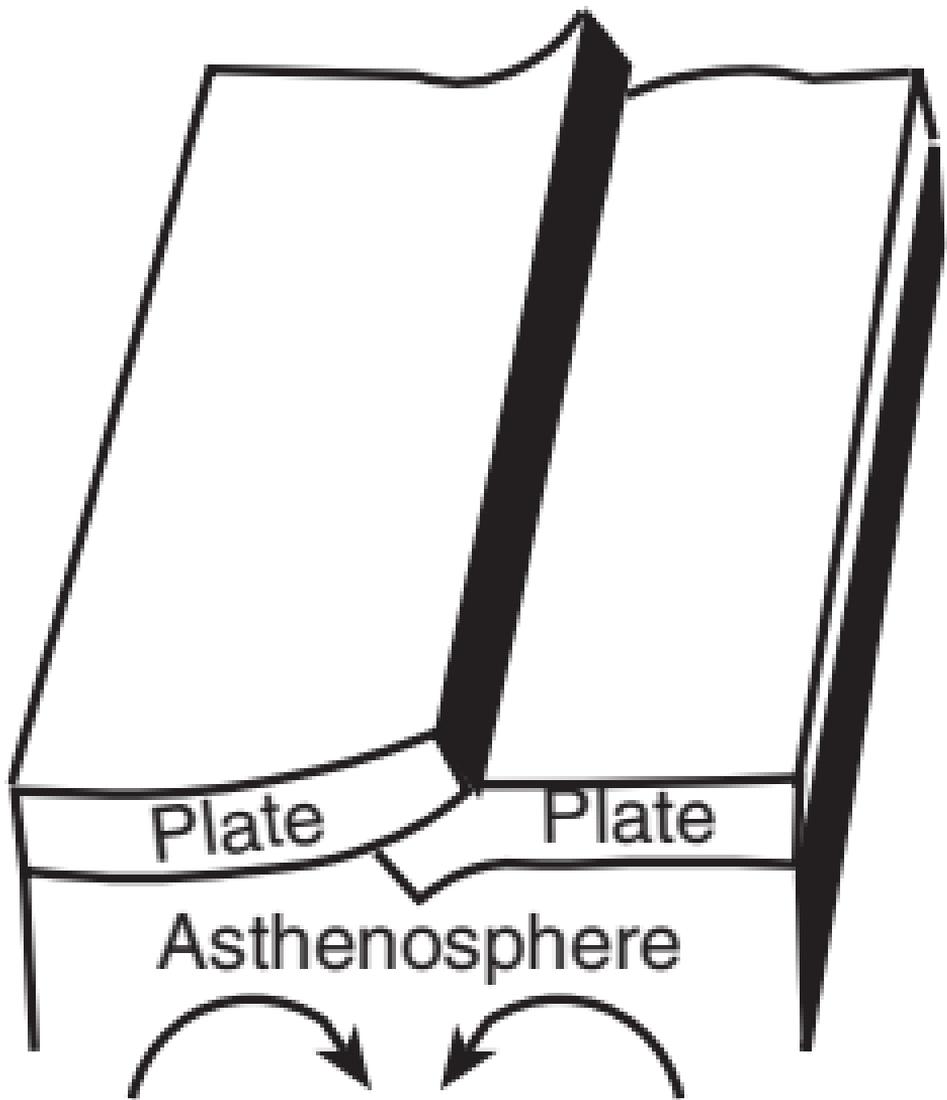


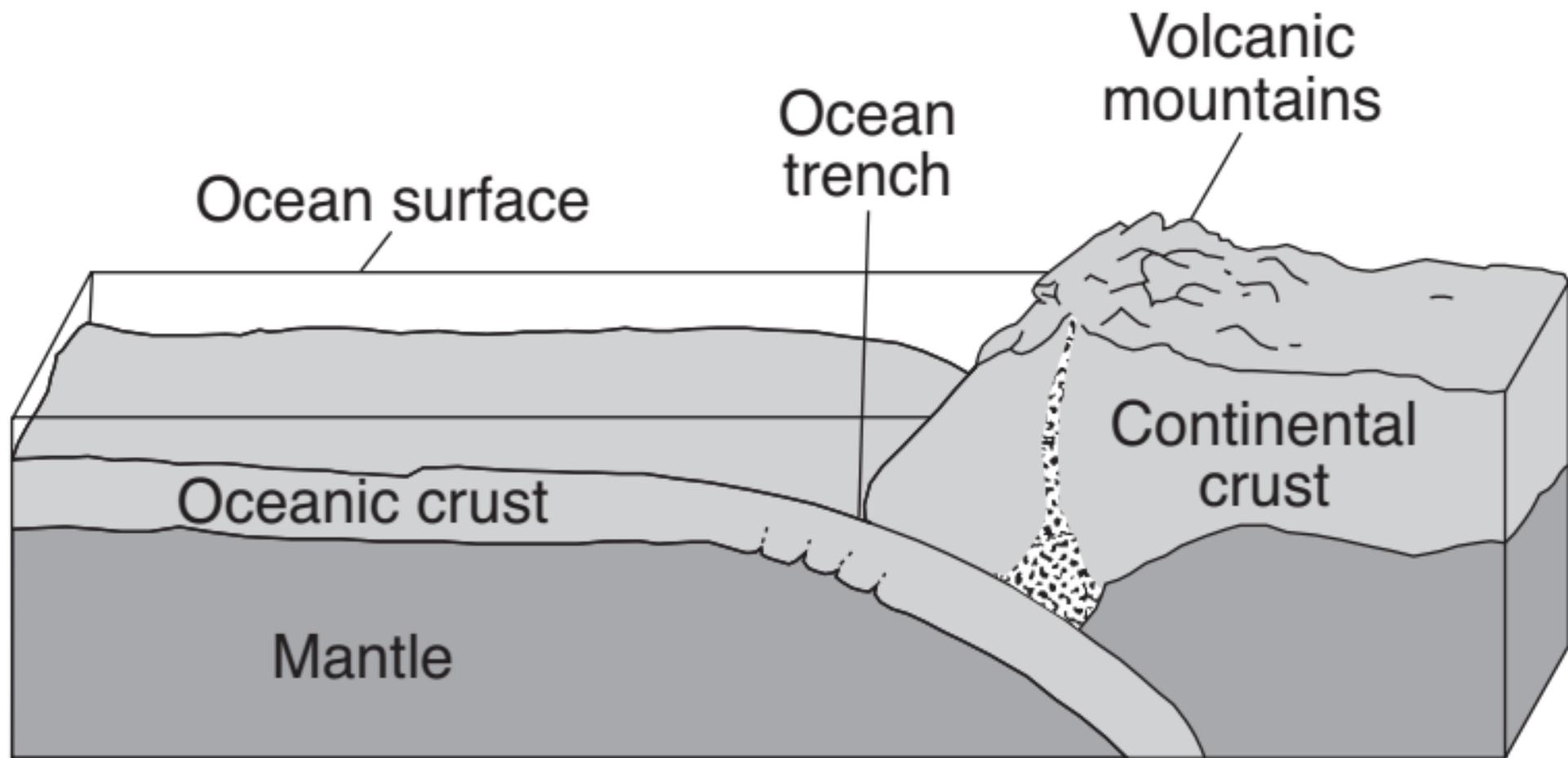
Enlarged Map Showing Volcanoes of Colombia

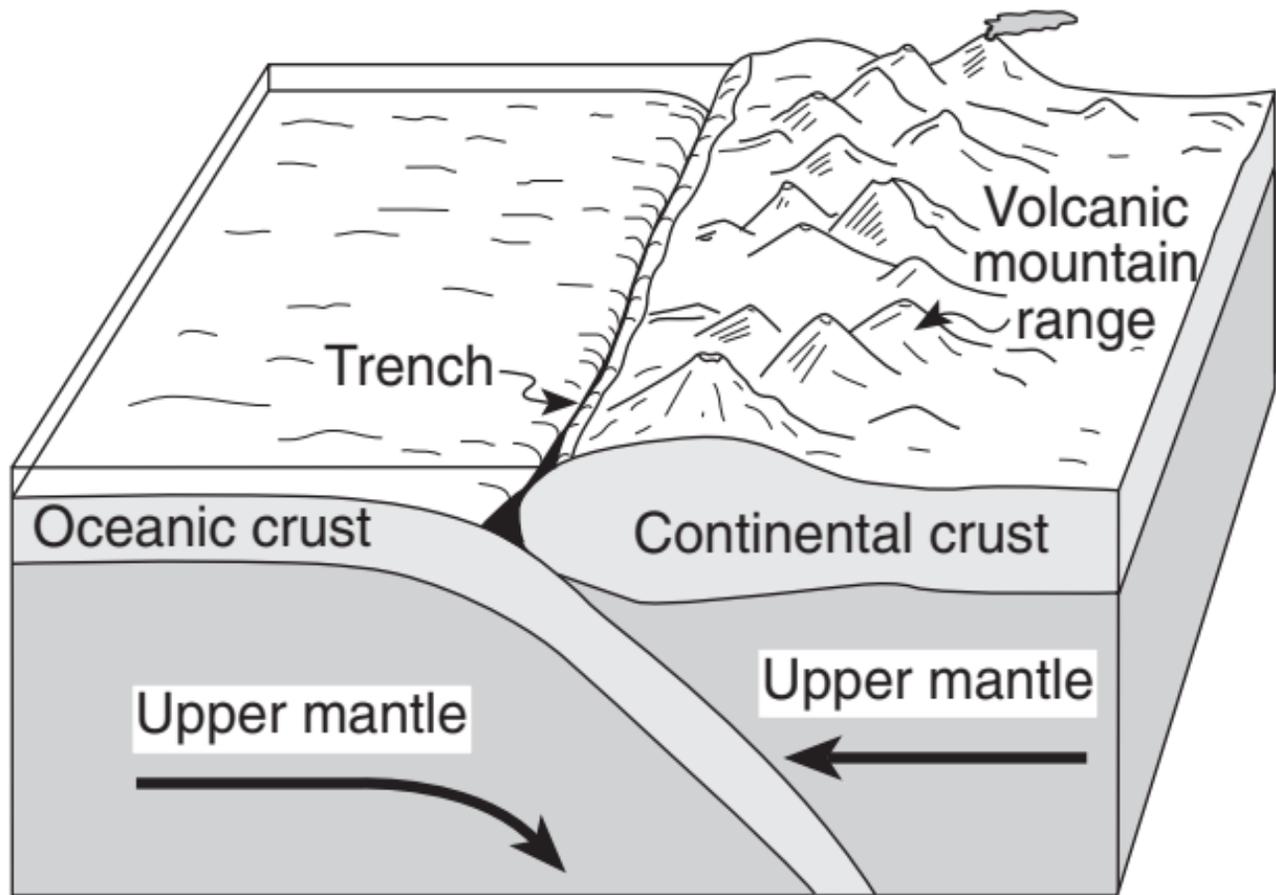




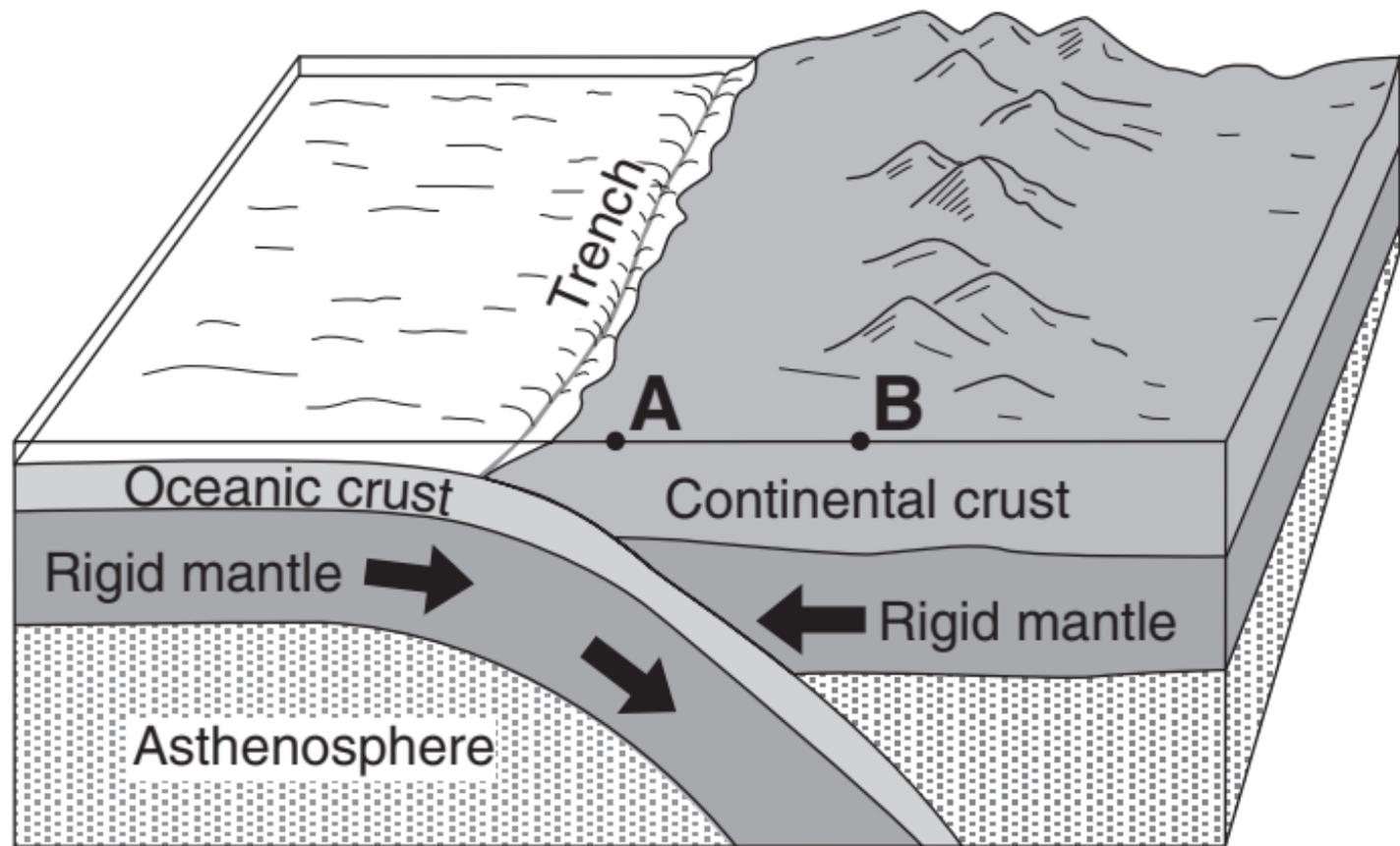






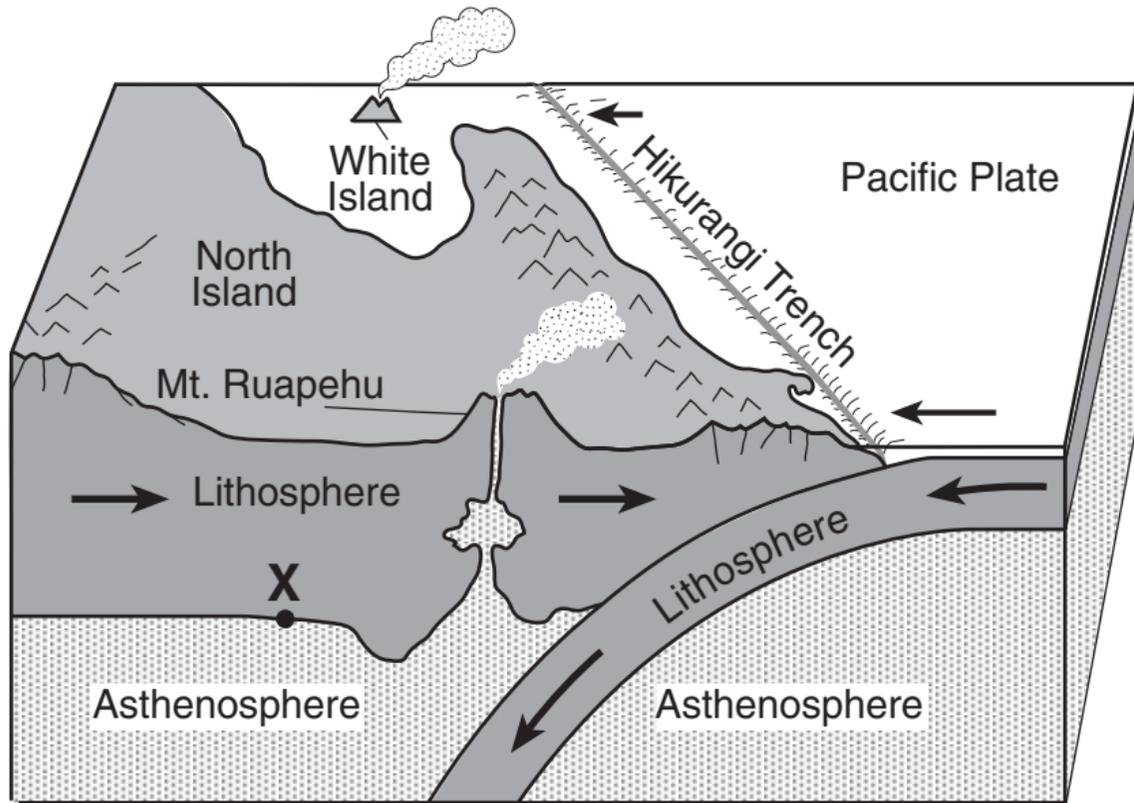


(Not drawn to scale)

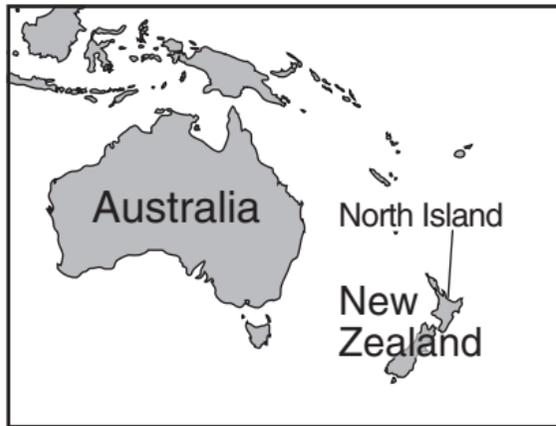


(Not drawn to scale)

Block Diagram

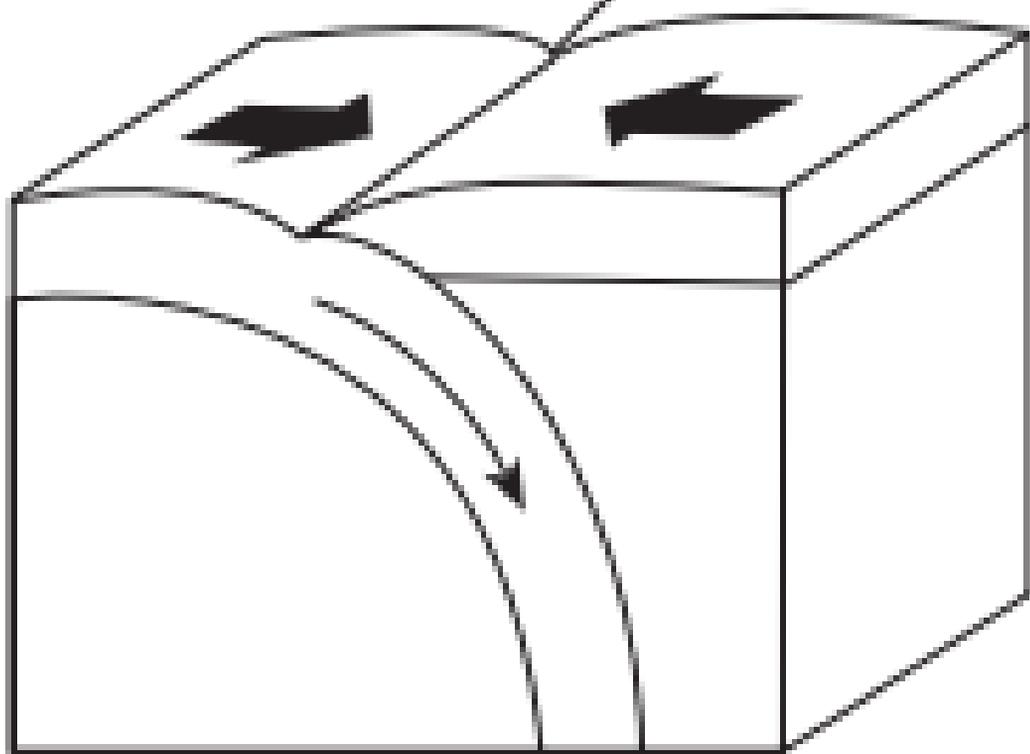


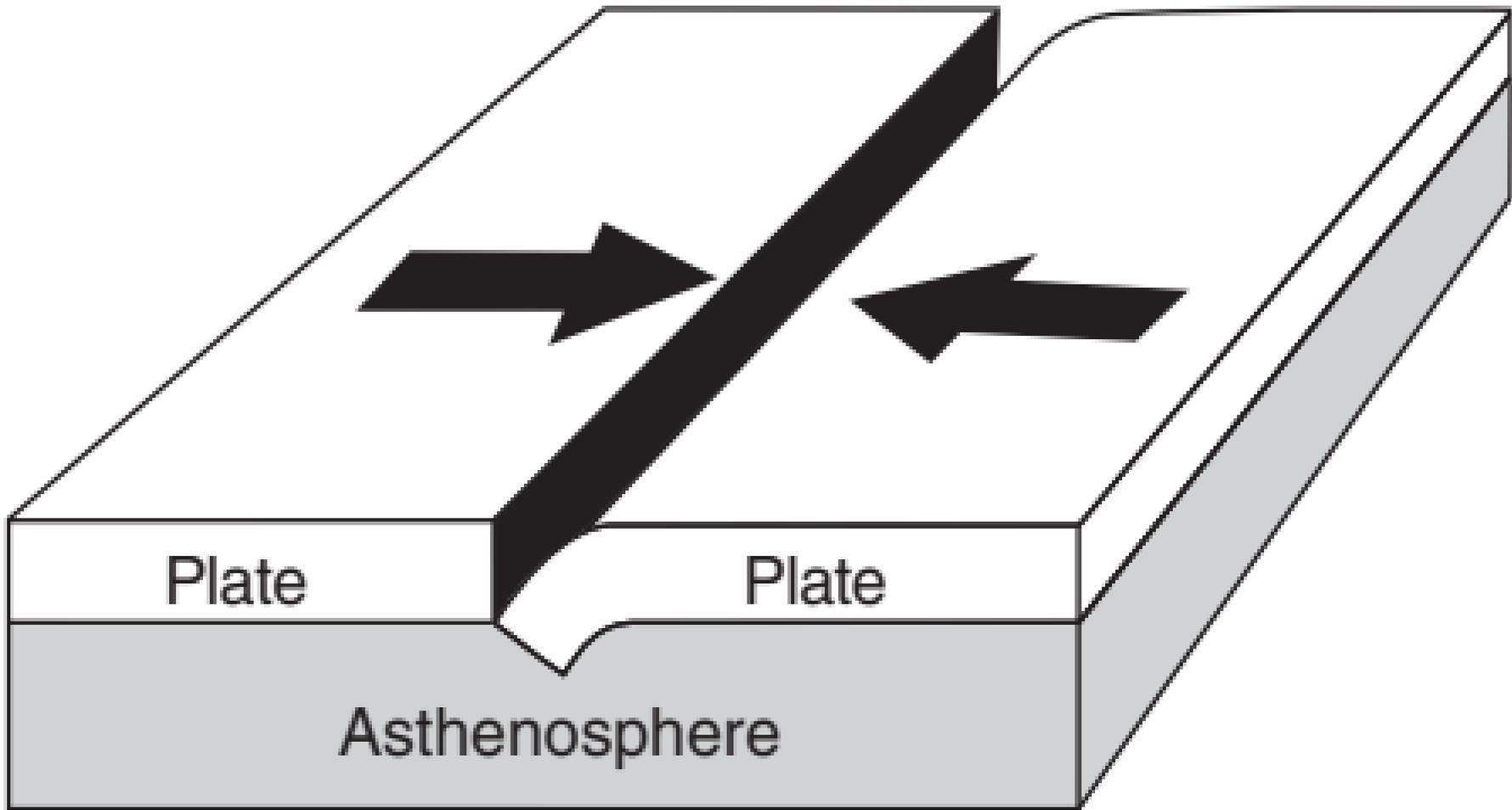
Map

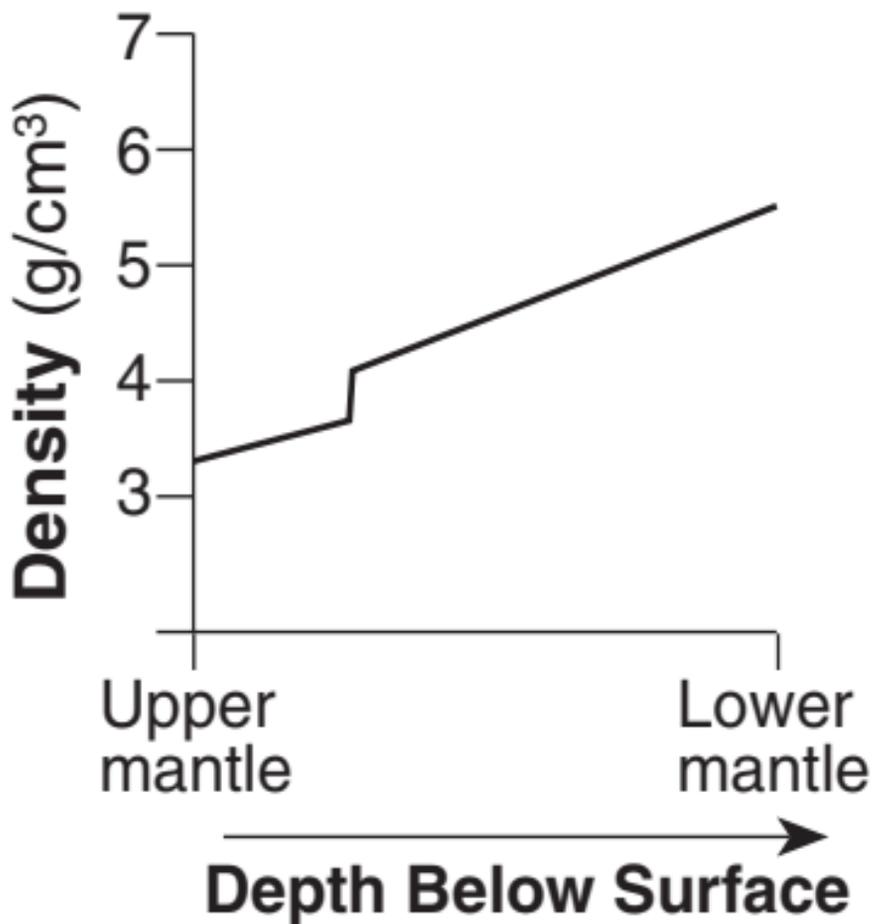


(Not drawn to scale)

Trench





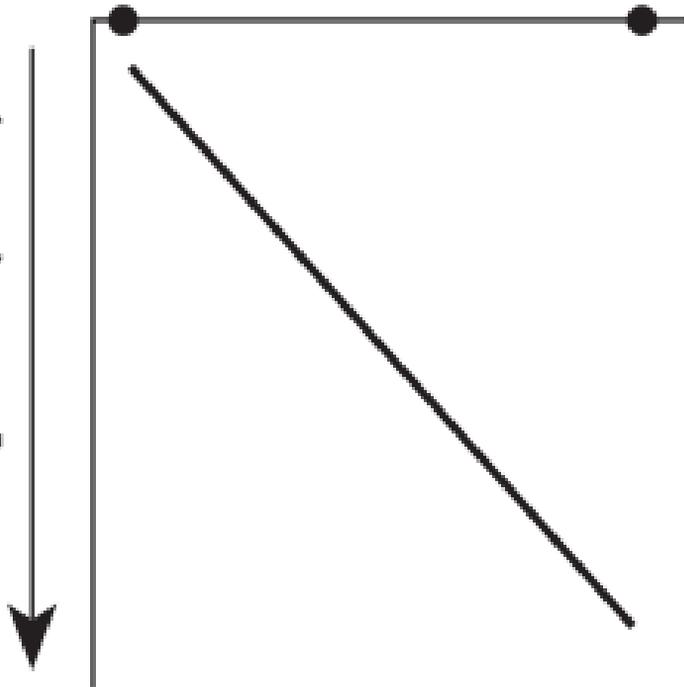


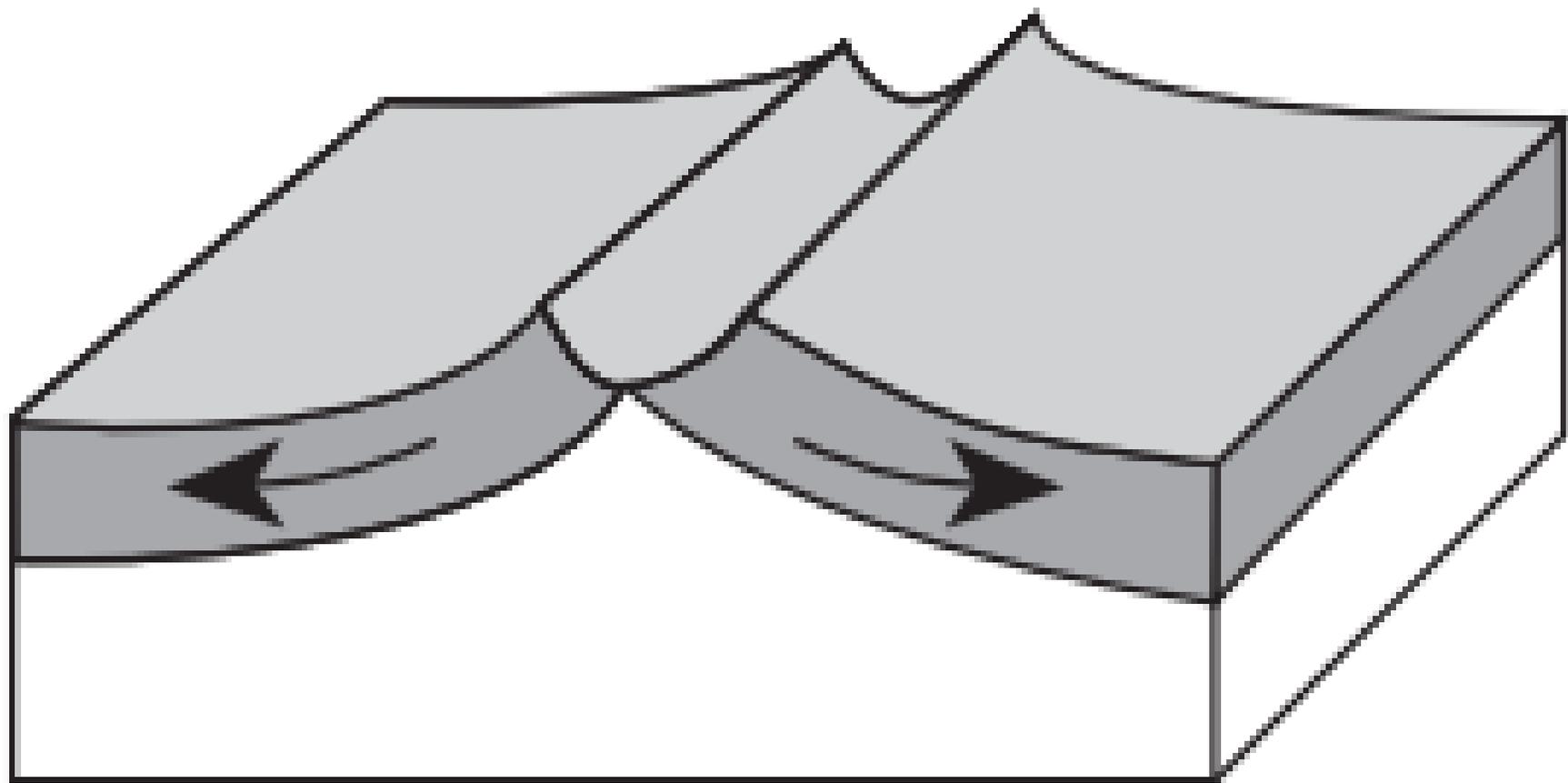
Earth's Surface

A

B

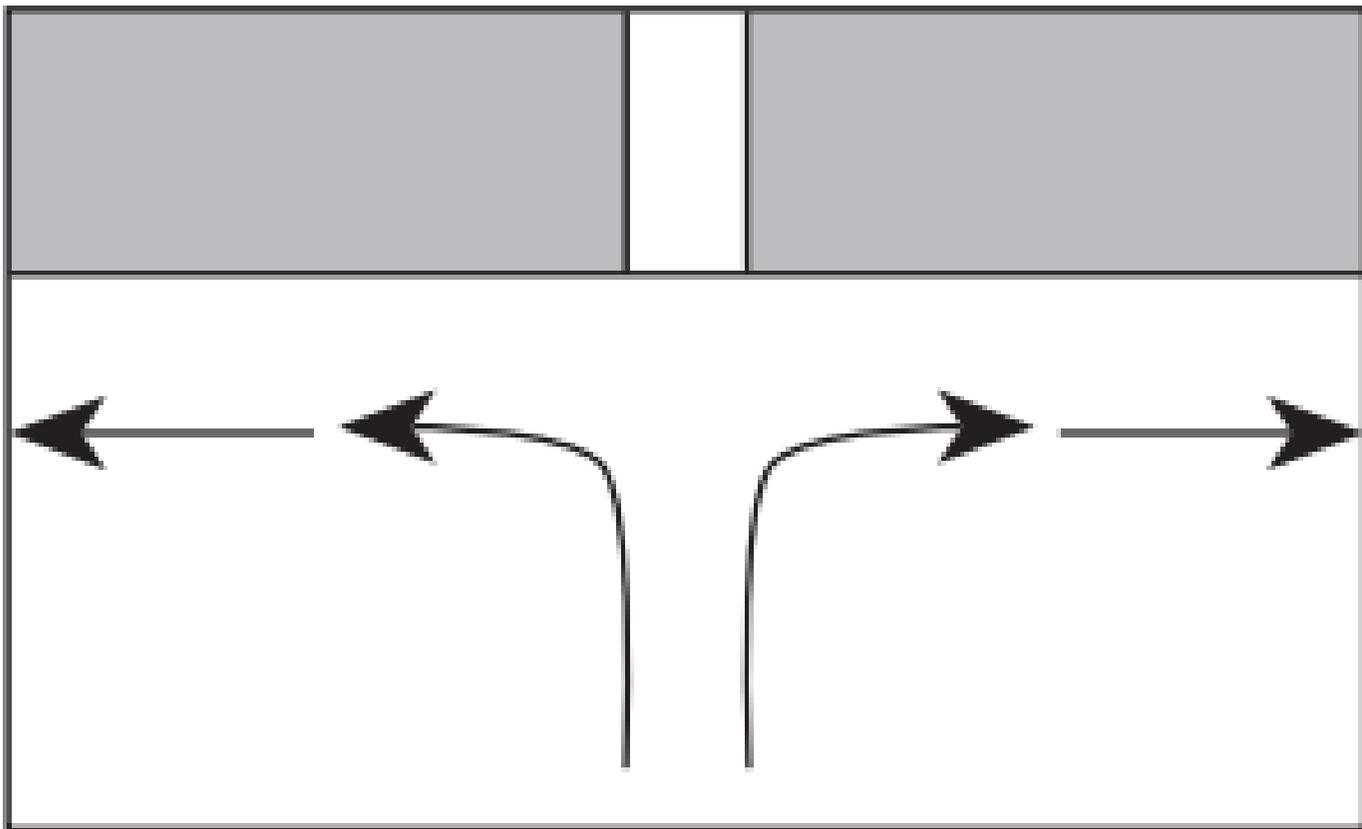
Depth (km)



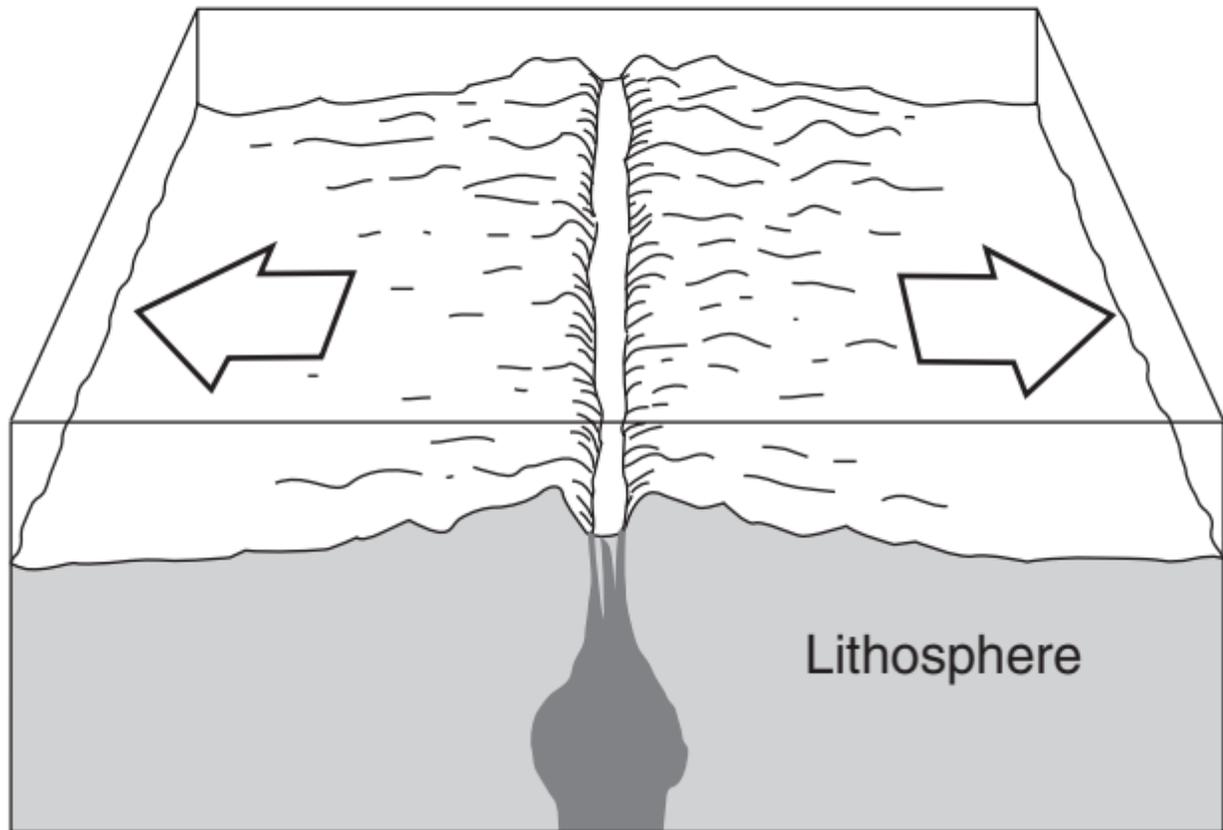


X

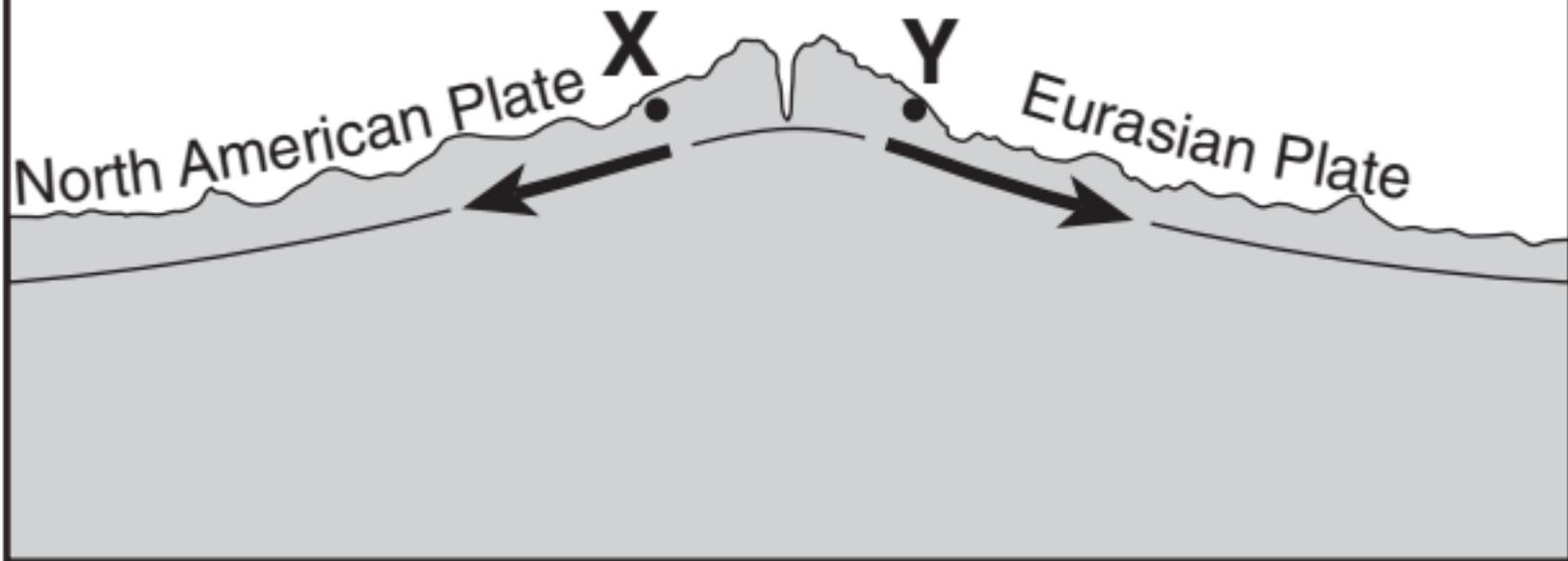
Y



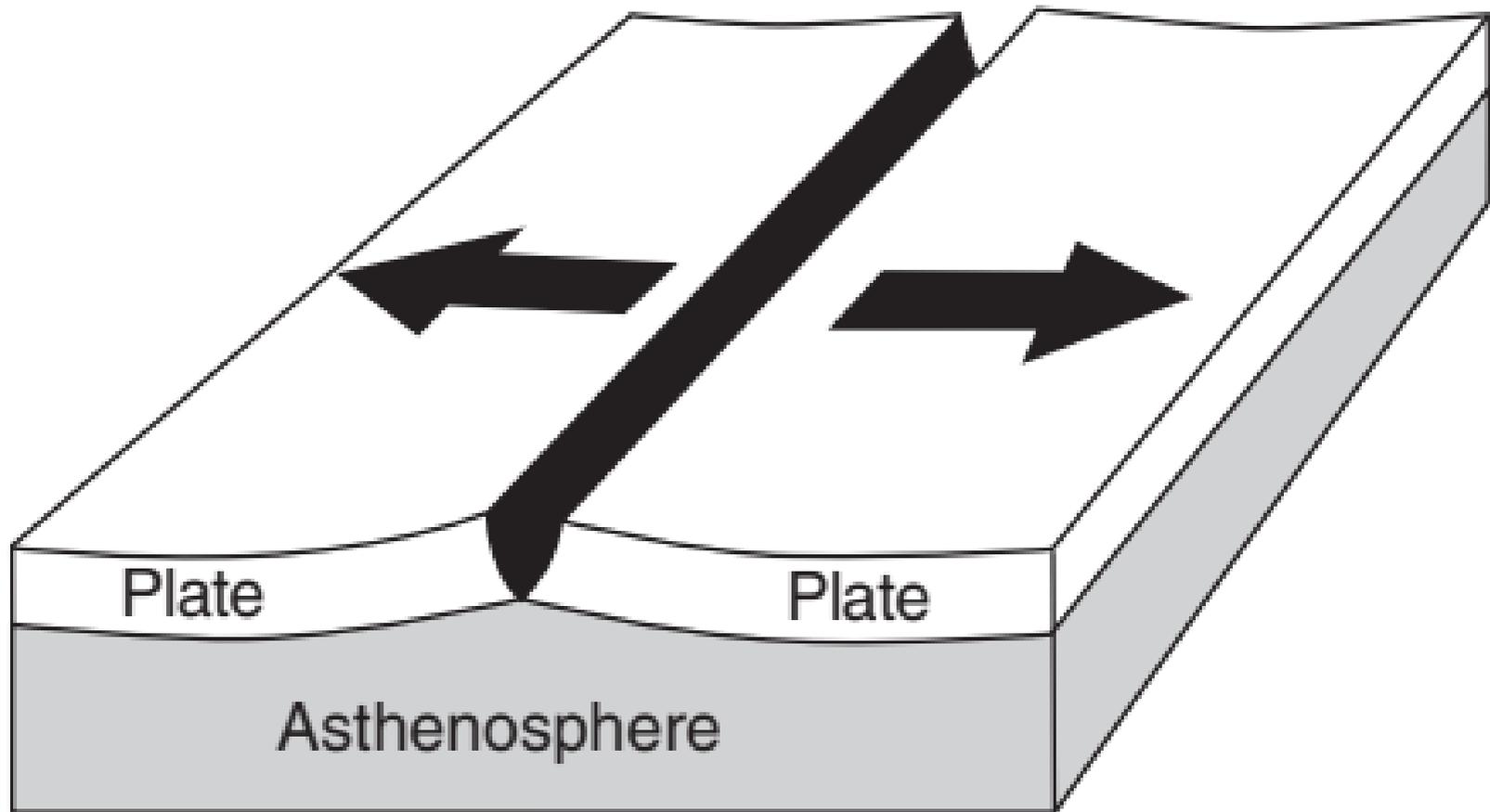
Oceanic Ridge at a Divergent Plate Boundary



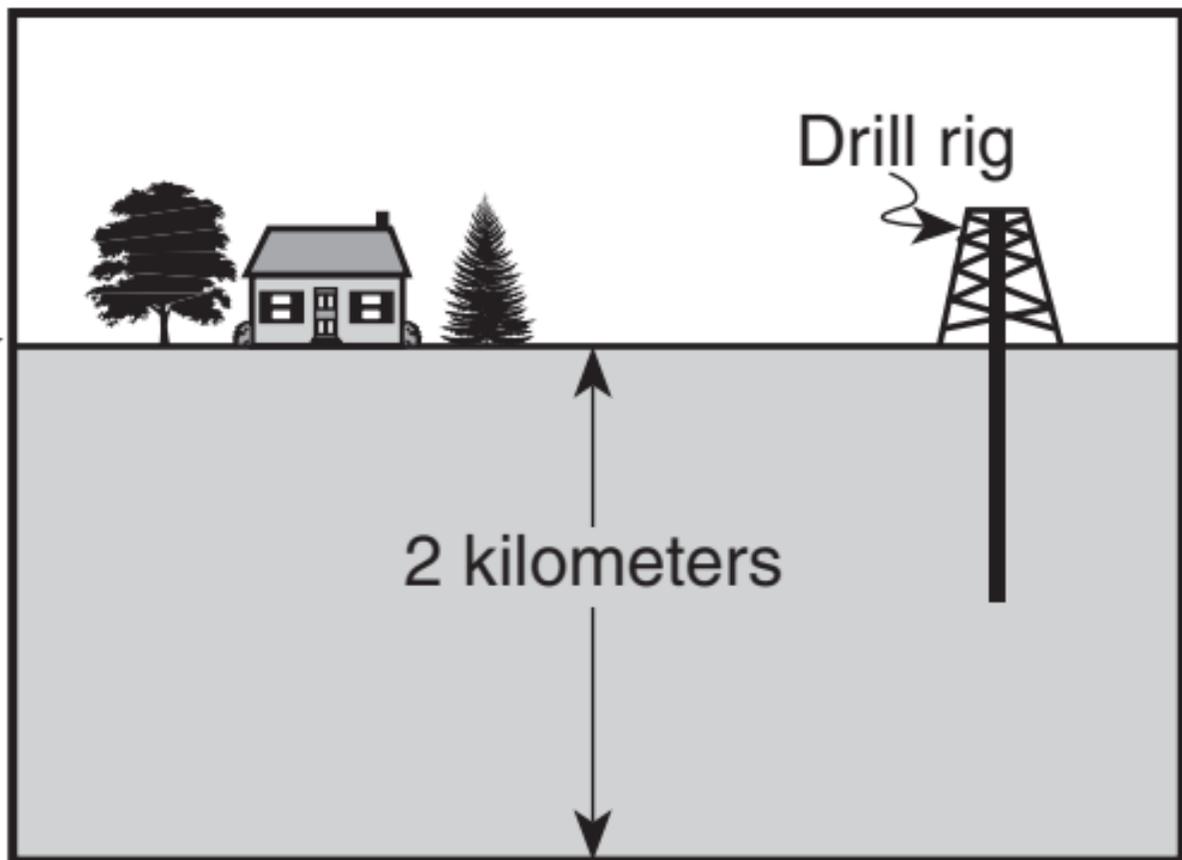
Atlantic Ocean



(Not drawn to scale)



Earth's
surface

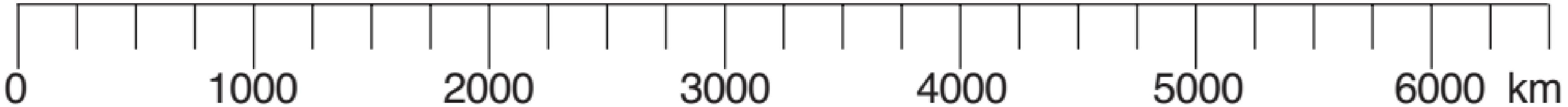
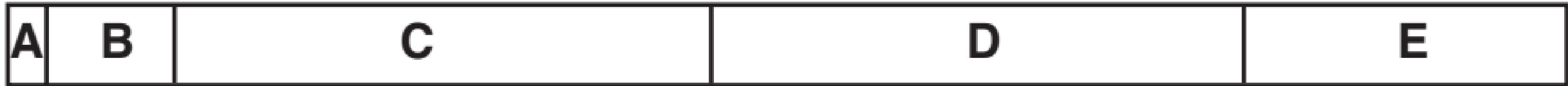


Drill rig

2 kilometers

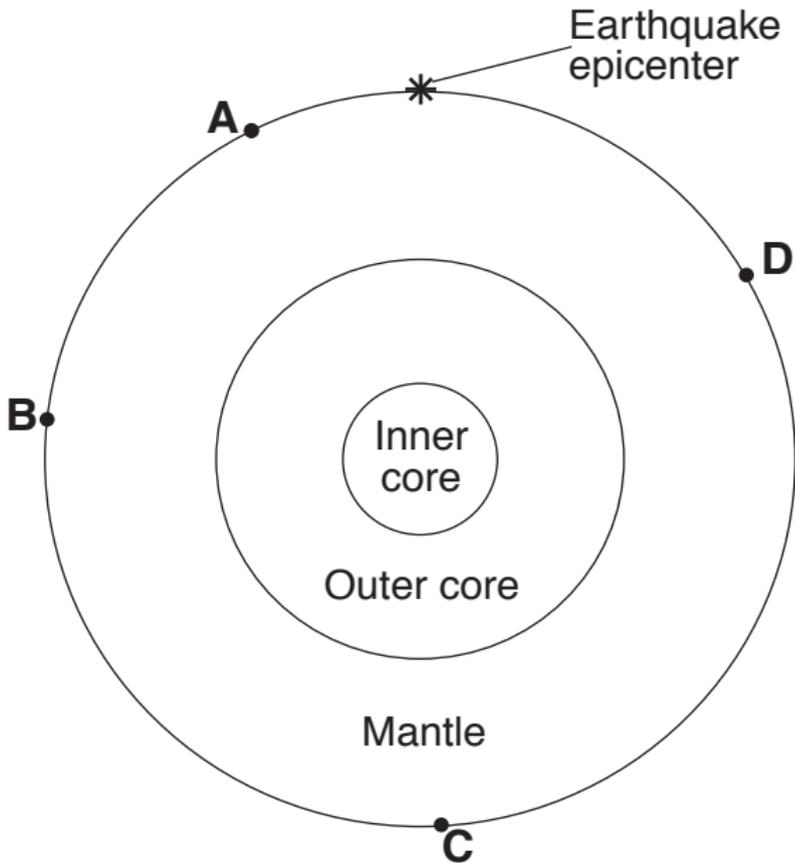
(Not drawn to scale)

Zones of Earth's Interior



Depth Below Earth's Surface

Diagram 1



Earthquake
epicenter

(Not drawn to scale)

Data Table

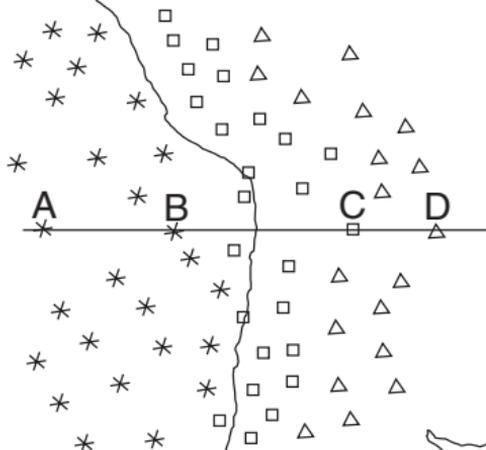
Location	Richter Magnitude	Year
San Francisco, United States	7.8	1906
Messina, Italy	7.5	1908
Tokyo, Japan	8.3	1923
San Francisco, United States	7.1	1989

Data Table

Depth Below Surface (km)	Number of Earthquakes
0–33	27,788
34–100	17,585
101–300	7,329
301–700	3,167

Pacific Ocean

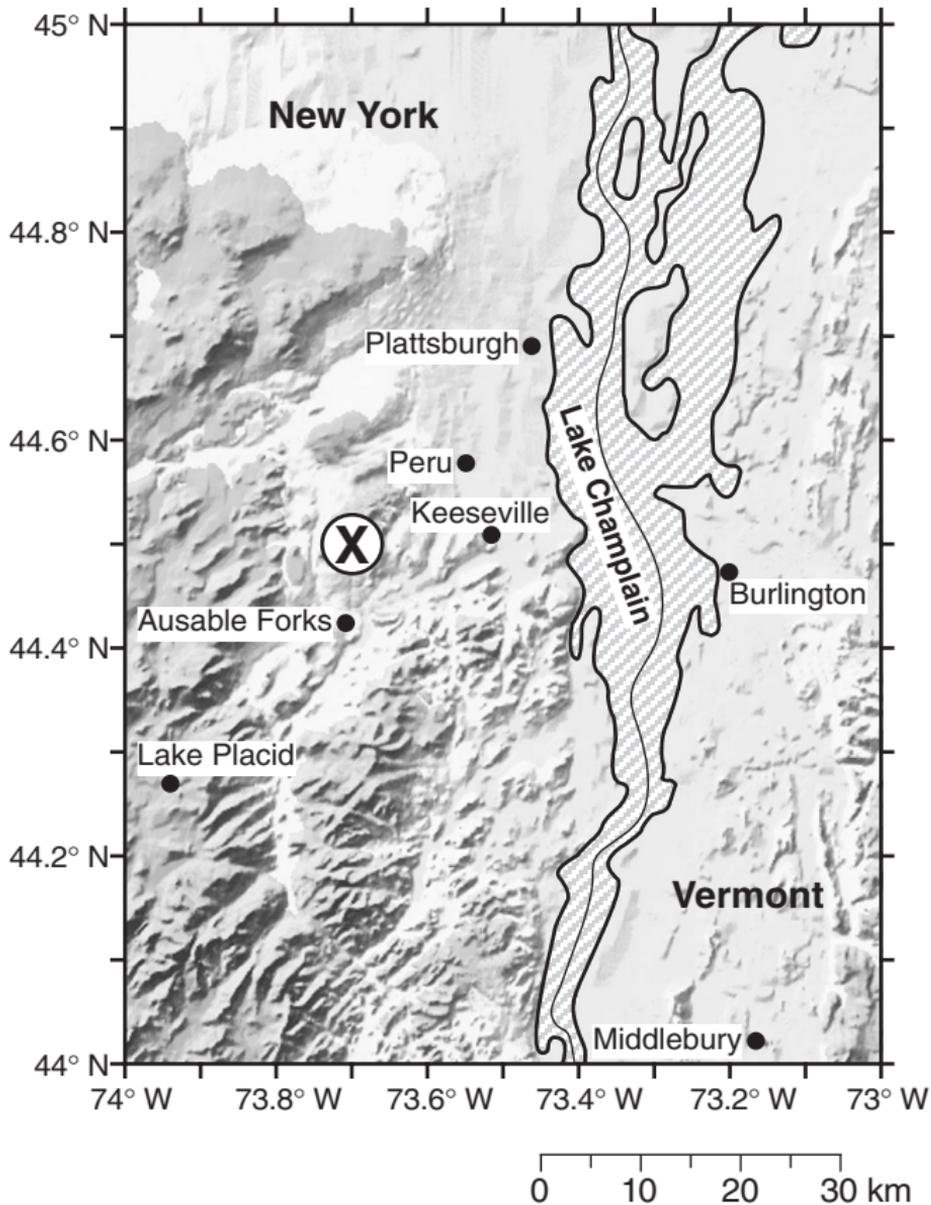
South America



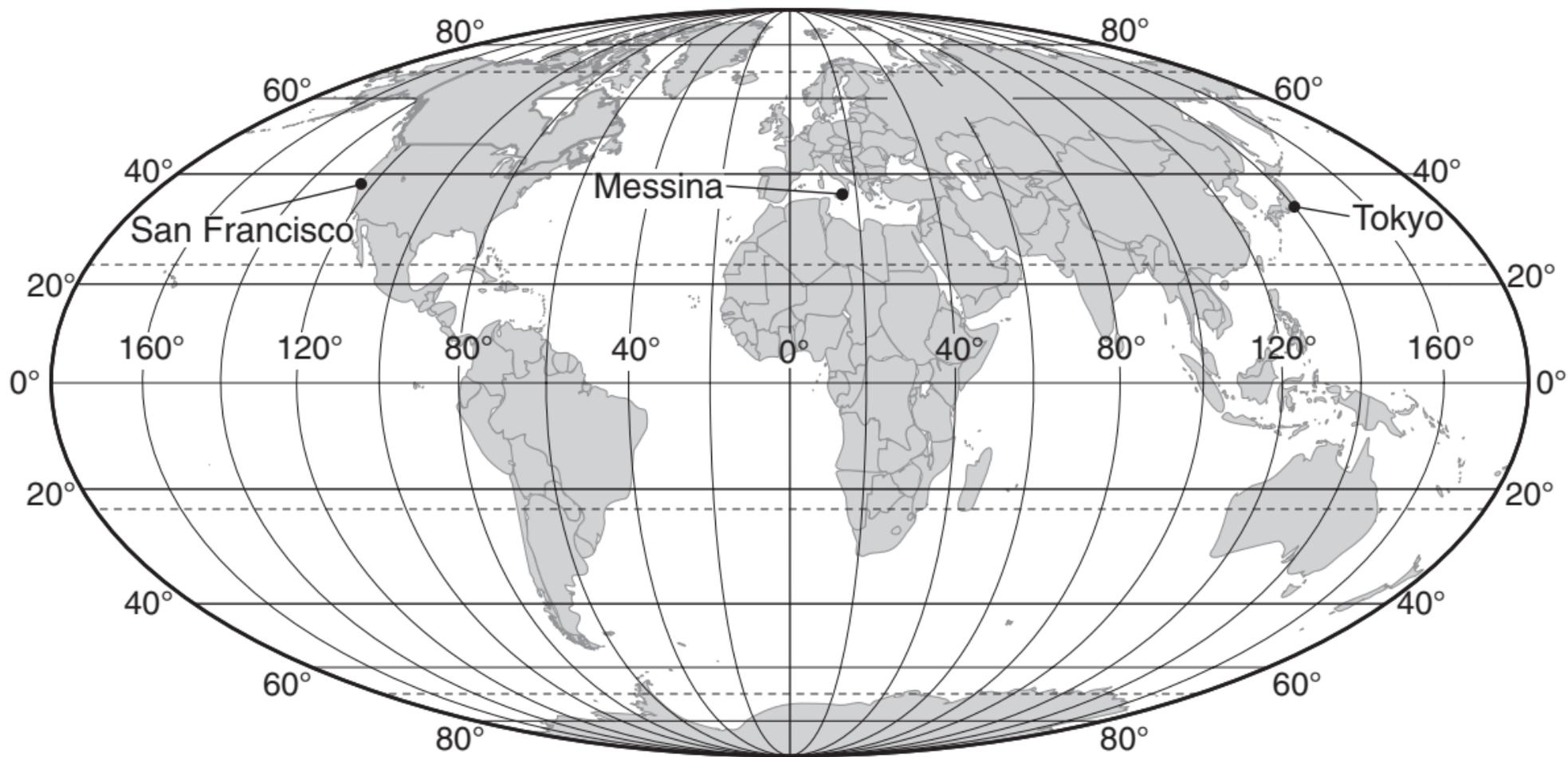
Key

Earthquake	Average depth
* Shallow	50 km
□ Intermediate	250 km
△ Deep	500 km

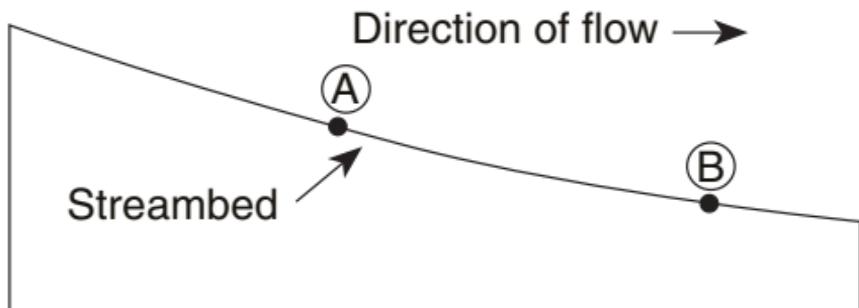
Plattsburgh, New York Earthquake on April 20, 2002



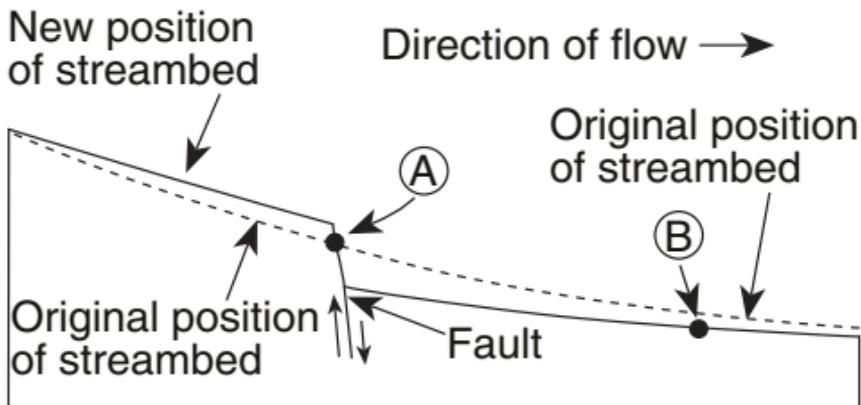
Seismic Station	<i>P</i>-Wave Arrival Time	<i>S</i>-Wave Arrival Time	Difference in Arrival Times	Distance to Epicenter
<i>A</i>	08:48:20	No <i>S</i> -waves arrived		
<i>B</i>	08:42:00		00:04:40	
<i>C</i>	08:39:20		00:02:40	
<i>D</i>	08:45:40			6,200 km



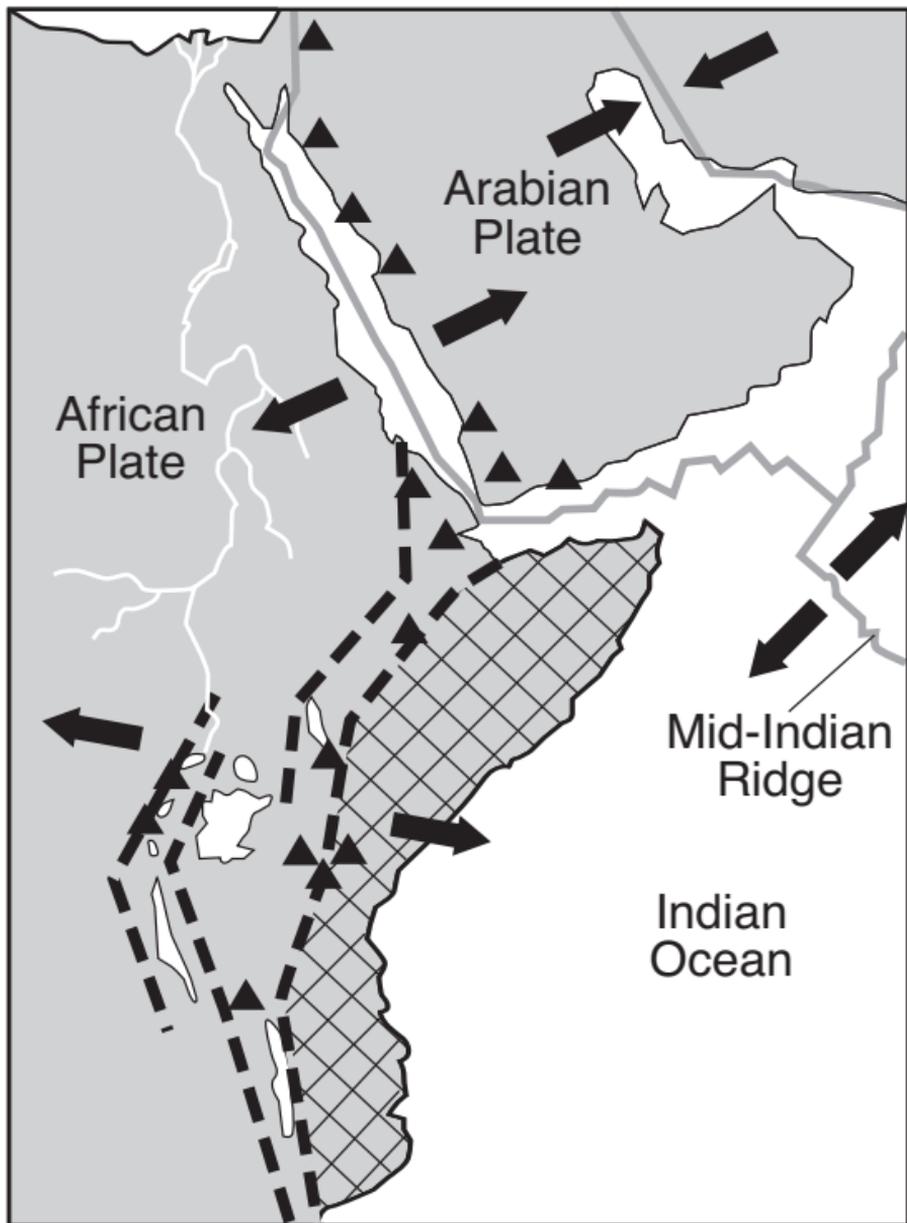
Before Earthquake



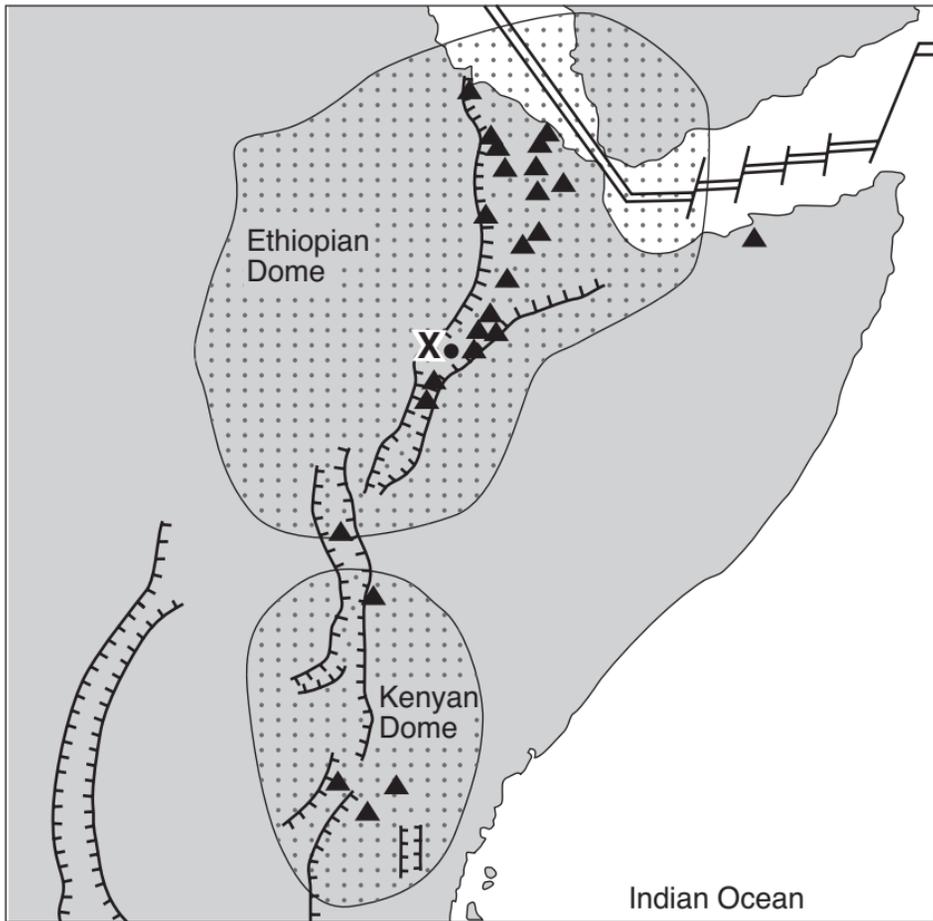
After Earthquake



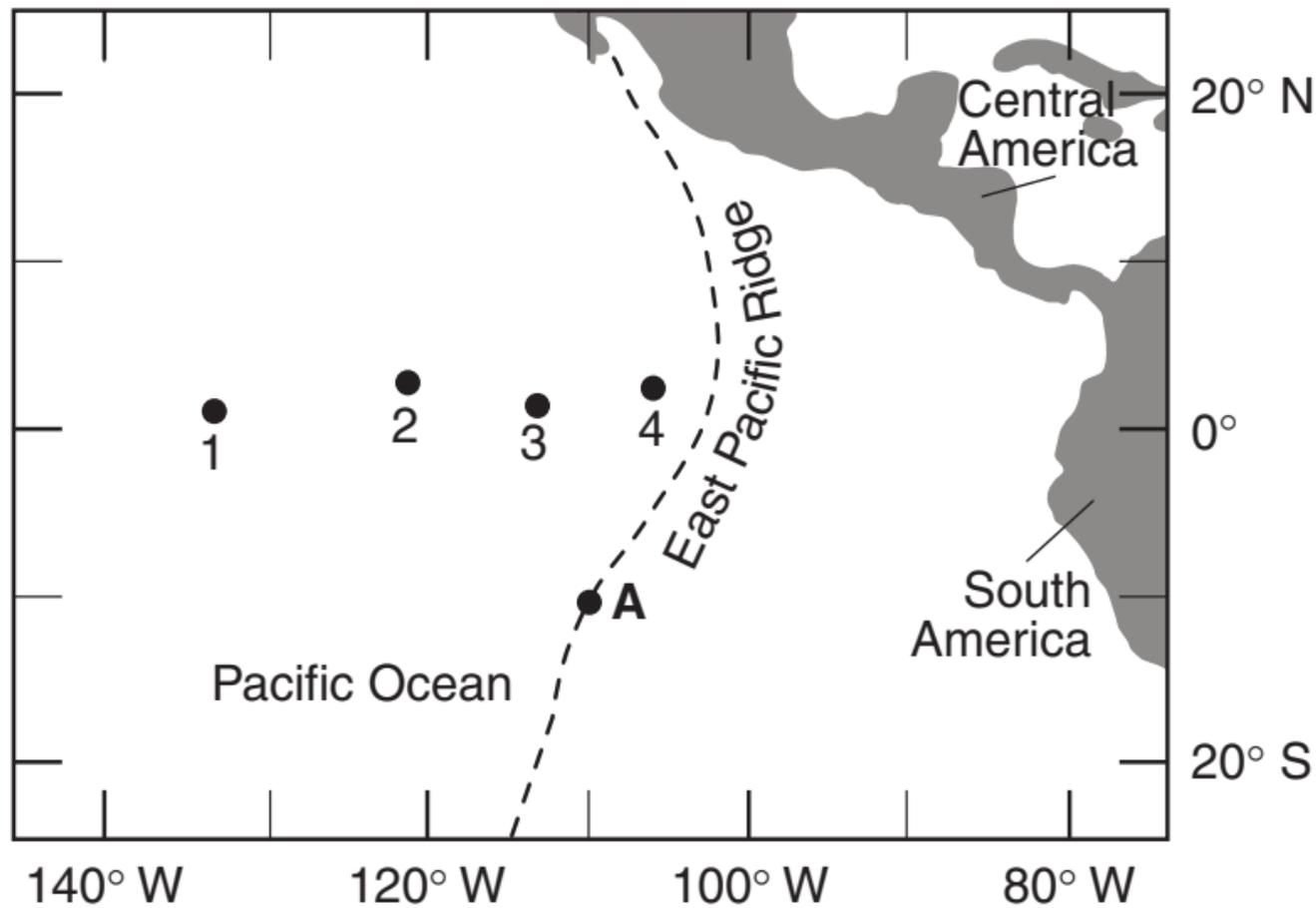
East African Rift Region

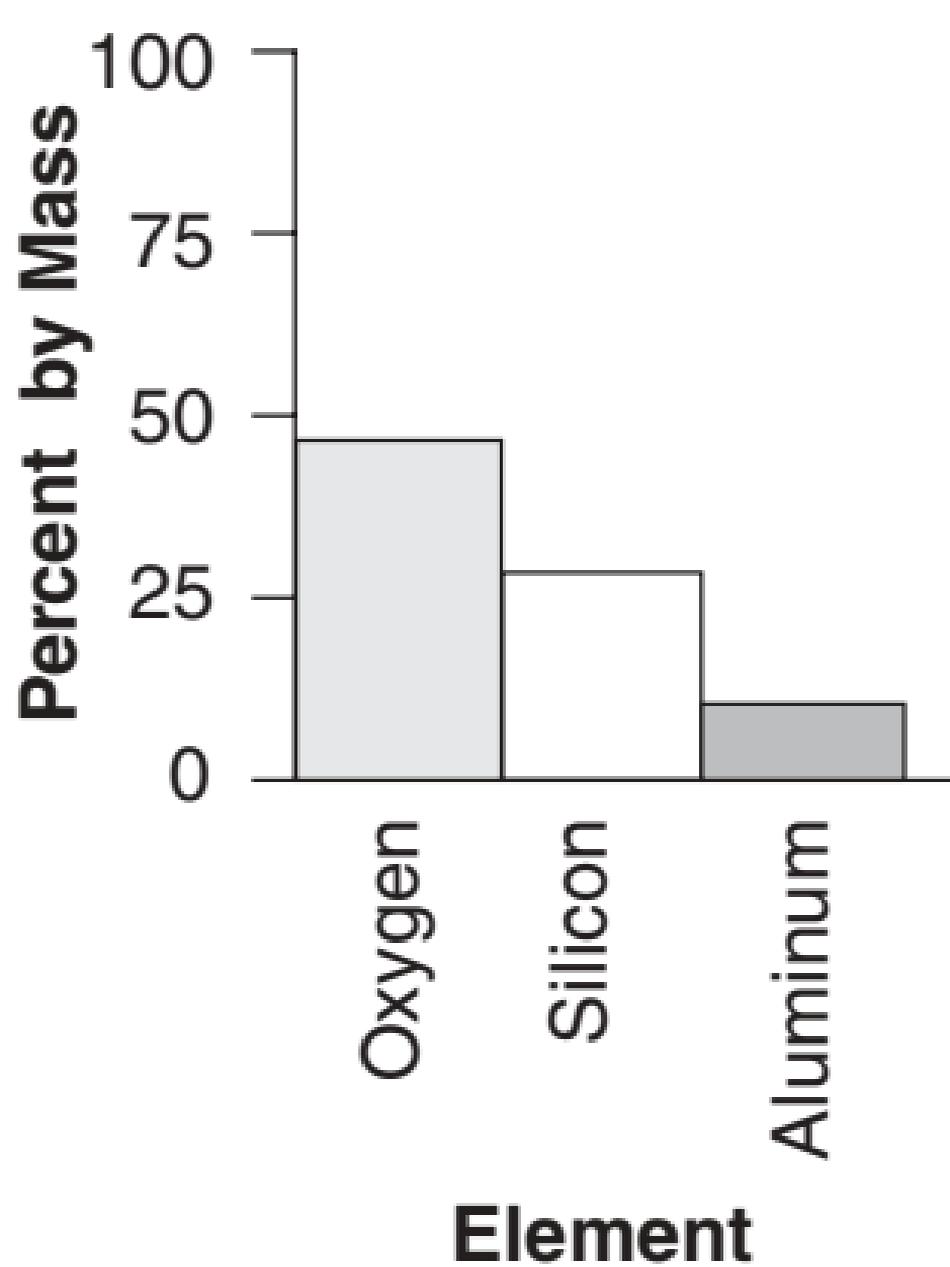


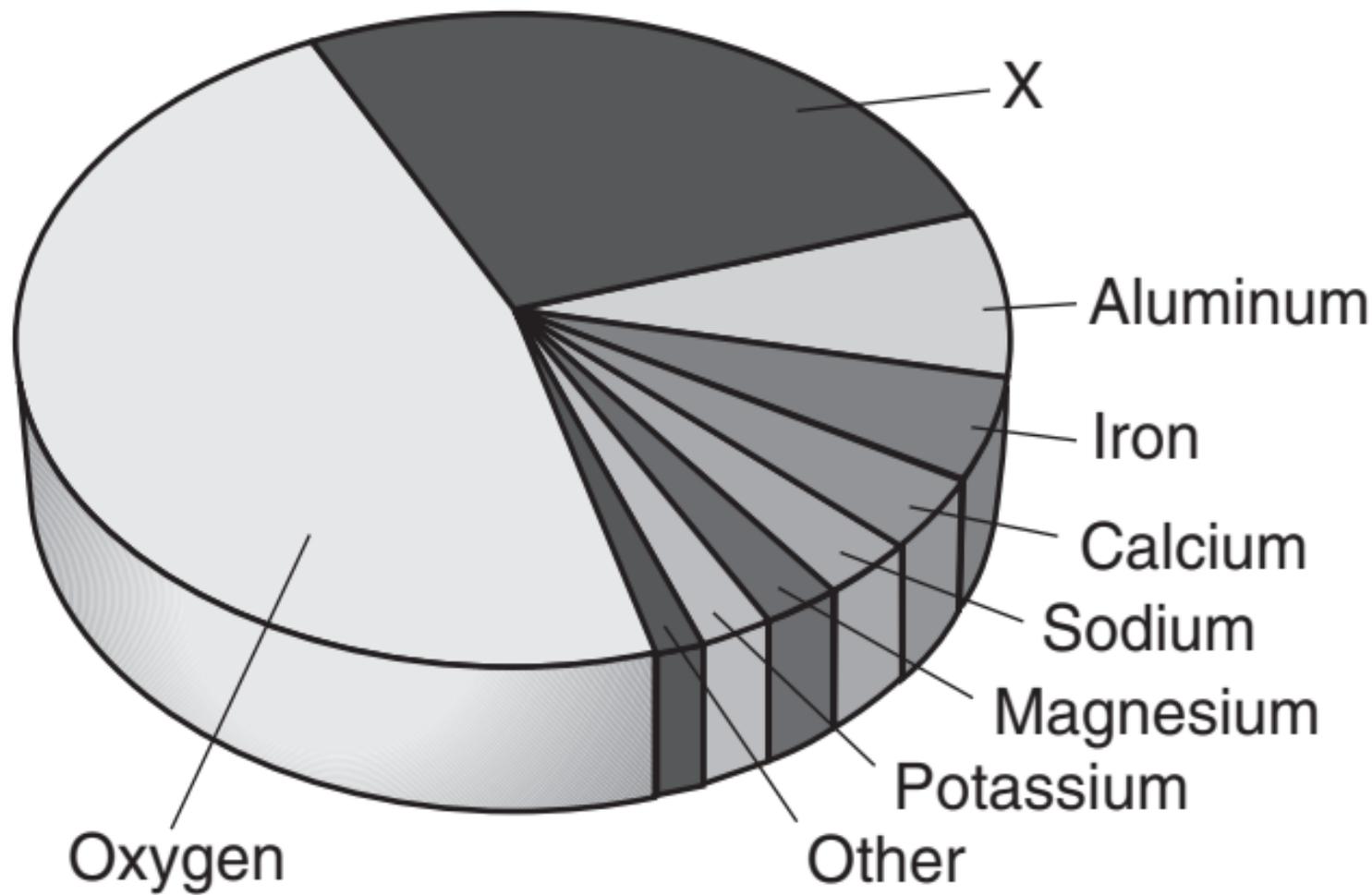
East African Rift System

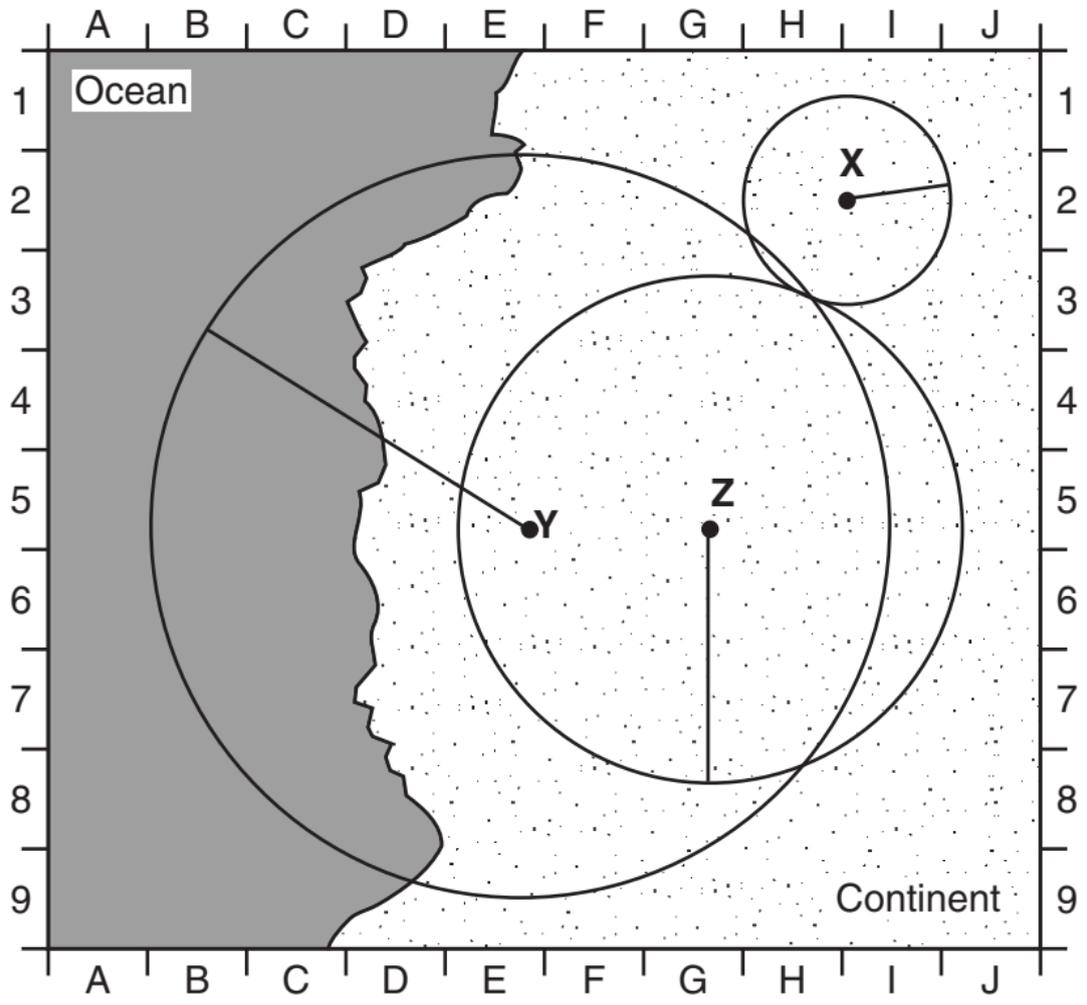


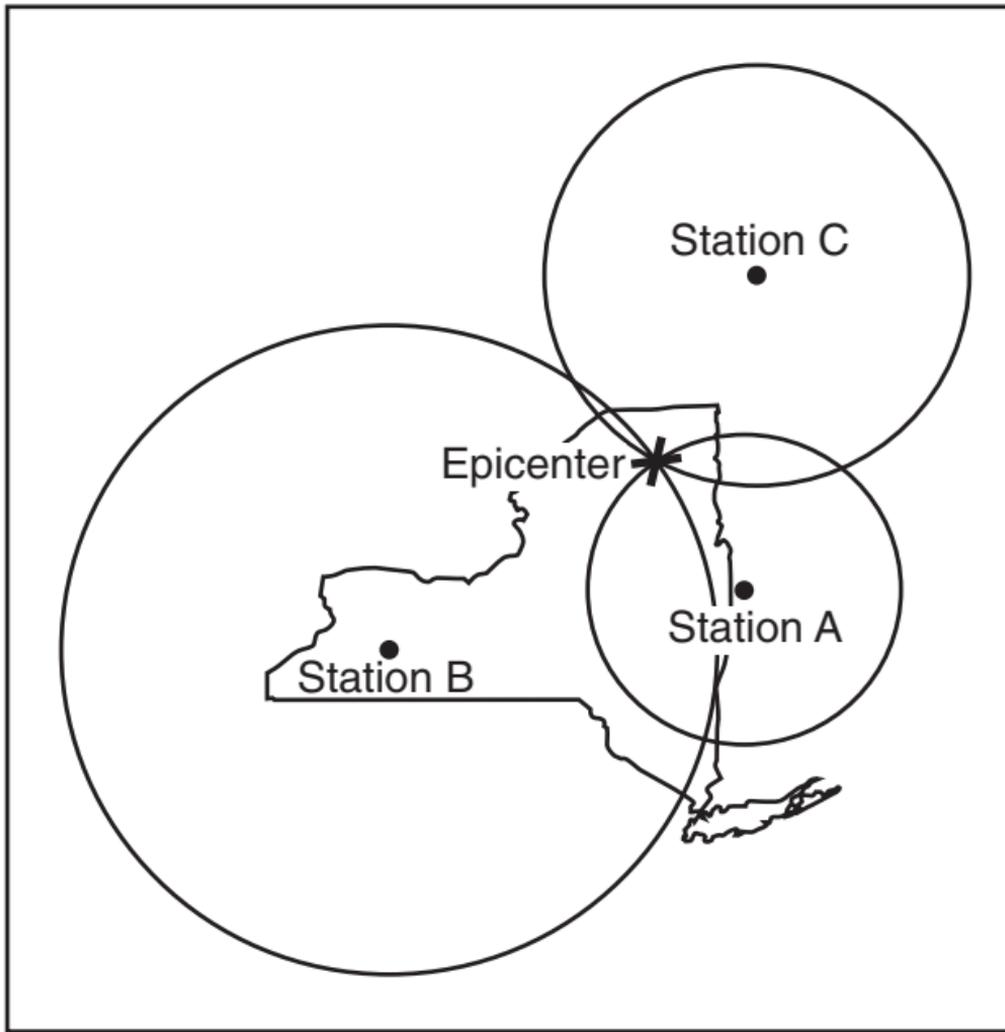
Map of Drilling Sites



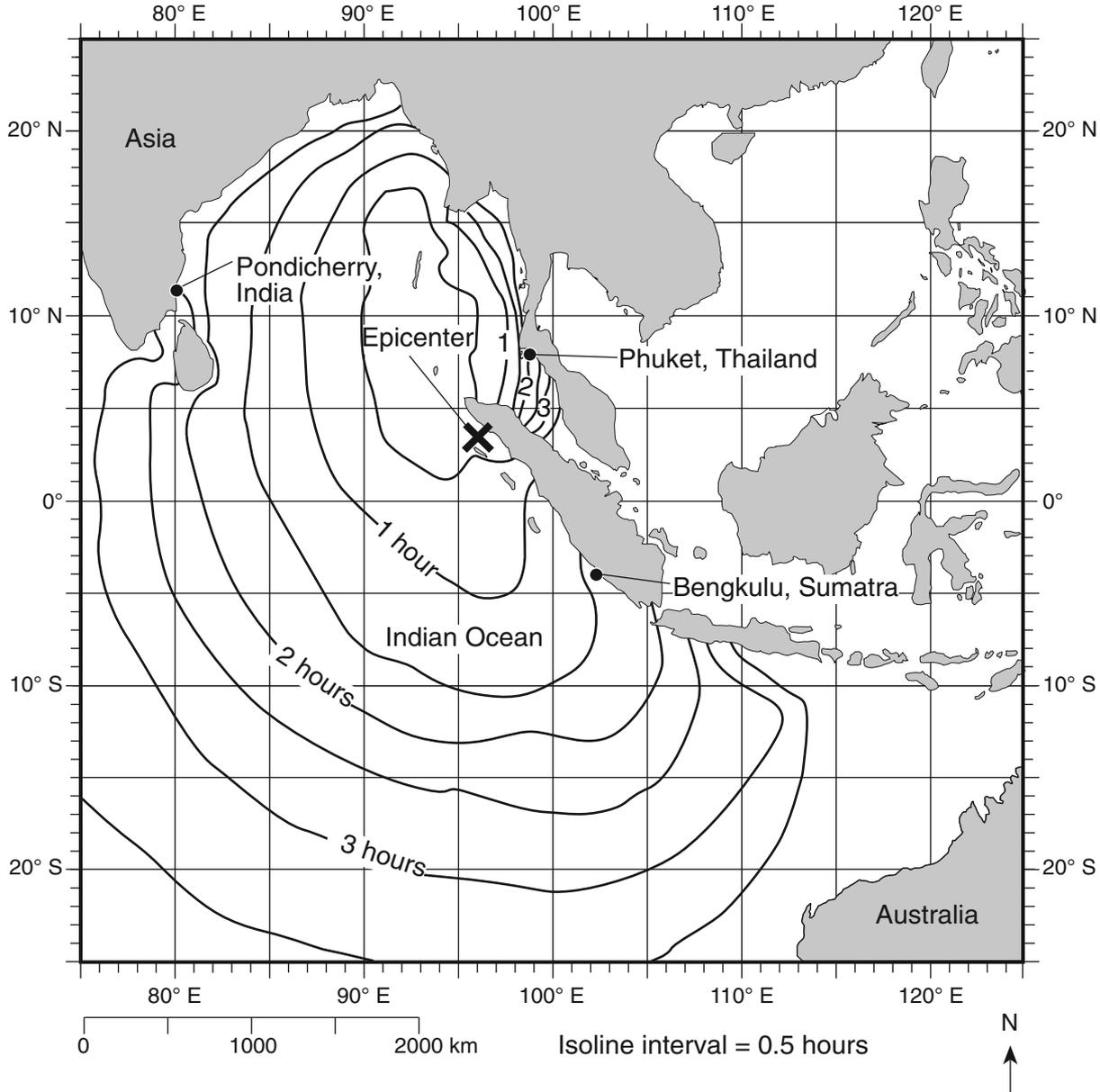












180° W 172° W 164° W 156° W 148° W 140° W 132° W 124° W



III-IV

V

VI

VII

VIII-IX

Arctic Ocean

CANADA

ALASKA

Epicenter

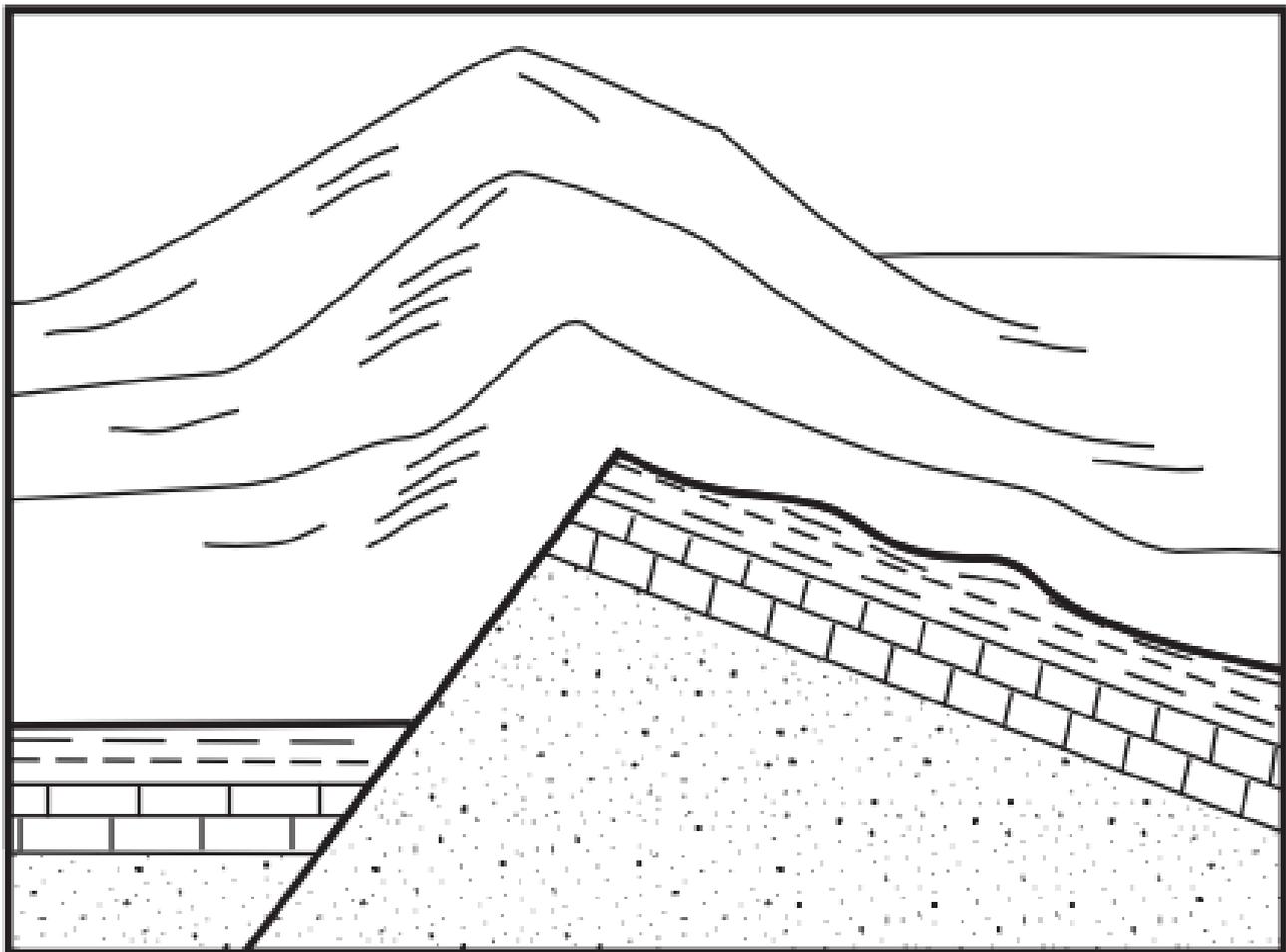
Anchorage

Kodiak

Pacific Ocean



0 200 400 600 800 km

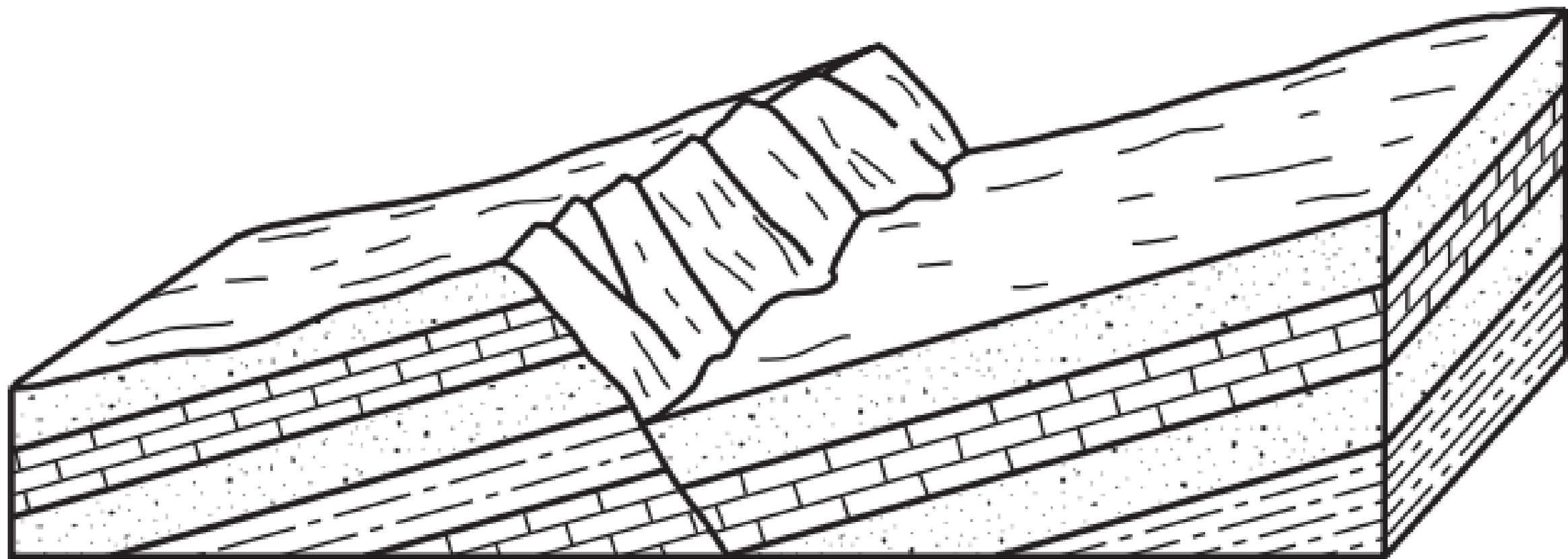


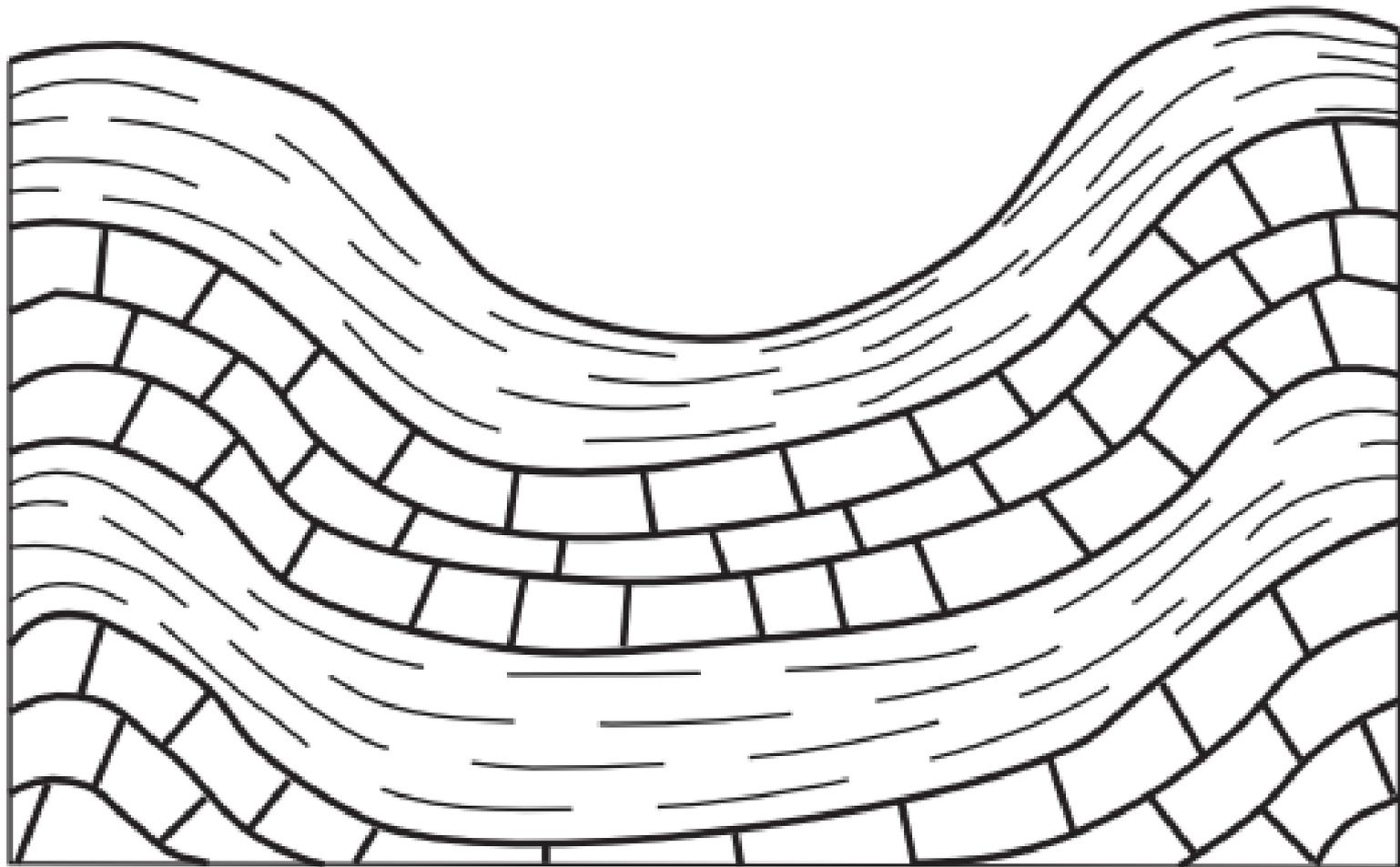
North

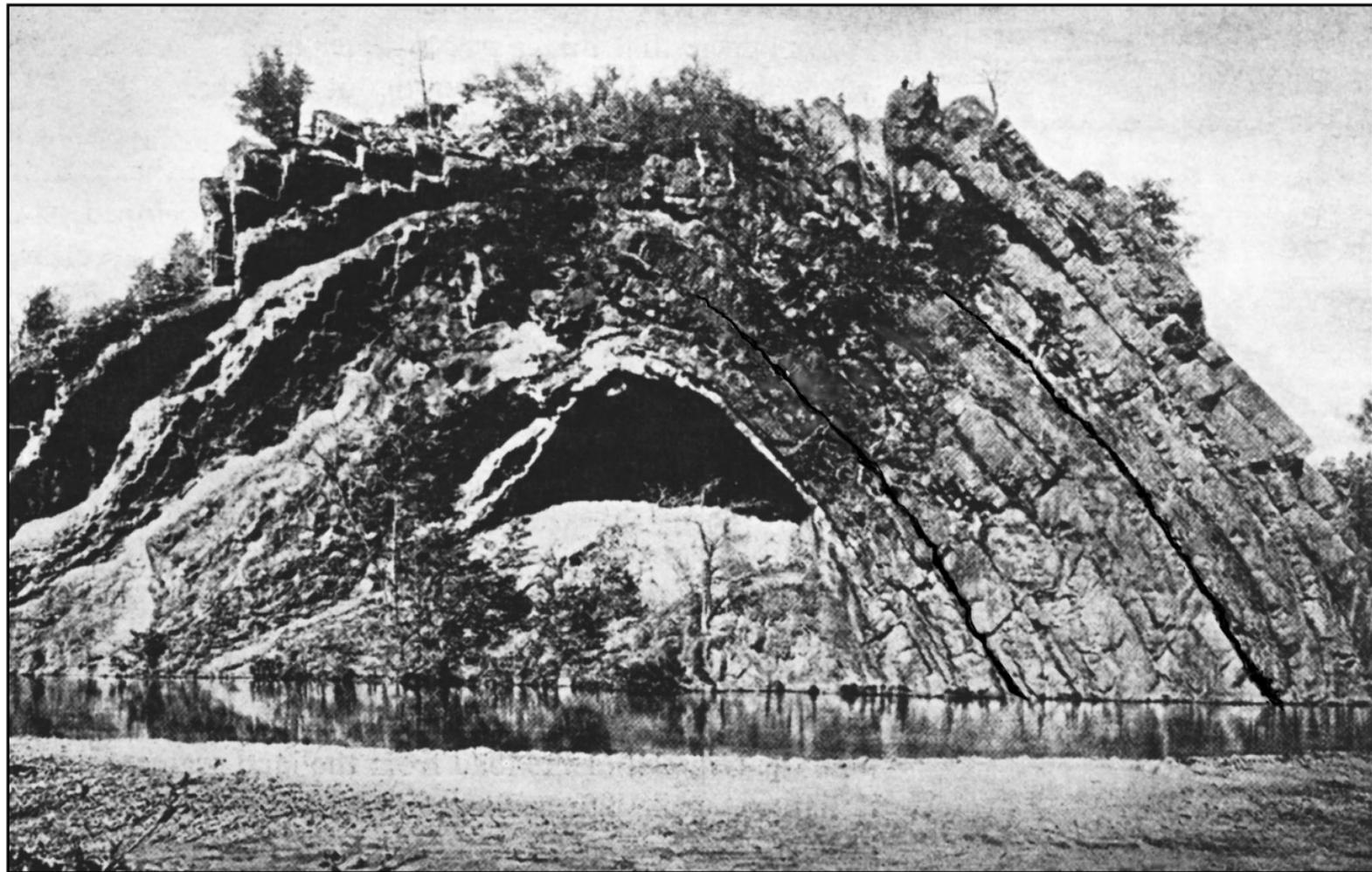


South

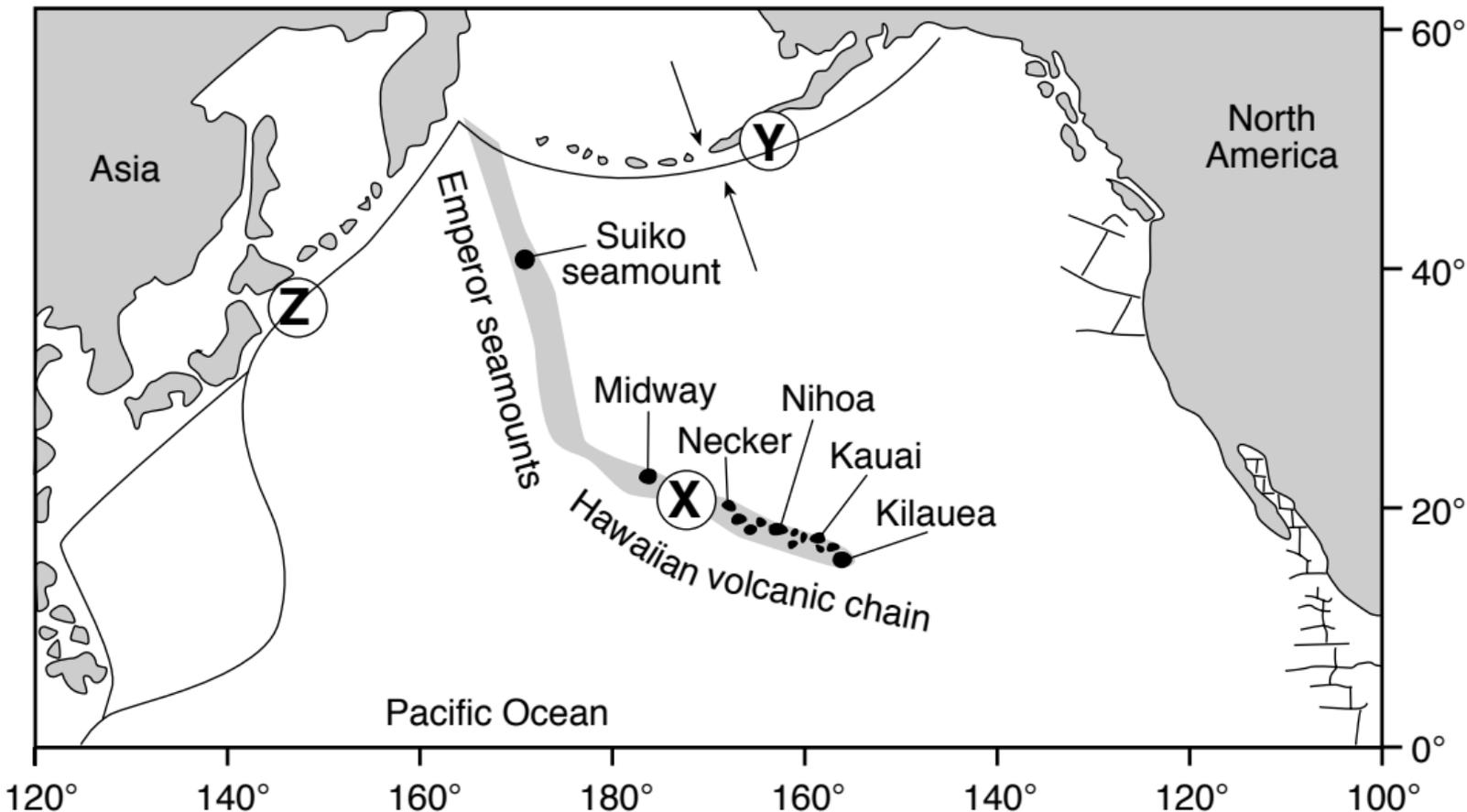


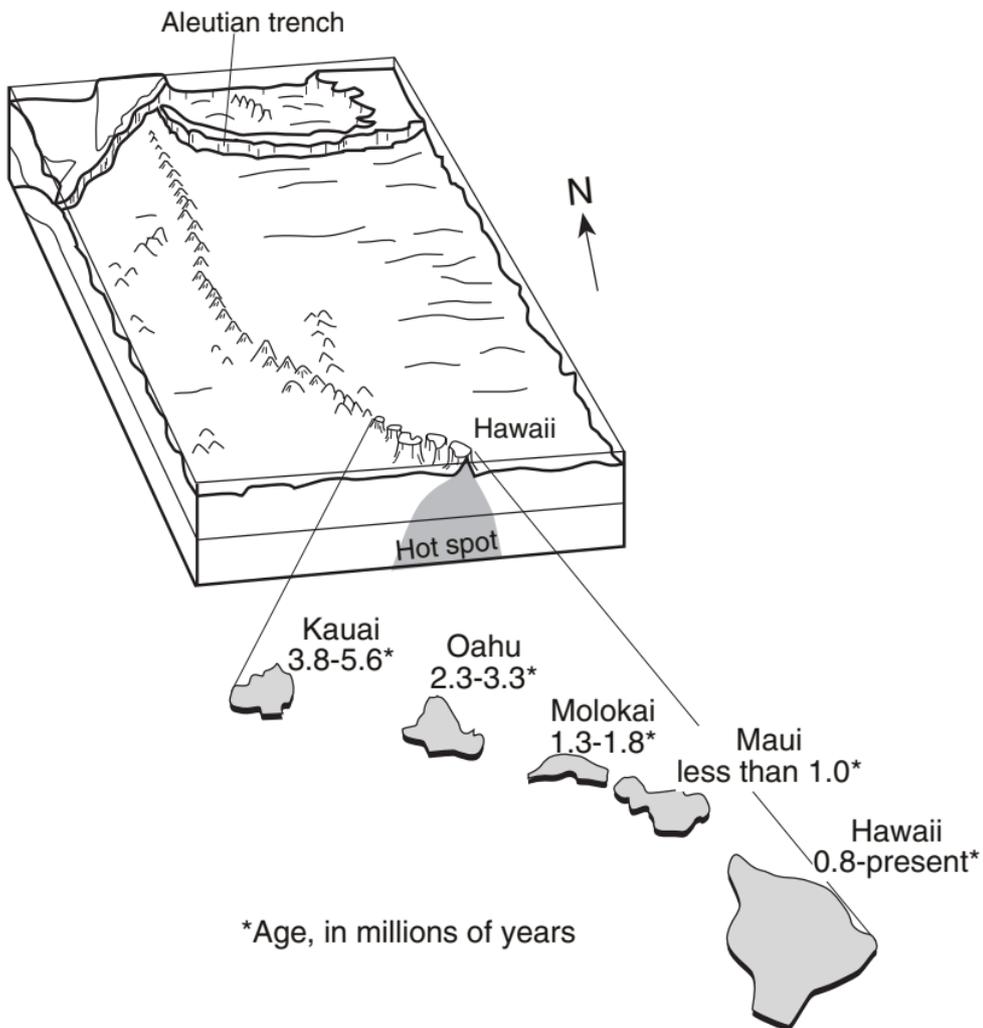


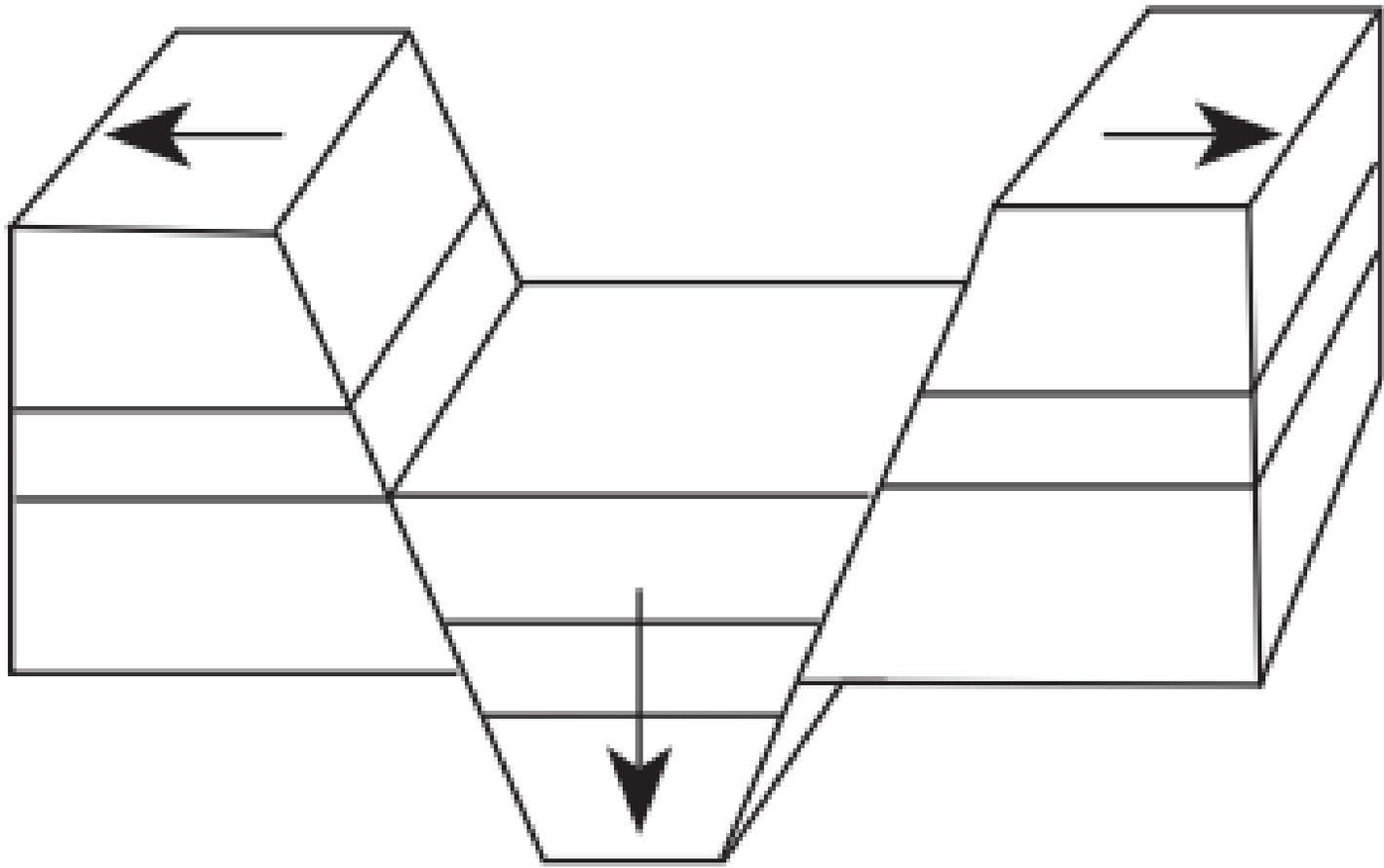


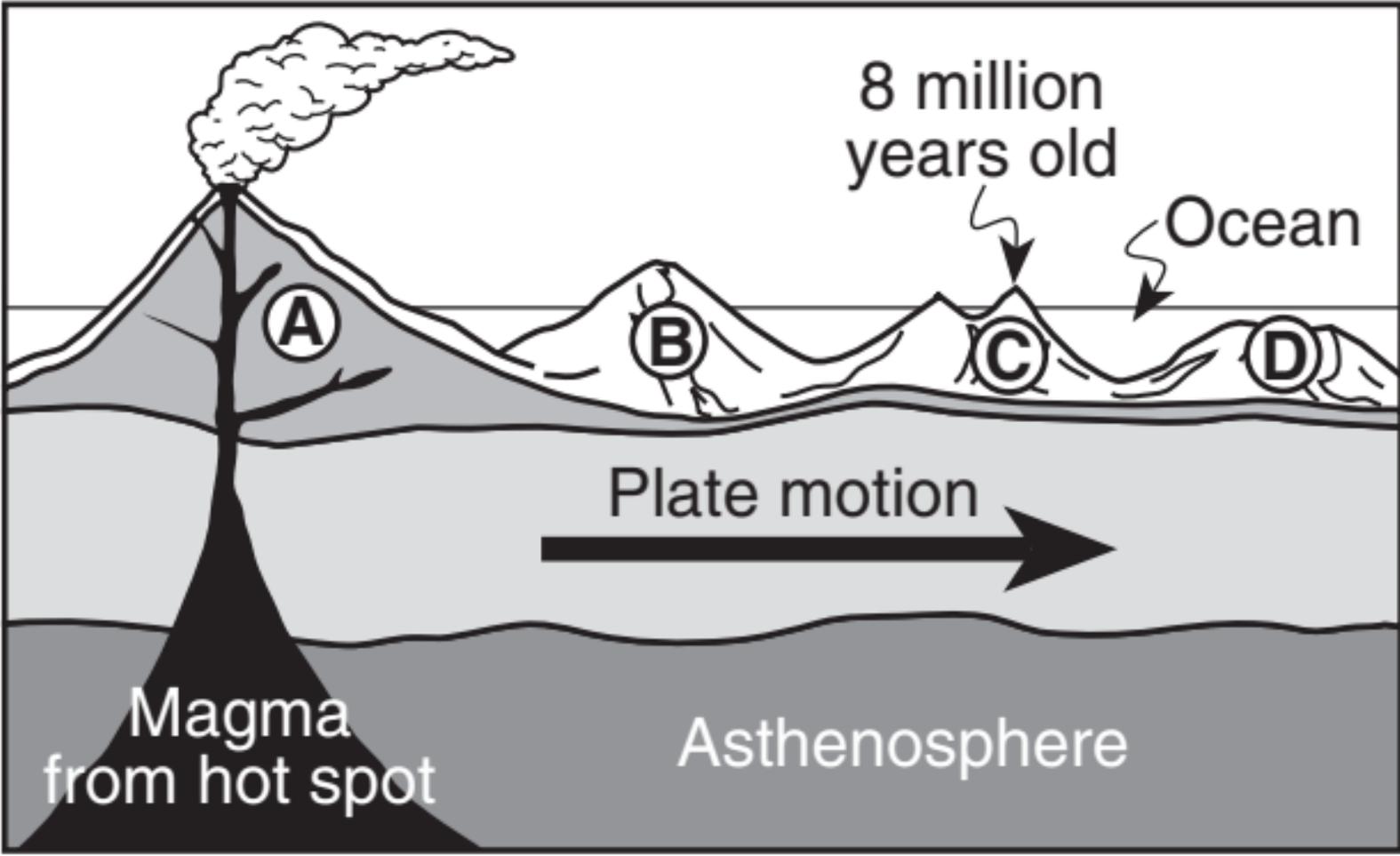


Map of Volcanic Features









8 million
years old

Ocean

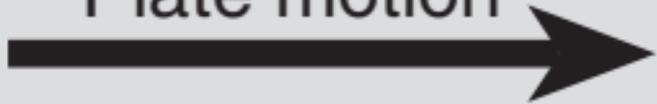
A

B

C

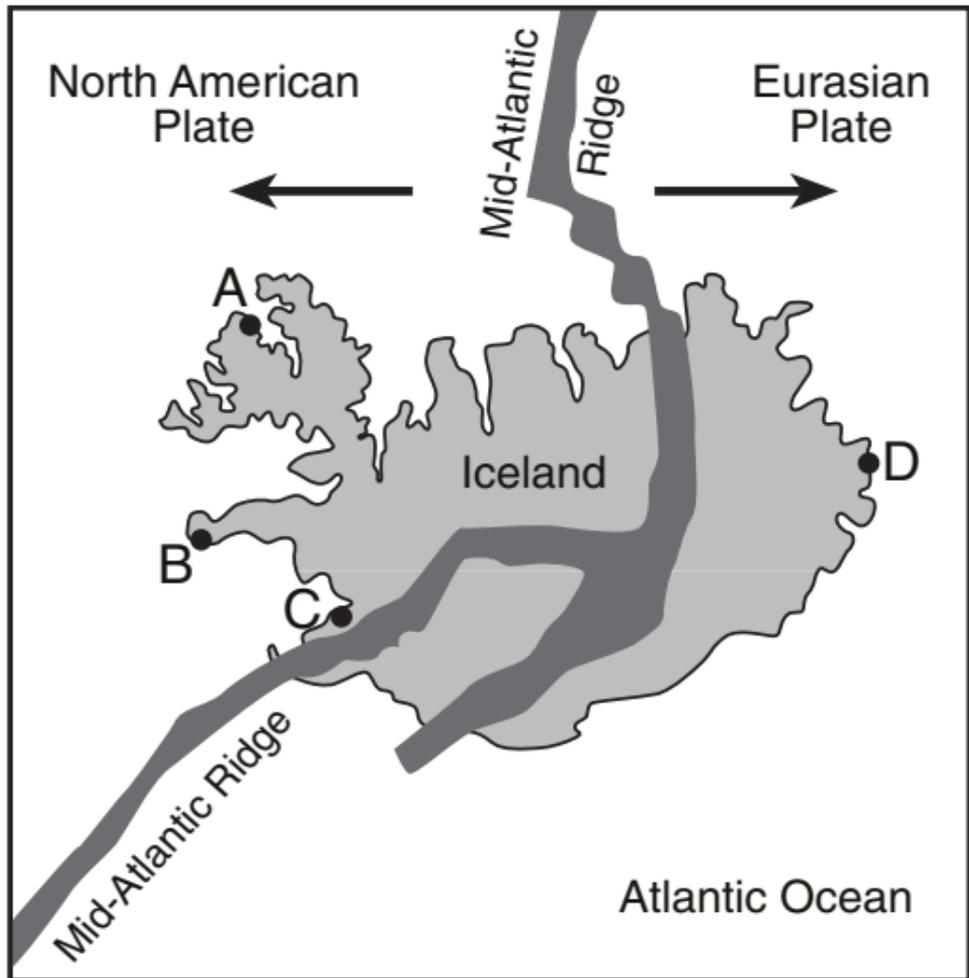
D

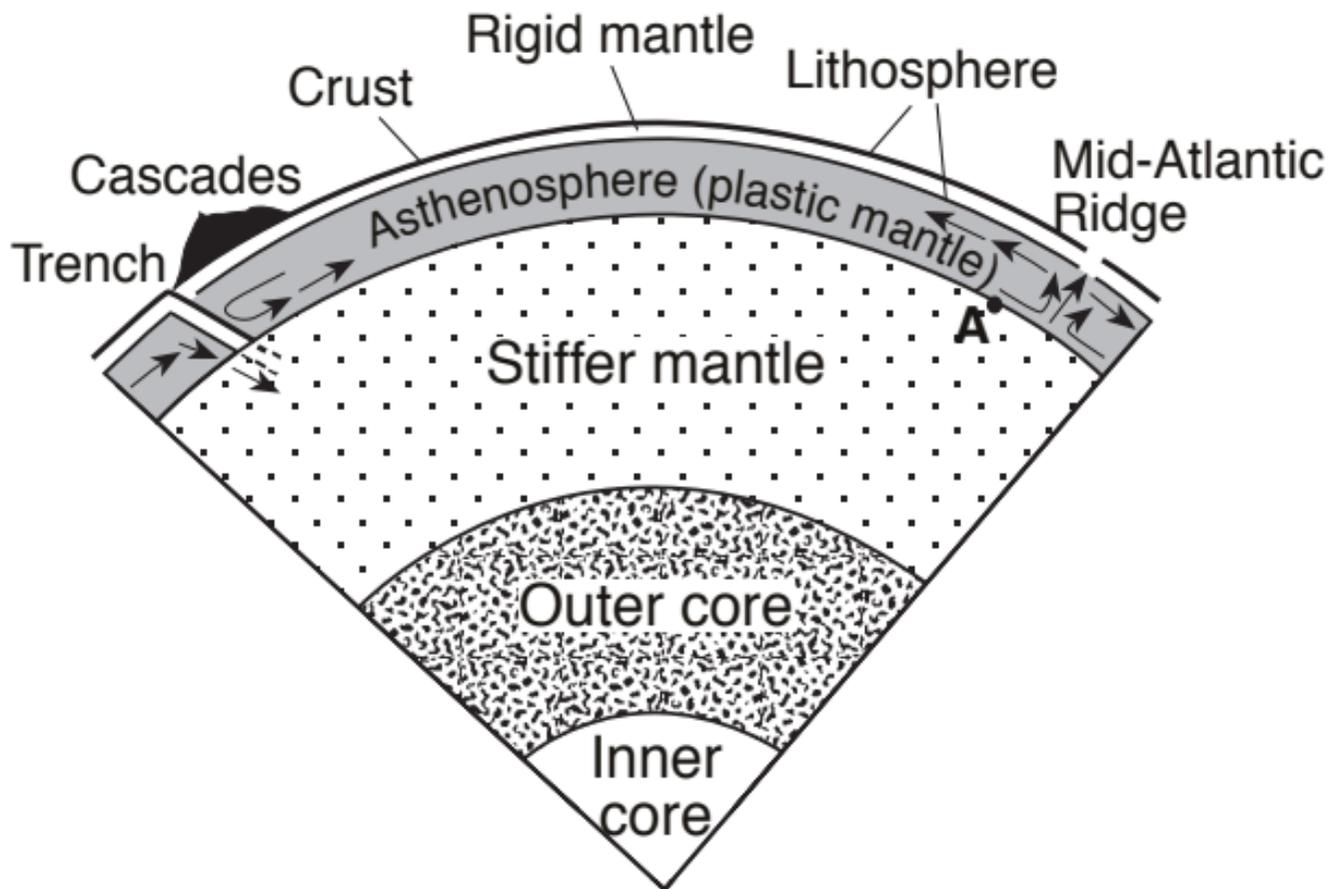
Plate motion



Magma
from hot spot

Asthenosphere





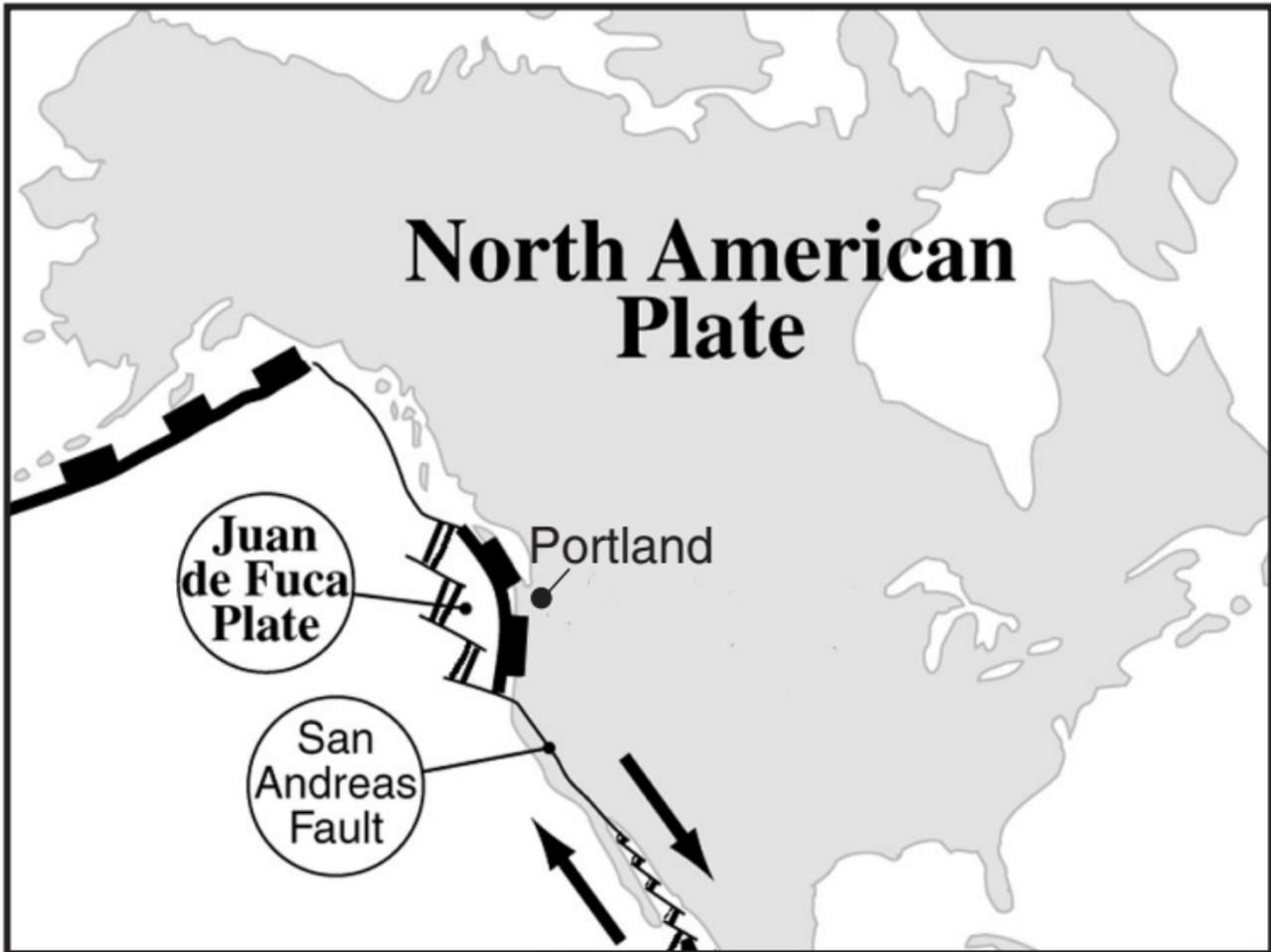
(Not drawn to scale)

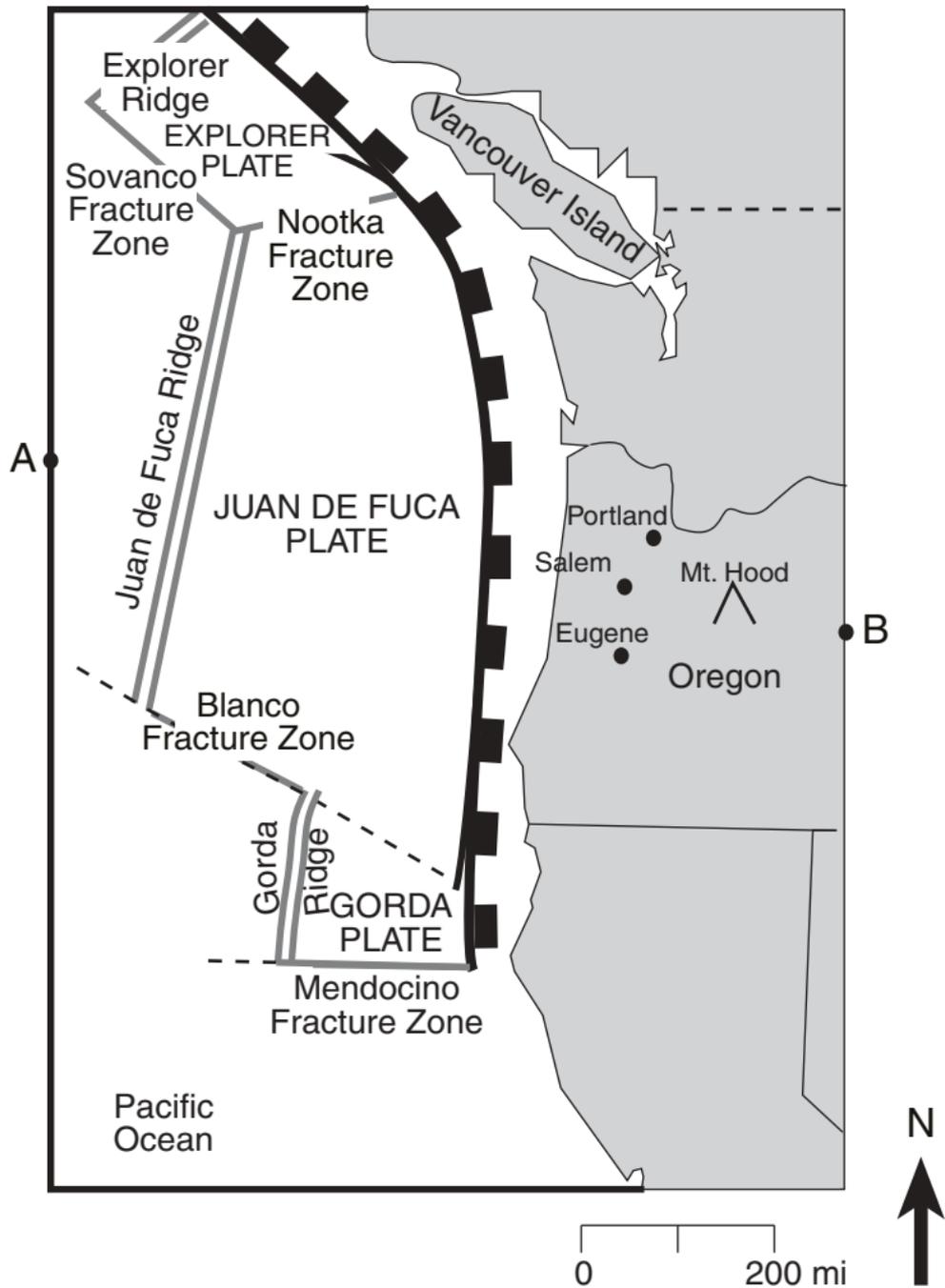
North American Plate

Juan de Fuca Plate

Portland

San Andreas Fault

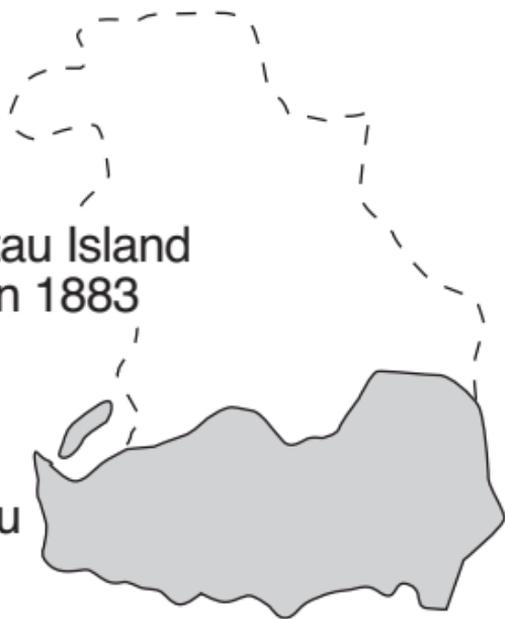


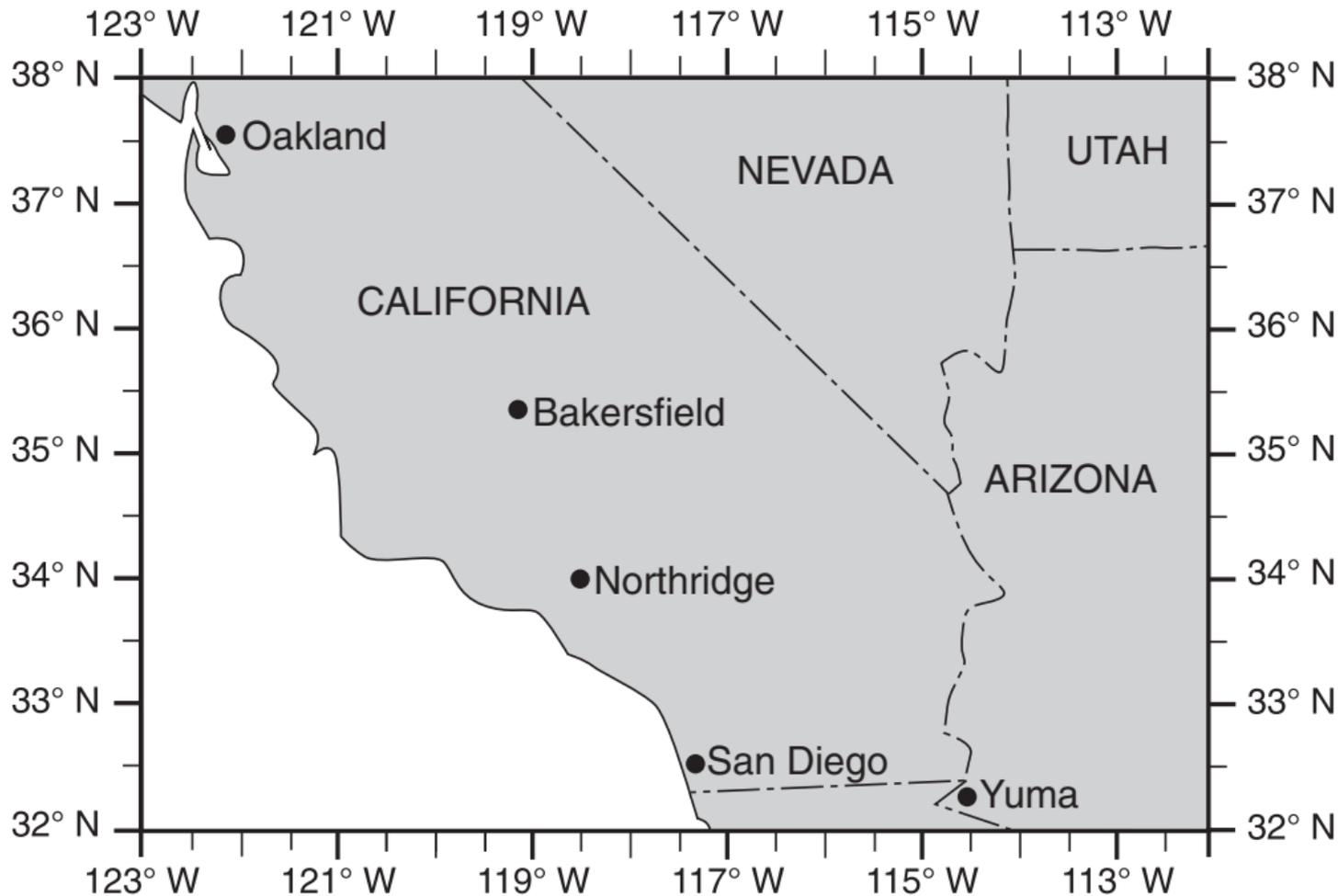


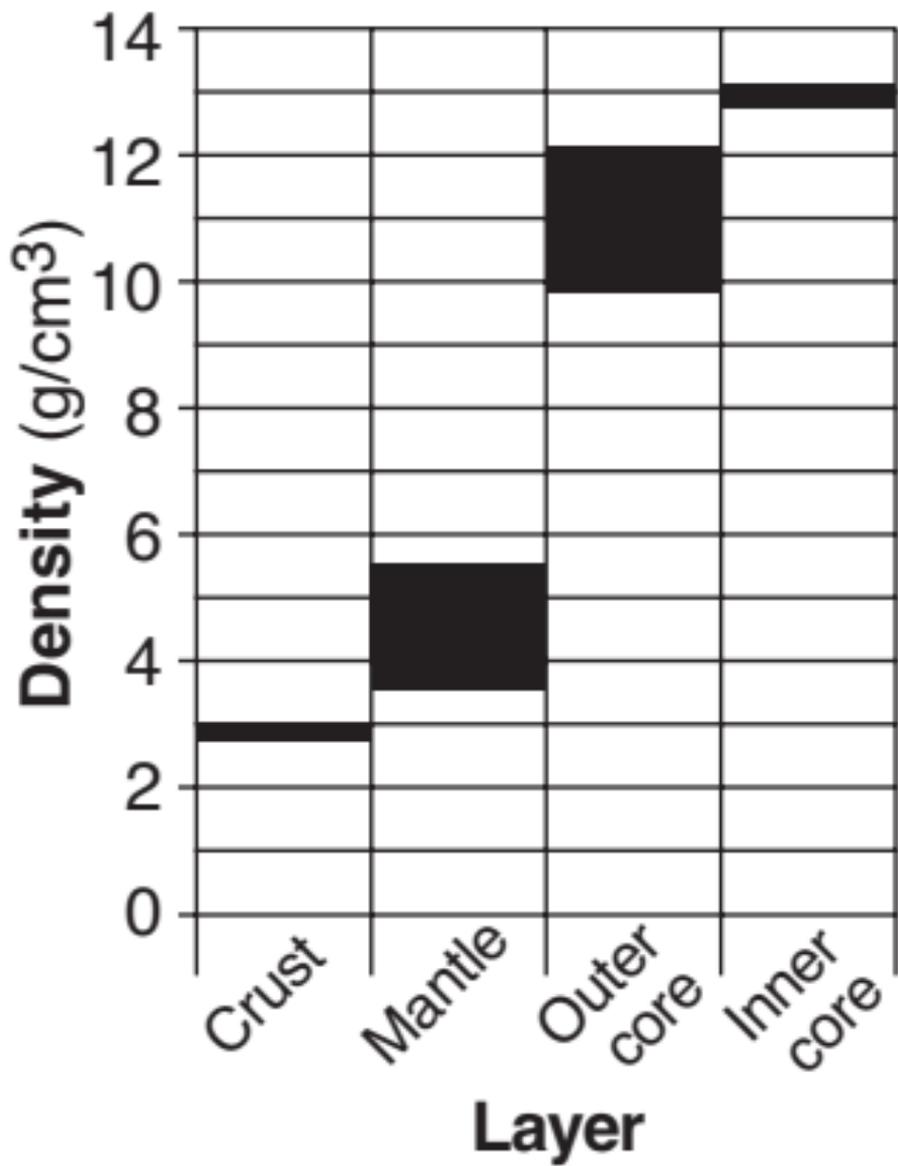
Volcanic Island of Krakatau

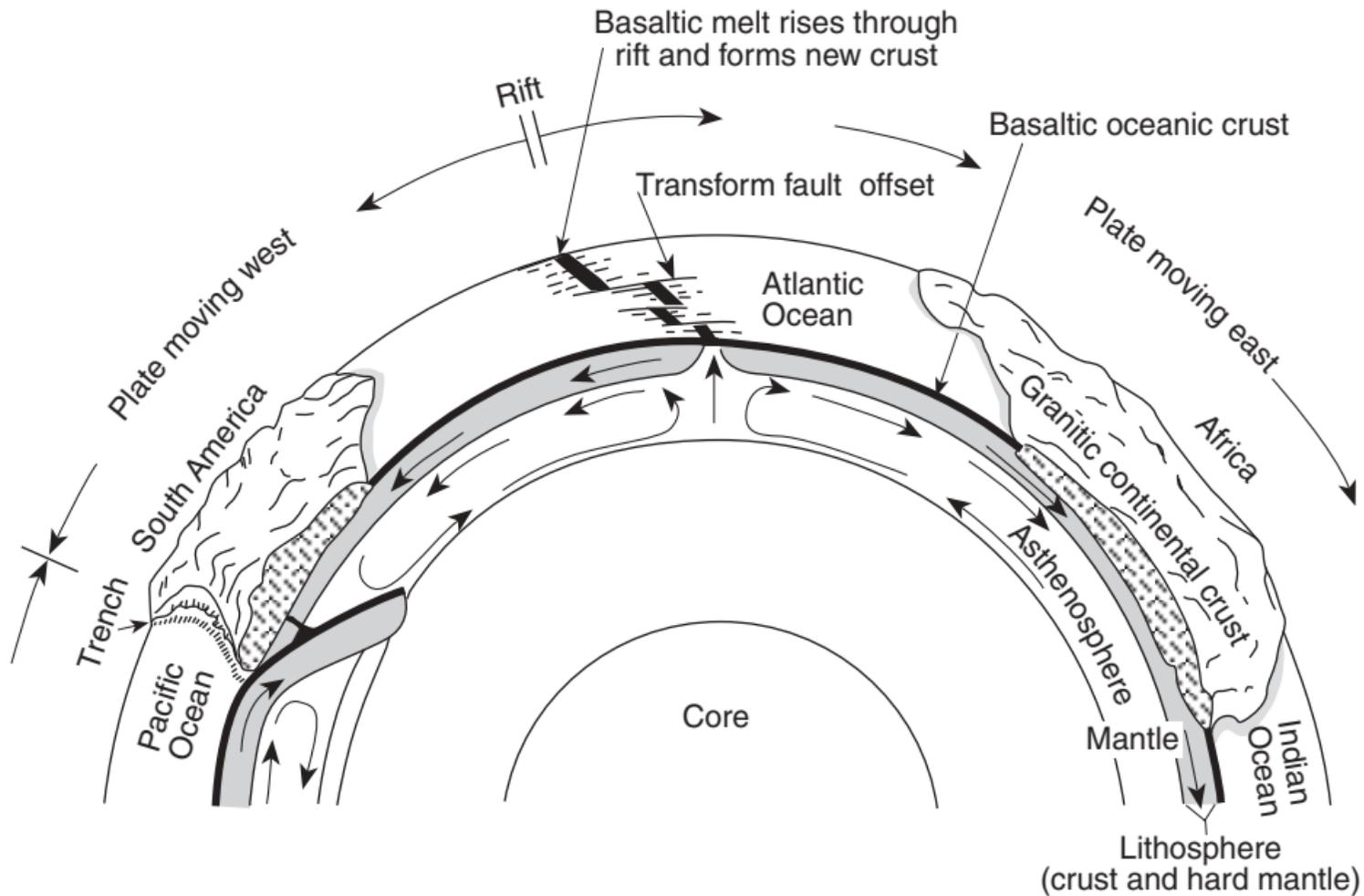
Part of Krakatau Island
destroyed in 1883

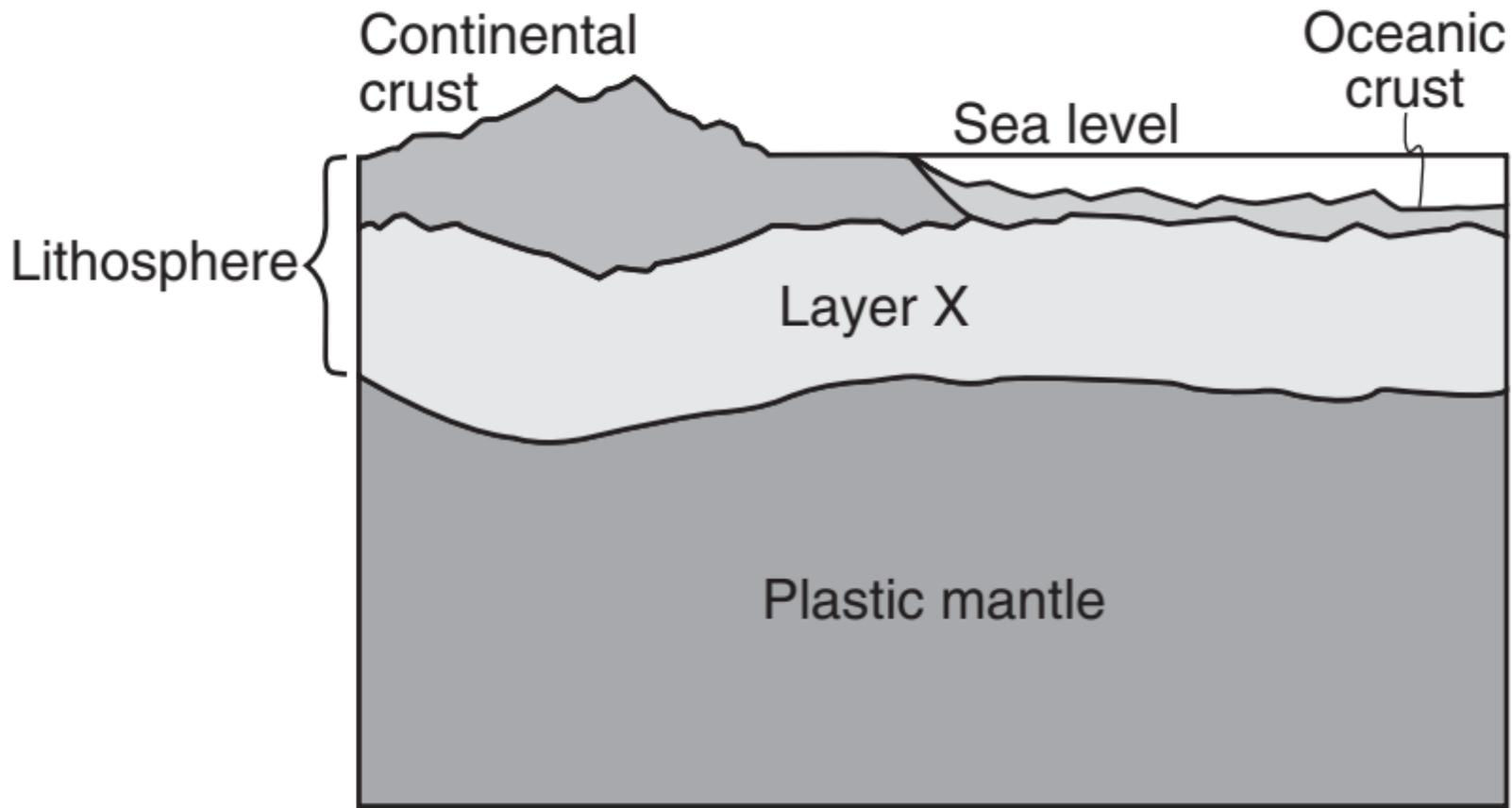
Krakatau
Island
today



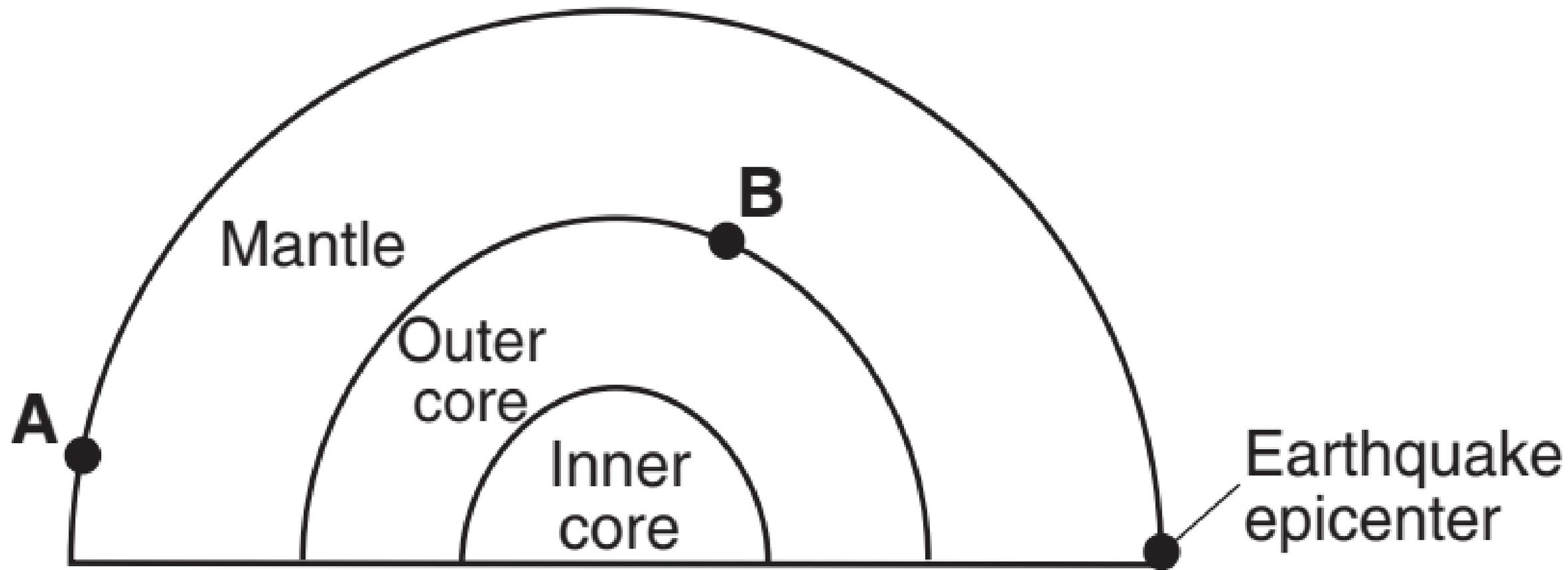




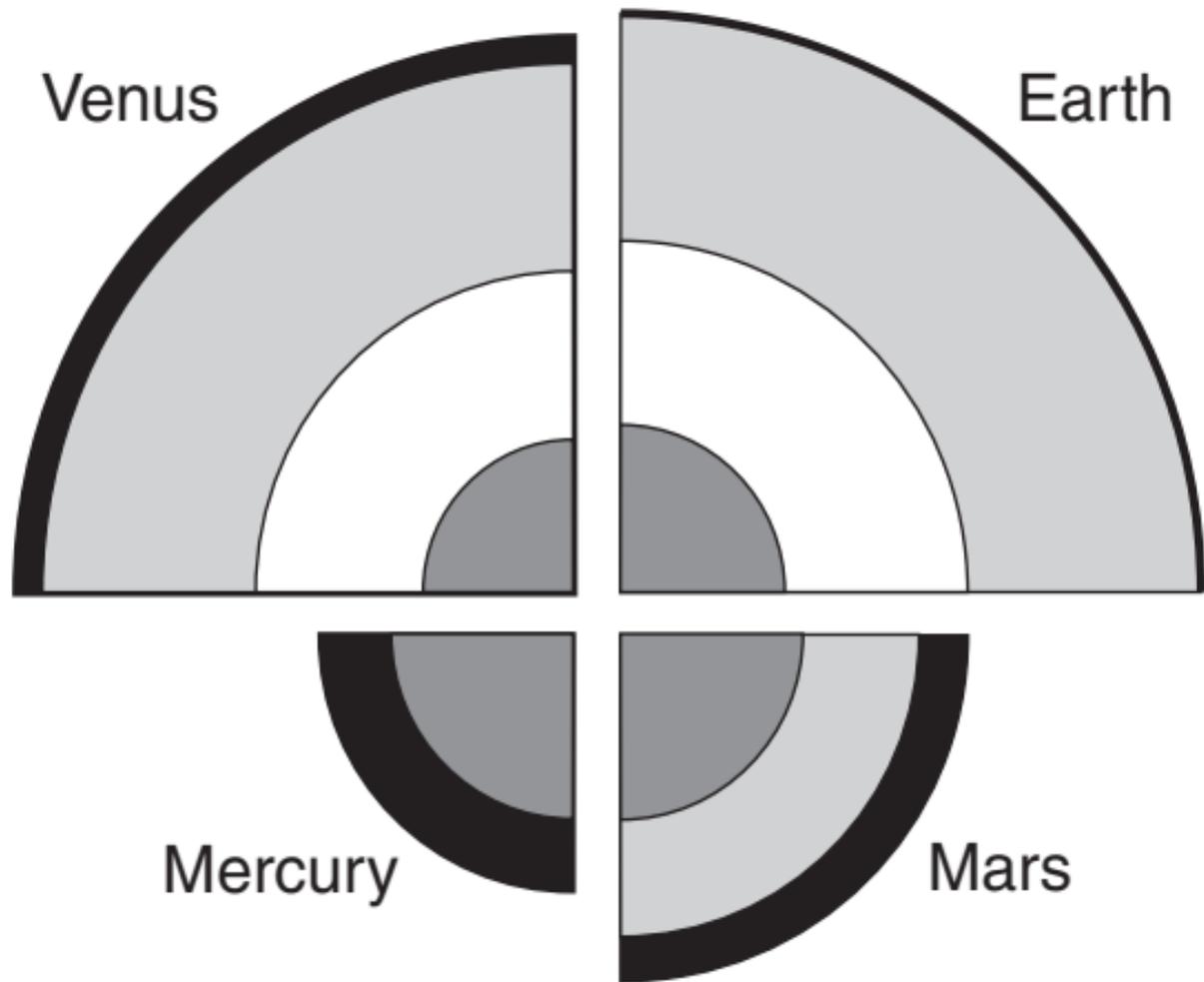


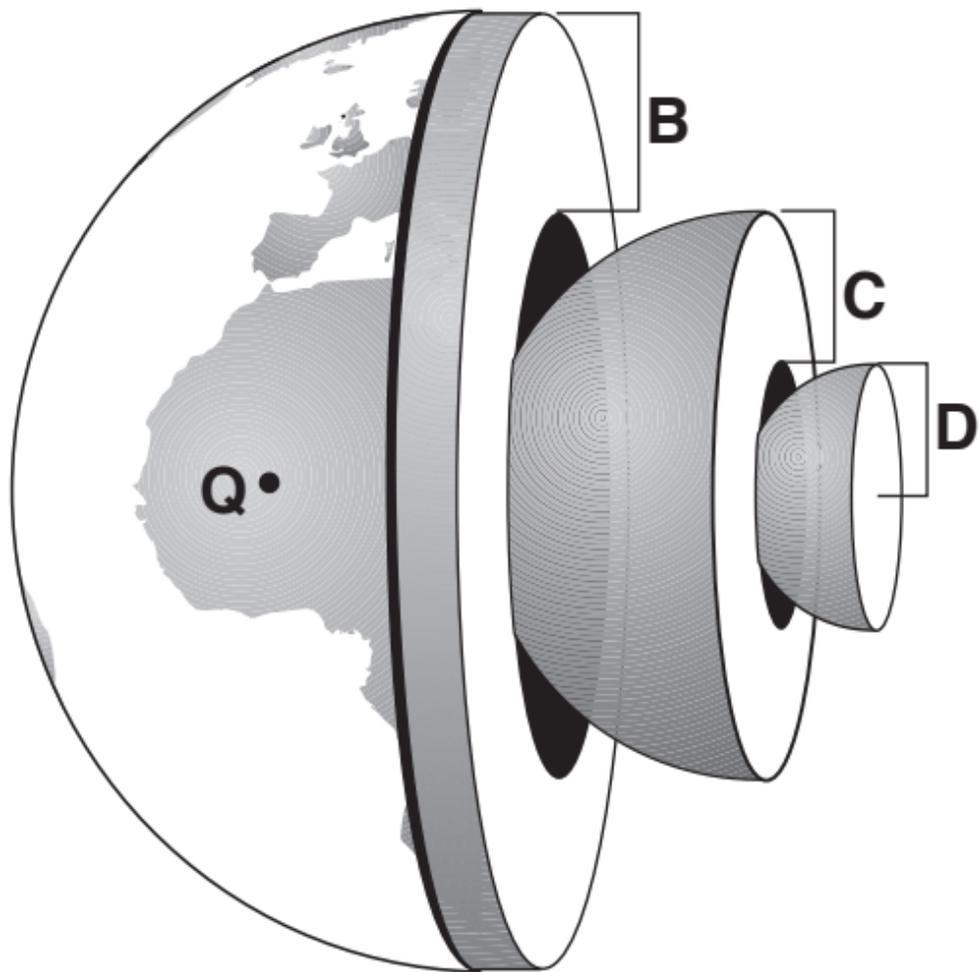


(Not drawn to scale)



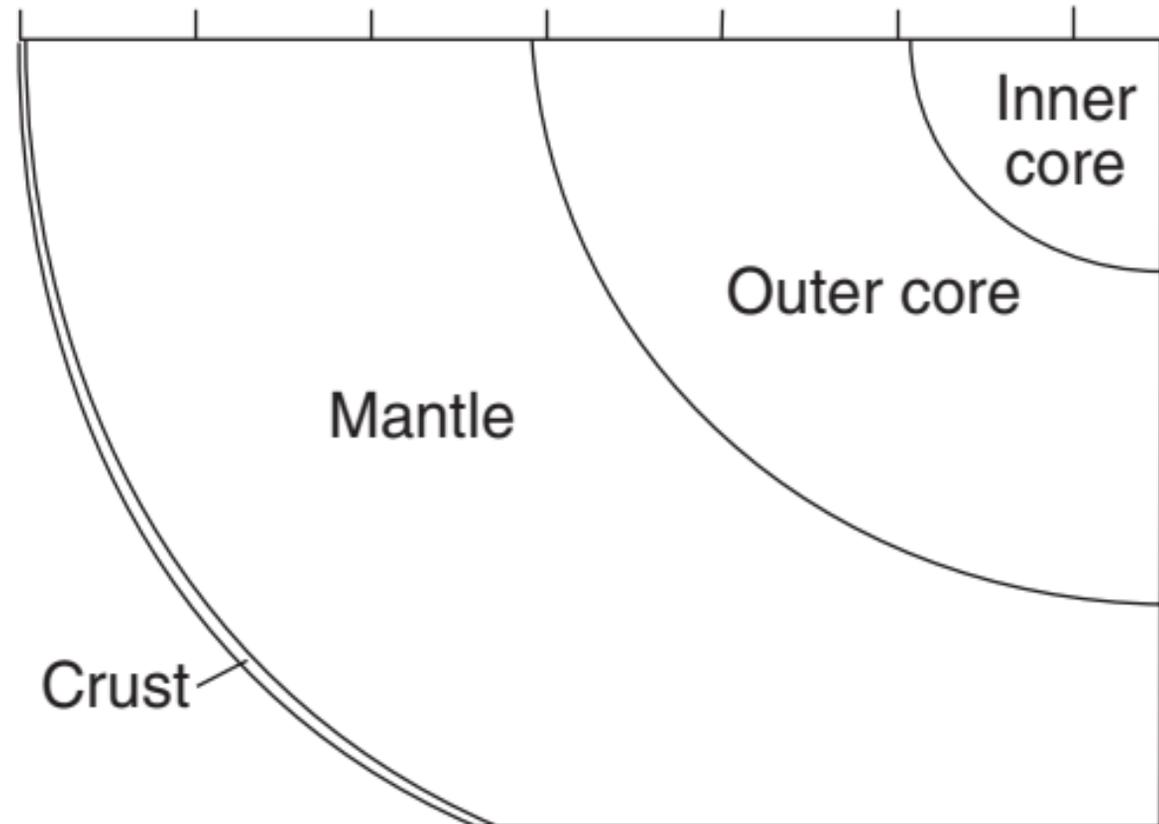
(Not drawn to scale)

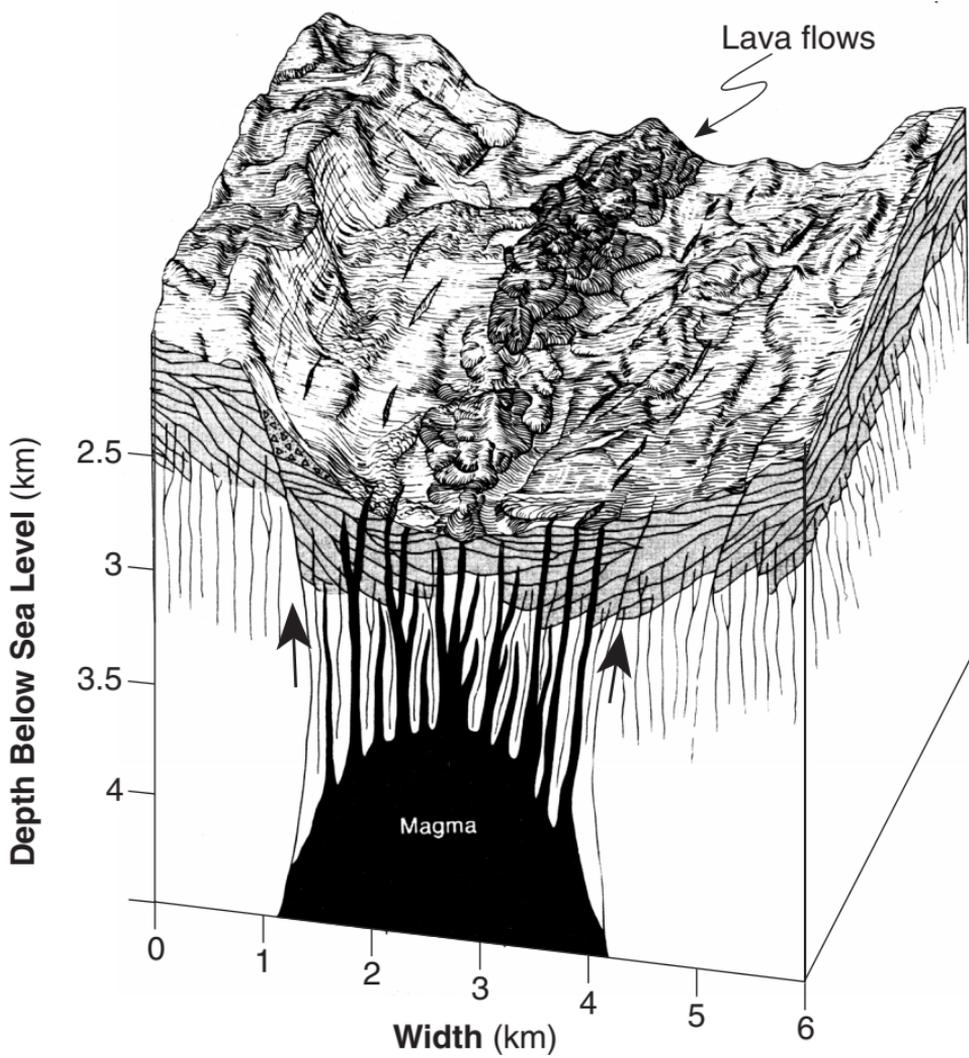


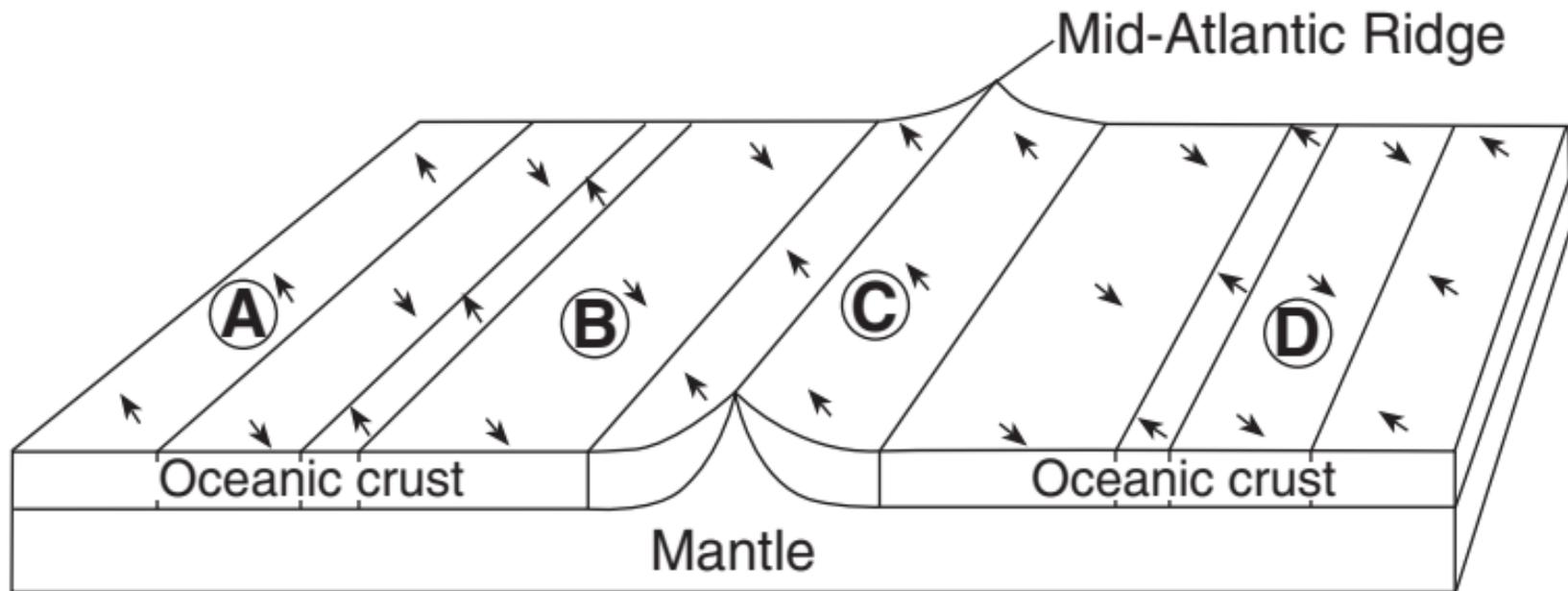


Depth (km)

0 1000 2000 3000 4000 5000 6000

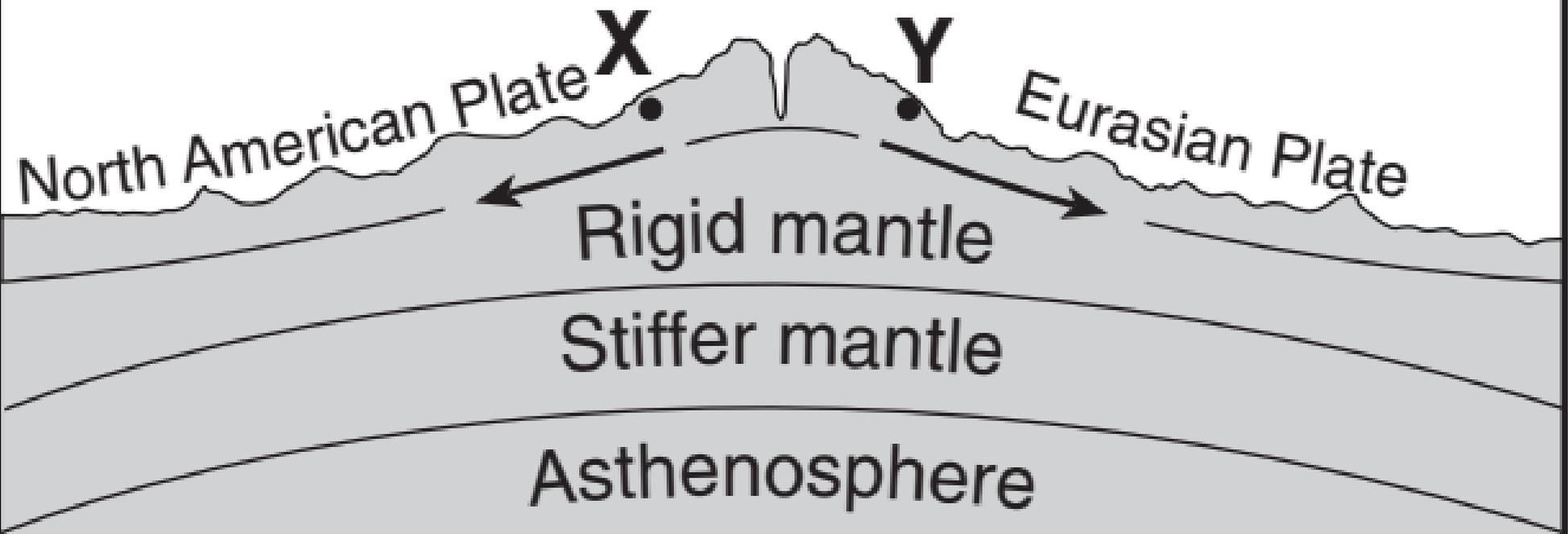






Key	
Magnetic Polarity of the Bedrock	
↗ Normal	↘ Reversed

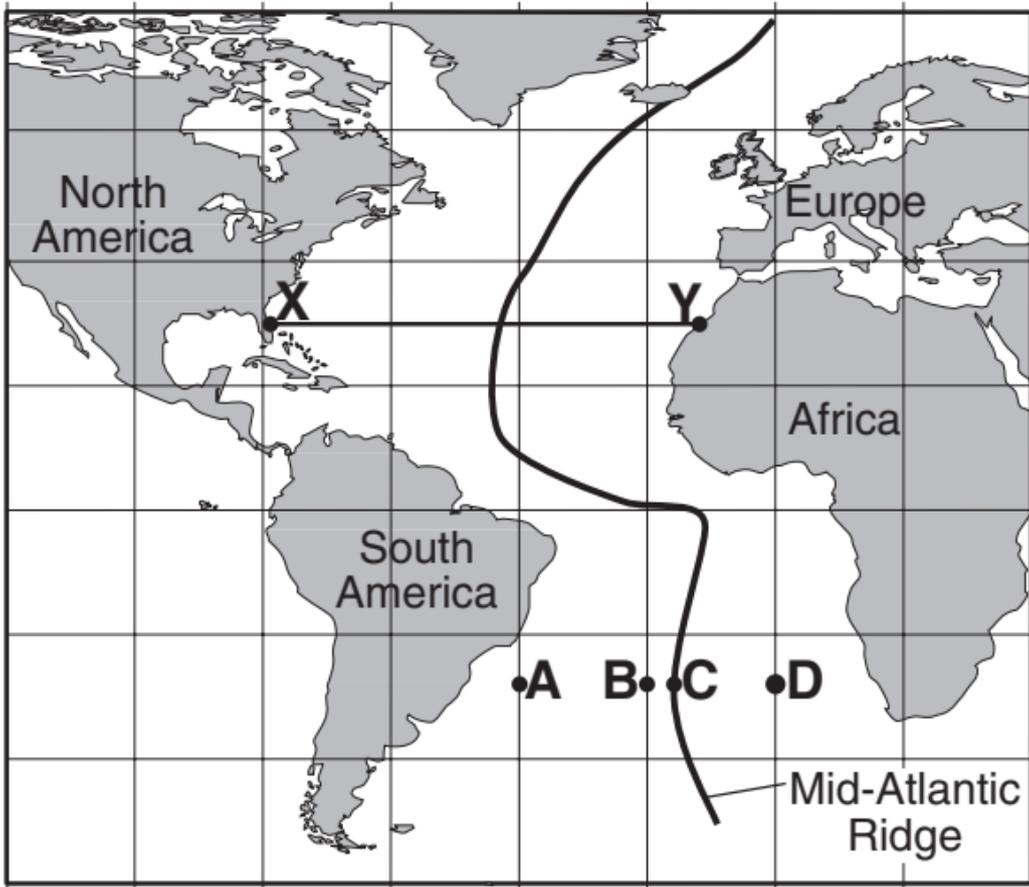
Atlantic Ocean





0 400 800 1,200 km

120° W 100° W 80° W 60° W 40° W 20° W 0 20° E 40° E



North
America

Europe

Africa

South
America

Mid-Atlantic
Ridge

X

Y

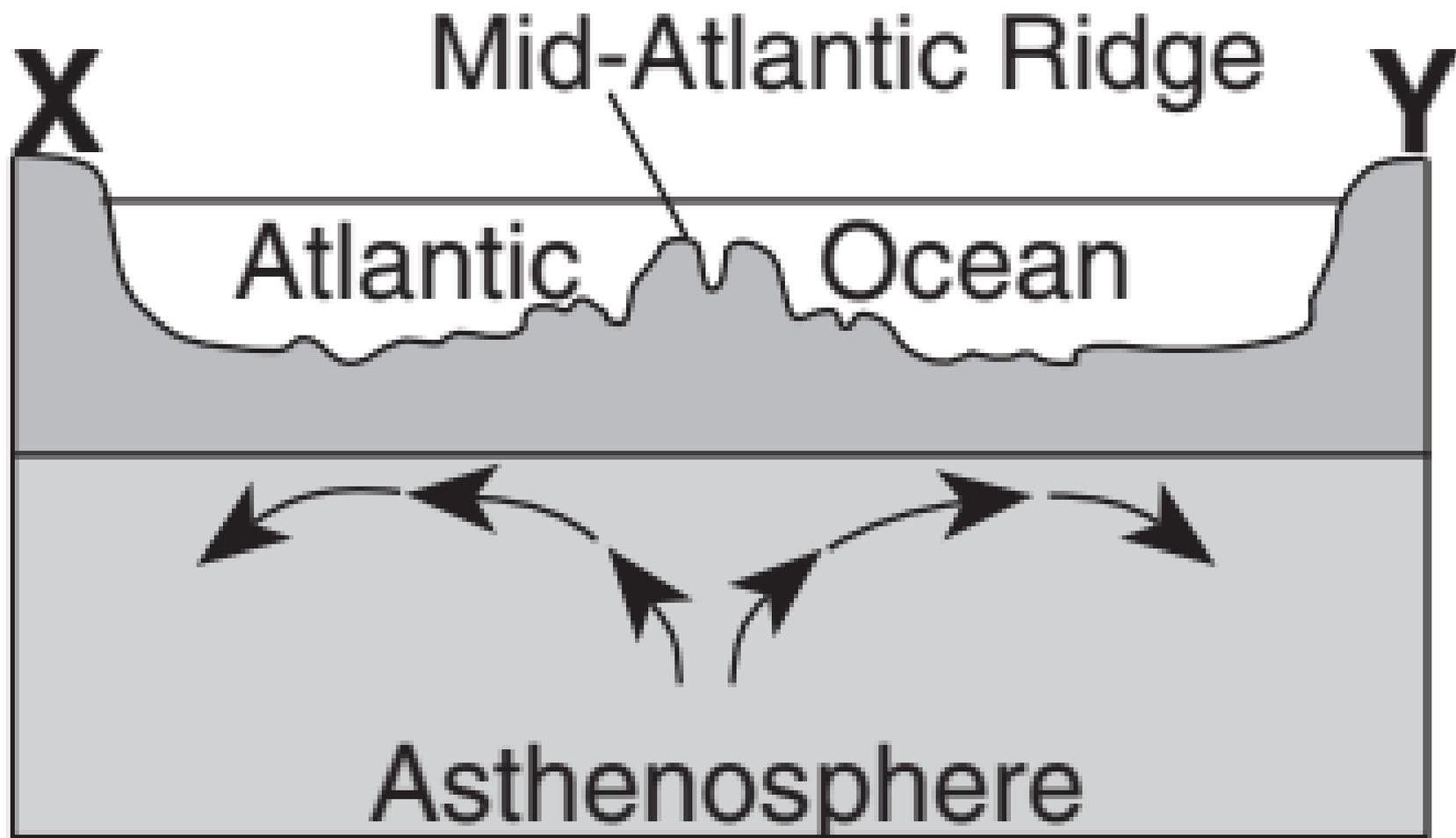
A

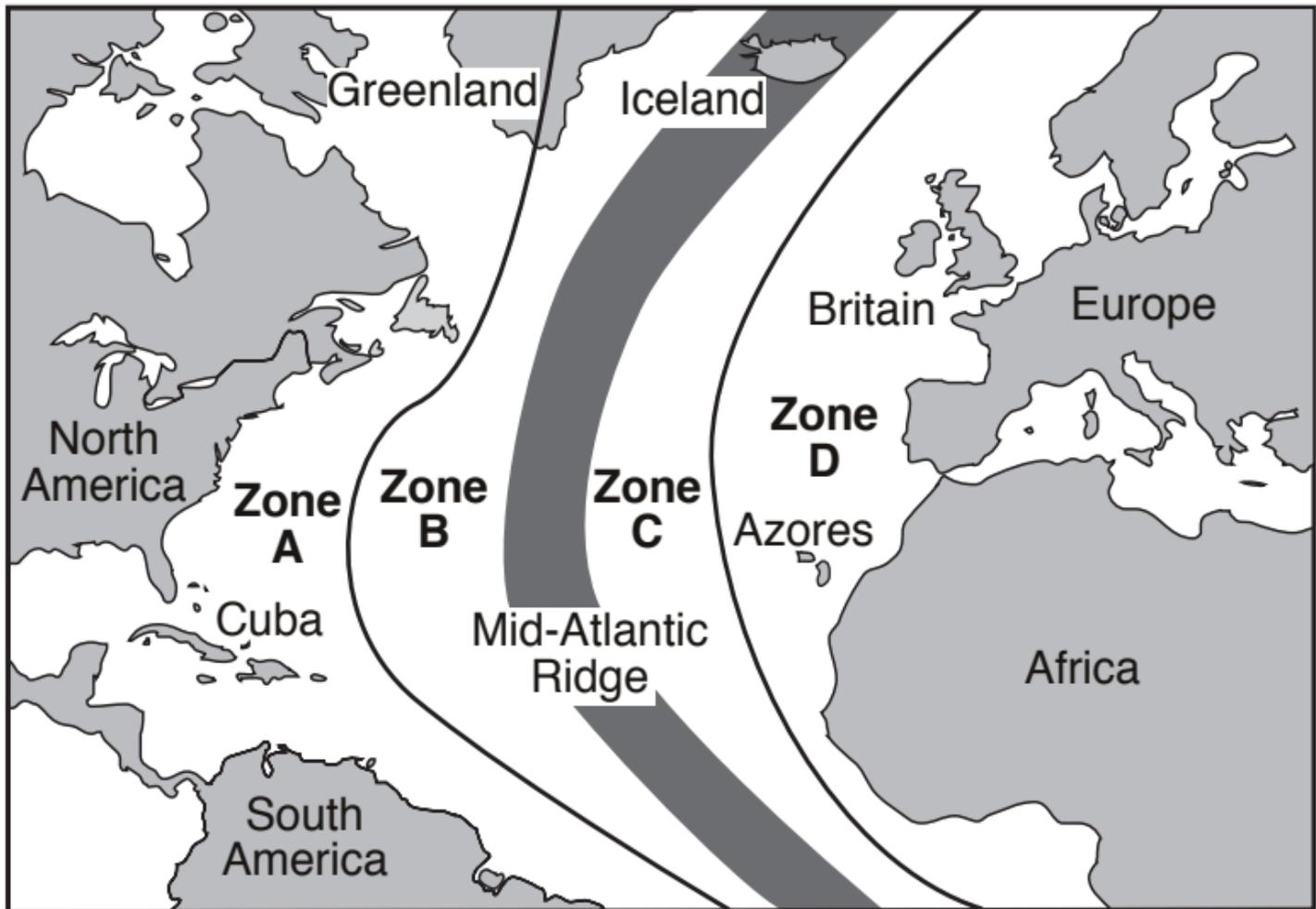
B

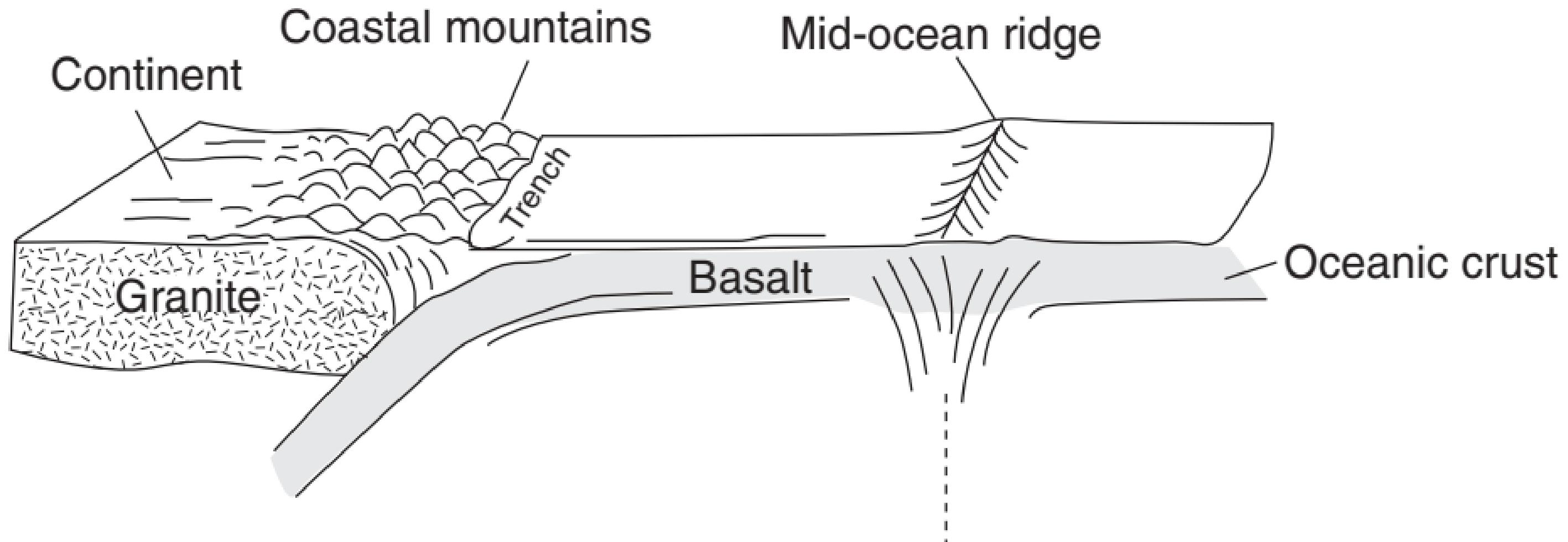
C

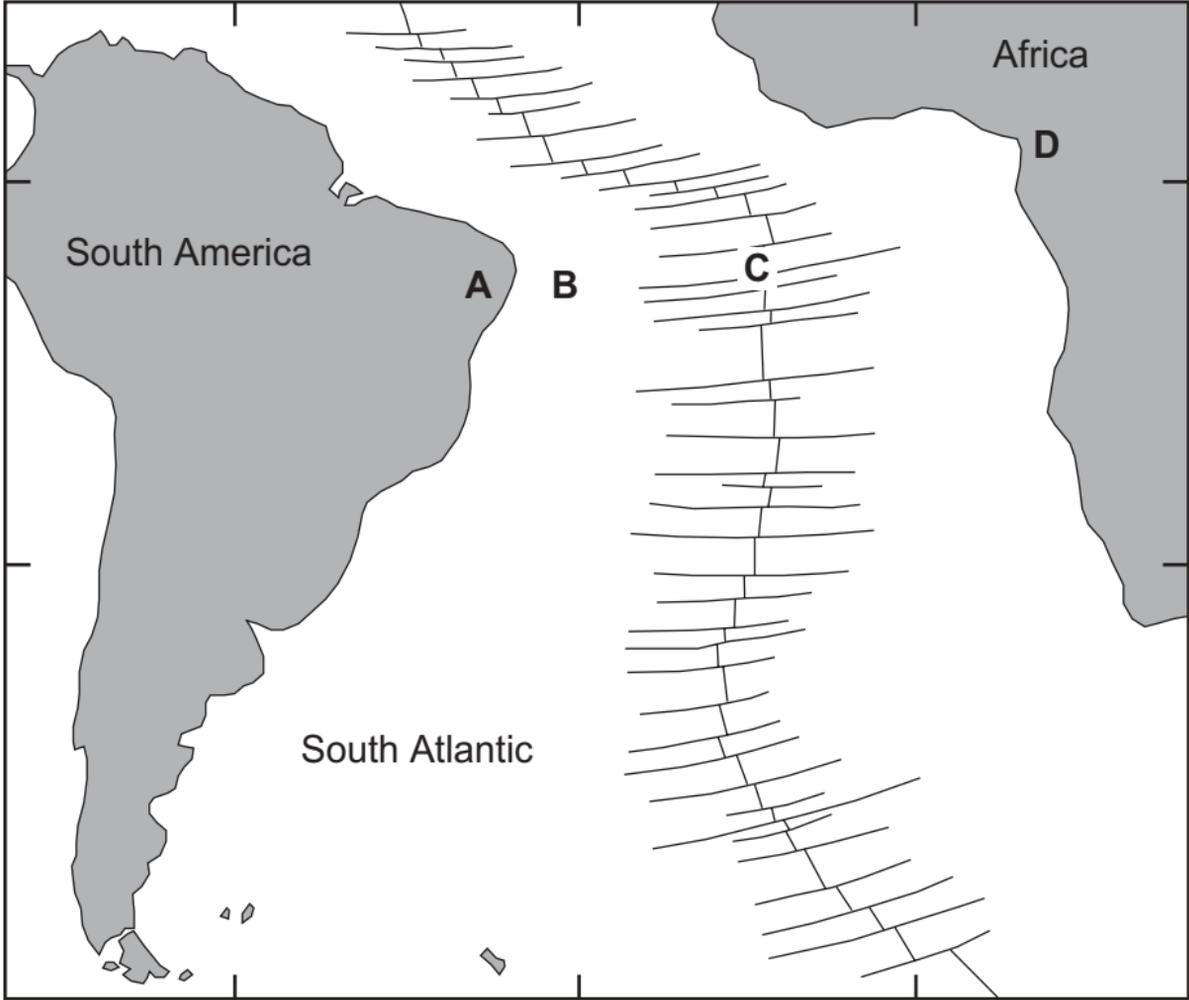
D

120° W 100° W 80° W 60° W 40° W 20° W 0 20° E 40° E









Africa

D

South America

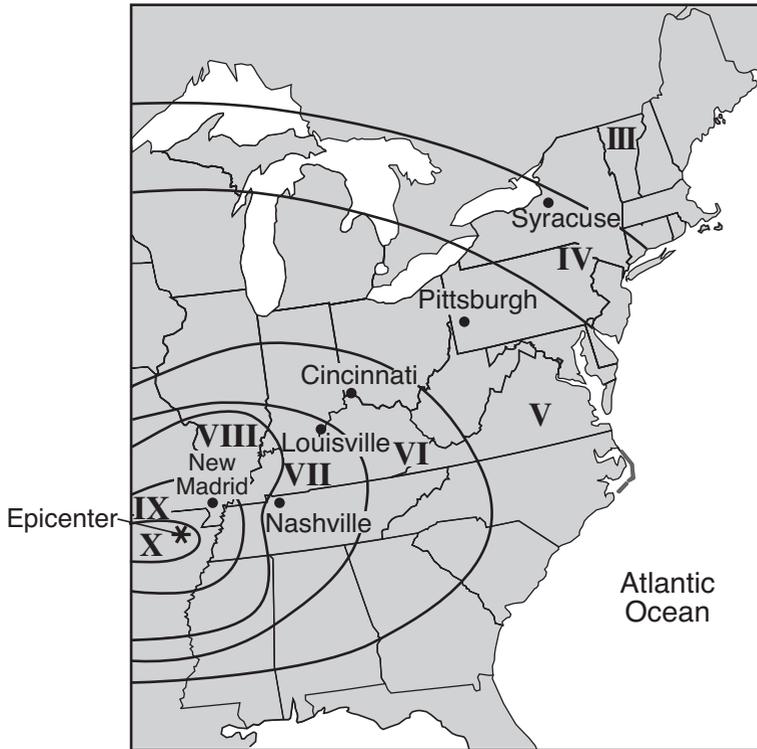
A

B

C

South Atlantic

Earthquake Intensity with Modified Mercalli Scale

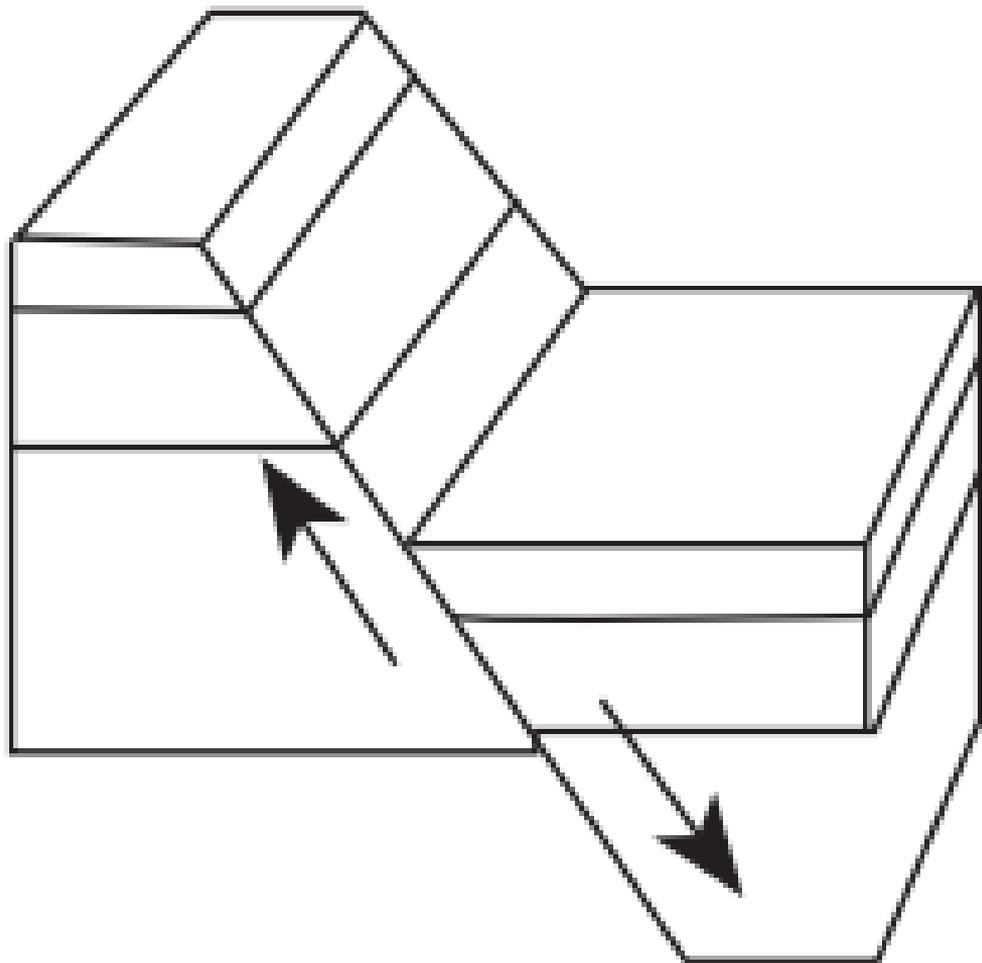


Modified Mercalli Intensity Scale

I:	Not felt except under unusual conditions
II:	Felt by only a few persons Suspended objects might swing
III:	Quite noticeable indoors
IV:	Dishes and windows rattle
V:	Felt by nearly everyone Some dishes and windows break
VI:	Furniture moves Some plaster falls
VII:	Everybody runs outdoors Some chimneys break
VIII:	Chimneys, smokestacks, and walls fall Heavy furniture is overturned
IX:	Buildings shift off foundations Ground cracks
X:	Most ordinary structures are destroyed Landslides are common
XI:	Few structures remain standing Bridges are destroyed Broad cracks form in the ground
XII:	Damage is total Objects are thrown upward into the air

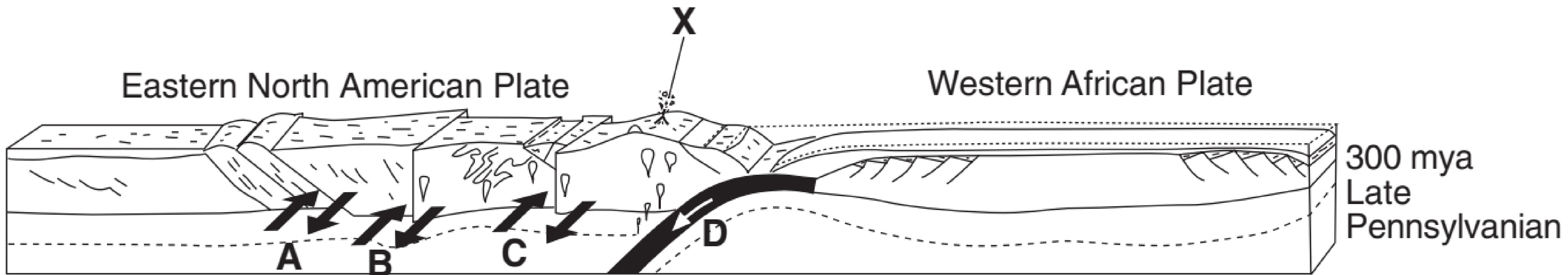
Modified Mercalli Intensity Scale

I	Instrumental: detected only by instruments	VII	Very strong: noticed by people in autos Damage to poor construction
II	Very feeble: noticed only by people at rest	VIII	Destructive: chimneys fall, much damage in substantial buildings, heavy furniture overturned
III	Slight: felt by people at rest Like passing of a truck	IX	Ruinous: great damage to substantial structures Ground cracked, pipes broken
IV	Moderate: generally perceptible by people in motion Loose objects disturbed	X	Disastrous: many buildings destroyed
V	Rather strong: dishes broken, bells rung, pendulum clocks stopped People awakened	XI	Very disastrous: few structures left standing
VI	Strong: felt by all, some people frightened Damage slight, some plaster cracked	XII	Catastrophic: total destruction

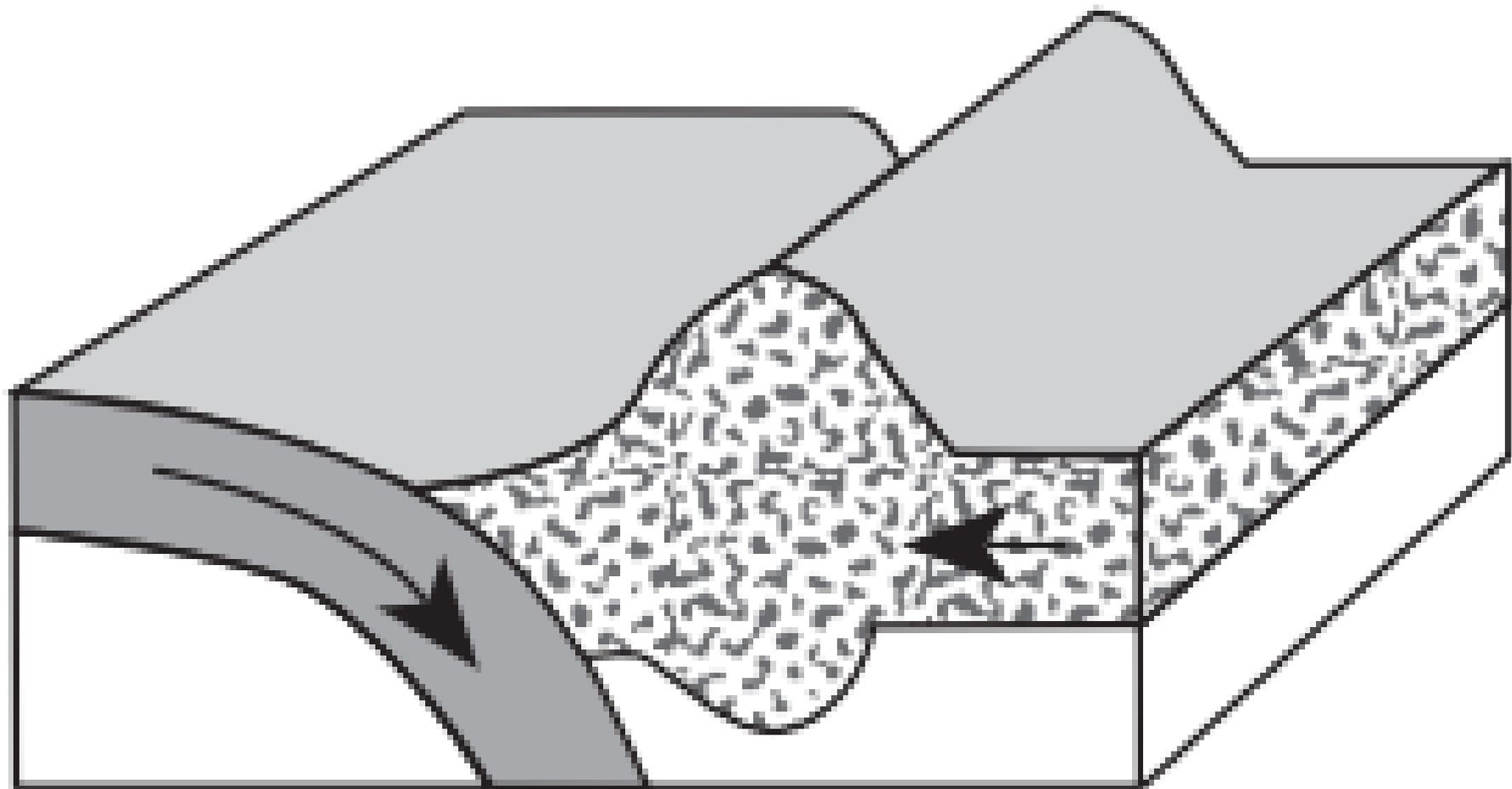


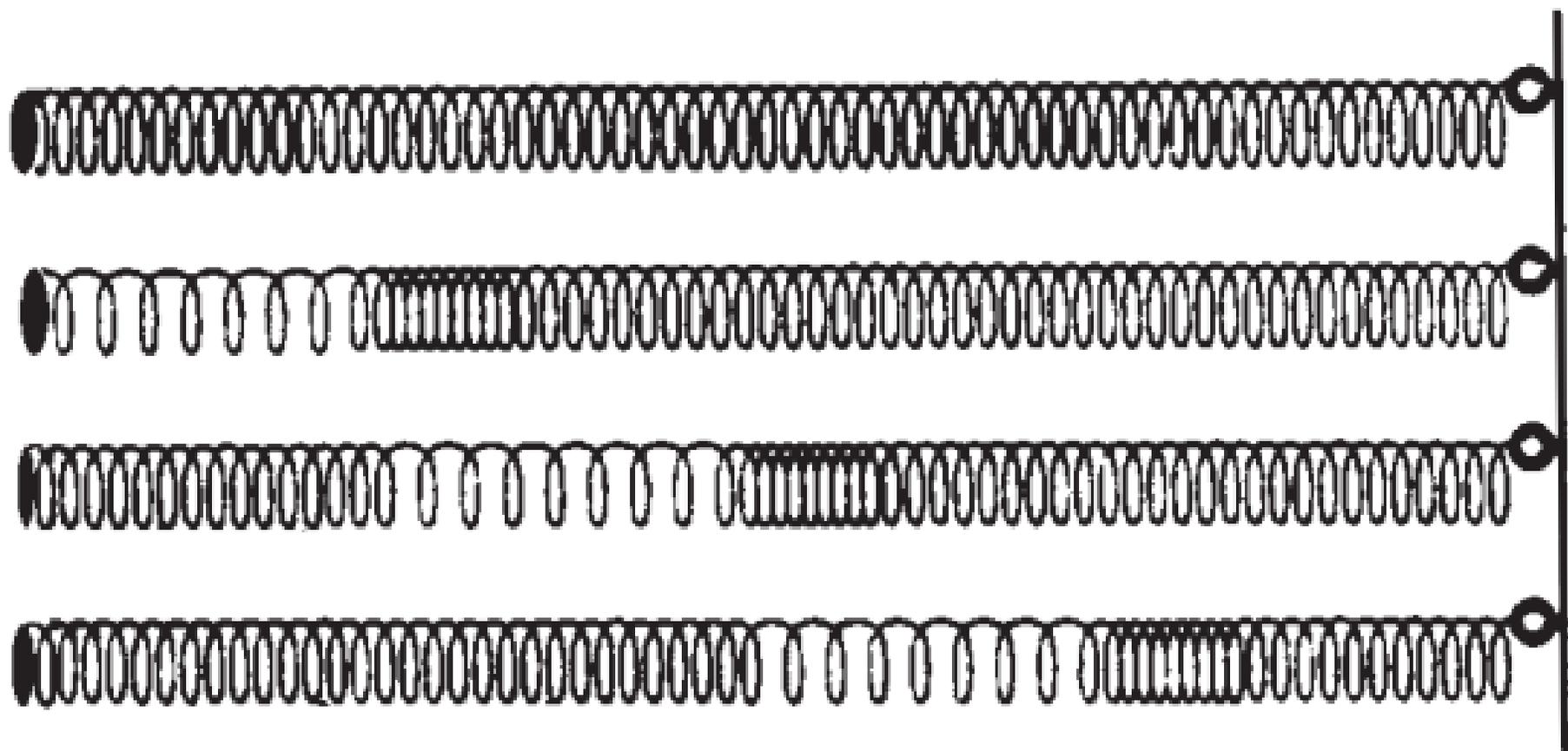
Eastern North American Plate

Western African Plate



300 mya
Late
Pennsylvanian

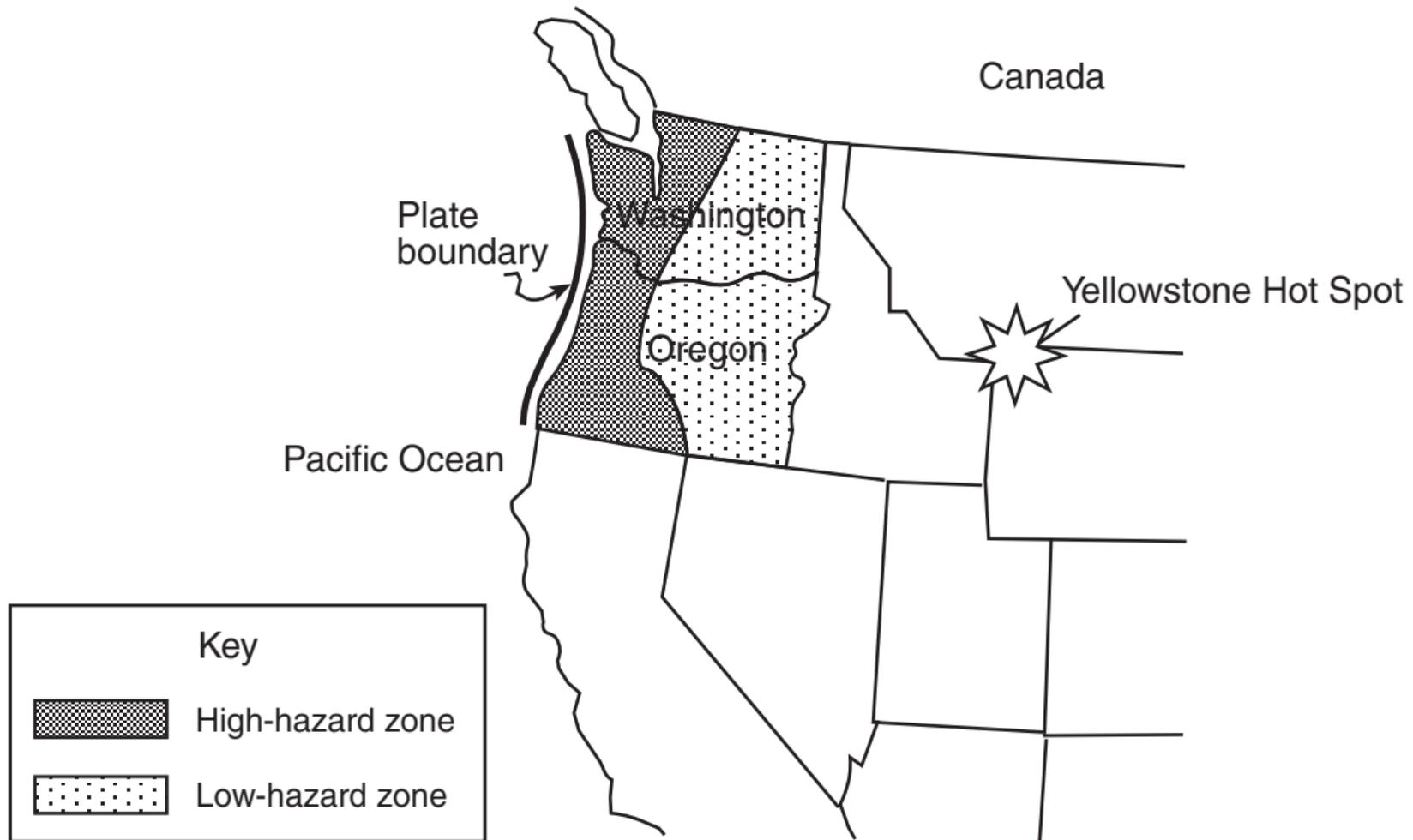


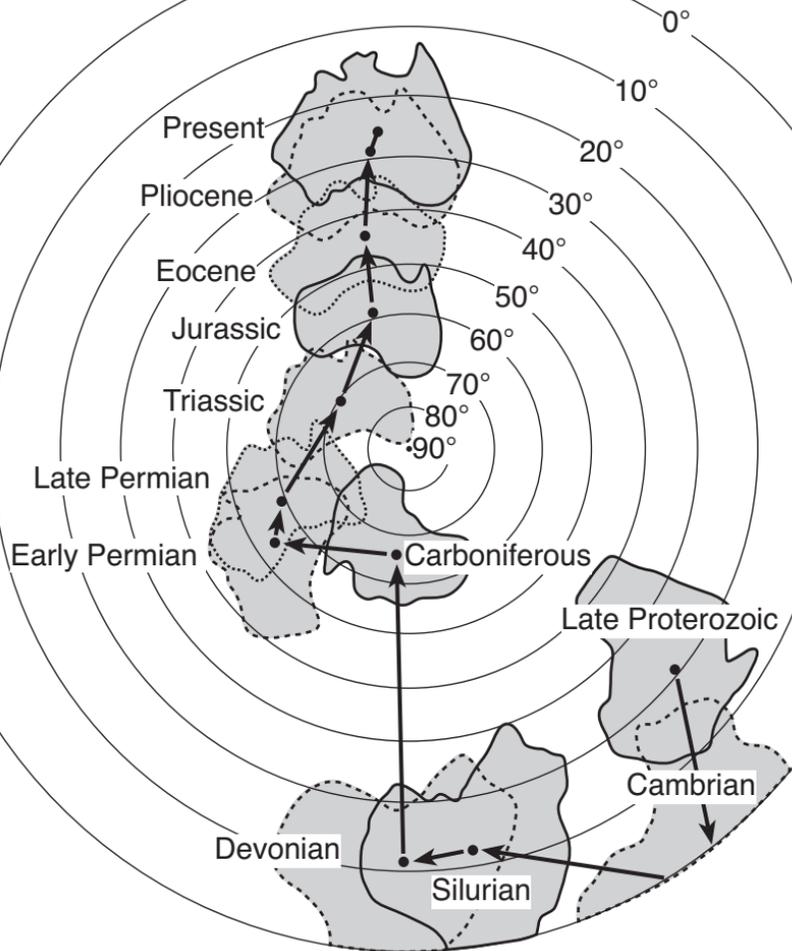


Model A

Data Table

Seismic Station	P-Wave Arrival Time (h:min:s)	S-Wave Arrival Time (h:min:s)	Difference in Arrival Times (h:min:s)	Distance to Epicenter (km)
W	10:50:00	no S-waves arrived		
X	10:42:00	10:46:40		
Y	10:39:20		00:02:40	
Z	10:45:40			6200





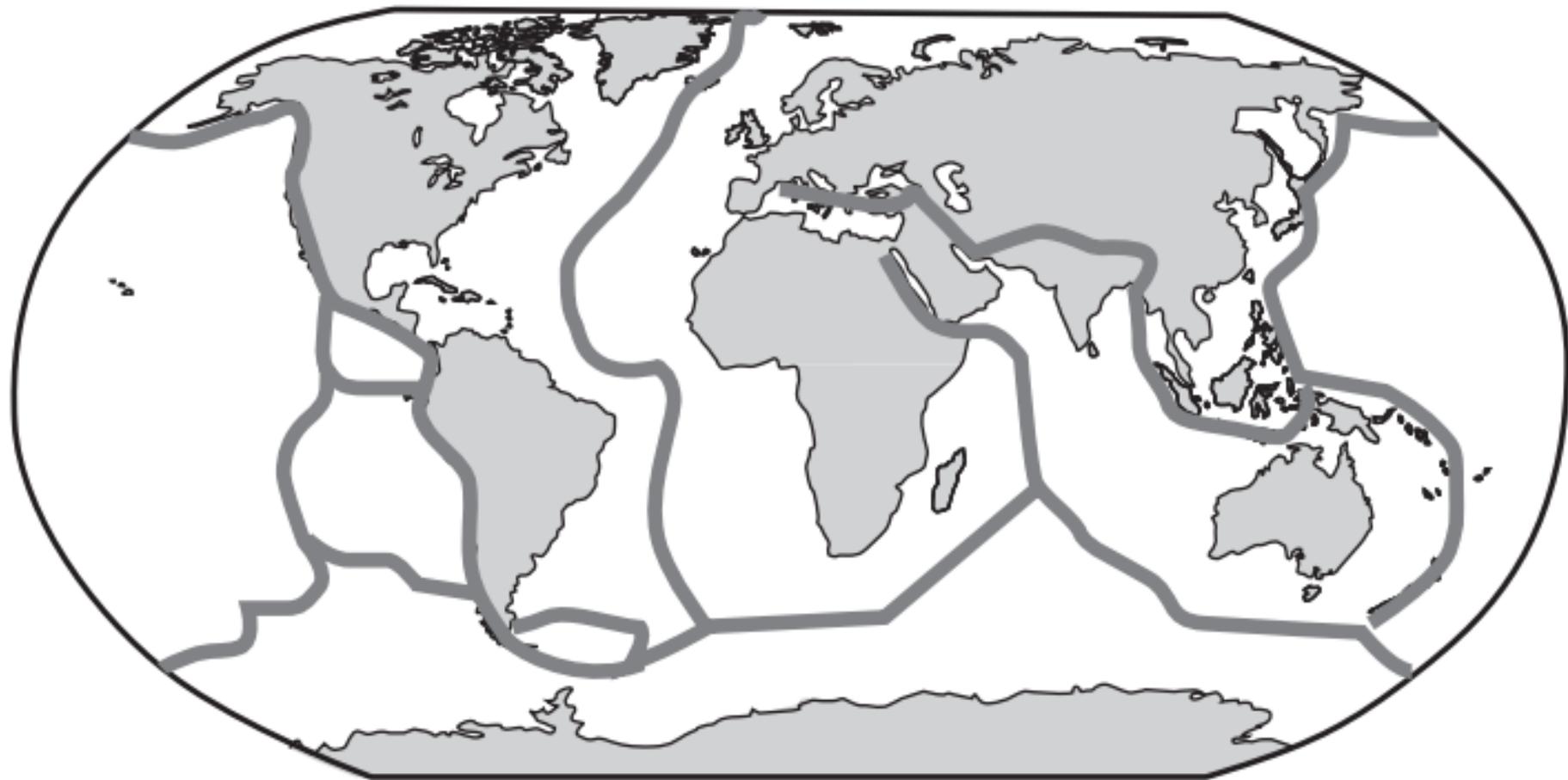


North
America

Pacific
Ocean

South
America

Peru-Chile
Trench



Earth's Crustal Plate Boundaries

one major type is

one major type is

divergent
boundary

where two plates

B

an example is

the Rift Valley
in eastern Africa

one major type is

A

where two plates

move
together

three types are

transform
boundary

where two plates

slide past
one another

an example is

D

where two oceanic
plates collide

this occurs

with subduction

an example is

the Japanese
island arc

where

C

this occurs

without subduction

an example is

the Himalayas

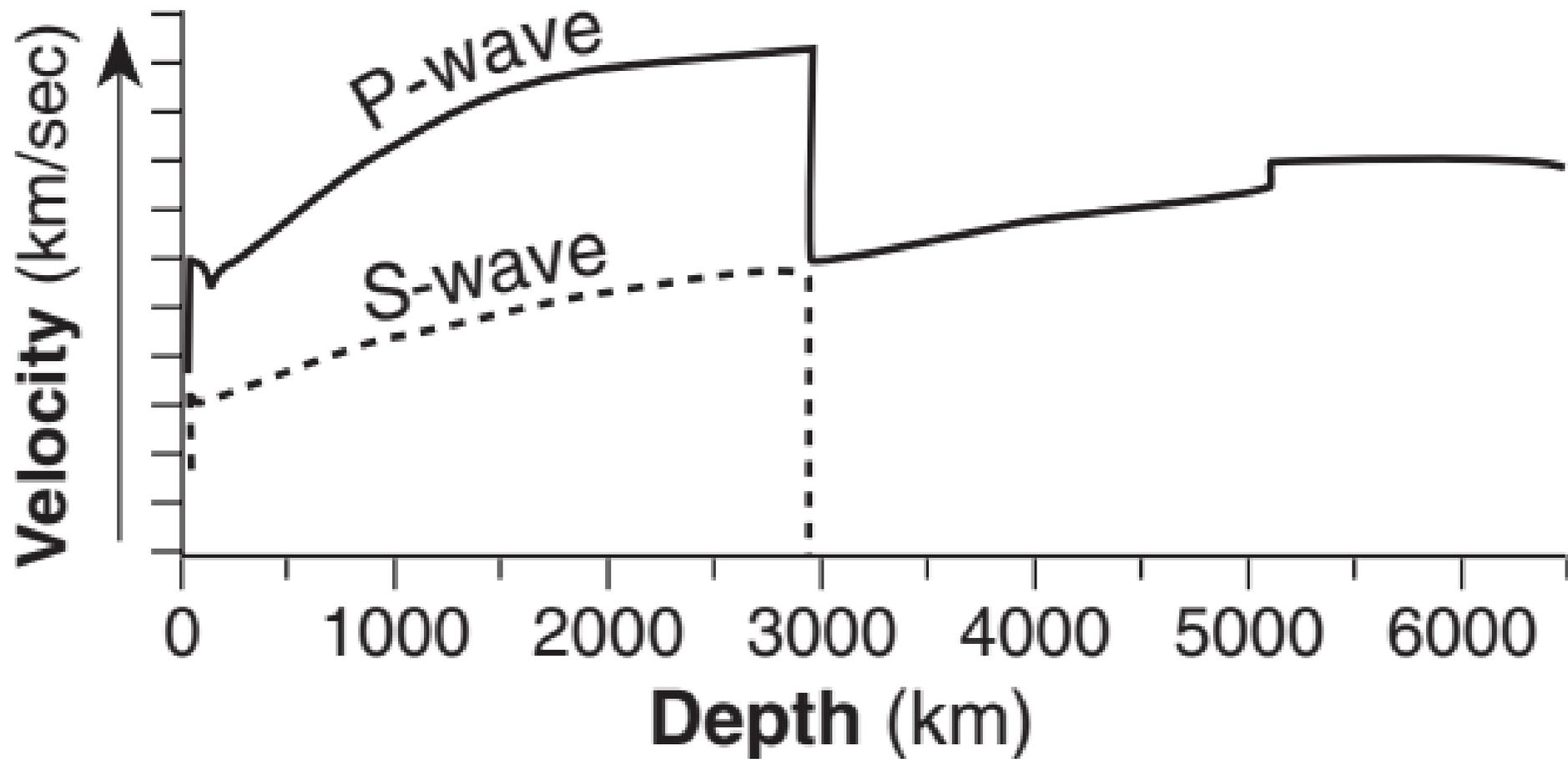
where oceanic and
continental
plates collide

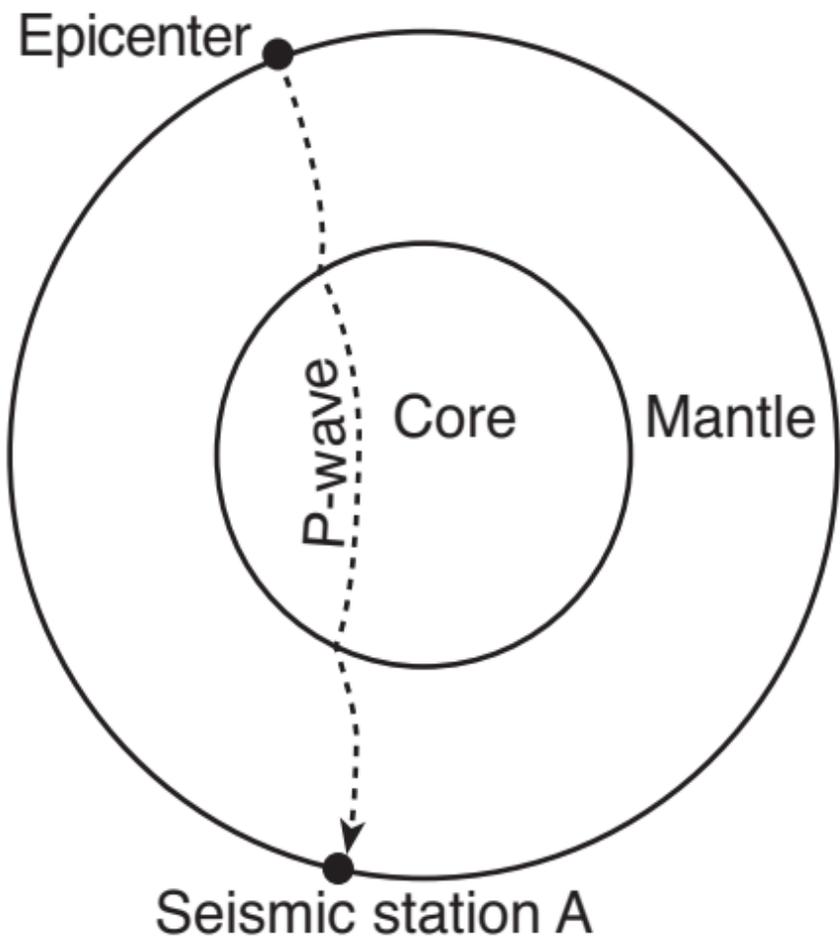
this occurs

with subduction

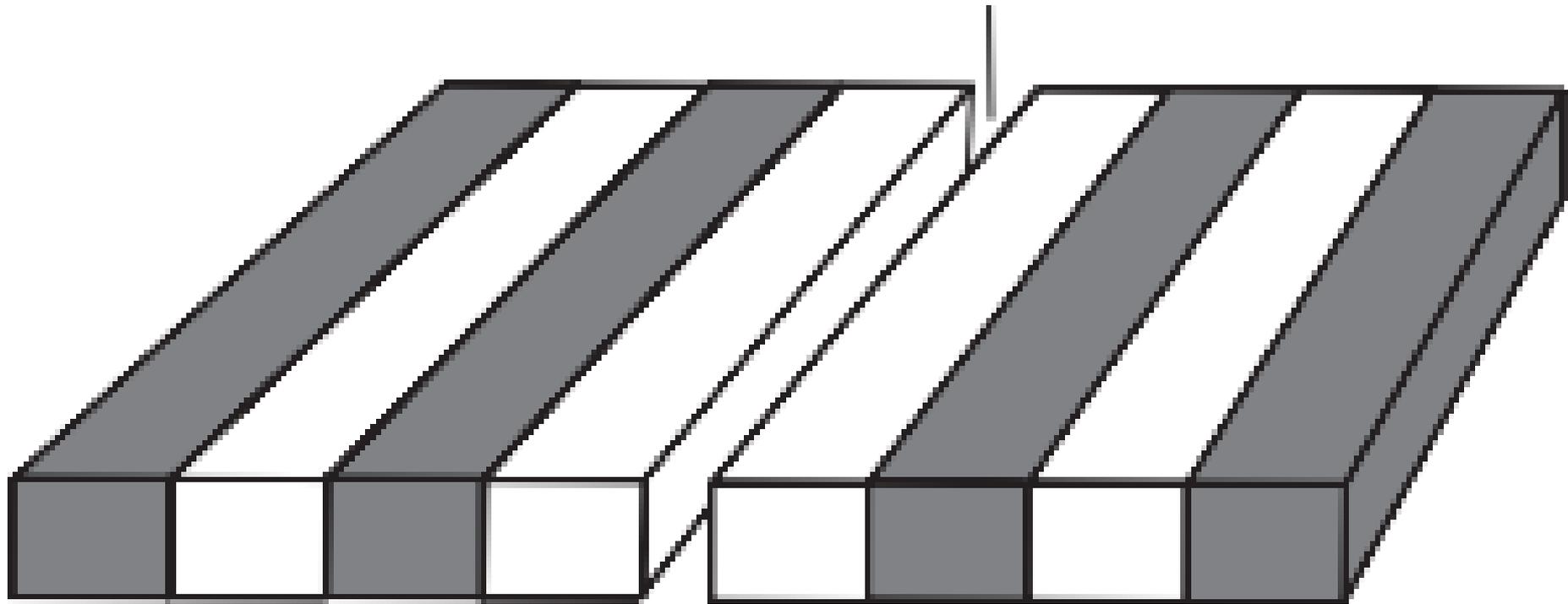
an example is

E

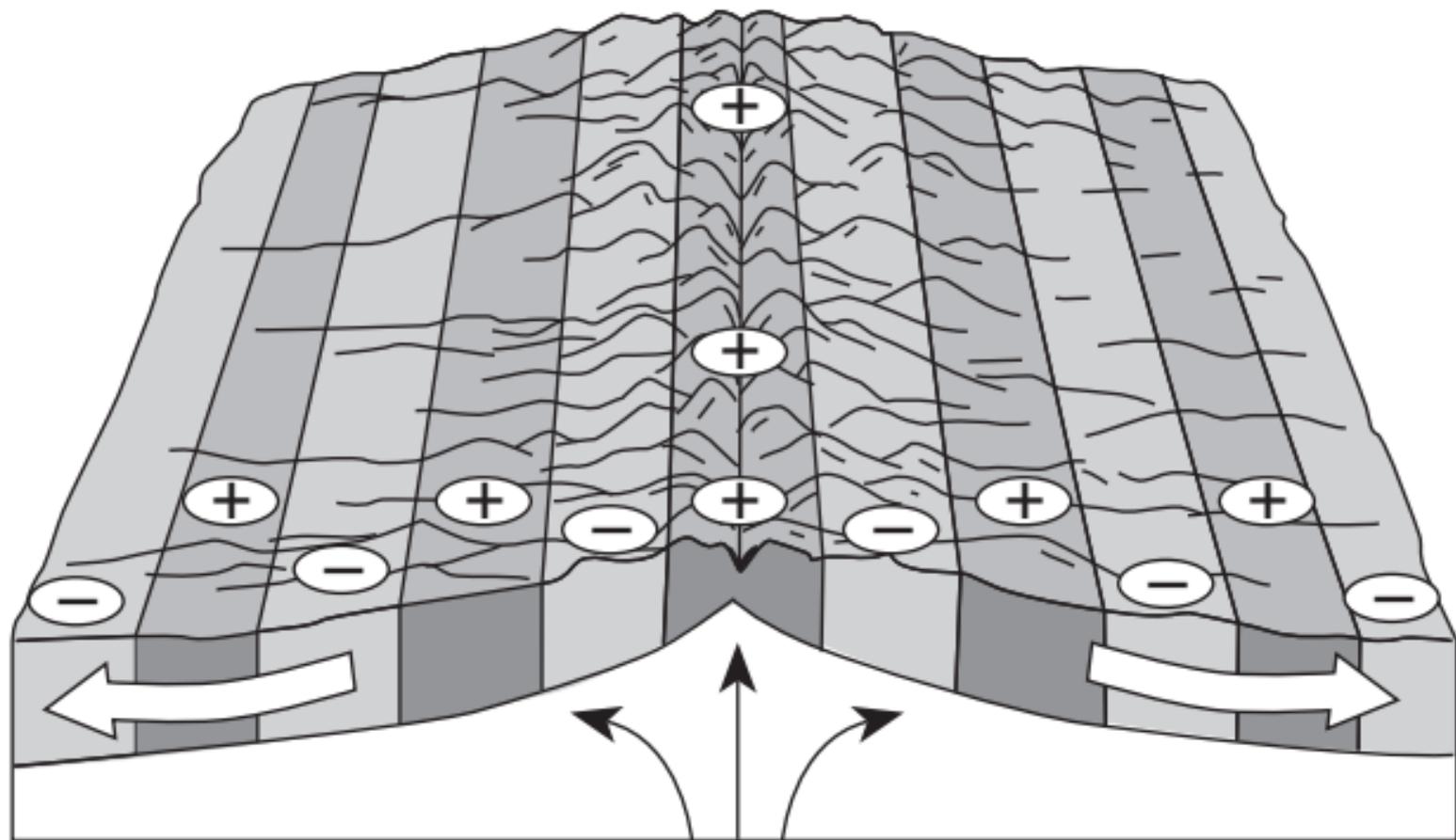


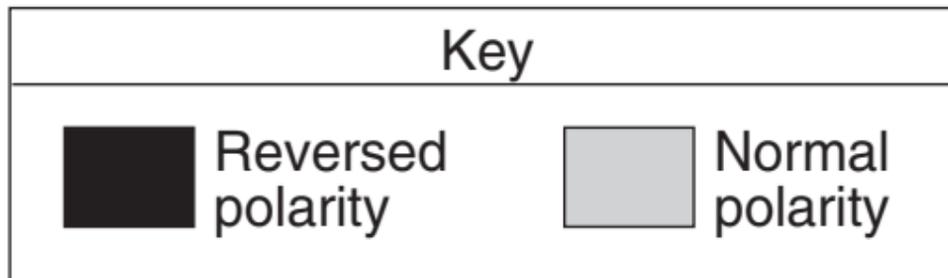
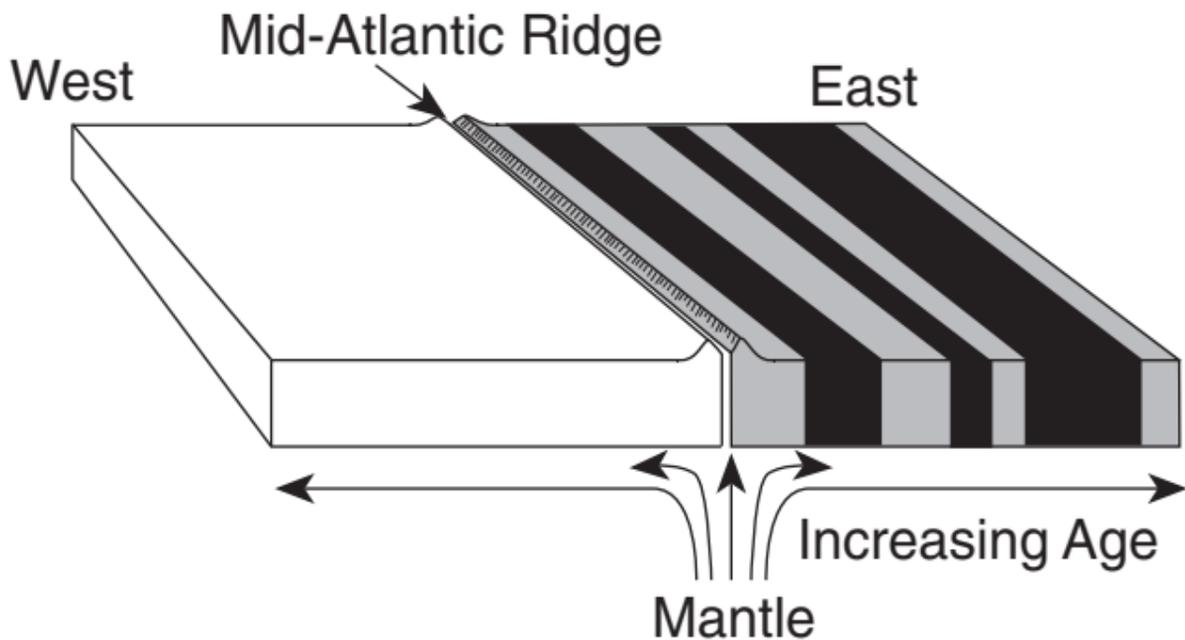


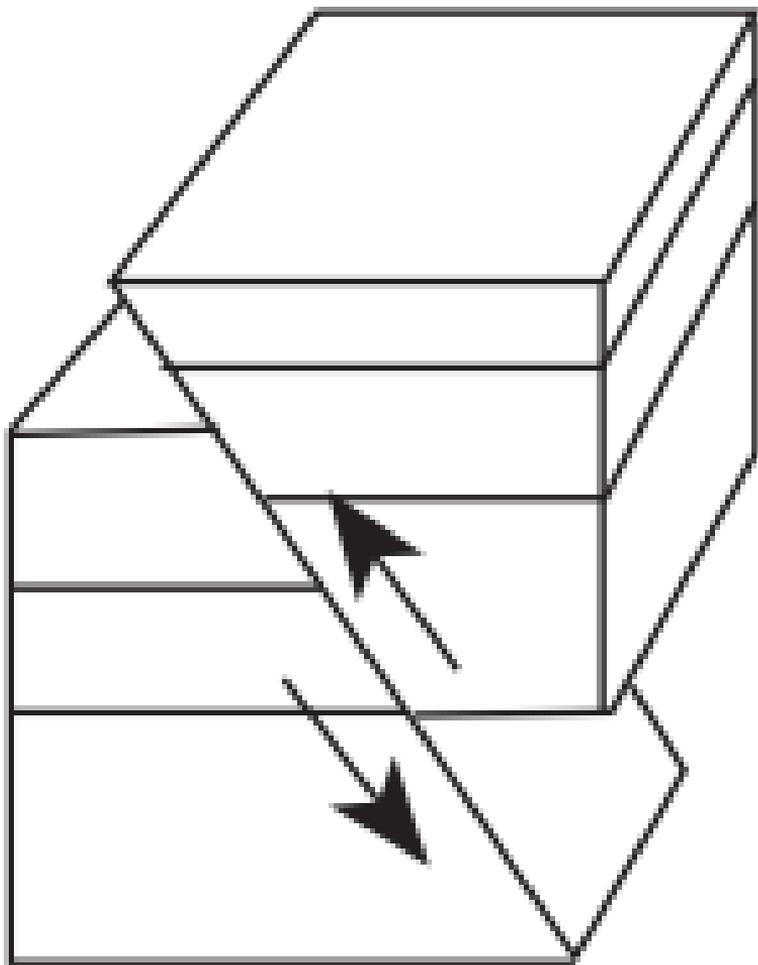
Mid-Indian Ridge



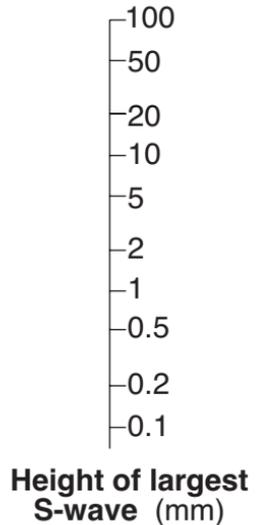
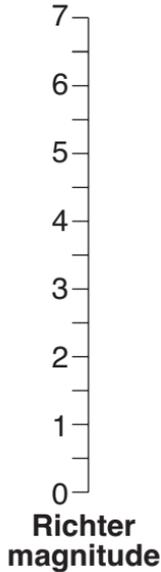
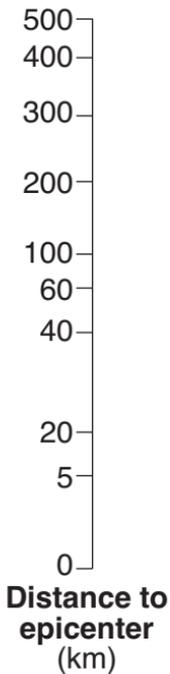
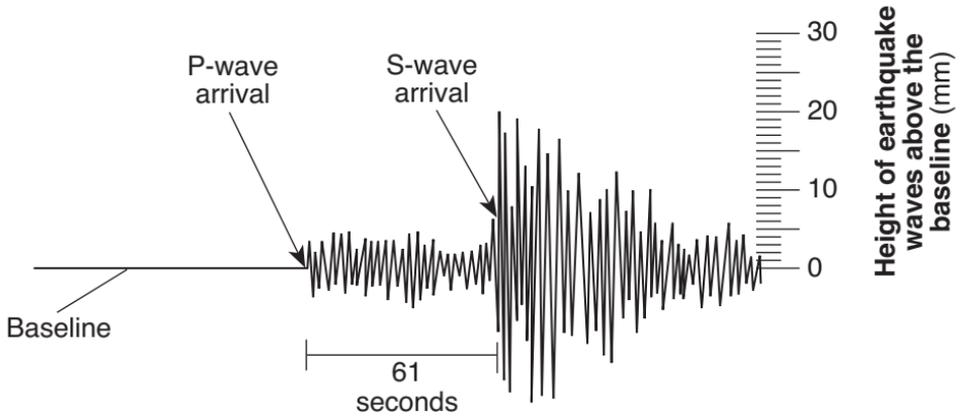
Ridge



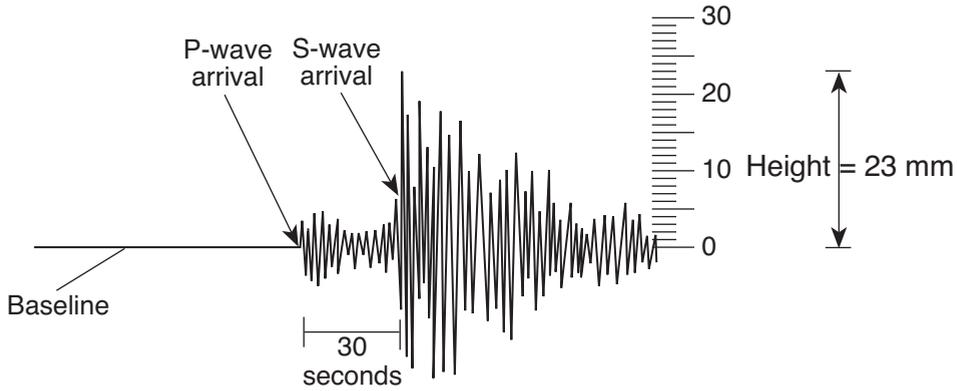




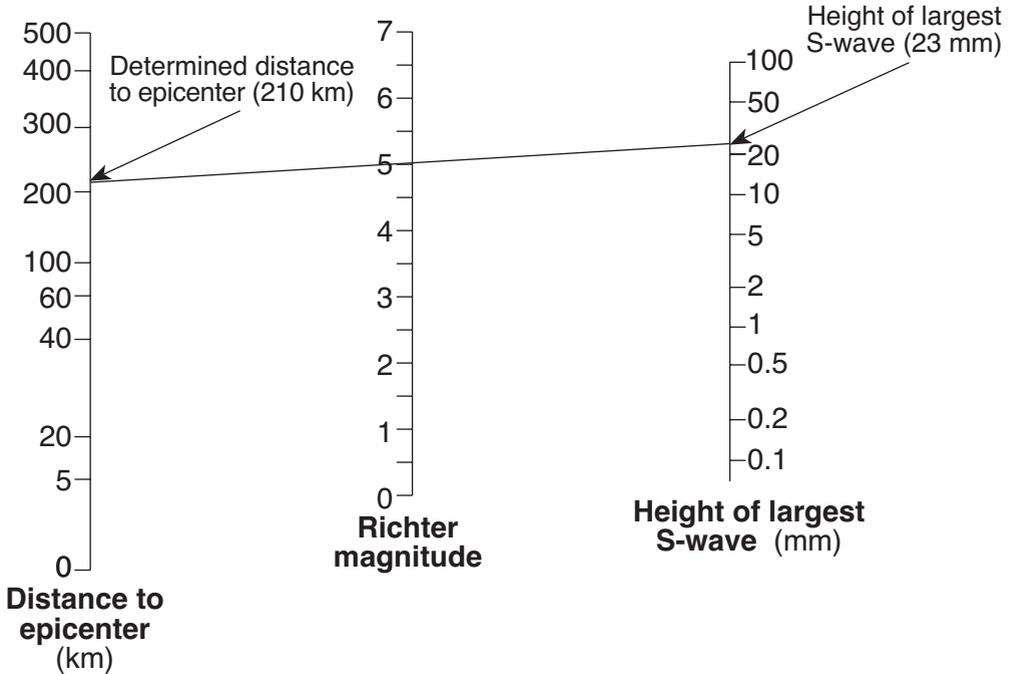
Seismogram of an Earthquake

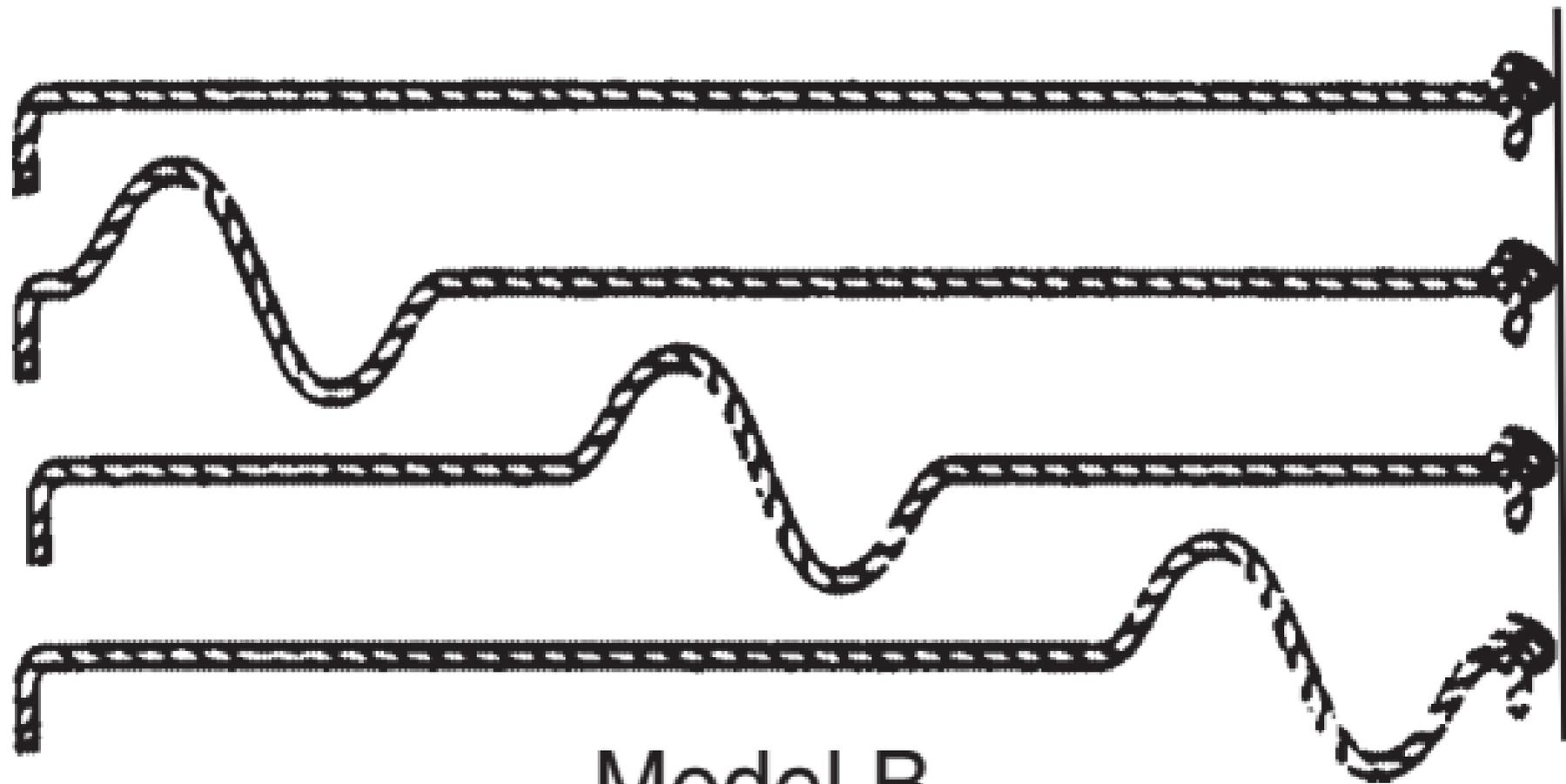


Example of a Seismogram of an Earthquake

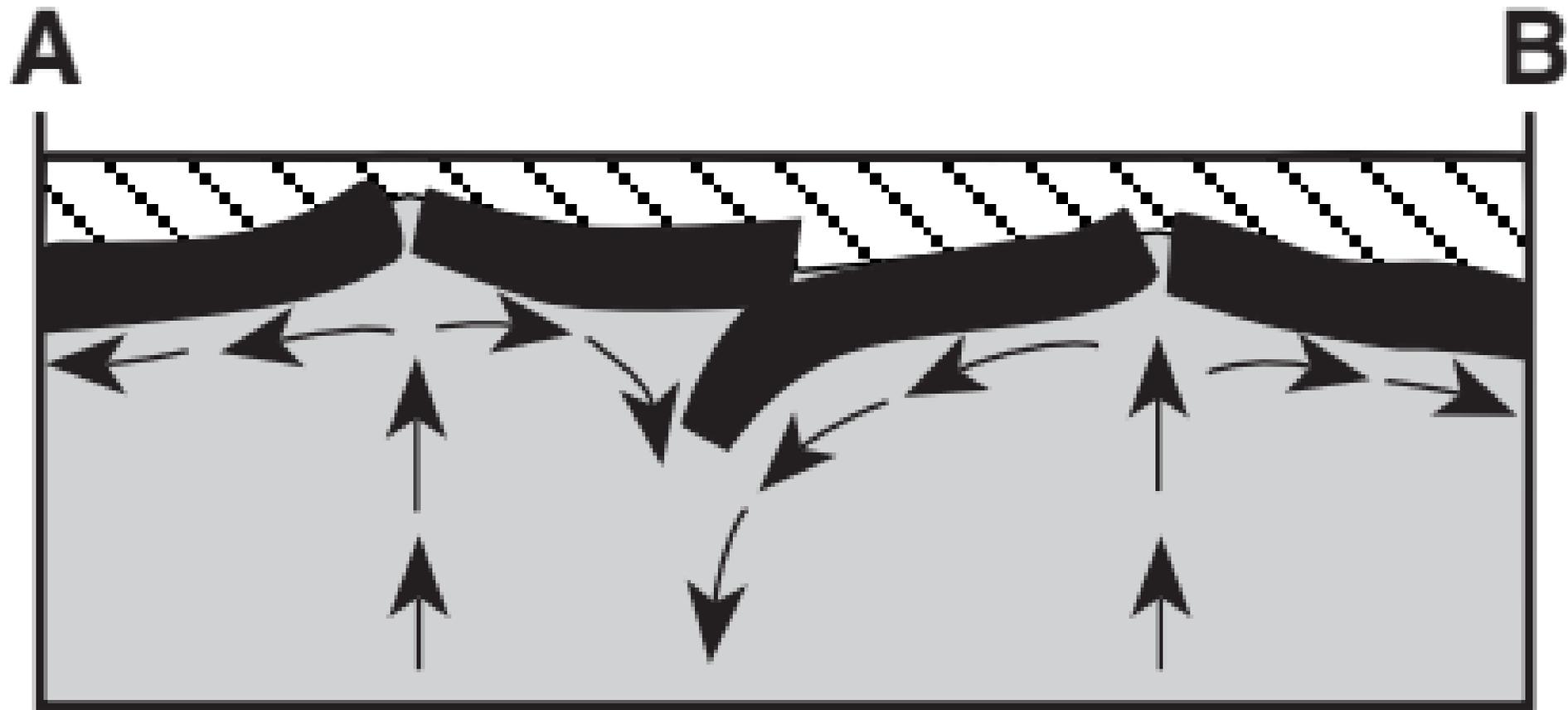


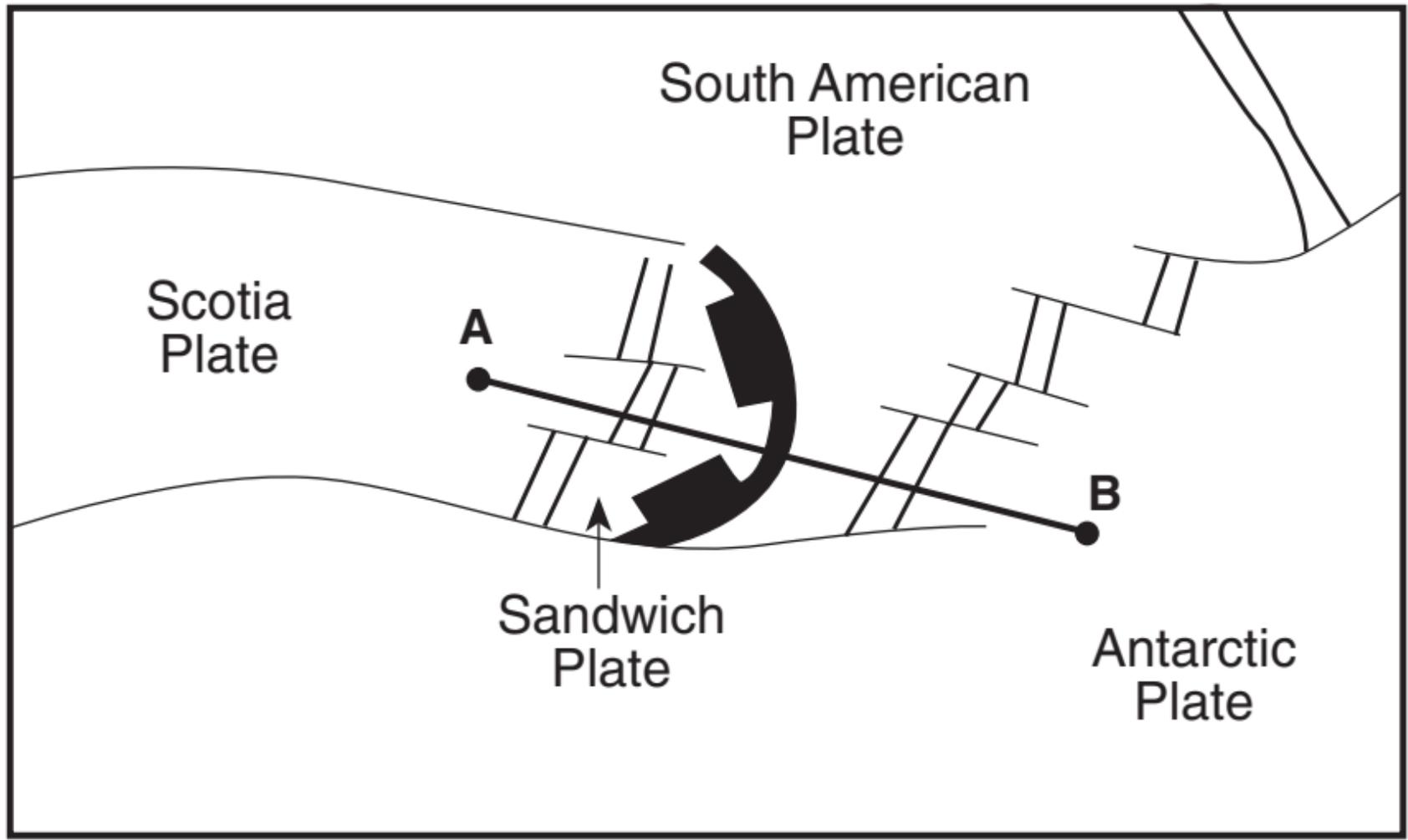
Height of earthquake waves above the baseline (mm)





Model B





South American Plate

Scotia Plate

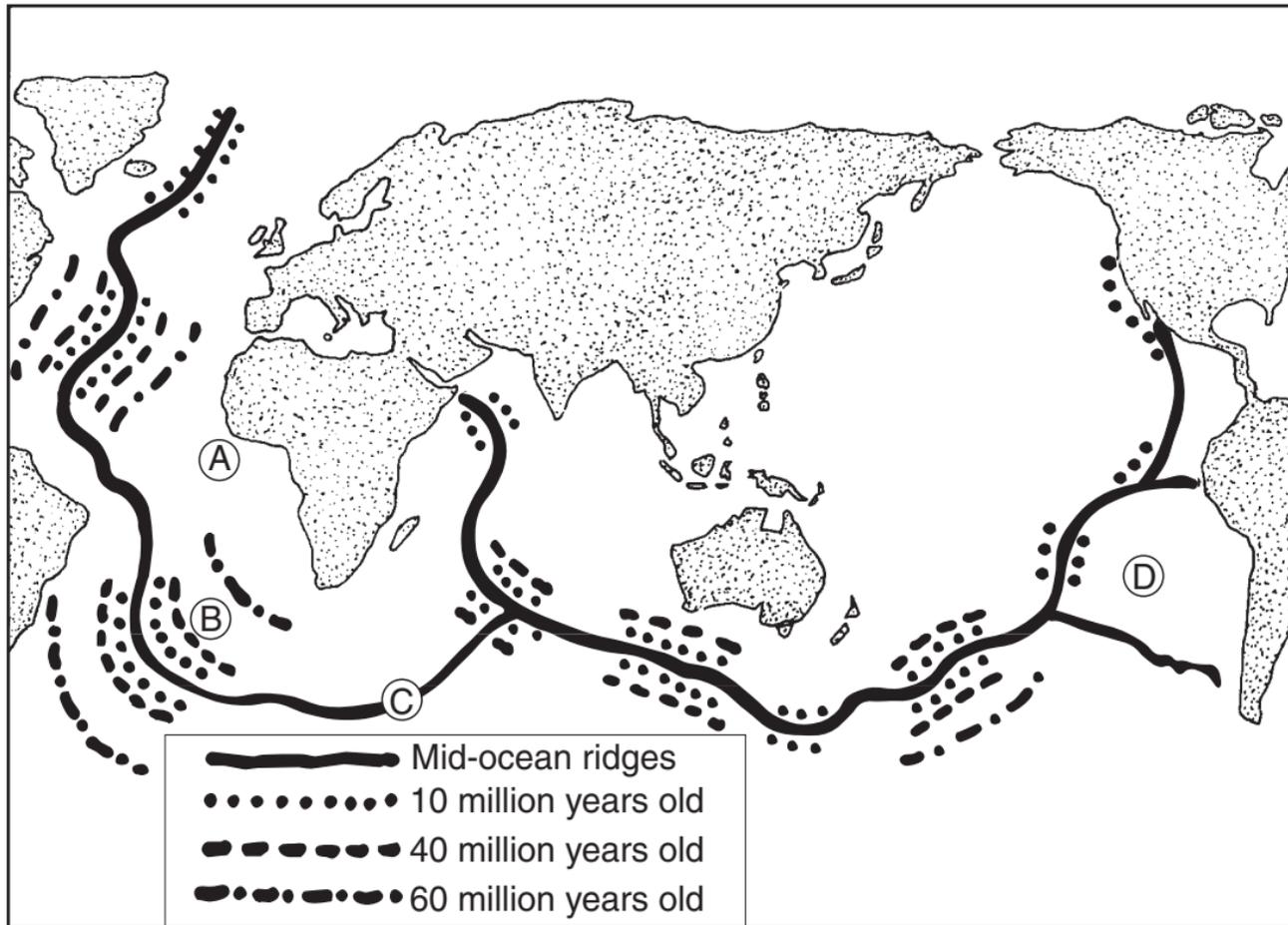
A

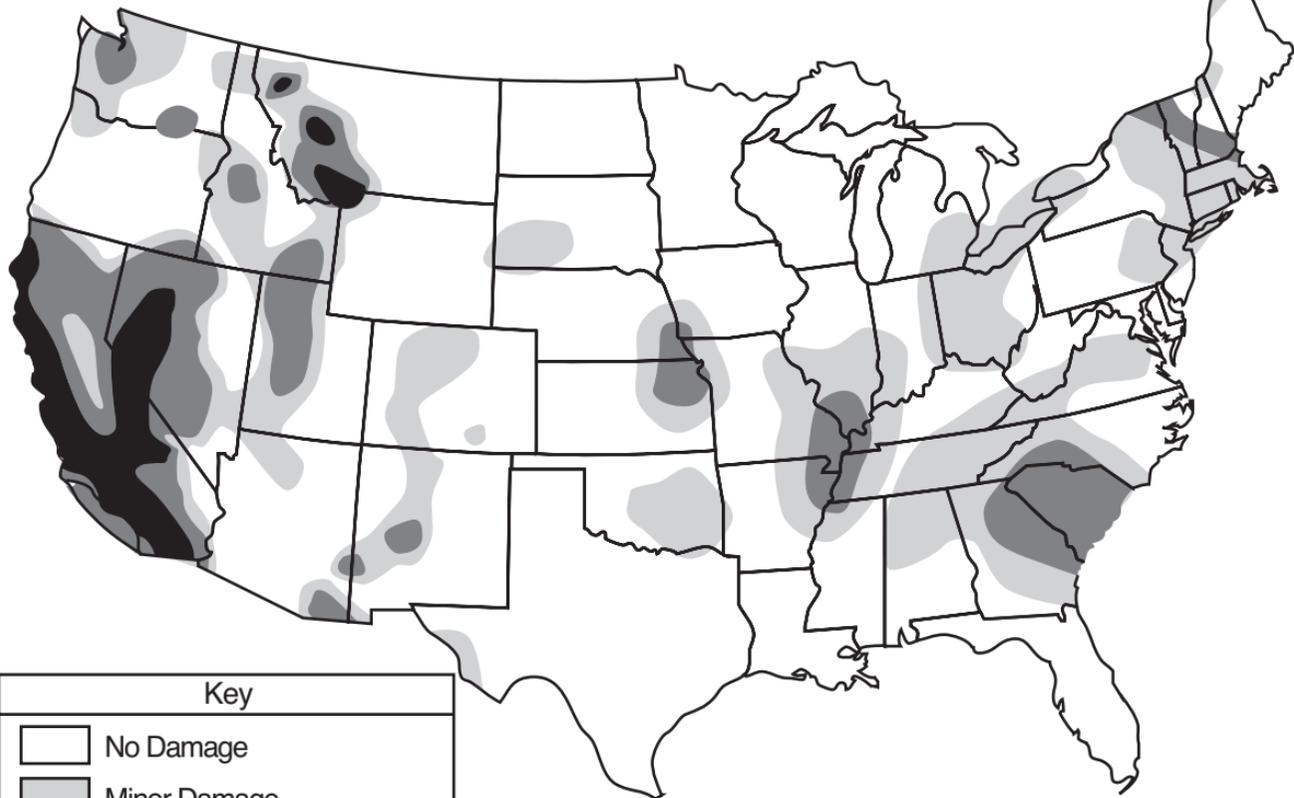
B

Sandwich Plate

Antarctic Plate

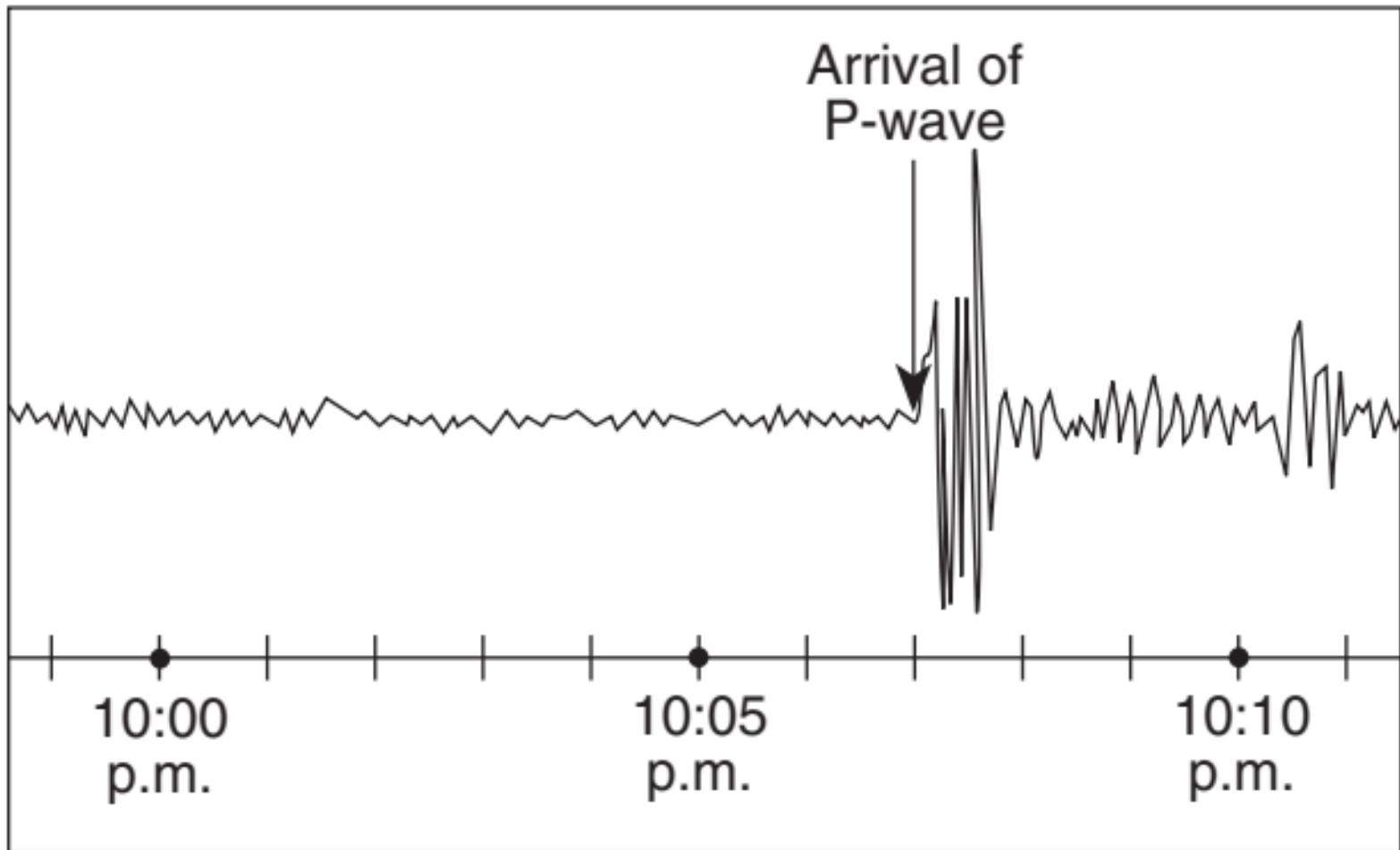
Age of Rocks on the Sea Bottom Relative to Ridges

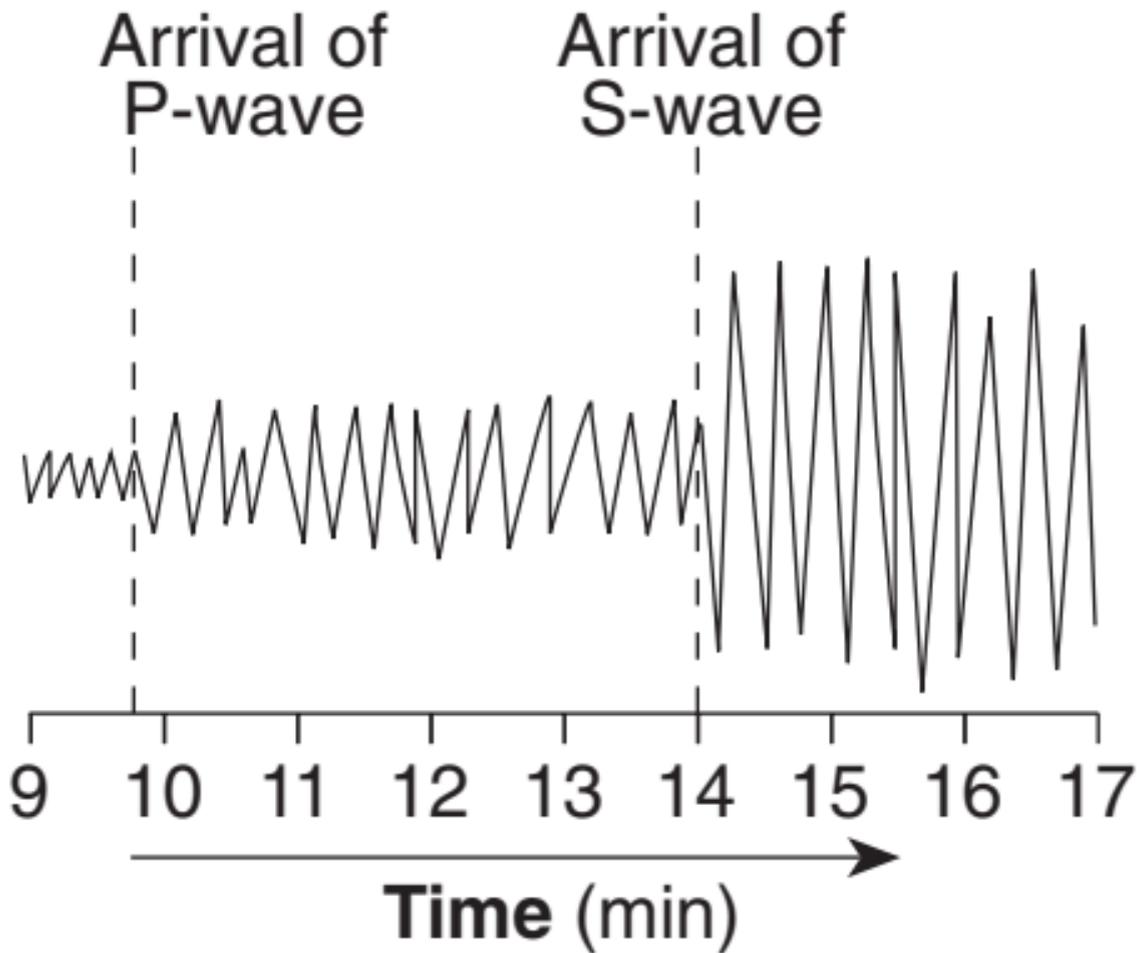




Key

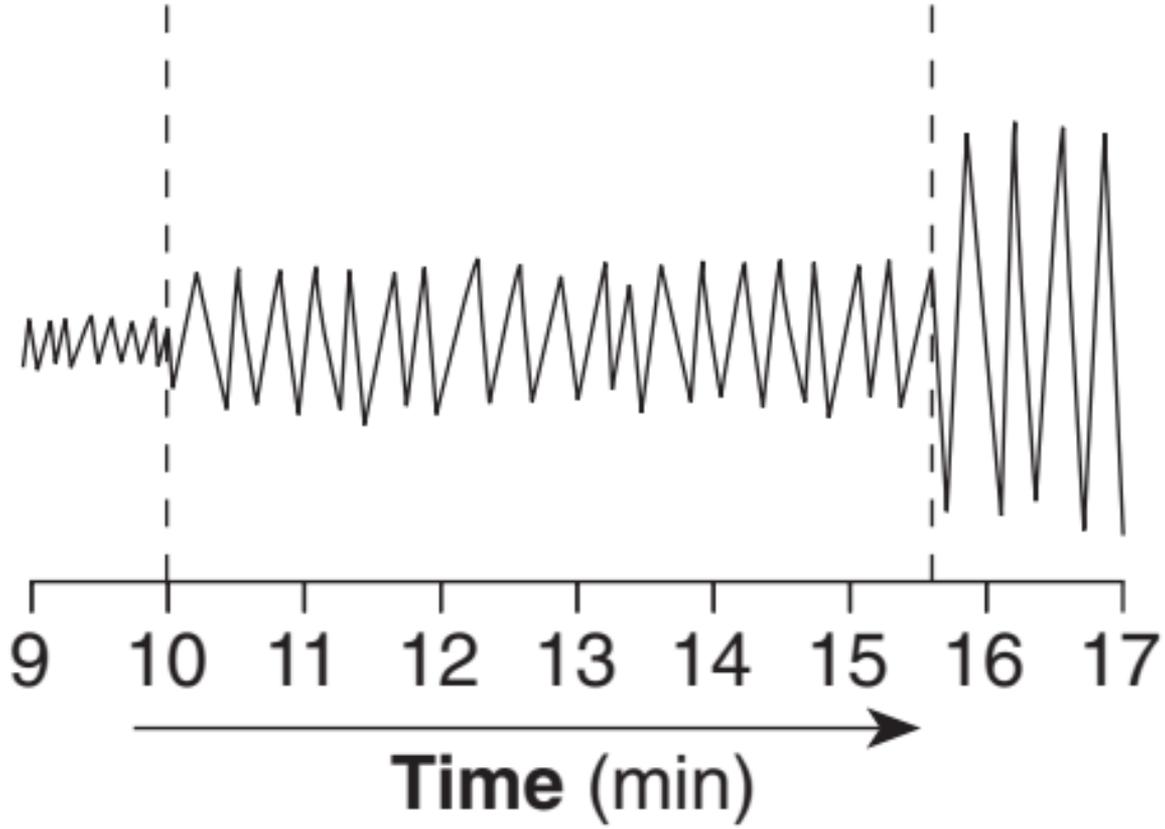
- No Damage
- Minor Damage
- Moderate Damage
- Major to Extreme Damage





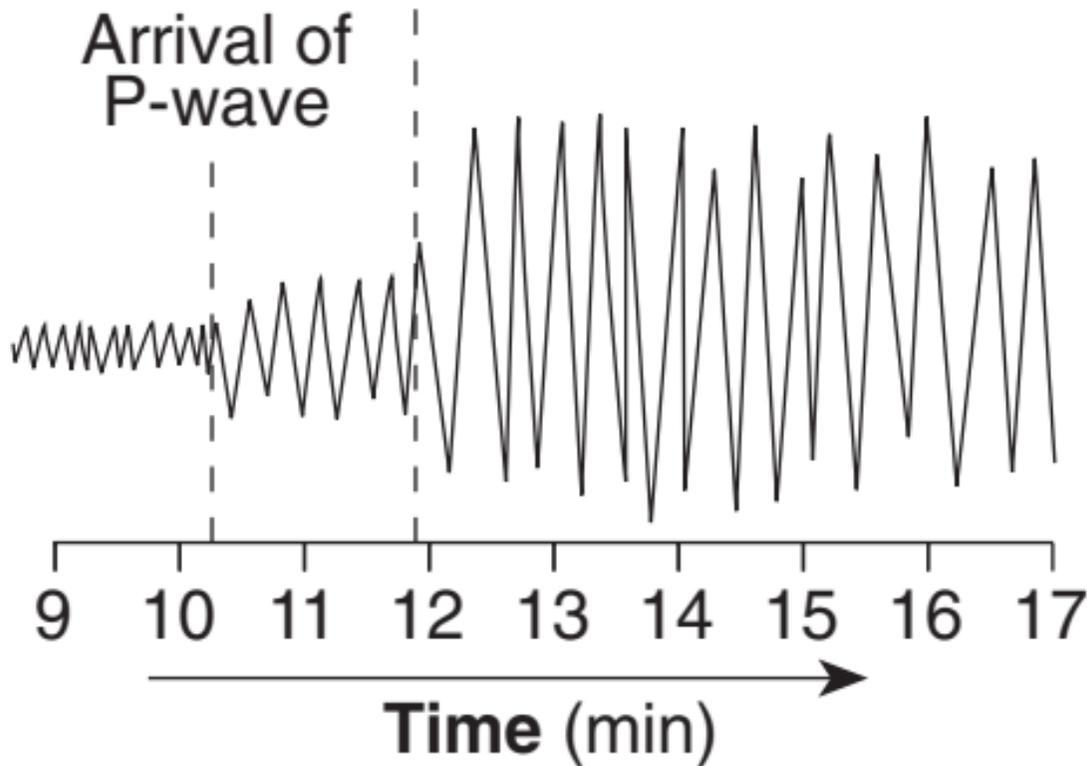
Arrival of
P-wave

Arrival of
S-wave



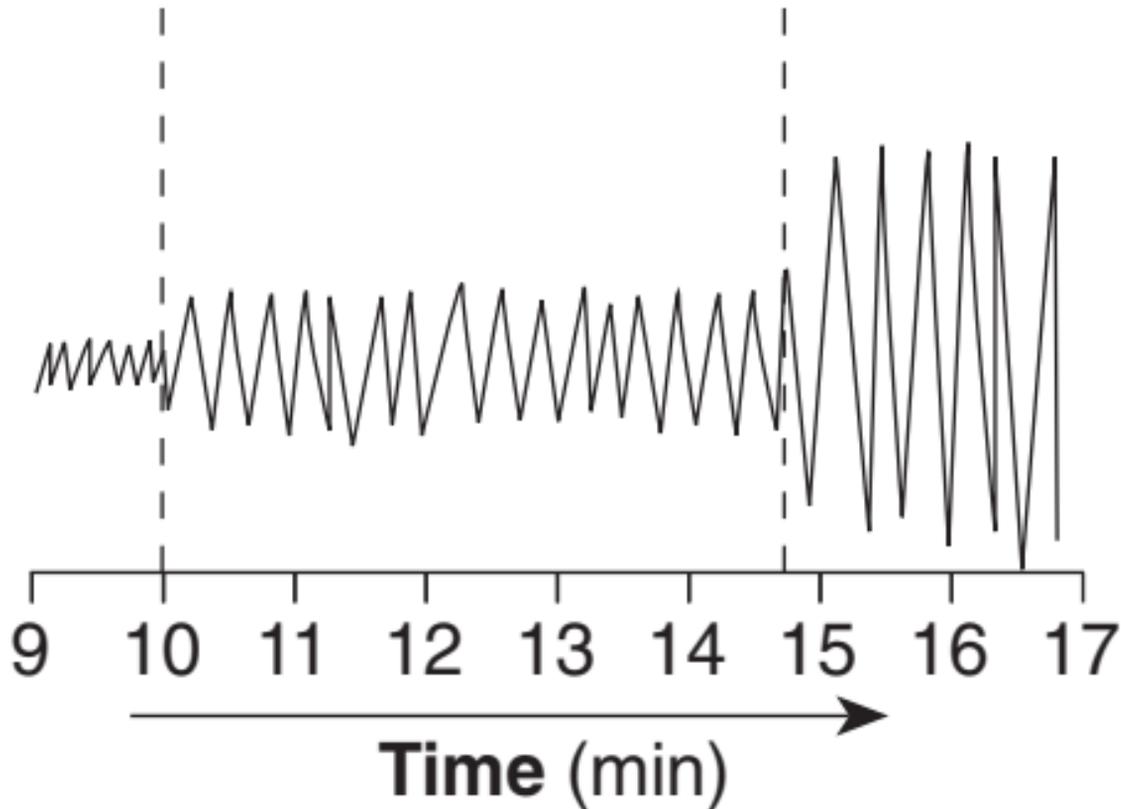
Arrival of
S-wave

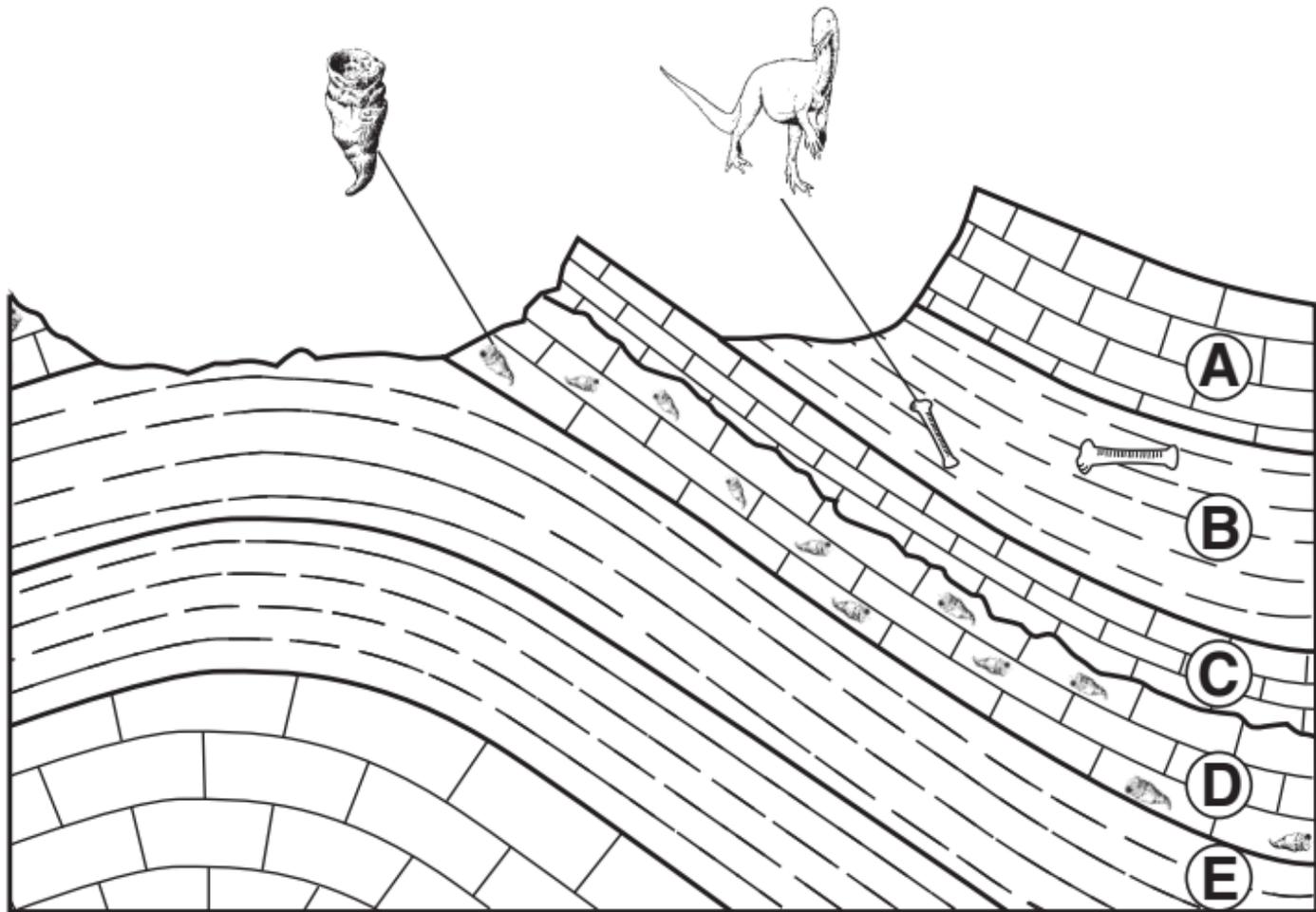
Arrival of
P-wave



Arrival of
P-wave

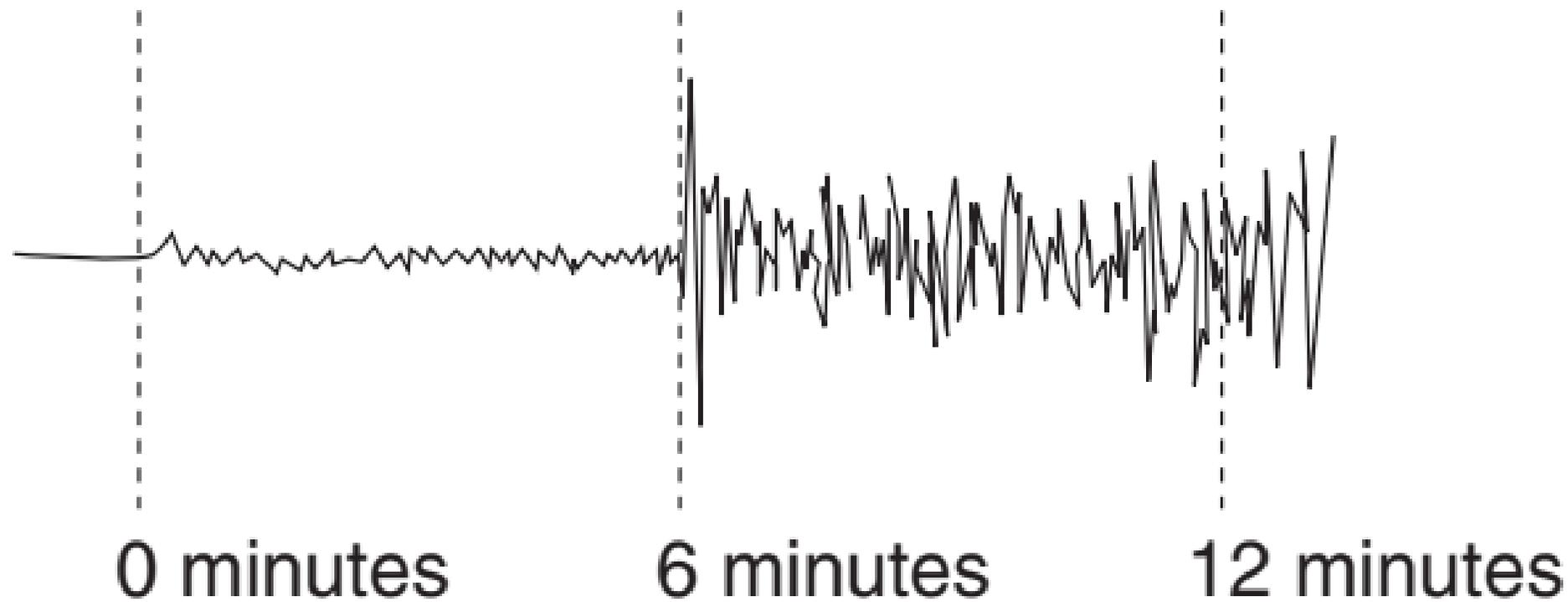
Arrival of
S-wave

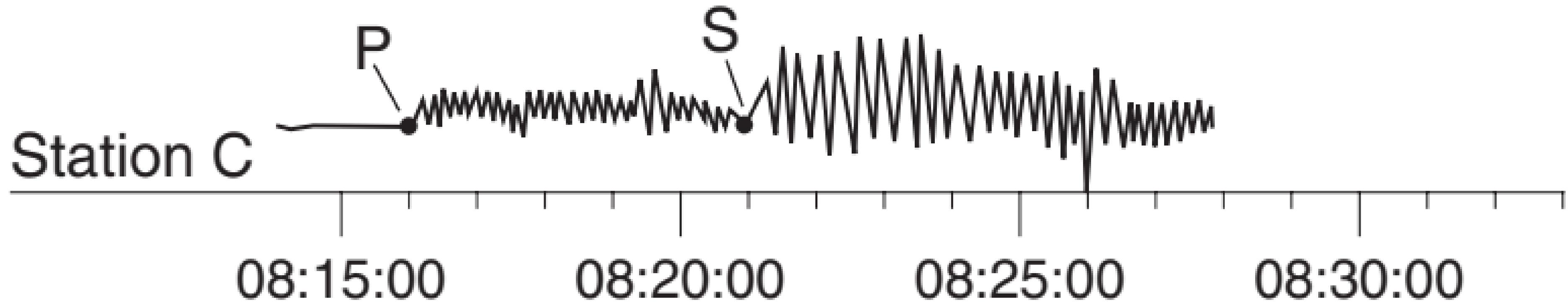


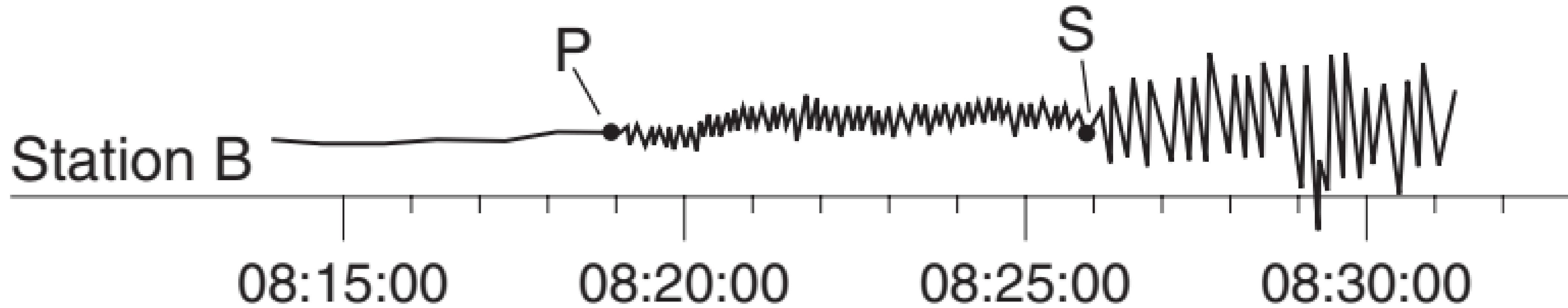


Arrival of
P-waves

Arrival of
S-waves







Station A

08:15:00

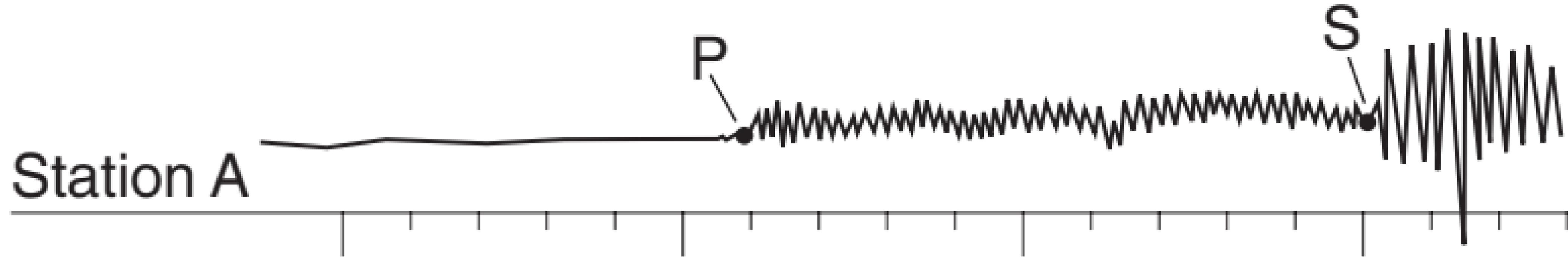
08:20:00

08:25:00

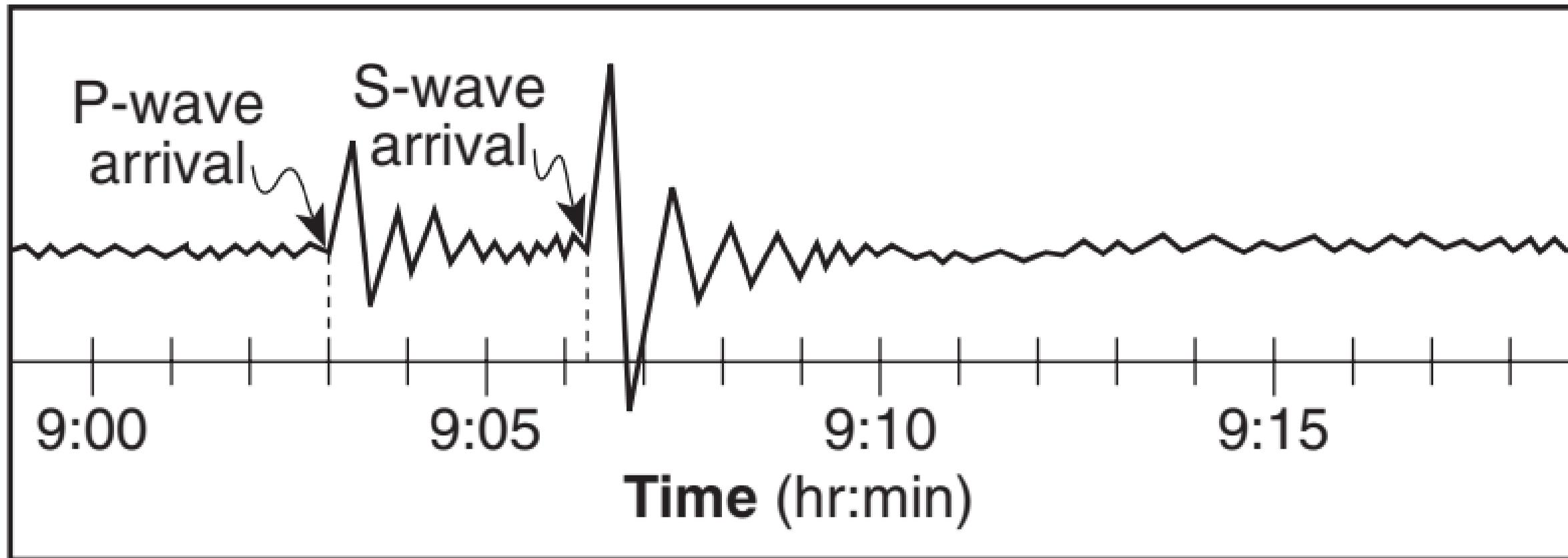
08:30:00

P

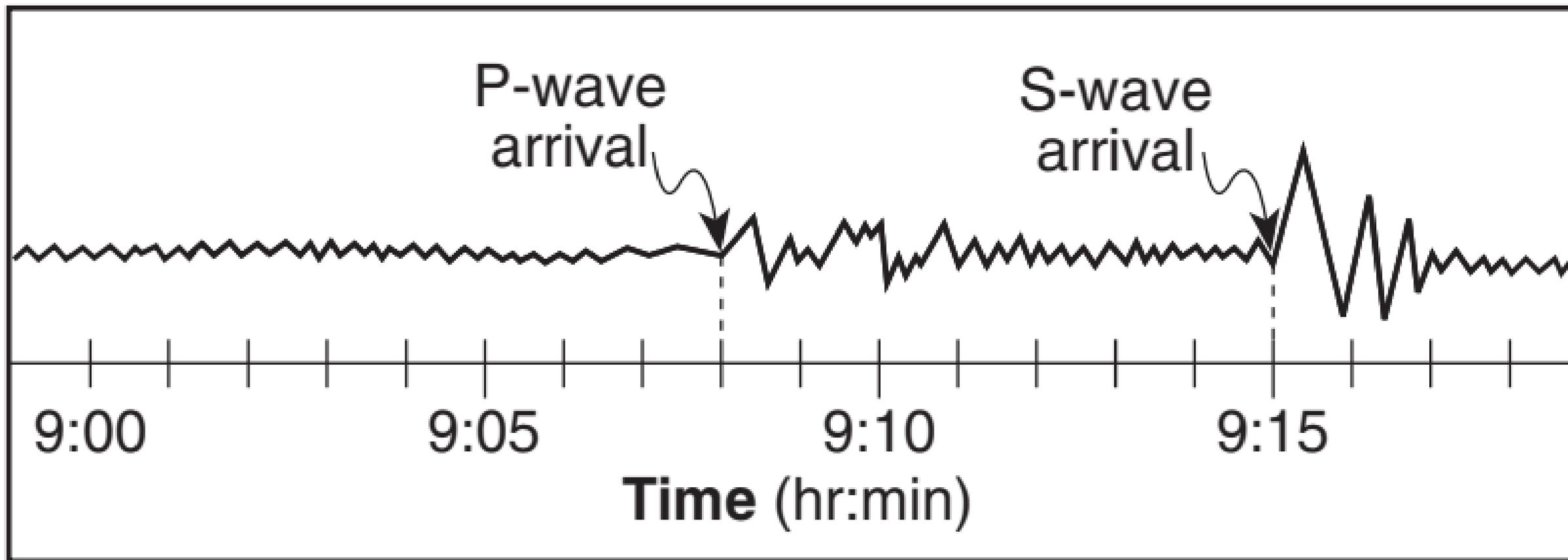
S



Station B



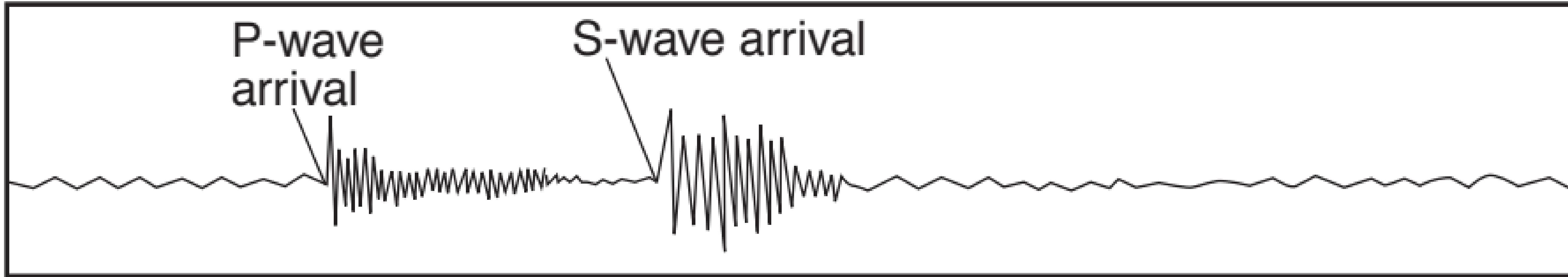
Station A



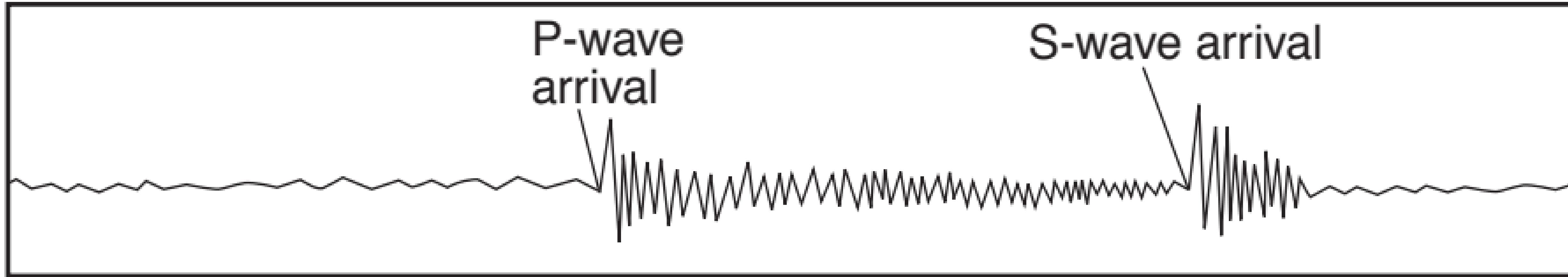
II

P-wave arrival

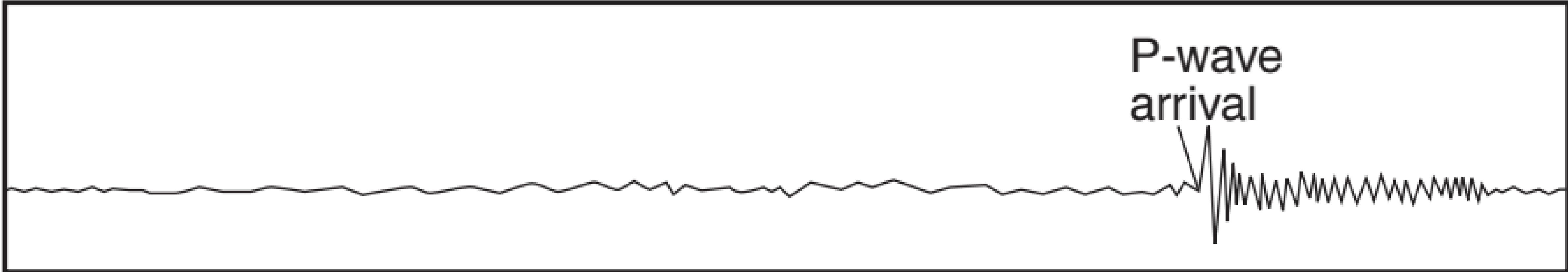
S-wave arrival



III

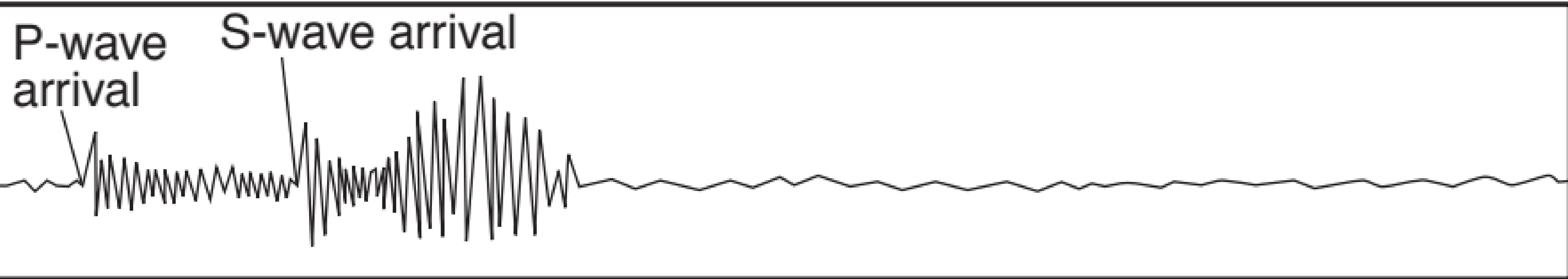


IV



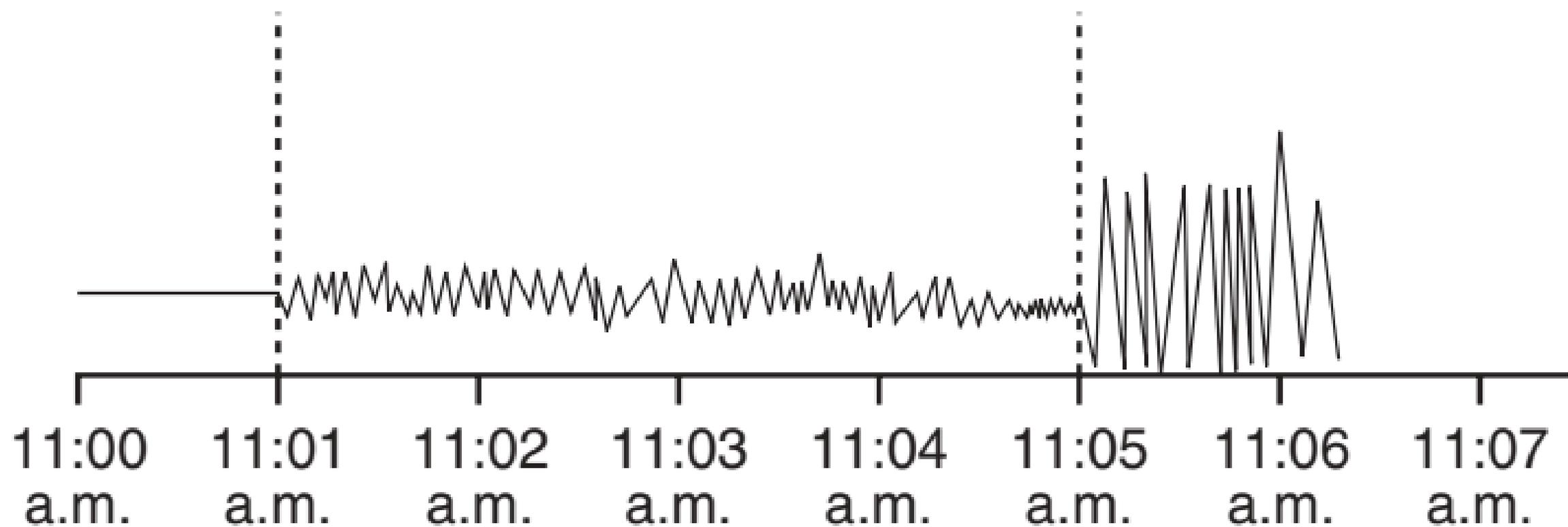
P-wave
arrival

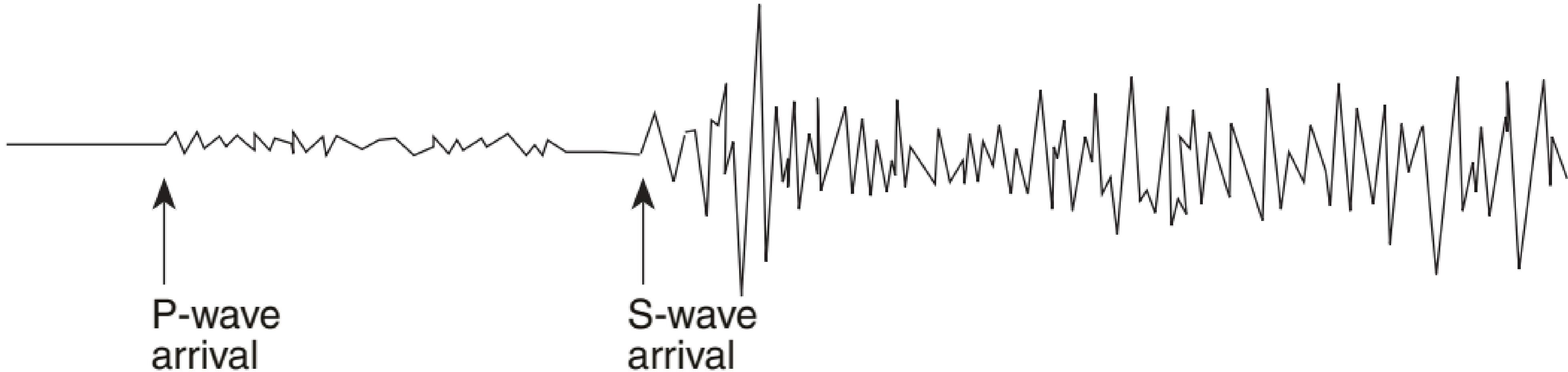
I

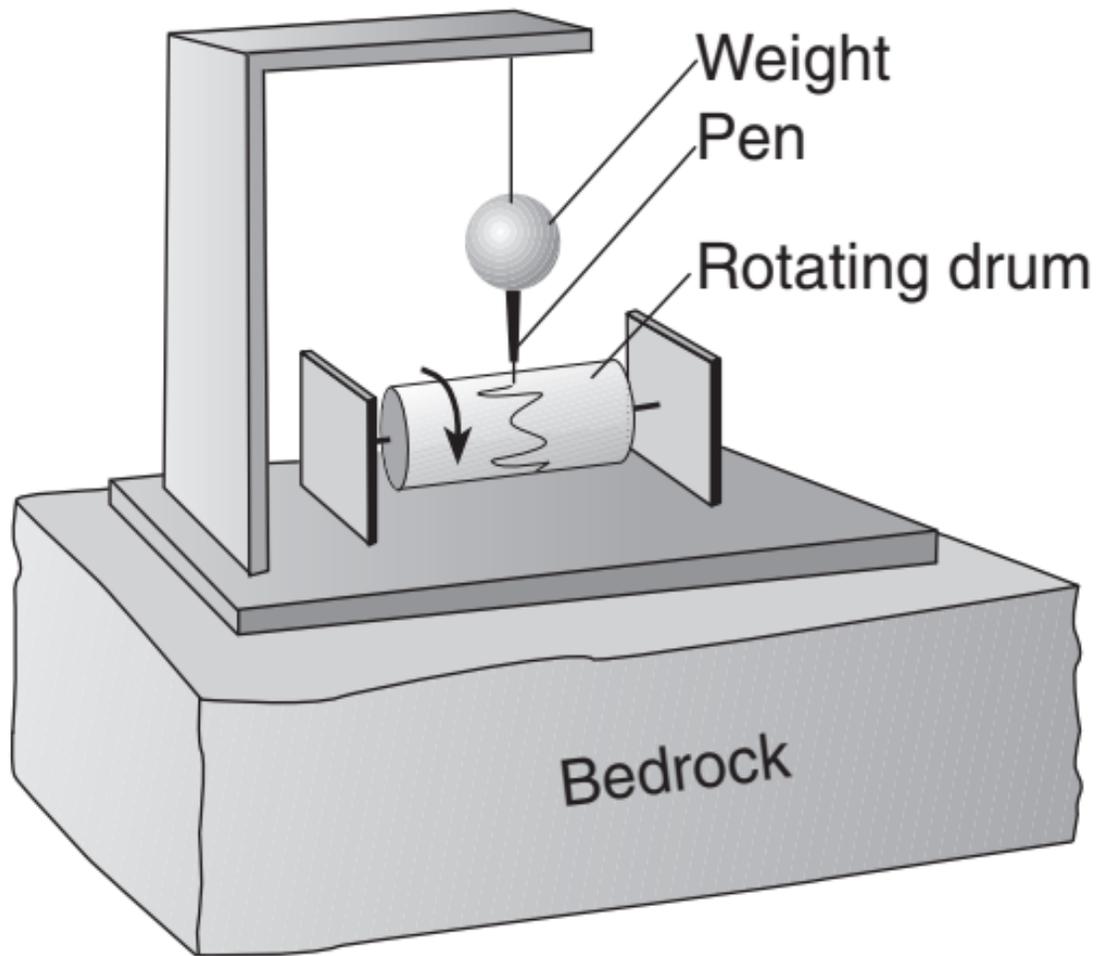


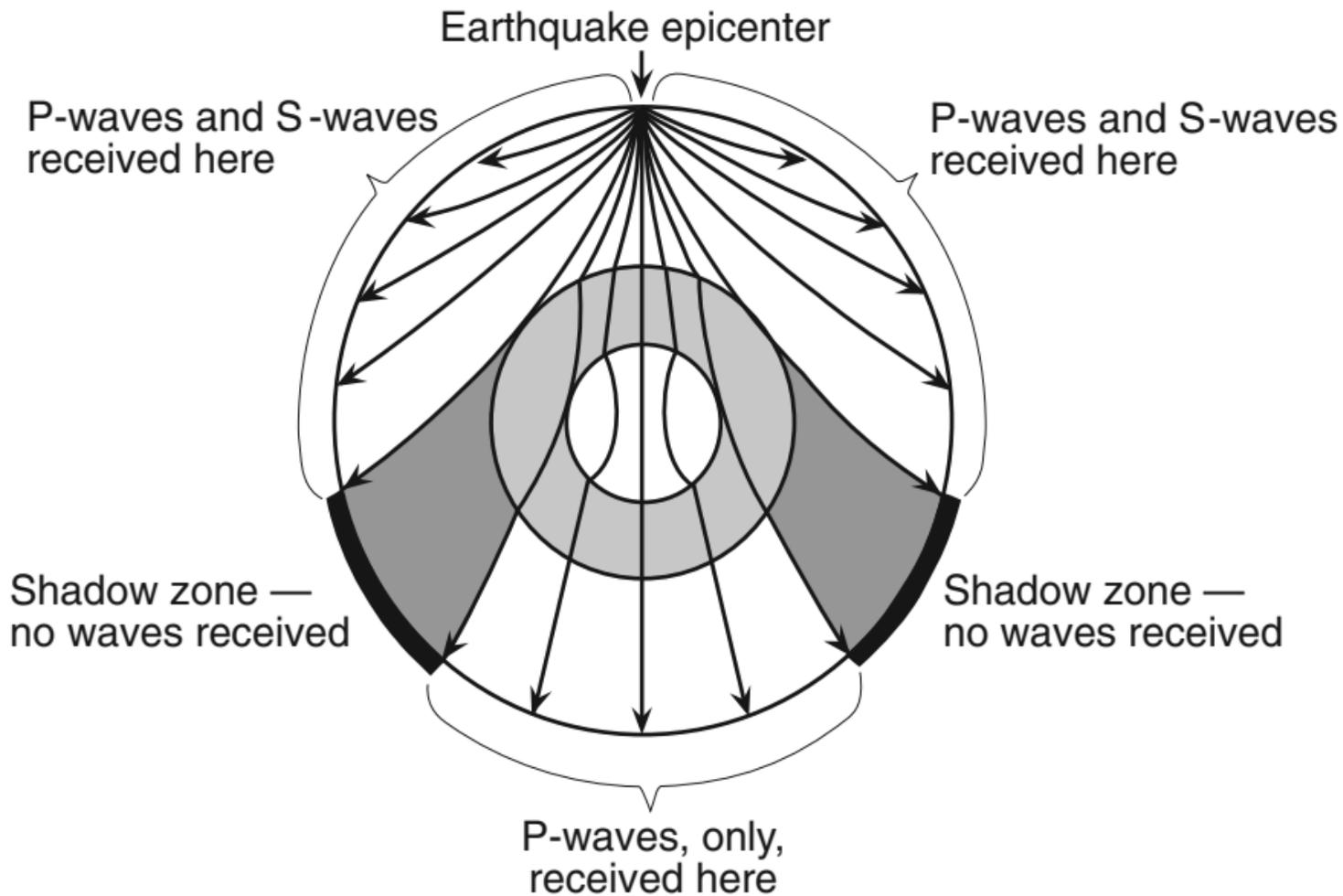
Arrival of
P-waves

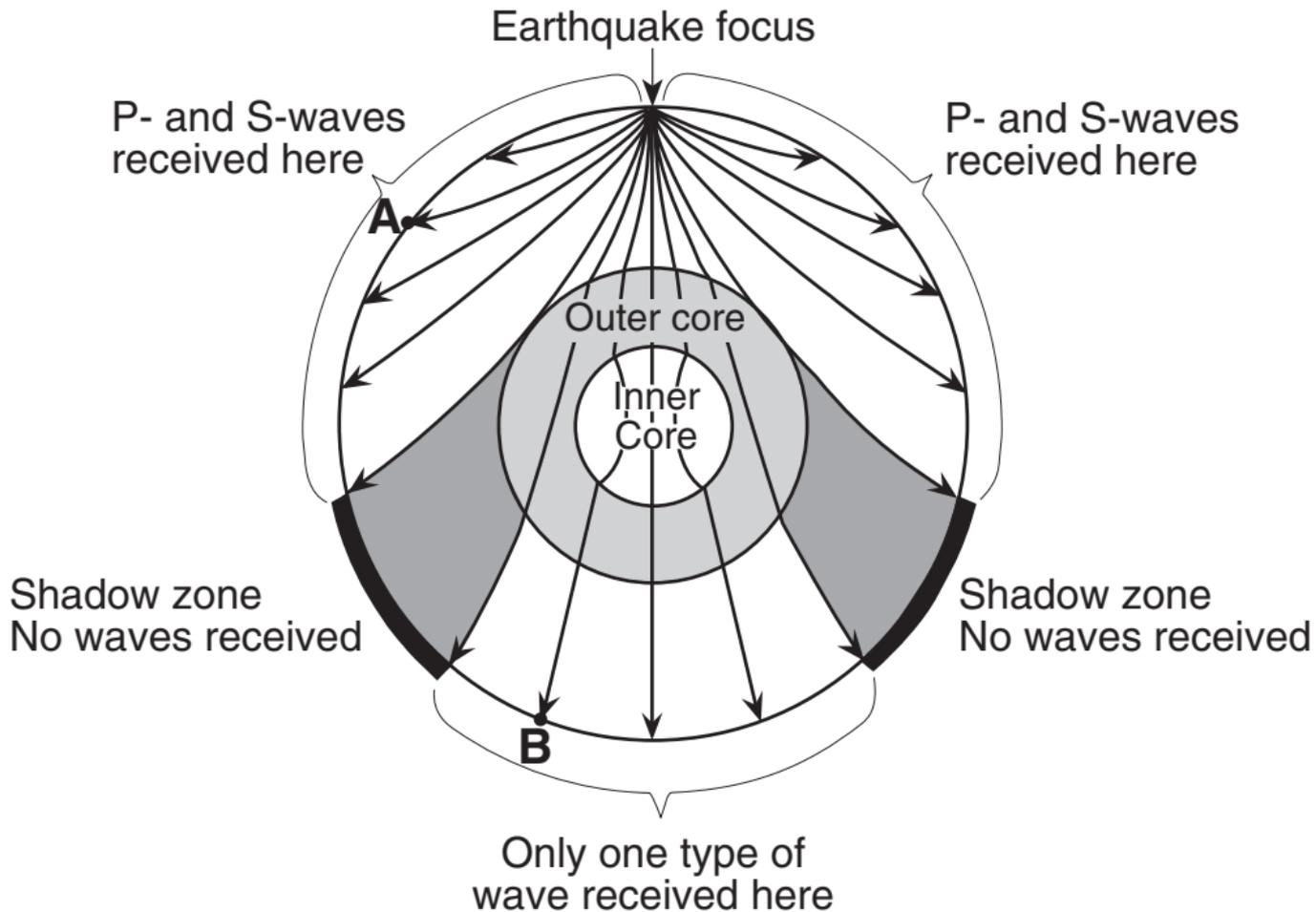
Arrival of
S-waves



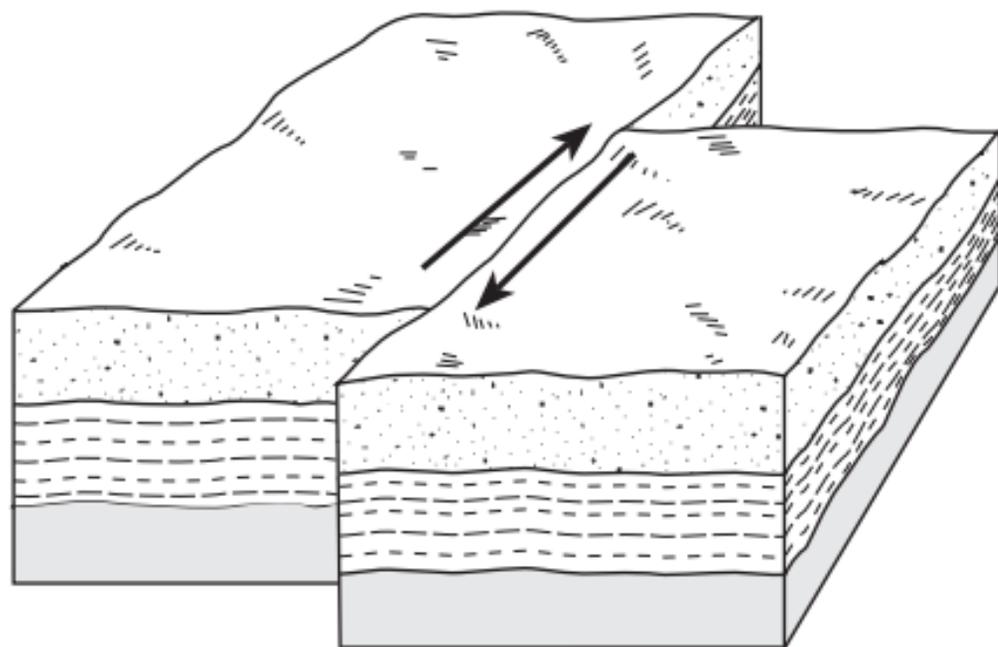


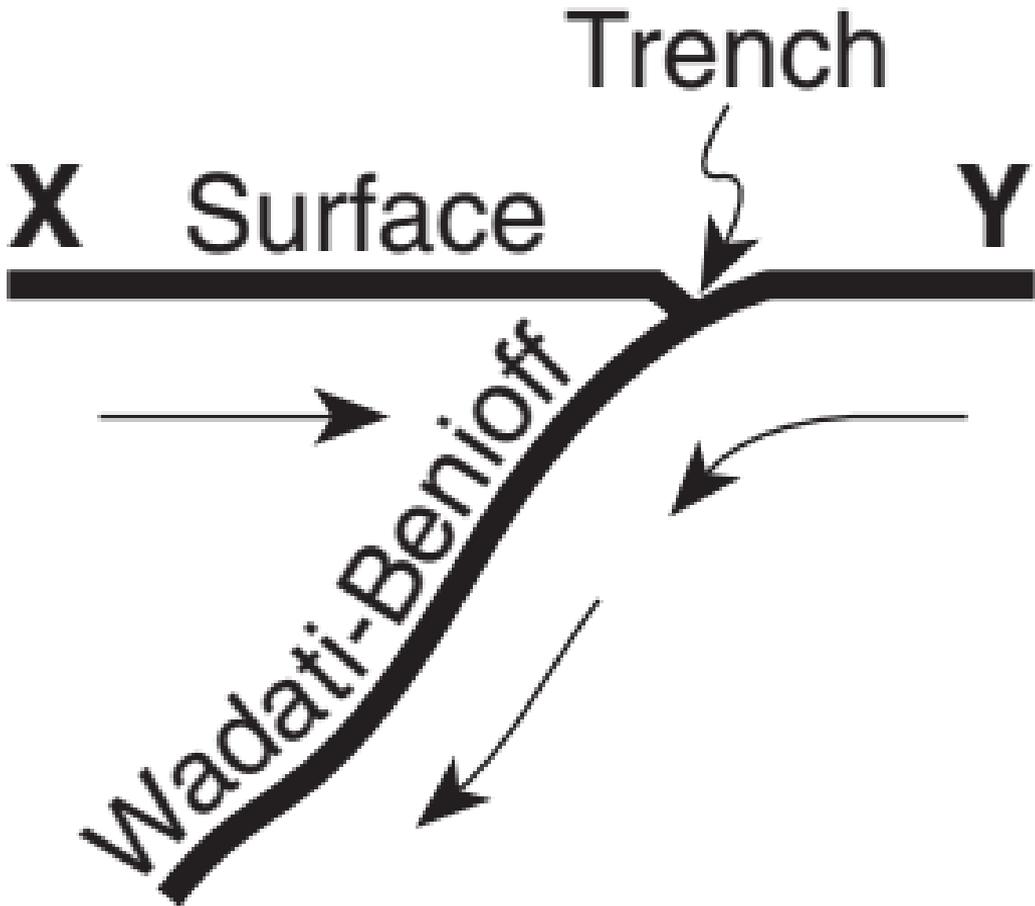




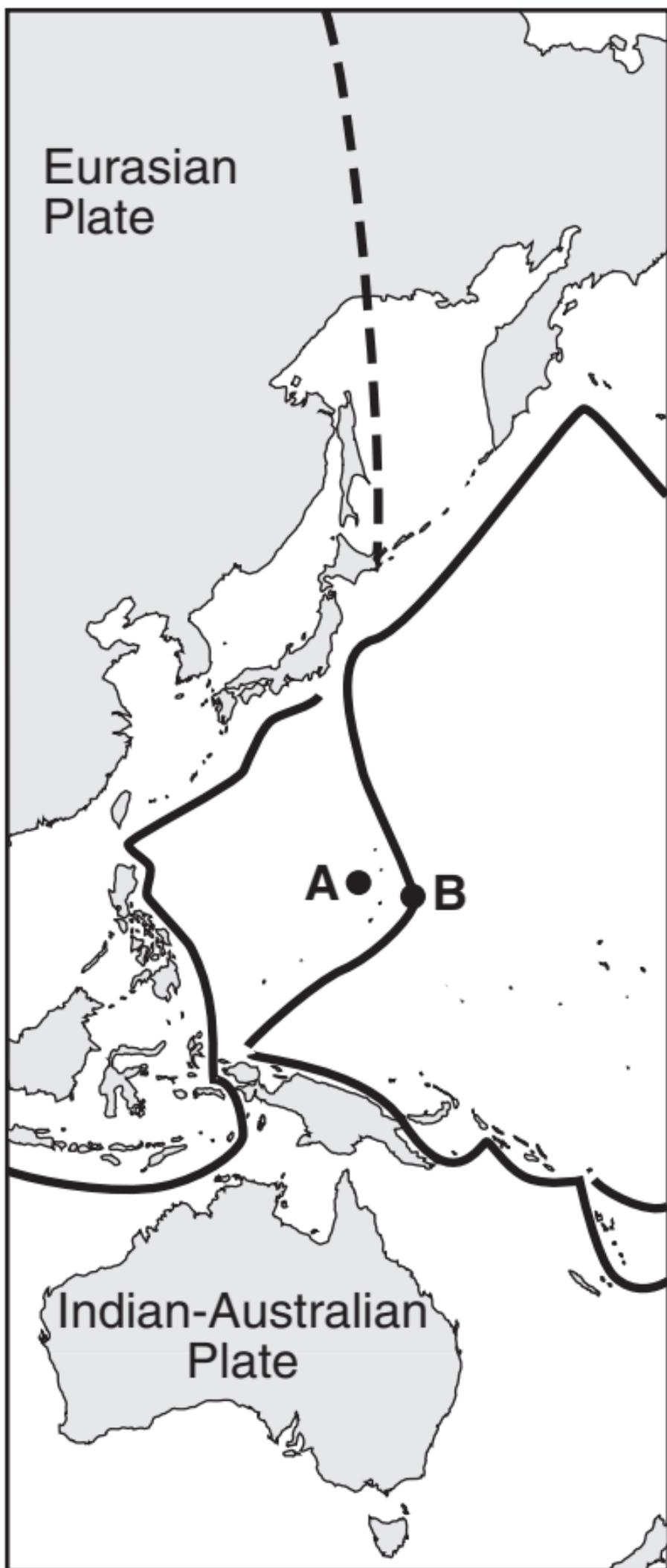


Lateral Fault (shearing)

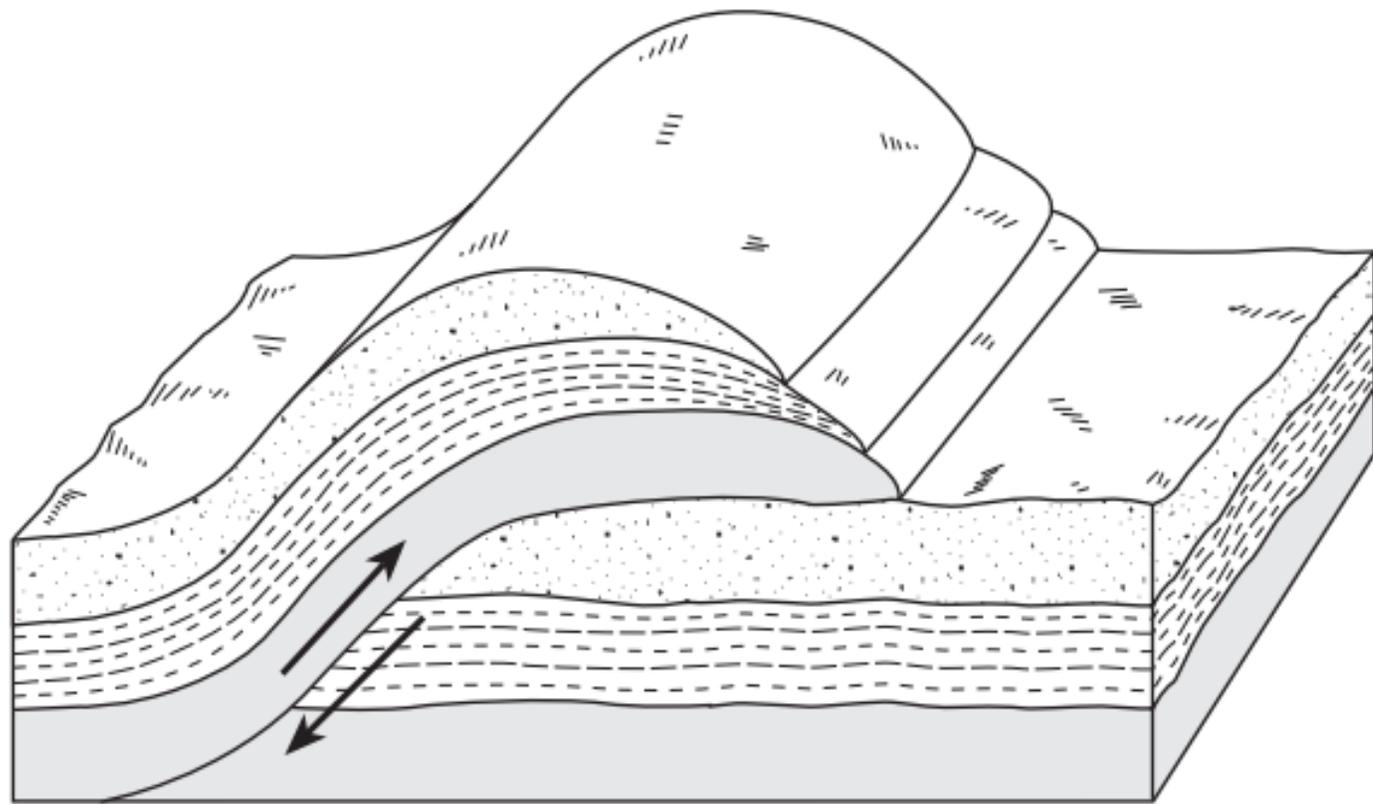




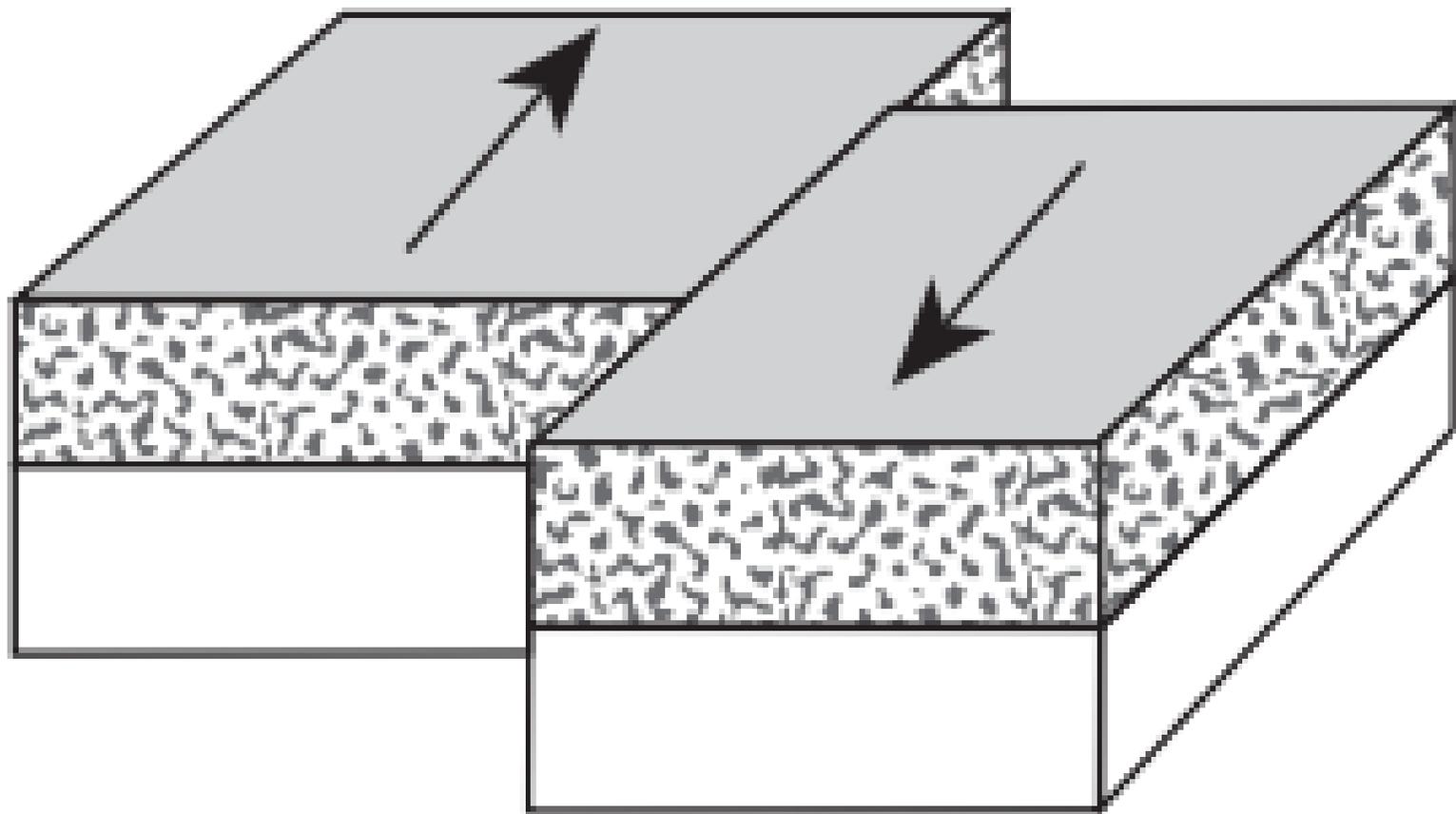
Map

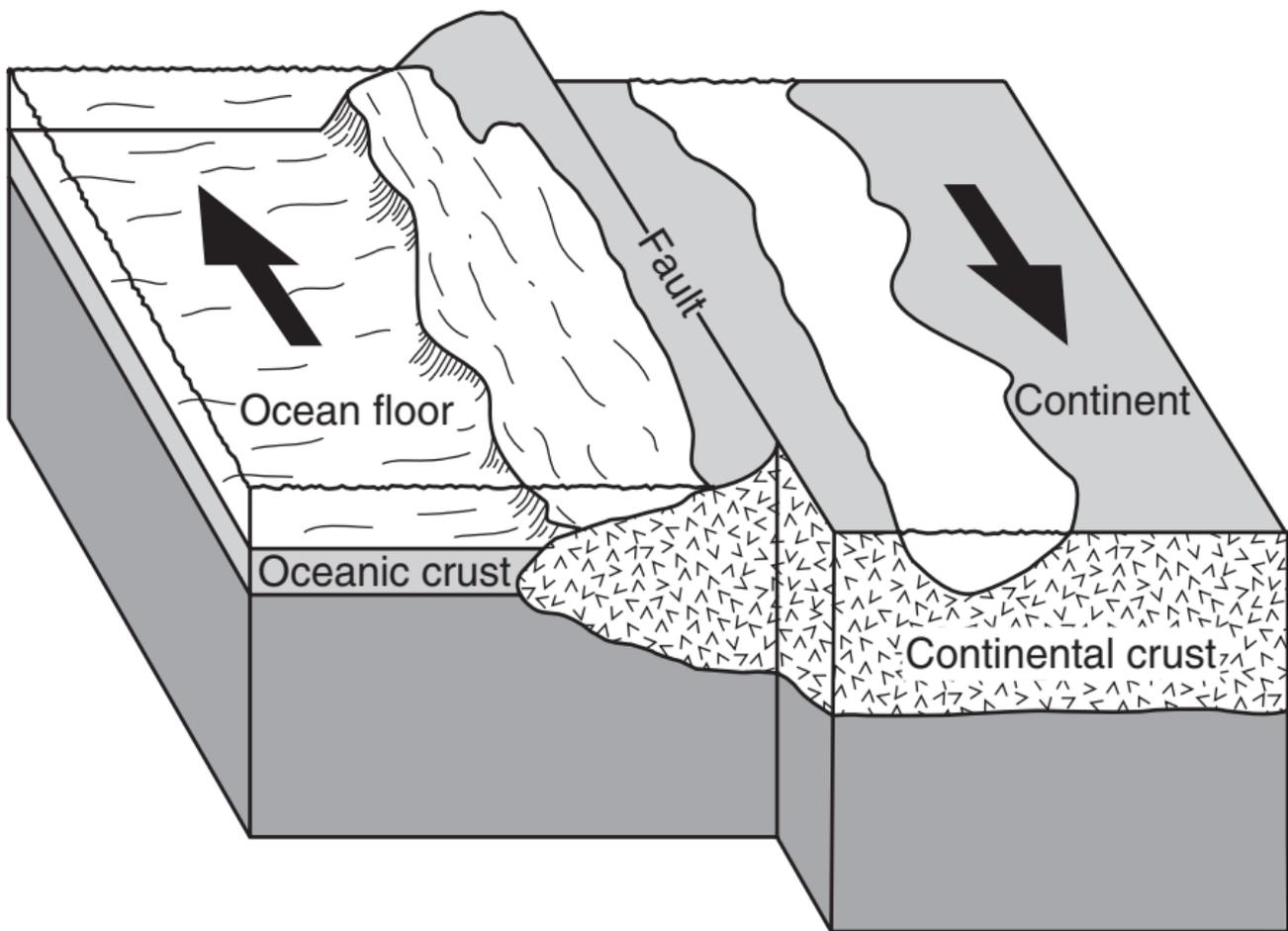


Thrust Fault

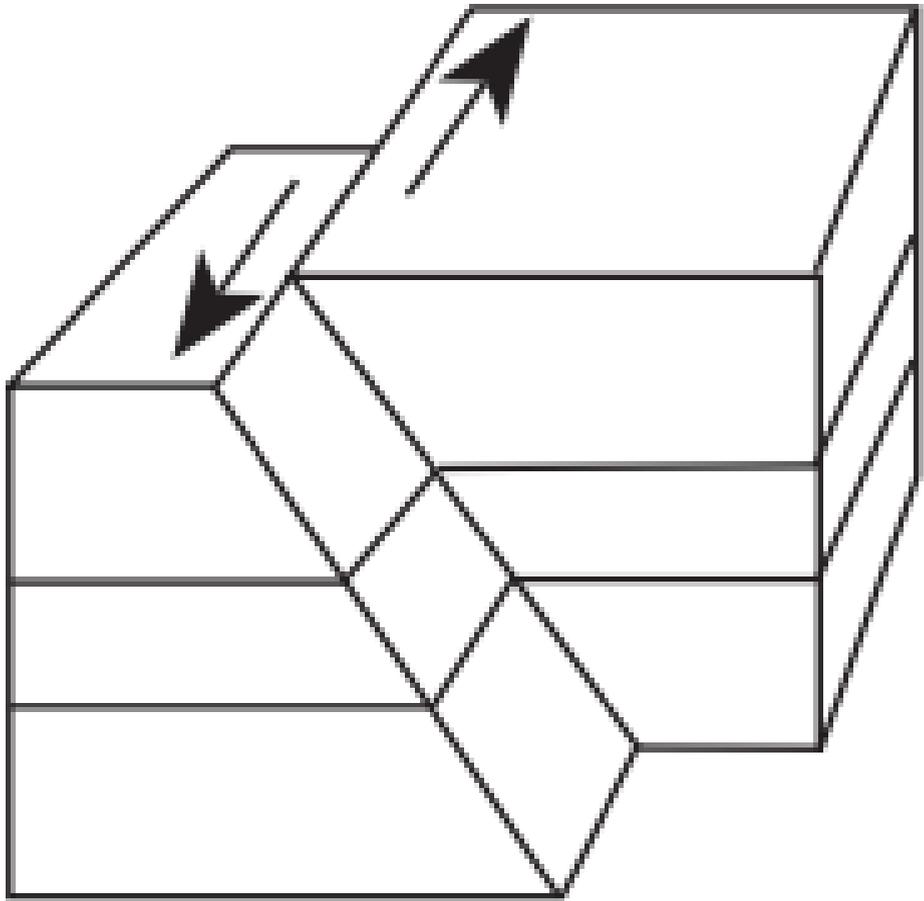


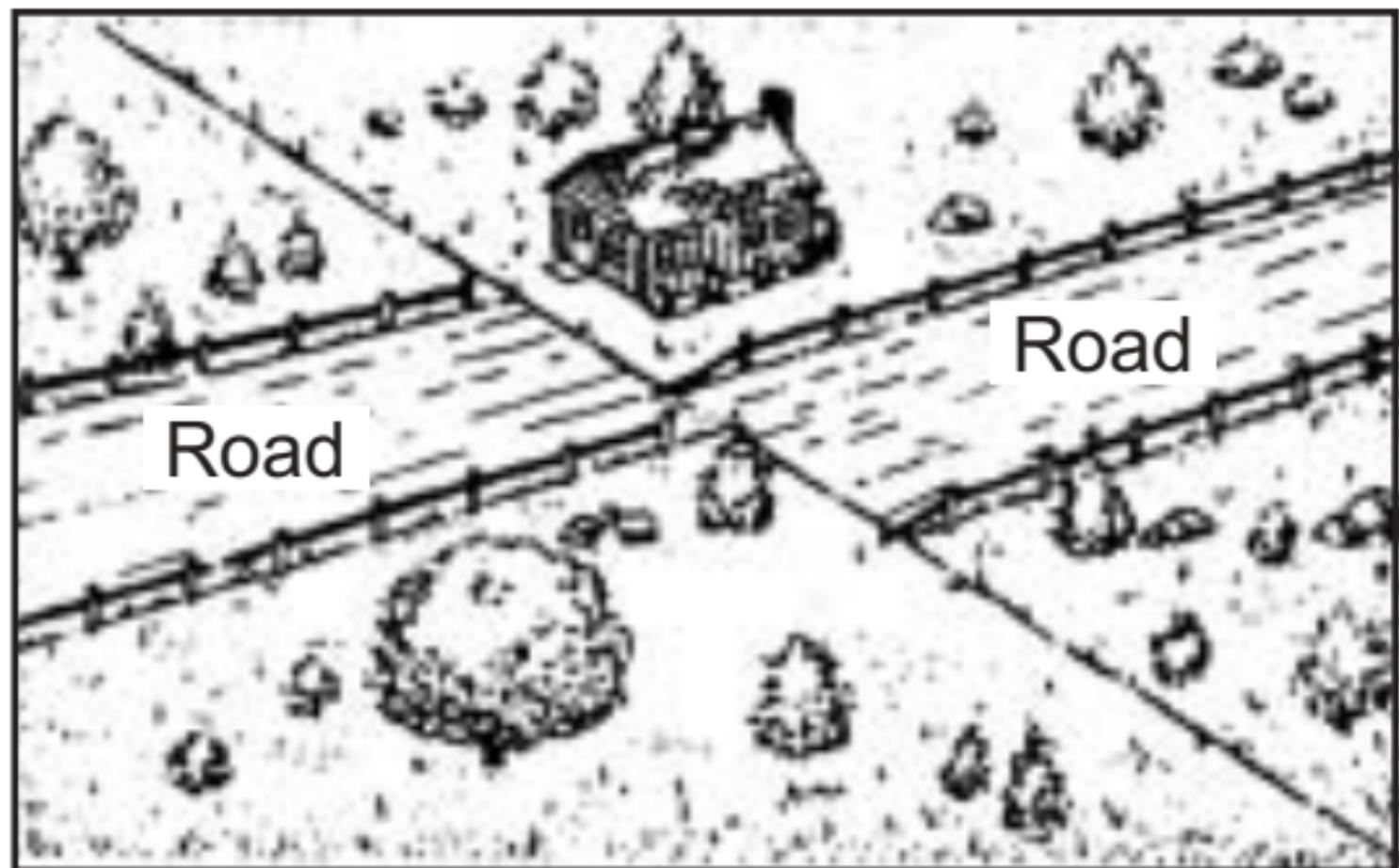


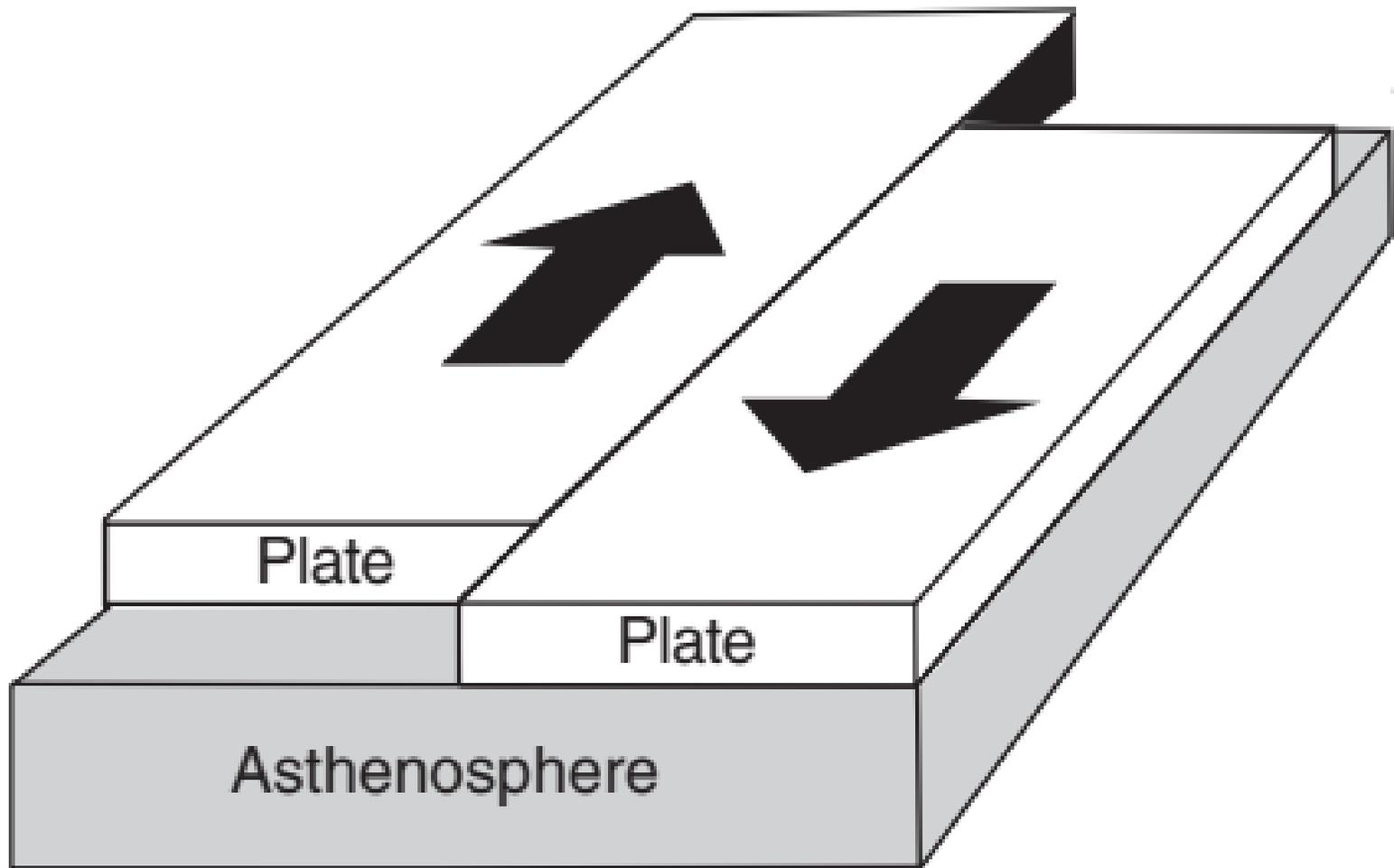




(Not drawn to scale)

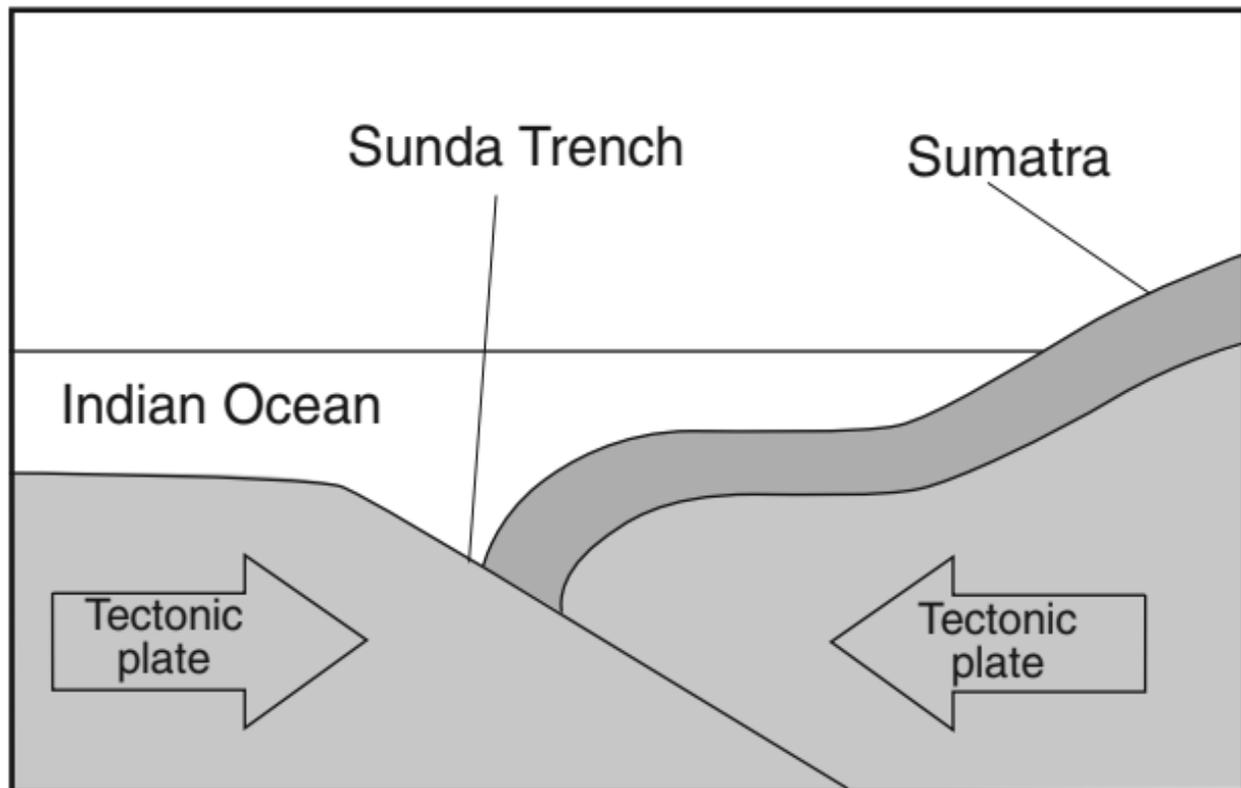






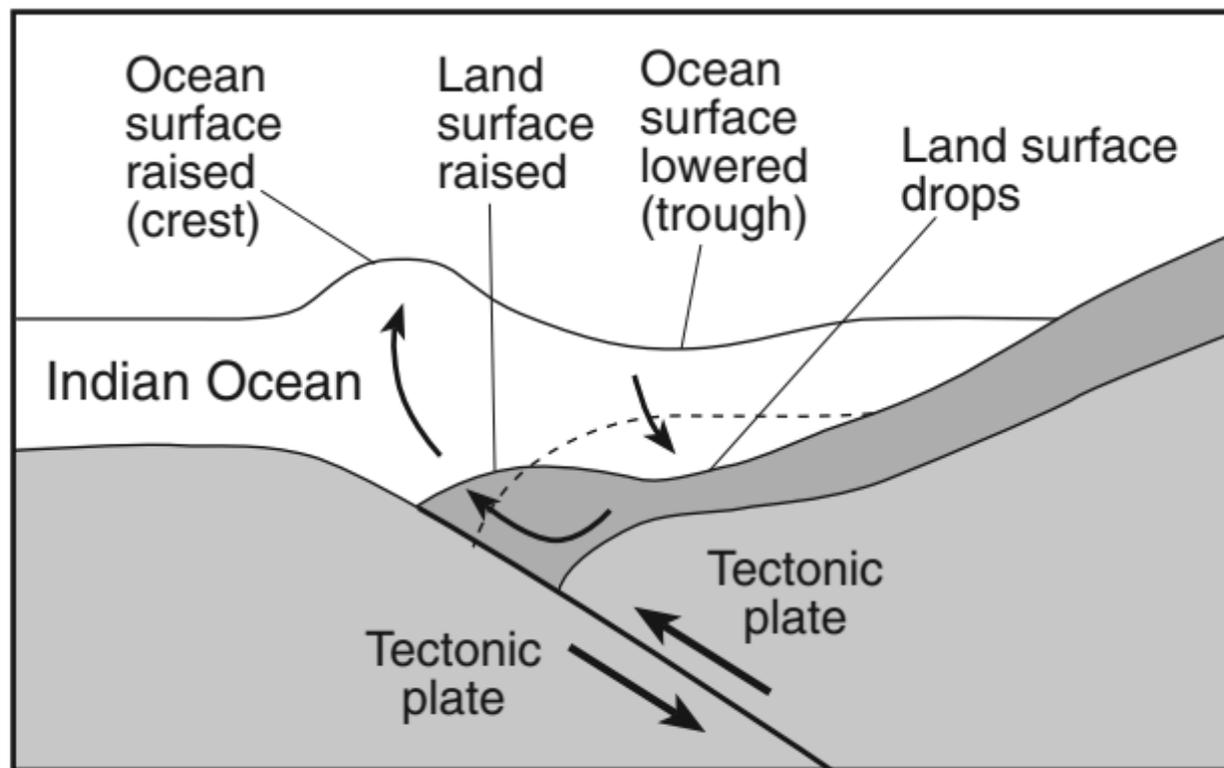
Cross section I

Tectonic setting before the earthquake occurred



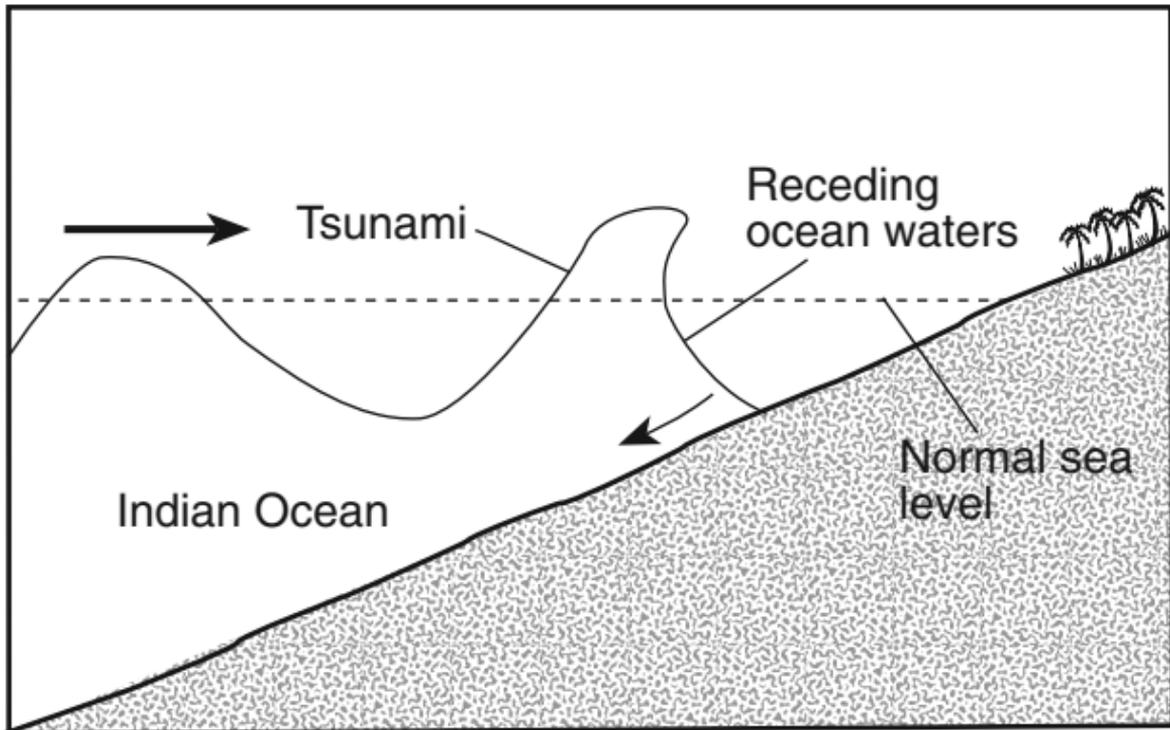
Cross section II

Chain reaction caused by tectonic plate motion and the resulting movement of the seafloor

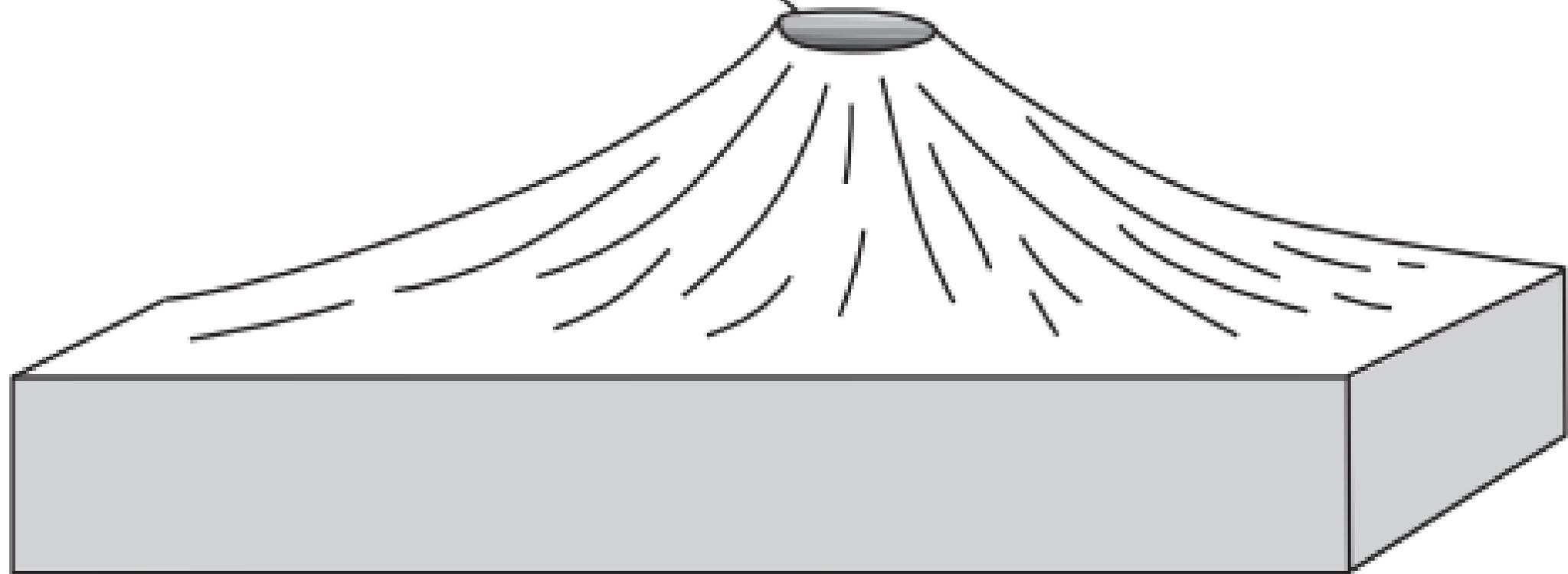


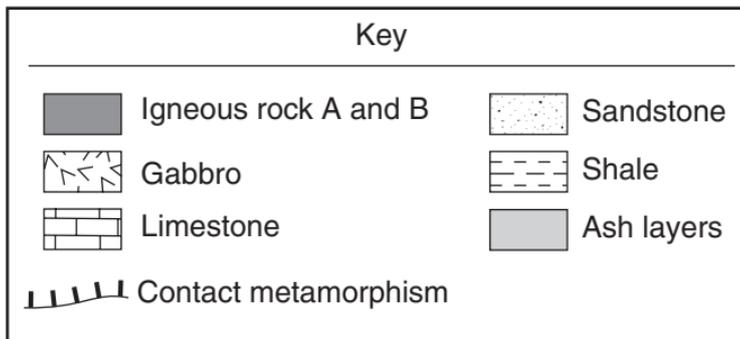
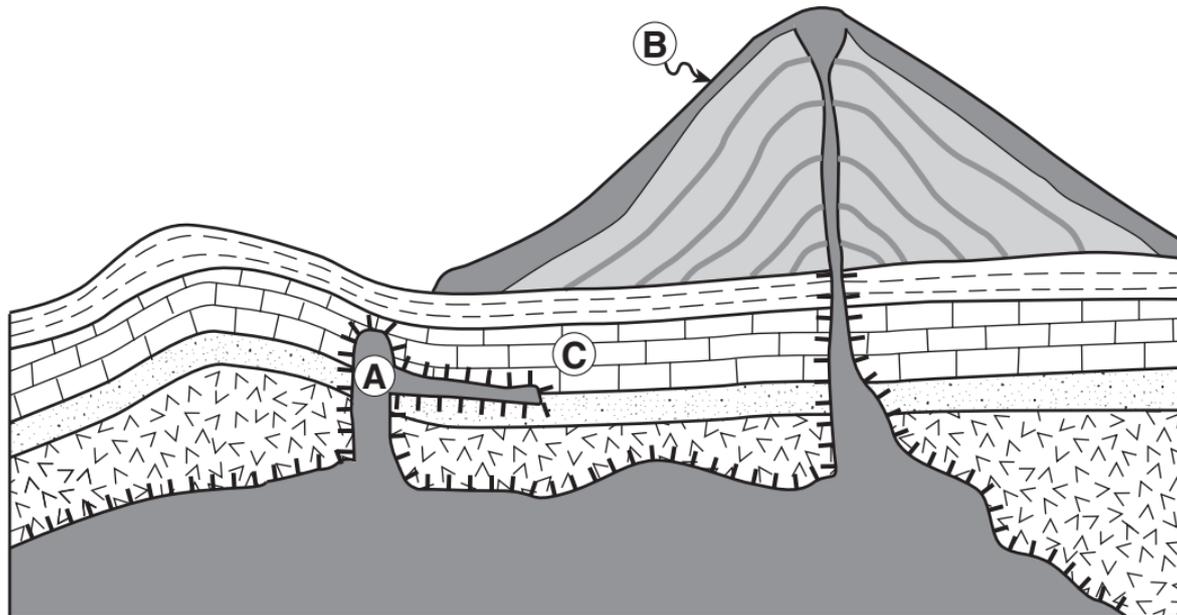
Cross section III

As the tsunami moves into shallow waters and approaches land, the trough reaches land before the first wave crest hits land.



Crater





Yellowstone Volcanic Calderas

