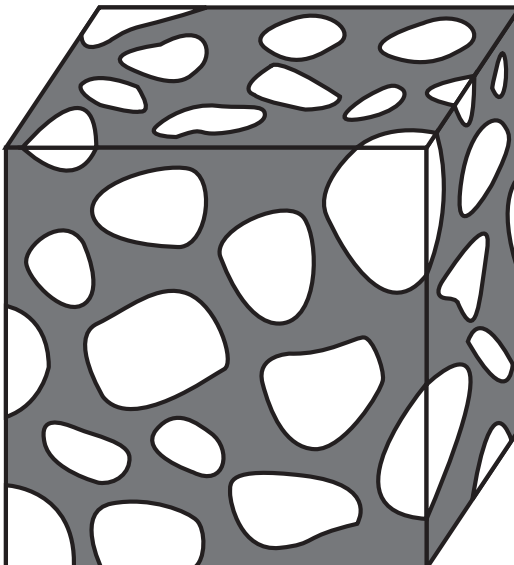
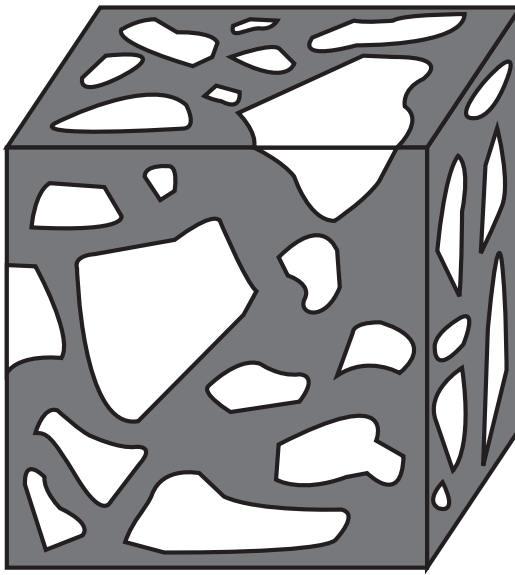
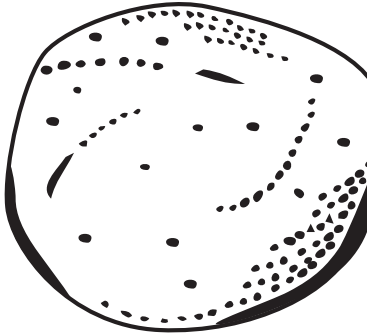
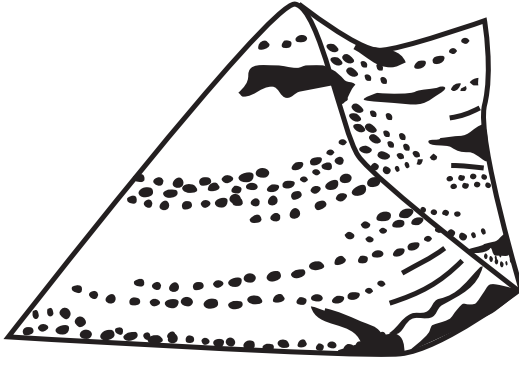








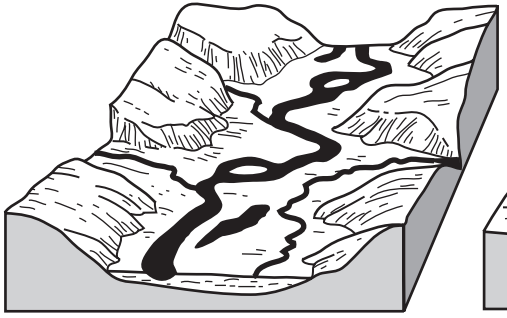


Diagram A

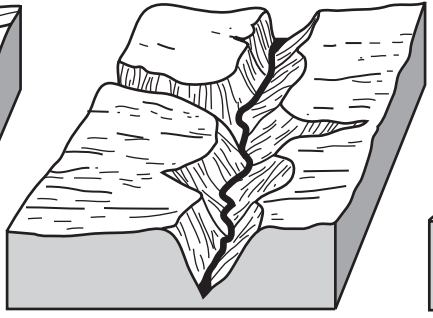


Diagram B

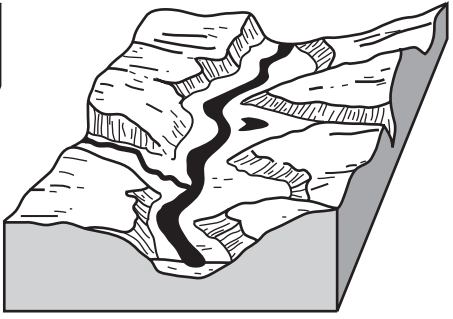
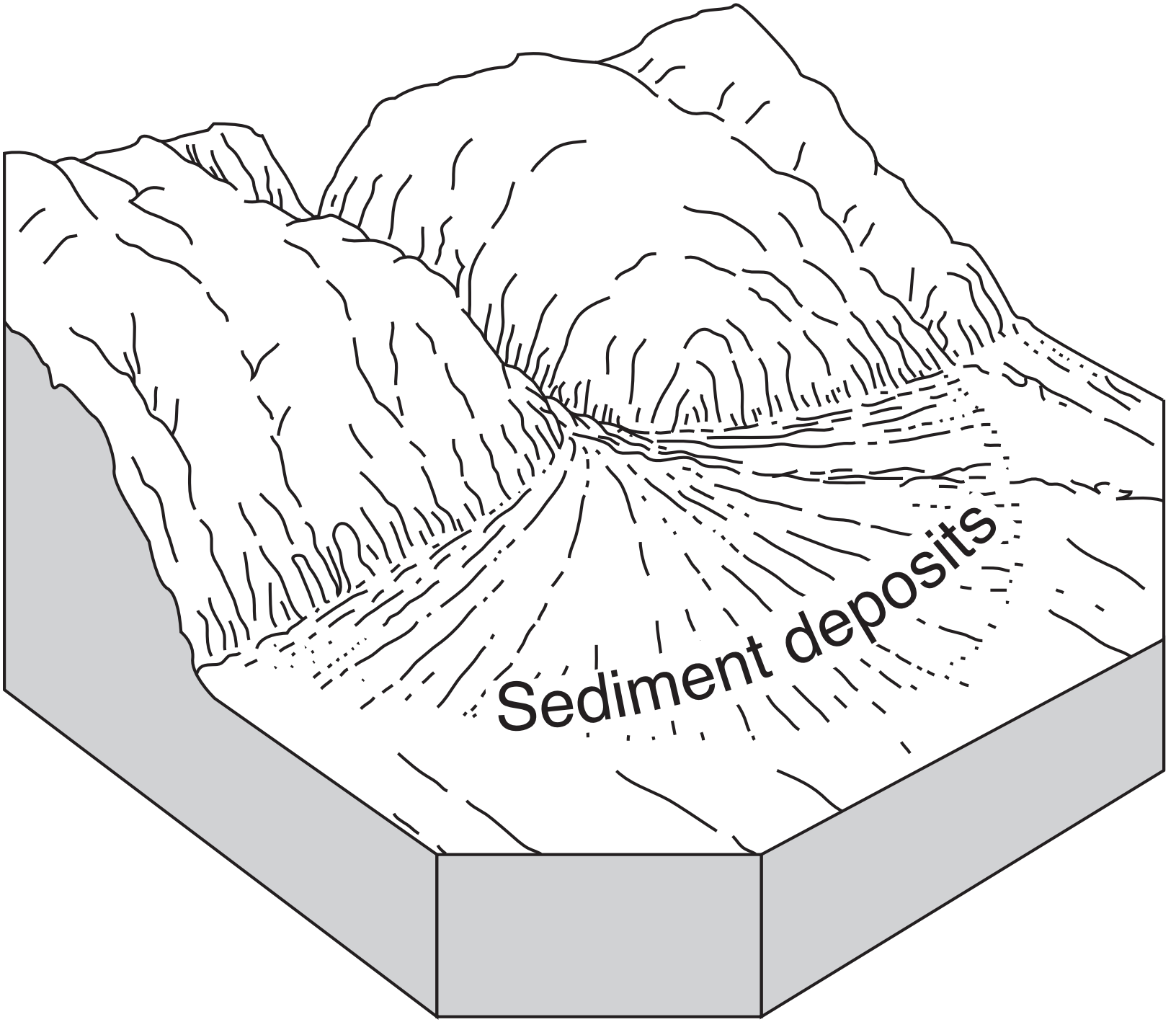
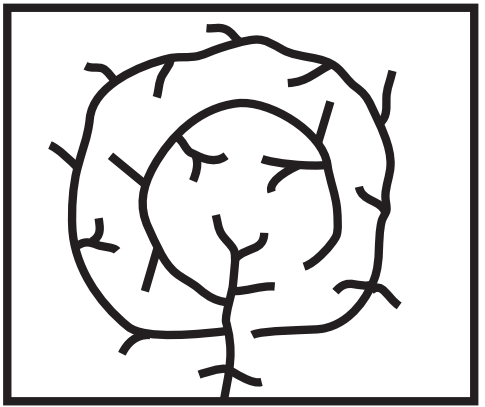
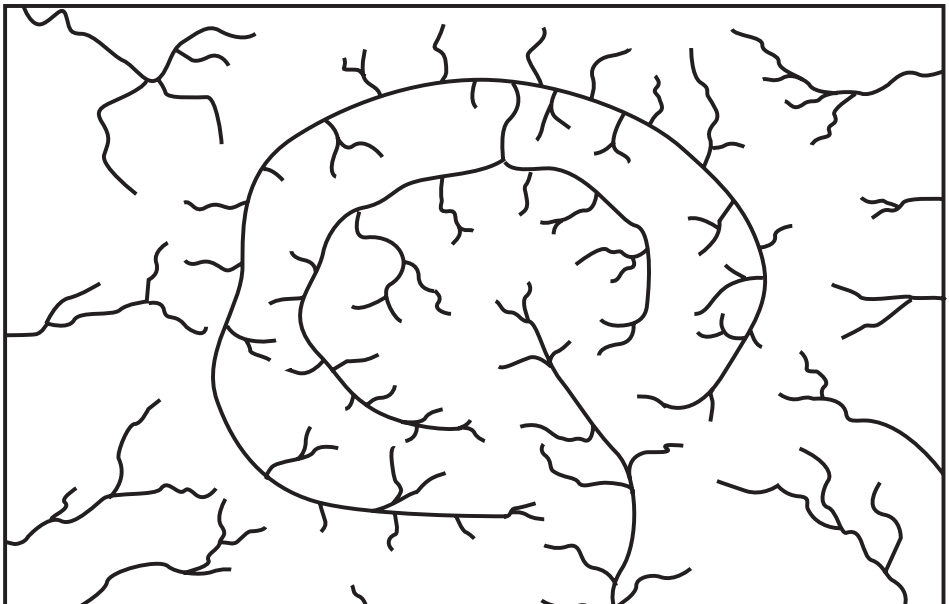
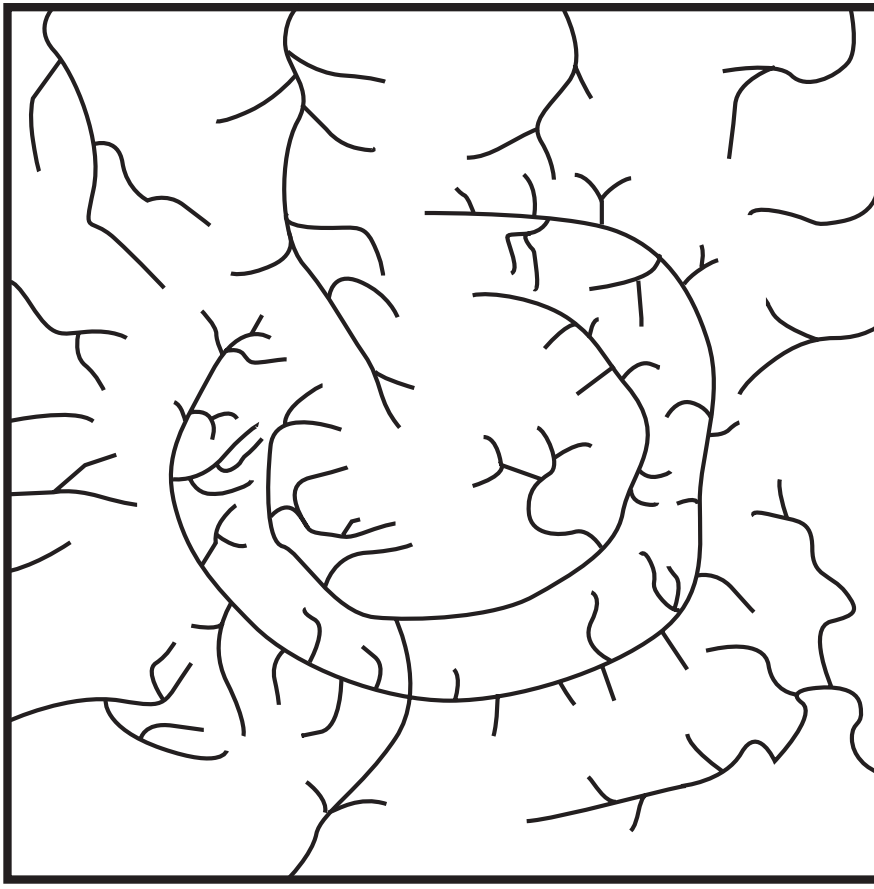


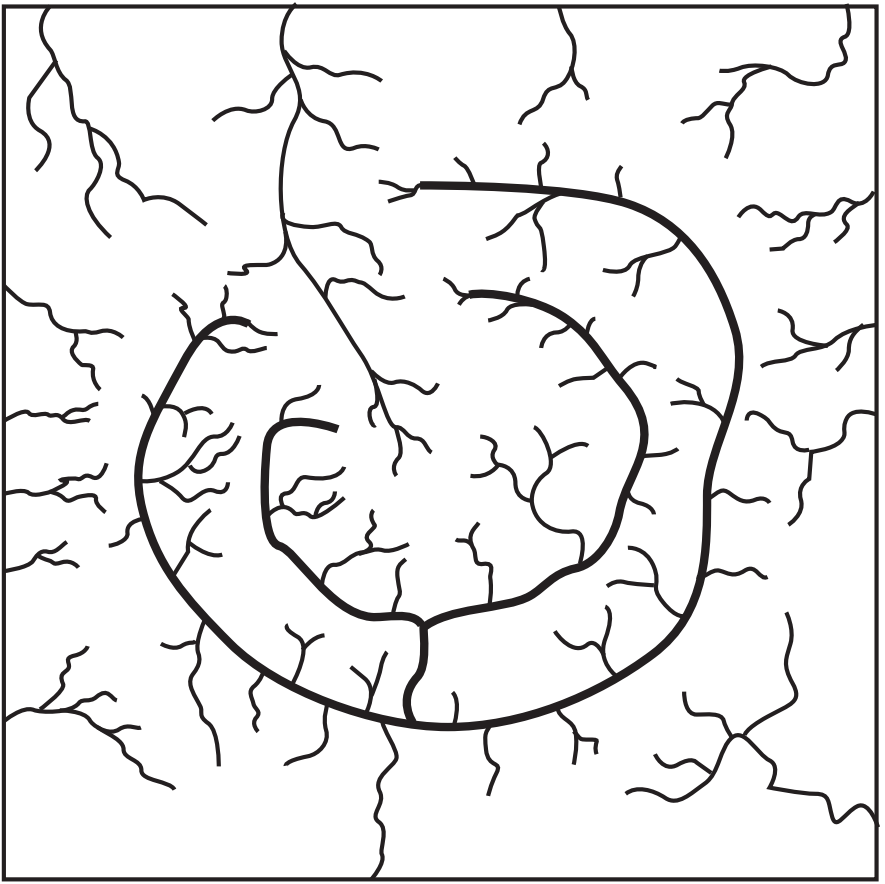
Diagram C

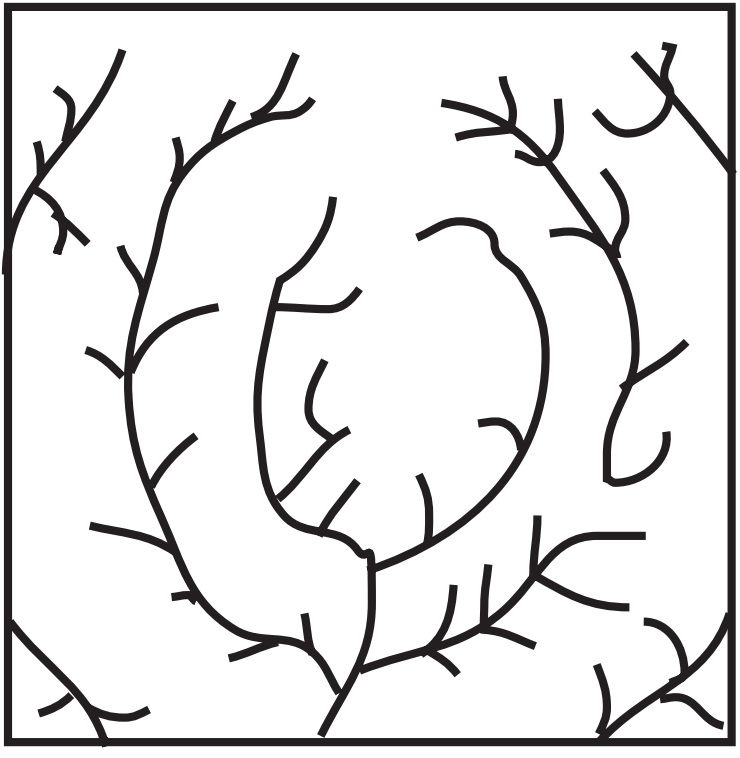

Sediment deposits

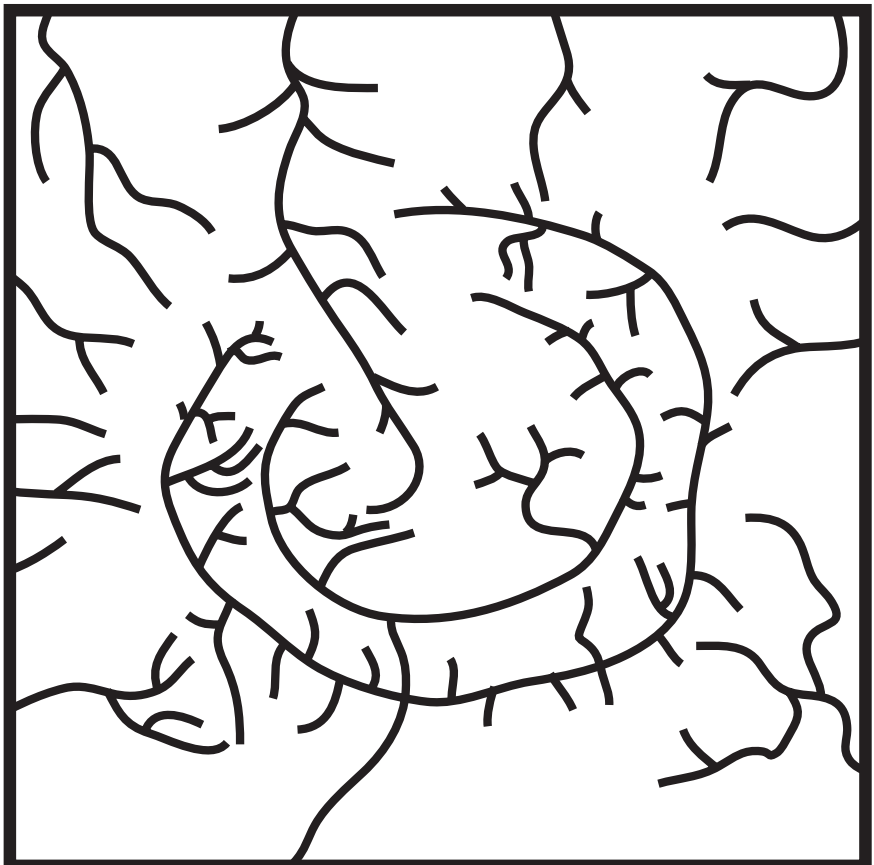


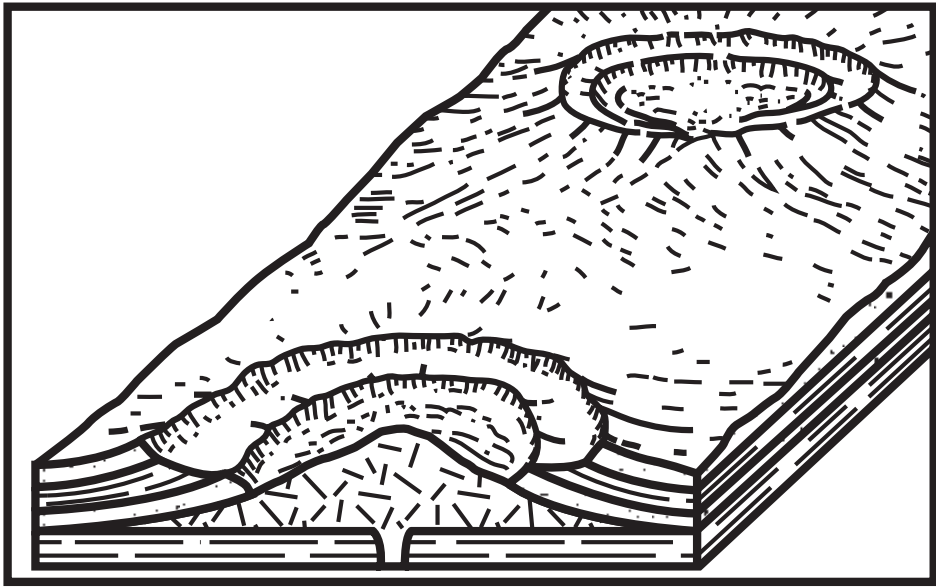


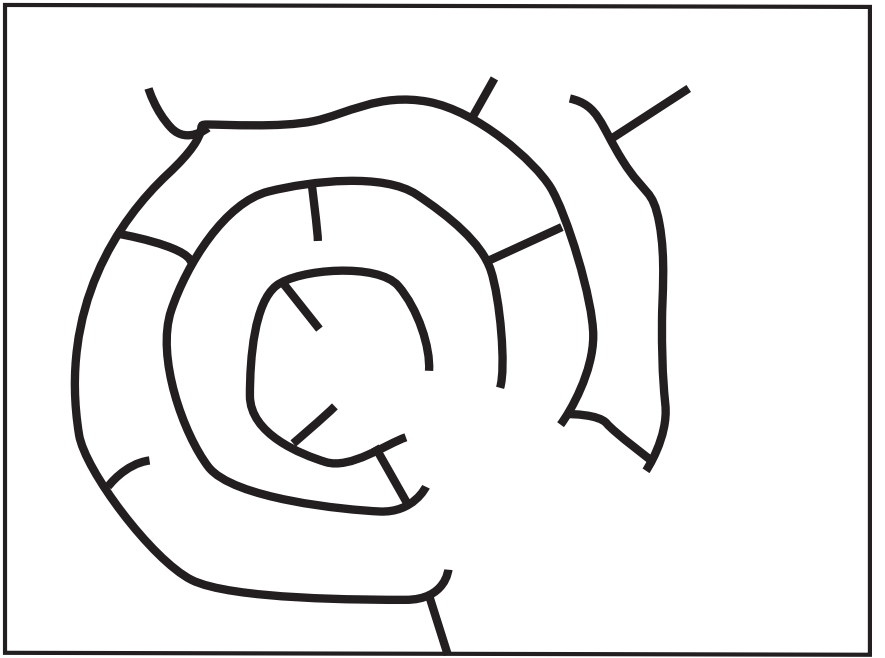


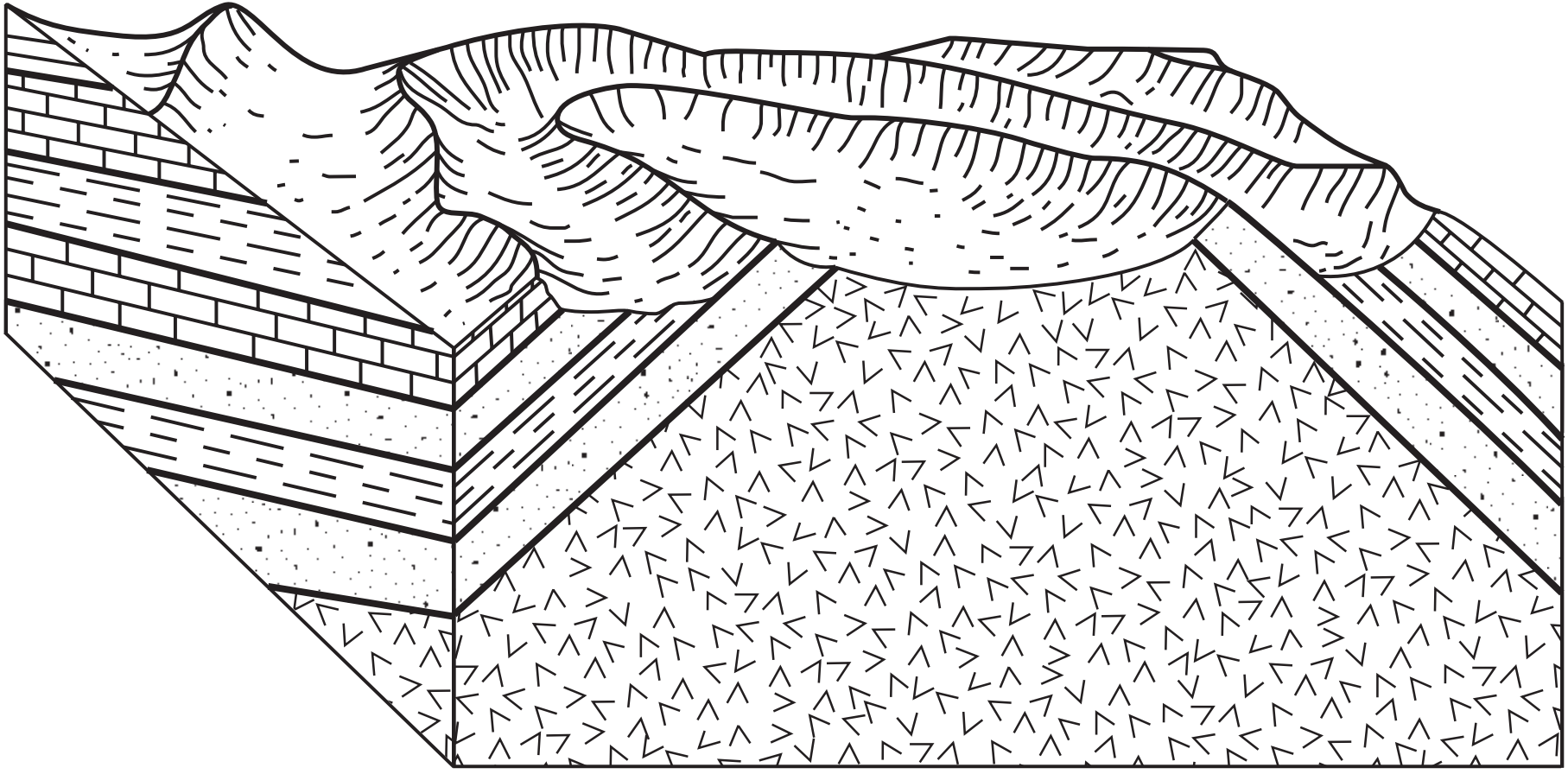


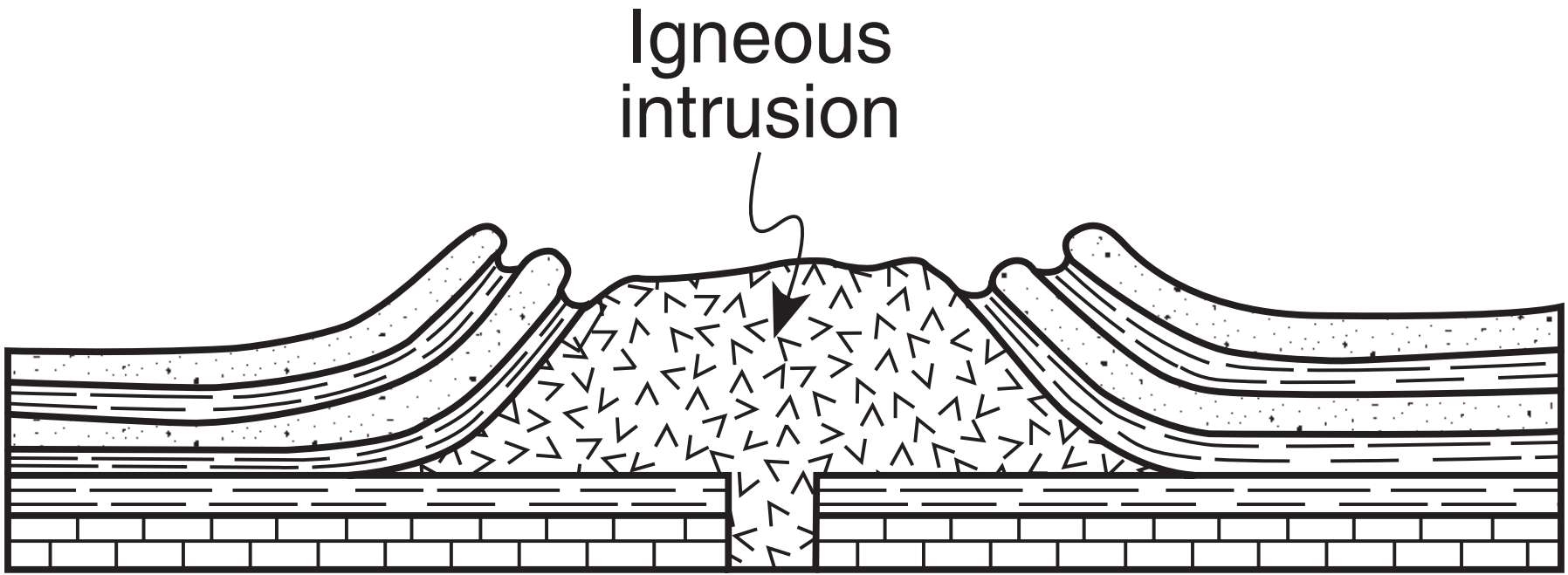




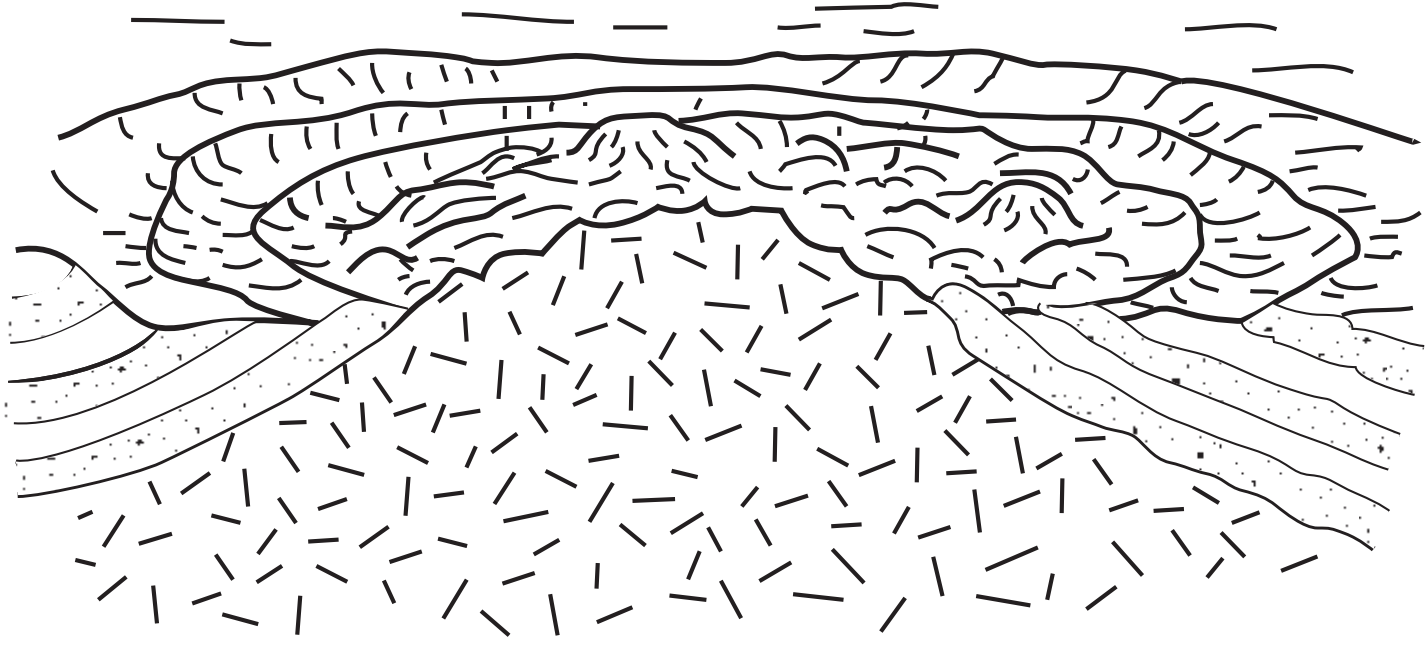


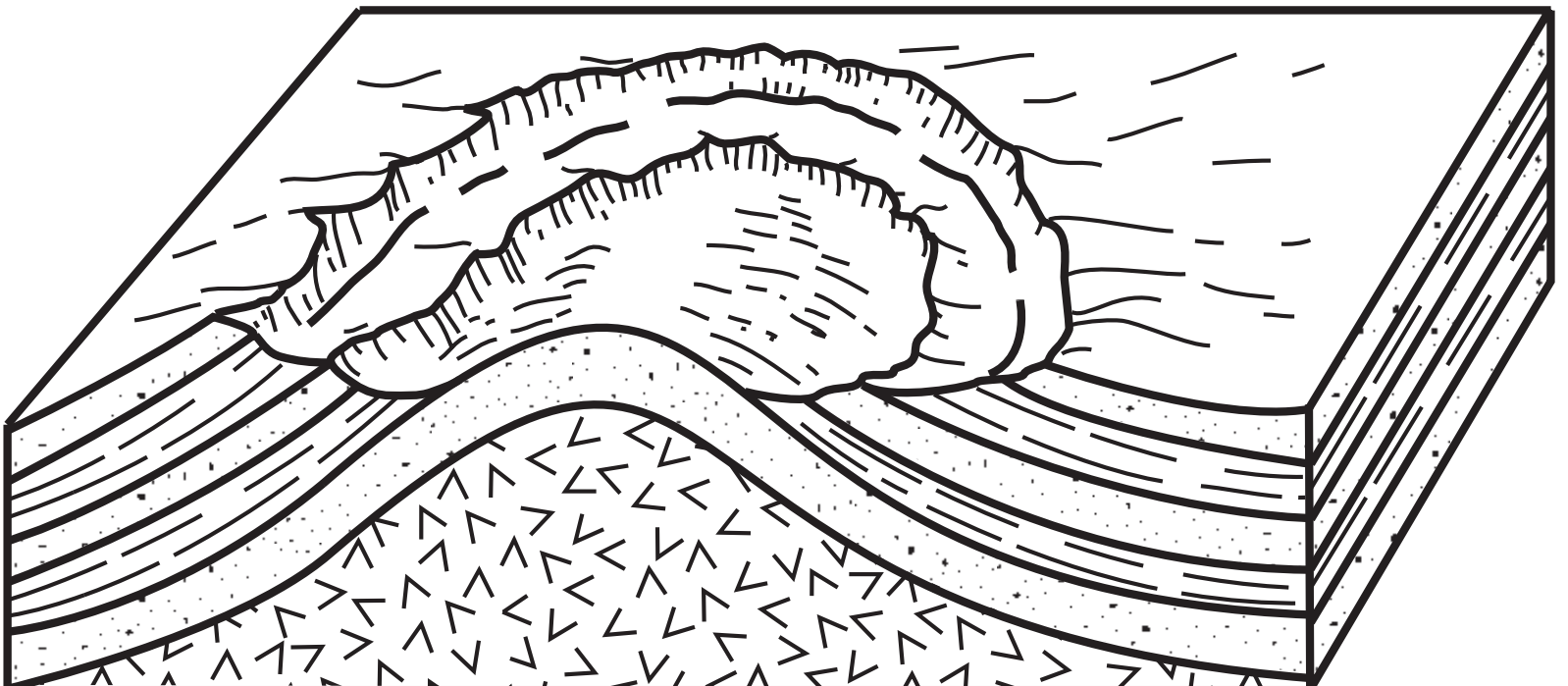


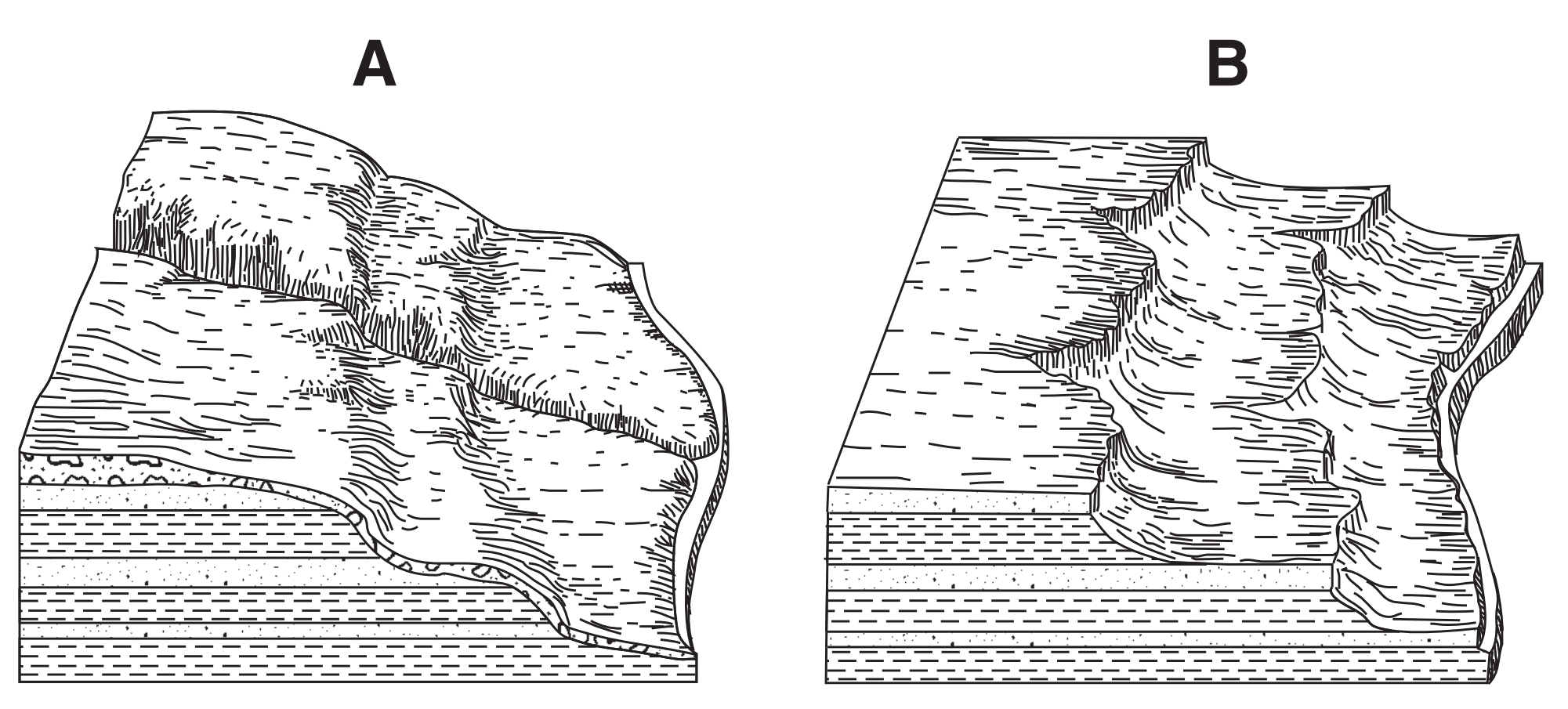





(Not drawn to scale)

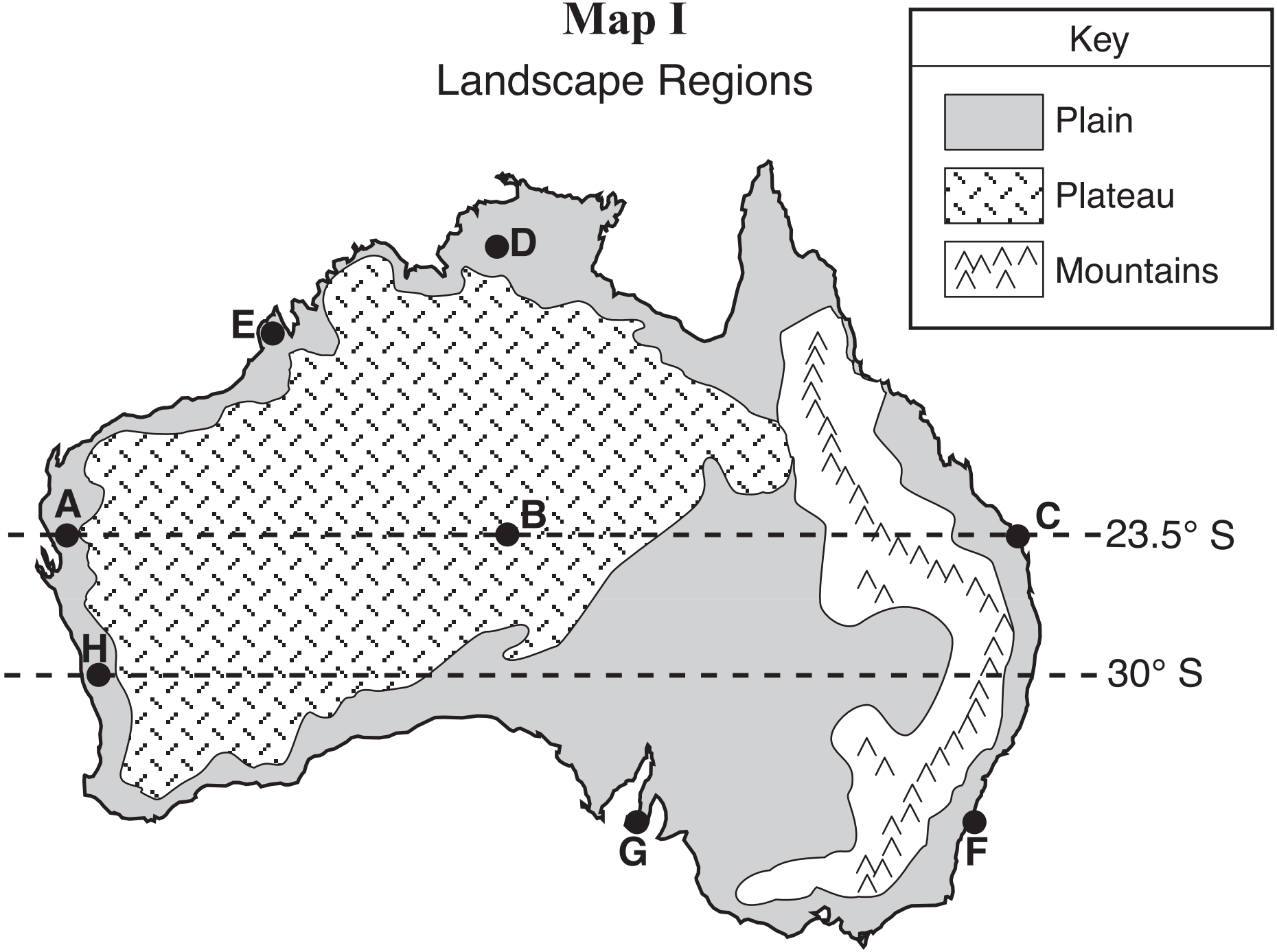


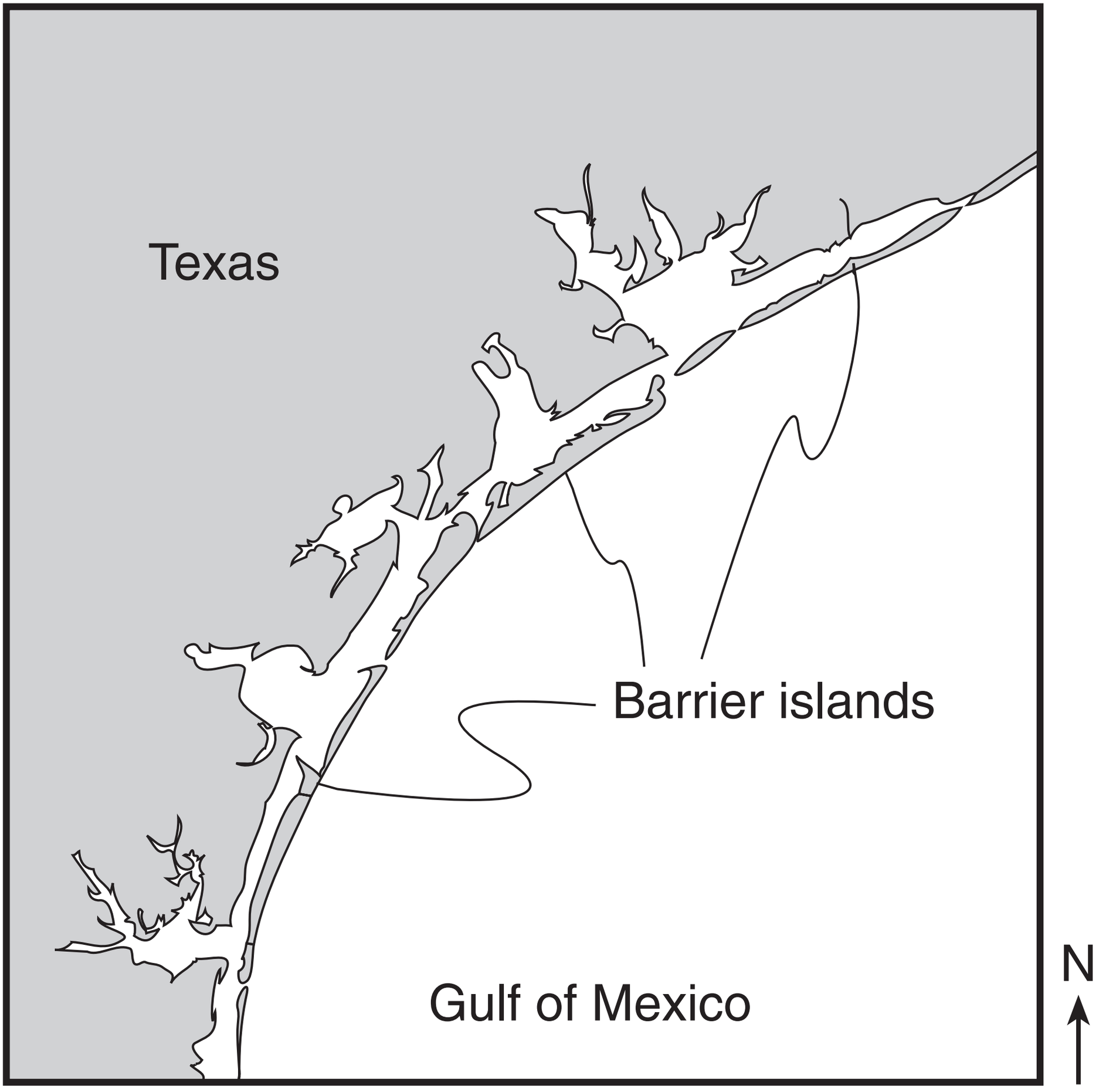



A
B

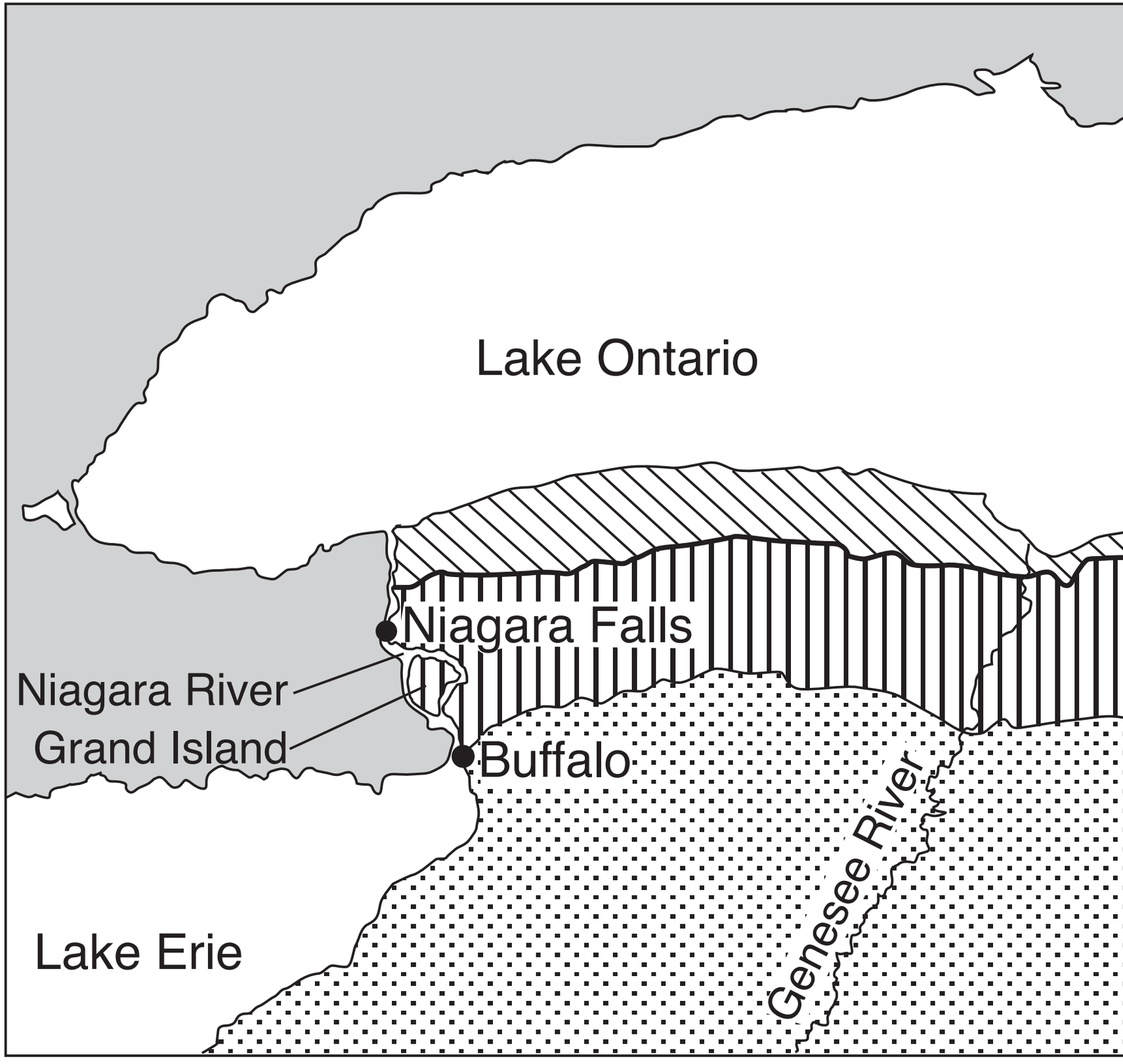
# Map I

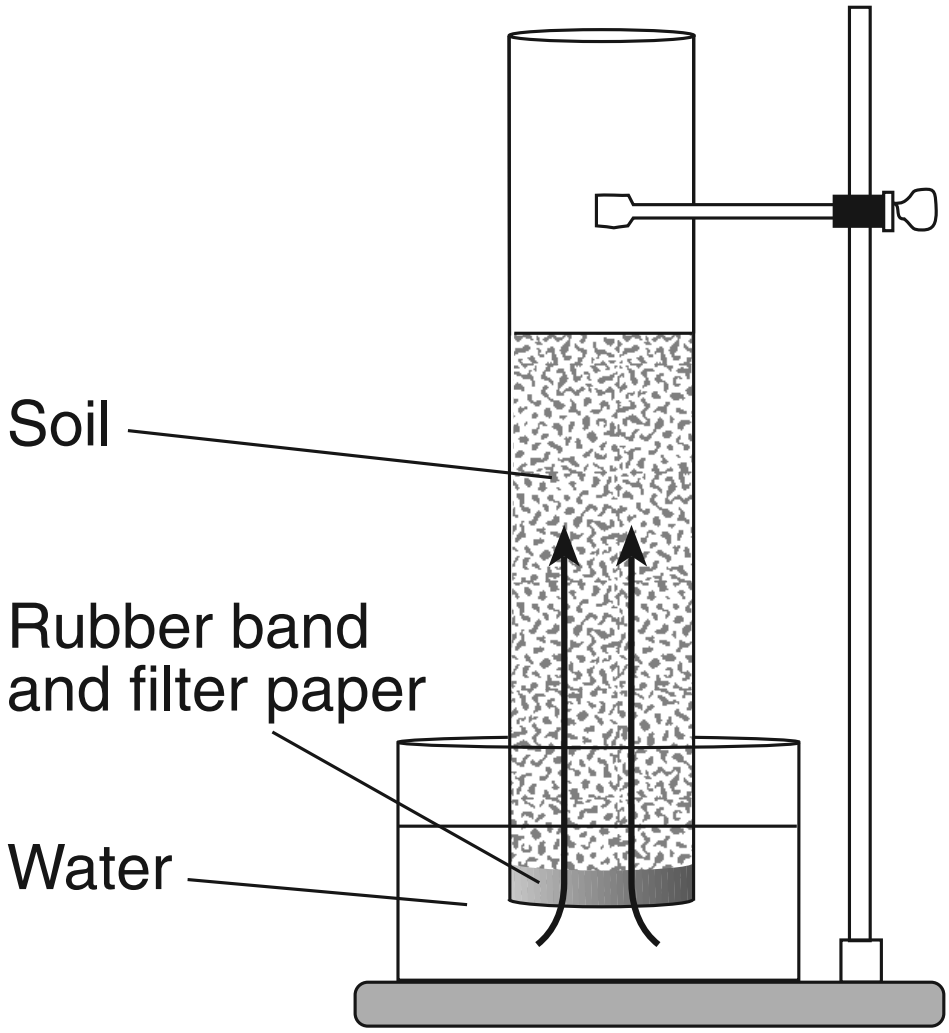
## Landscape Regions




Texas
Barrier islands
Gulf of Mexico
N

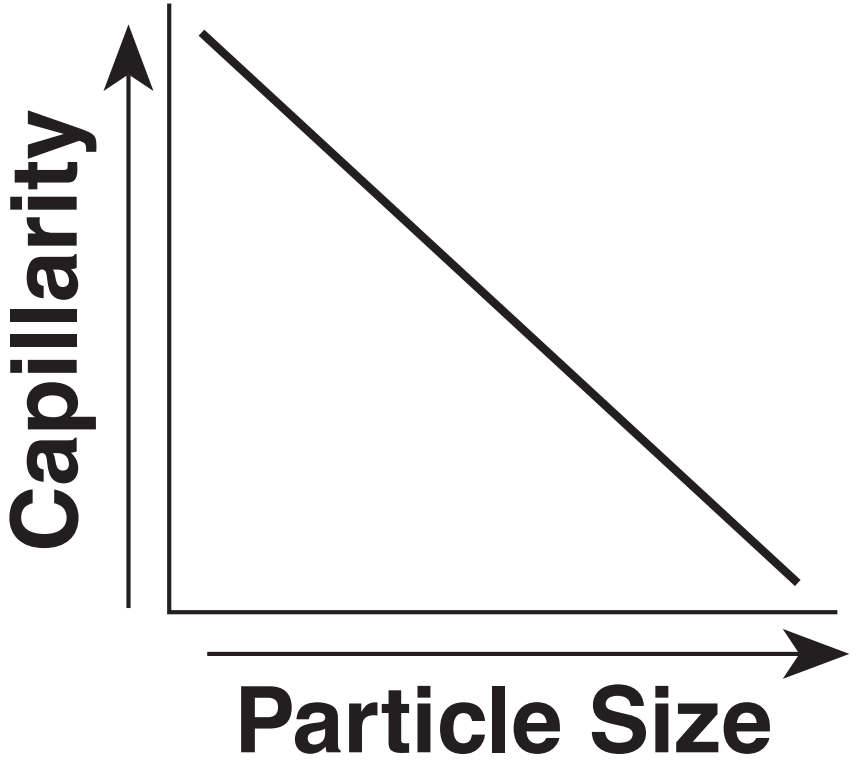
# Generalized Bedrock Map

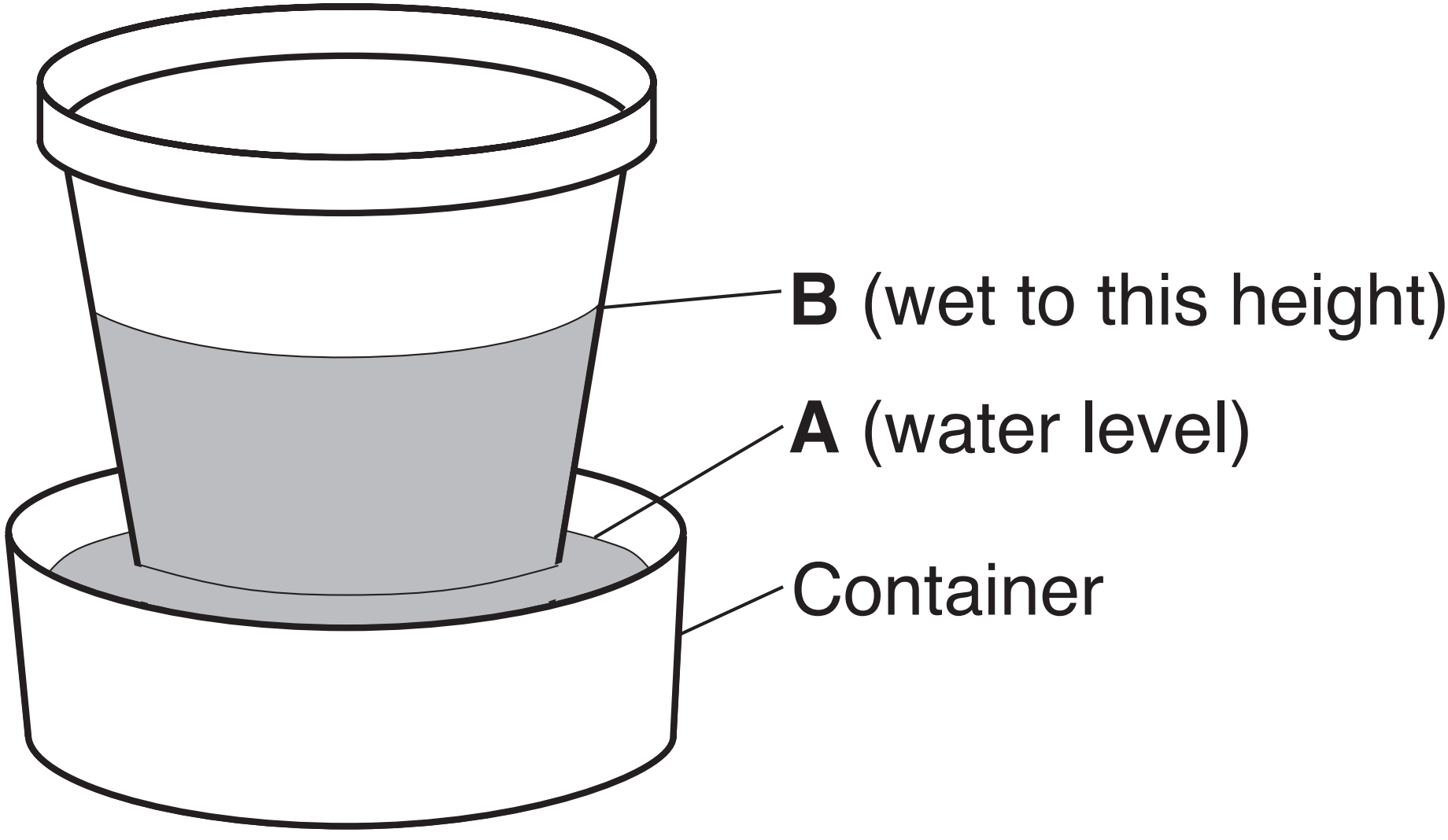


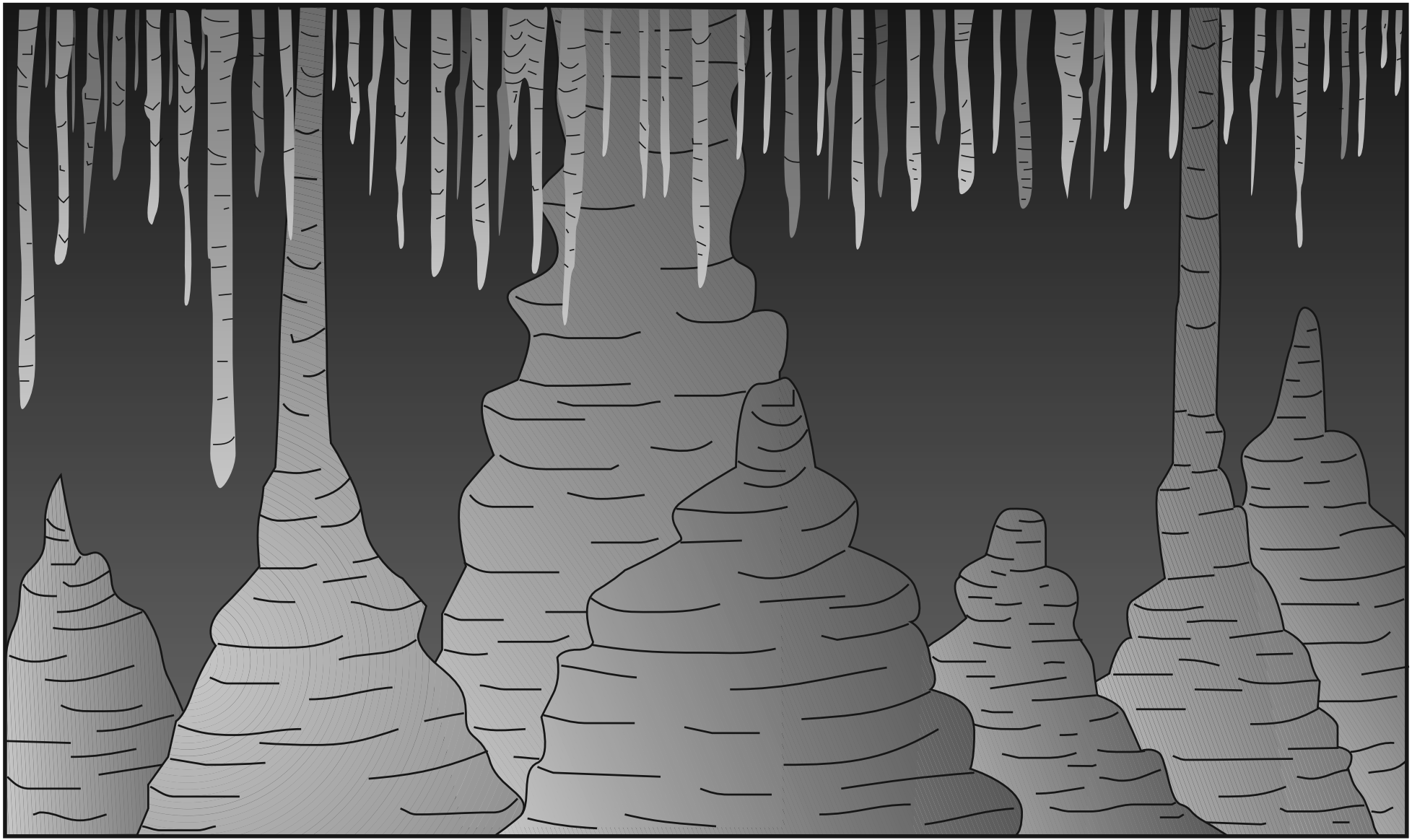


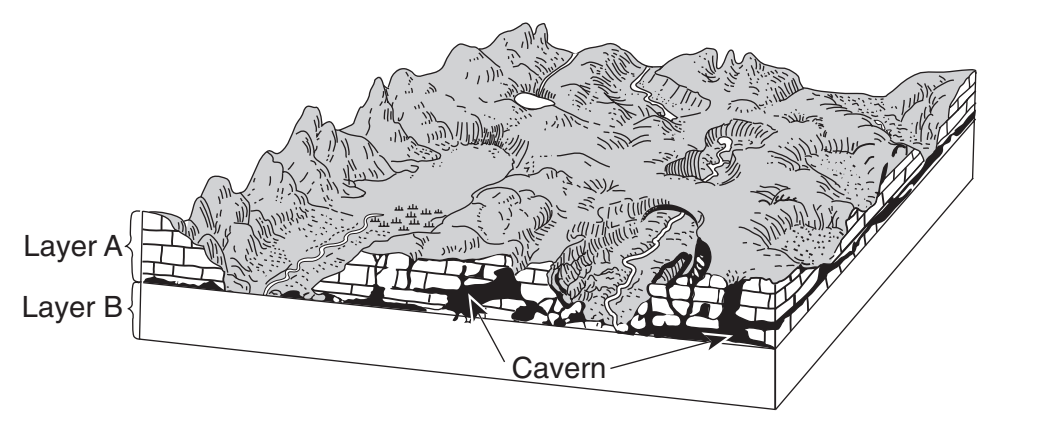

## Data Table

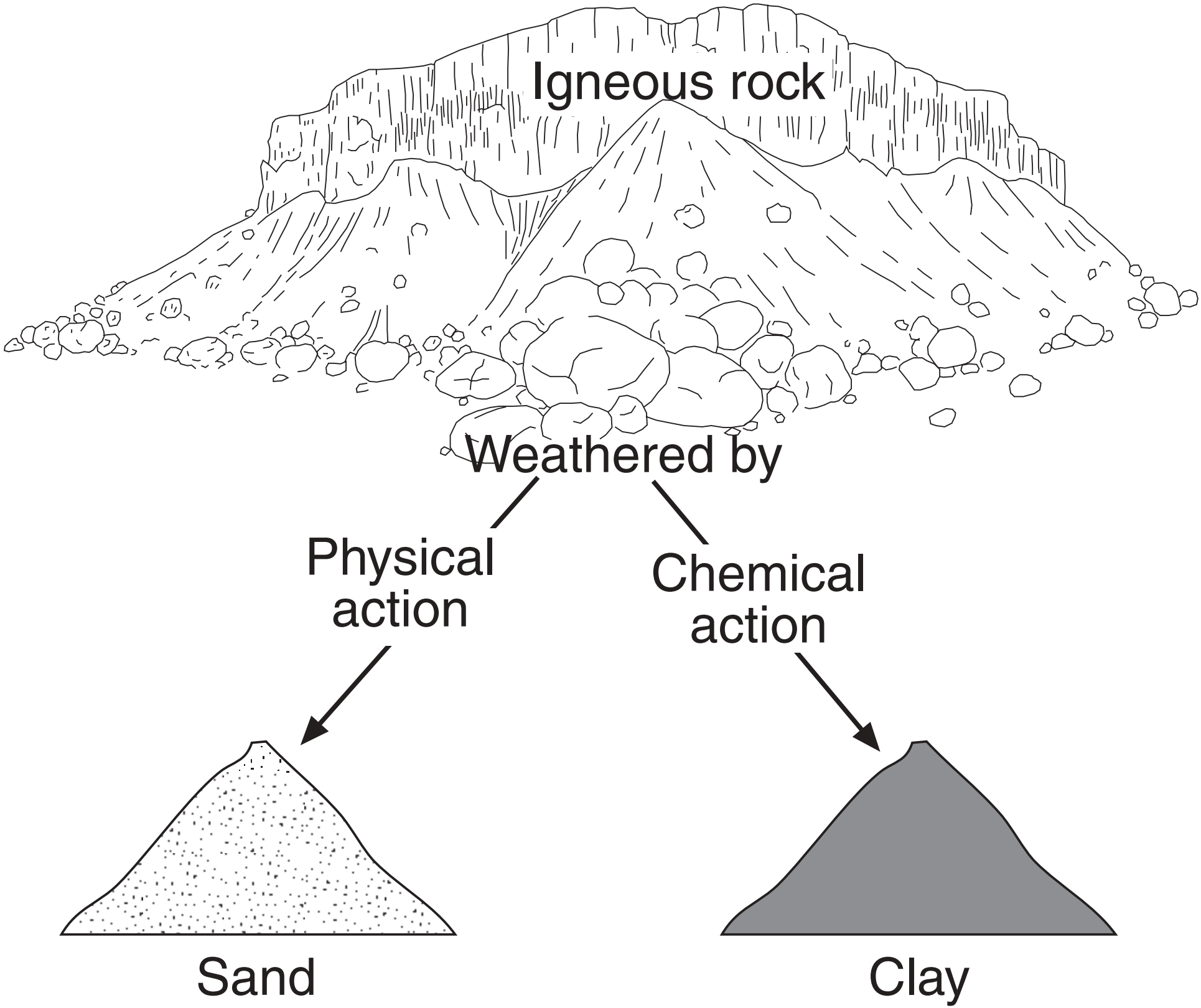
| **Average Soil Particle Diameter** (cm) | **Height of Water in Column** (cm) |
|---|---|
| 0.006 | 30.0 |
| 0.2 | 8.0 |
| 1.0 | 0.5 |

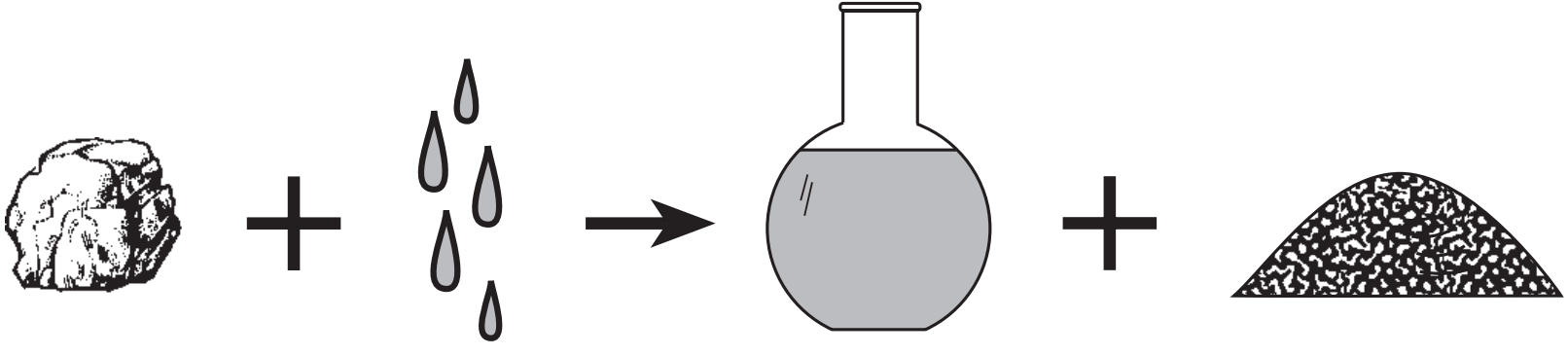

Capillarity
Particle Size


B (wet to this height)
A (water level)
Container

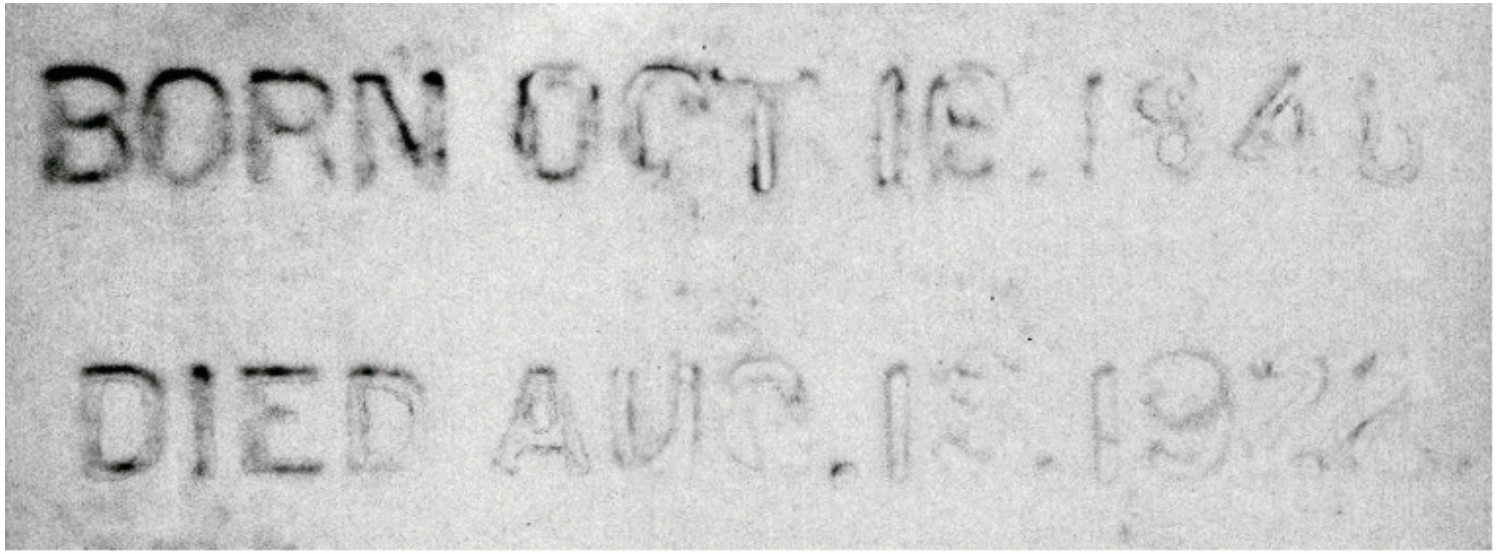



Layer A
Layer B
Cavern


Igneous rock
Weathered by
Physical action
Chemical action
Sand
Clay

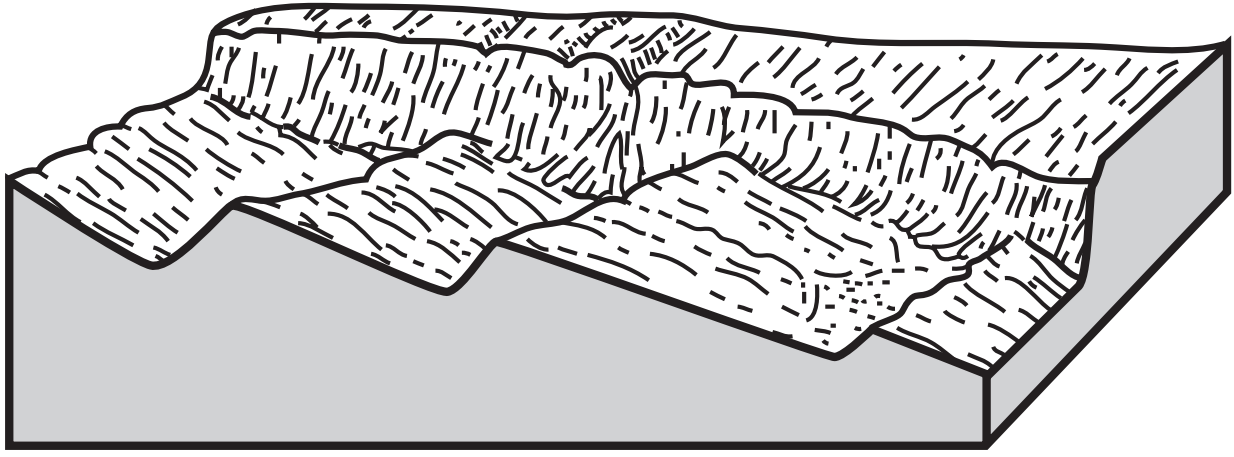


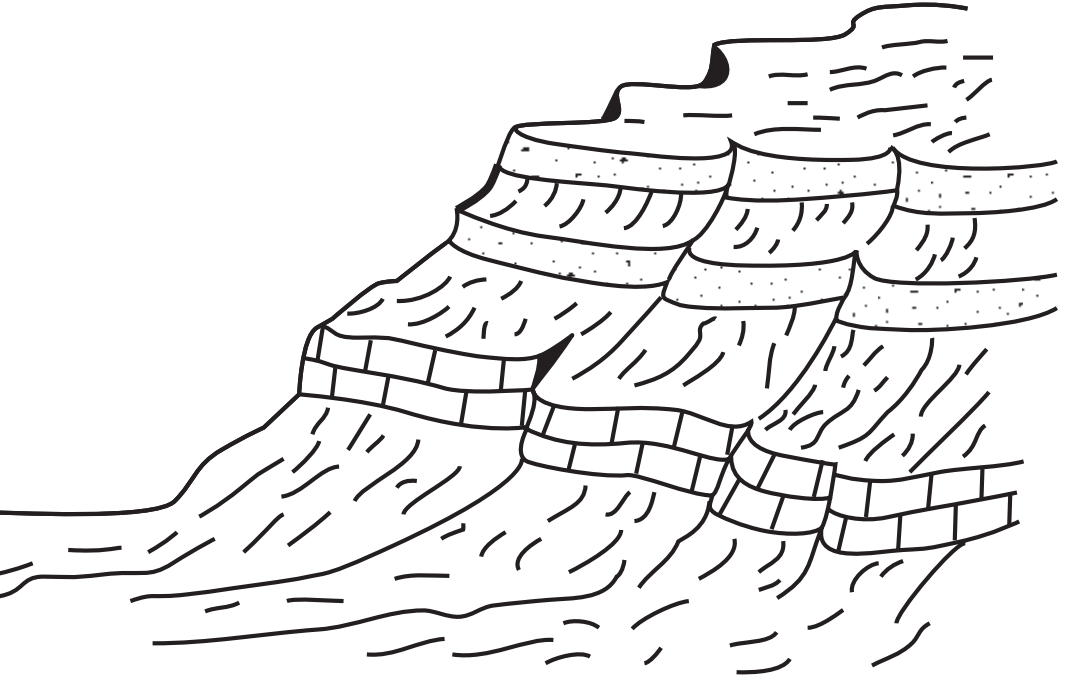
Feldspar + Water → Salts of calcium, potassium, and sodium dissolved in water + Clay minerals (less than 0.0004 cm)



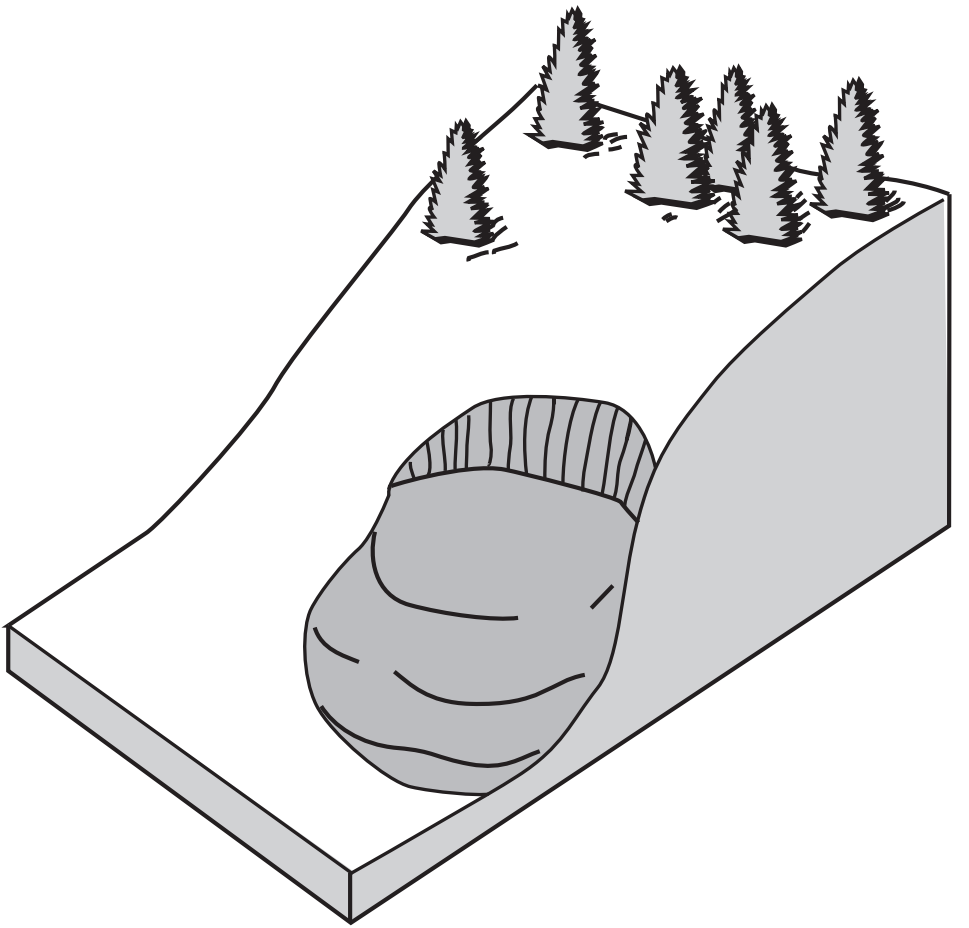

Tombstone A (1922)

Tombstone B (1892)

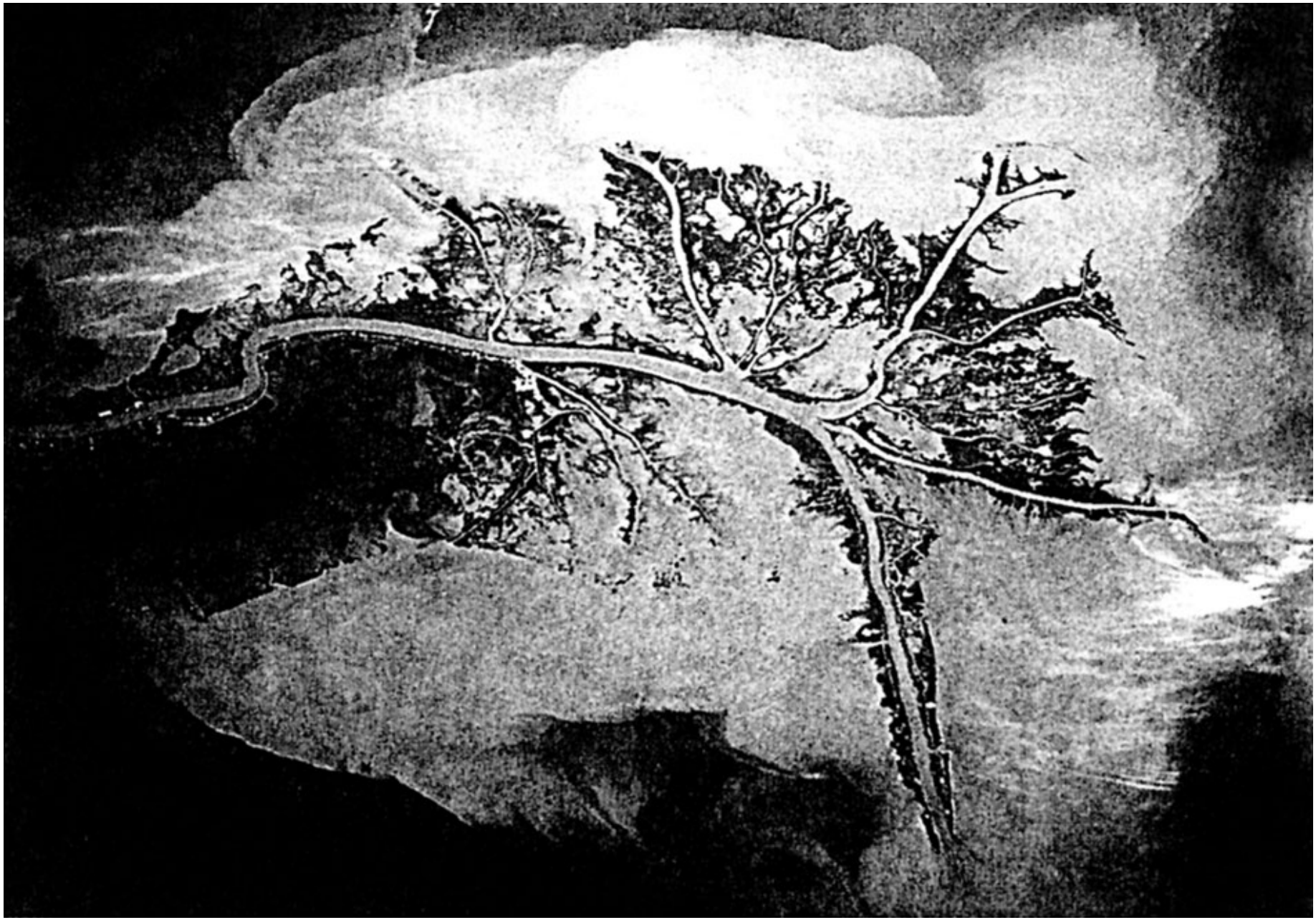


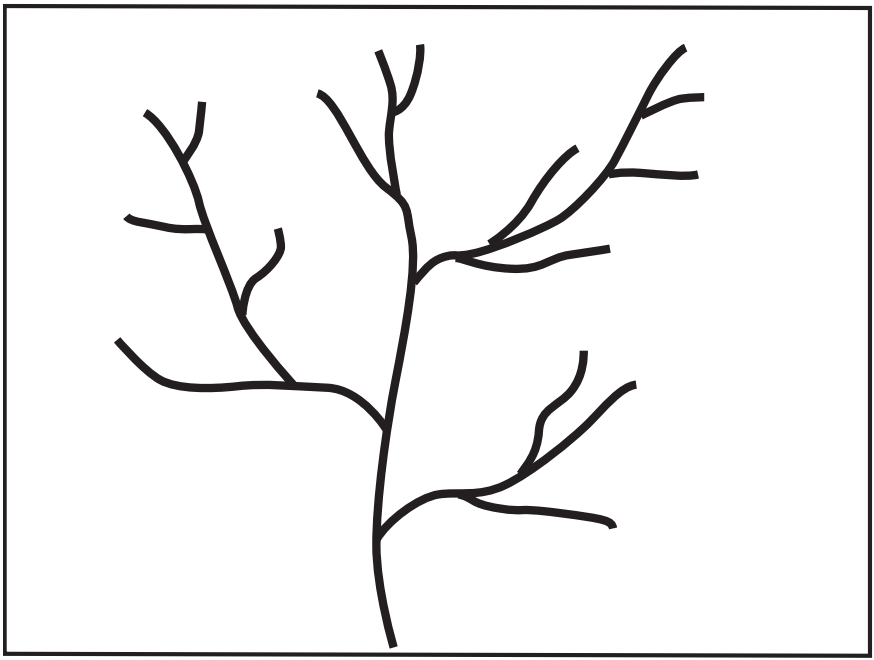


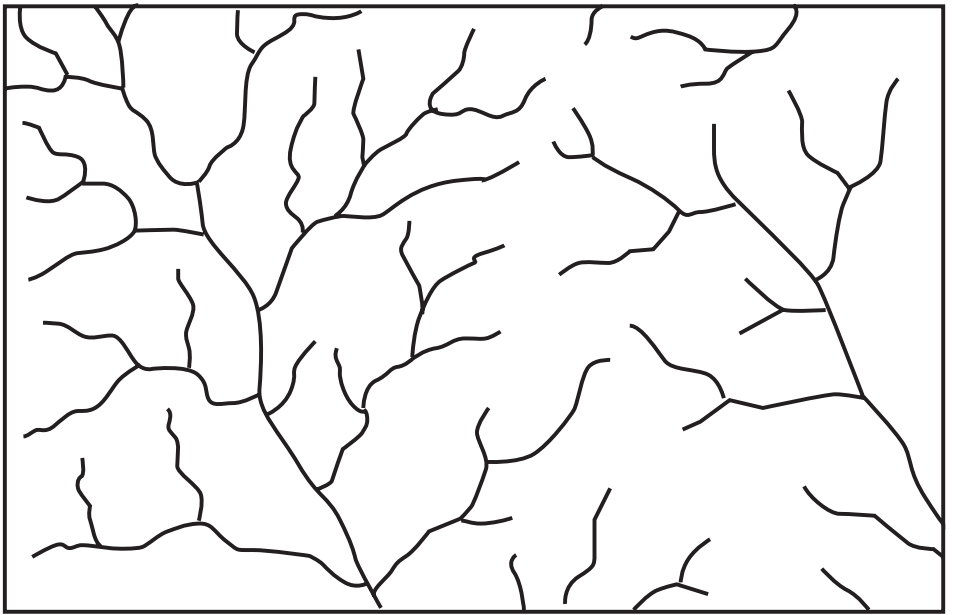
# Debris flow

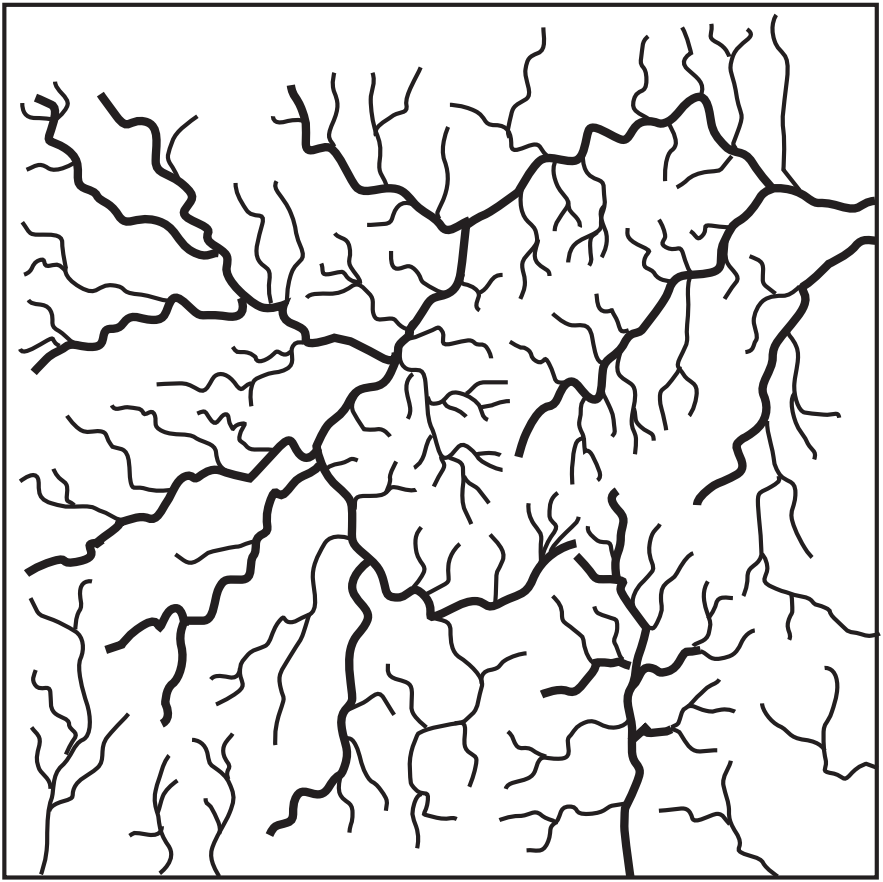


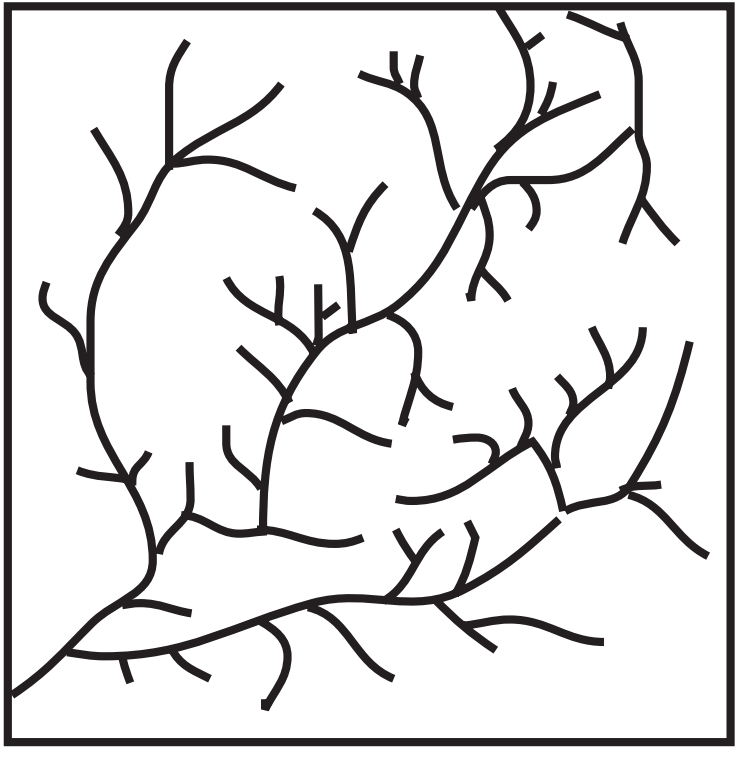
Rapid downslope flow of debris

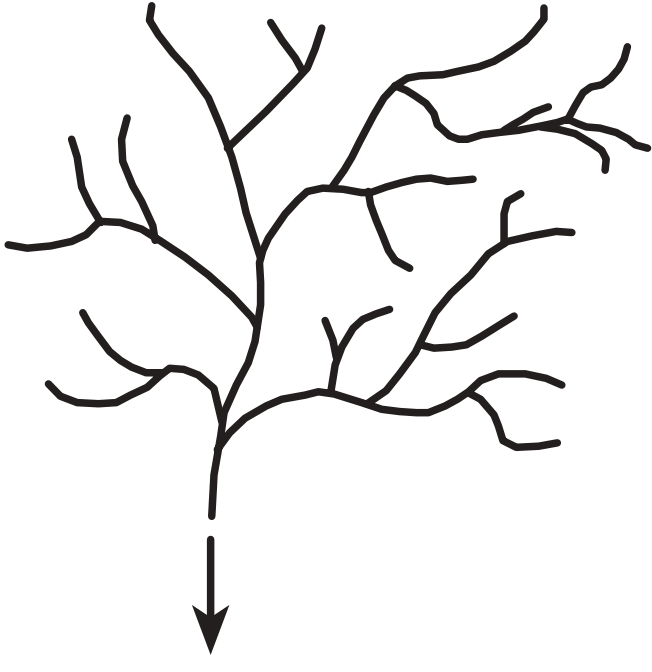


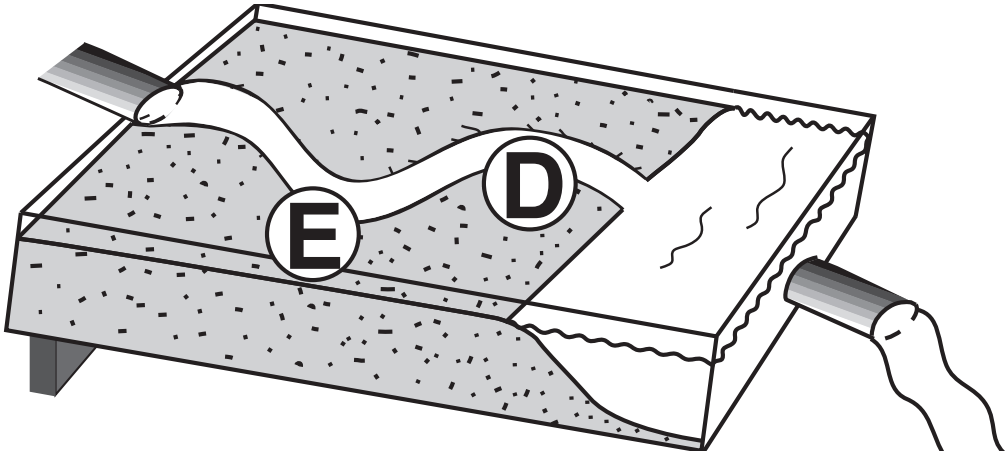


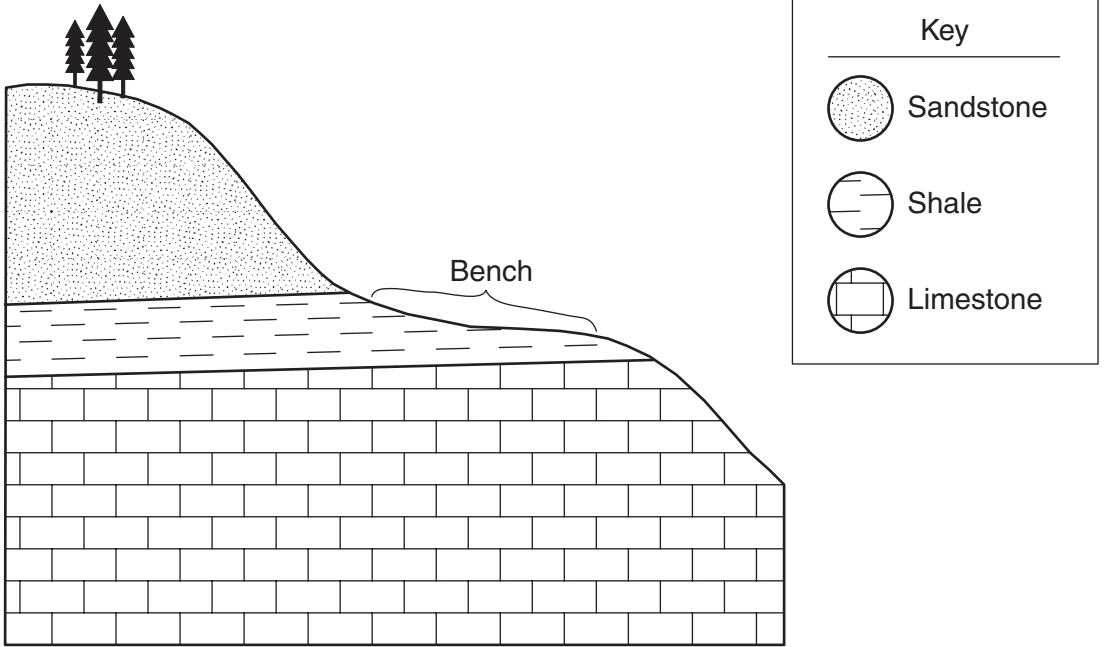


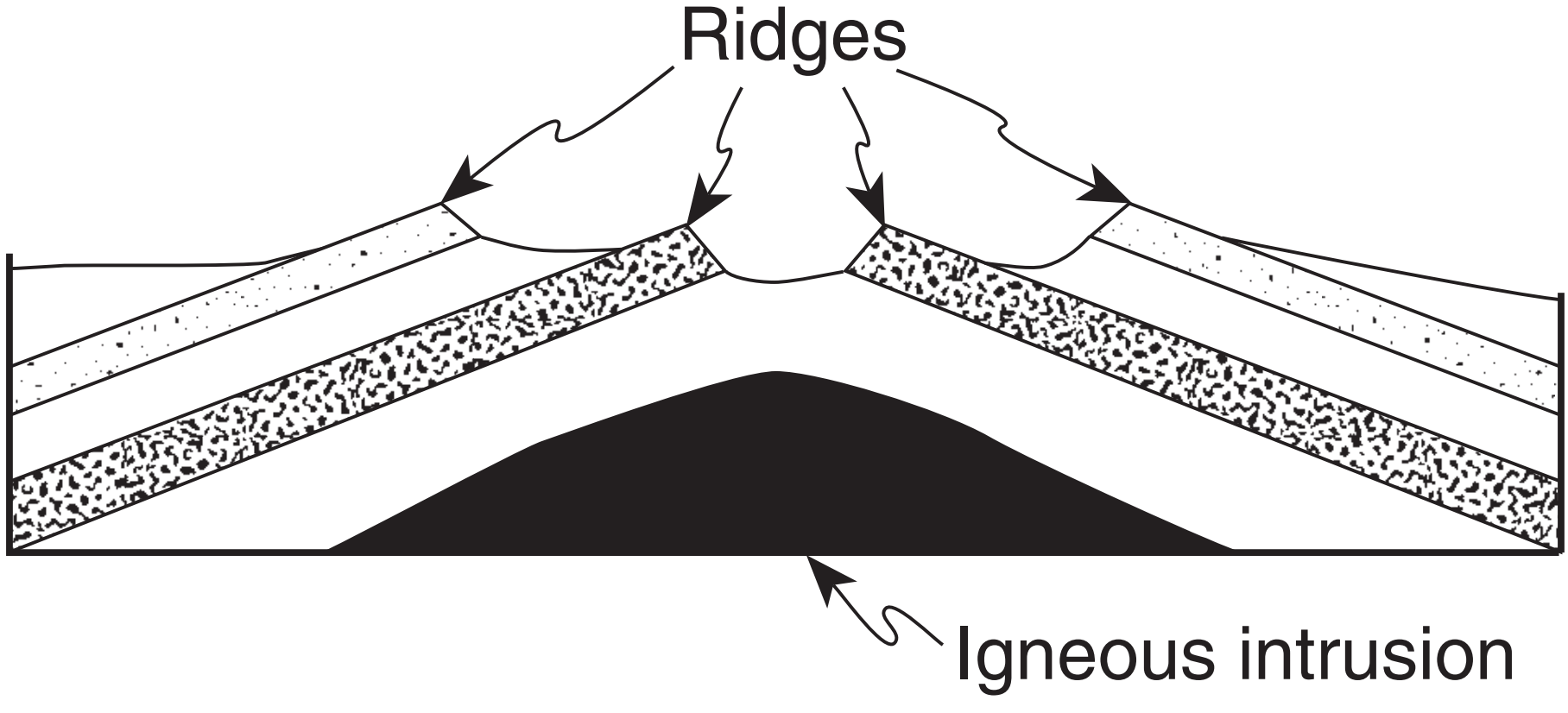


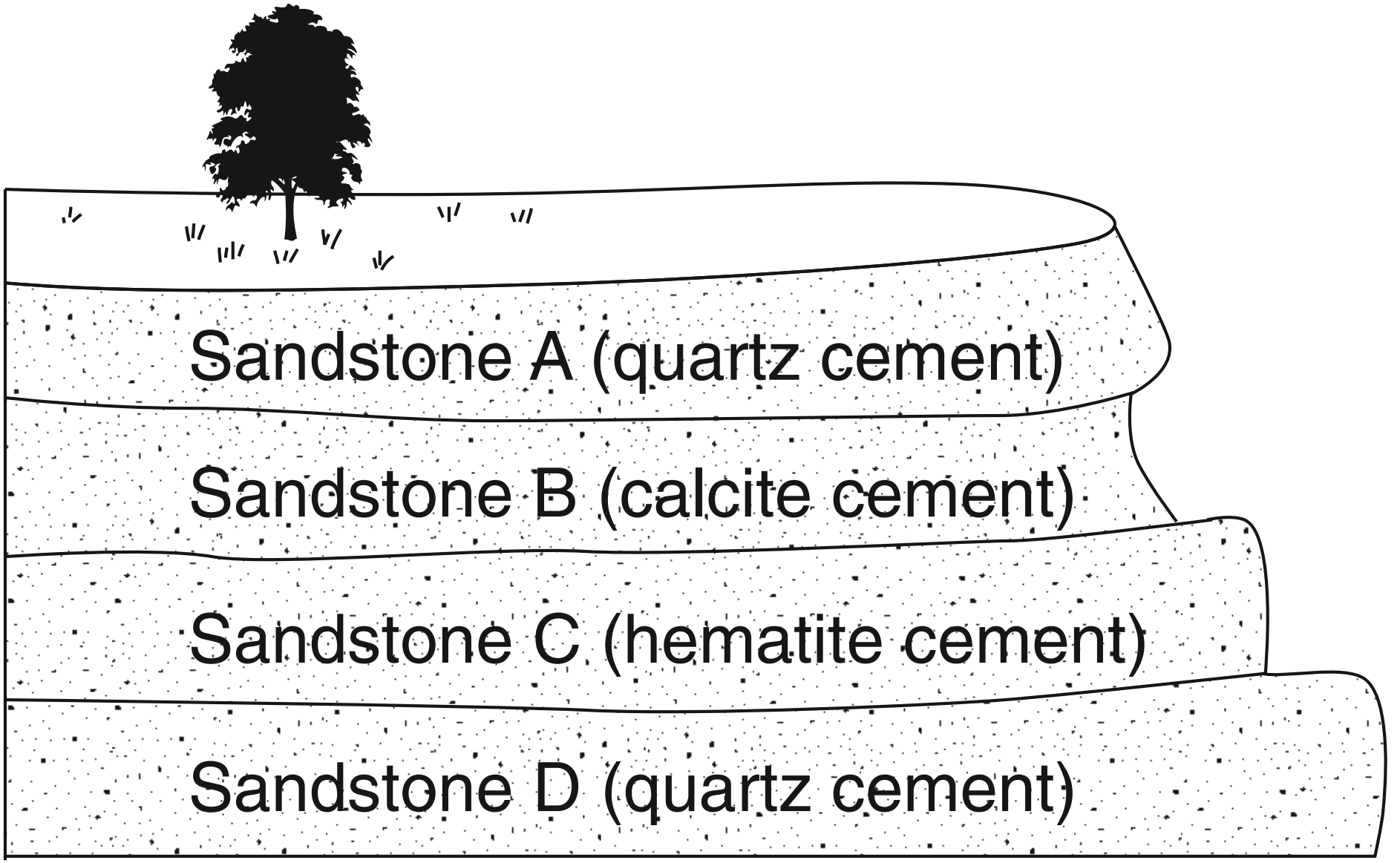


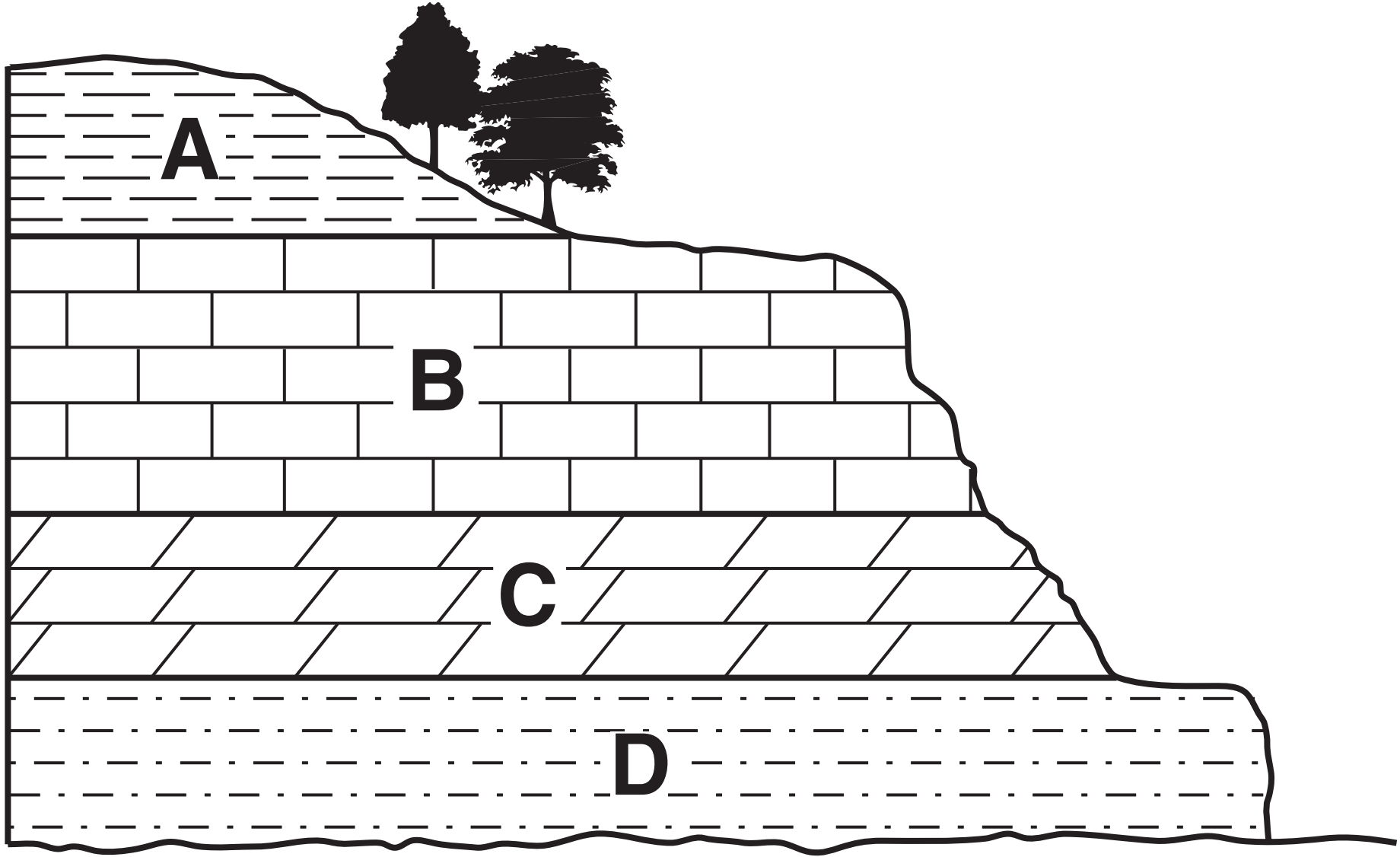


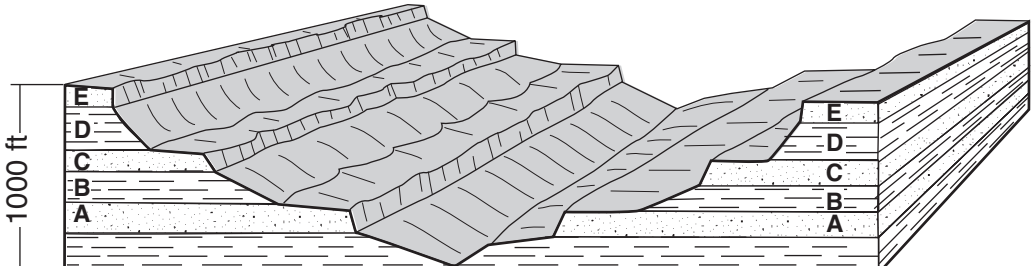

E
D

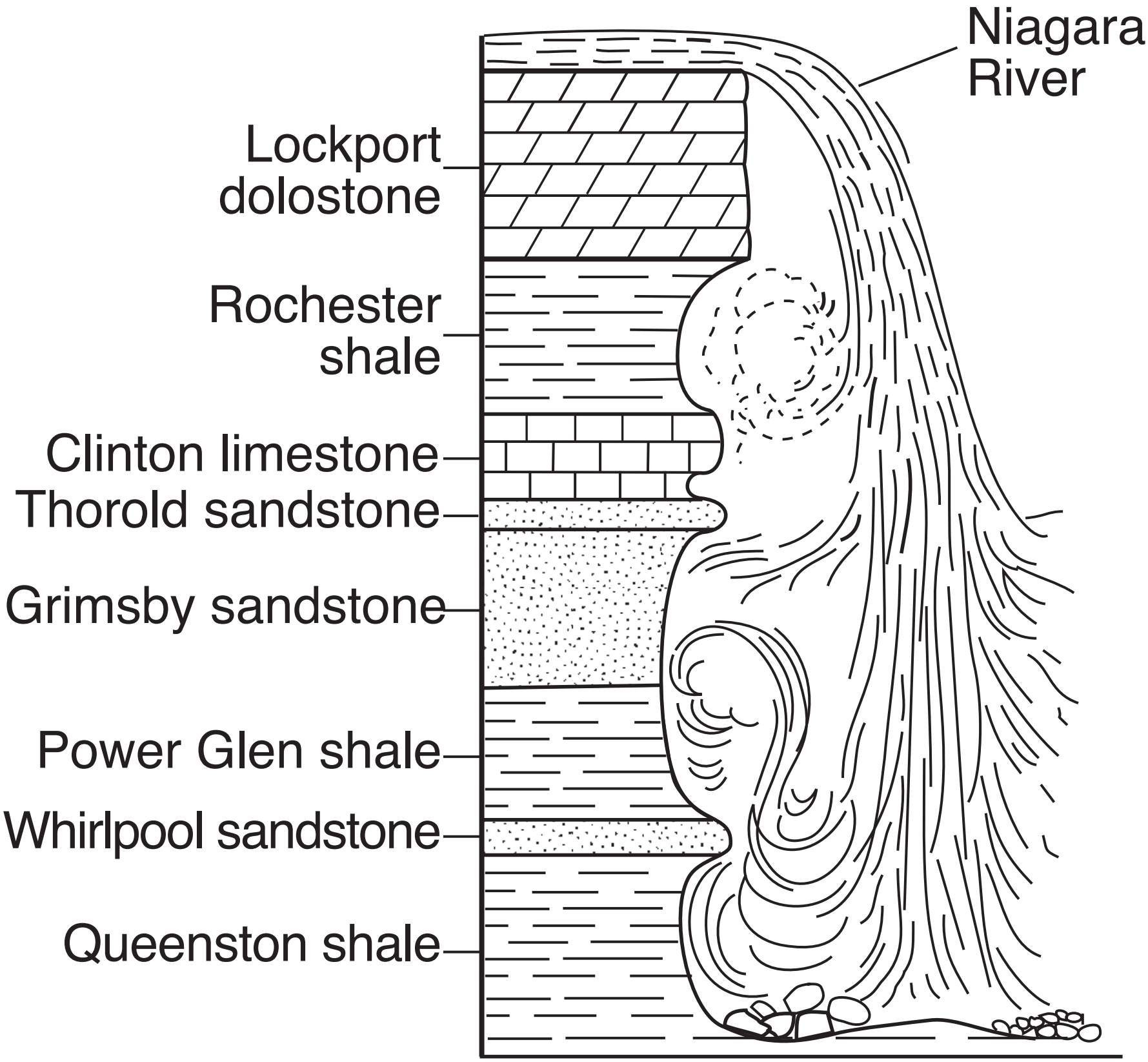

Bench
Key
Sandstone
Shale
Limestone

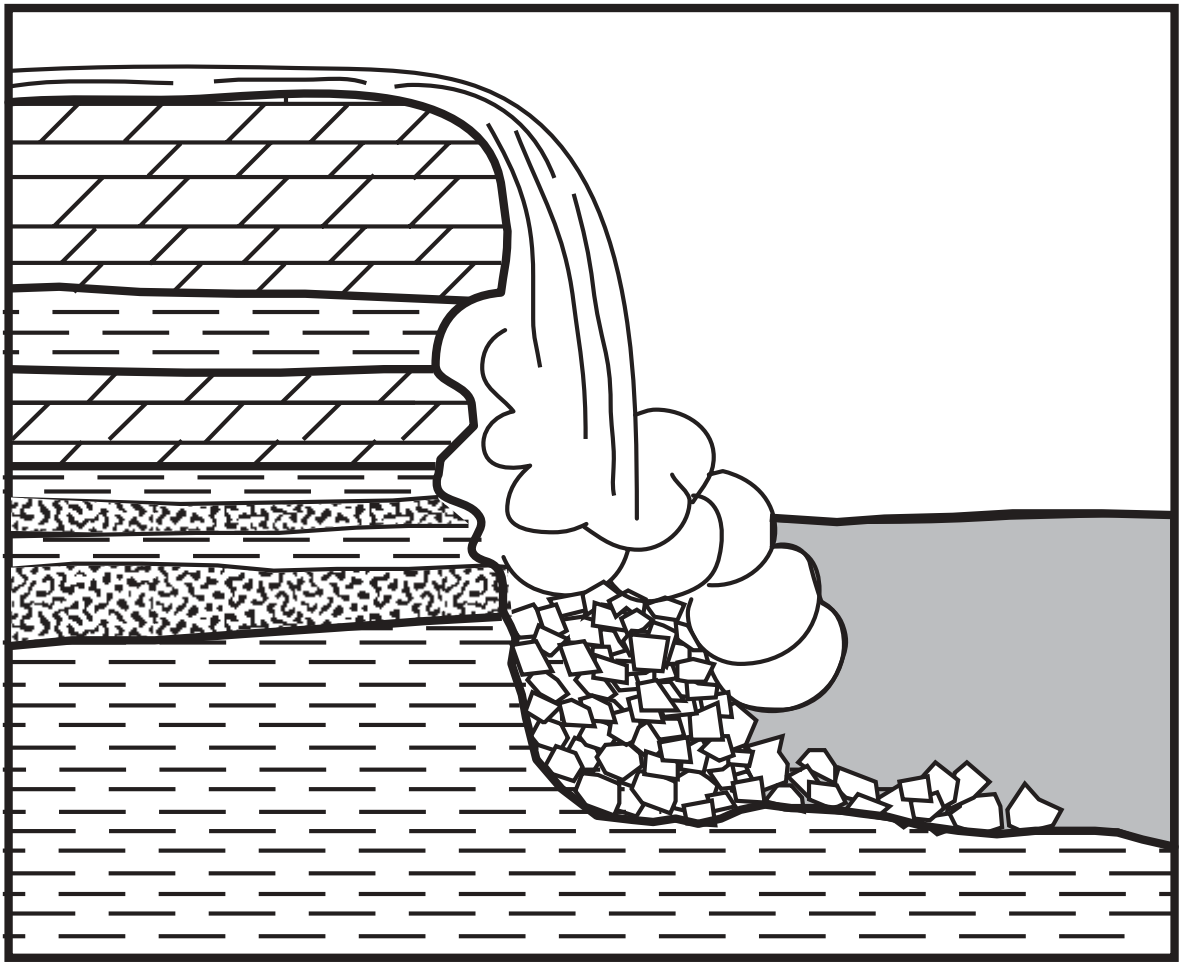

Ridges
Igneous intrusion


Sandstone A (quartz cement)
Sandstone B (calcite cement)
Sandstone C (hematite cement)
Sandstone D (quartz cement)


A
B
C
D

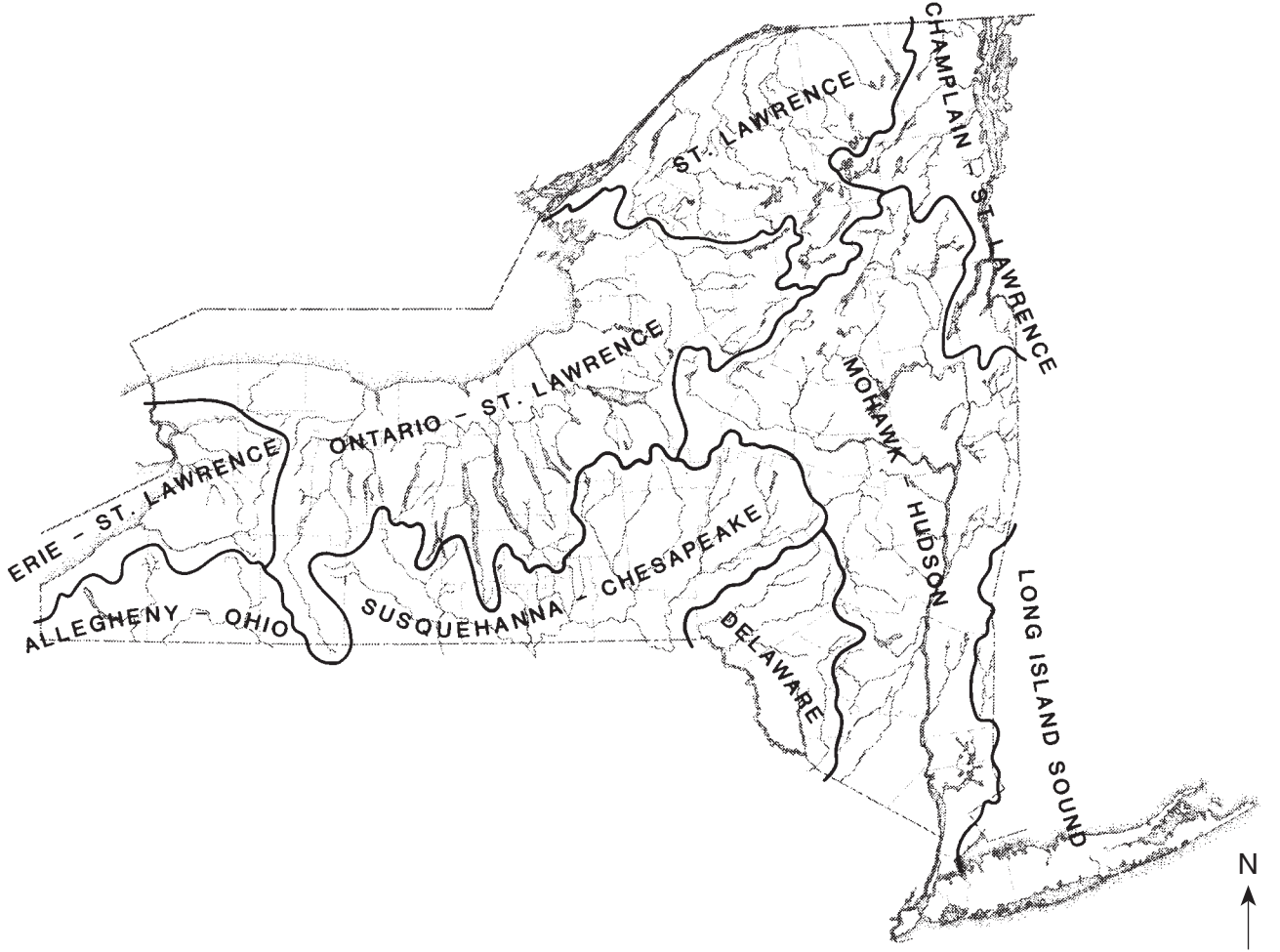

1000 ft
E
D
C
B
A
E
D
C
B
A

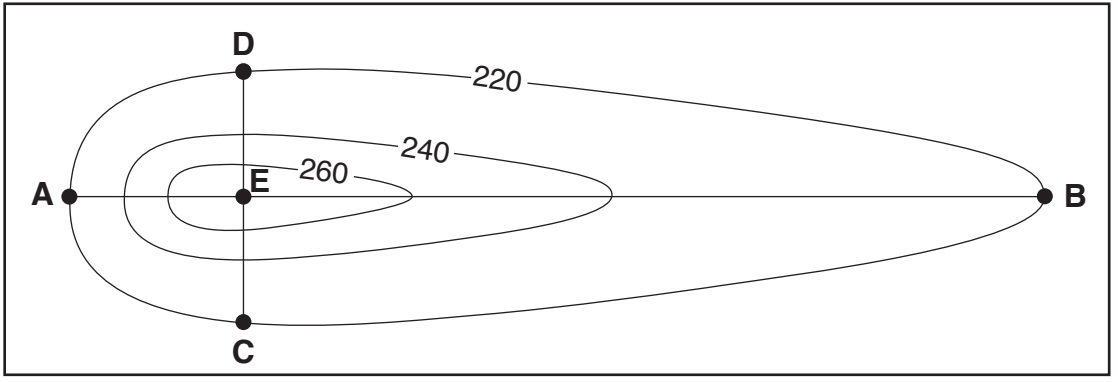

Niagara River
Lockport dolostone
Rochester shale
Clinton limestone
Thorold sandstone
Grimsby sandstone
Power Glen shale
Whirlpool sandstone
Queenston shale



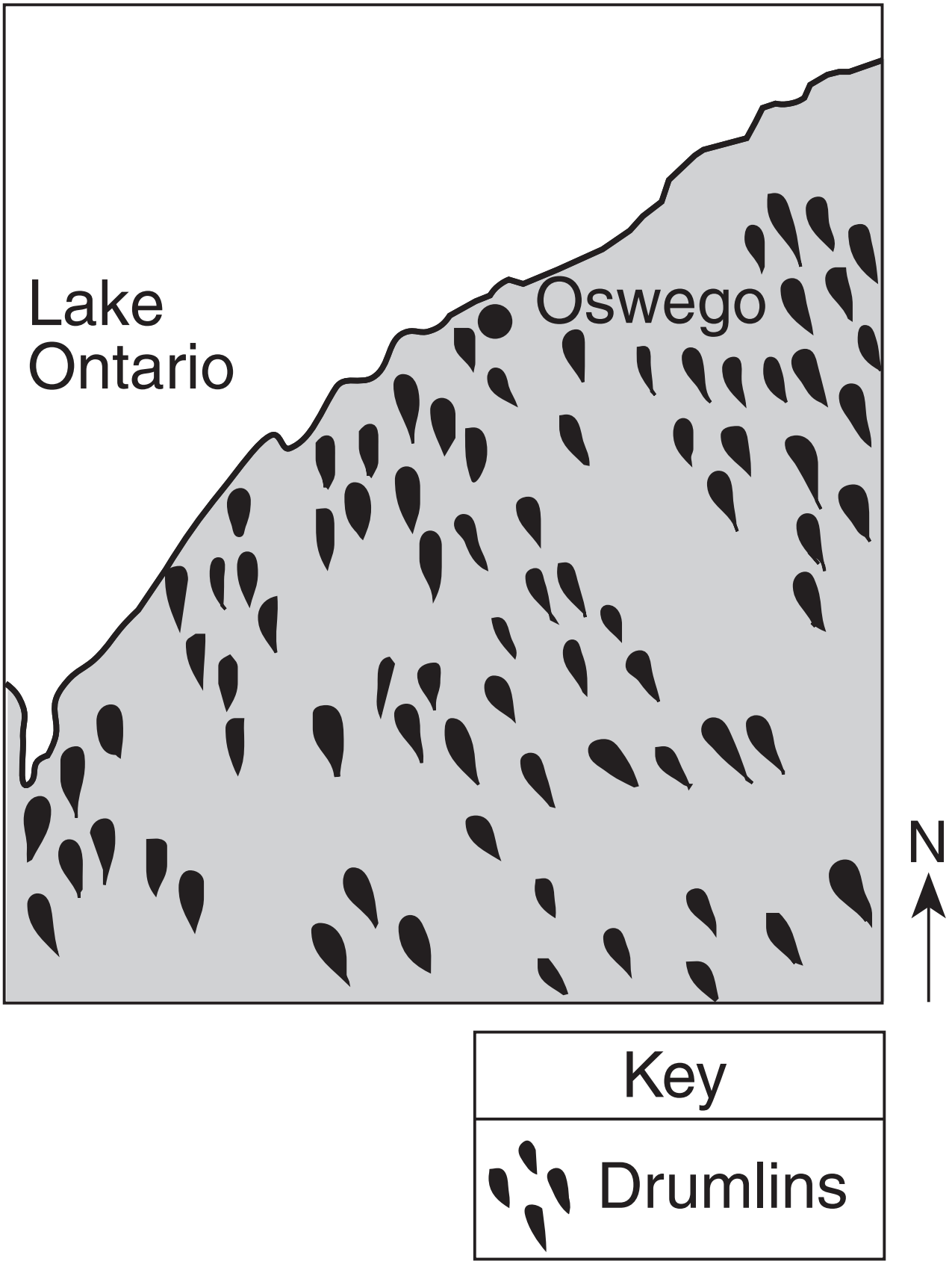
## Data Table

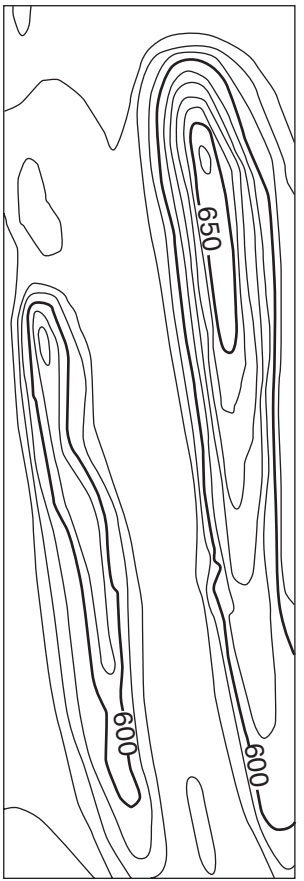
| **Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Discharge** ($ft^3$/sec) | 48 | 52 | 59 | 66 | 62 | 70 | 72 | 59 | 55 | 42 | 47 | 53 |

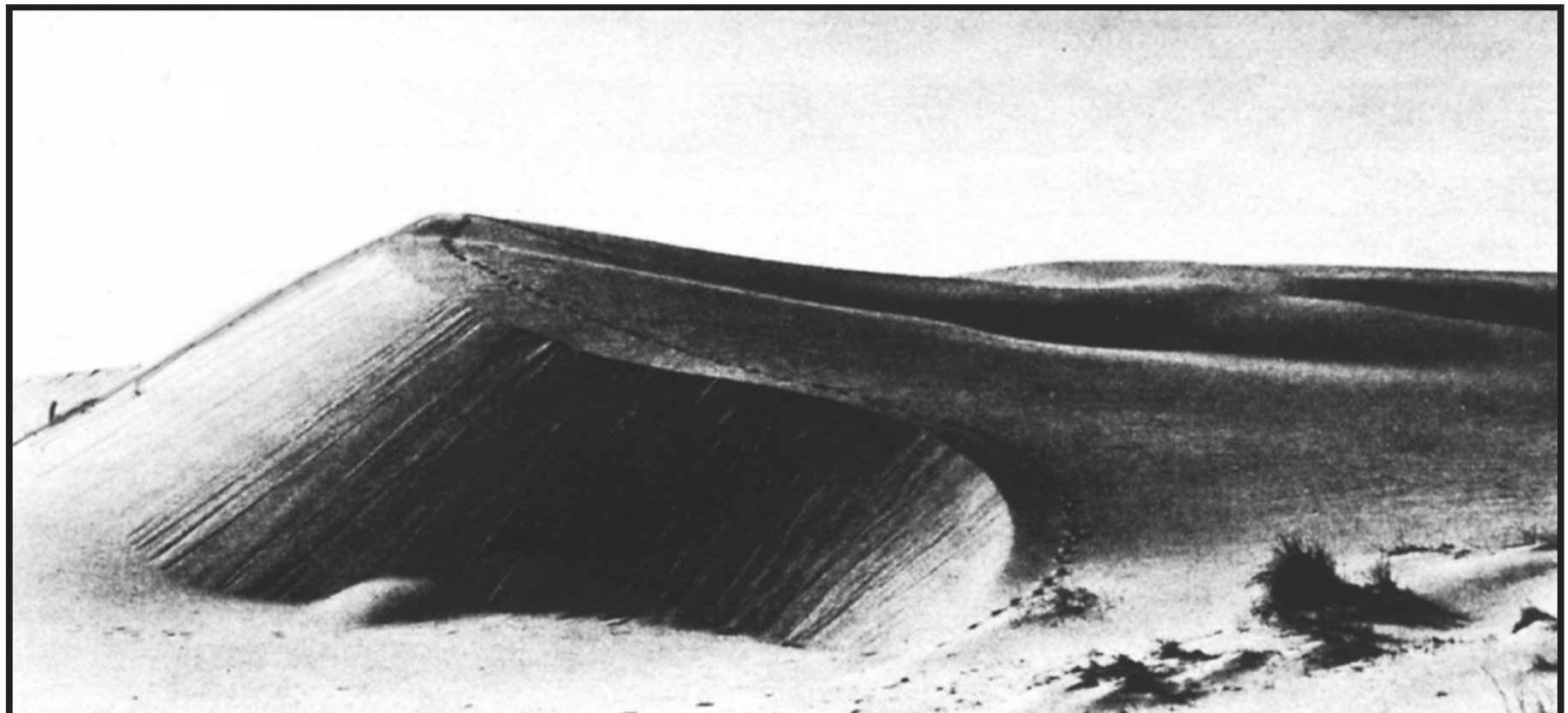

CHAMPLAIN - ST. LAWRENCE
ST. LAWRENCE
MOHAWK - HUDSON
ONTARIO - ST. LAWRENCE
ERIE - ST. LAWRENCE
SUSQUEHANNA - CHESAPEAKE
ALLEGHENY - OHIO
DELAWARE
LONG ISLAND SOUND
N


D
220
240
260
A
E
B
C
N

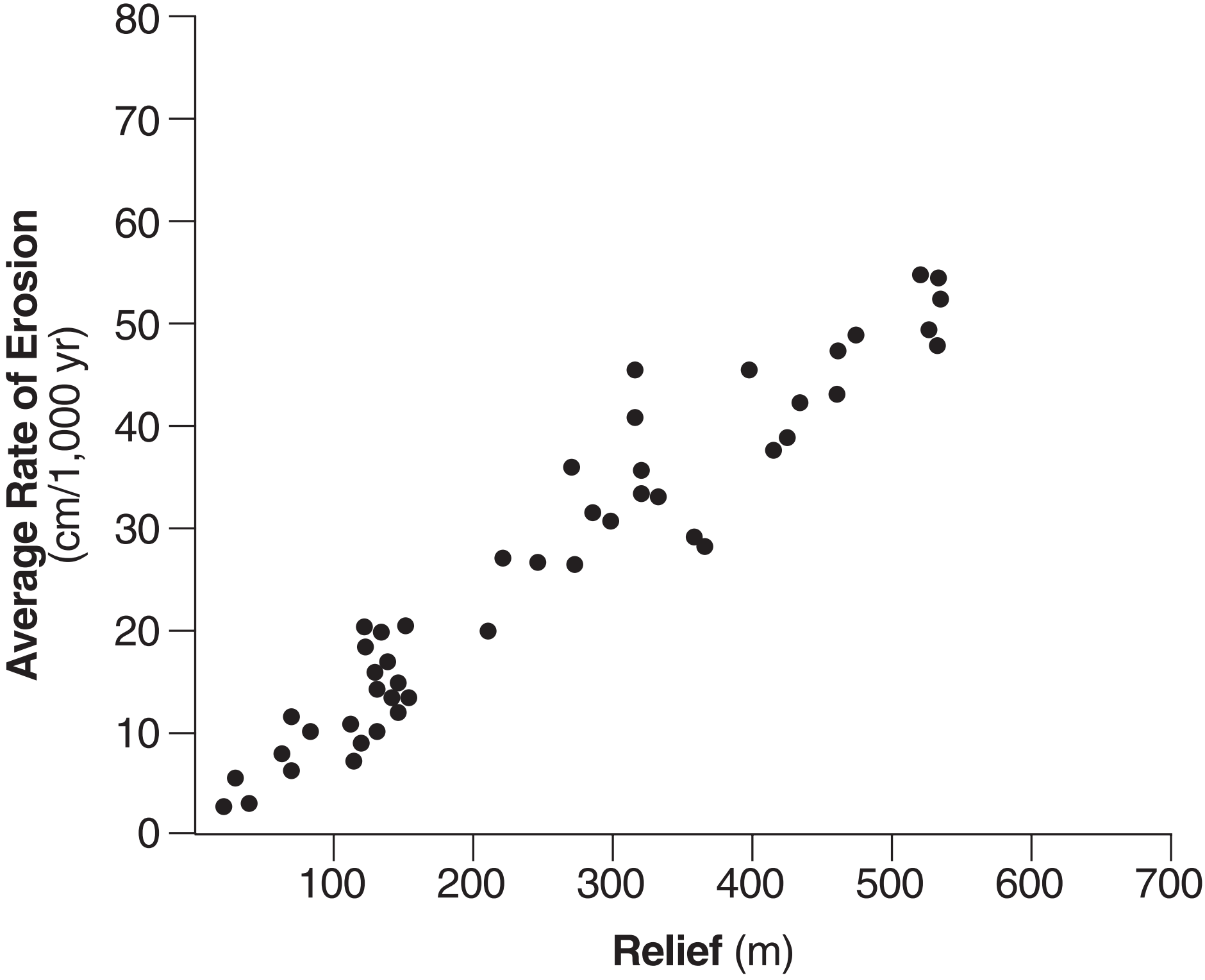
# Map B

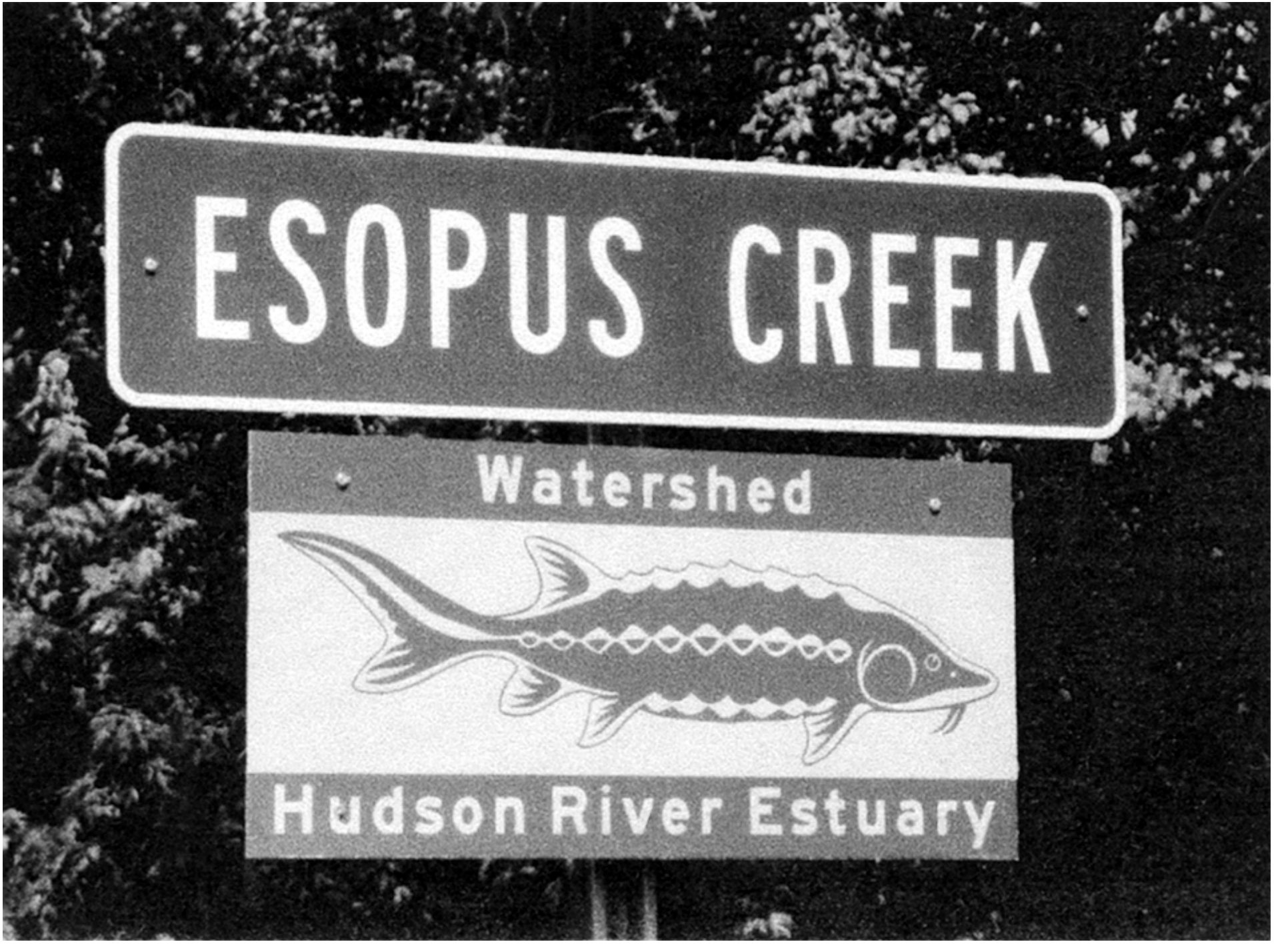



650
600
600
N
miles
0
0.1
0.2
0.3
0.4

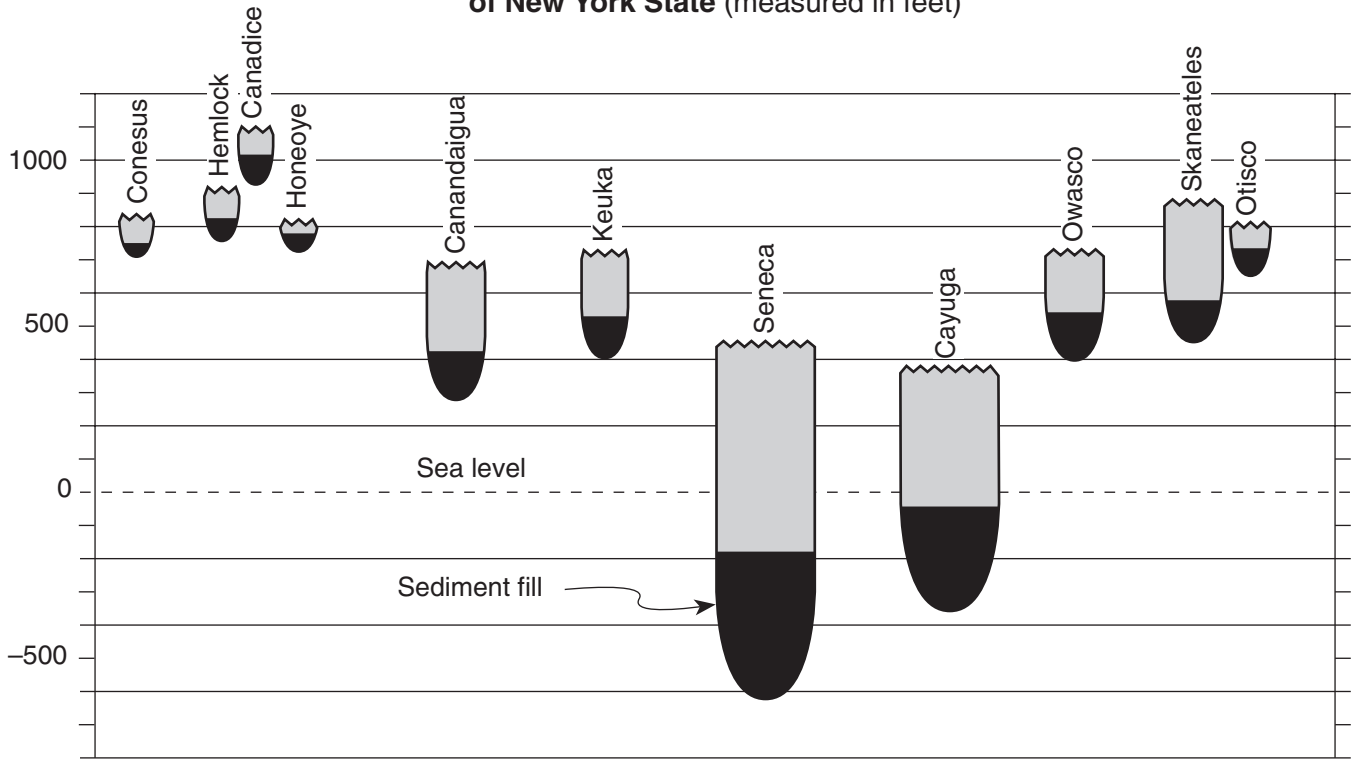


| **Location** | **Rate of Erosion** (tons/year) | **Rate of Deposition** (tons/year) |
|---|---|---|
| *A* | 3.00 | 3.25 |
| *B* | 4.00 | 4.00 |
| *C* | 4.50 | 4.65 |
| *D* | 5.60 | 5.20 |

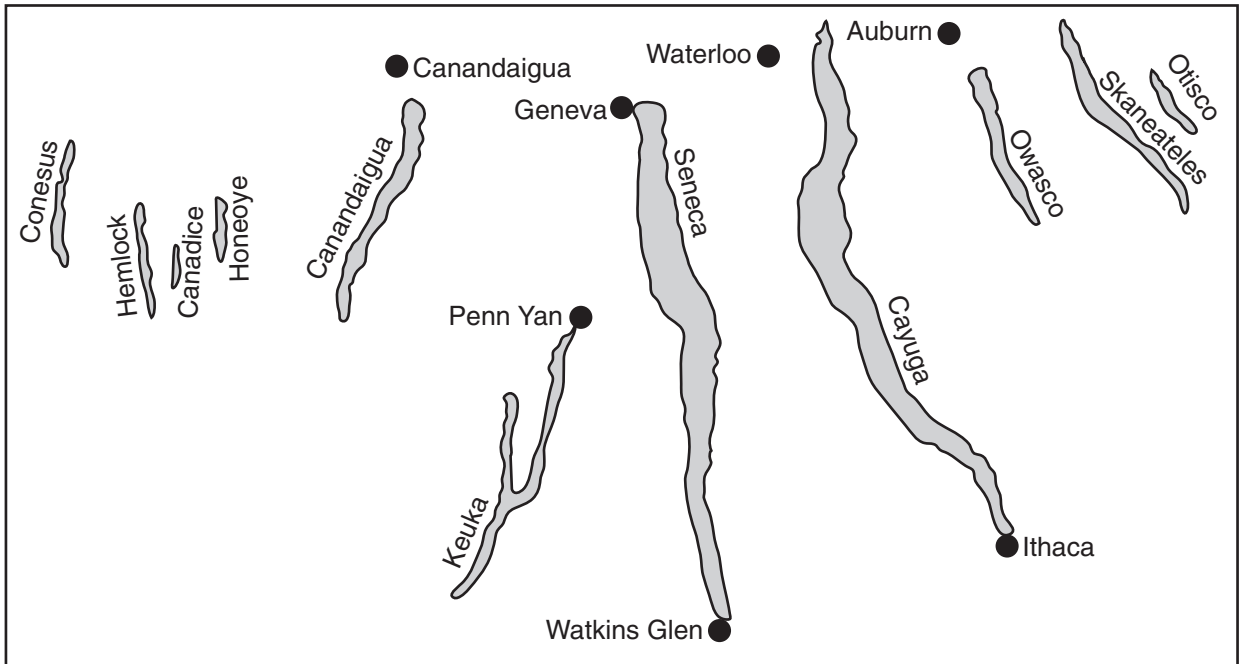

Average Rate of Erosion
(cm/1,000 yr)
80
70
60
50
40
30
20
10
0
100
200
300
400
500
600
700
Relief (m)


ESOPUS CREEK
Watershed
Hudson River Estuary

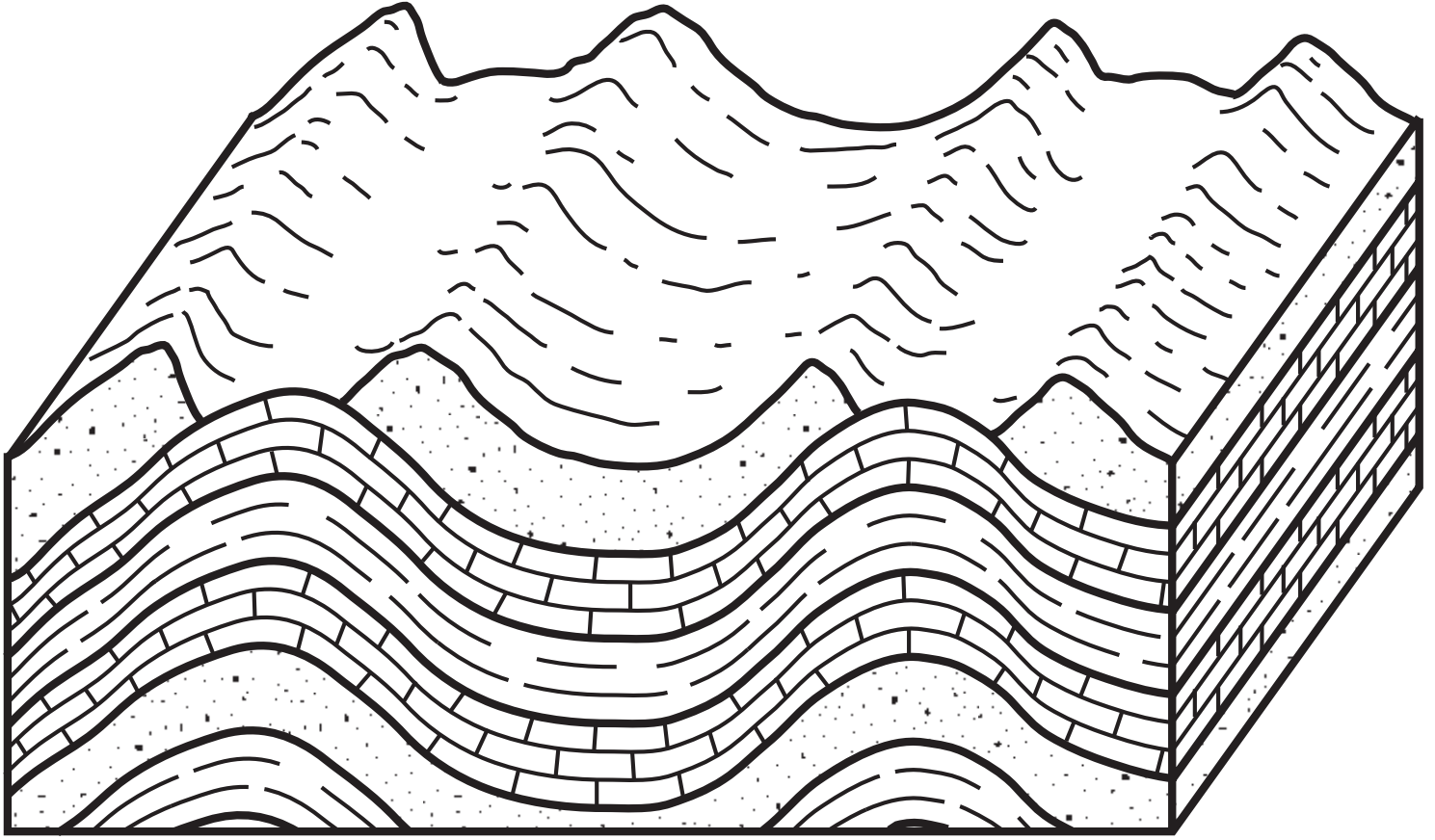
**Elevation and Depth of the Finger Lakes of New York State** (measured in feet)

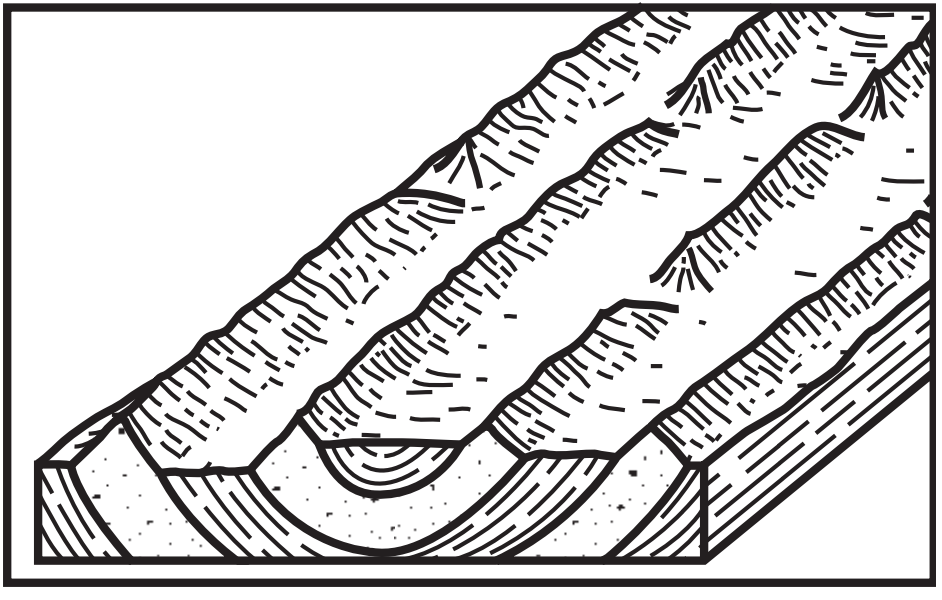


**Finger Lakes Region of New York State**



Density = 2.4 g/mL

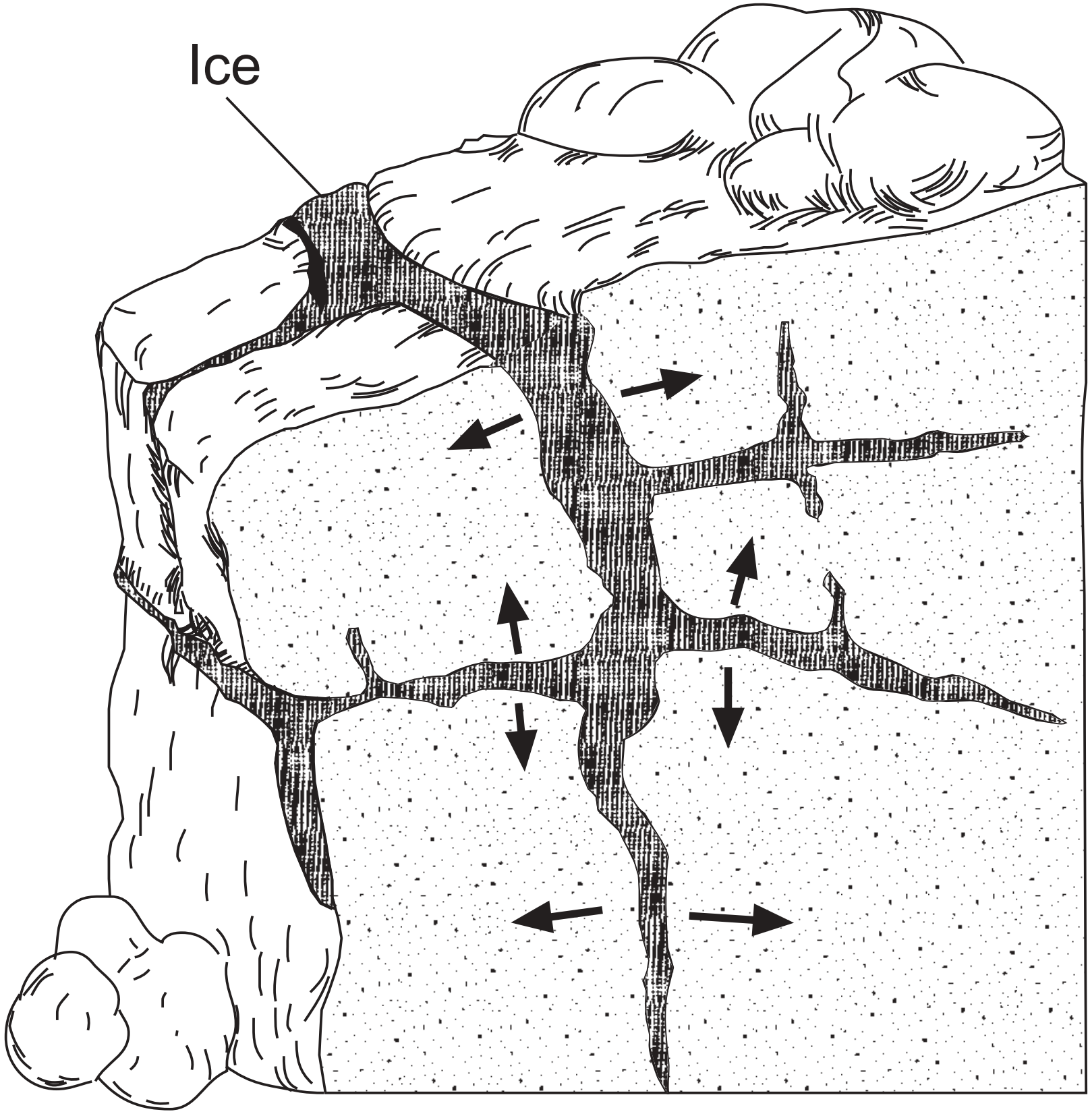


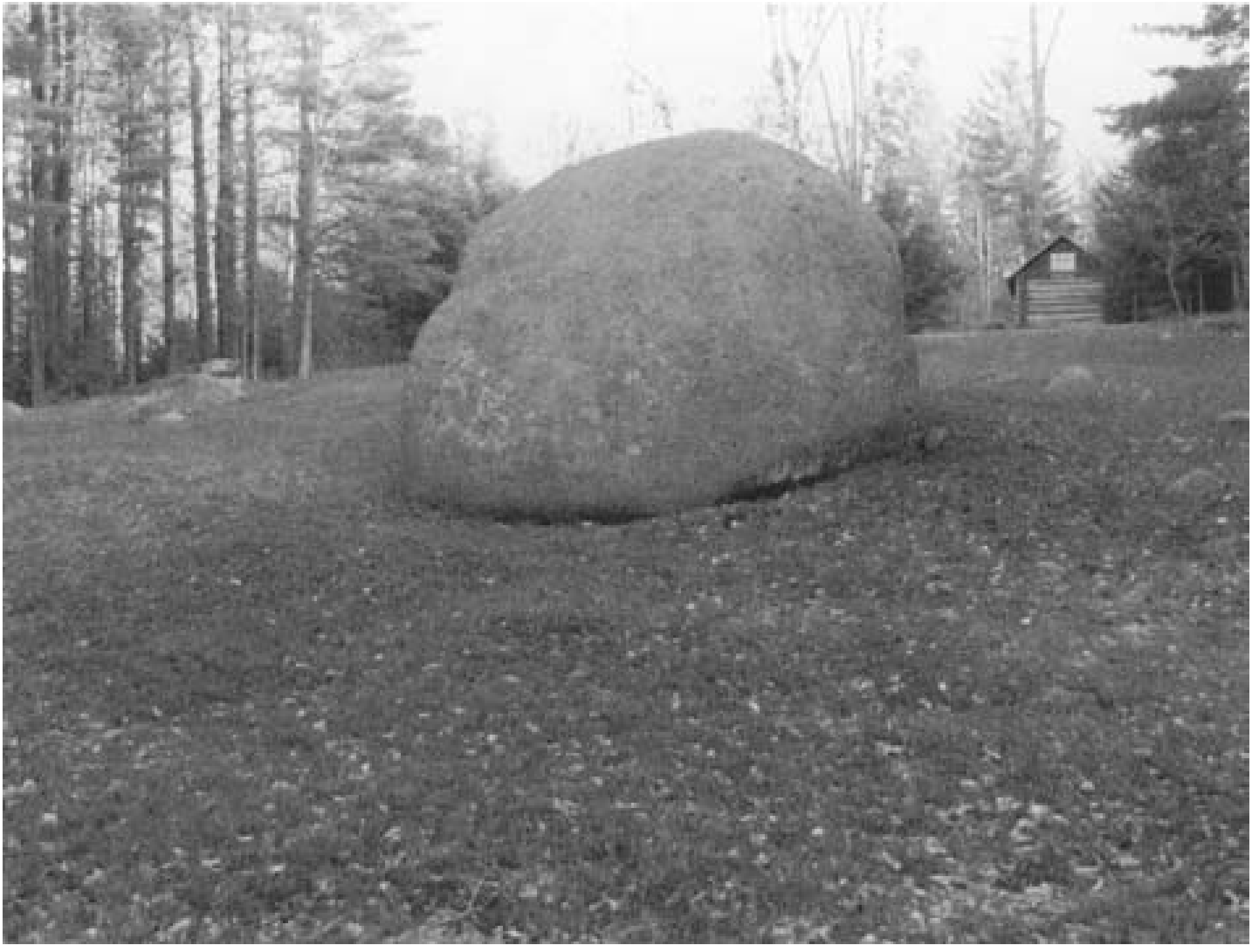


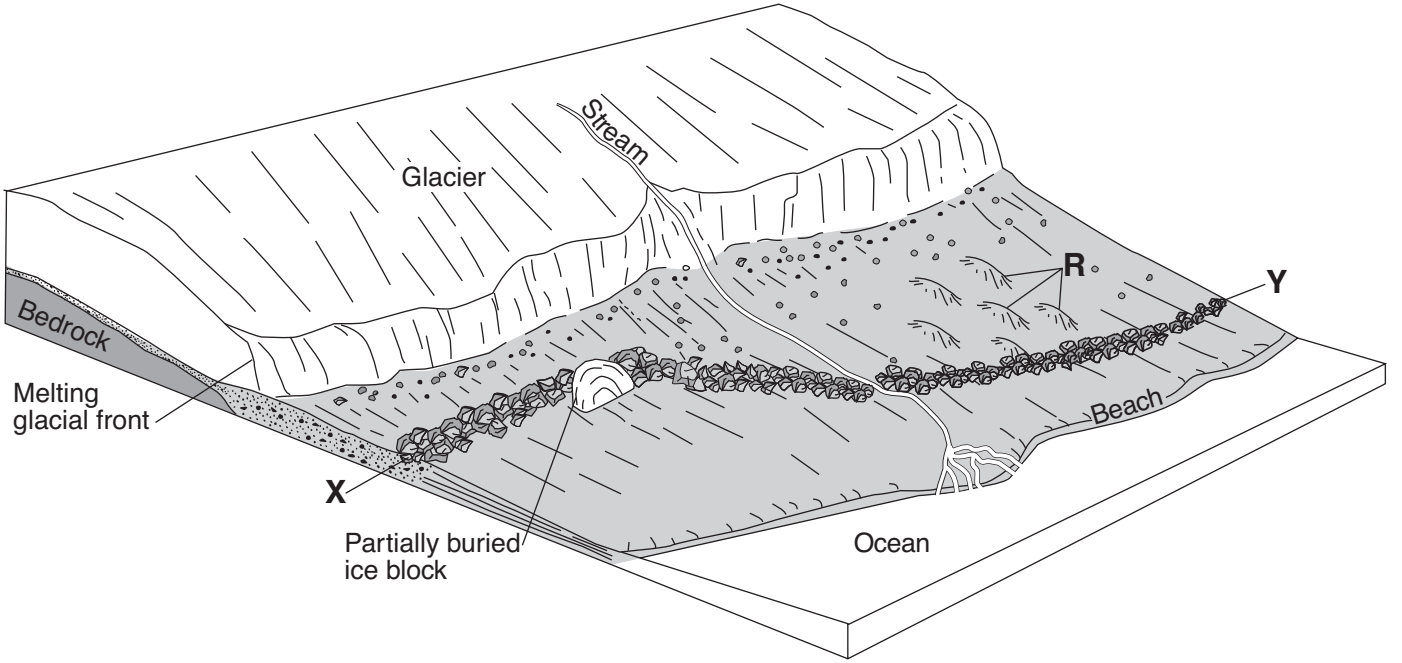
Stage 1

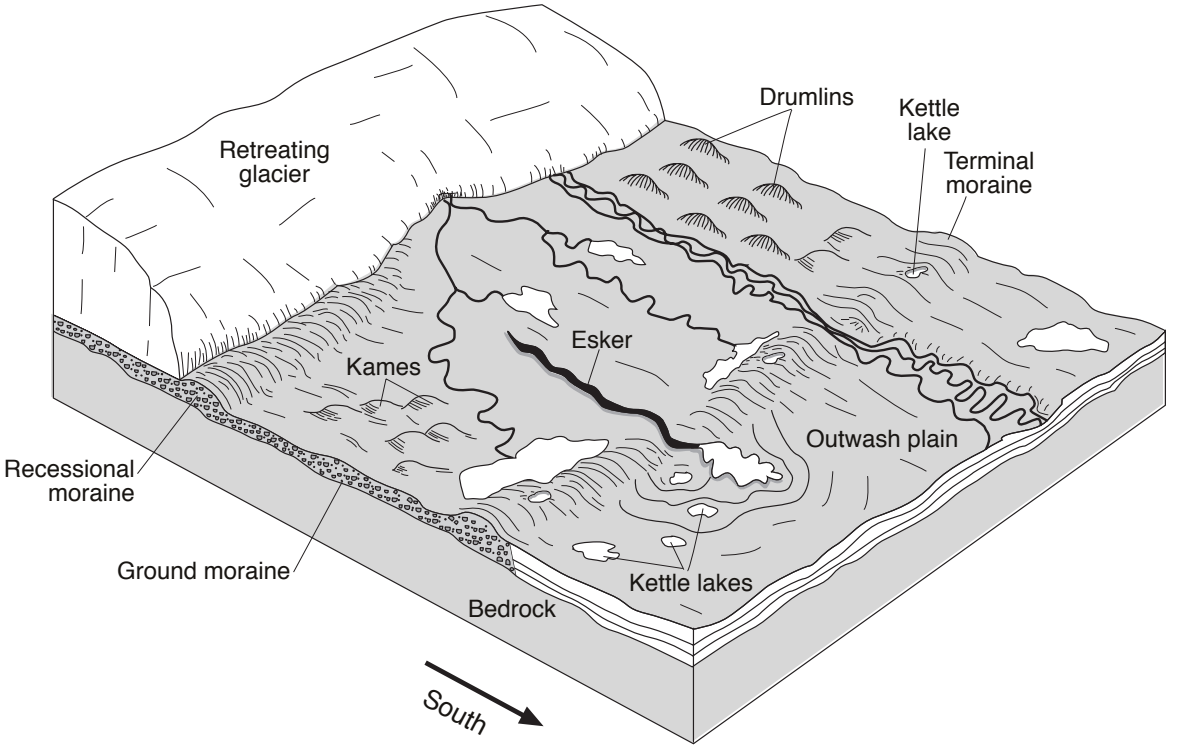
Stage 2

Stage 3

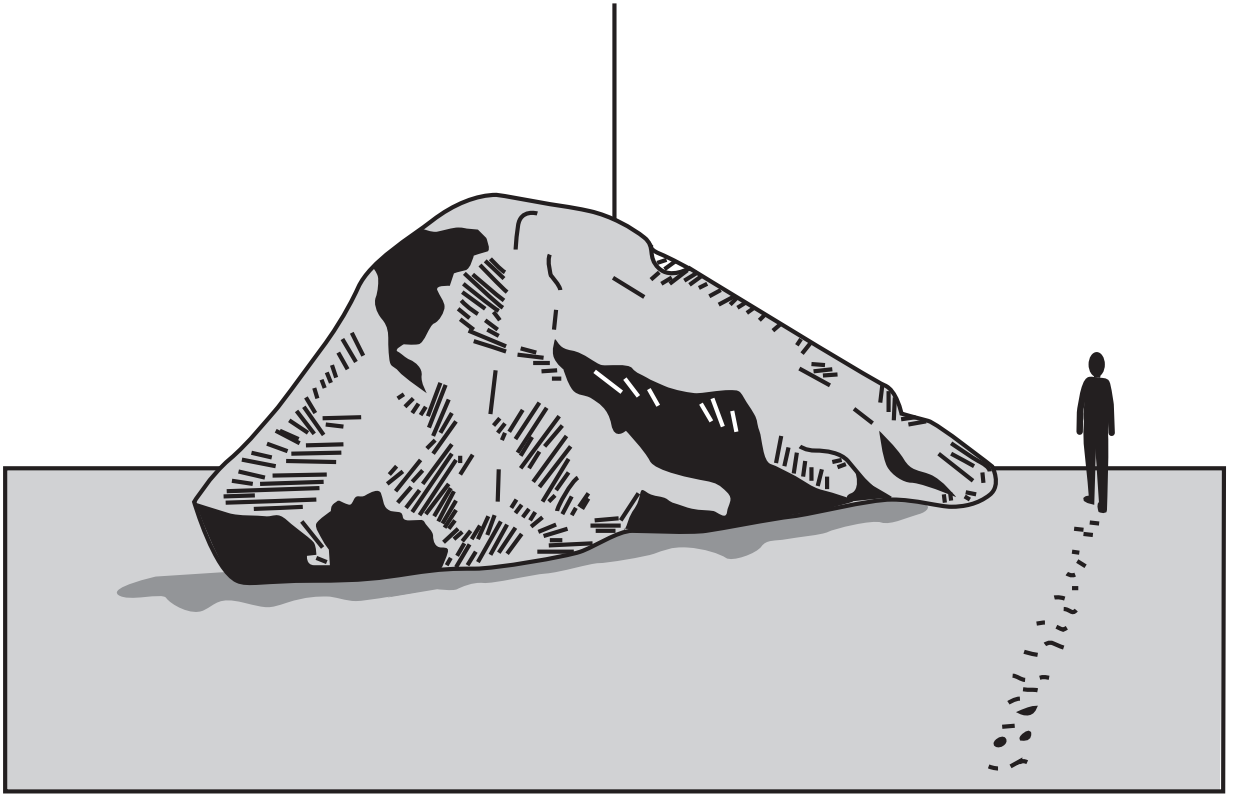

Ice

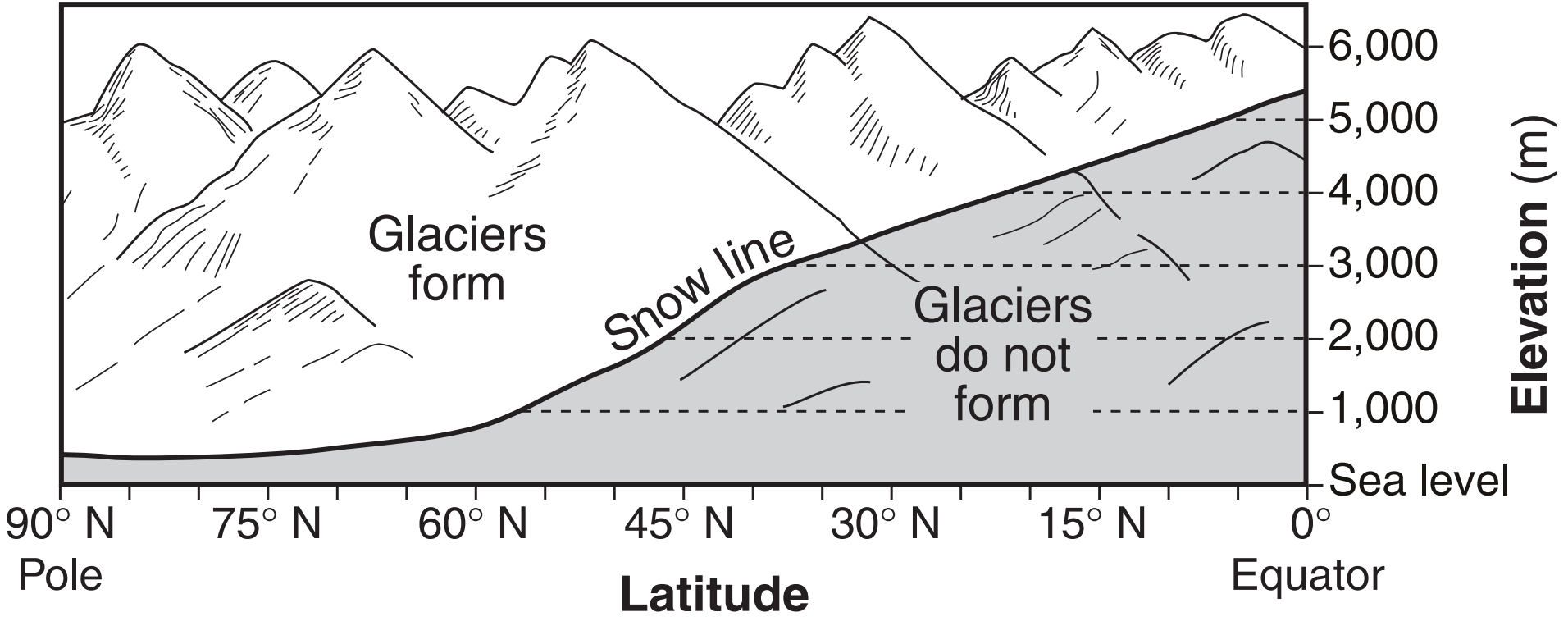


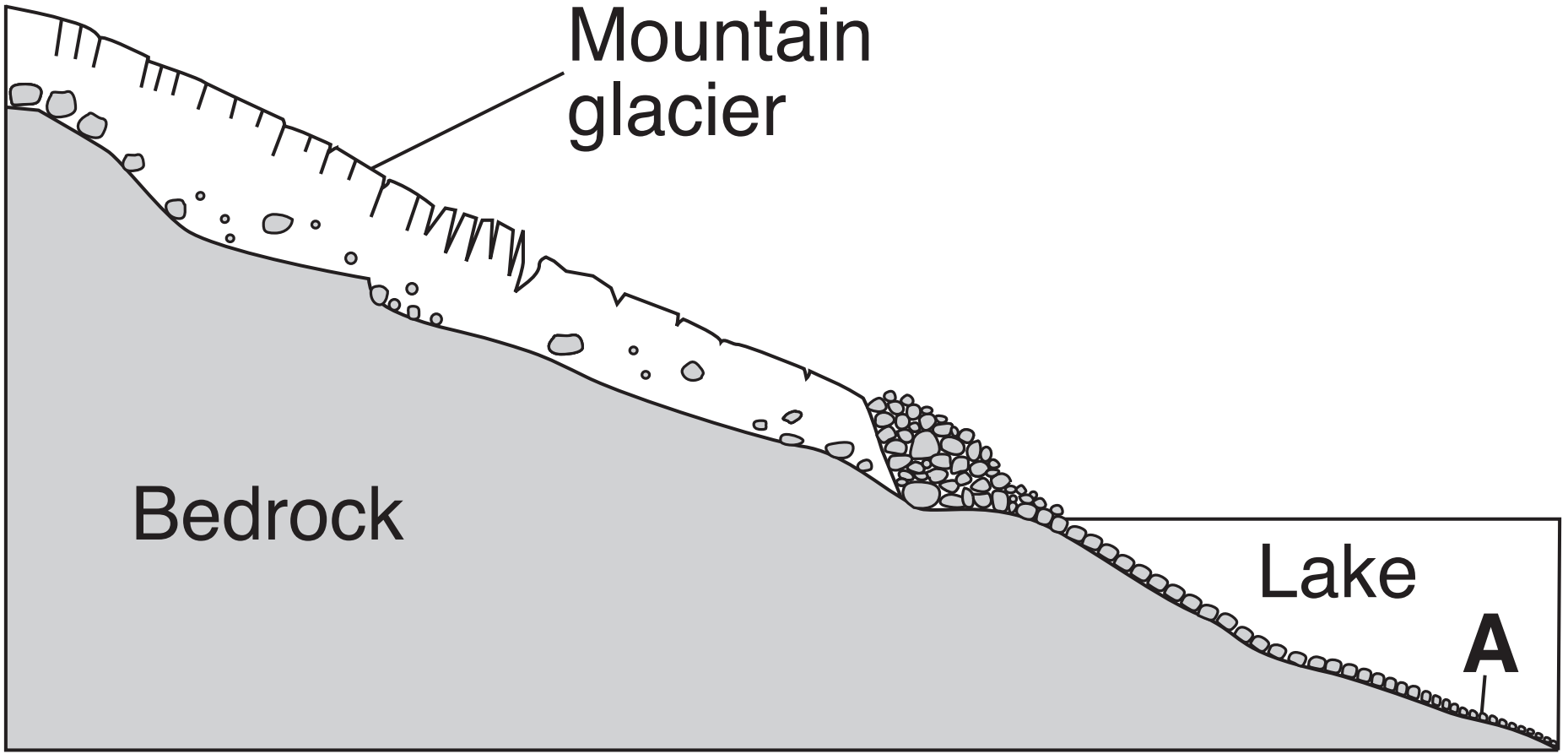

Glacier
Stream
Bedrock
Melting
glacial front
X
Partially buried
ice block
R
Y
Beach
Ocean


Retreating glacier
Drumlins
Kettle lake
Terminal moraine
Esker
Kames
Outwash plain
Recessional moraine
Ground moraine
Kettle lakes
Bedrock
South

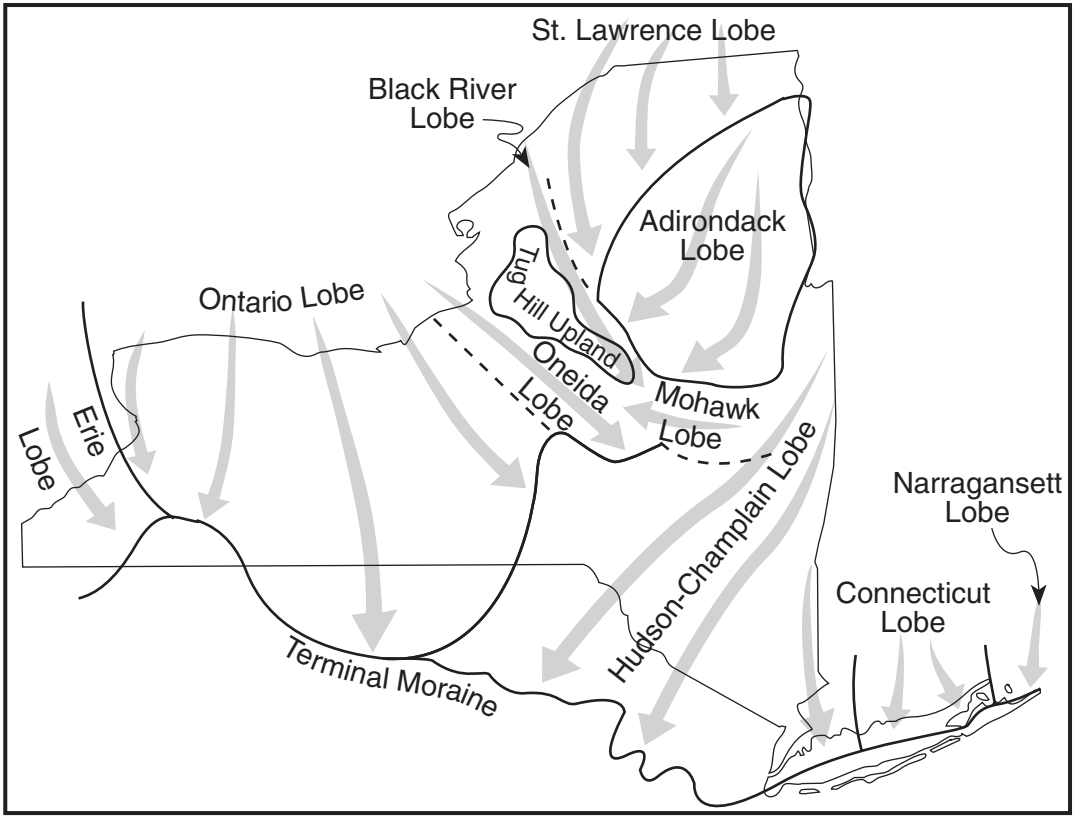
# Glacial erratic

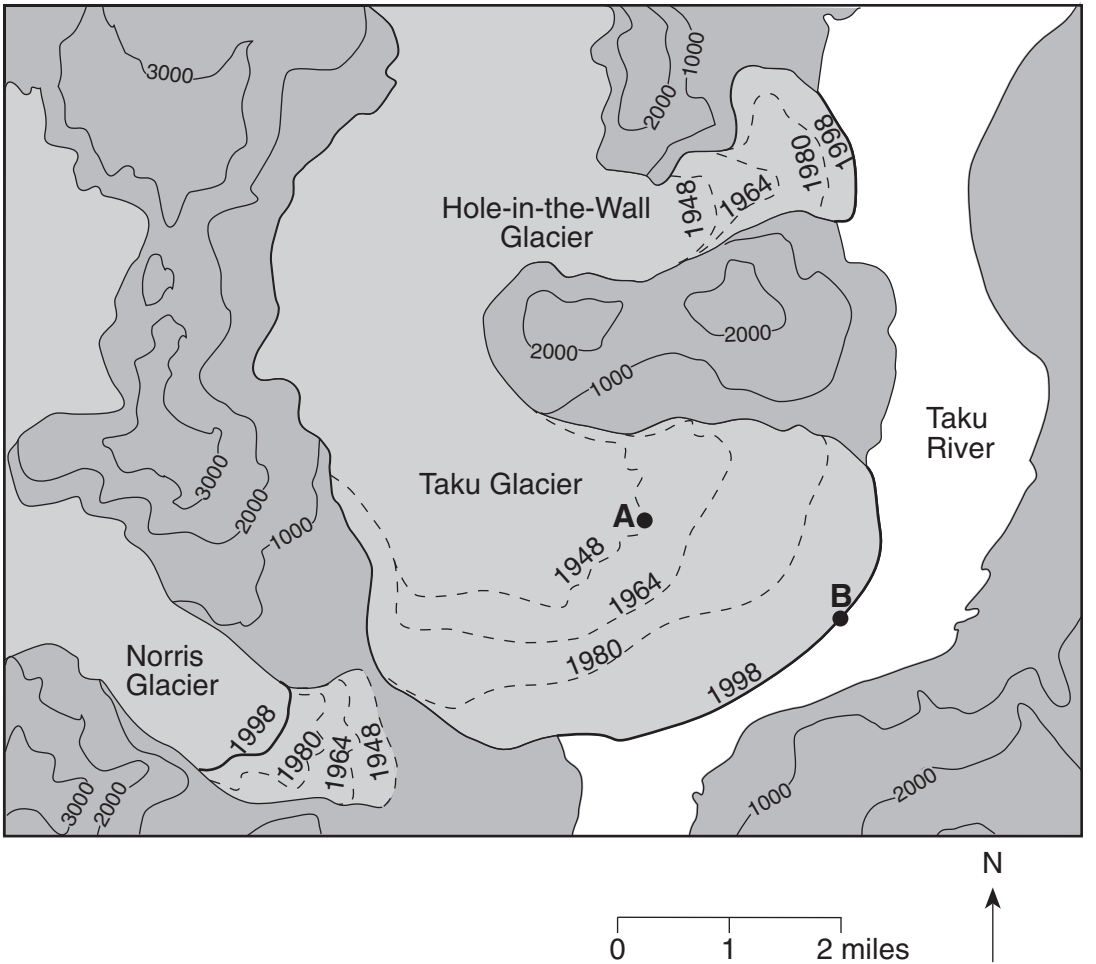


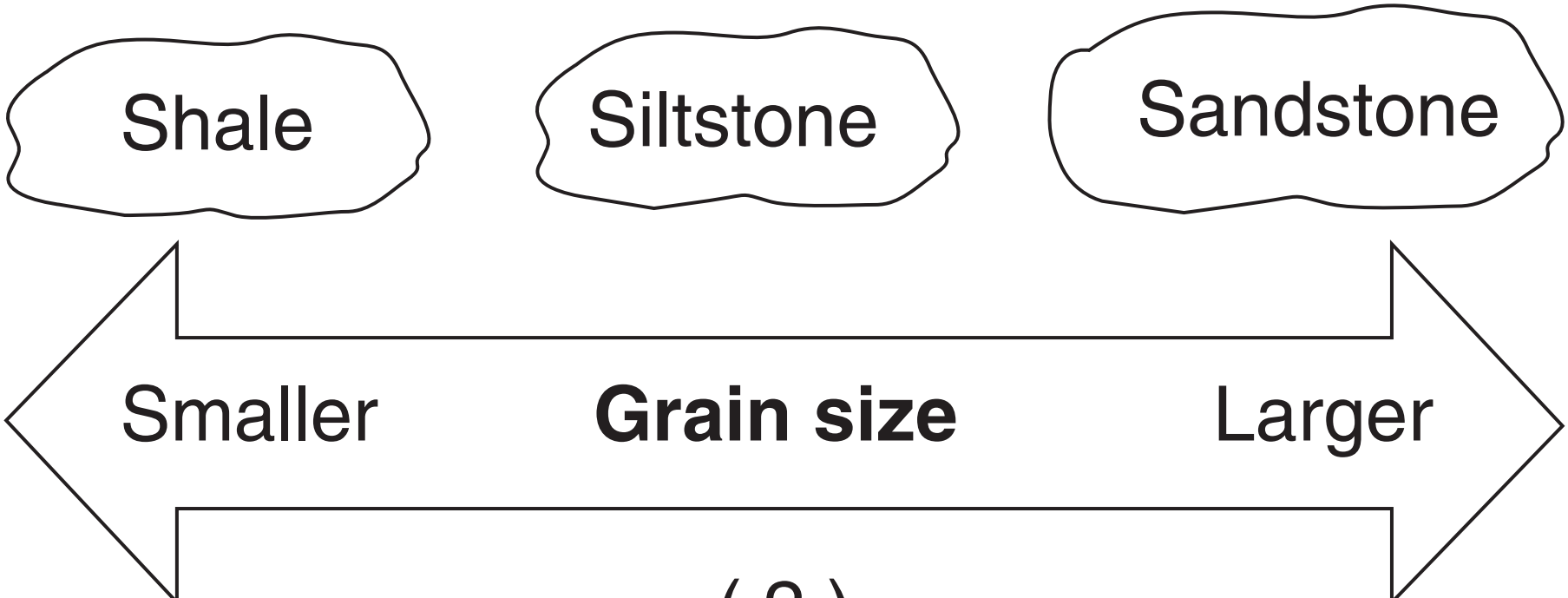

Glaciers form
Snow line
Glaciers do not form
6,000
5,000
4,000
3,000
2,000
1,000
Sea level
Elevation (m)
90° N
Pole
75° N
60° N
45° N
30° N
15° N
0°
Equator
Latitude



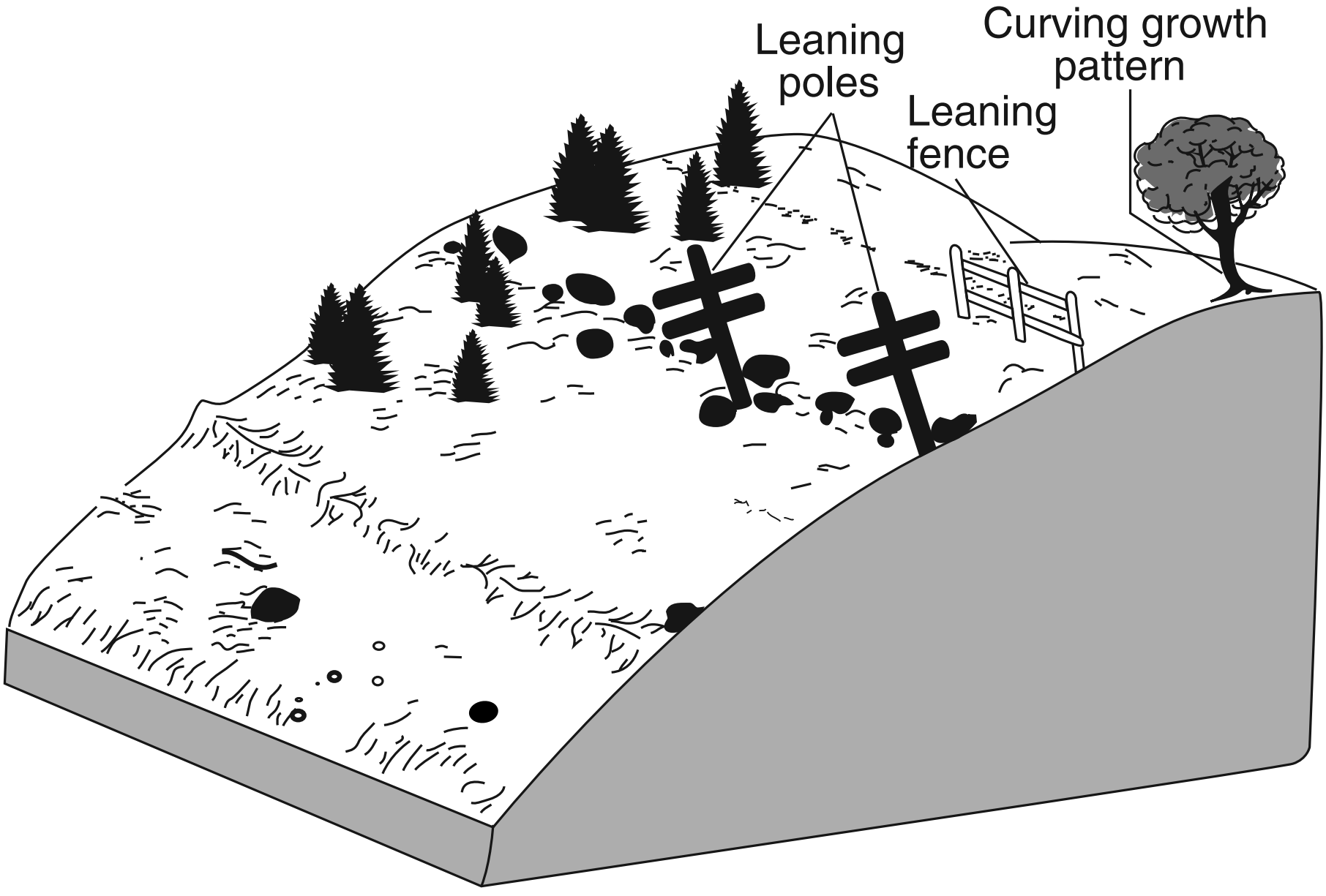

(Not drawn to scale)

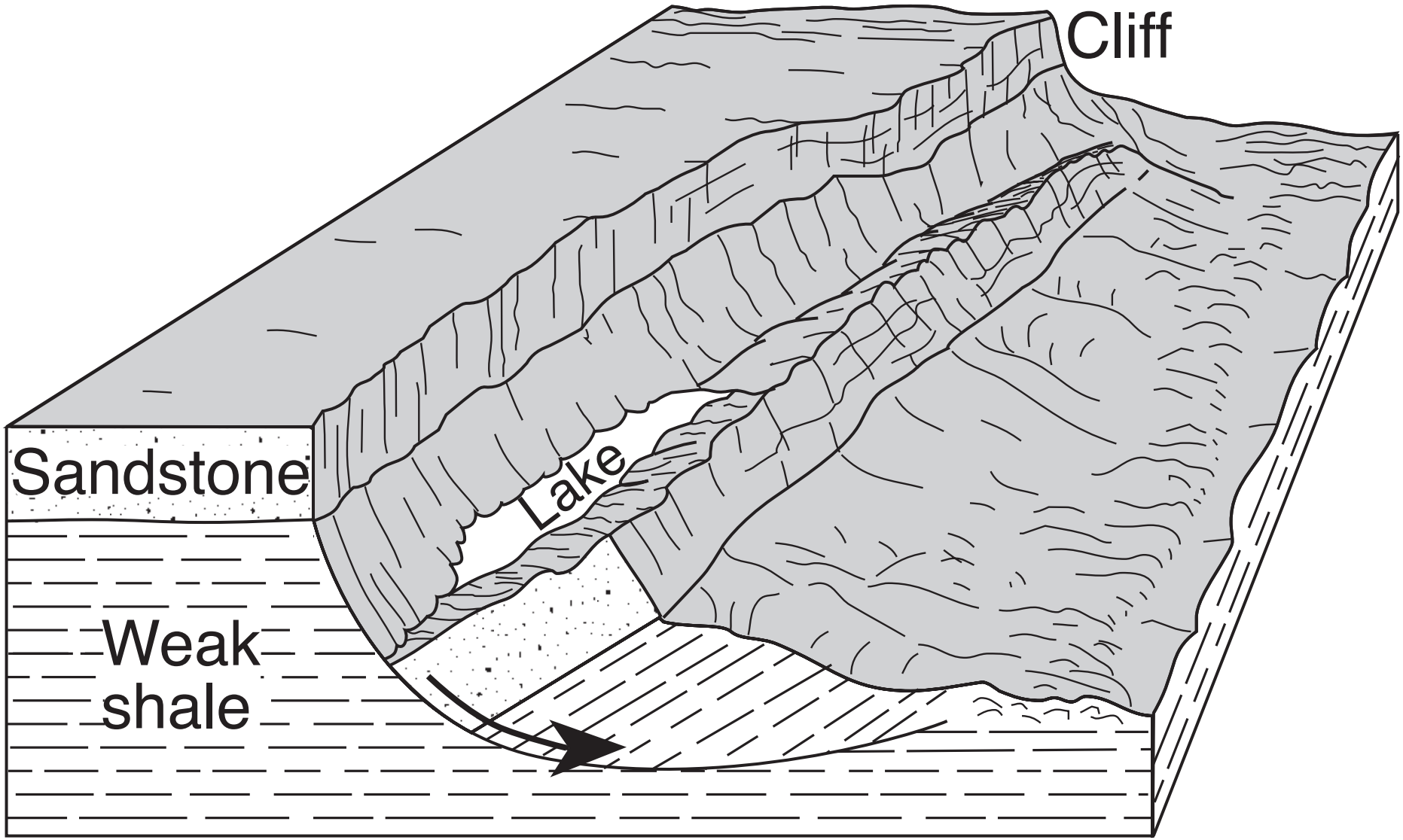

St. Lawrence Lobe
Black River Lobe
Adirondack Lobe
Tug Hill Upland
Ontario Lobe
Oneida Lobe
Mohawk Lobe
Erie Lobe
Narragansett Lobe
Connecticut Lobe
Hudson-Champlain Lobe
Terminal Moraine
N

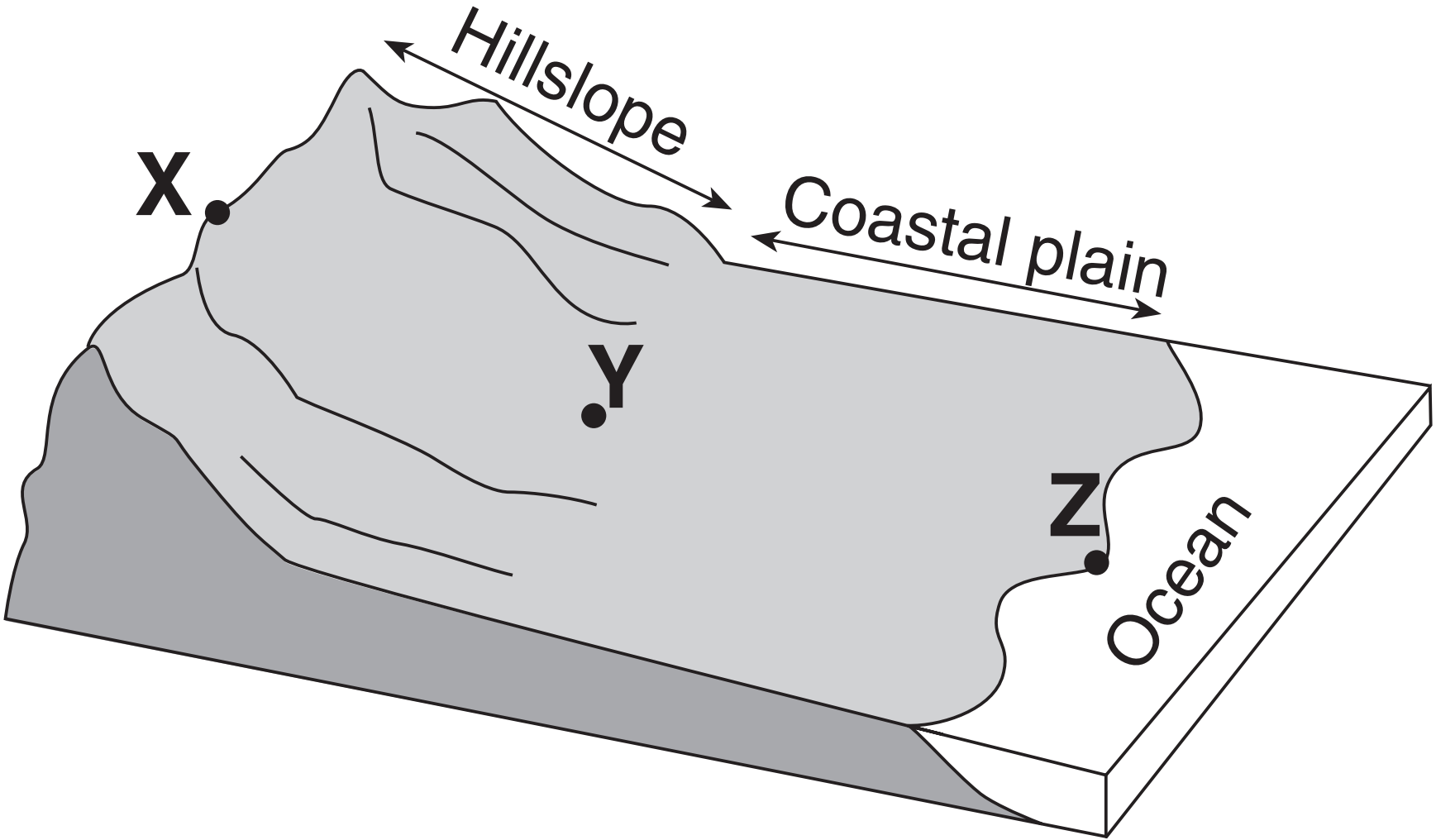

Hole-in-the-Wall Glacier
Taku Glacier
Taku River
Norris Glacier
A
B
3000
2000
1000
1998
1980
1964
1948
0
1
2 miles
N

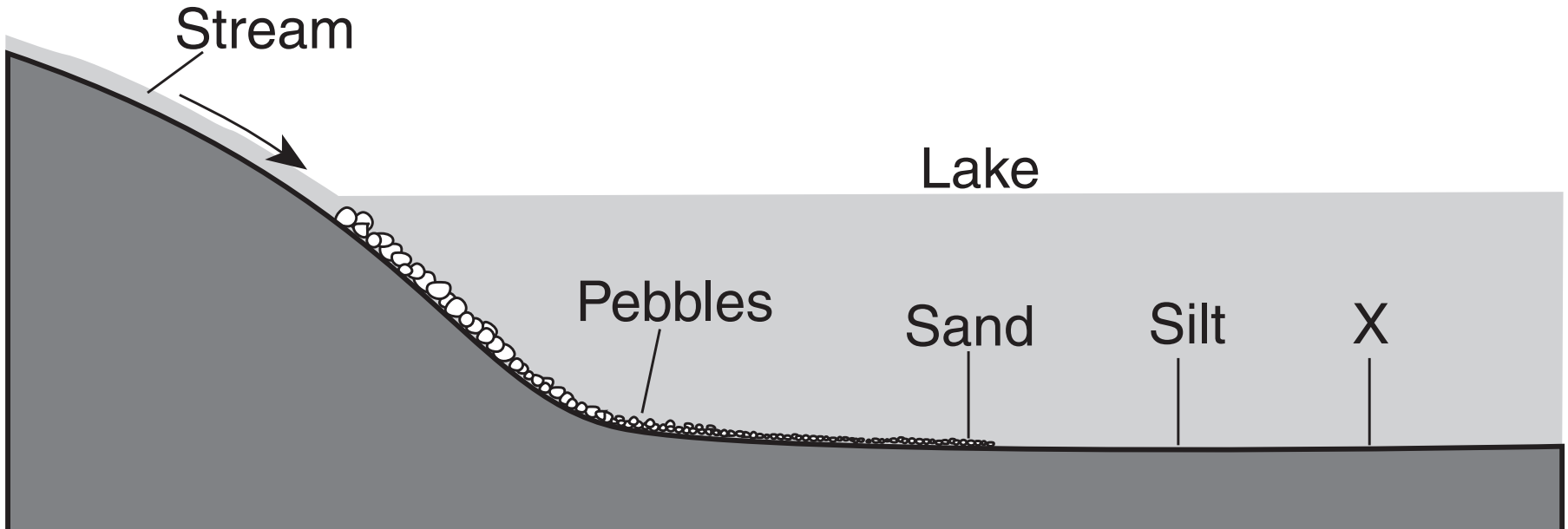



( 2 )

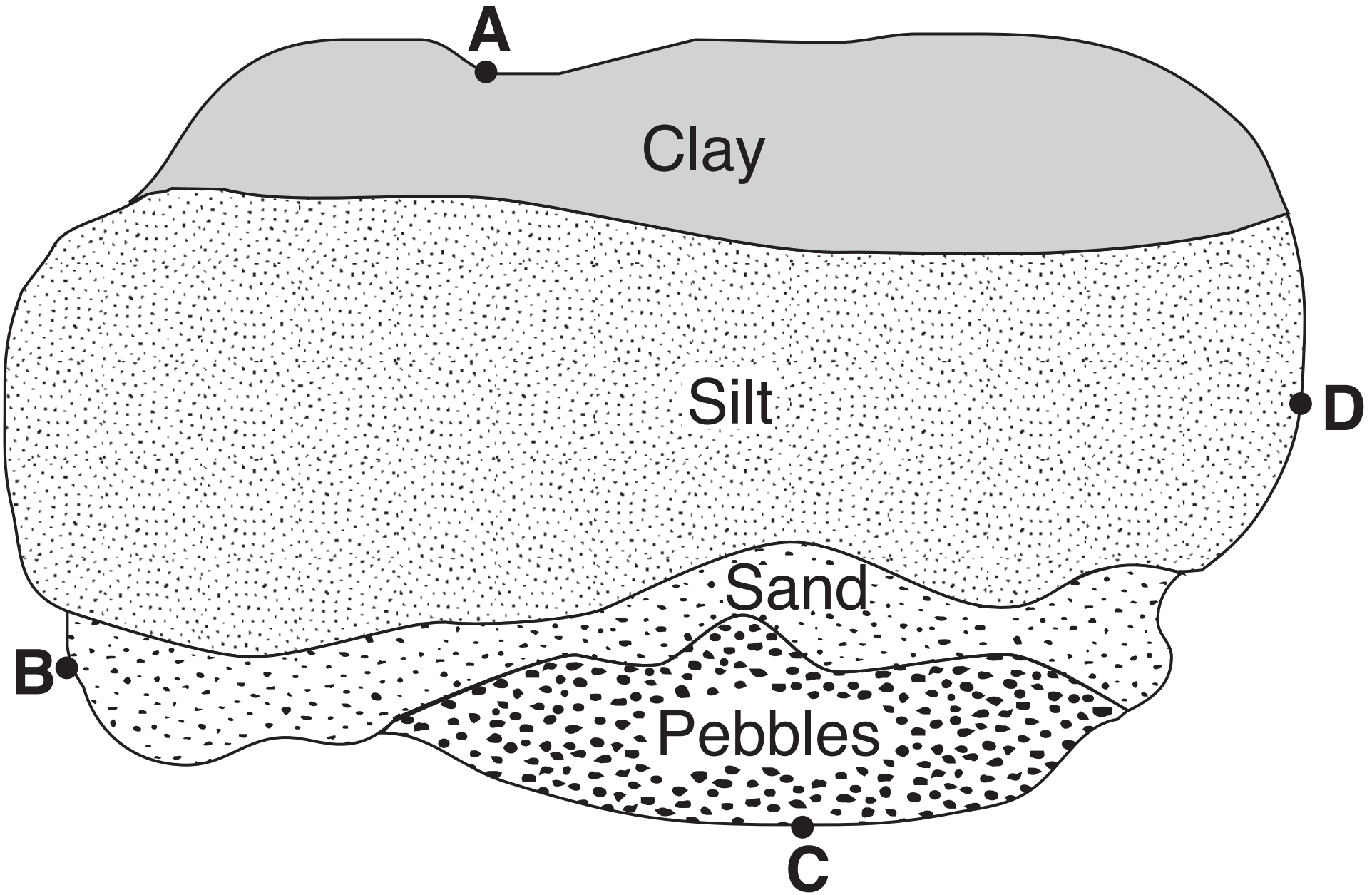

Leaning poles
Curving growth pattern
Leaning fence

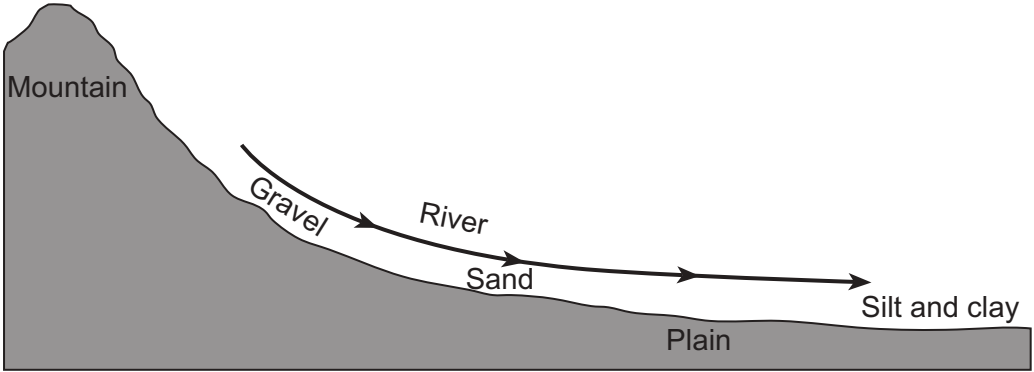

Cliff
Sandstone
Lake
Weak
shale


Hillslope
Coastal plain
X
Y
Z
Ocean

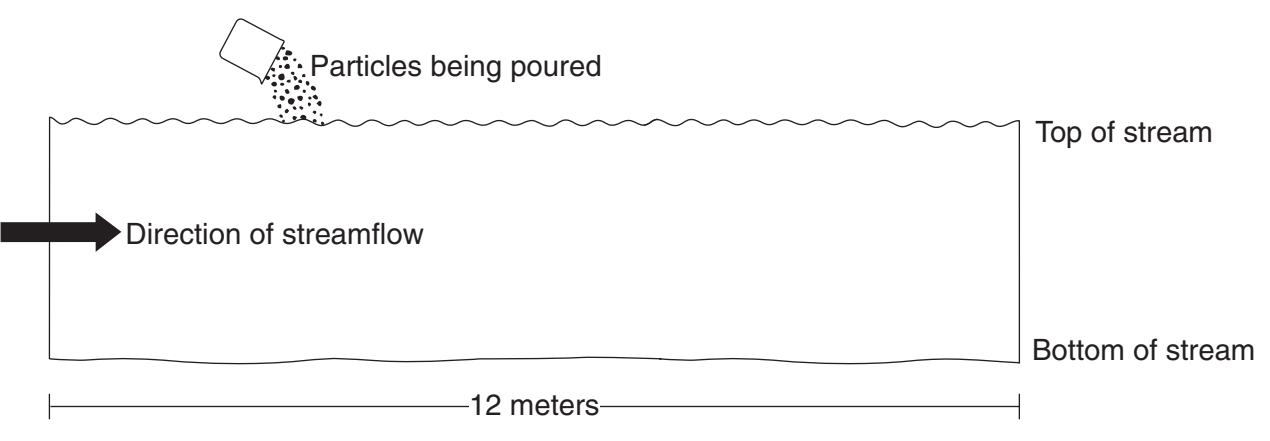


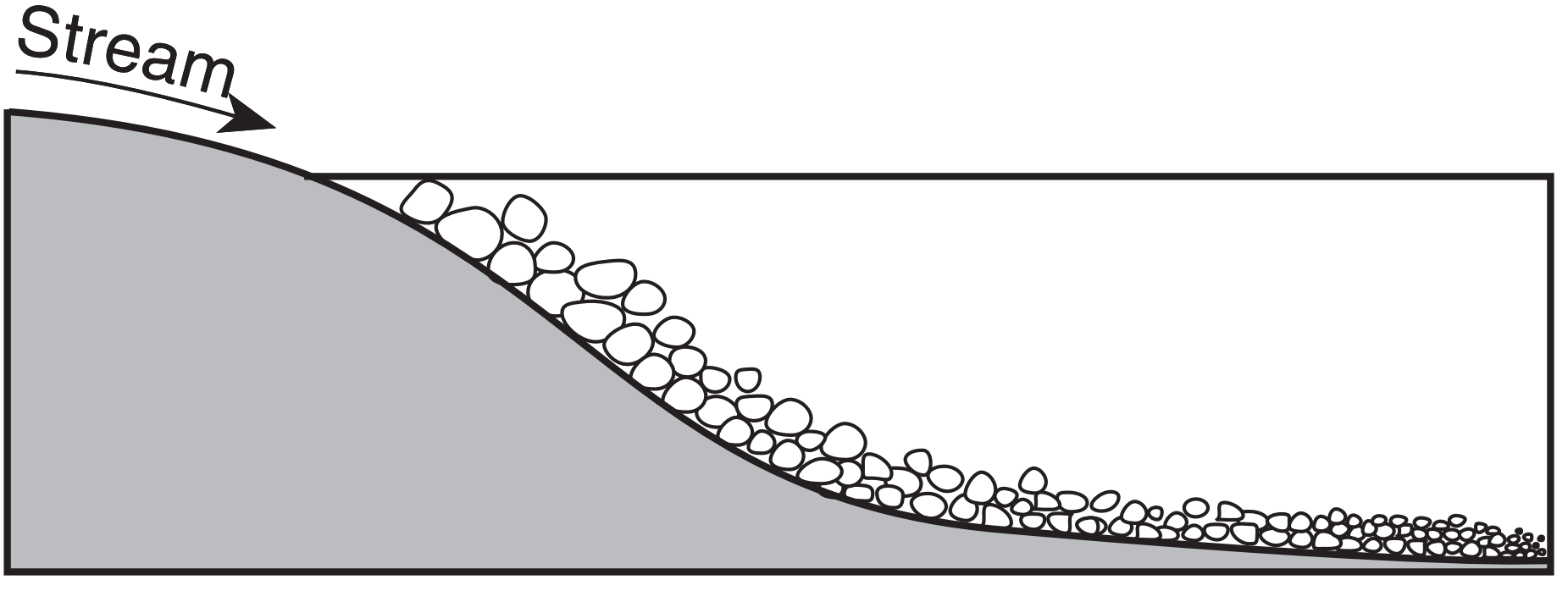

(Not drawn to scale)

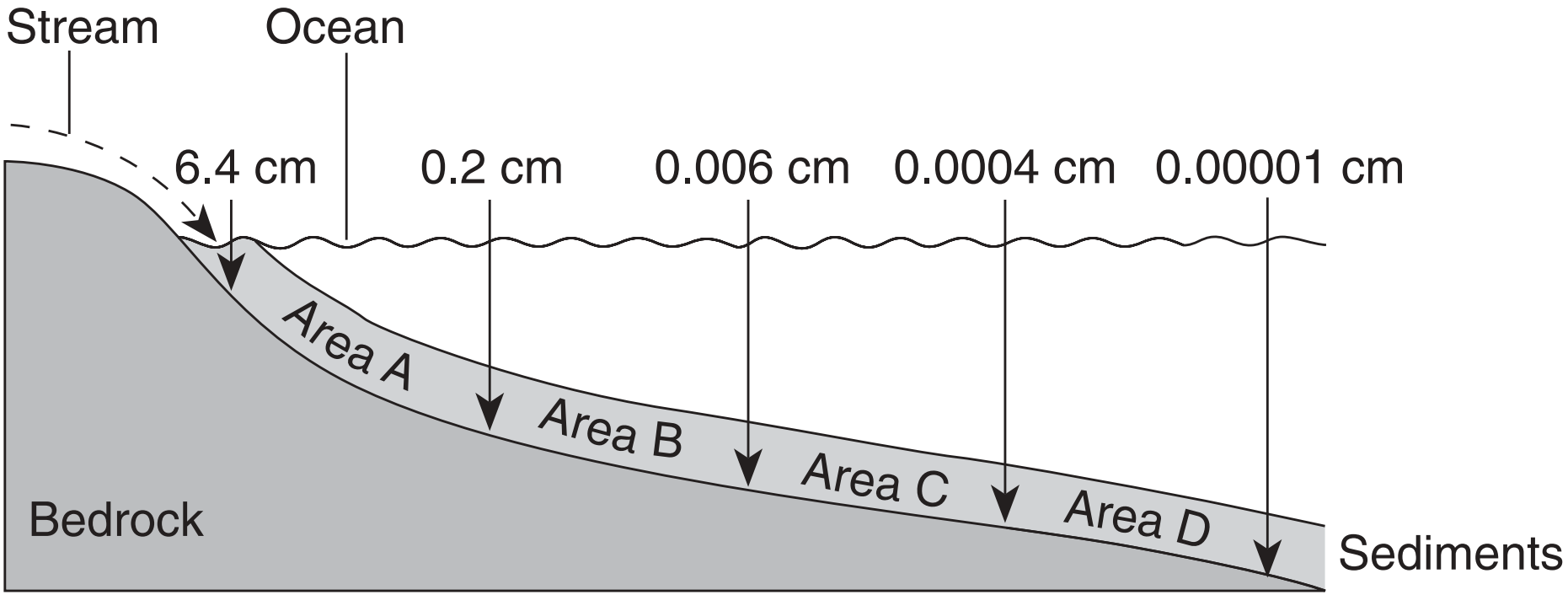

A
Clay
Silt
D
Sand
B
Pebbles
C

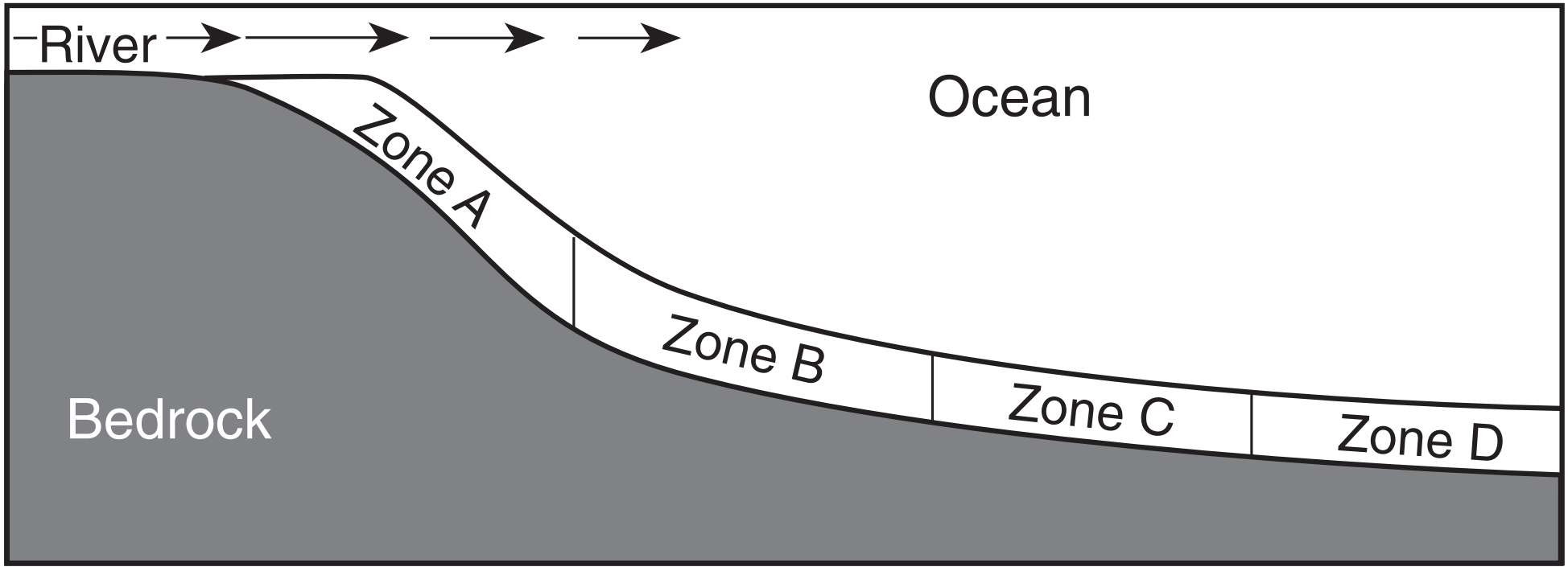


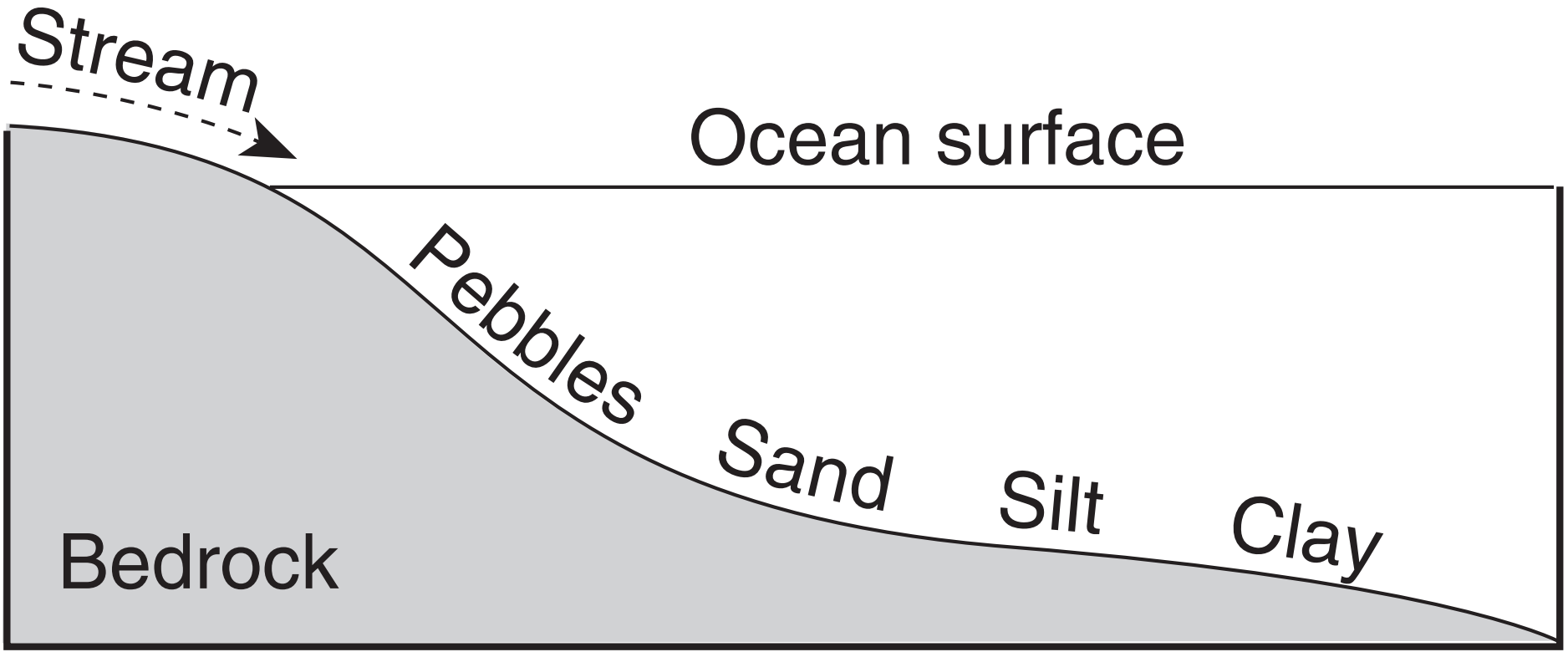

(Not drawn to scale)

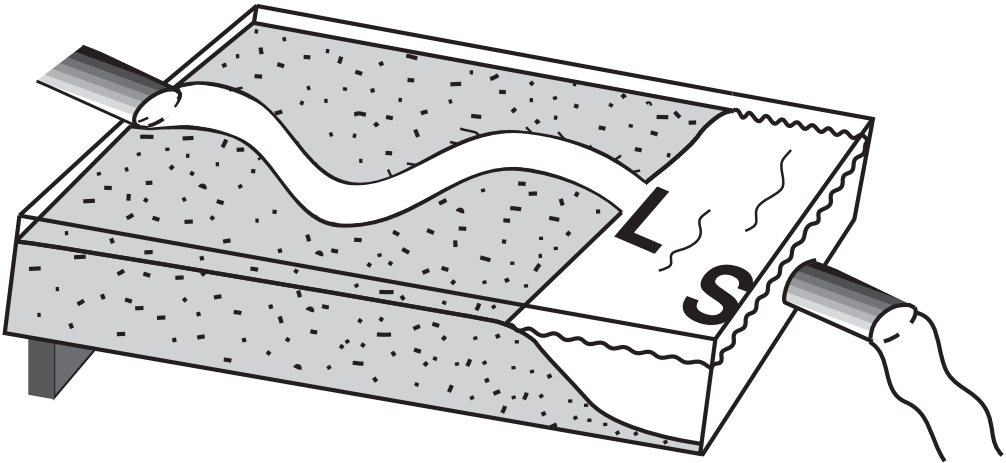

Particles being poured
Top of stream
Direction of streamflow
Bottom of stream
12 meters

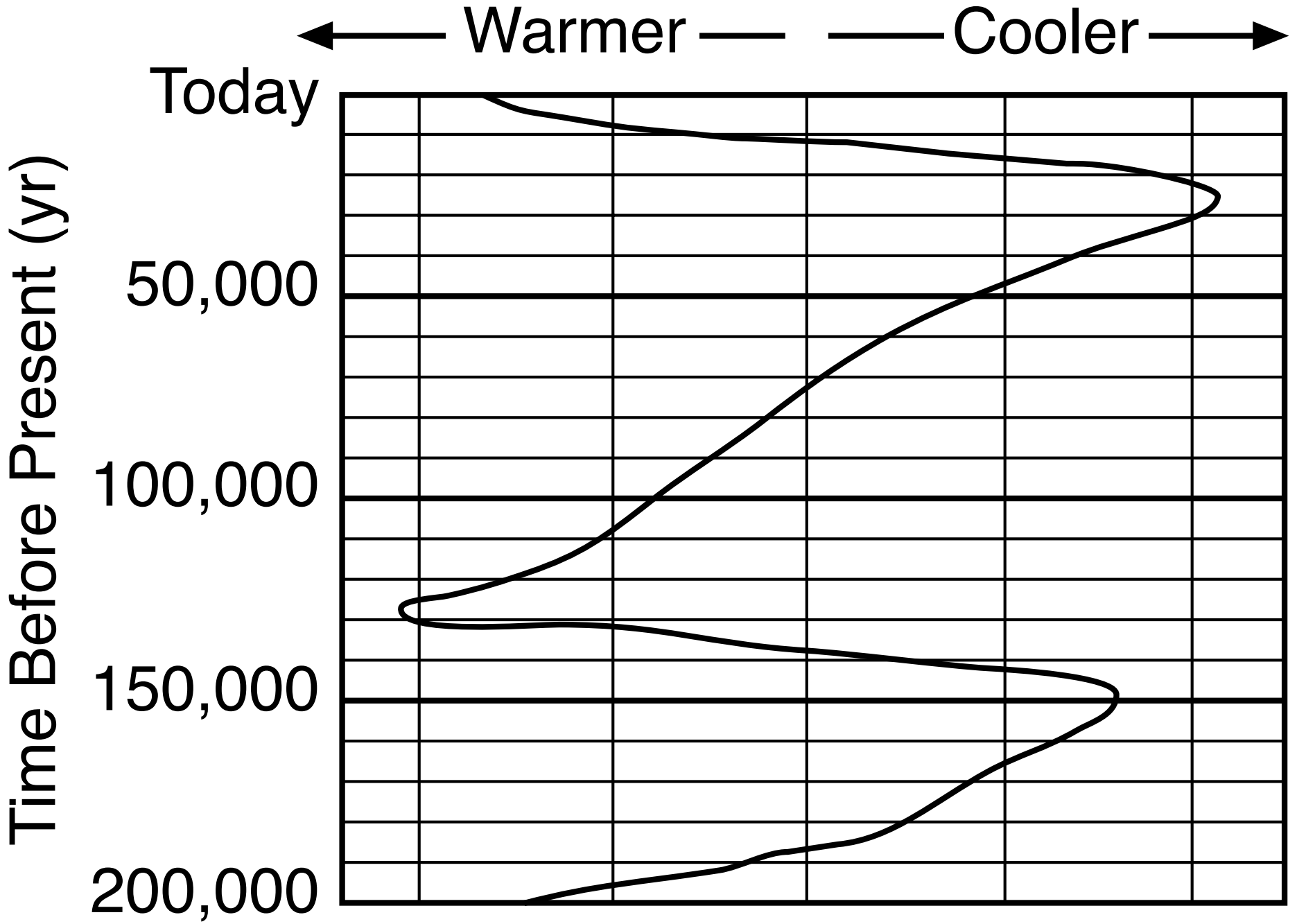

Stream

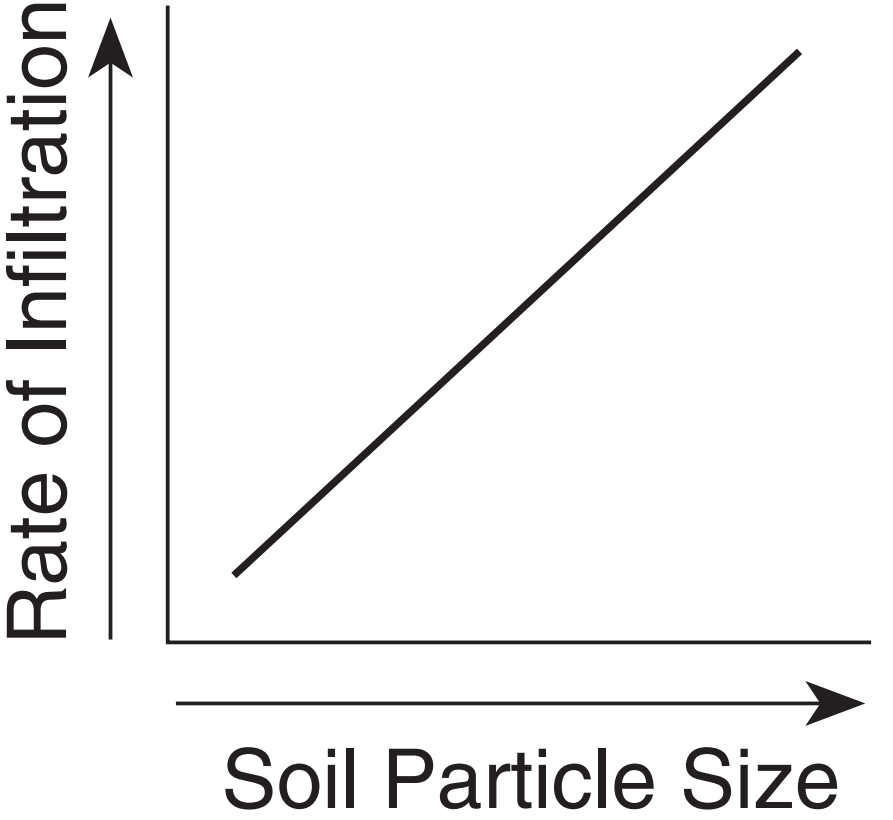

Stream
Ocean
6.4 cm
0.2 cm
0.006 cm
0.0004 cm
0.00001 cm
Area A
Area B
Area C
Area D
Bedrock
Sediments

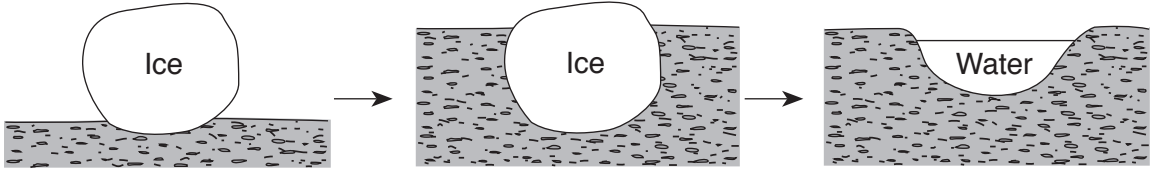

River
Ocean
Zone A
Zone B
Zone C
Zone D
Bedrock

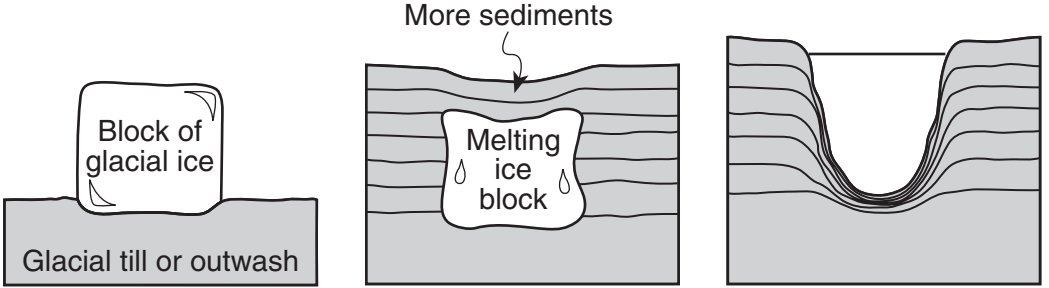

Stream
Ocean surface
Pebbles
Sand
Silt
Clay
Bedrock


L
S

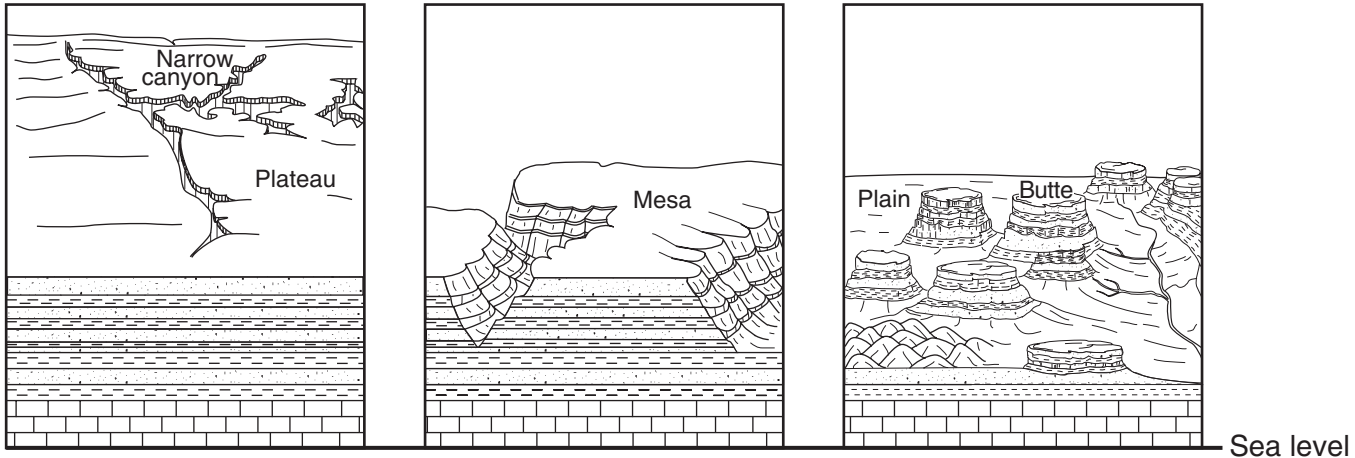

Warmer
Cooler
Today
50,000
100,000
150,000
200,000
Time Before Present (yr)


Rate of Infiltration
Soil Particle Size

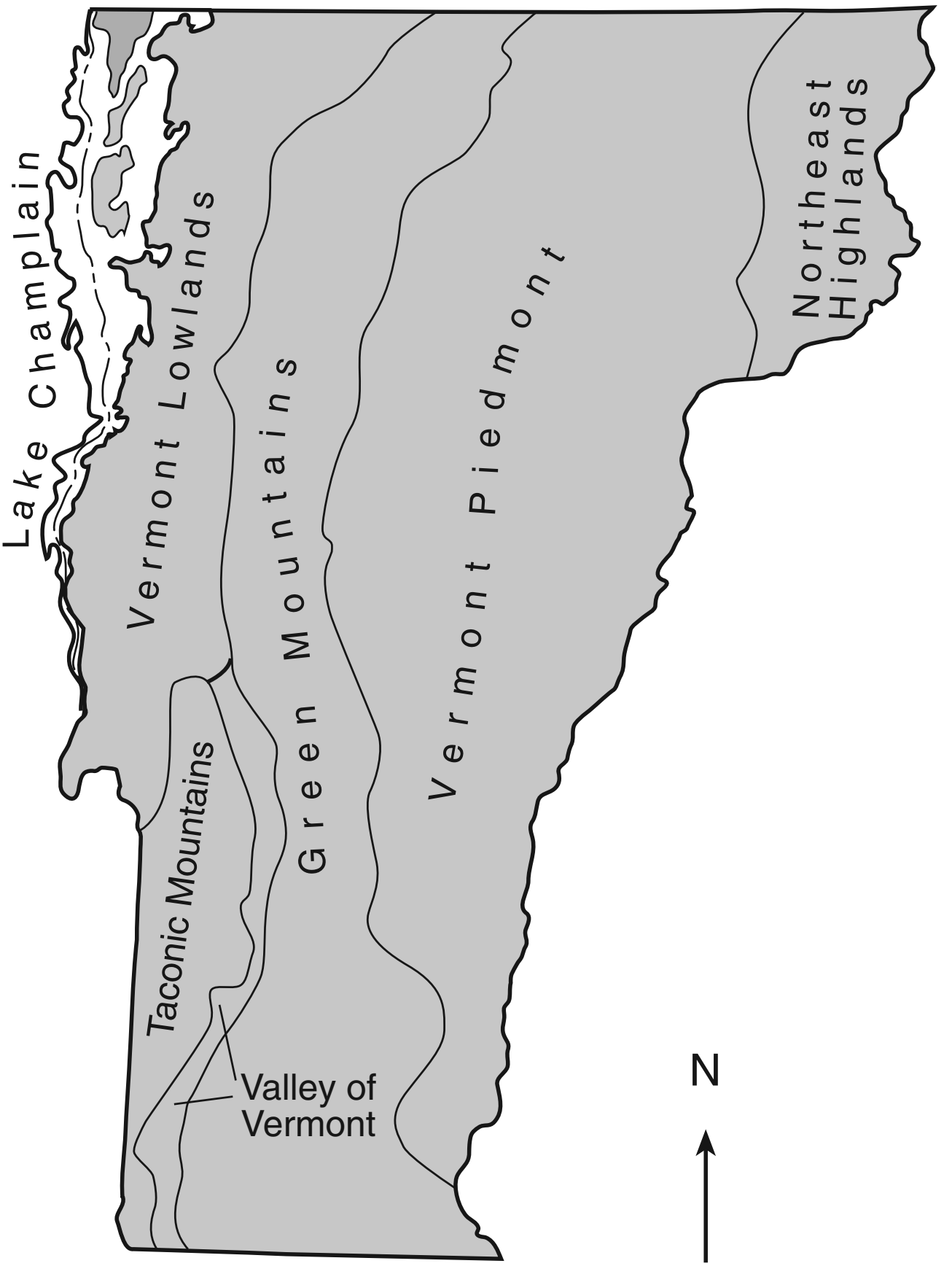

Ice
Ice
Water
Block of ice dropped by a glacier
Ice block becomes surrounded by sediment
Ice block melts

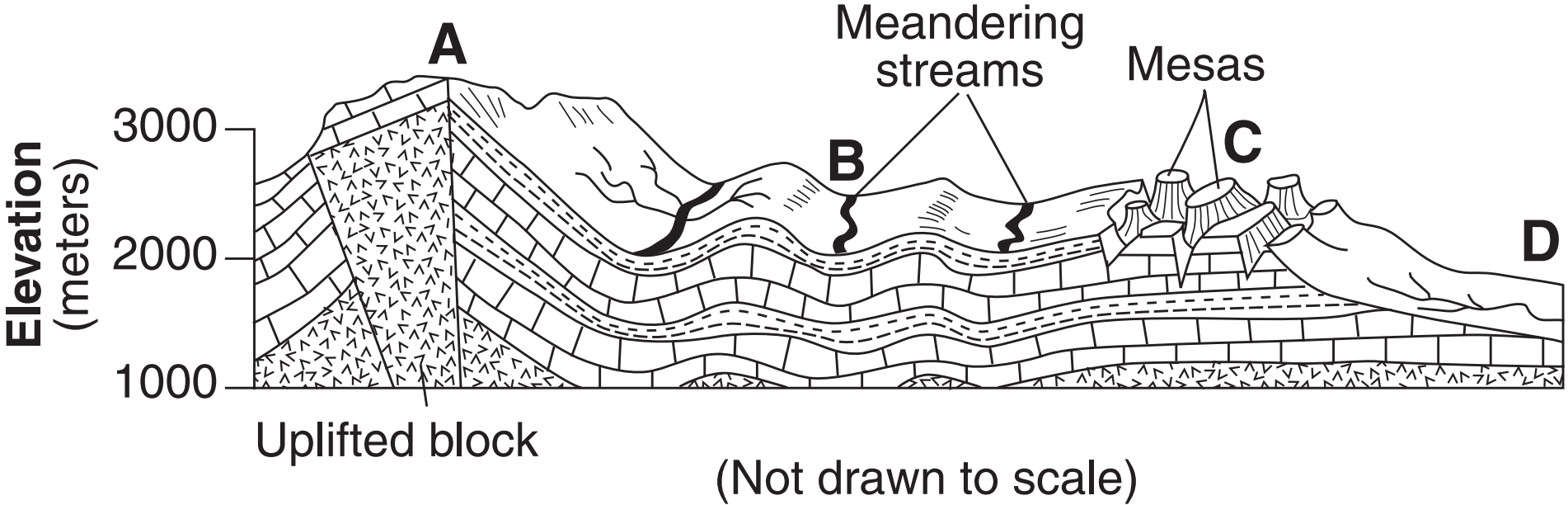

Block of glacial ice
Glacial till or outwash
Stage 1
More sediments
Melting ice block
Stage 2
Stage 3

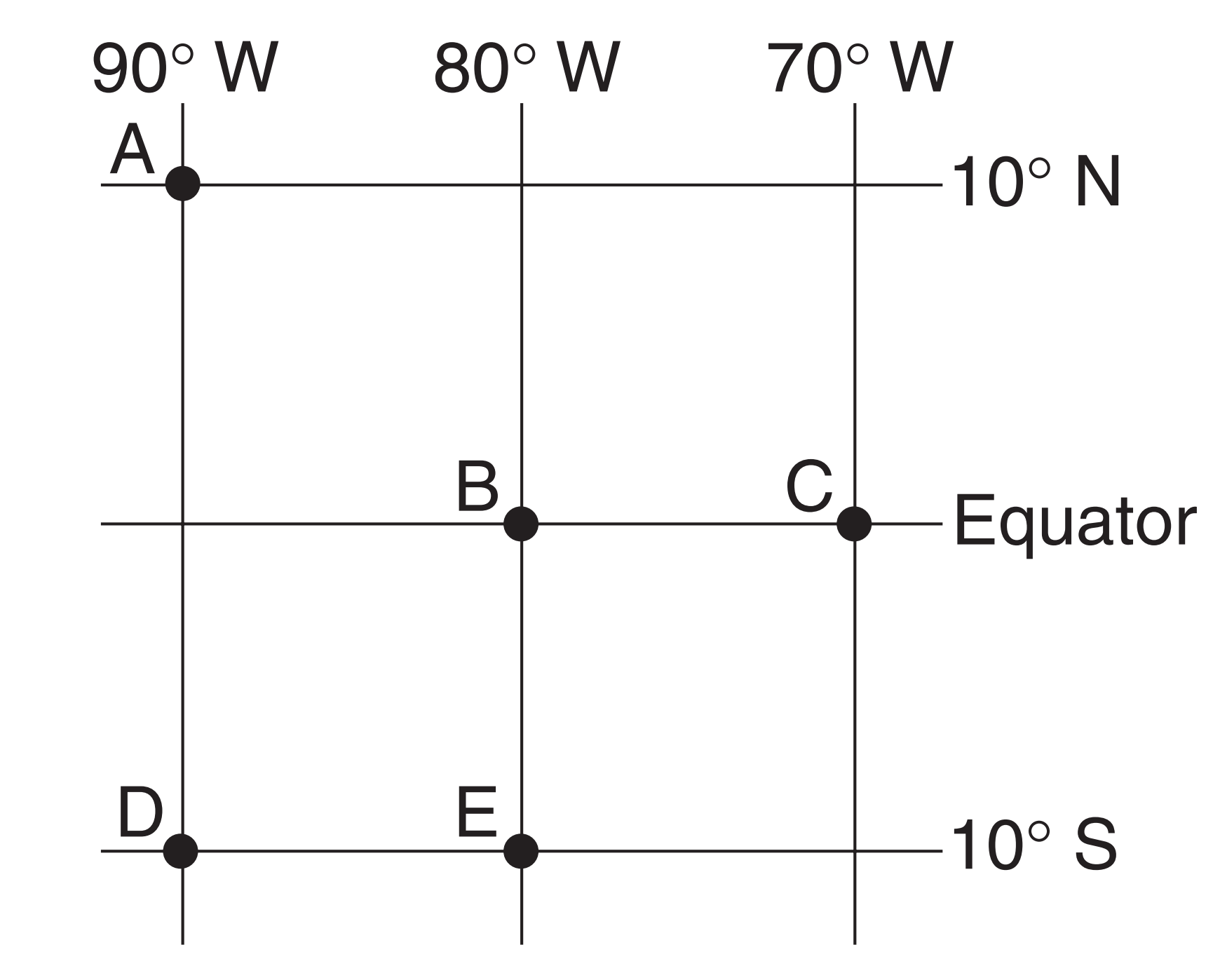
| Landscape Region | Relief | Bedrock |
|---|---|---|
| *A* | great relief, high peaks, deep valleys | faulted and tilted structure; many bedrock types, including igneous |
| *B* | moderate relief, rounded peaks, wide valleys | folded sedimentary bedrock |
| *C* | moderate to high relief | horizontal sedimentary bedrock layers |
| *D* | very little relief, low elevations | horizontal sedimentary bedrock layers |

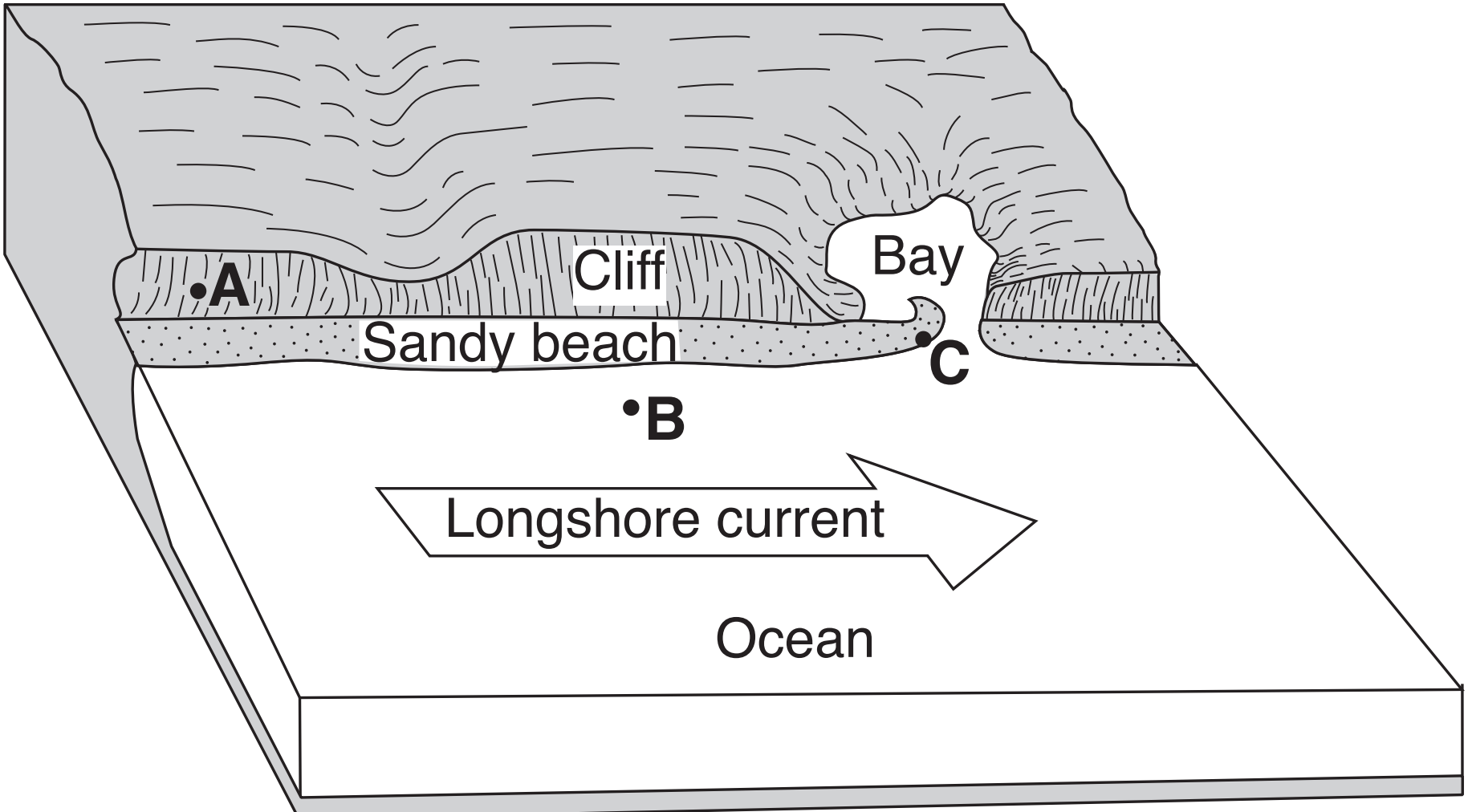

Narrow canyon
Plateau
Mesa
Plain
Butte
Sea level
25 million years ago
15 million years ago
Present time

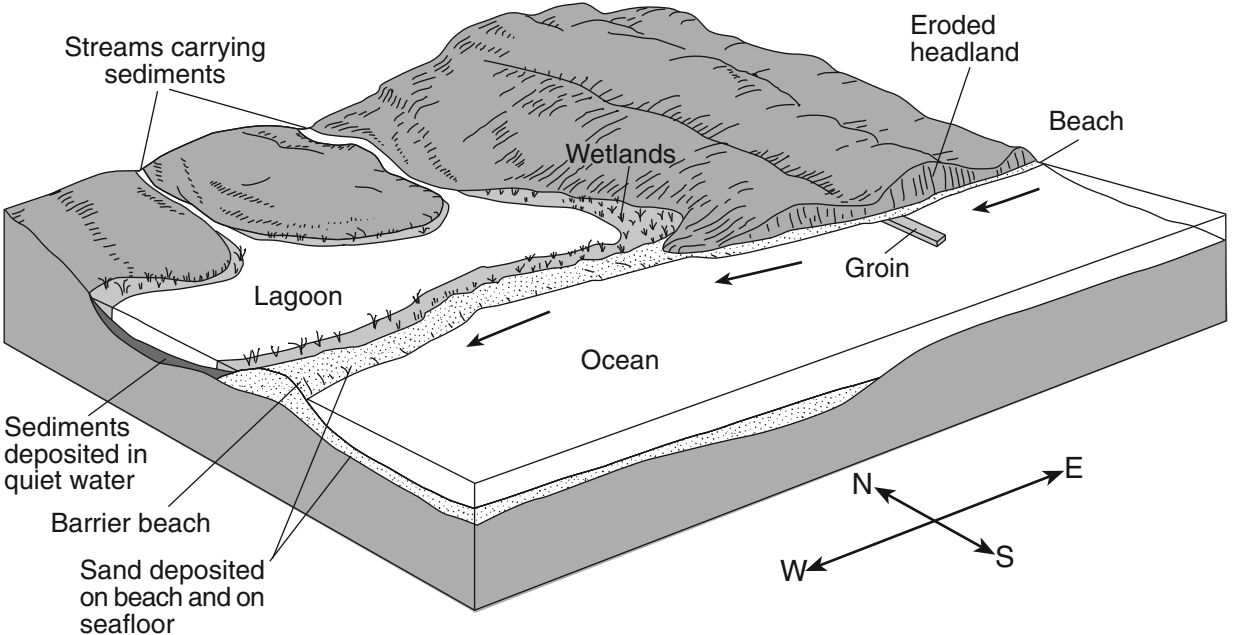
# Generalized Landscape Regions of Vermont

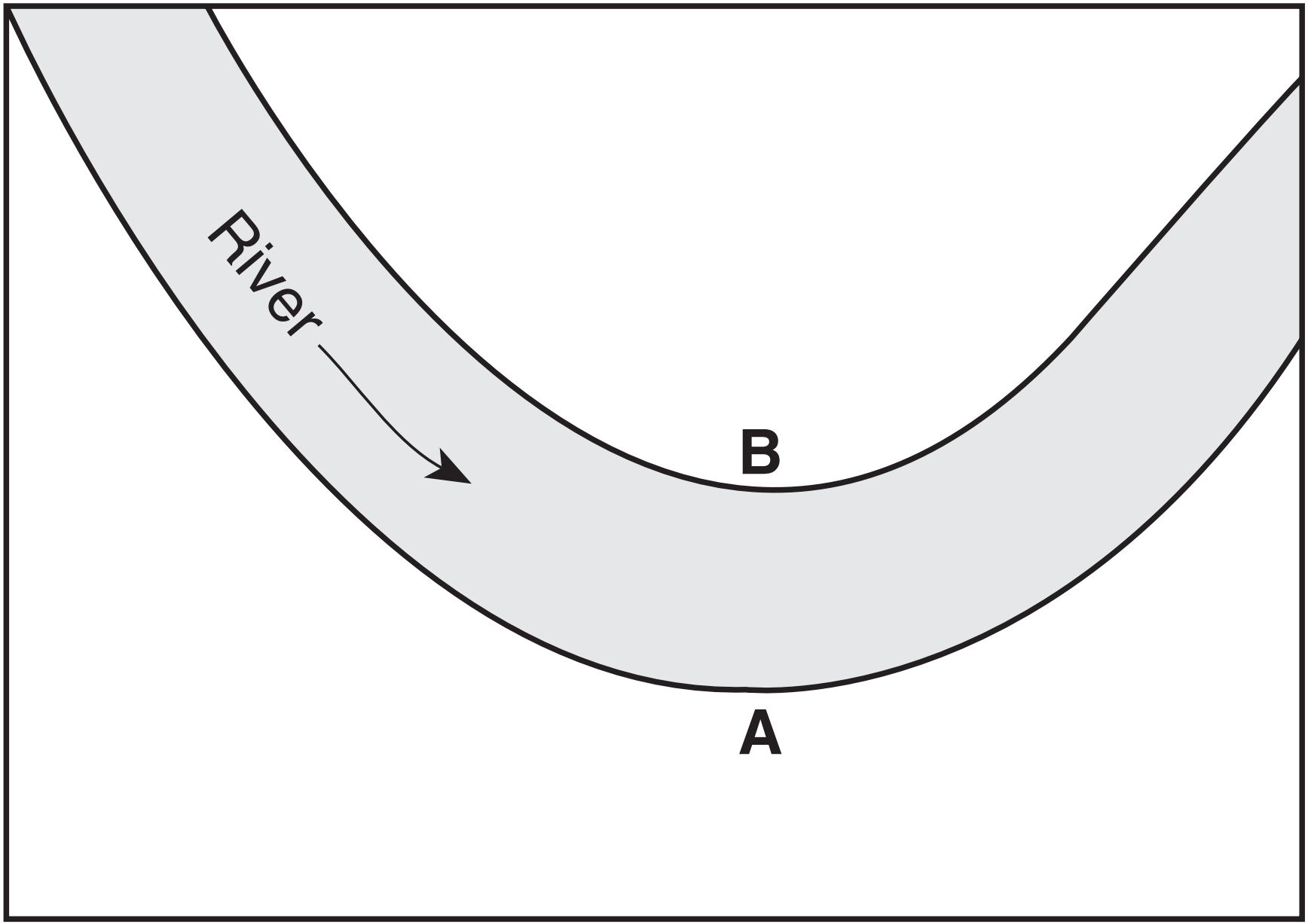


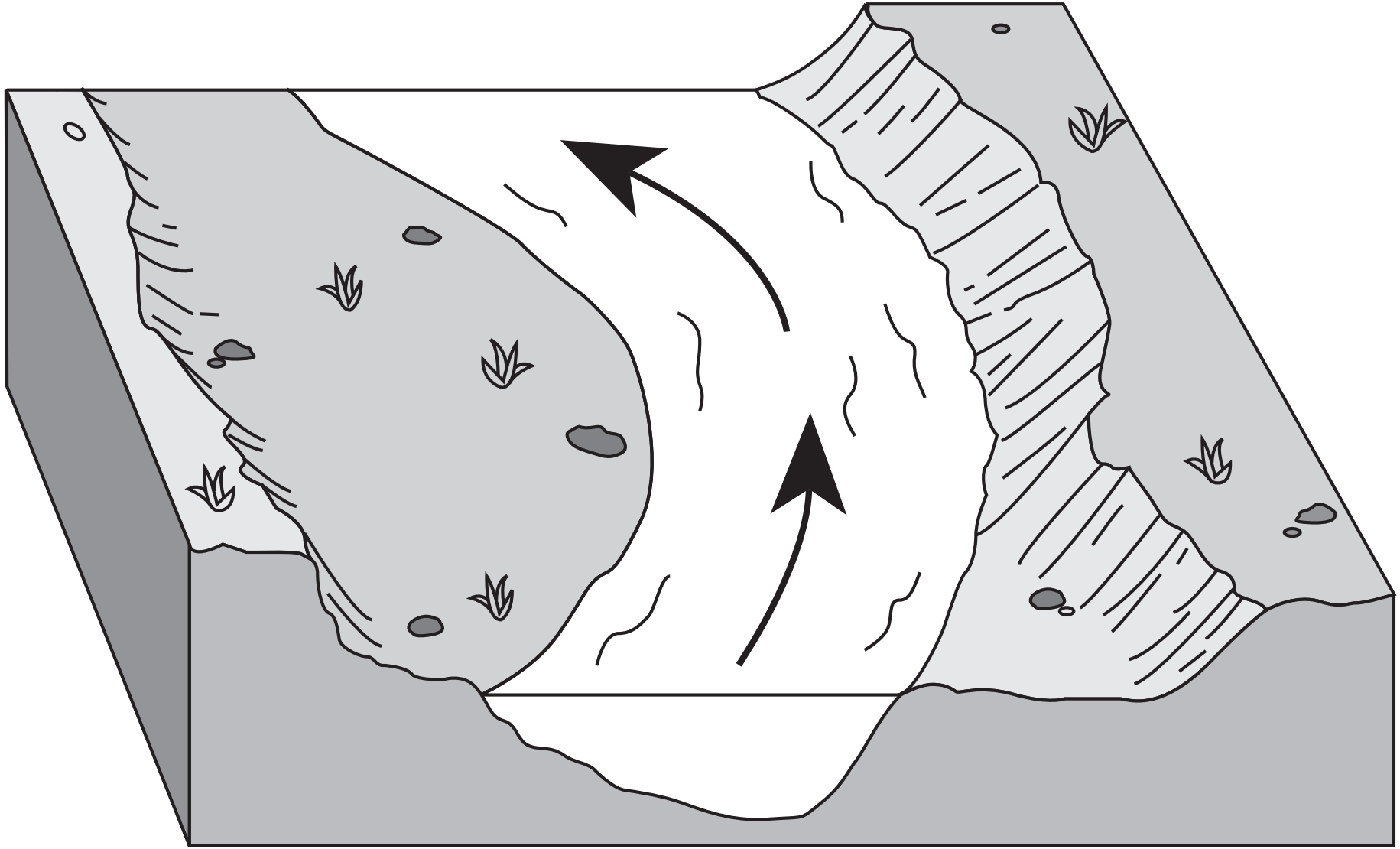

A
Meandering streams
Mesas
B
C
D
Elevation (meters)
3000
2000
1000
Uplifted block
(Not drawn to scale)

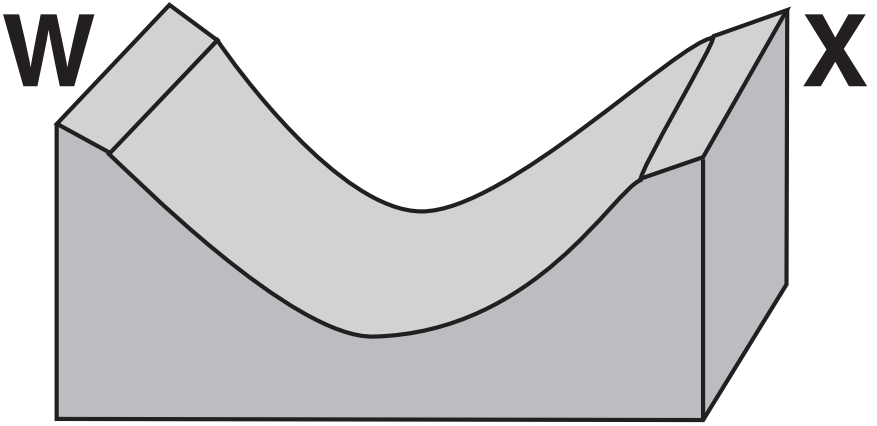

90° W
80° W
70° W
A
10° N
B
C
Equator
D
E
10° S

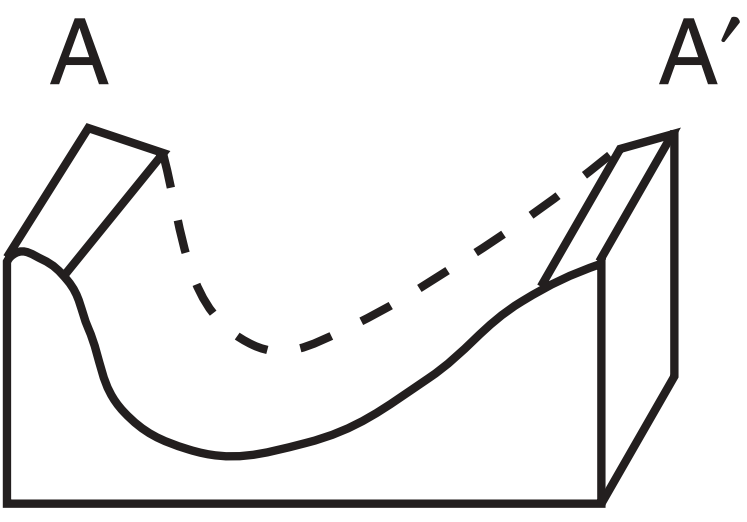

A
Cliff
Bay
Sandy beach
C
B
Longshore current
Ocean

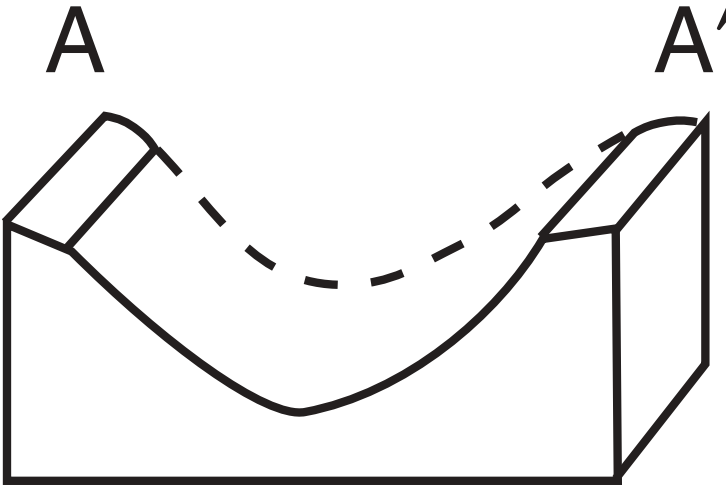

Streams carrying sediments
Eroded headland
Beach
Wetlands
Groin
Lagoon
Ocean
Sediments deposited in quiet water
Barrier beach
Sand deposited on beach and on seafloor
N
E
W
S

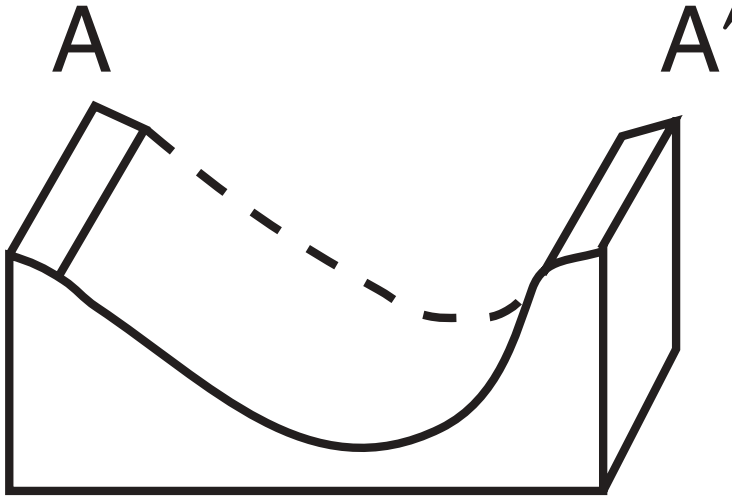

River
B
A

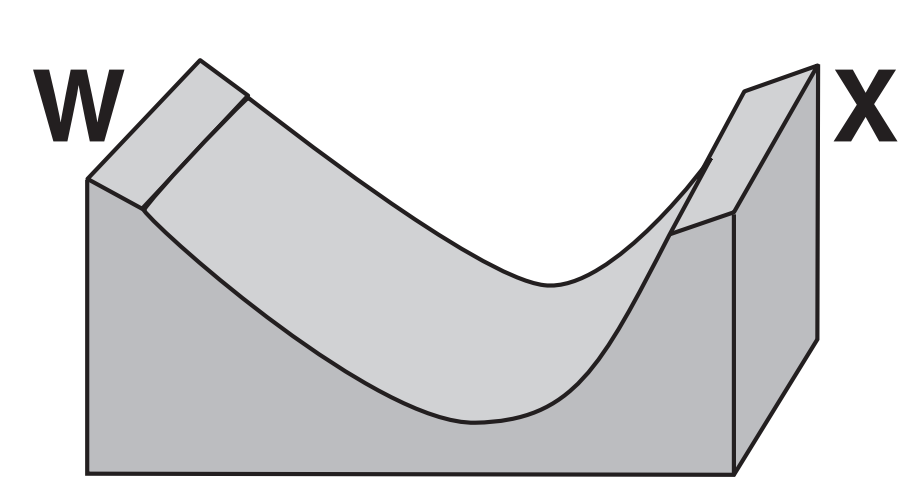


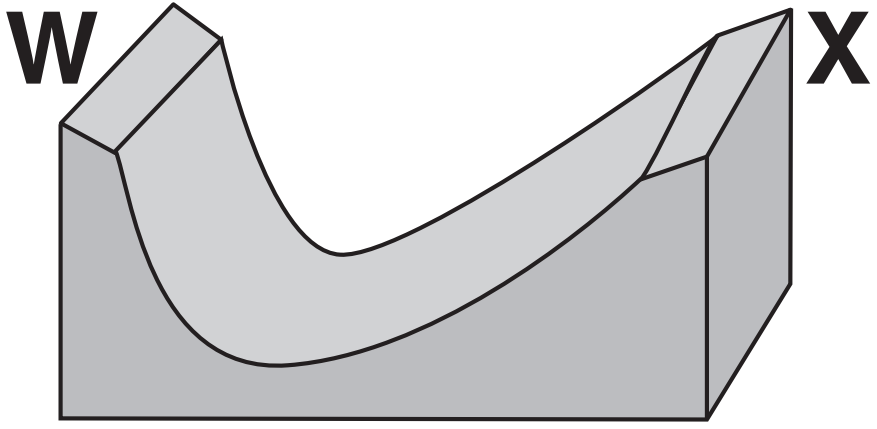

W
X

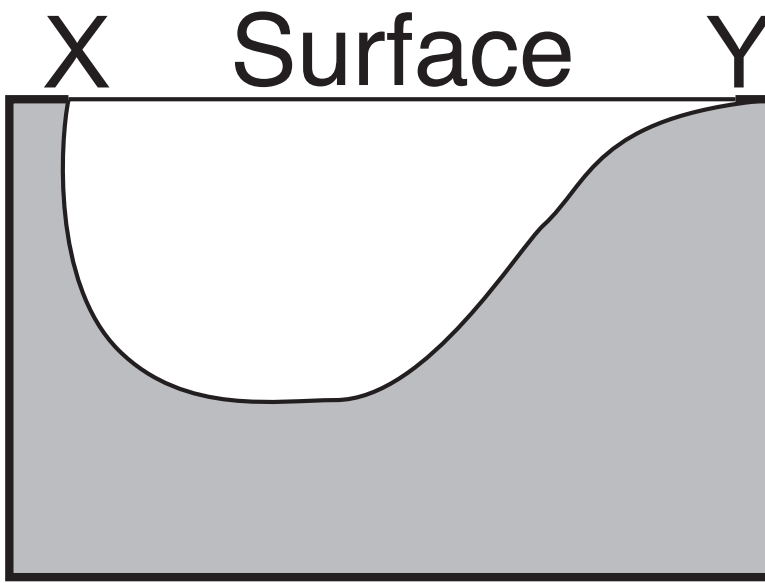

A
A′

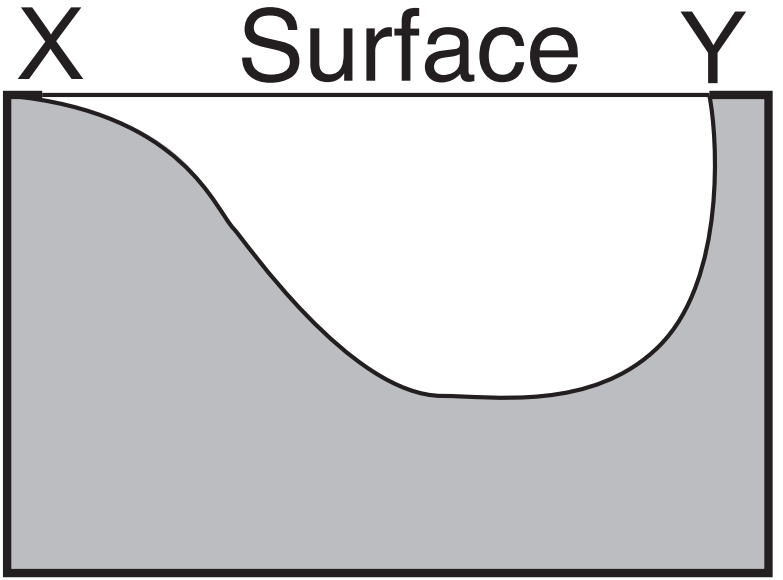

A
A′

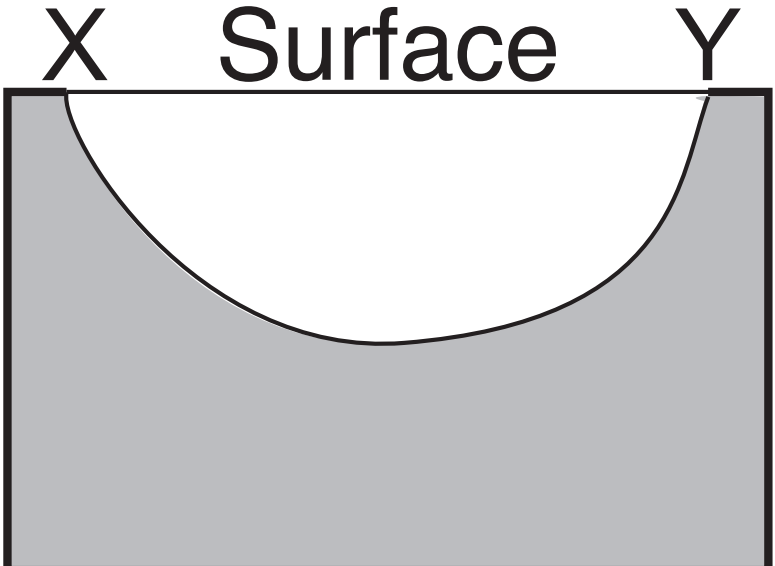

A
A′

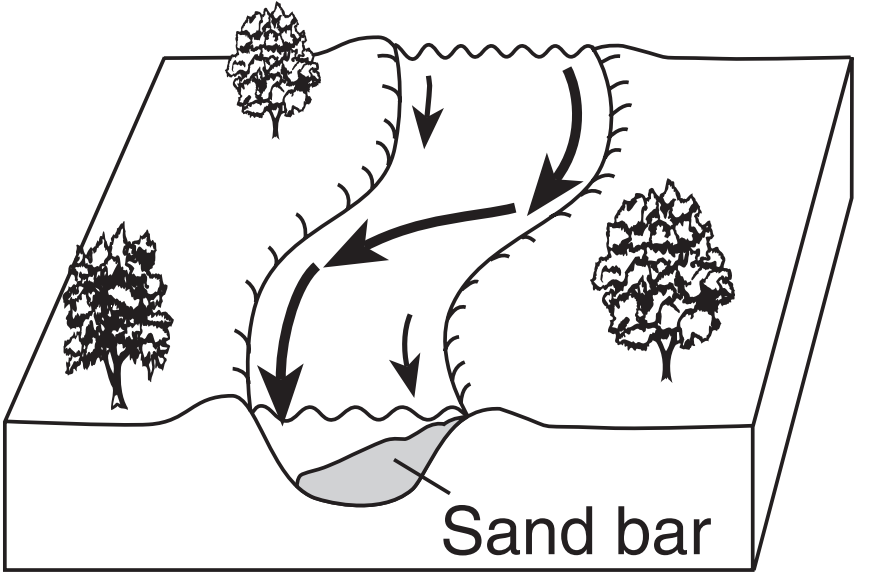

W
X

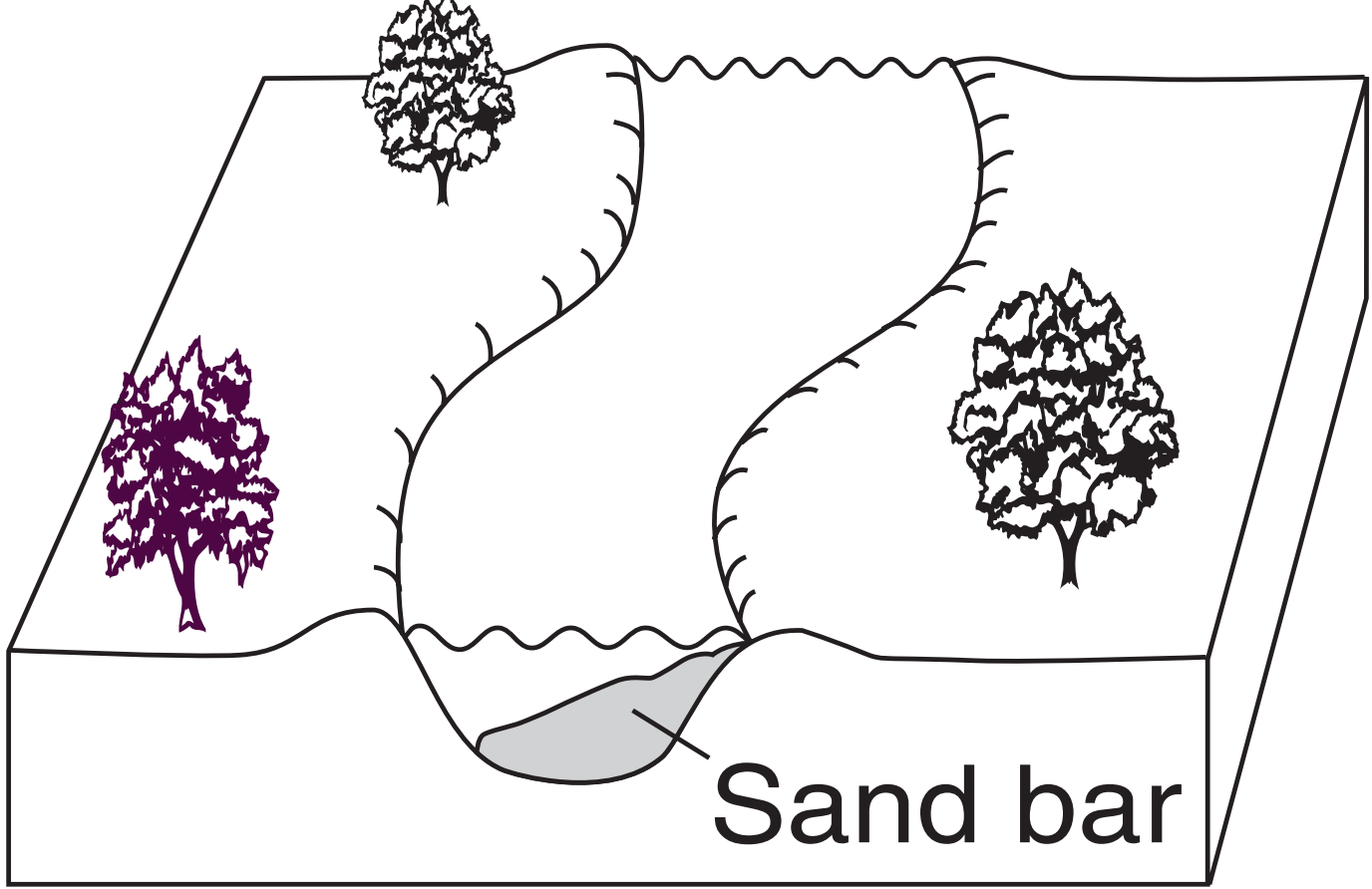

W
X

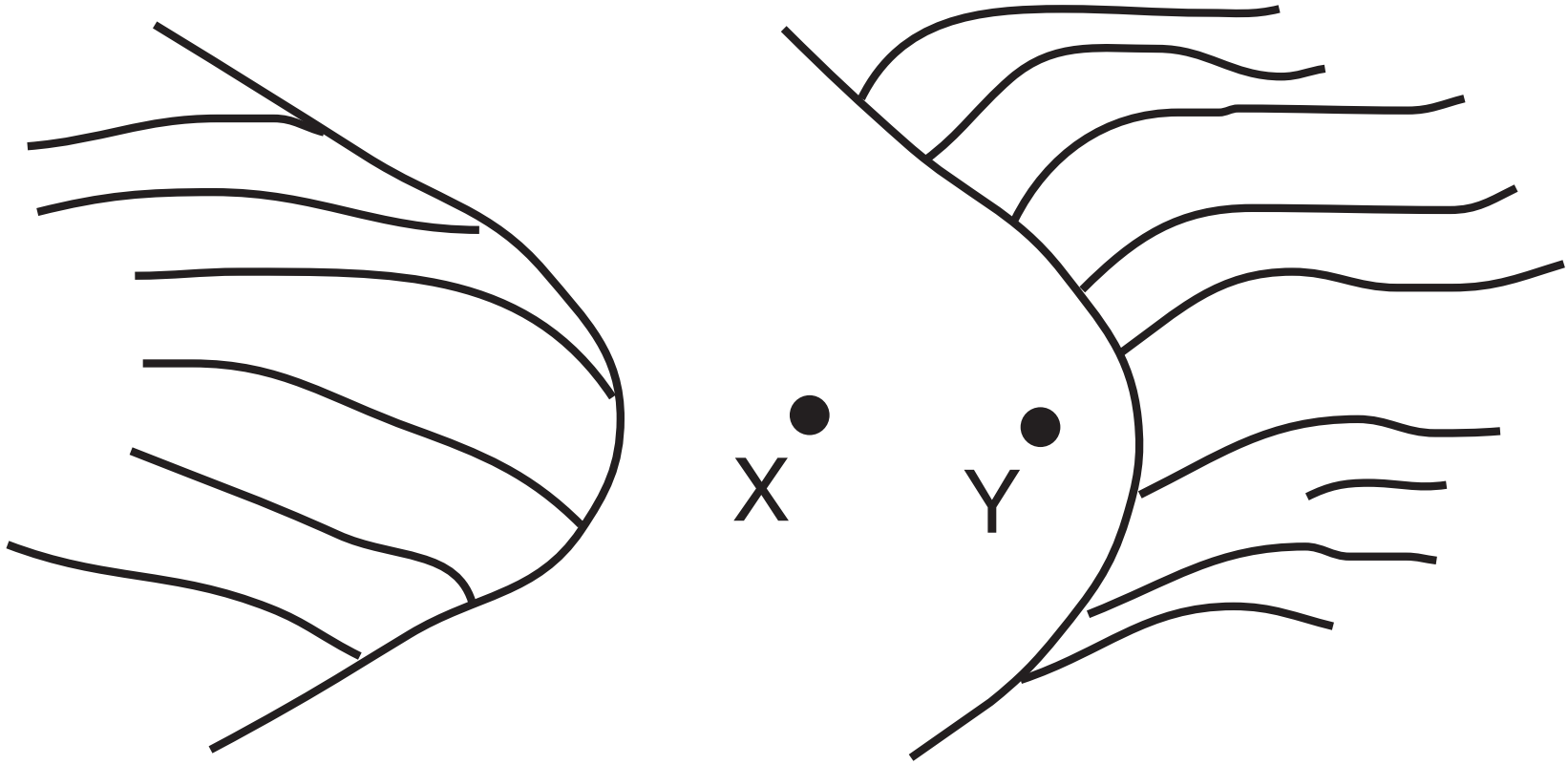

X
Surface
Y

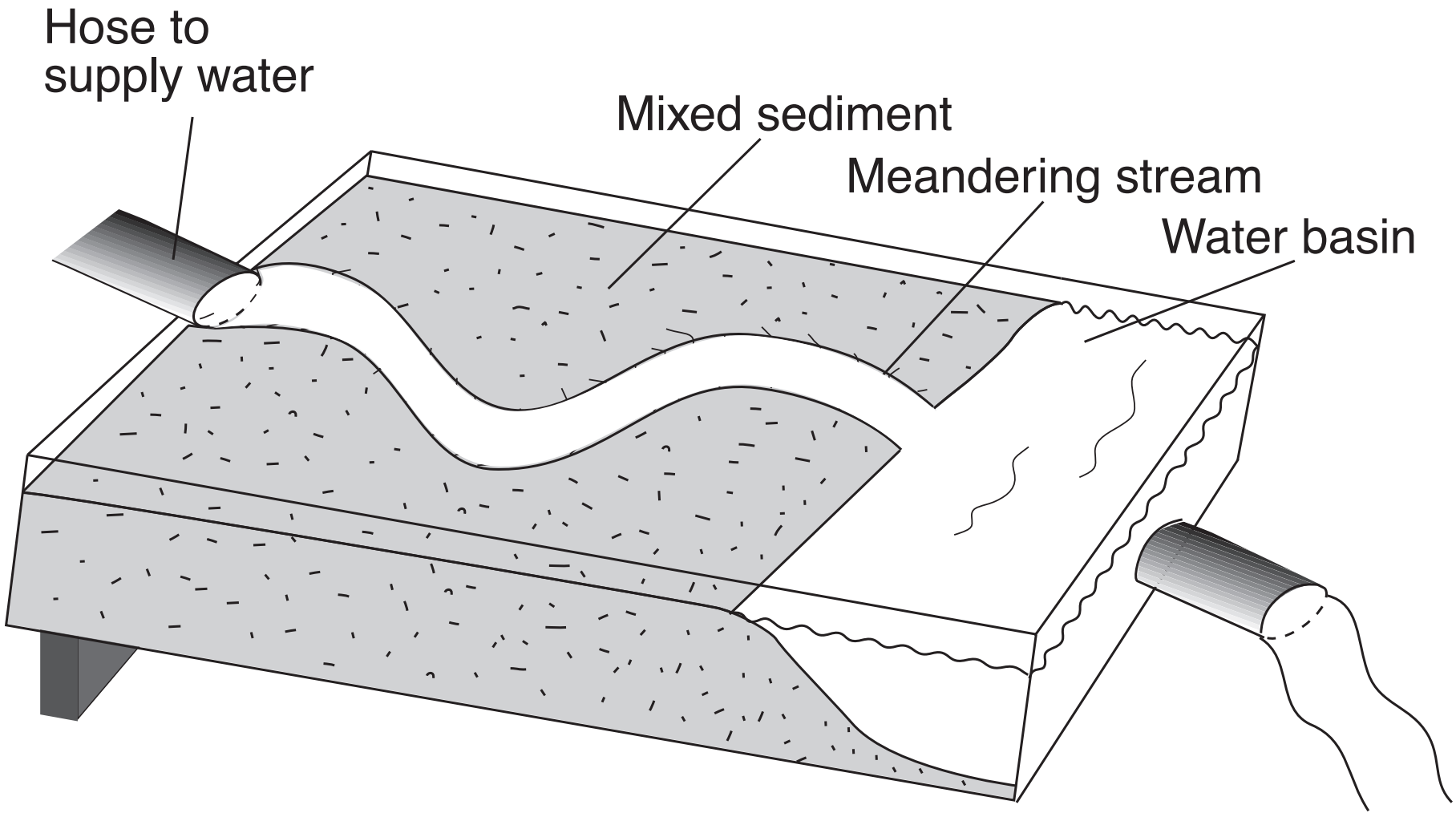

X
Surface
Y

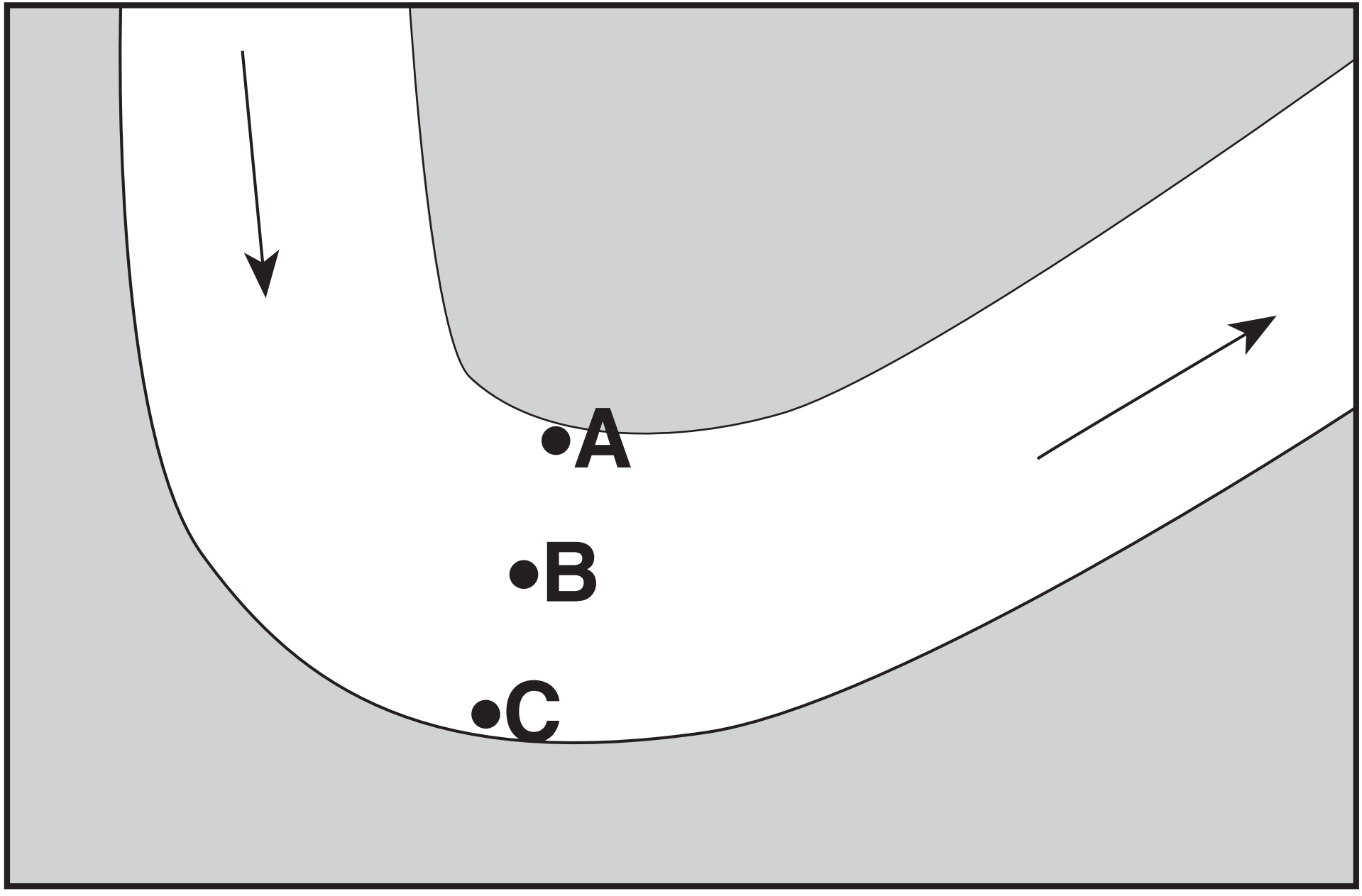

X
Surface
Y

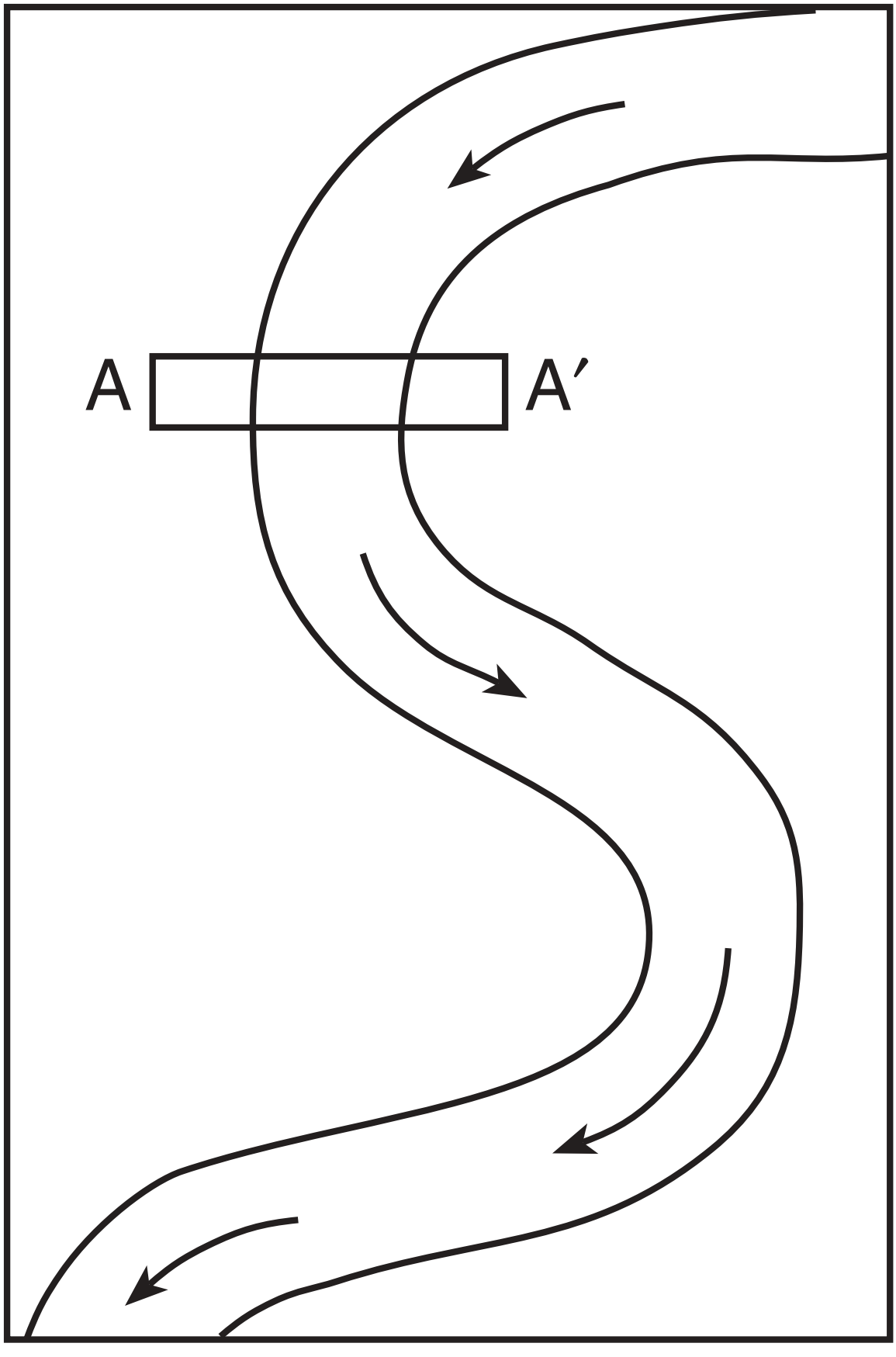

Sand bar

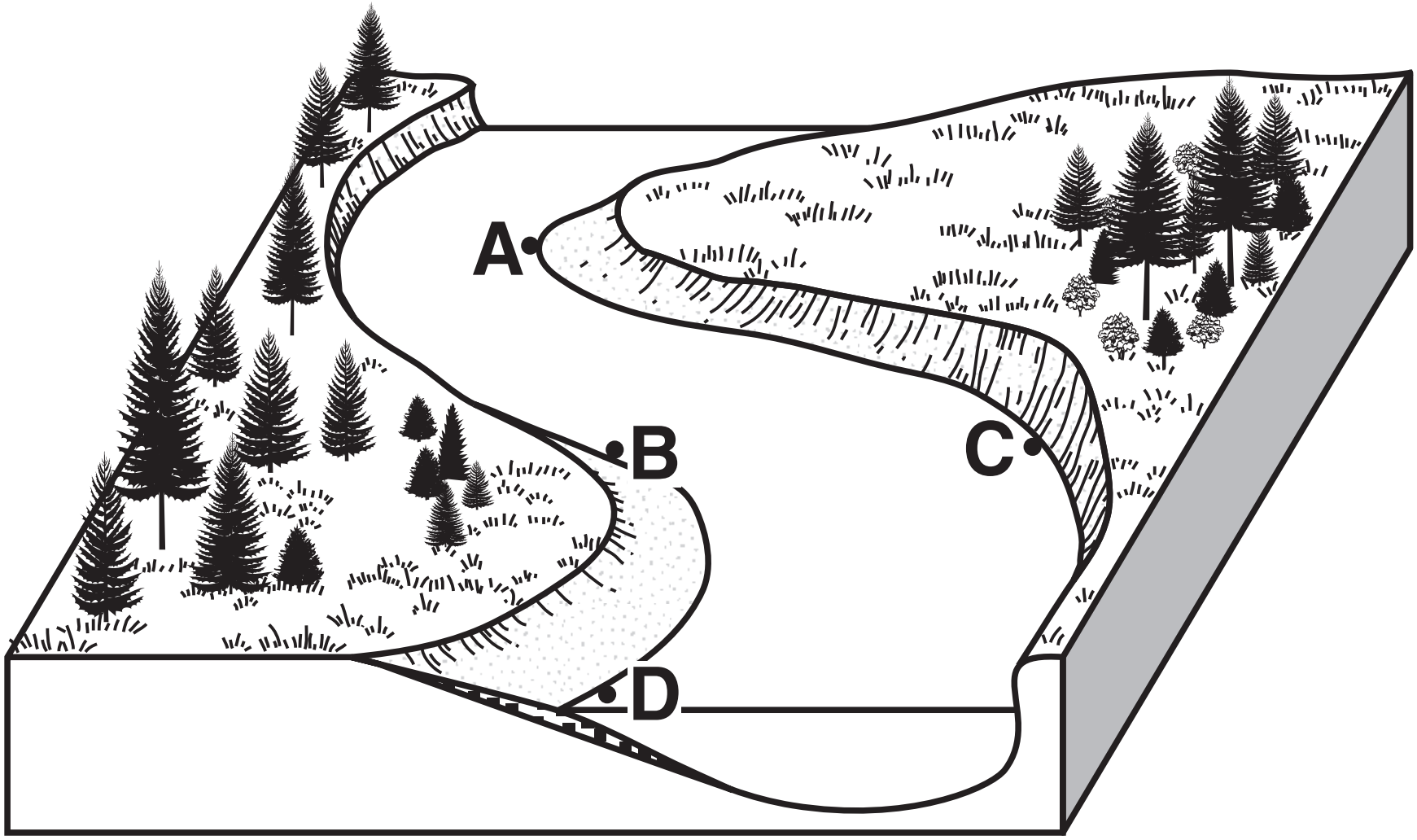

Sand bar

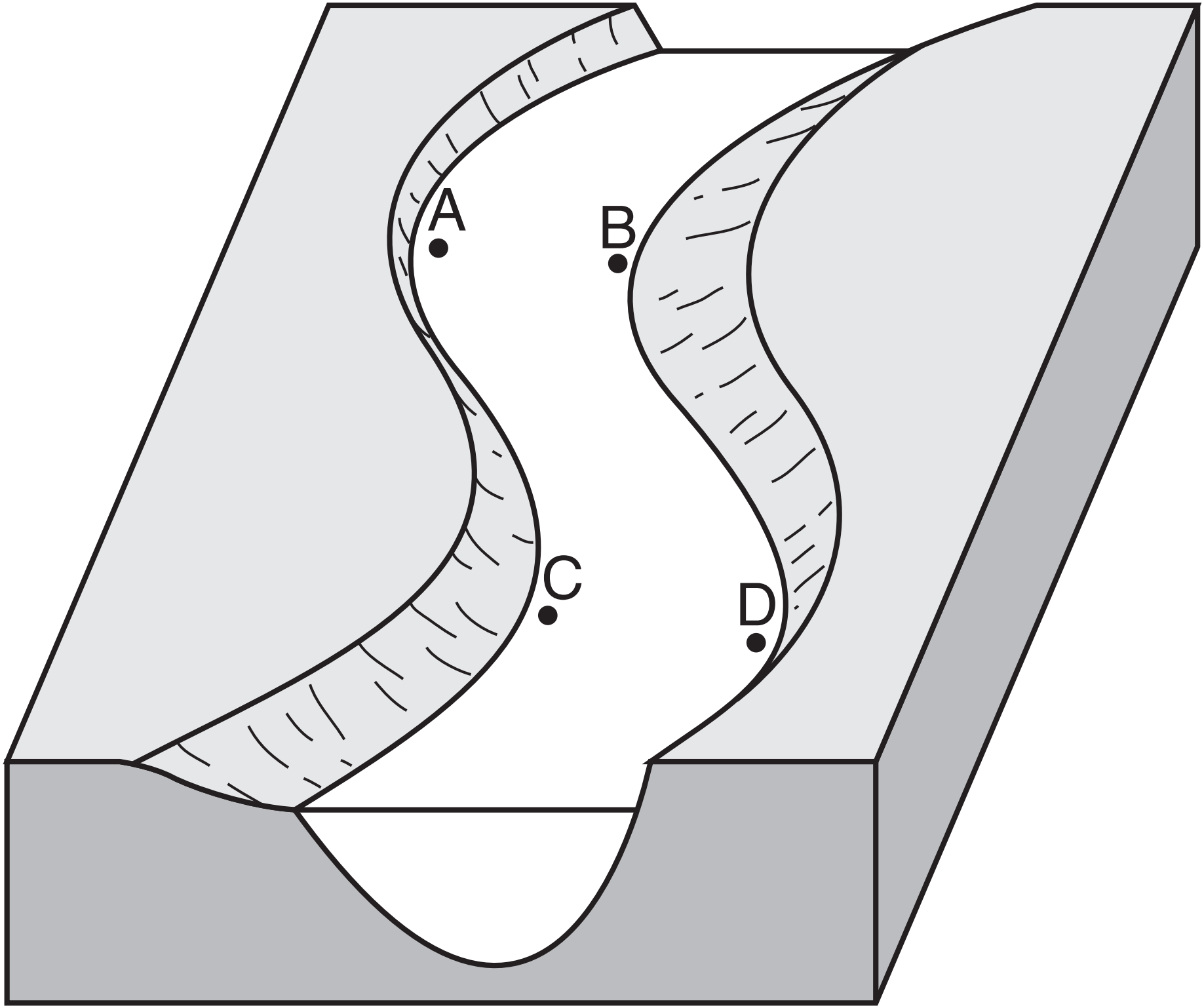

X
Y

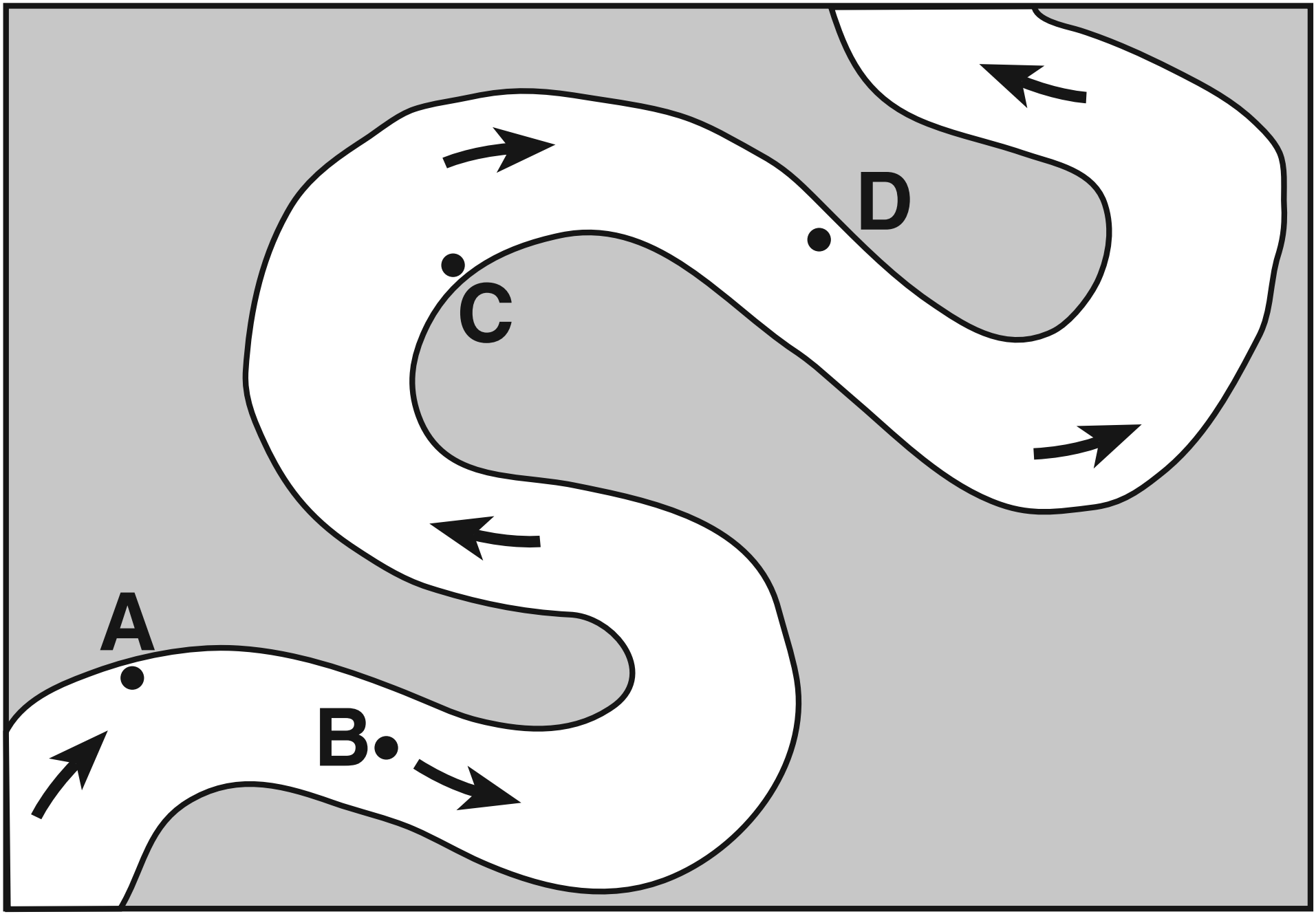

Hose to
supply water
Mixed sediment
Meandering stream
Water basin

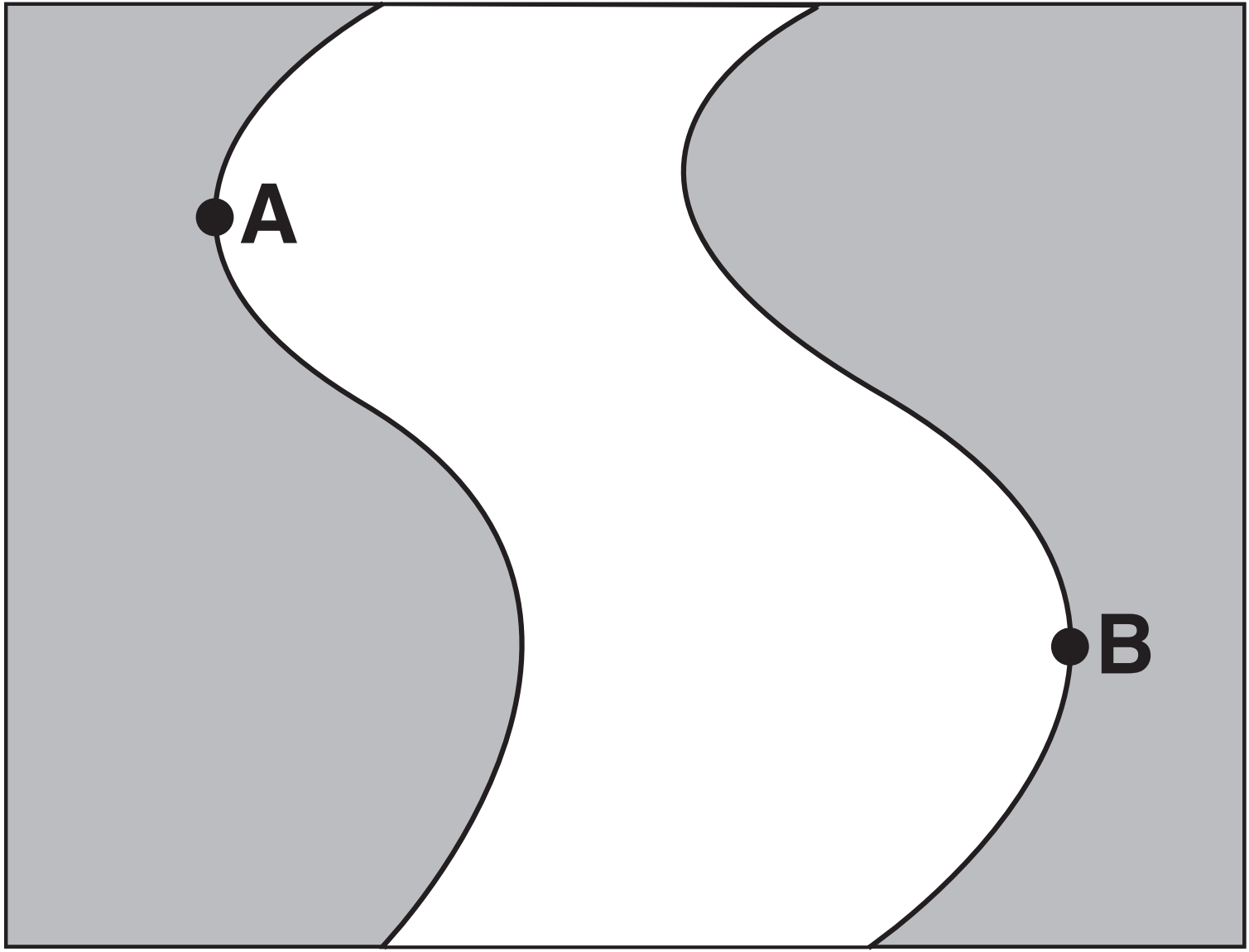

A
B
C

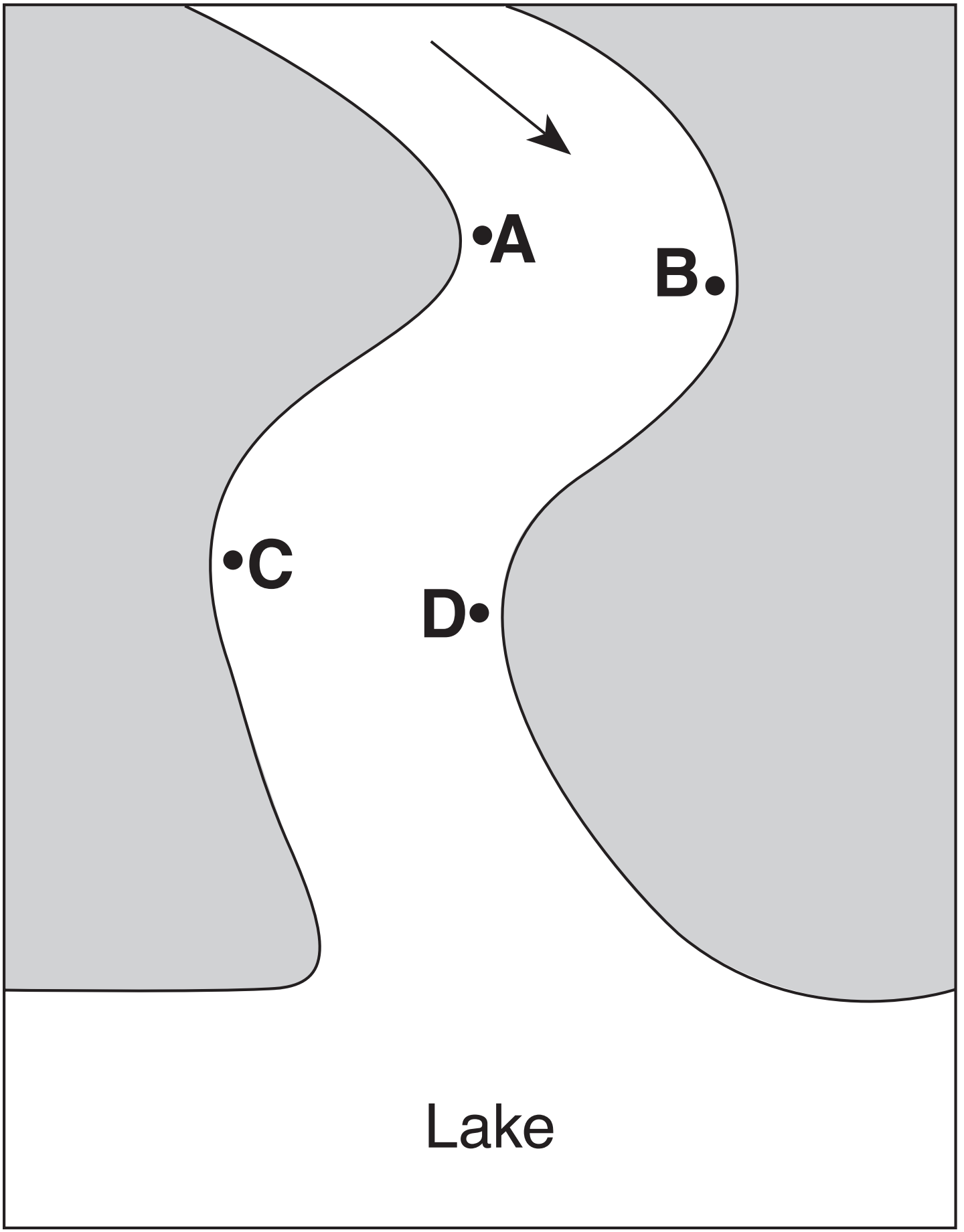

A
A′

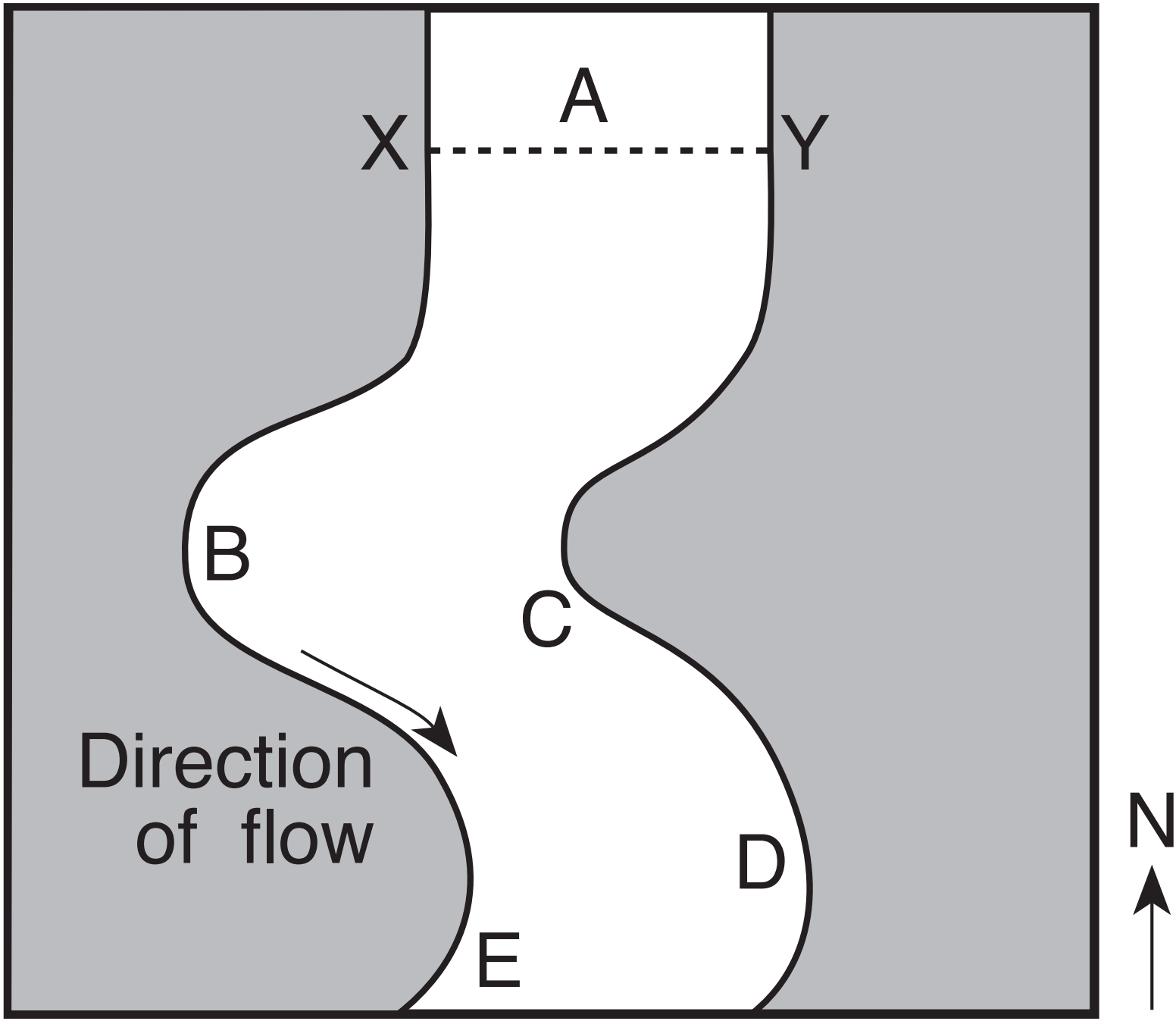

A
B
C
D

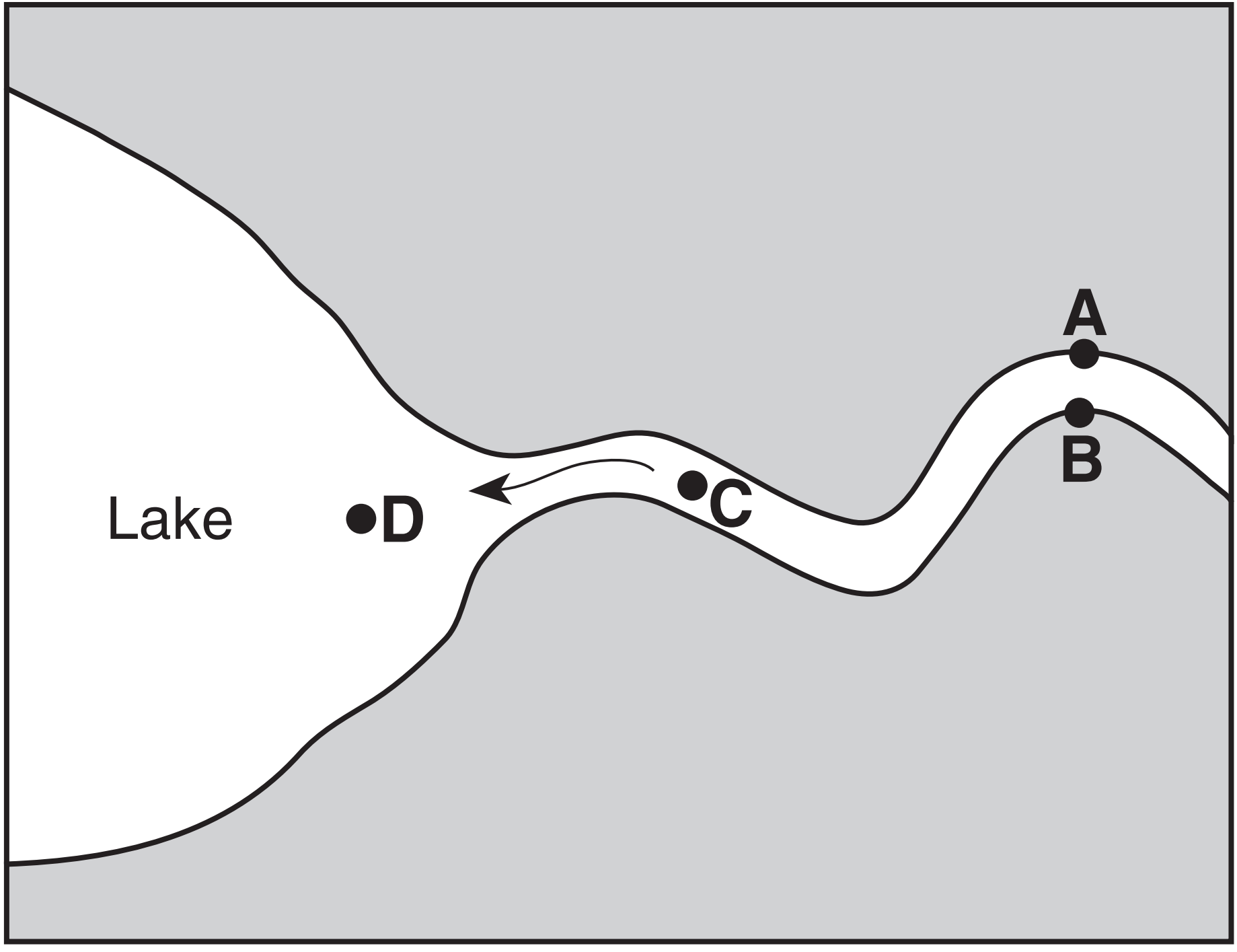

A
B
C
D

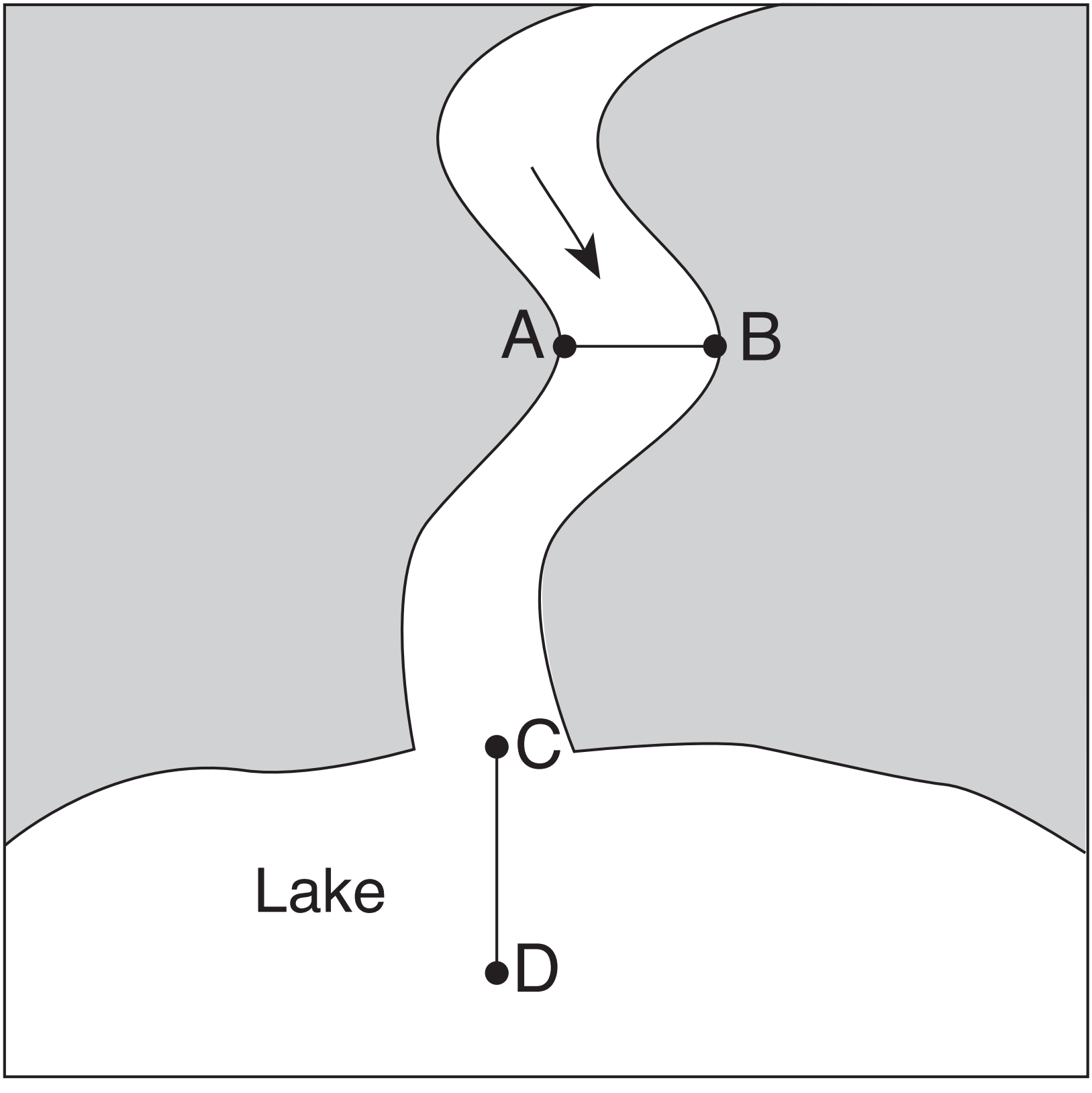

A
B
C
D

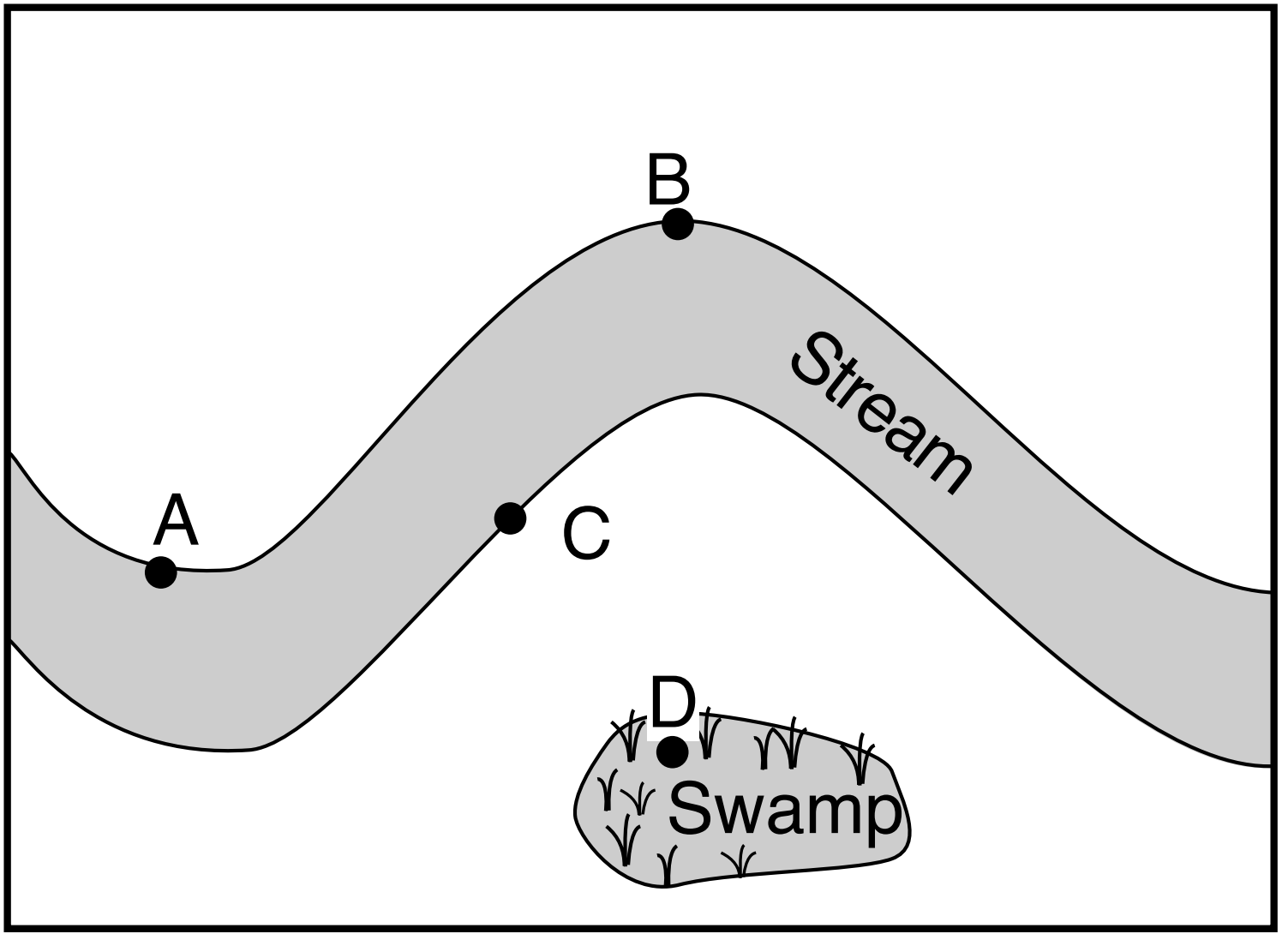

A
B

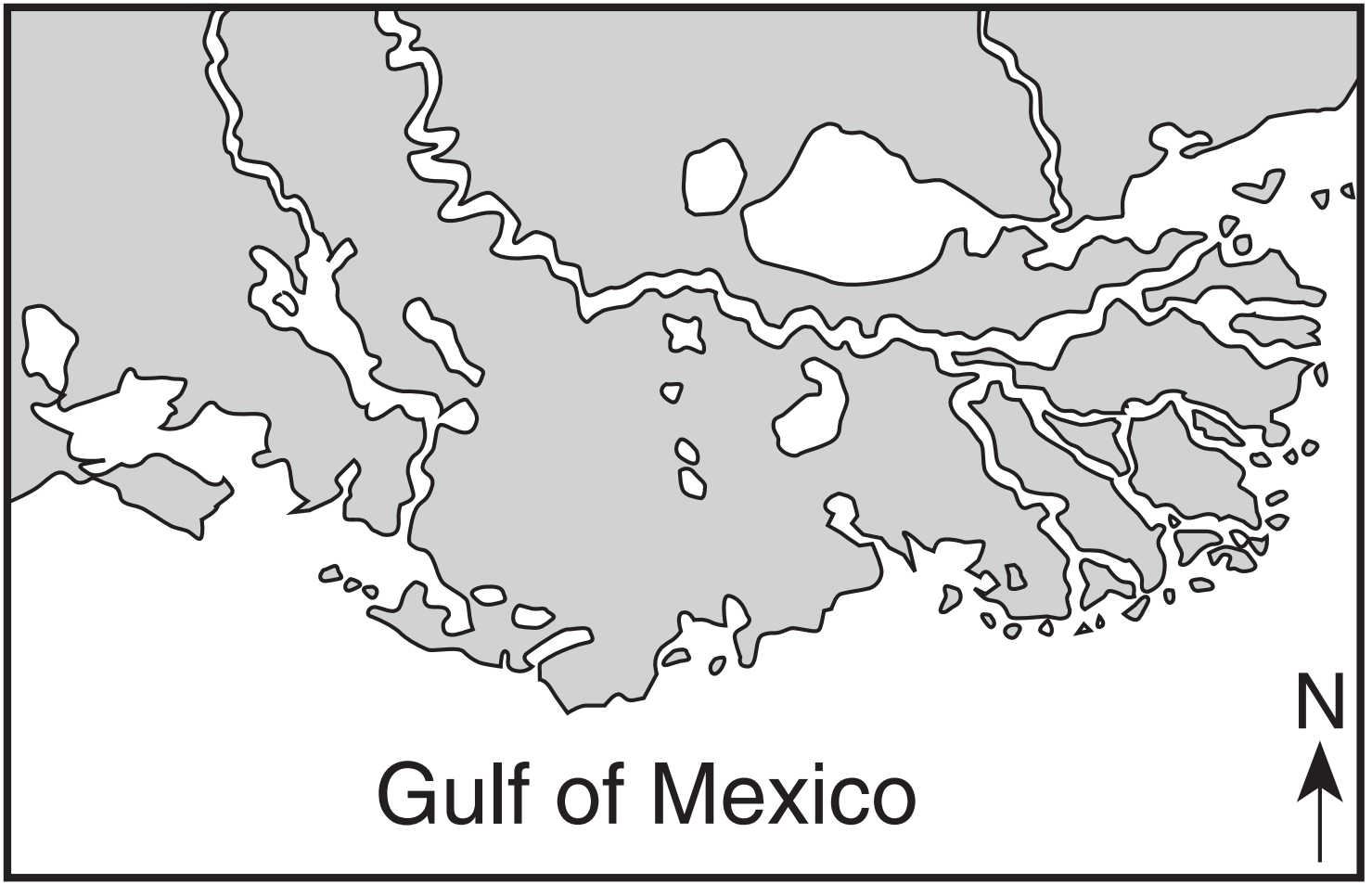

A
B
C
D
Lake

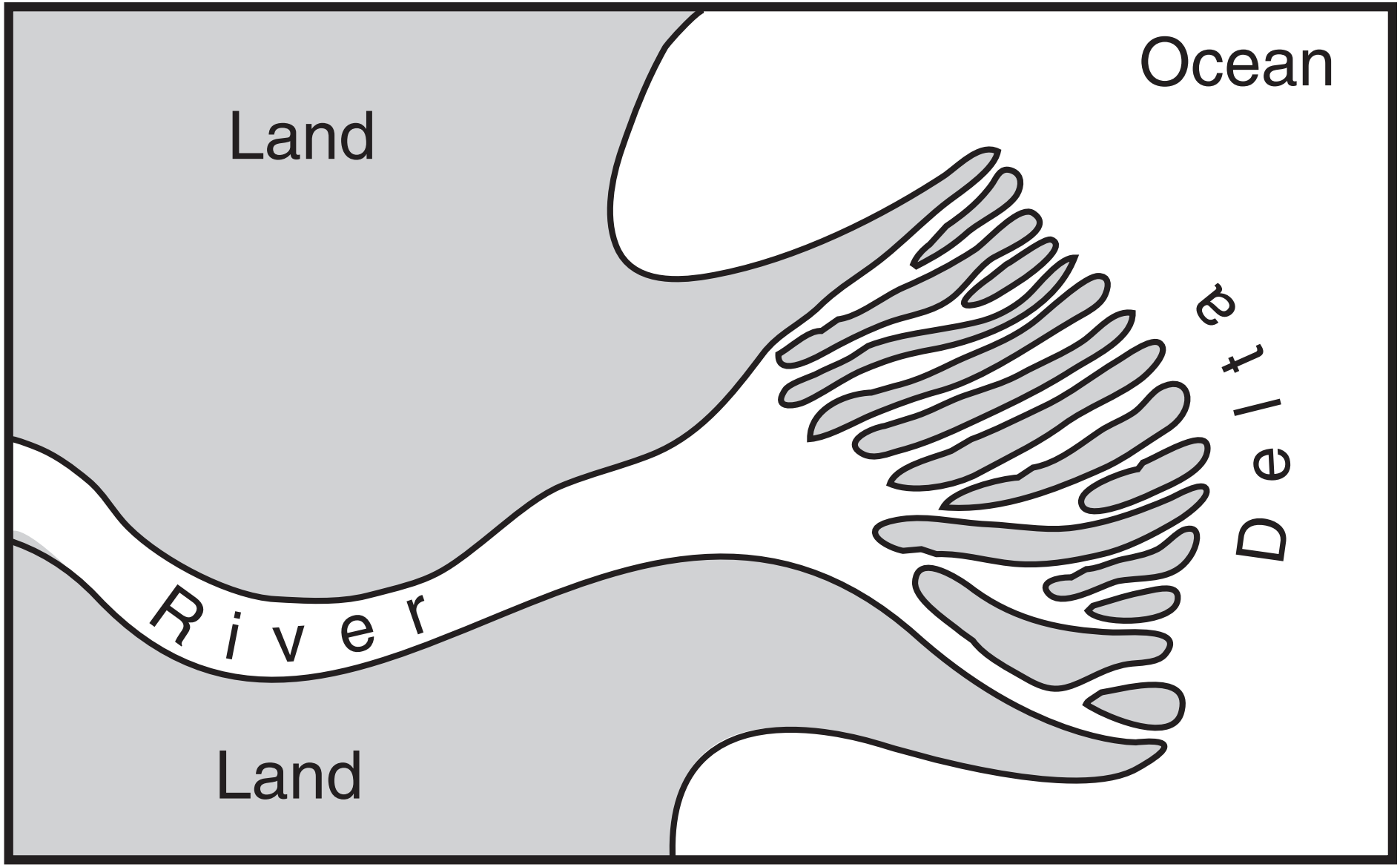

A
X
Y
B
C
Direction
of flow
D
E
N

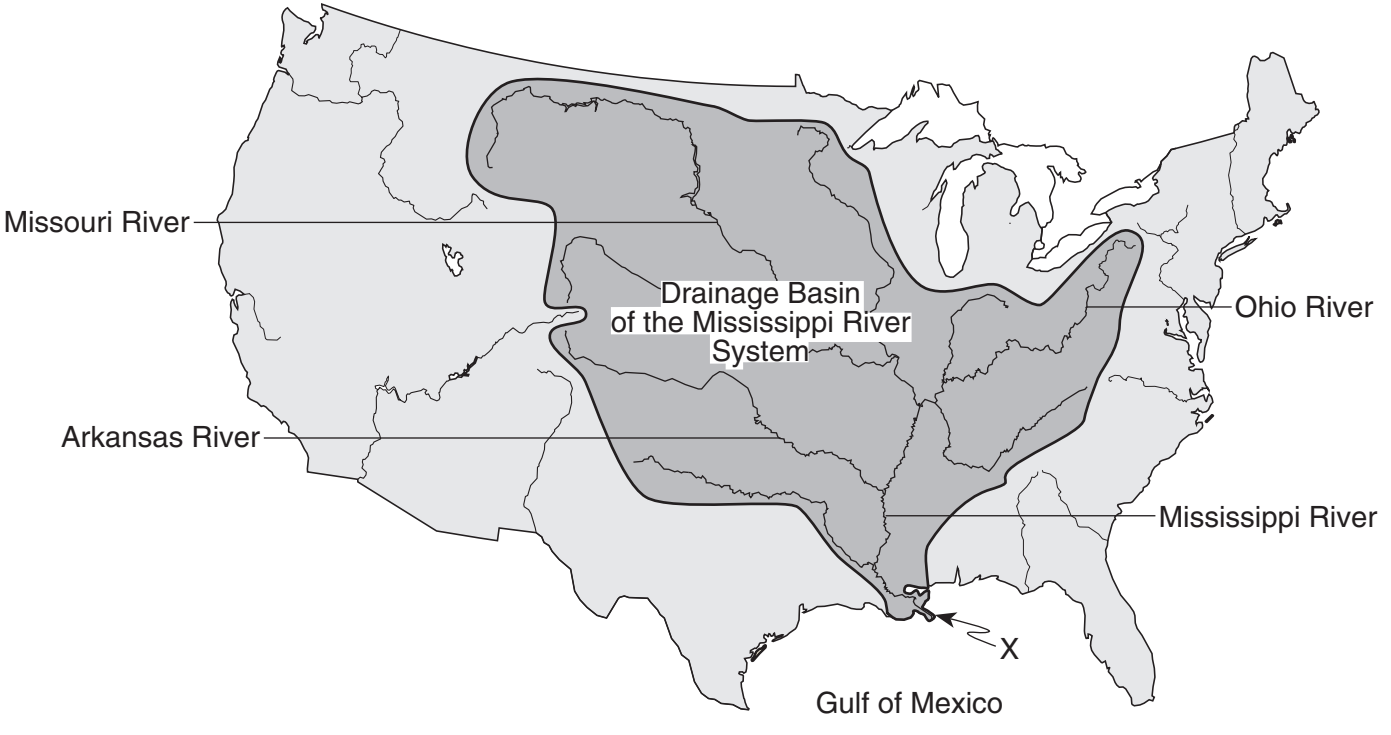

A
B
C
D
Lake


A
B
C
Lake
D

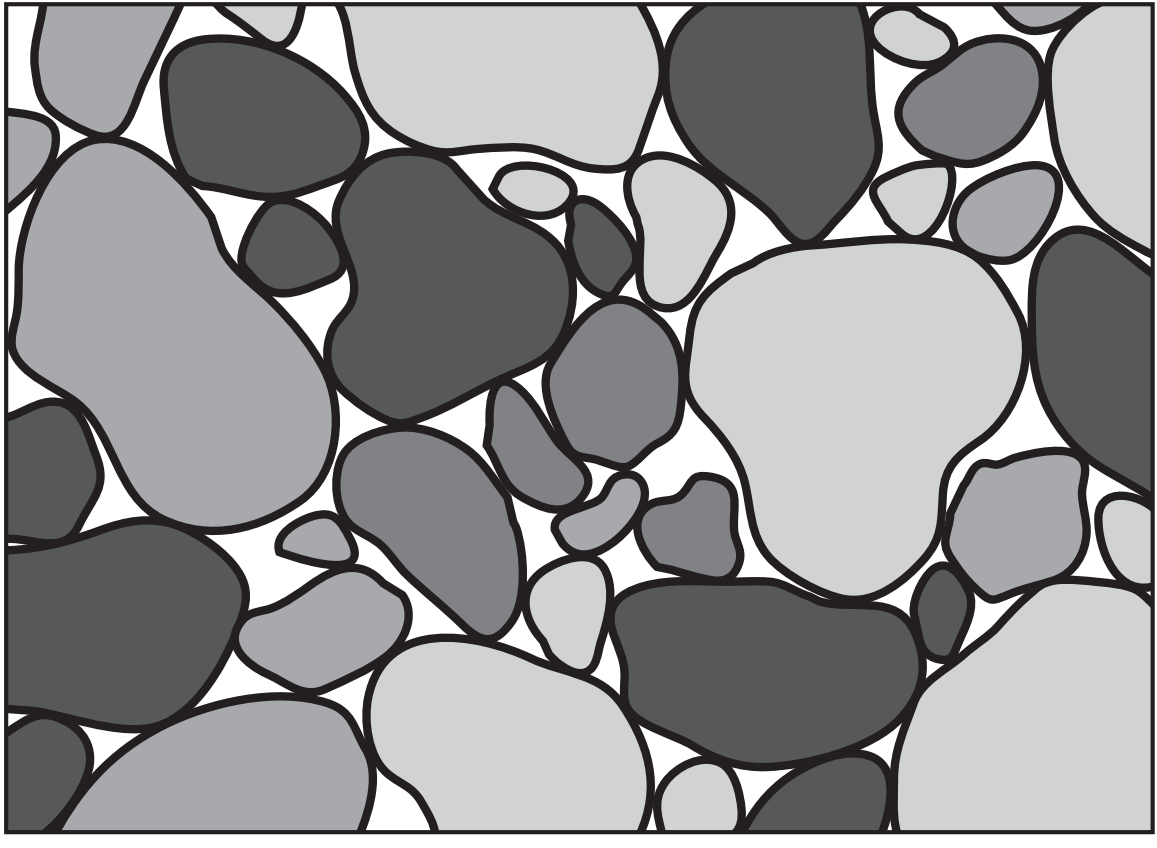

B
Stream
A
C
D
Swamp

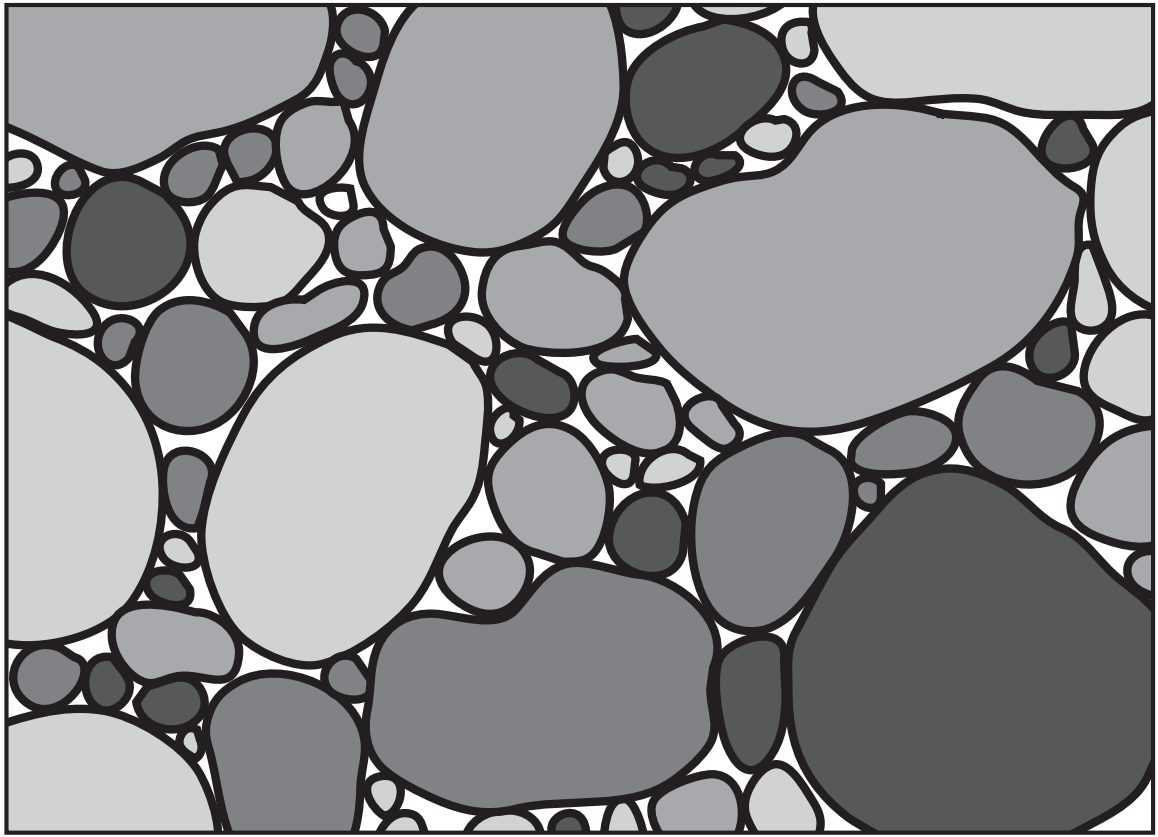

Gulf of Mexico
N


Ocean
Land
Delta
River
Land

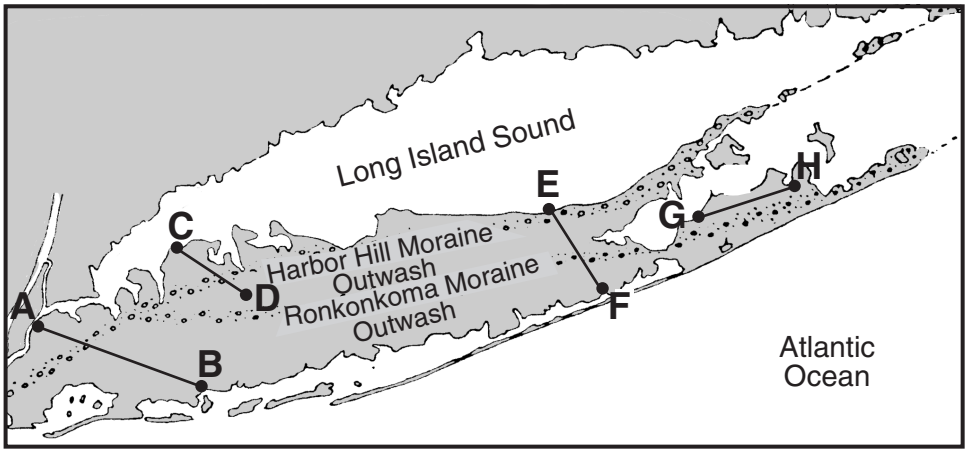

Missouri River
Drainage Basin
of the Mississippi River
System
Ohio River
Arkansas River
Mississippi River
X
Gulf of Mexico

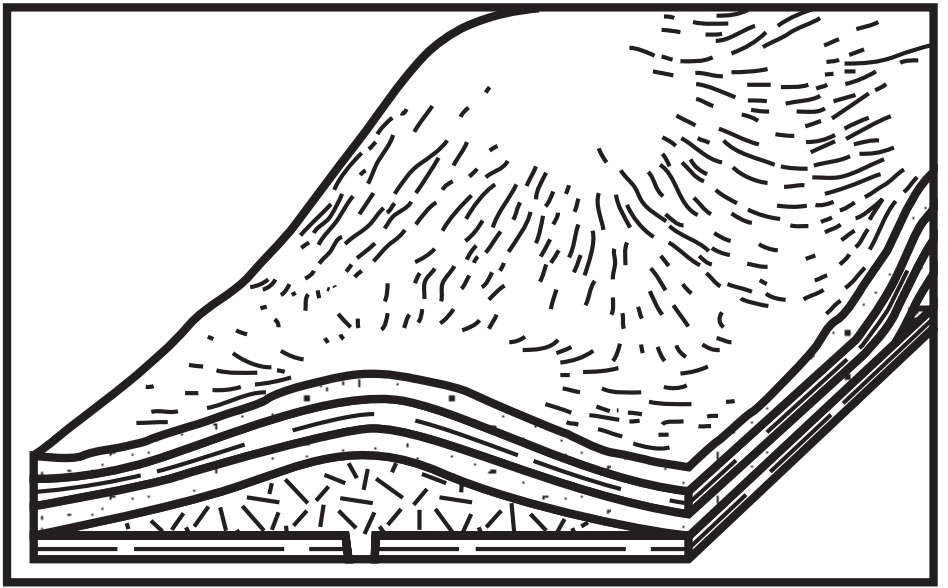
| Key |
| --- |
| — Mississippi watershed boundary |

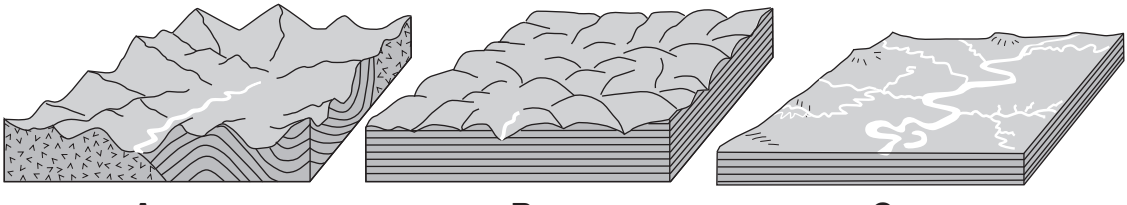




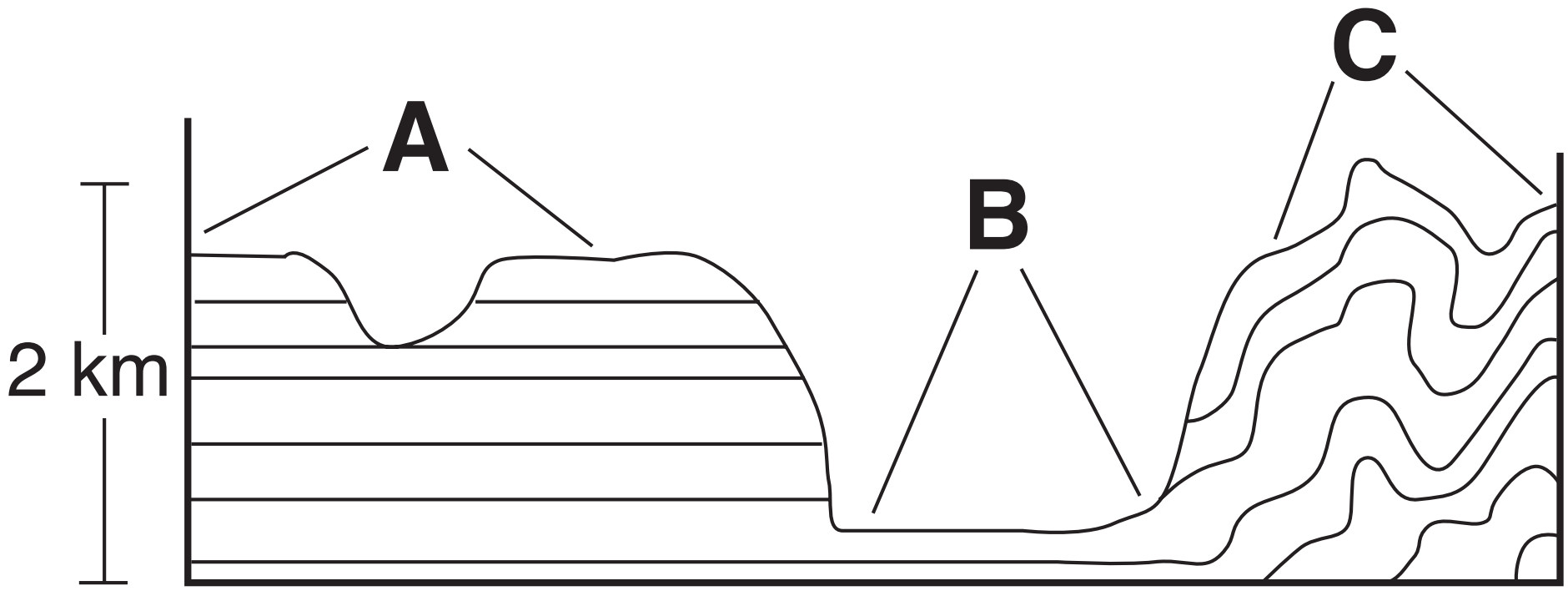
**Map**


Long Island Sound
Harbor Hill Moraine
Outwash
Ronkonkoma Moraine
Outwash
Atlantic
Ocean
A
B
C
D
E
F
G
H
N



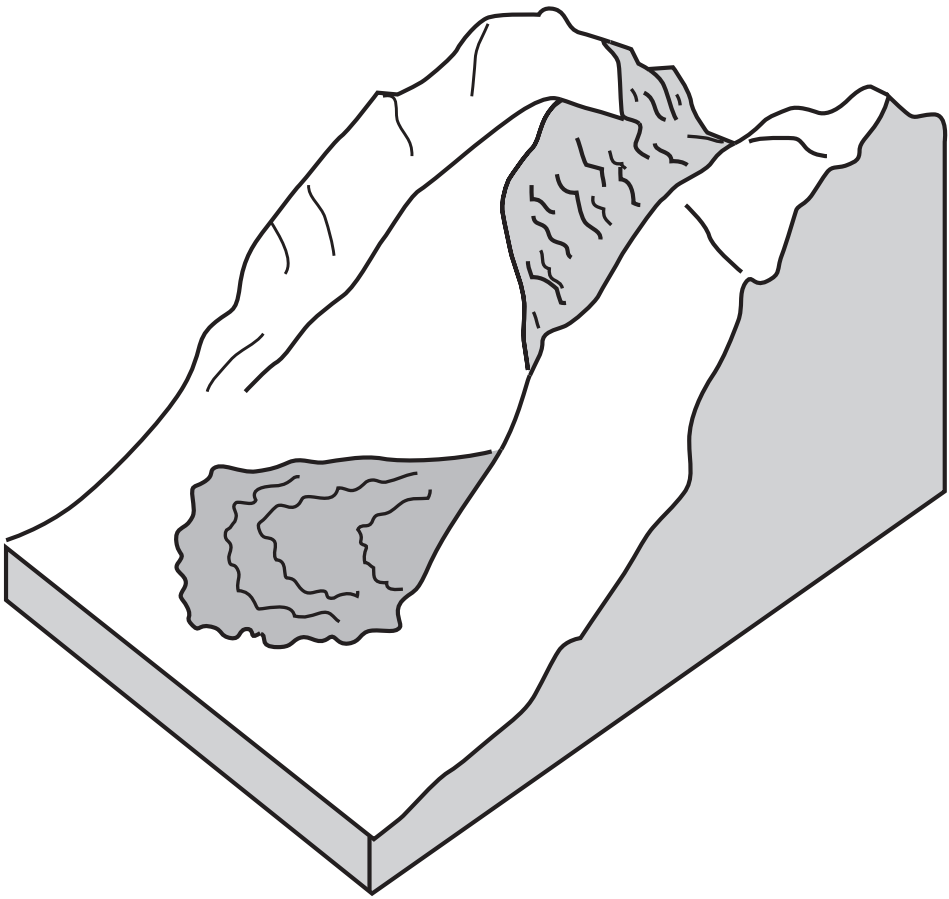

A
B
C

| Landscape | Bedrock | Elevation/Slopes | Streams |
|---|---|---|---|
| *A* | Faulted and folded gneiss and schist | High elevation<br>Steep slopes | High velocity<br>Rapids |
| *B* | Layers of sandstone and shale | Low elevation<br>Gentle slopes | Low velocity<br>Meanders |
| *C* | Thick horizontal layers of basalt | Medium elevation<br>Steep to gentle slopes | High to low velocity<br>Rapids and meanders |

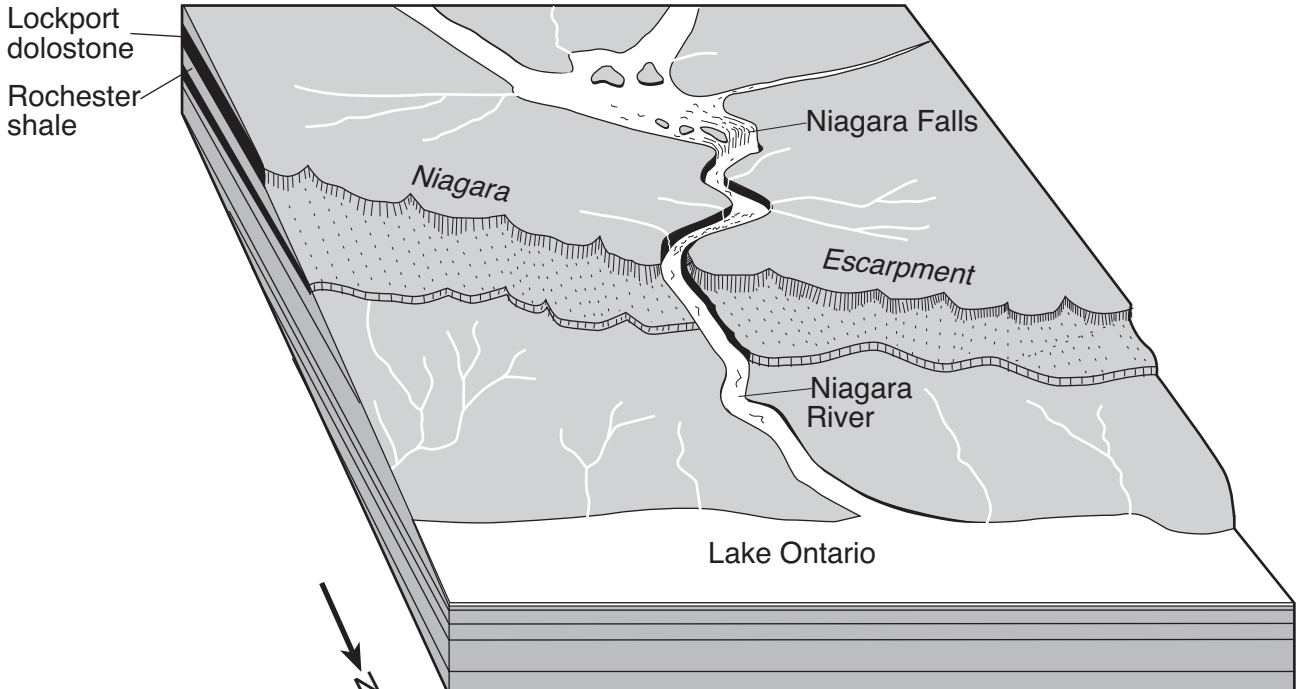



(Not drawn to scale)

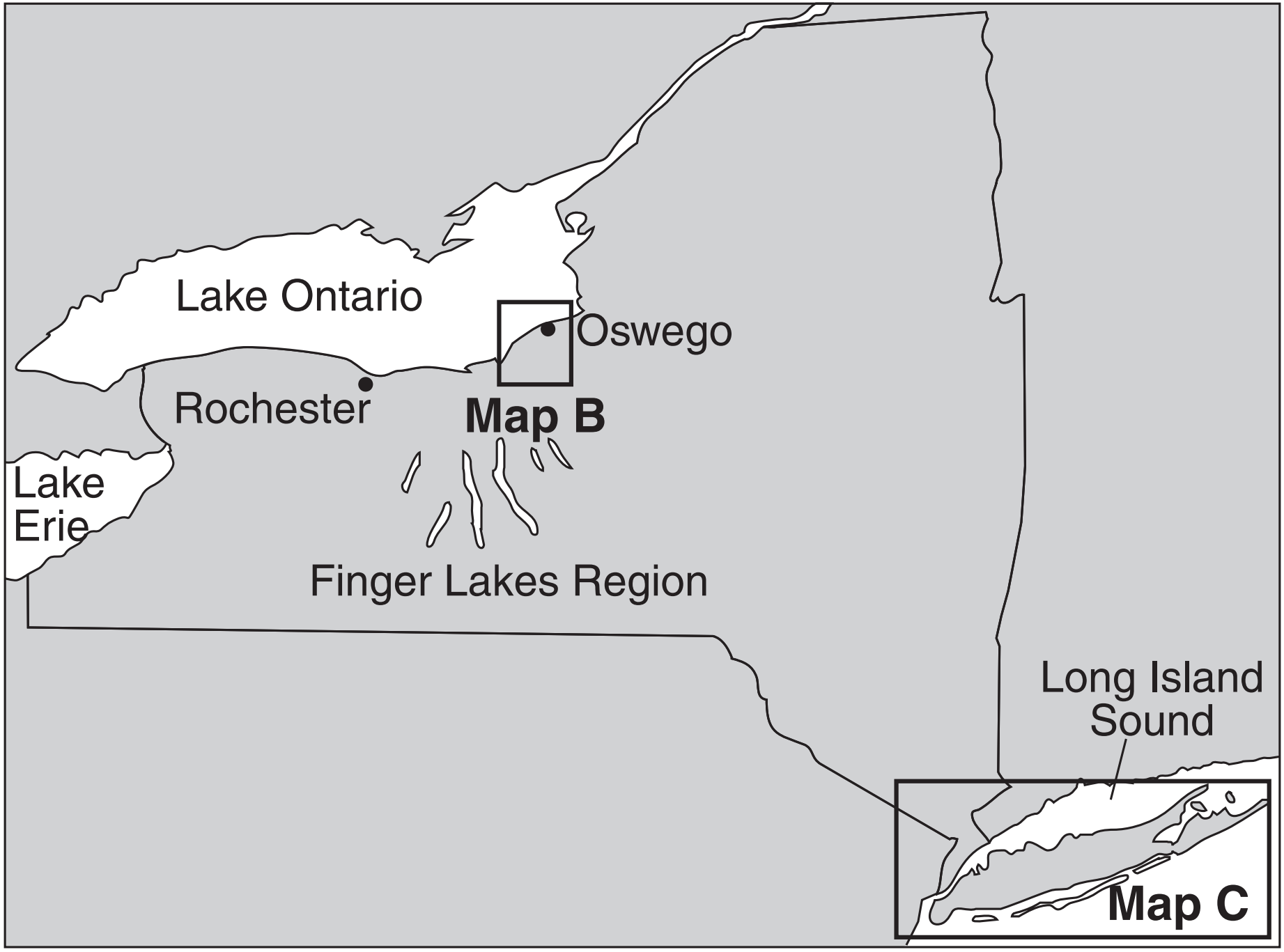
# Mud flow



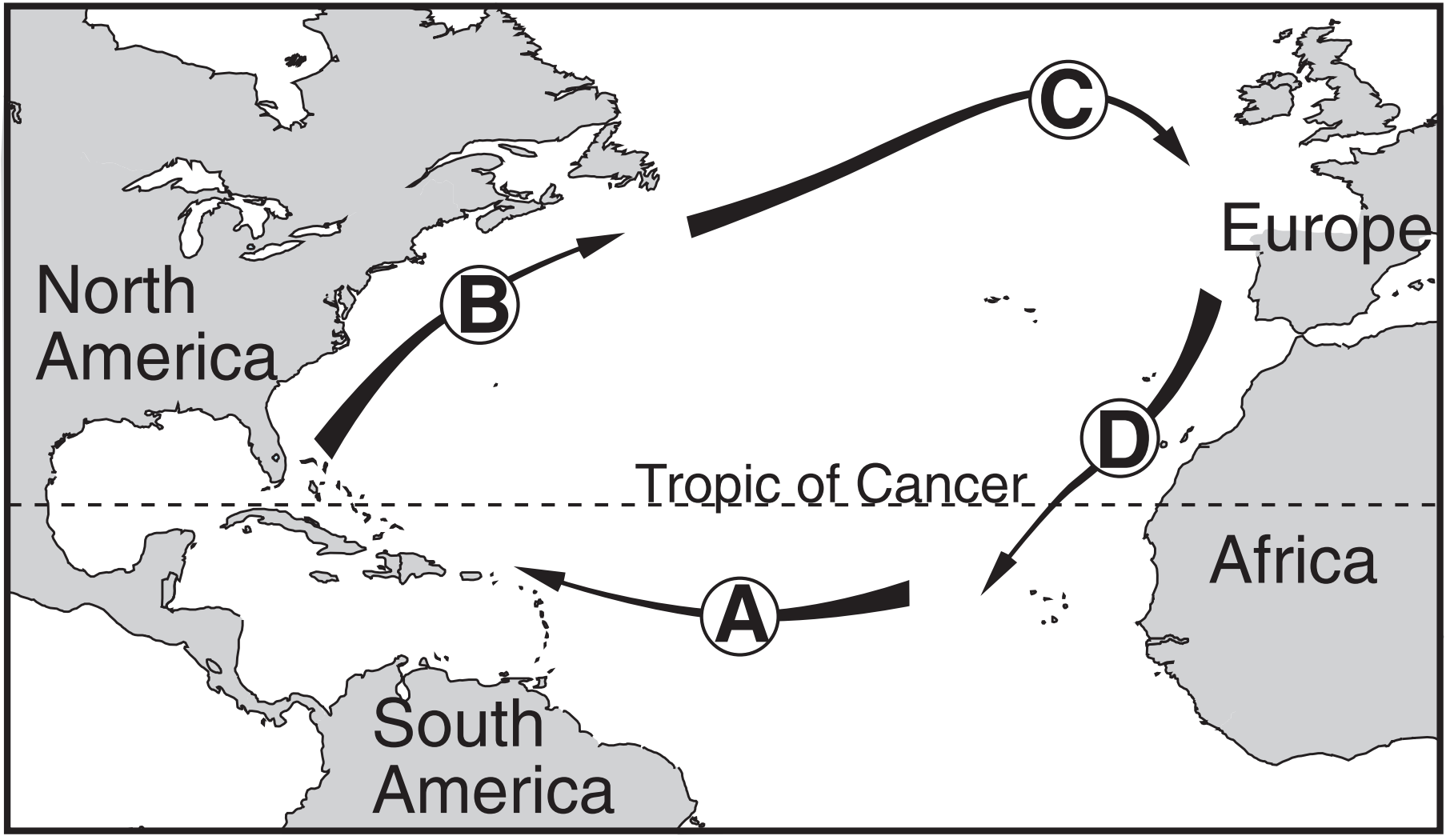
Downward flow of fine particles (mud) and large amounts of water

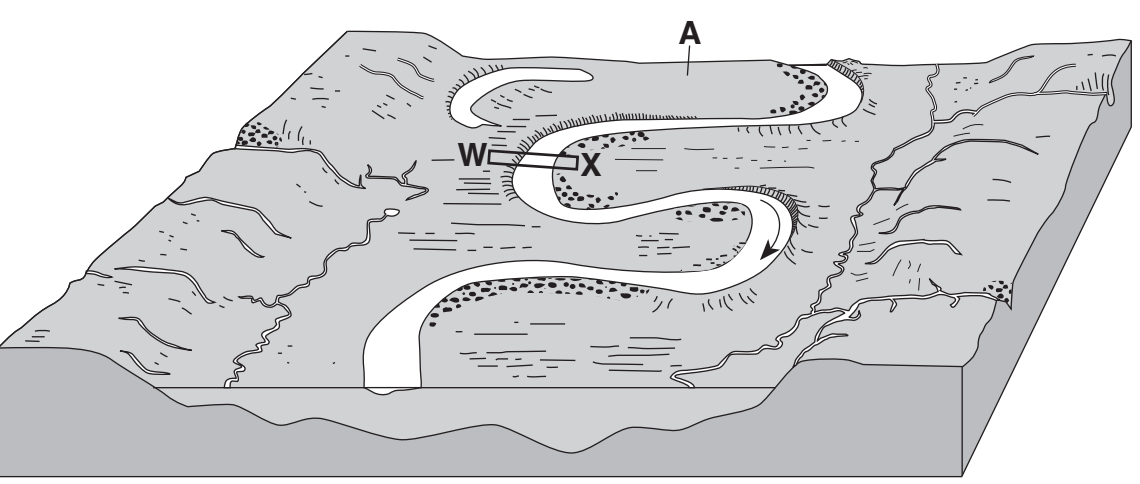

Lockport
dolostone
Rochester
shale
Niagara Falls
Niagara
Escarpment
Niagara
River
Lake Ontario
N

# Map A

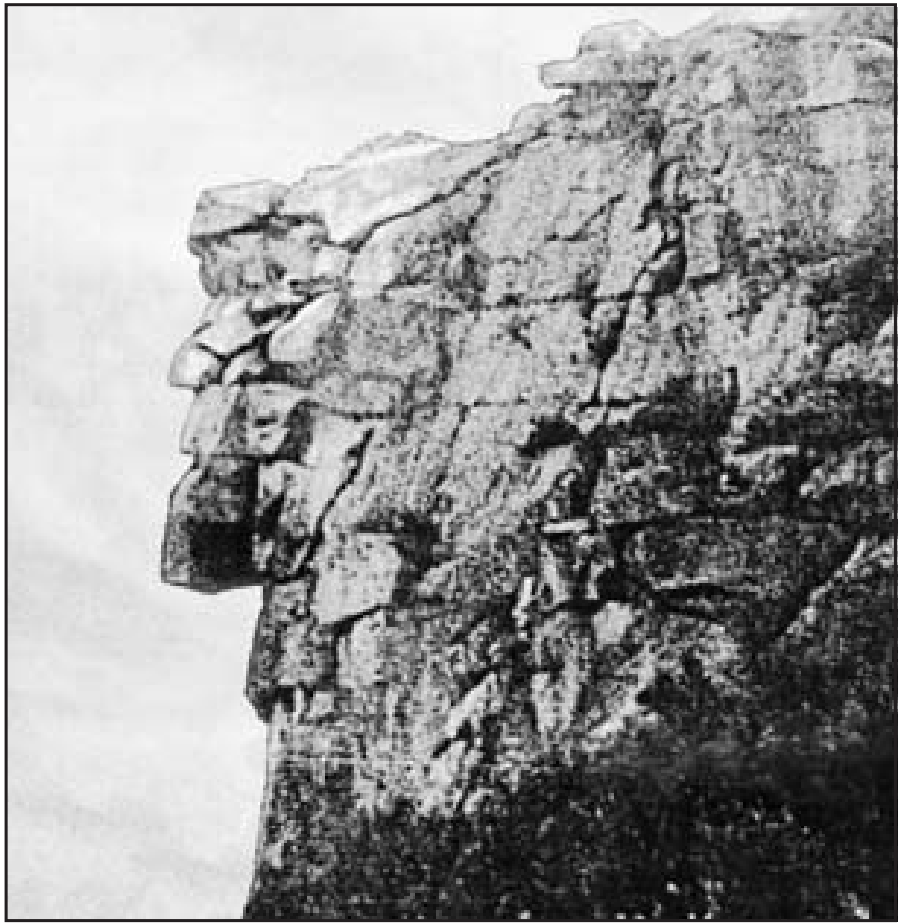

Lake Ontario
Oswego
Rochester
Map B
Lake
Erie
Finger Lakes Region
Long Island
Sound
Map C

## Watersheds


C
Europe
North
America
B
D
Tropic of Cancer
Africa
A
South
America

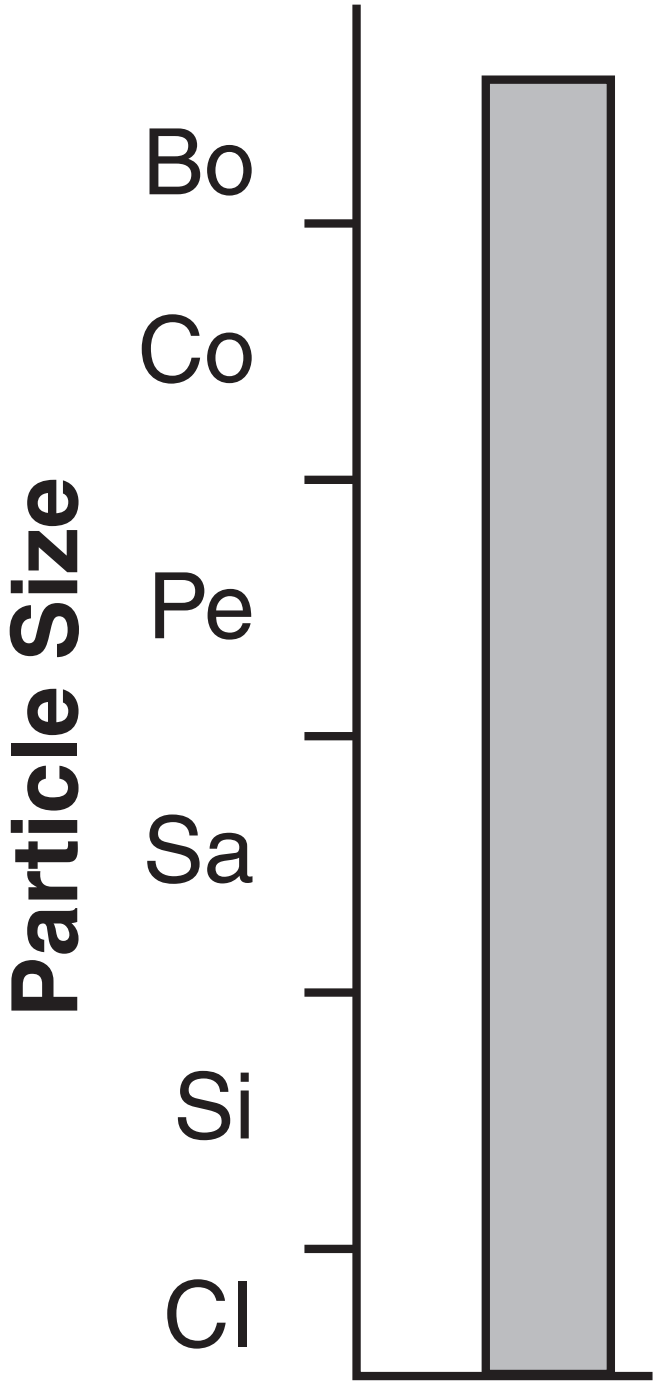


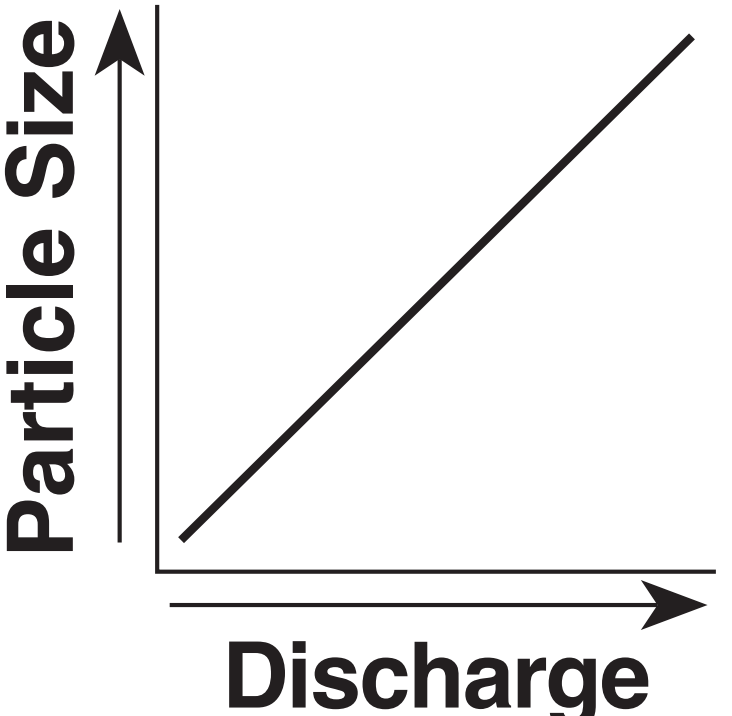

(Not drawn to scale)

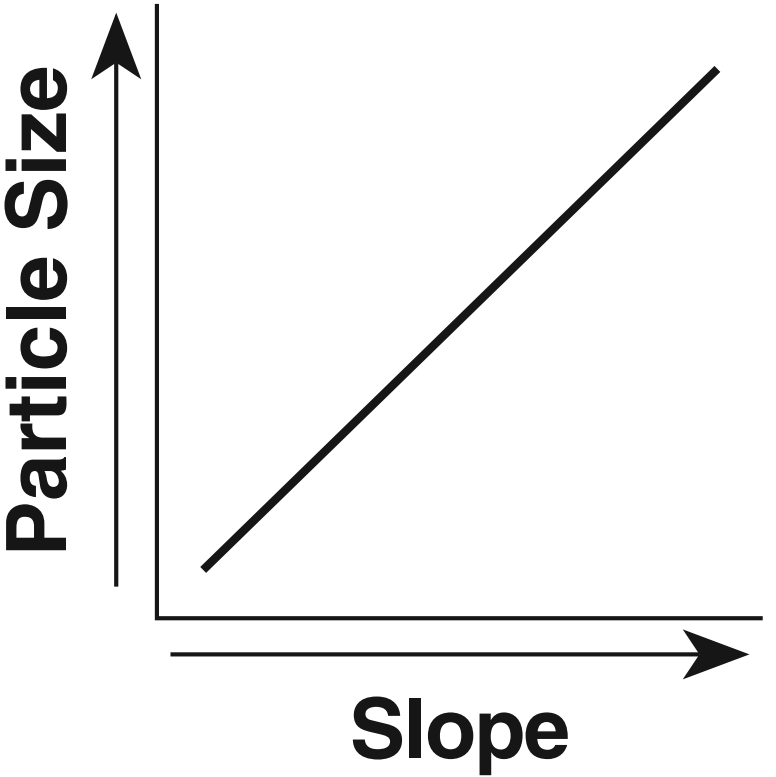


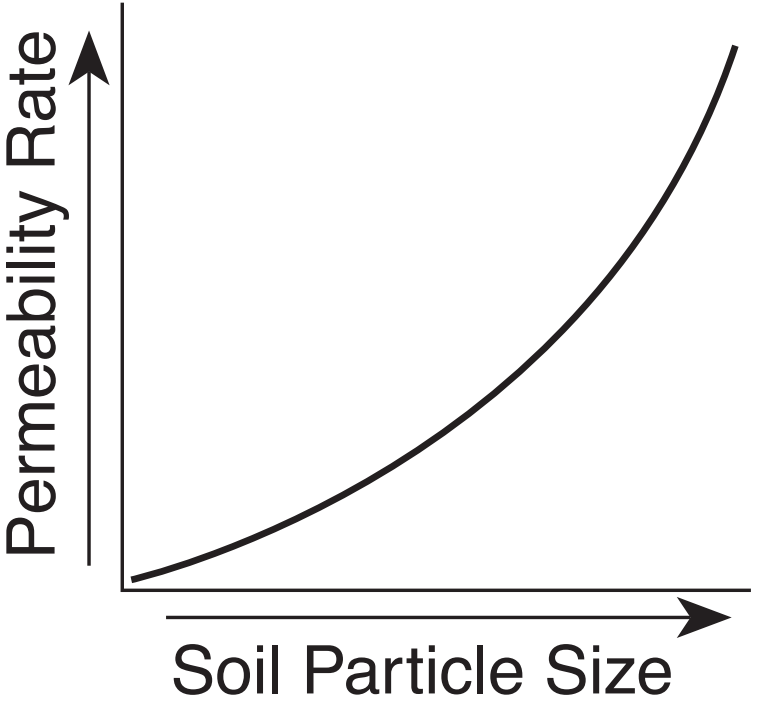
Associated Press

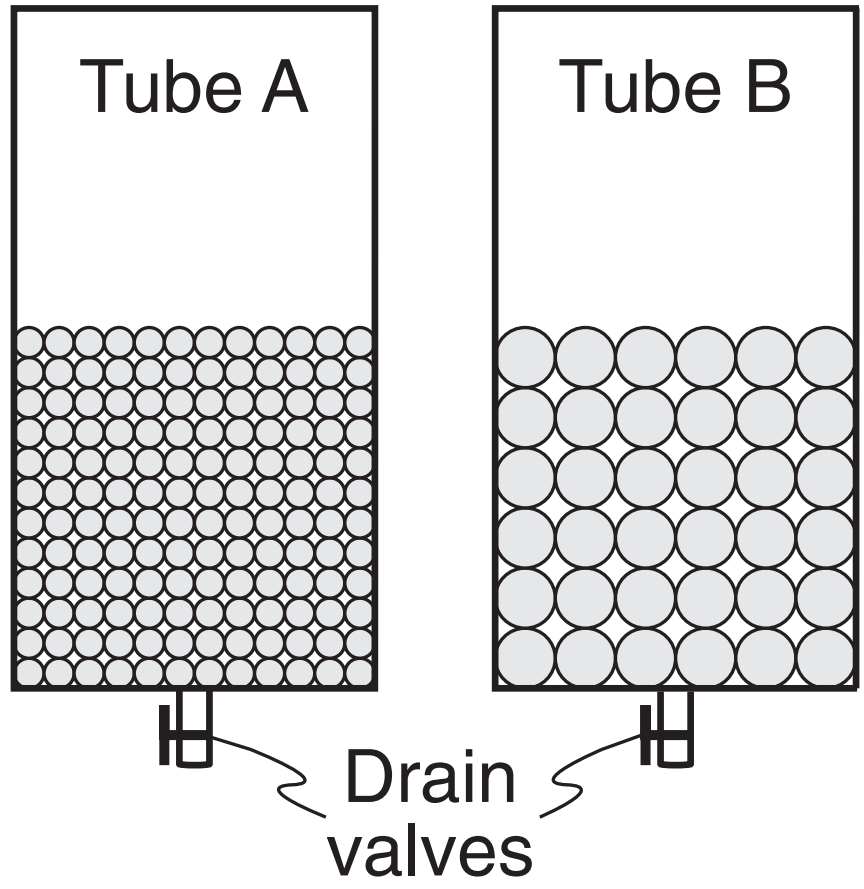
Granite profile of the Old Man of the Mountain is shown before the collapse, and after


Particle Size
Bo
Co
Pe
Sa
Si
Cl

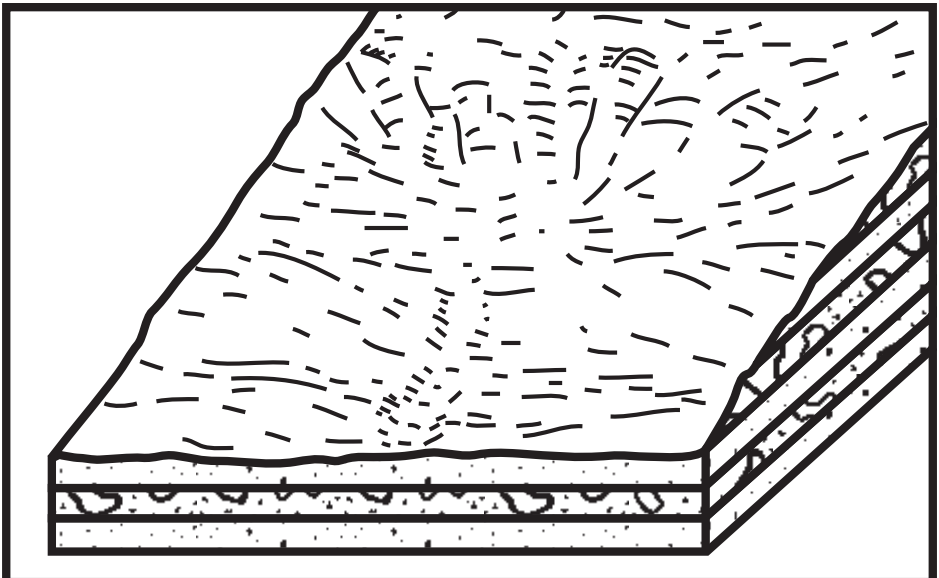

Particle Size
Discharge

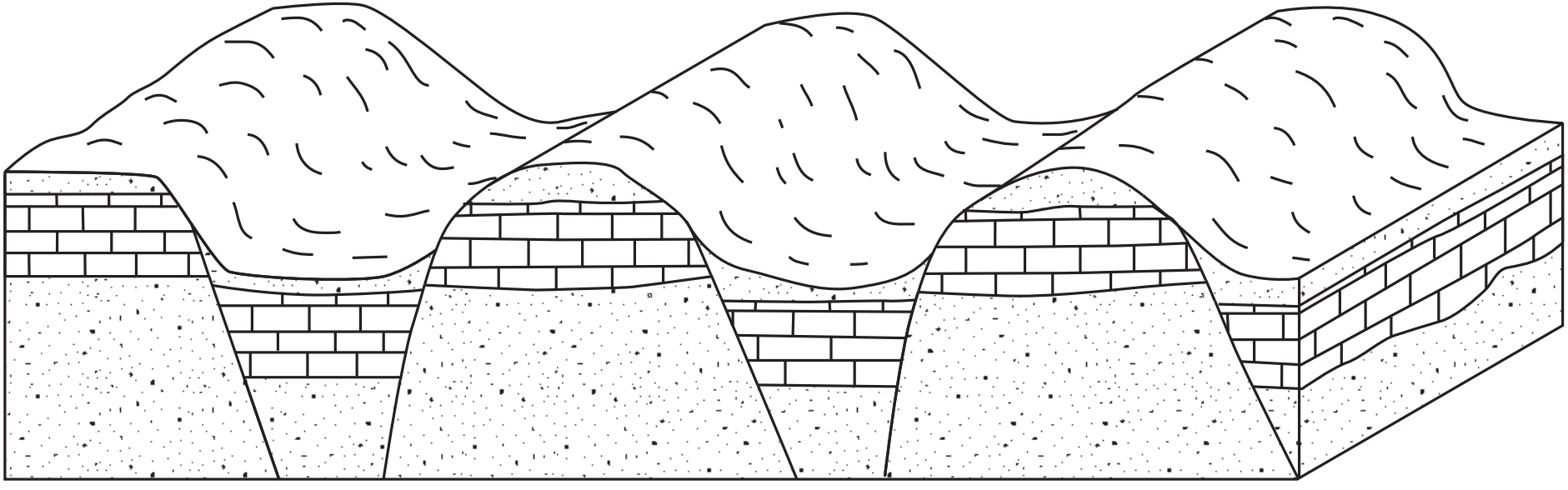

Particle Size
Slope

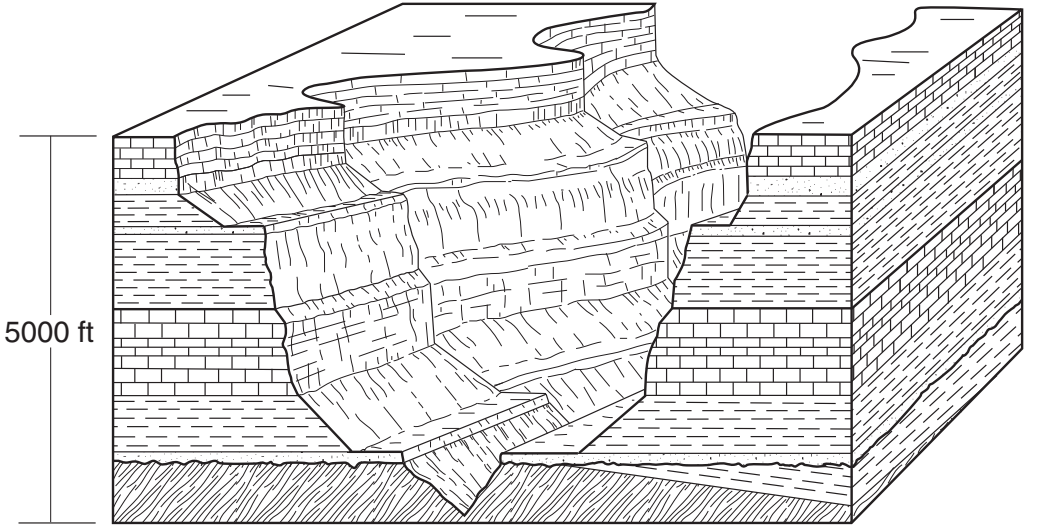

Permeability Rate
Soil Particle Size

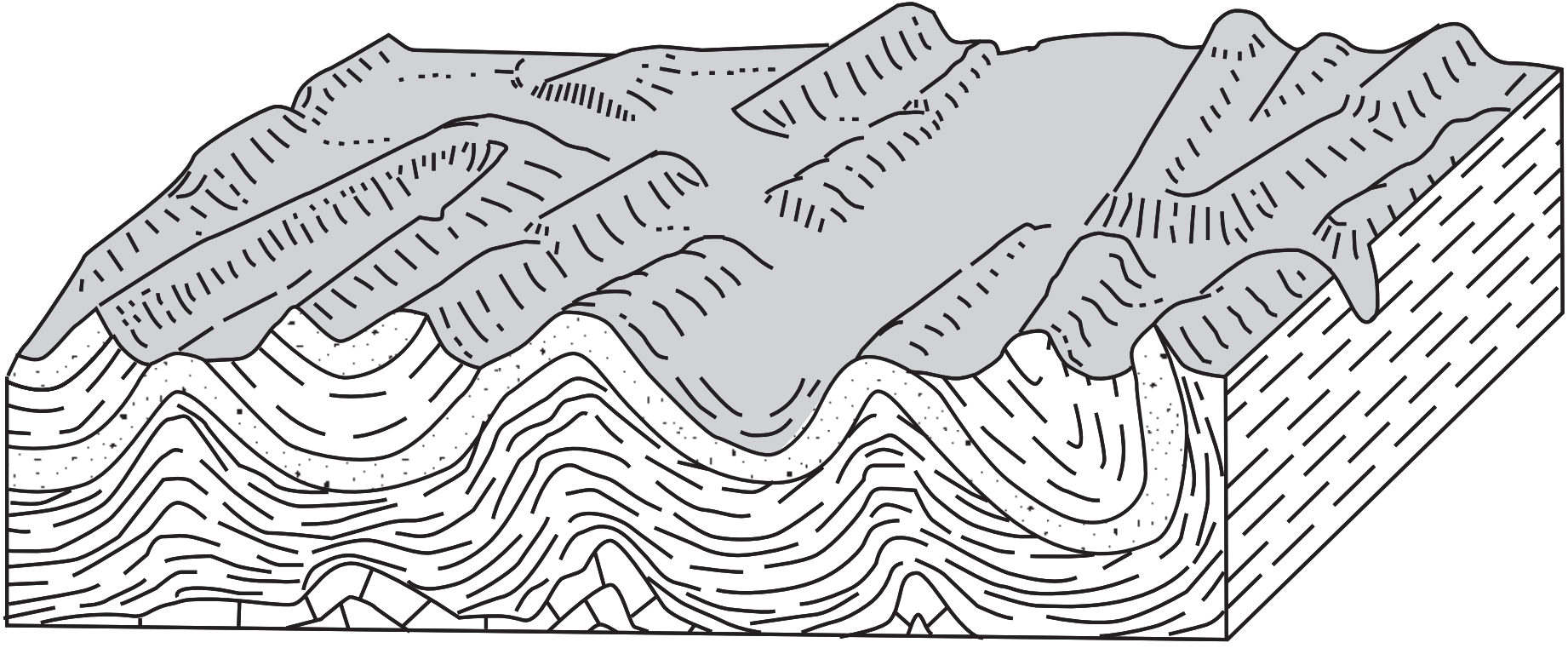


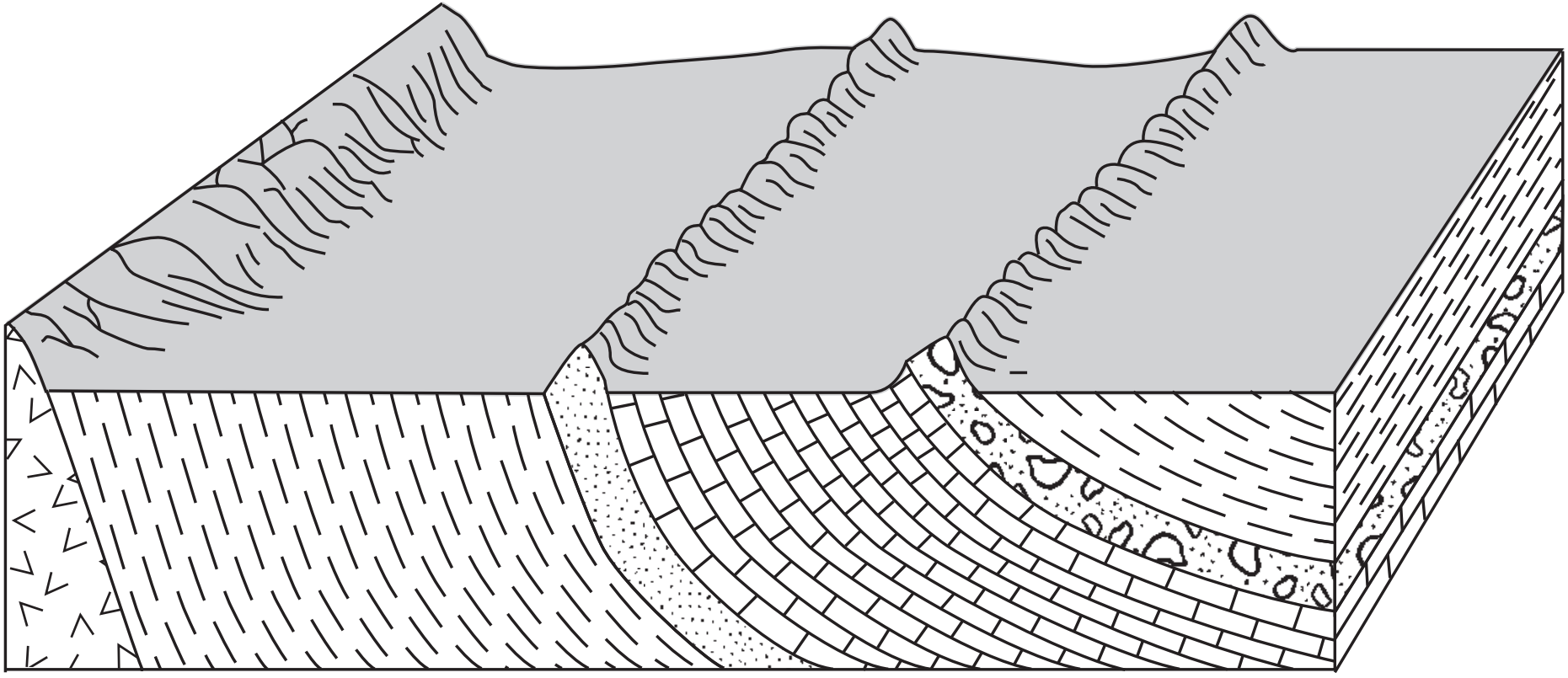

| Data Table 1: Tube A | |
|---|---|
| water required to fill pore spaces | 124 mL |
| time required for draining | 2.1 sec |
| water that remained around the beads after draining | 36 mL |

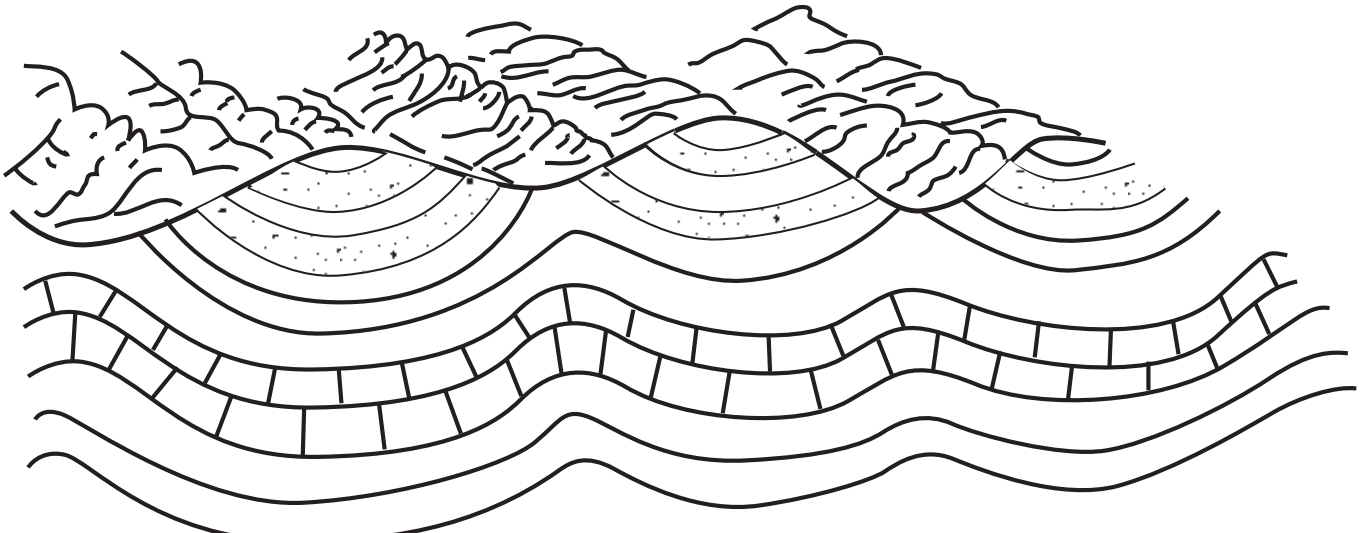


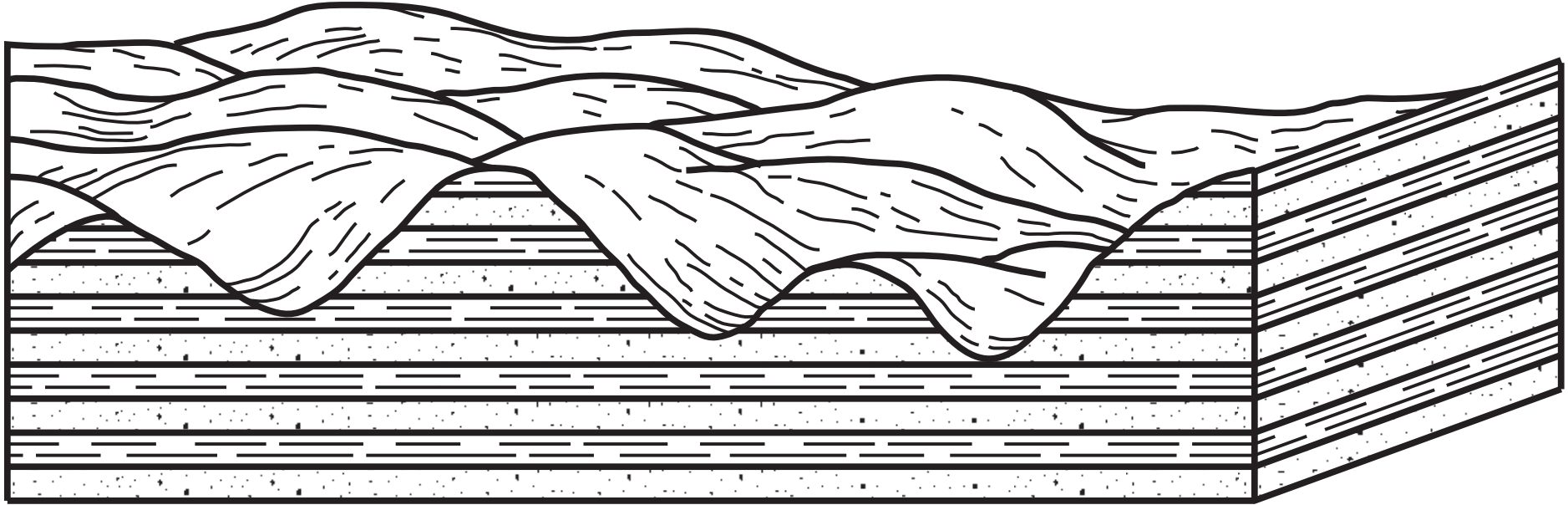


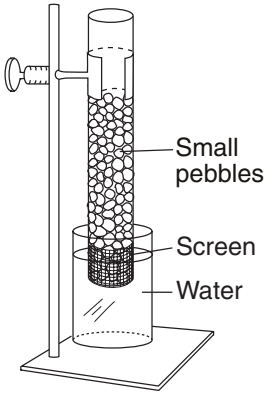

5000 ft



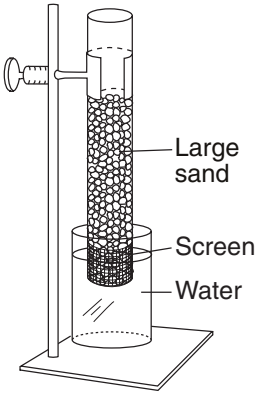




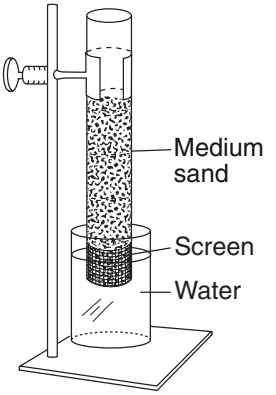




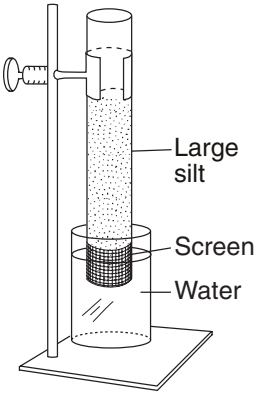

Column A



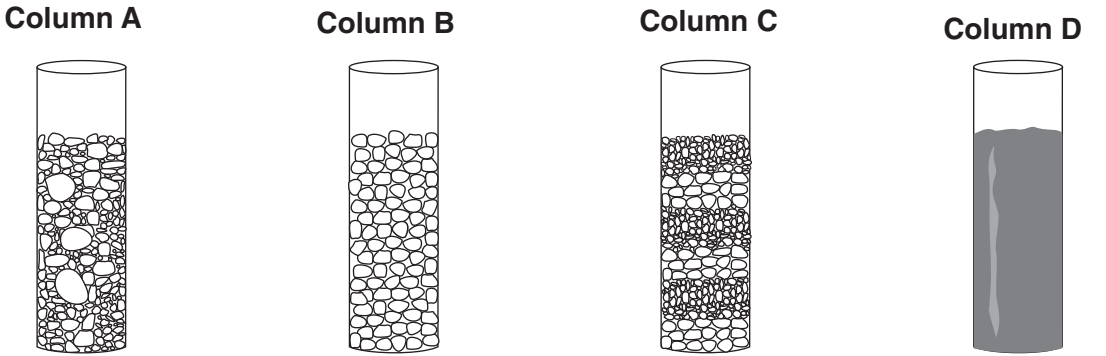

Column B

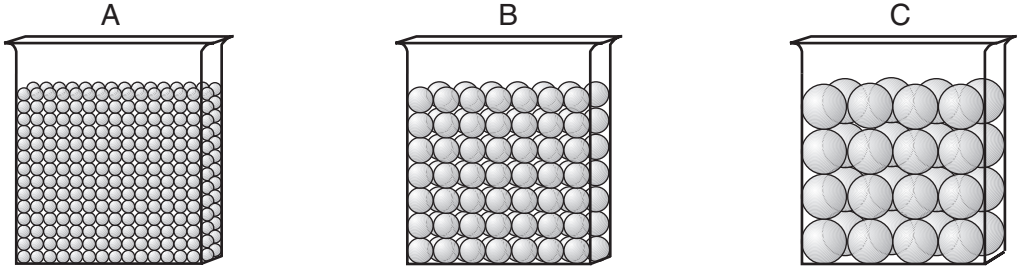


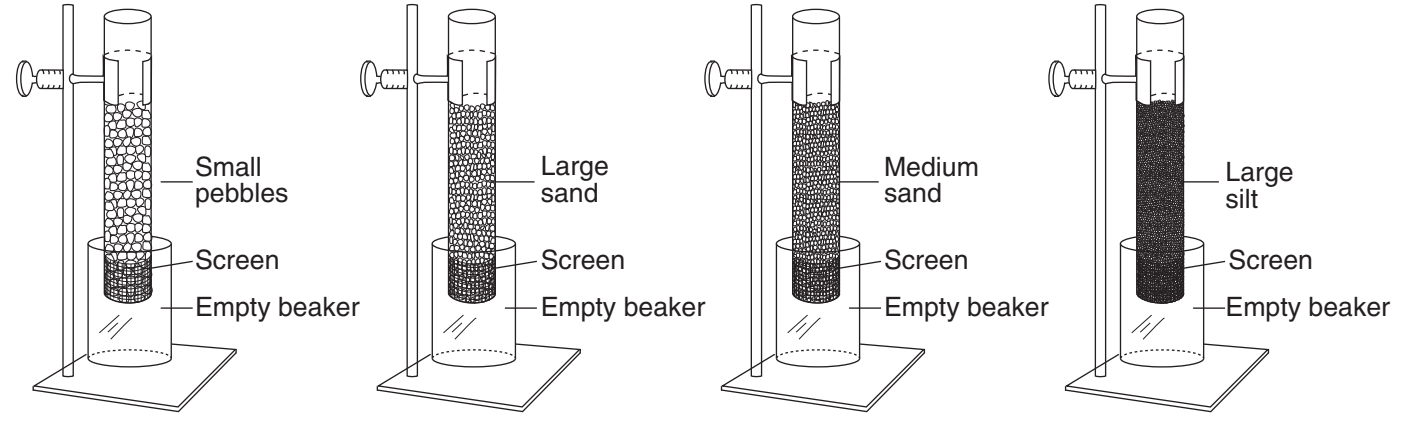

Column C



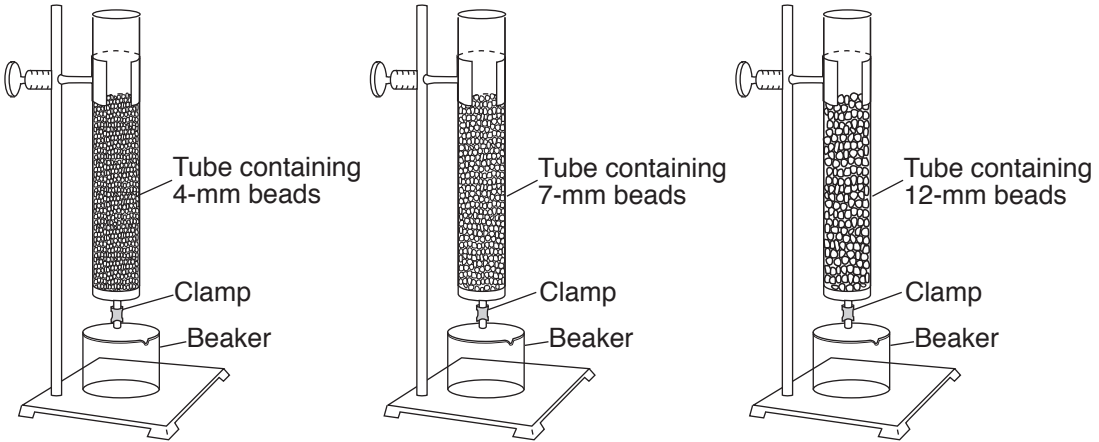

Column D

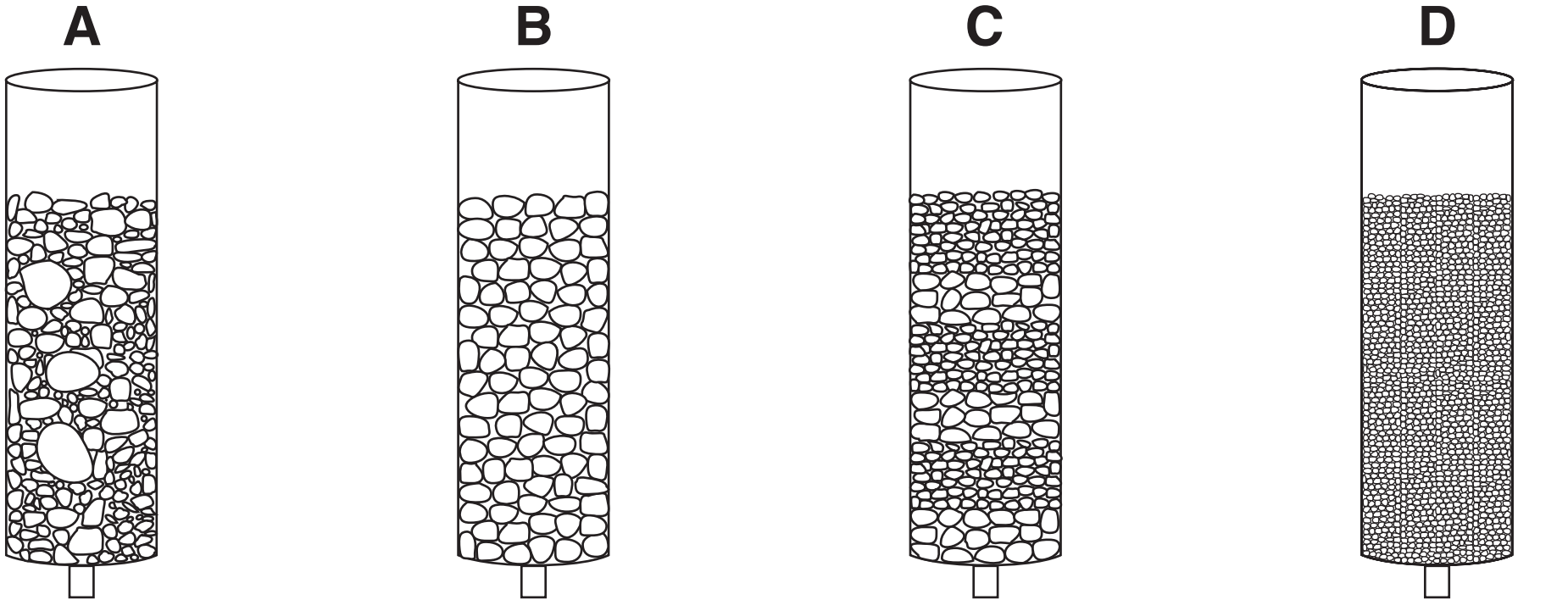

Column A
Column B
Column C
Column D
Mixed particles (0.00001 cm to 0.5 cm in size)
Uniform-sized particles (0.2 cm)
Sorted particles (0.0001 cm to 0.2 cm in size)
Dry mud (Smaller than 0.0004 cm in size)
(Not drawn to scale)

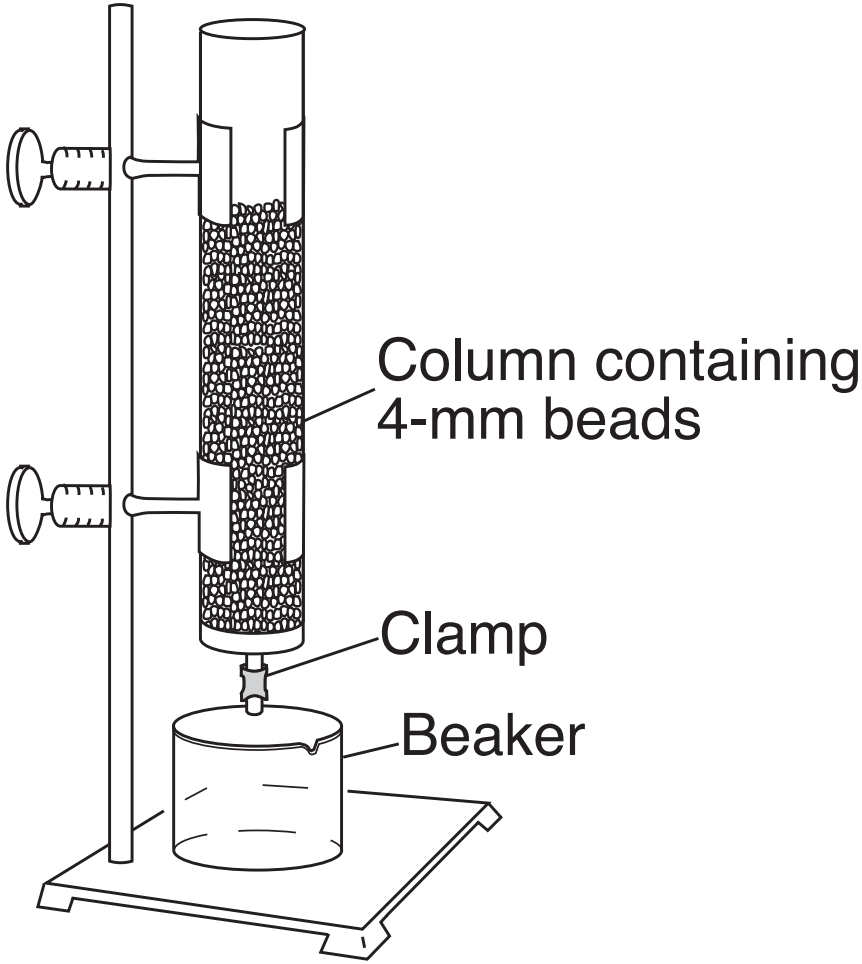

A
B
C

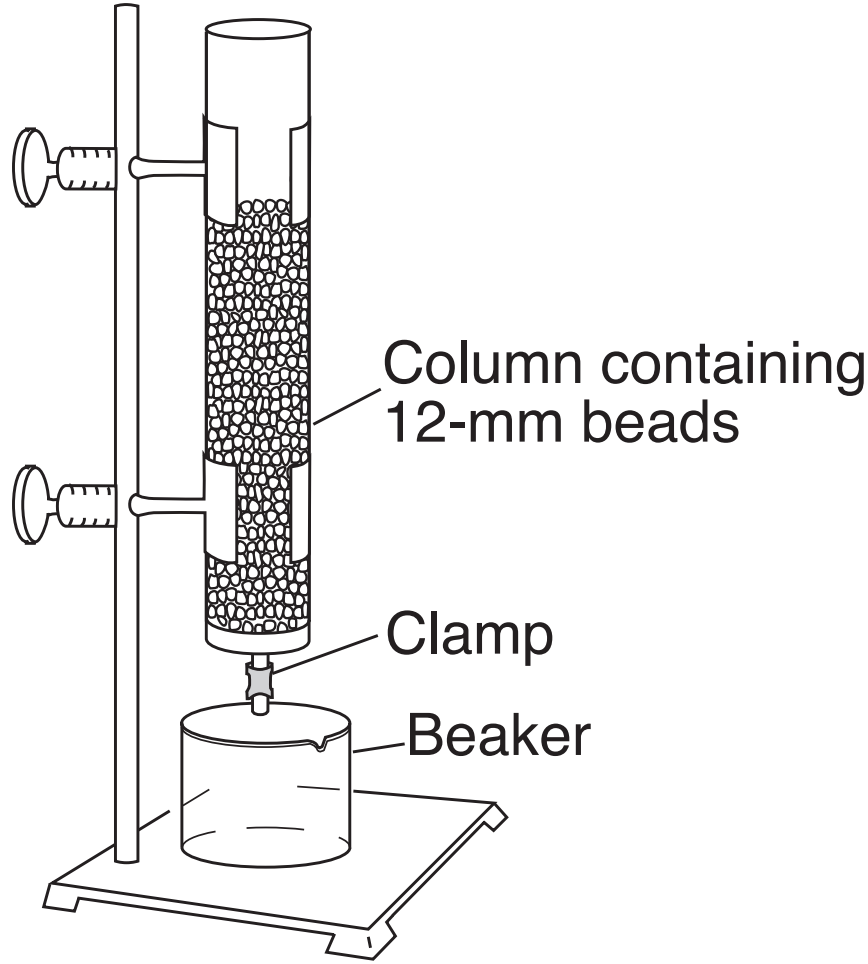


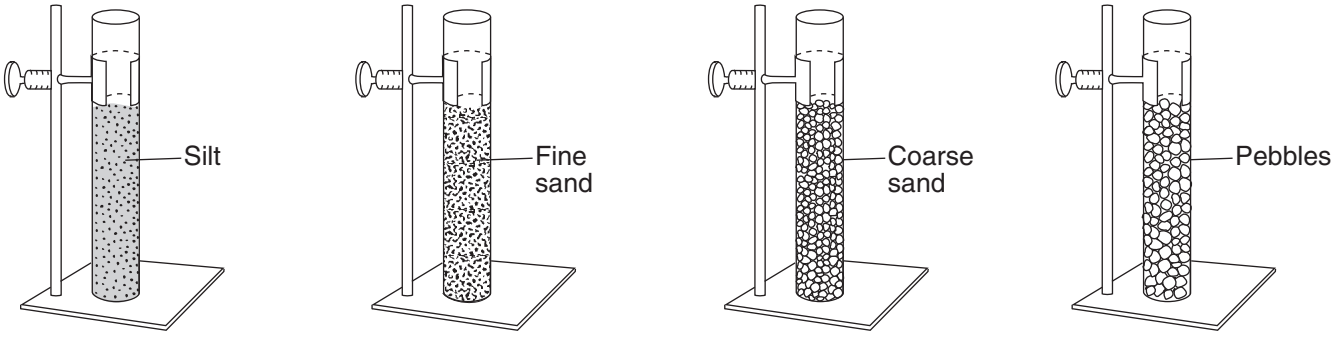

**Column A** **Column B** **Column C** **Column D**


Tube containing
4-mm beads
Clamp
Beaker
Tube containing
7-mm beads
Clamp
Beaker
Tube containing
12-mm beads
Clamp
Beaker

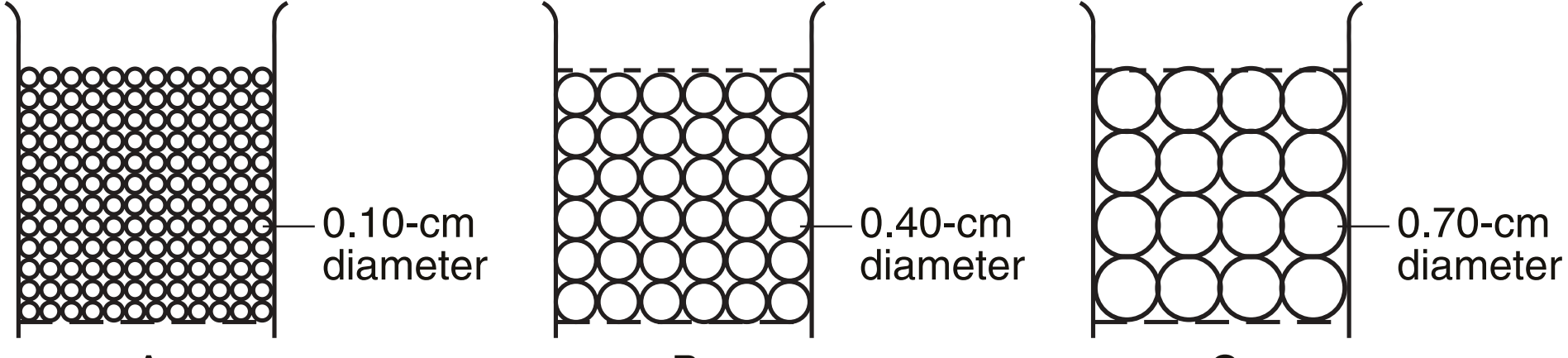

A
B
C
D
Mixed particles (0.001 cm to 0.5 cm in size)
Uniform-sized particles (0.2 cm)
Sorted particles (0.001 cm and 0.2 cm in size)
Uniform-sized particles (0.0004 cm)

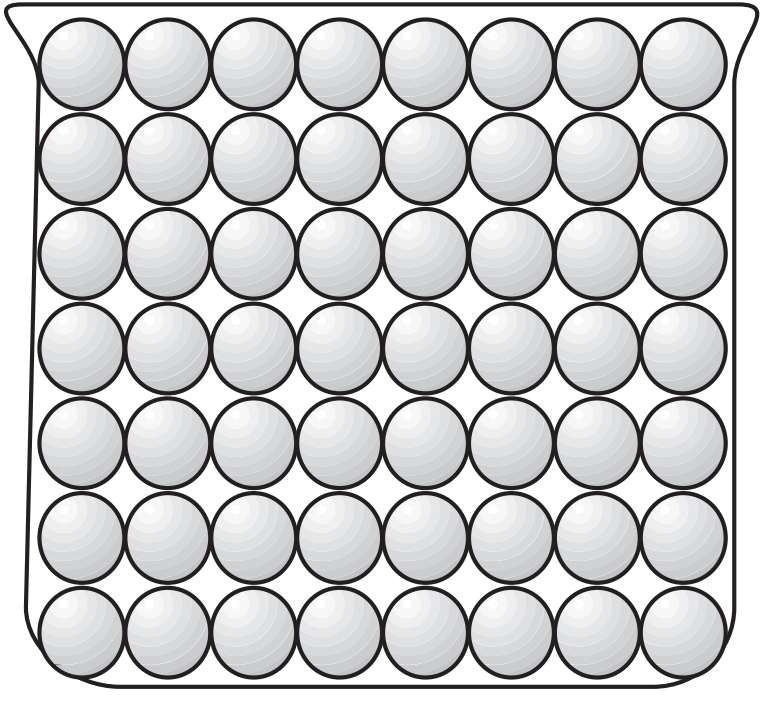

Column containing
4-mm beads
Clamp
Beaker

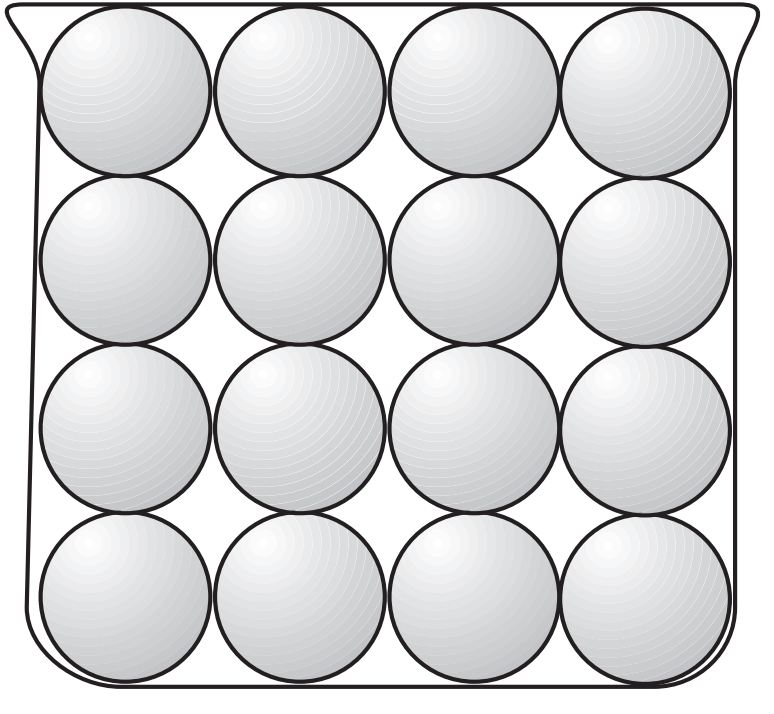

Column containing
12-mm beads
Clamp
Beaker

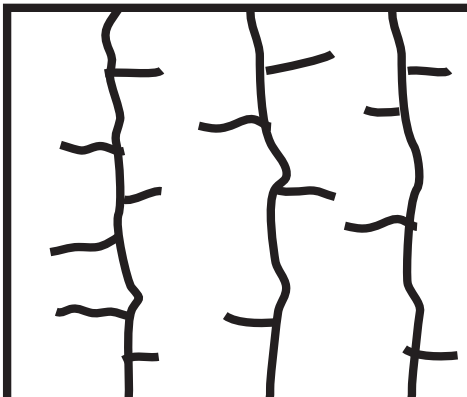


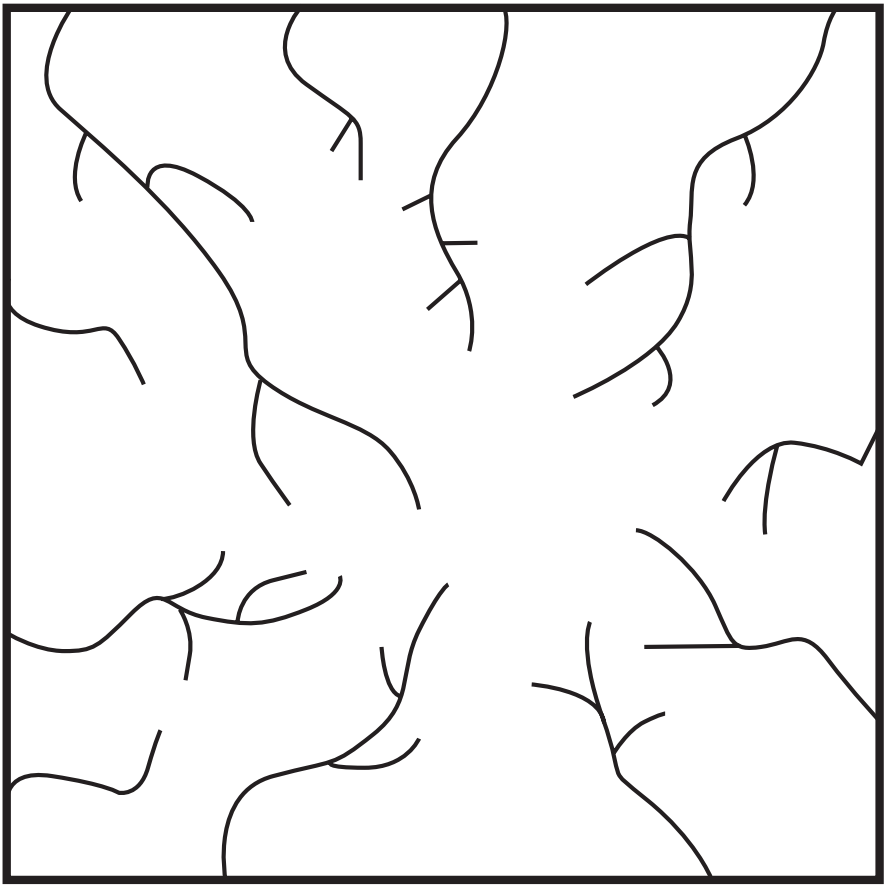

(Not drawn to scale)

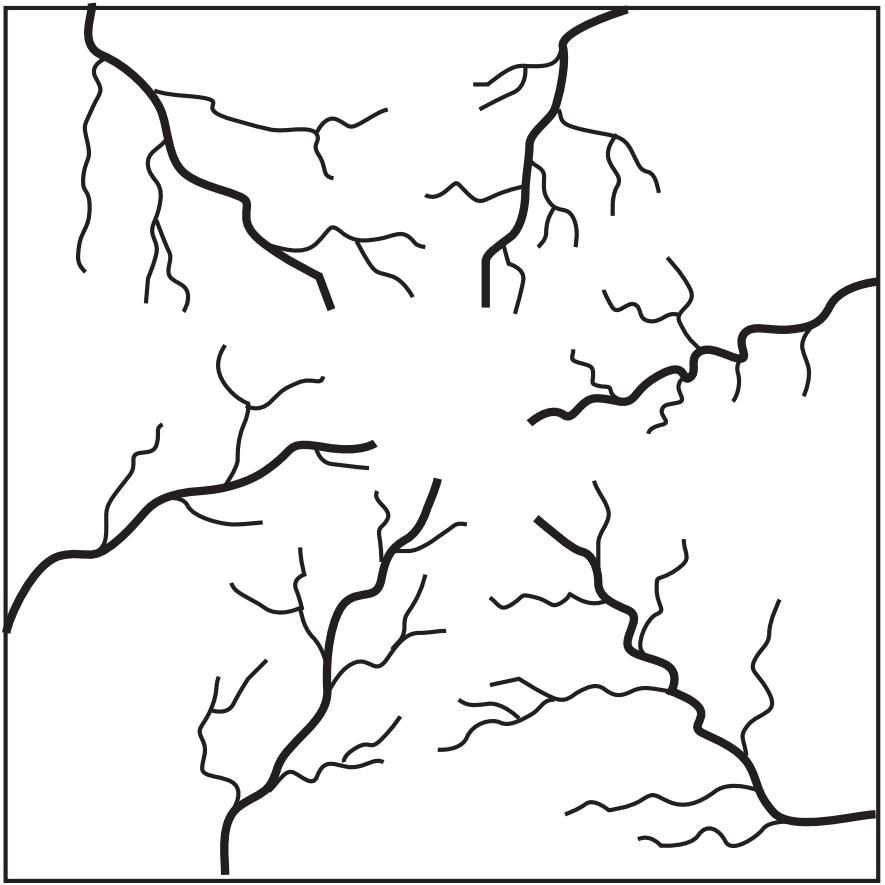

0.10-cm
diameter
A
0.40-cm
diameter
B
0.70-cm
diameter
C

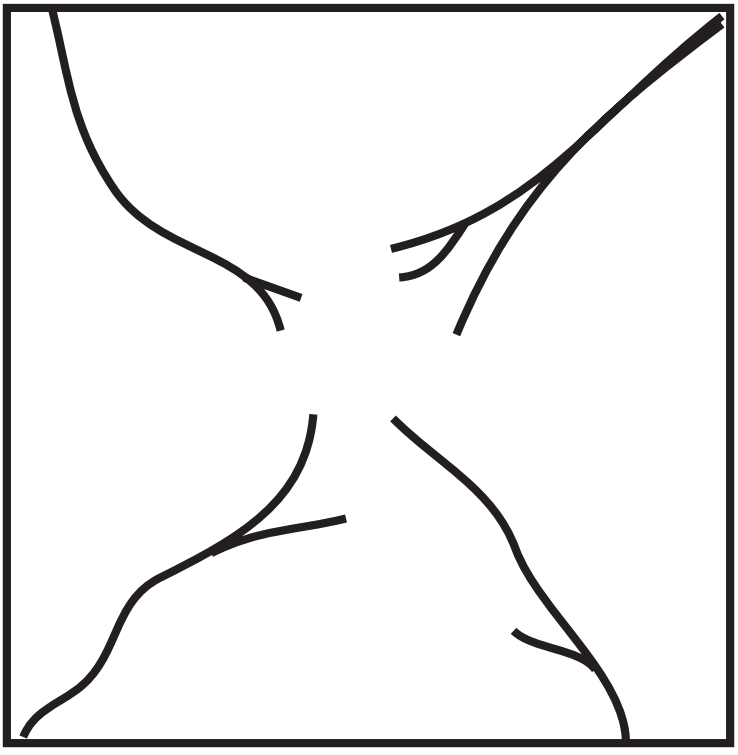


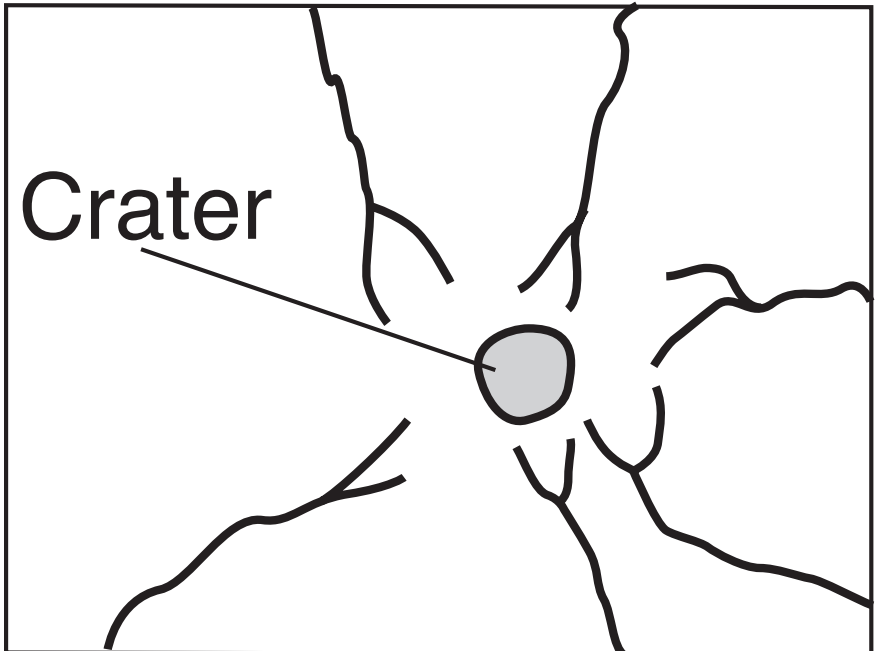


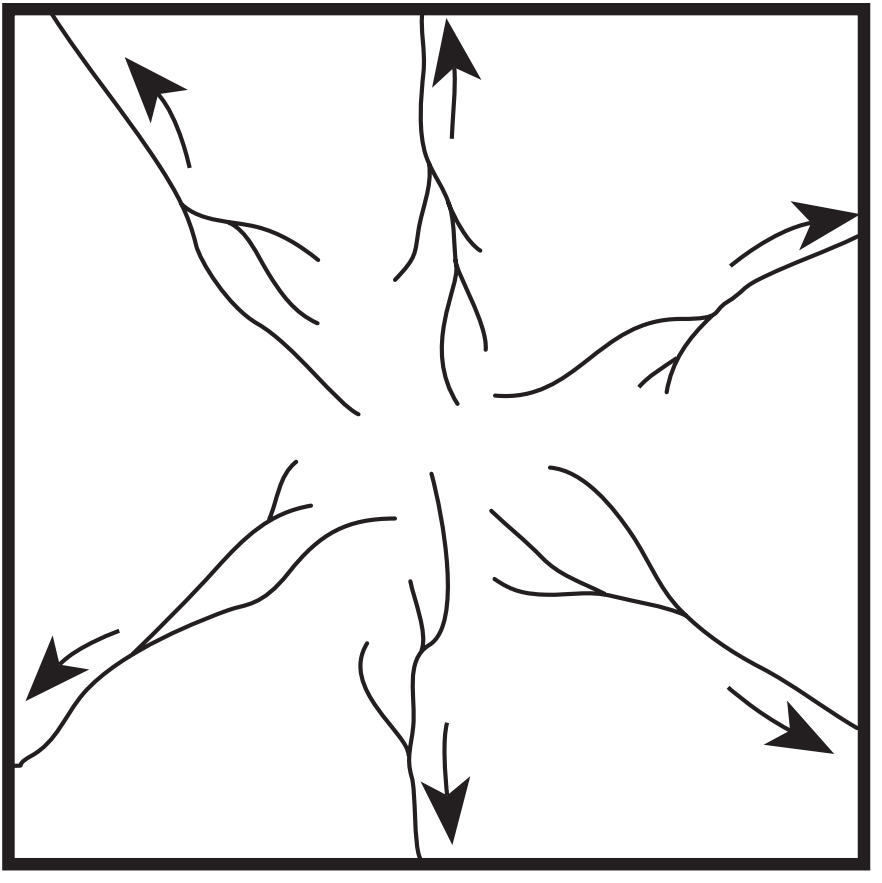


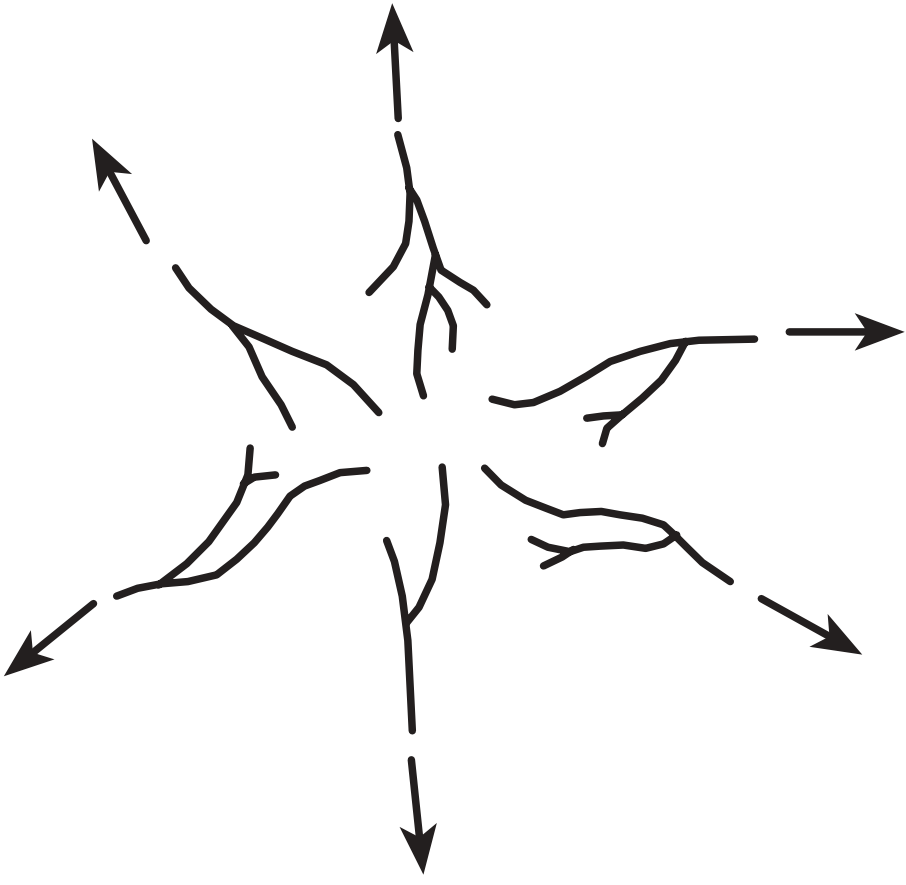


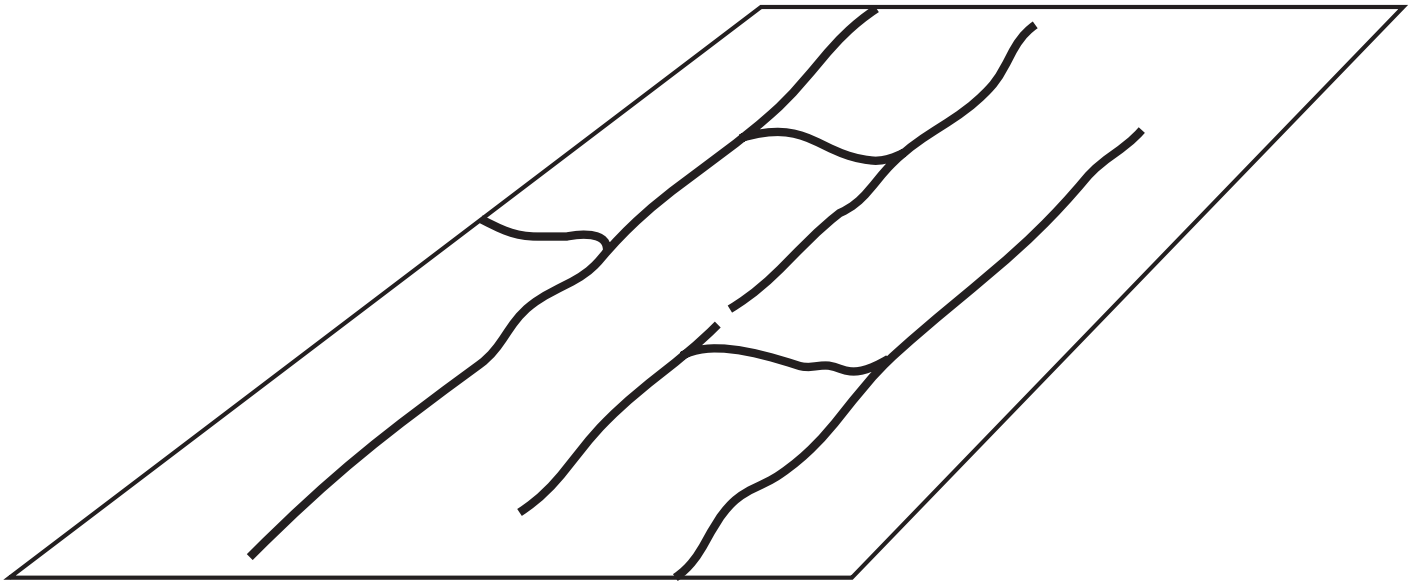


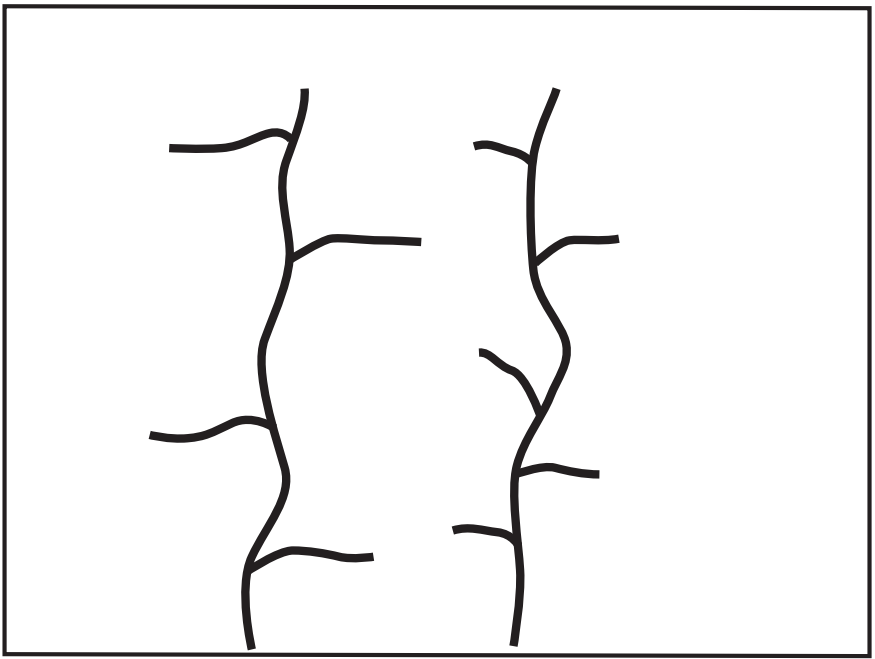


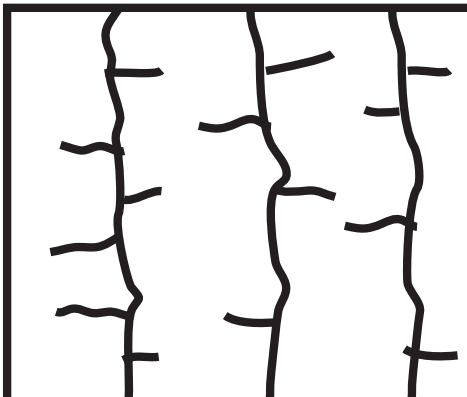

Crater

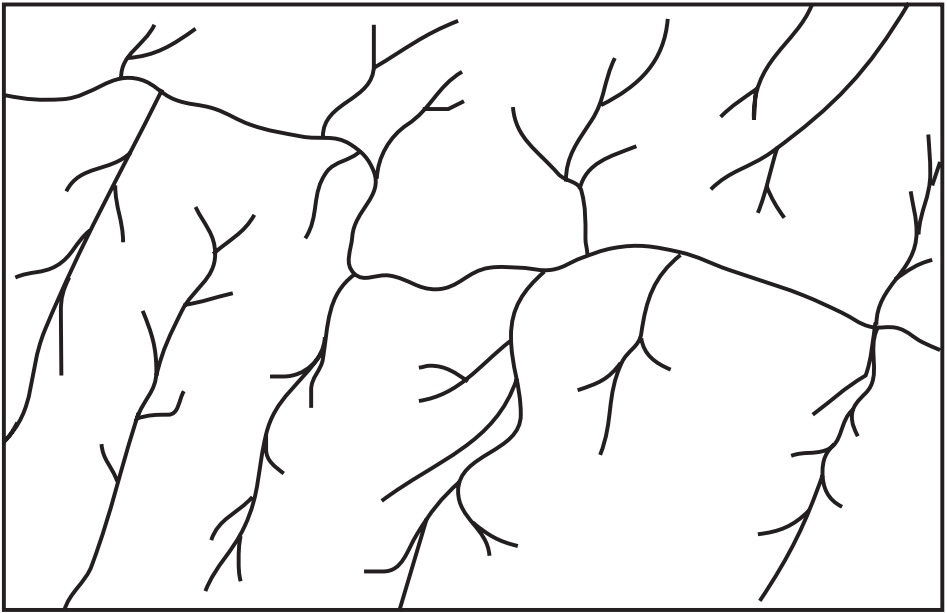


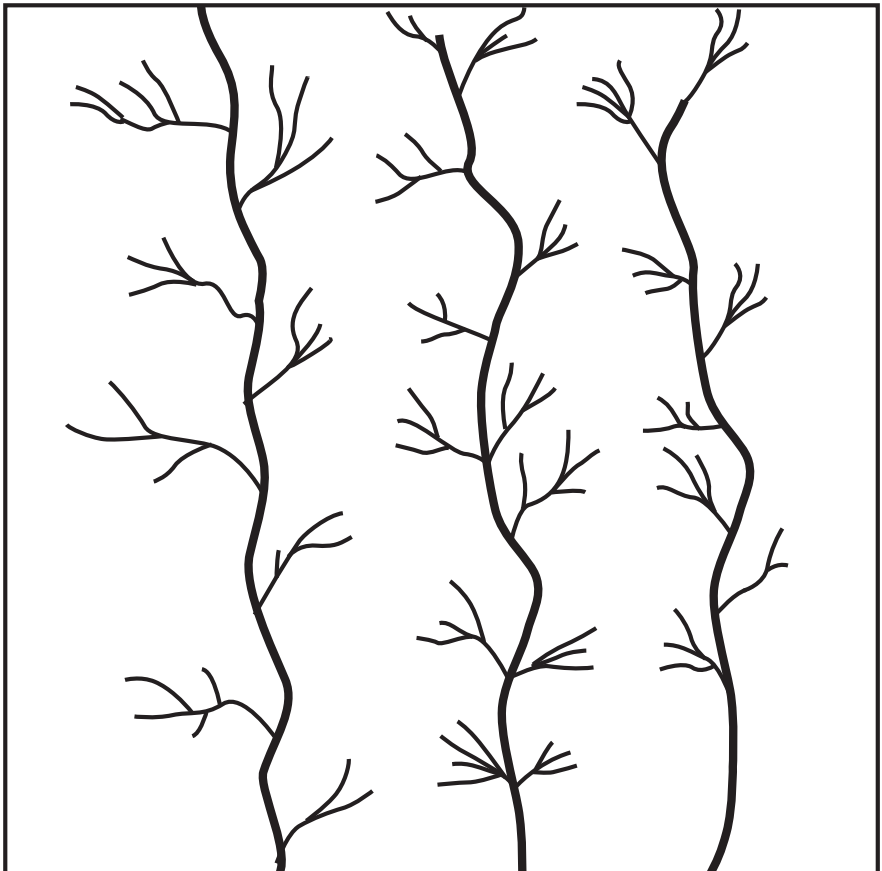


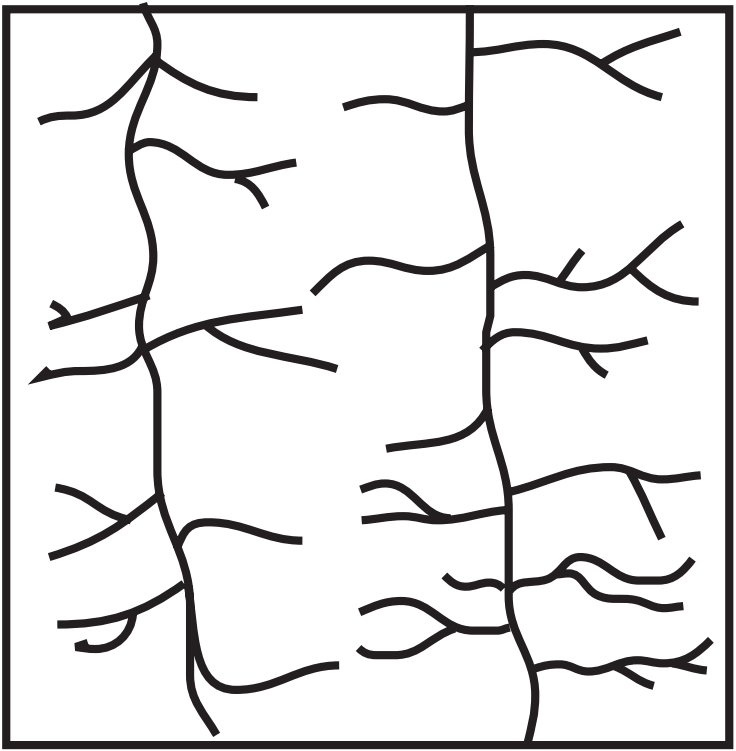


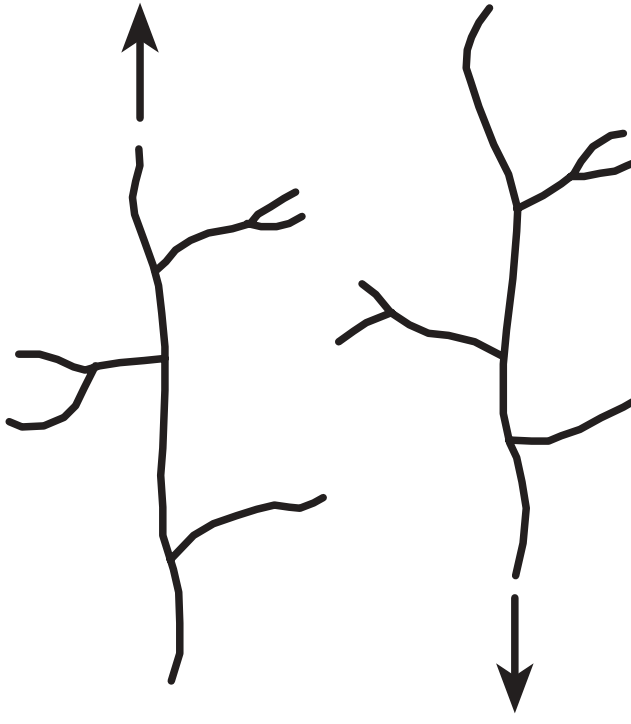


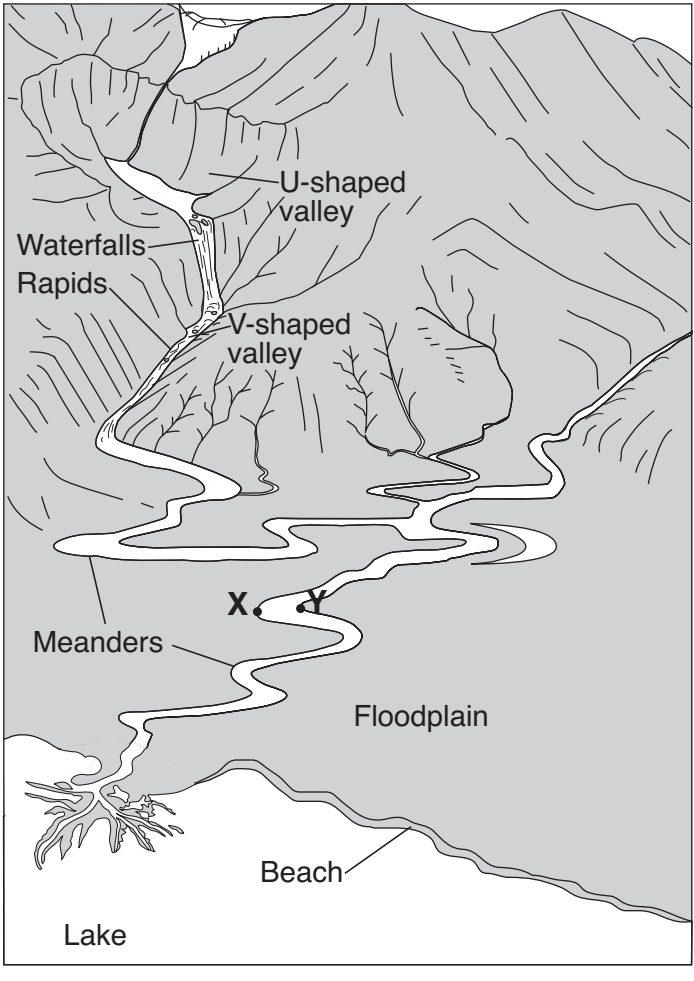




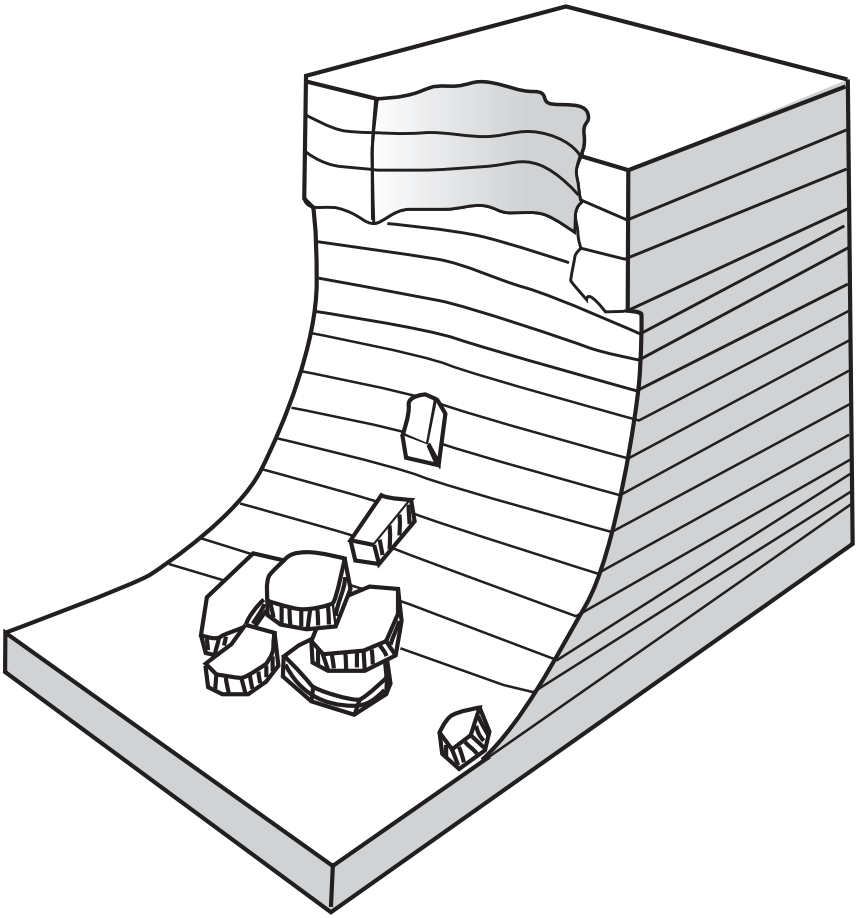




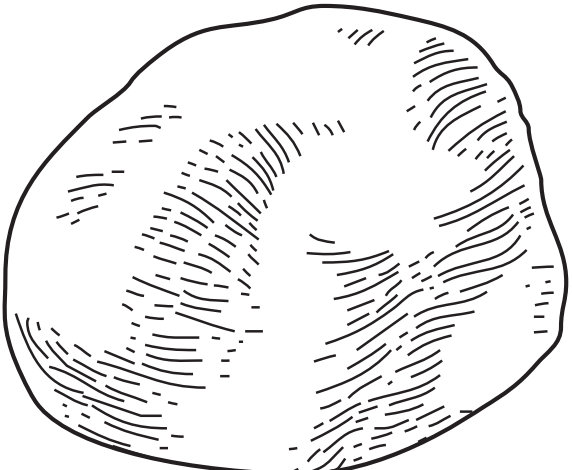


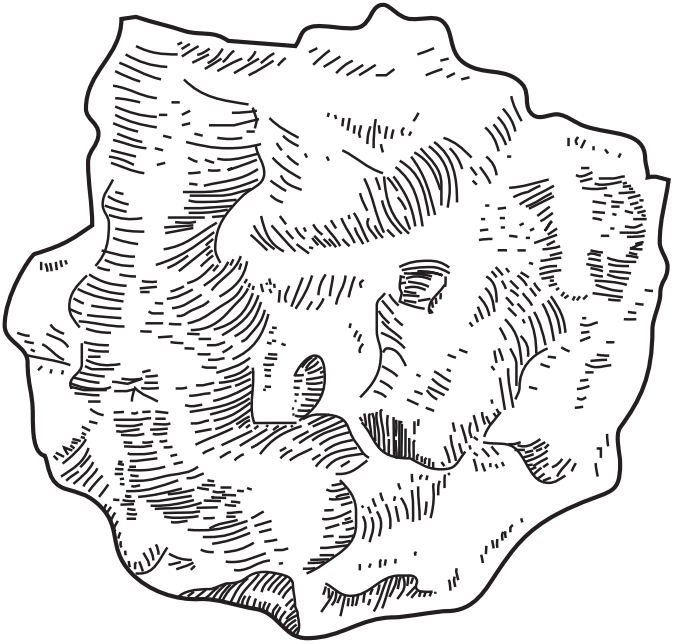

U-shaped valley
Waterfalls
Rapids
V-shaped valley
X
Y
Meanders
Floodplain
Beach
Lake

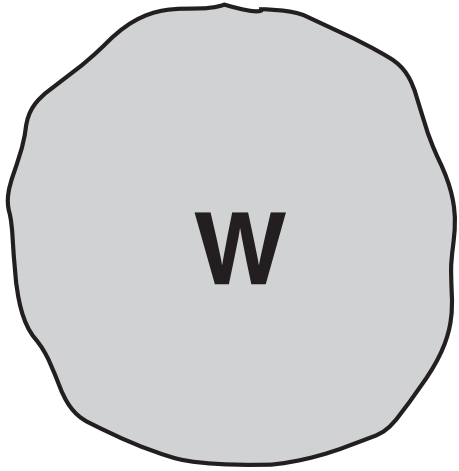
# Rock fall



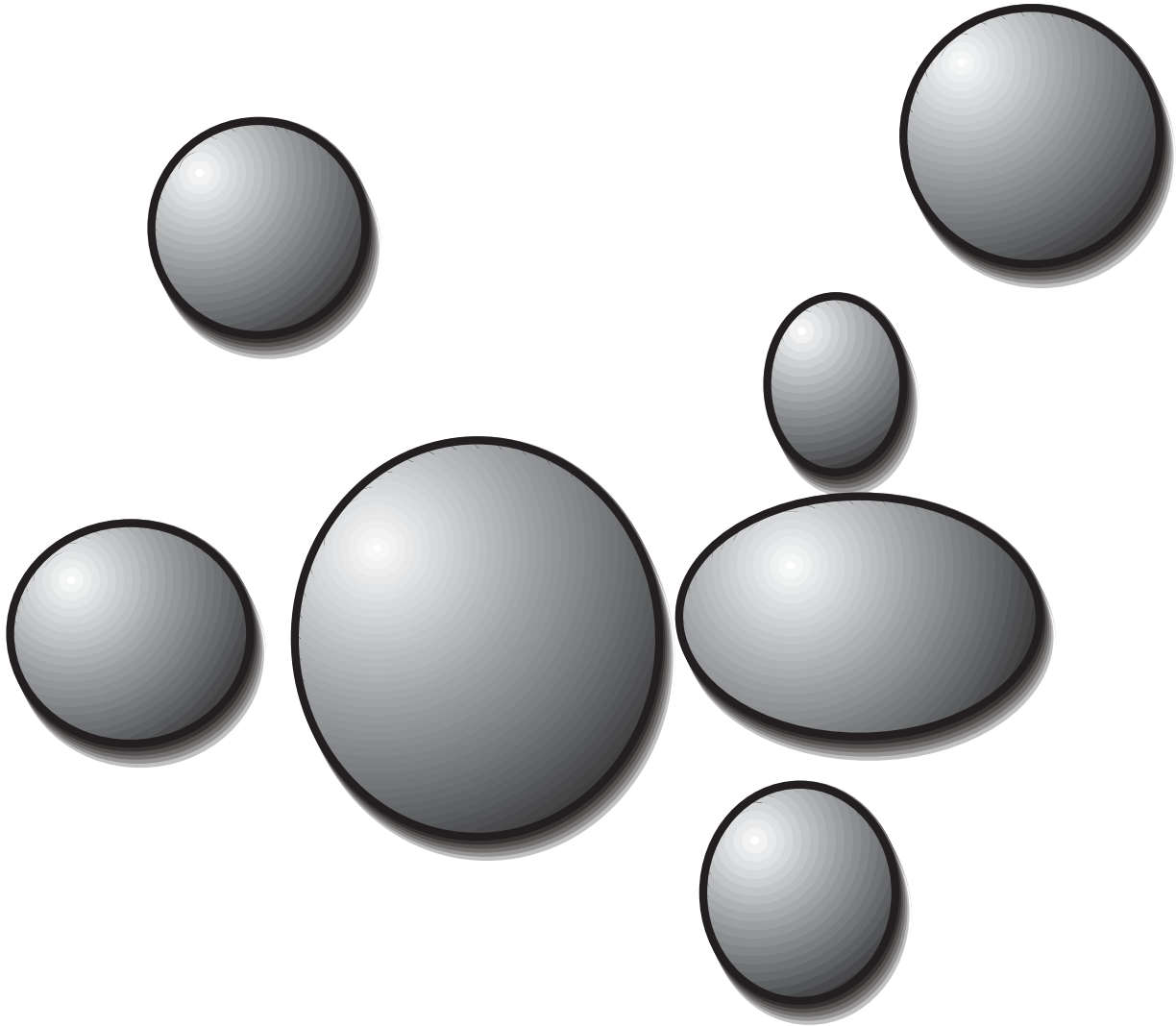
Rapid falling of pieces of rock from a cliff or steep slope

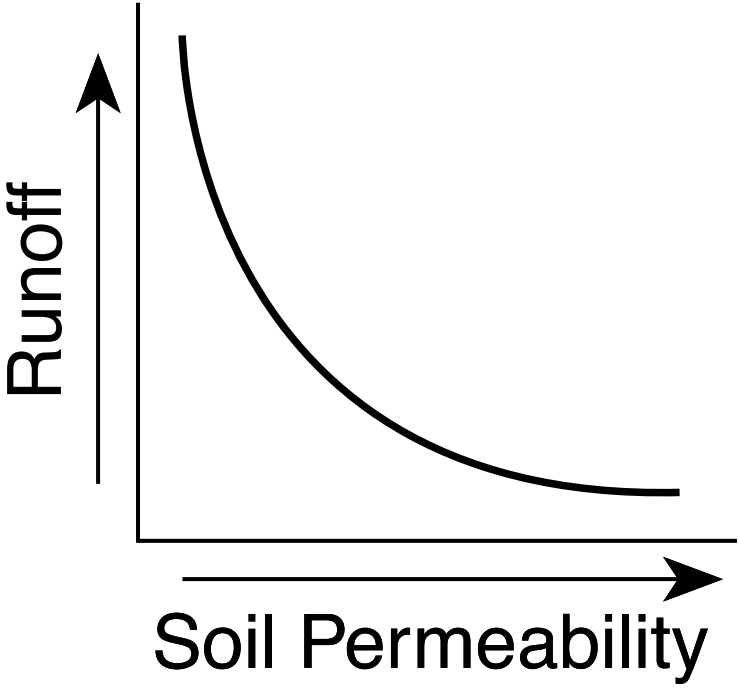


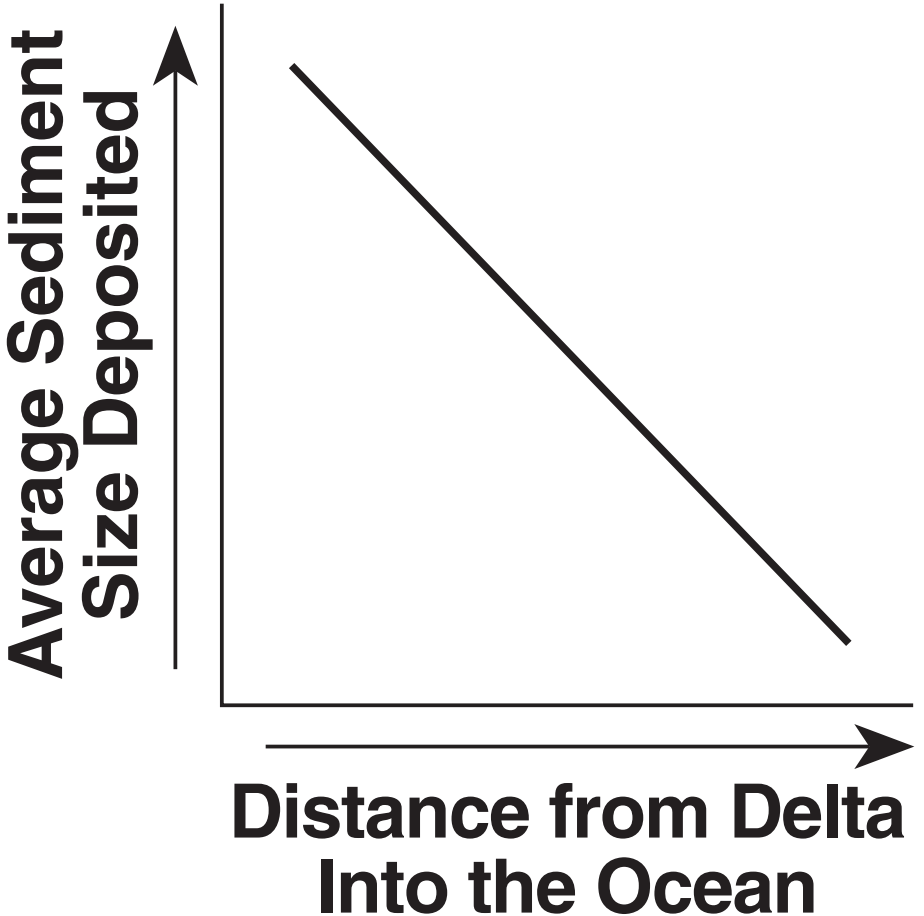


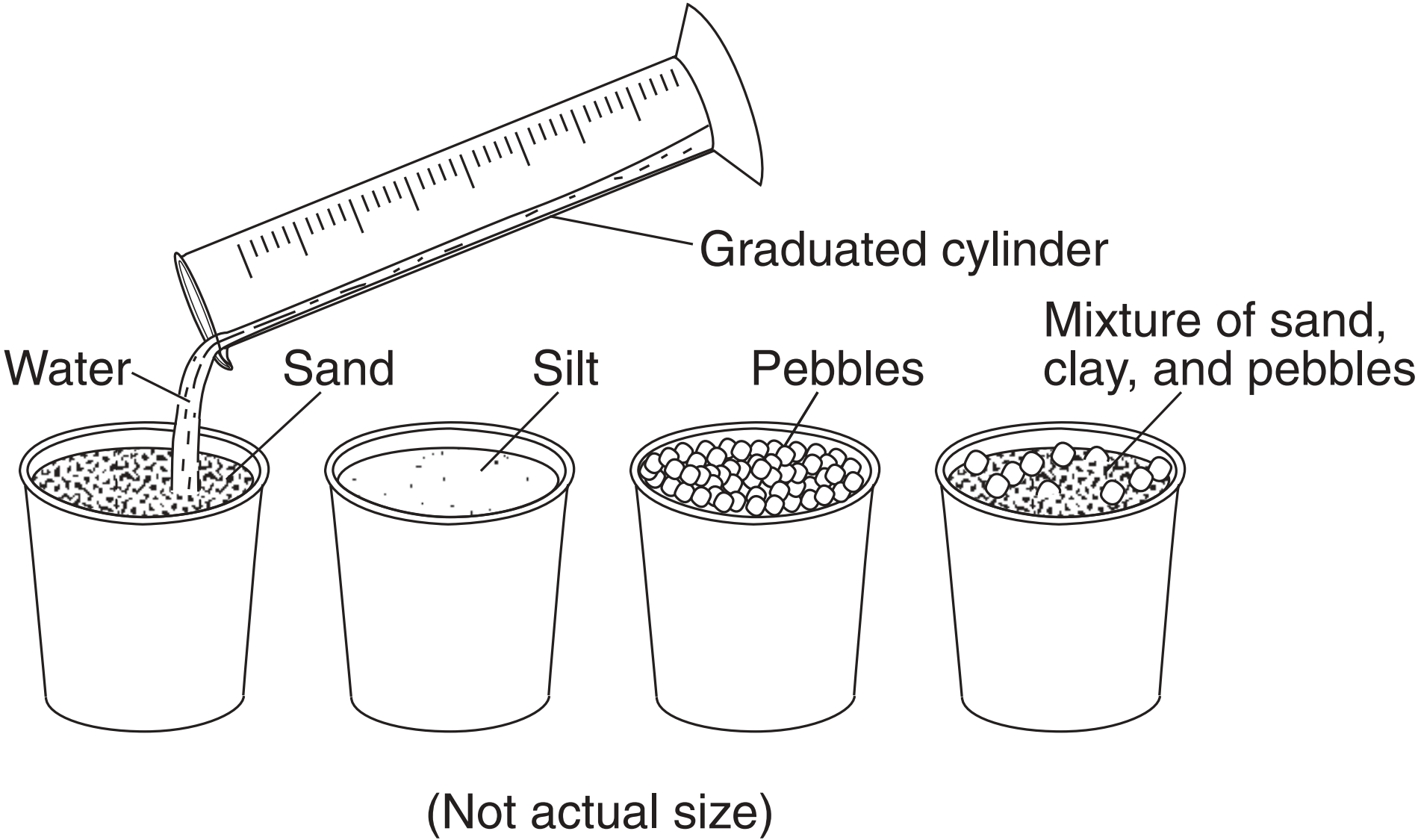



Density = 3.8 g/mL



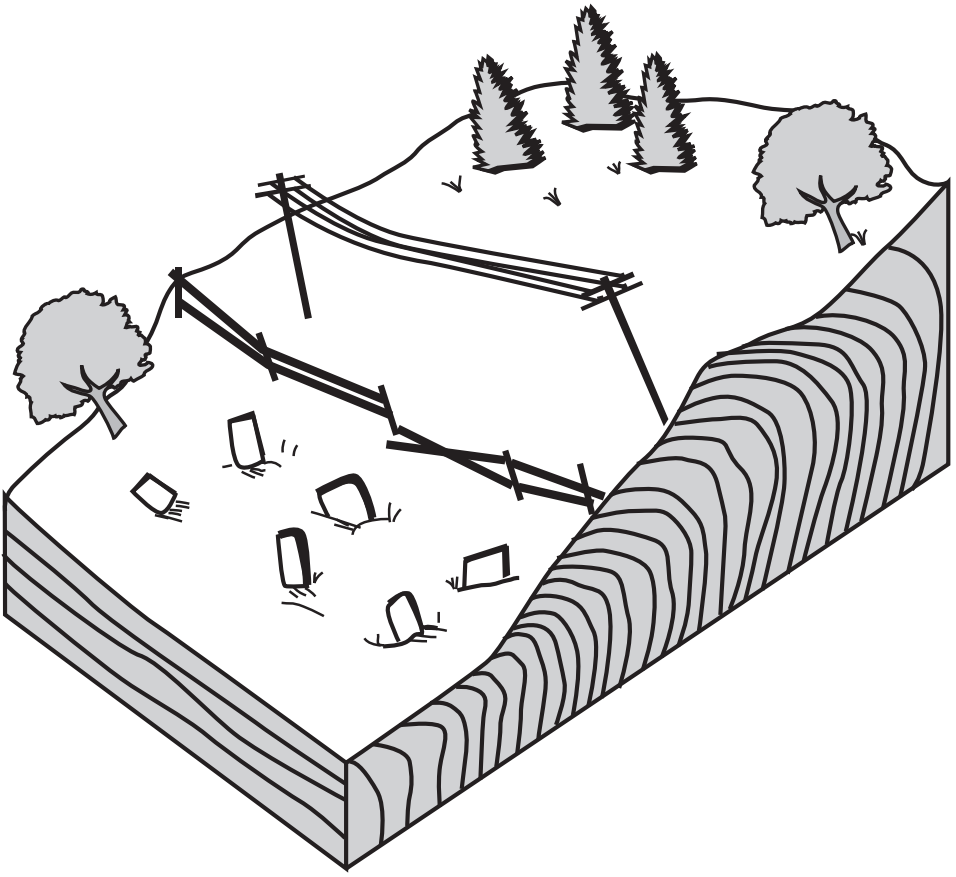

Runoff
Soil Permeability


Average Sediment Size Deposited
Distance from Delta Into the Ocean

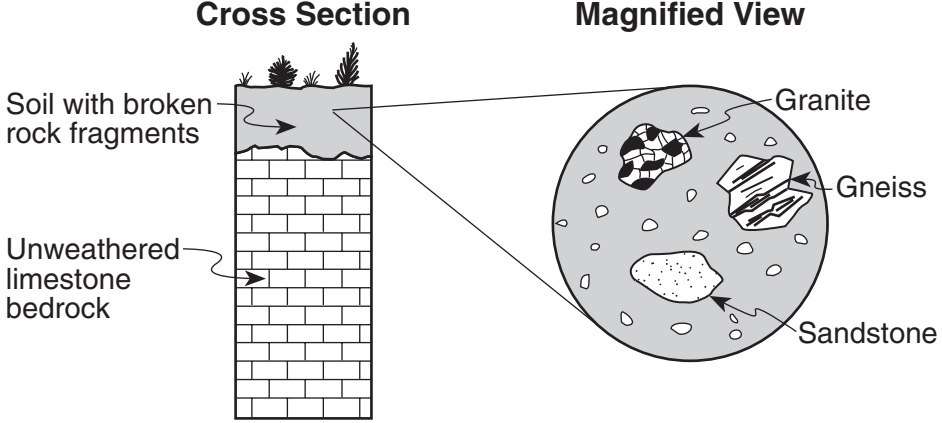

Graduated cylinder
Water
Sand
Silt
Pebbles
Mixture of sand, clay, and pebbles
(Not actual size)

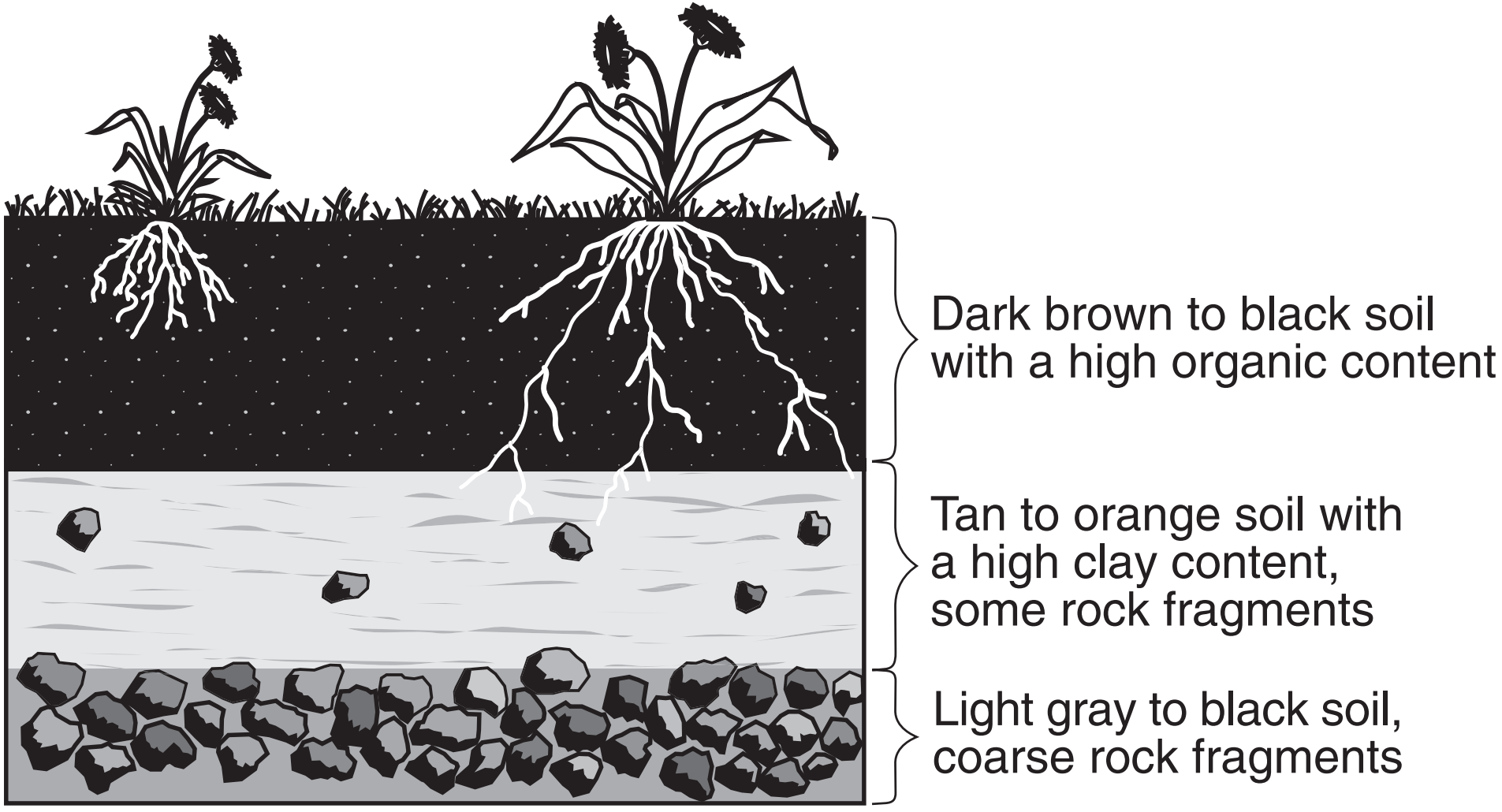
| Particle | Shape | Density |
|---|---|---|
| *A* | flat | 2.5 g/cm$^3$ |
| *B* | flat | 3.0 g/cm$^3$ |
| *C* | round | 2.5 g/cm$^3$ |
| *D* | round | 3.0 g/cm$^3$ |

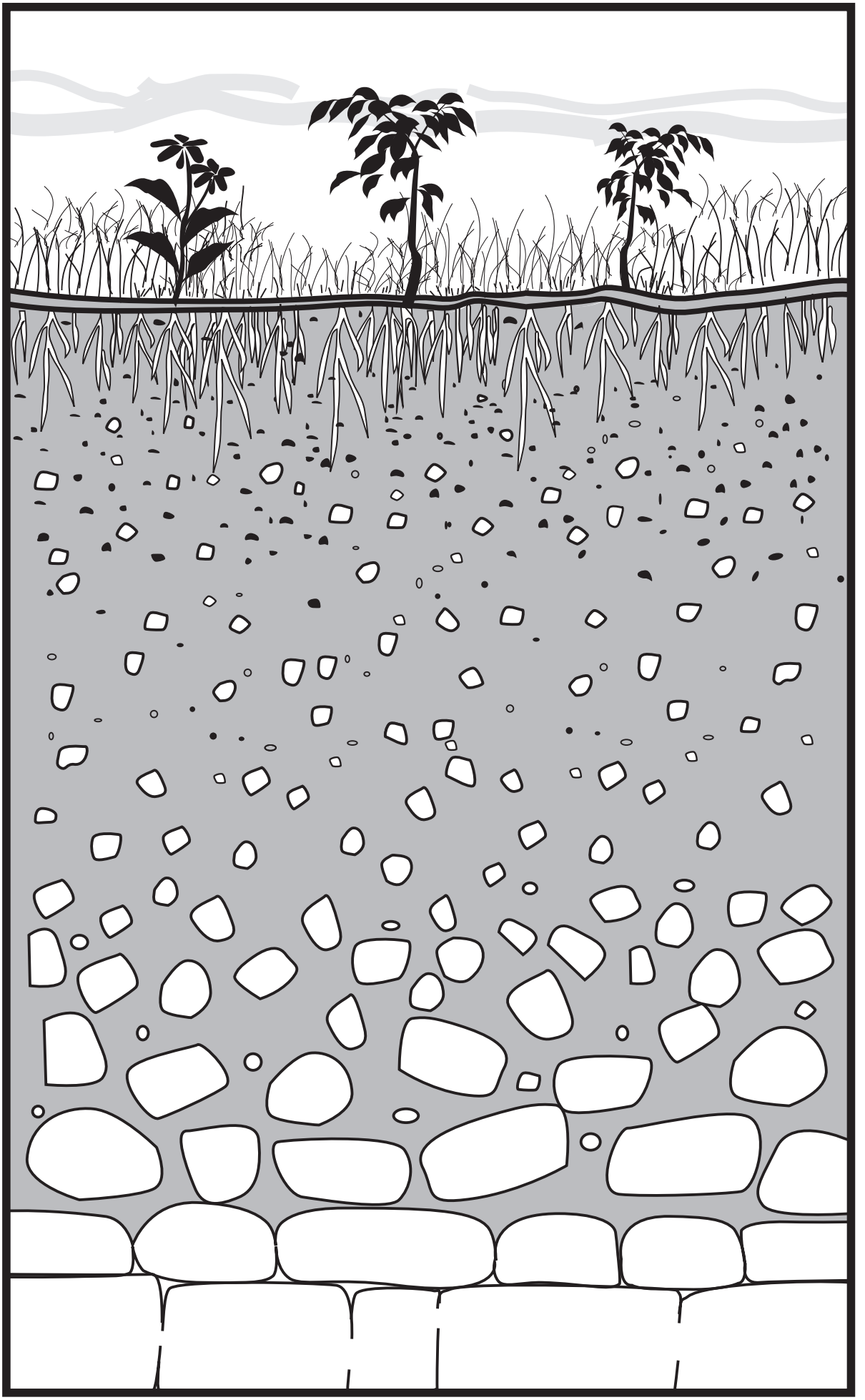
# Soil creep

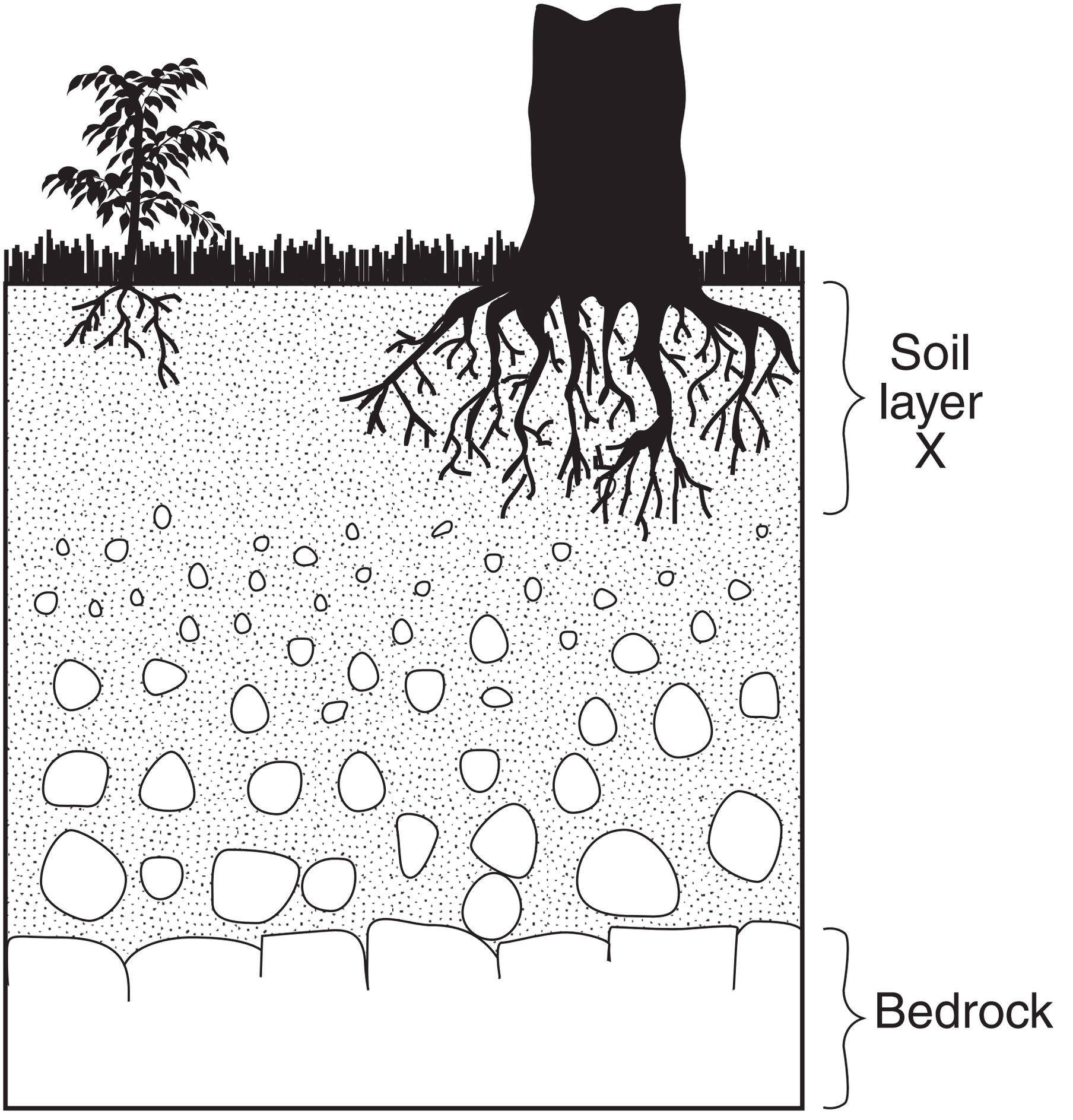


Gradual downhill movement of soil

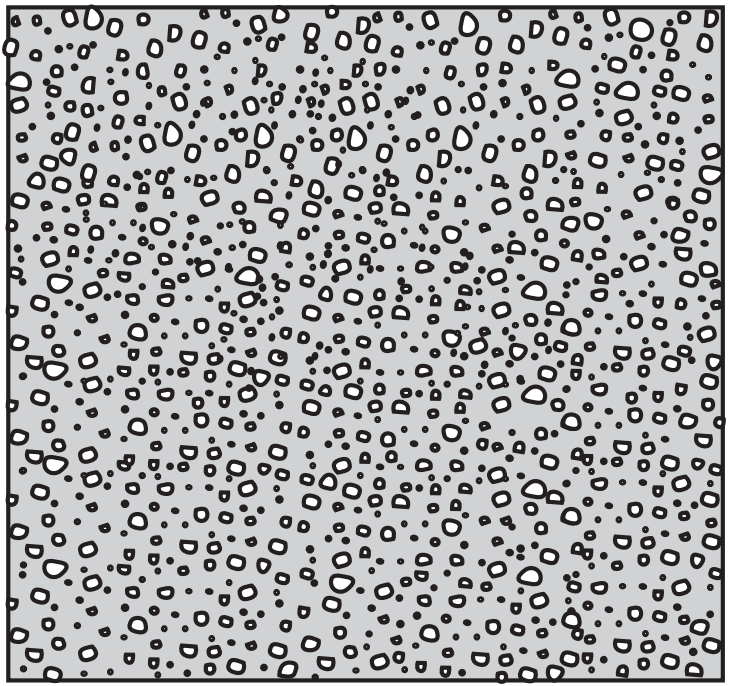

Cross Section
Magnified View
Soil with broken rock fragments
Unweathered limestone bedrock
Granite
Gneiss
Sandstone


Dark brown to black soil
with a high organic content
Tan to orange soil with
a high clay content,
some rock fragments
Light gray to black soil,
coarse rock fragments



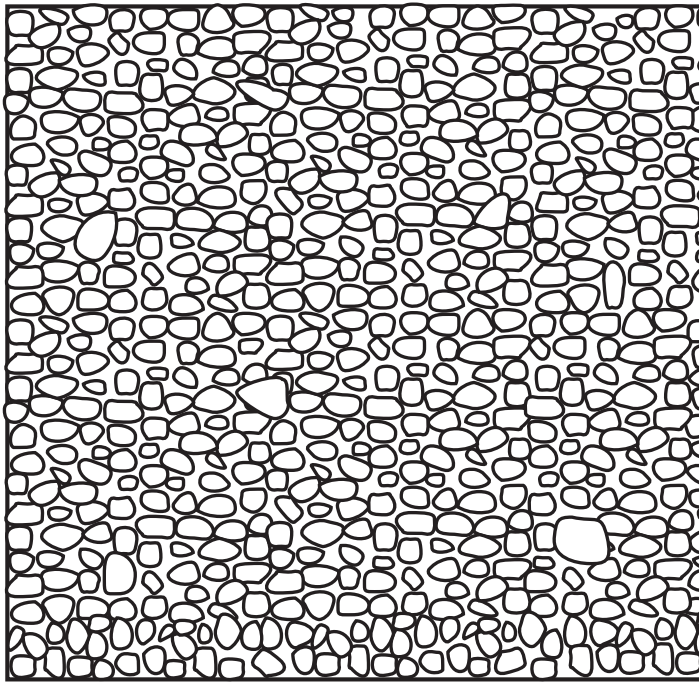

Soil
layer
X
Bedrock

# Sample X

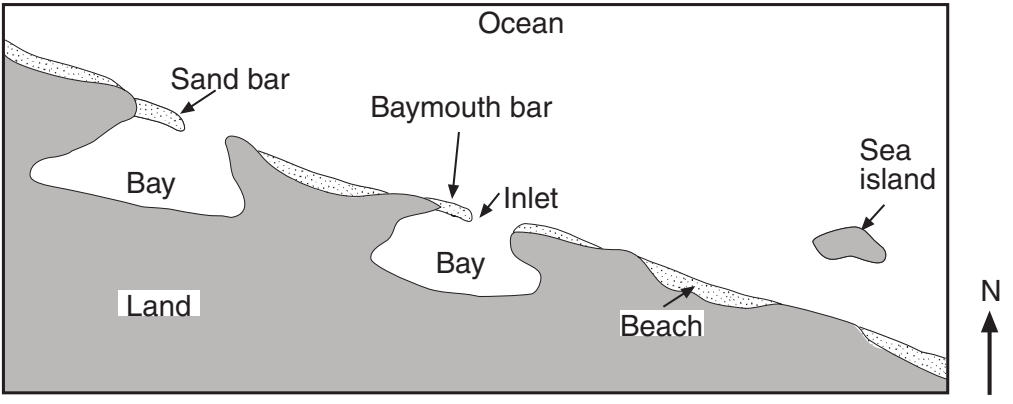


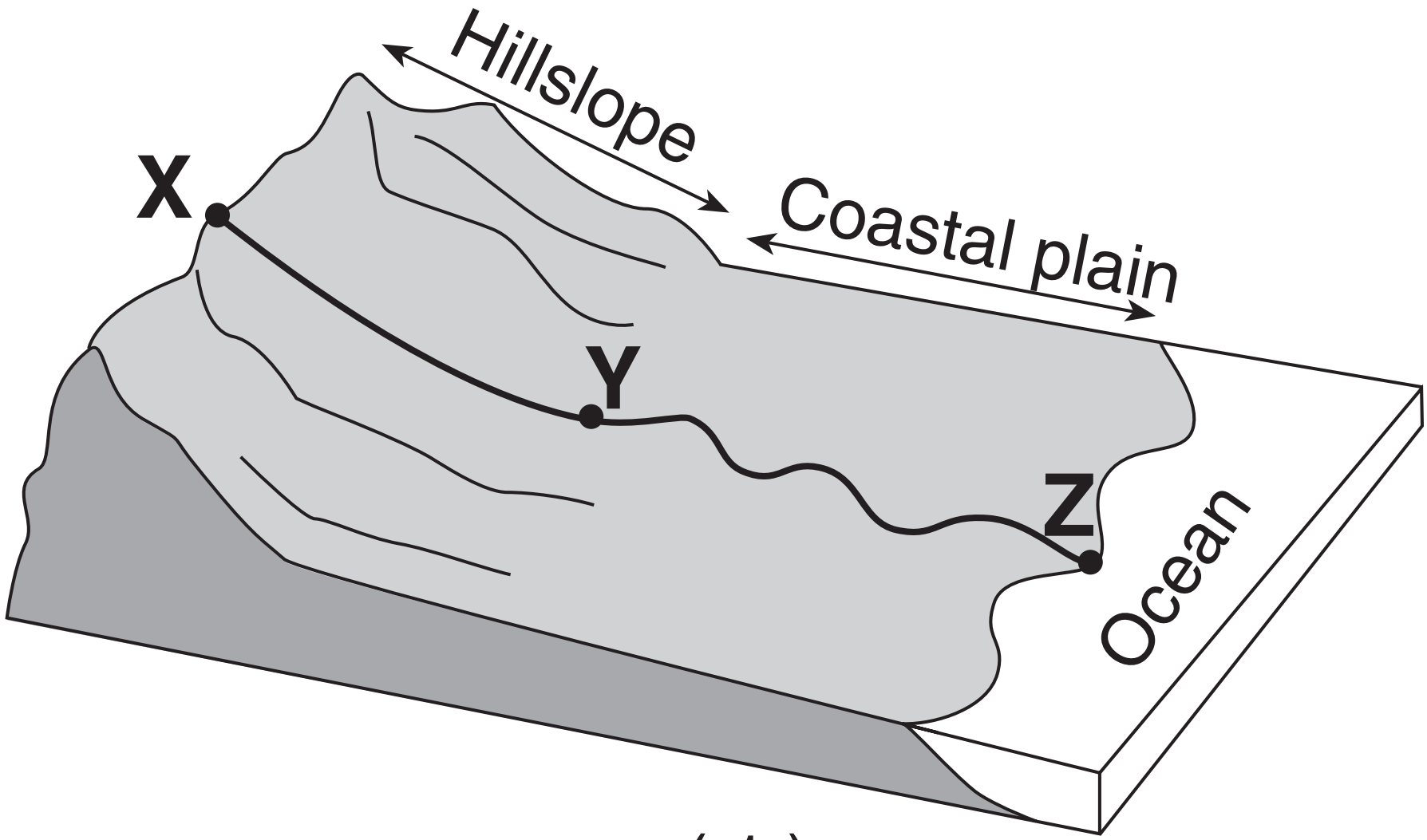
Sorted particle-size range: 0.005–0.09 cm

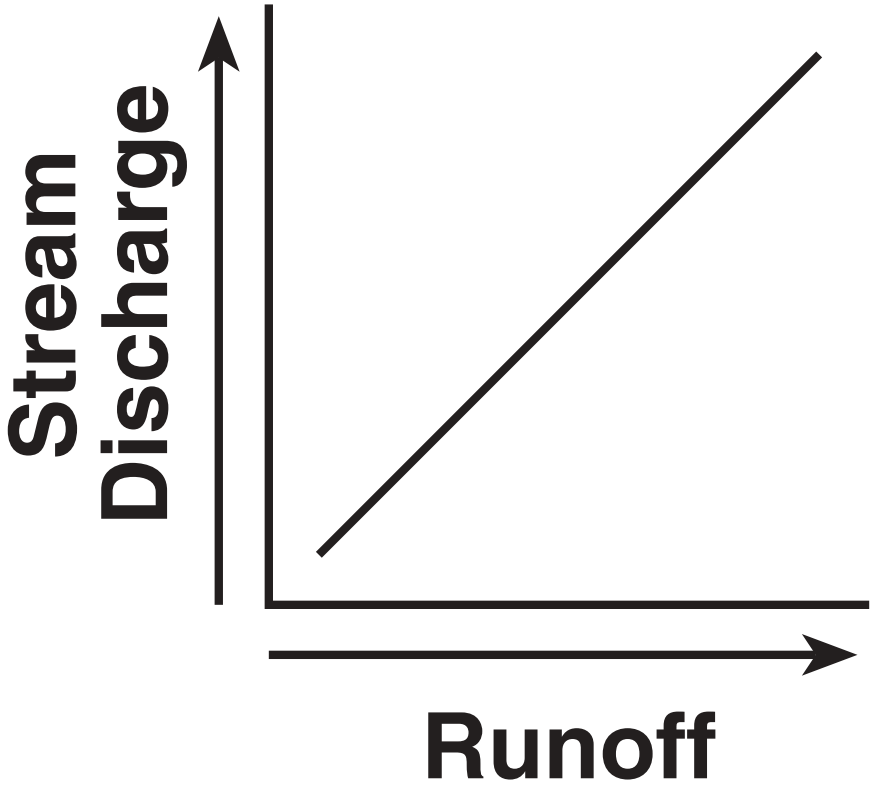
# Sample Z

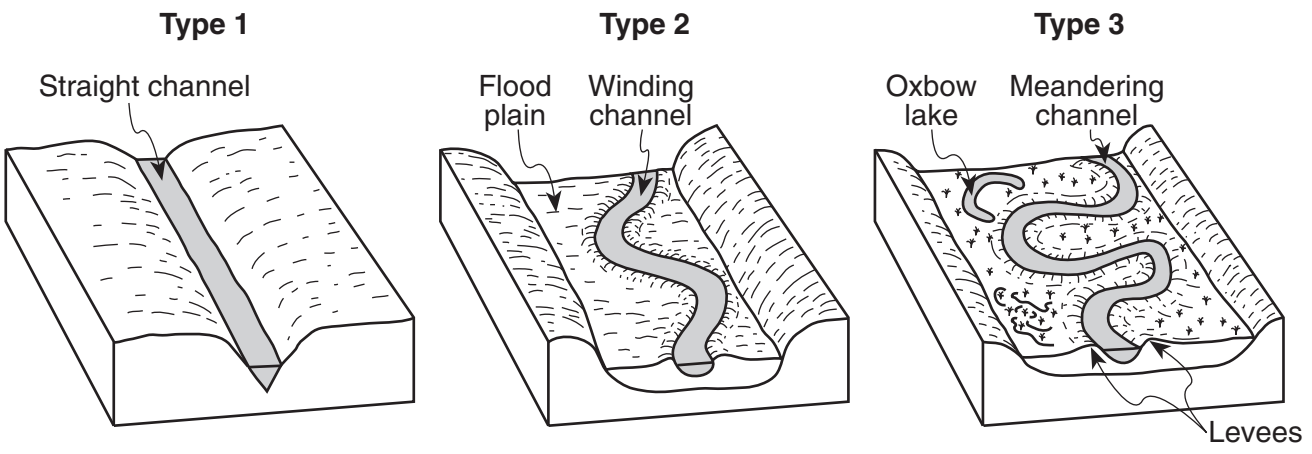


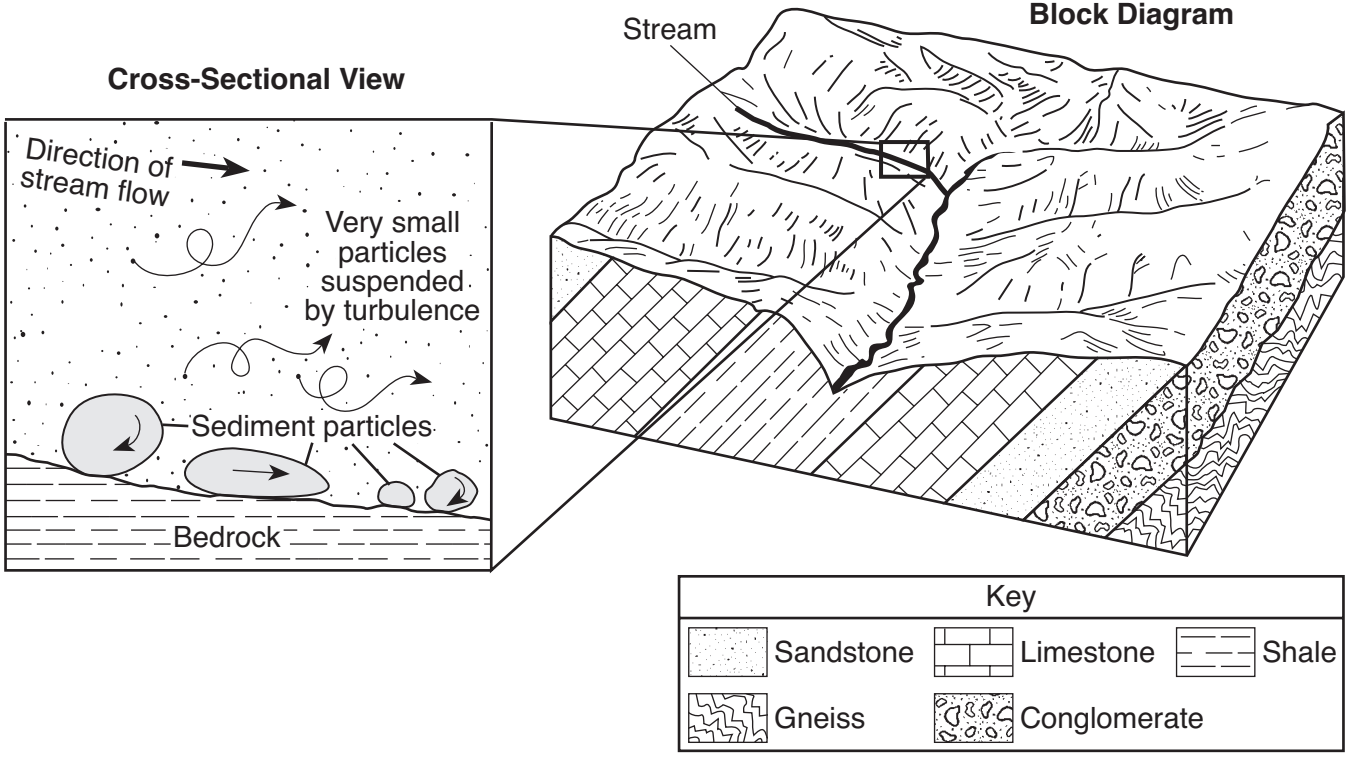
Sorted particle-size range: 0.1–0.3 cm

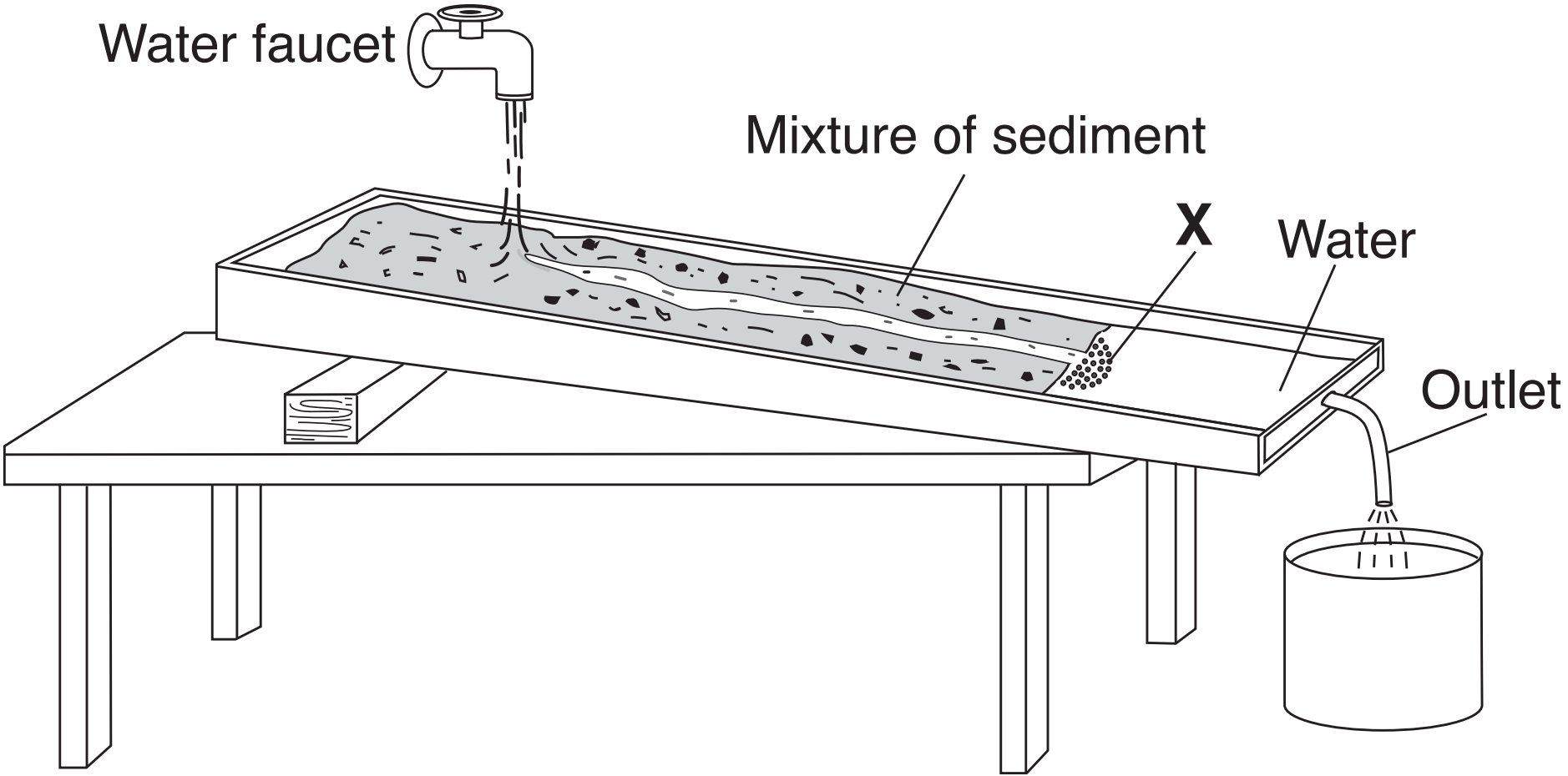

Ocean
Sand bar
Baymouth bar
Sea
island
Bay
Inlet
Bay
Land
Beach
N

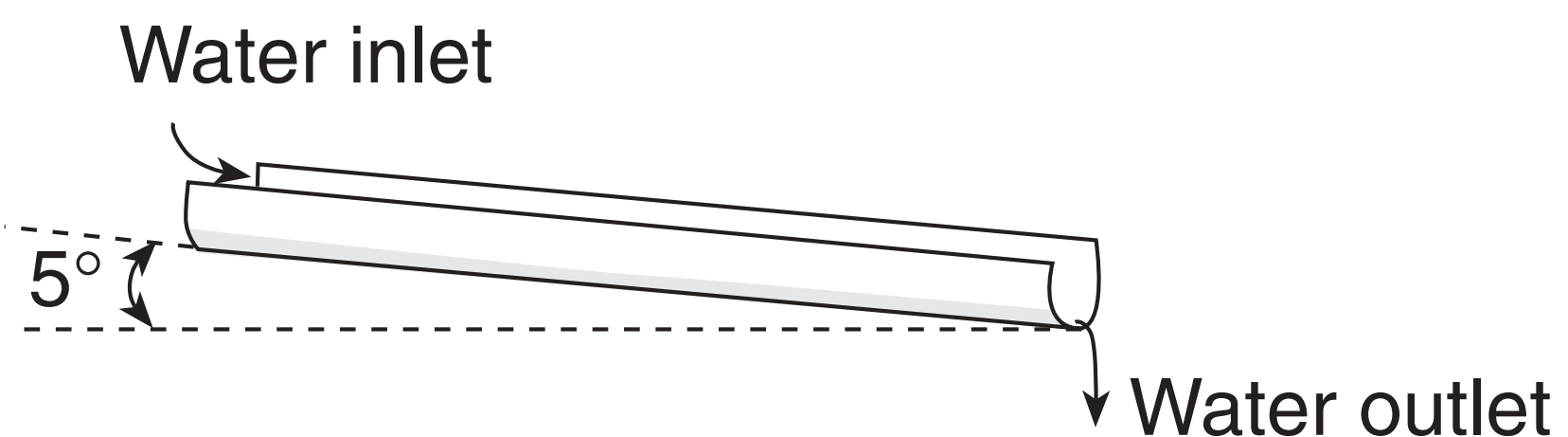

Hillslope
Coastal plain
X
Y
Z
Ocean

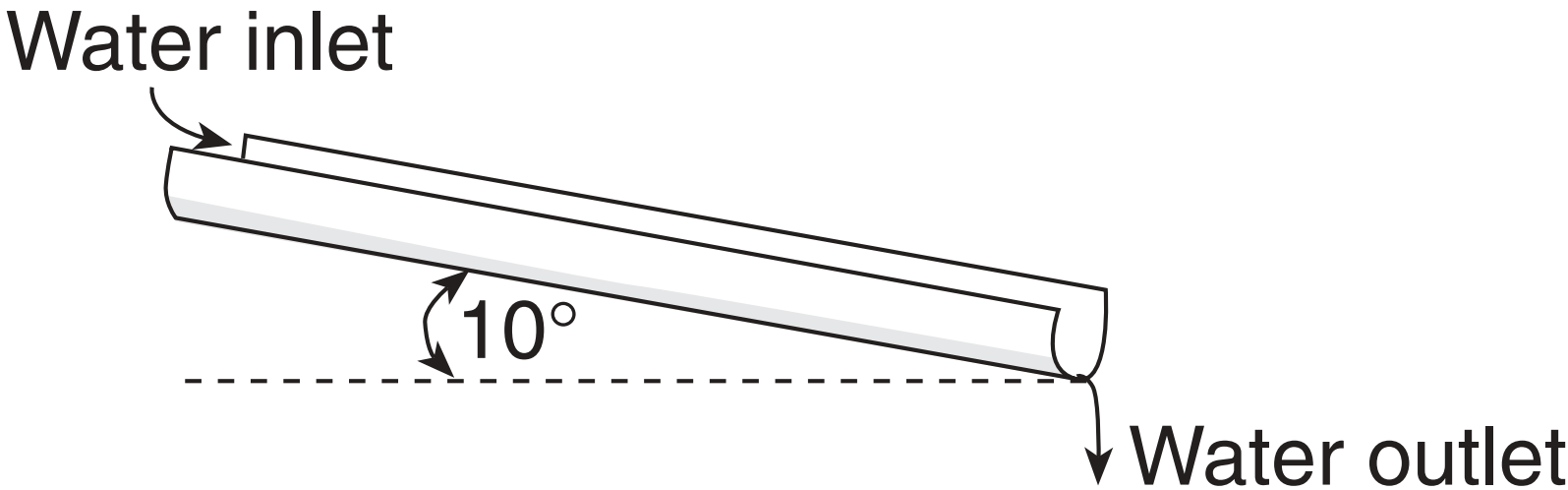

Stream
Discharge
Runoff

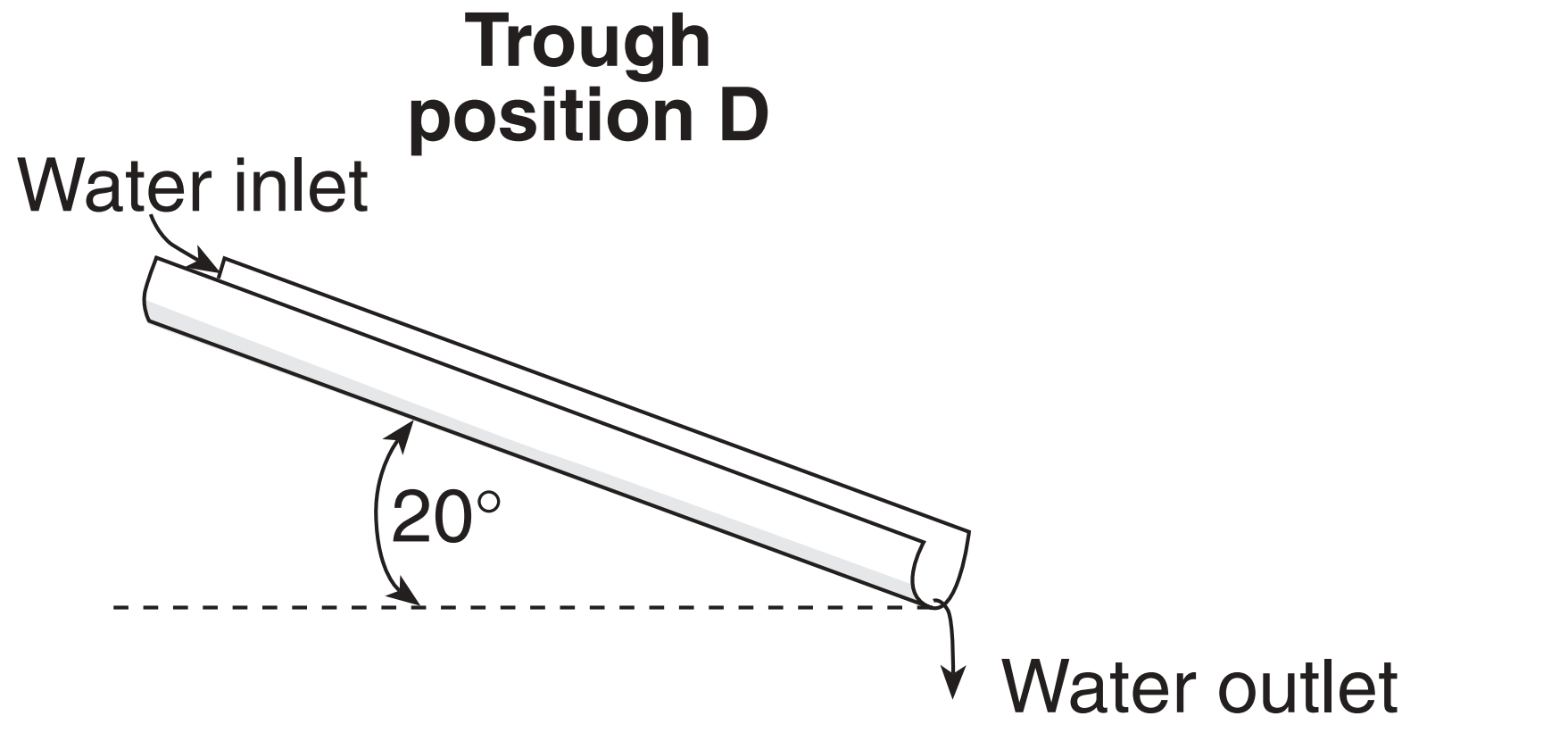

Type 1
Straight channel
Type 2
Flood plain
Winding channel
Type 3
Oxbow lake
Meandering channel
Levees
Narrow, V-shaped valley
Wider valley with sloping walls
Broad valley with wide, swampy flood plain

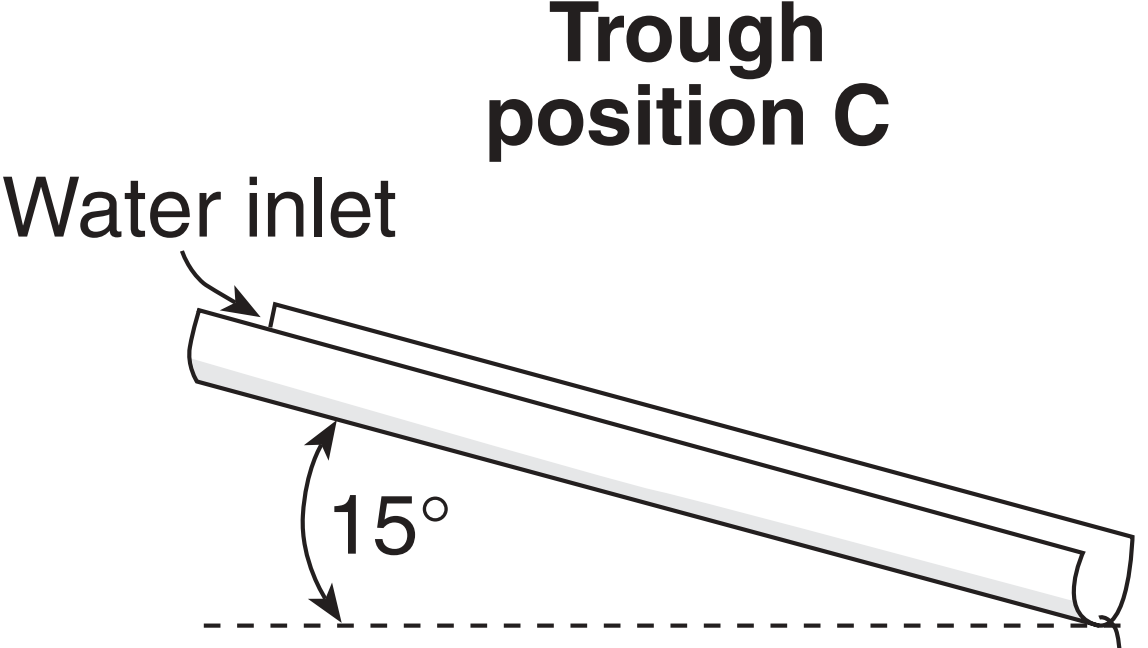

Cross-Sectional View
Direction of stream flow
Very small particles suspended by turbulence
Sediment particles
Bedrock
Block Diagram
Stream
Key
Sandstone
Limestone
Shale
Gneiss
Conglomerate

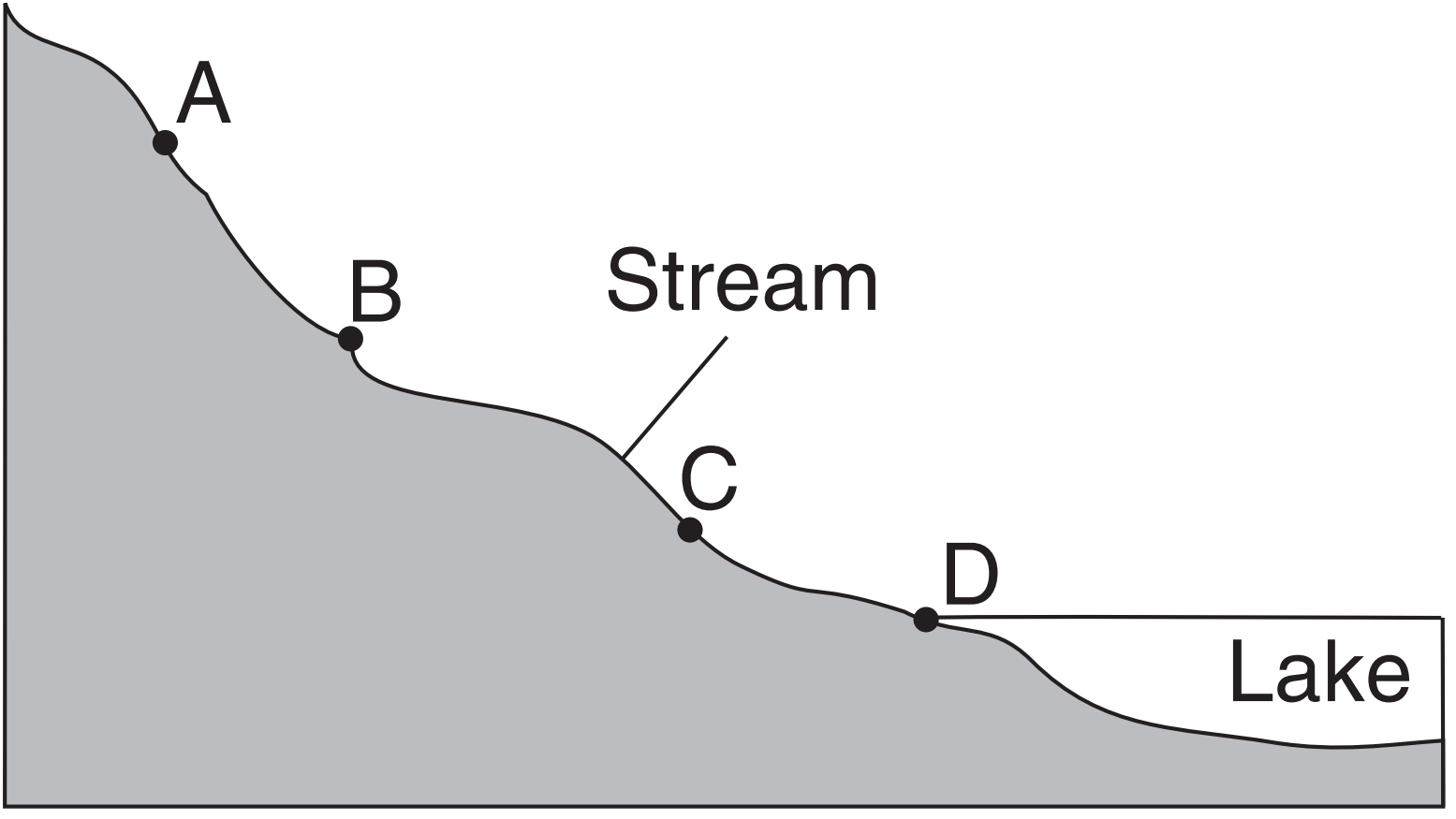

Water faucet
Mixture of sediment
X
Water
Outlet

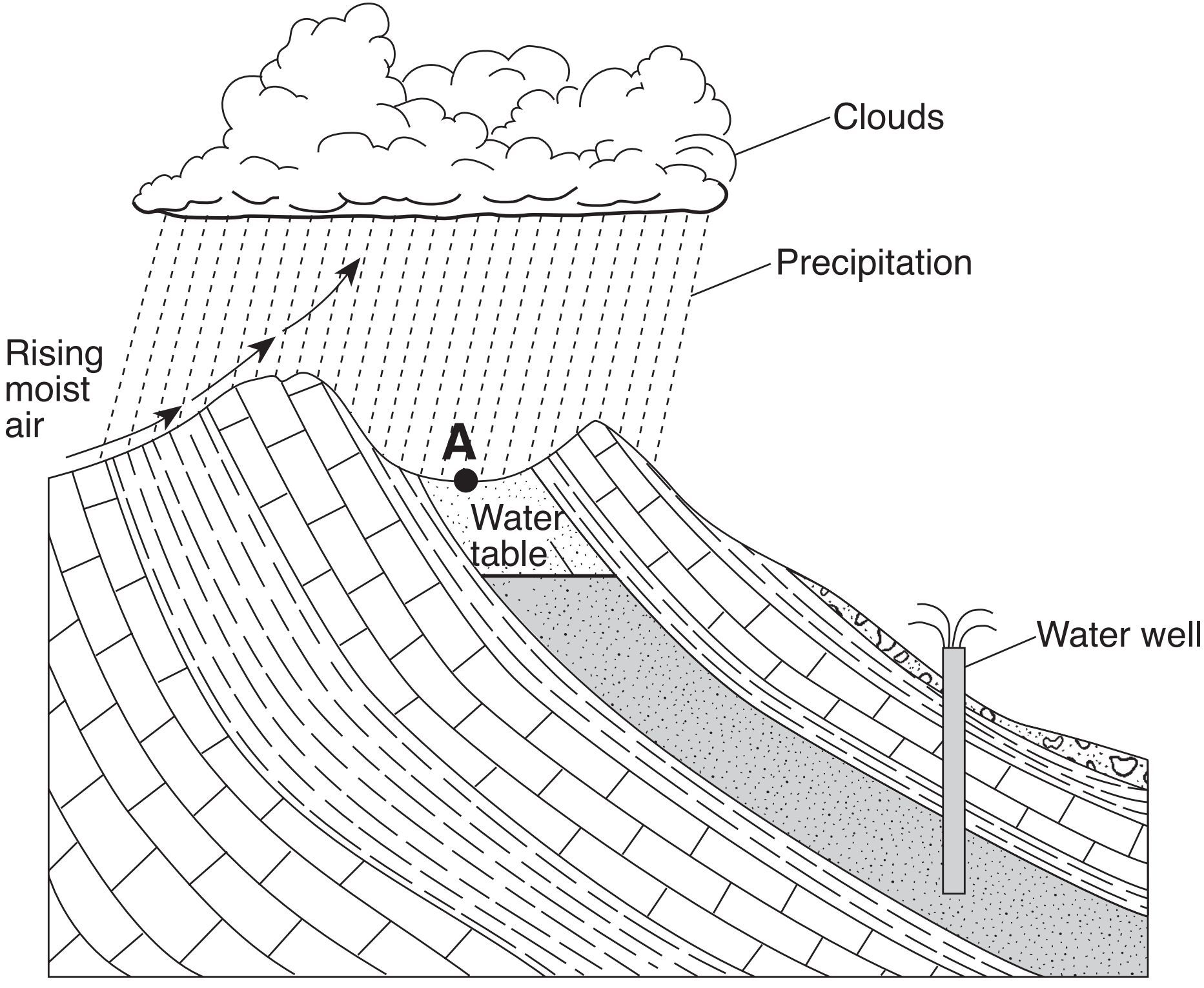

Water inlet
5°
Water outlet


Water inlet
10°
Water outlet

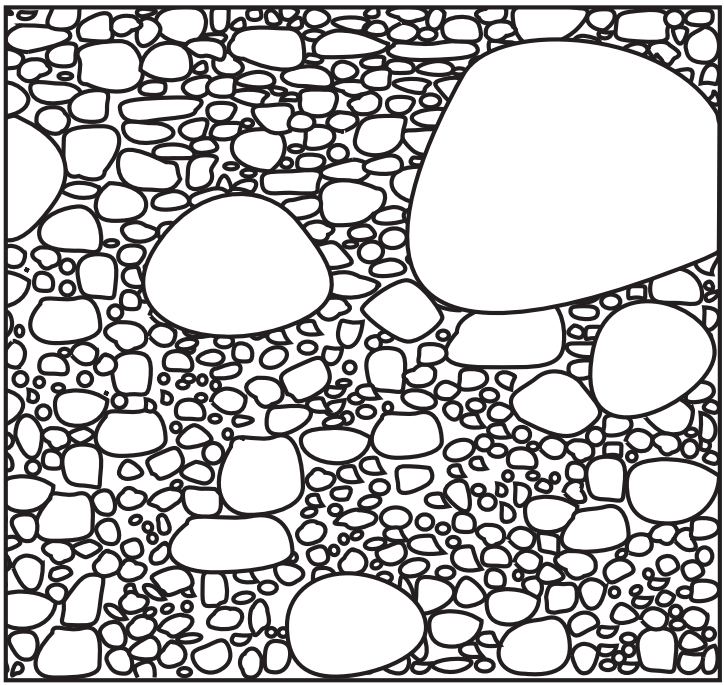

Trough
position D
Water inlet
20°
Water outlet


Trough
position C
Water inlet
15°

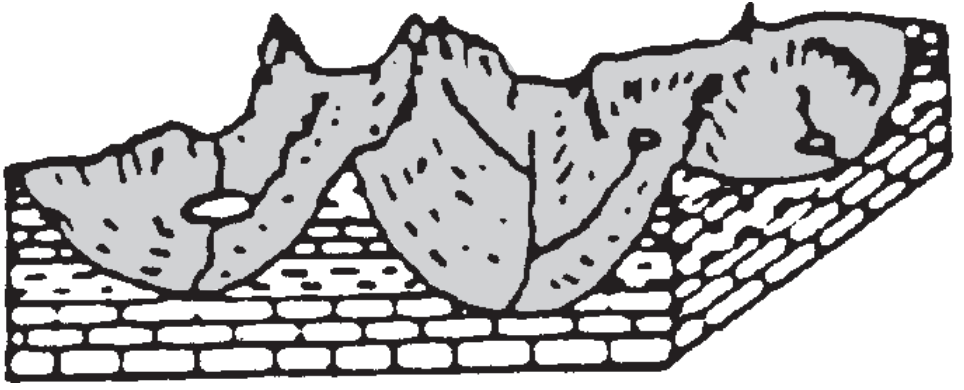

A
B
Stream
C
D
Lake

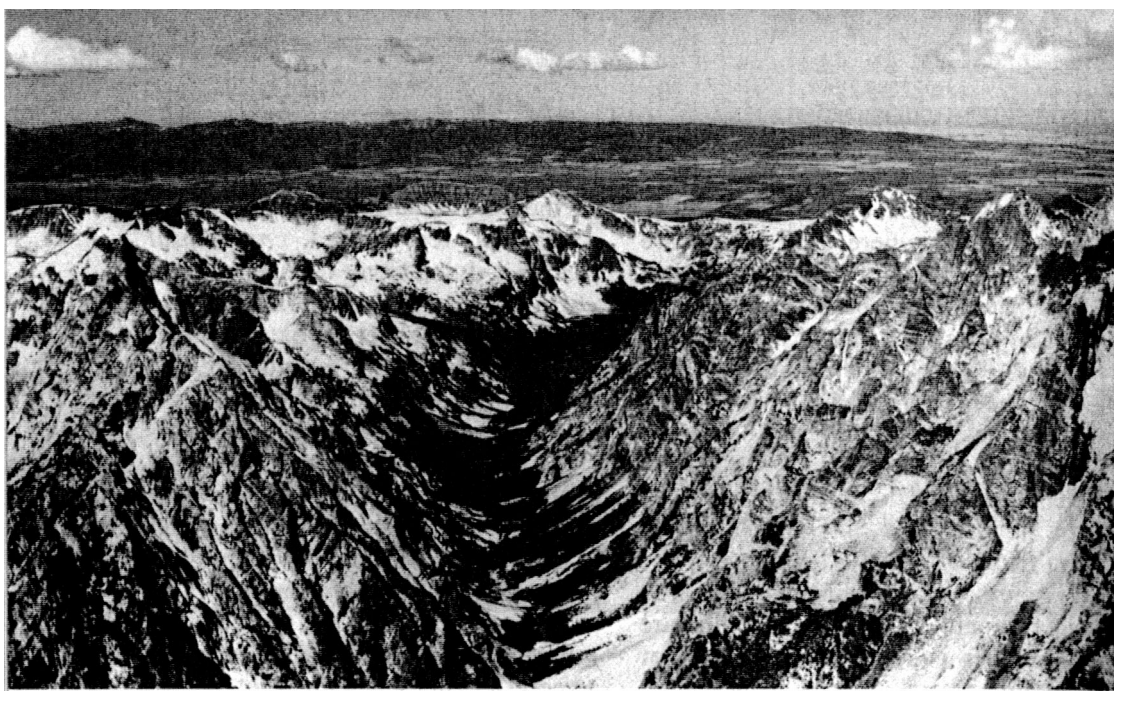

Clouds
Precipitation
Rising
moist
air
A
Water
table
Water well

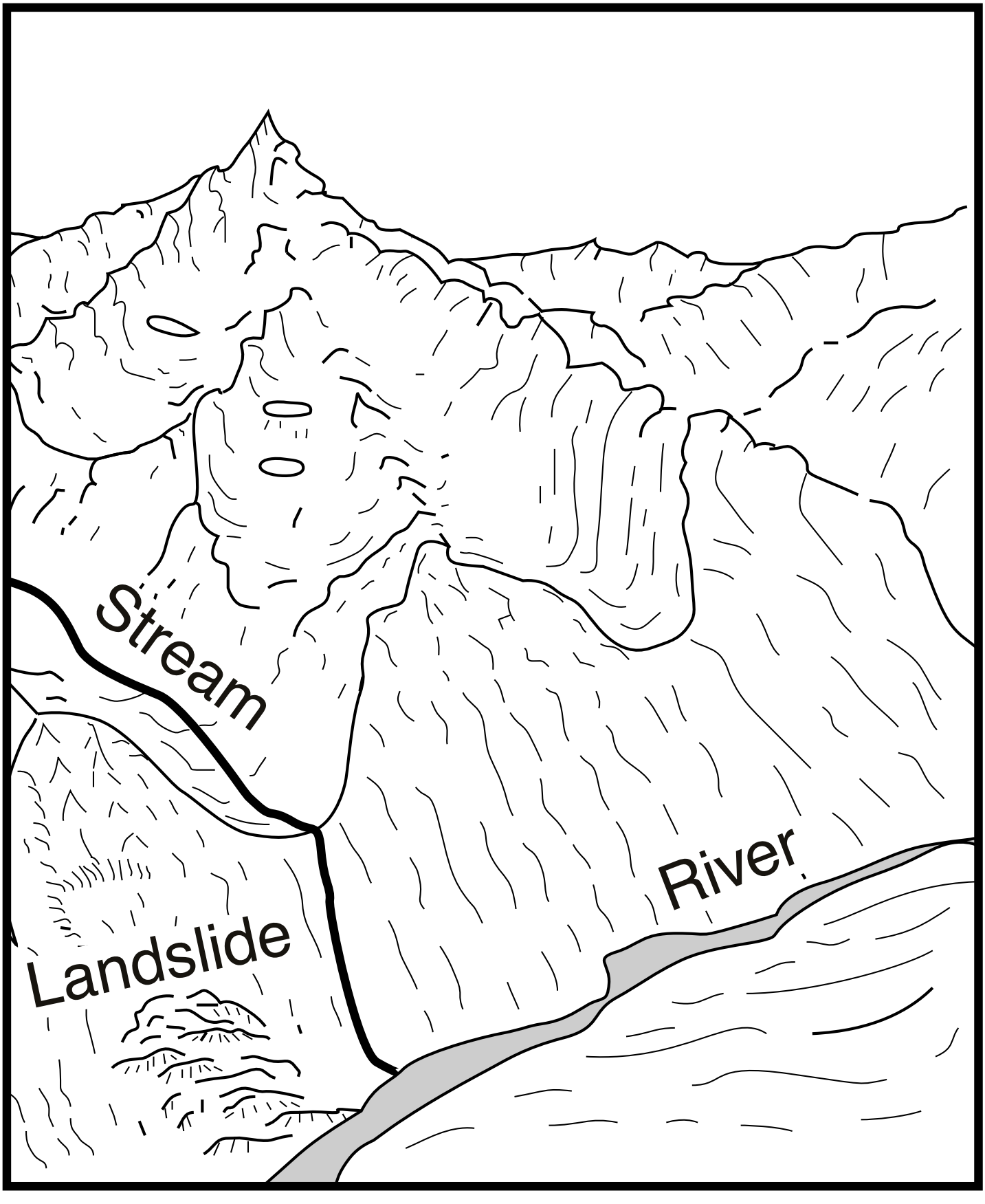
# Sample Y

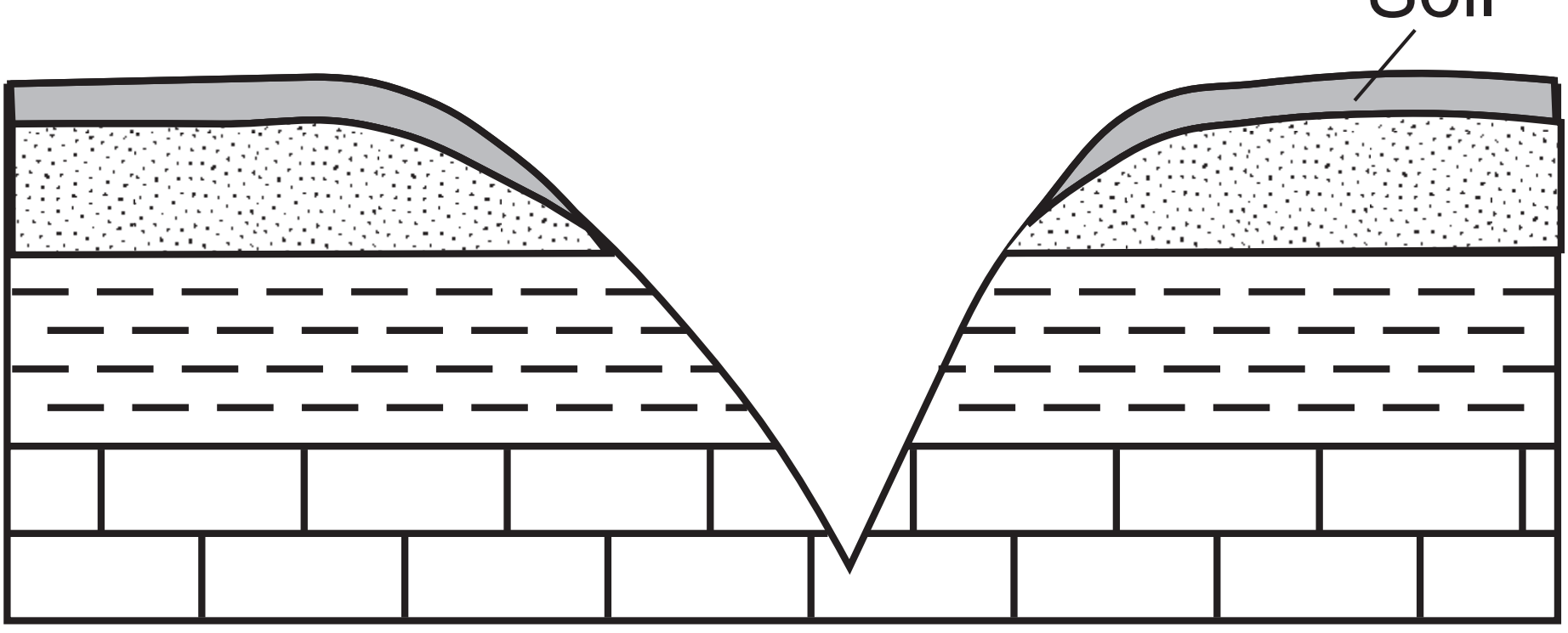


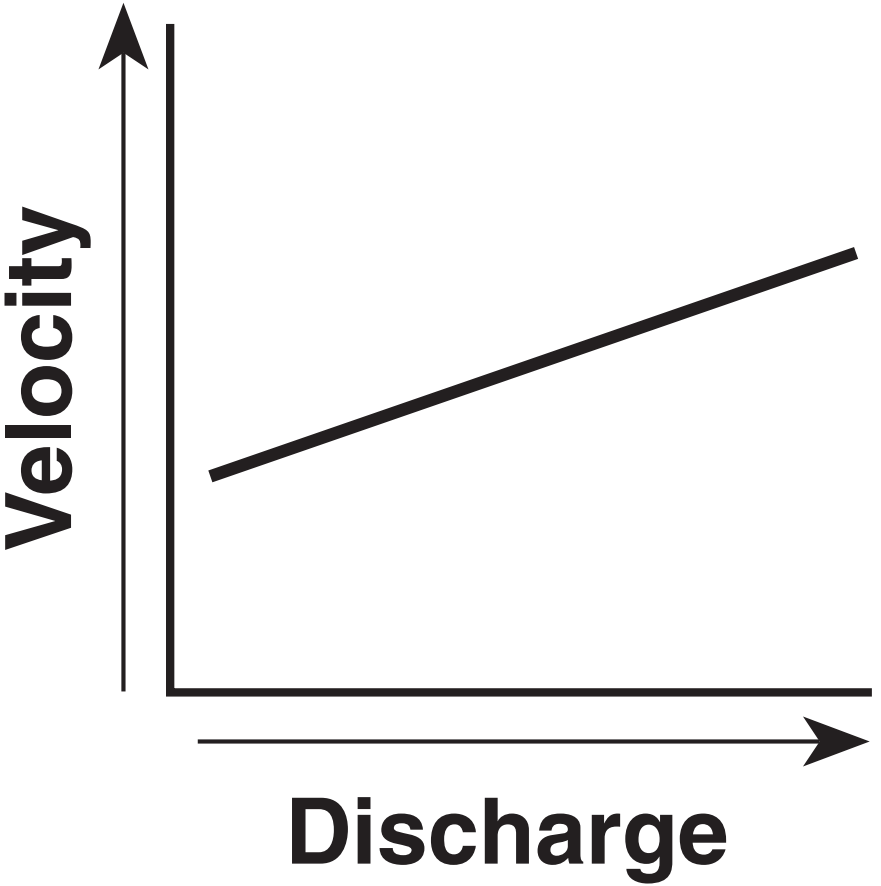
Unsorted particle-size range: 0.01–62 cm

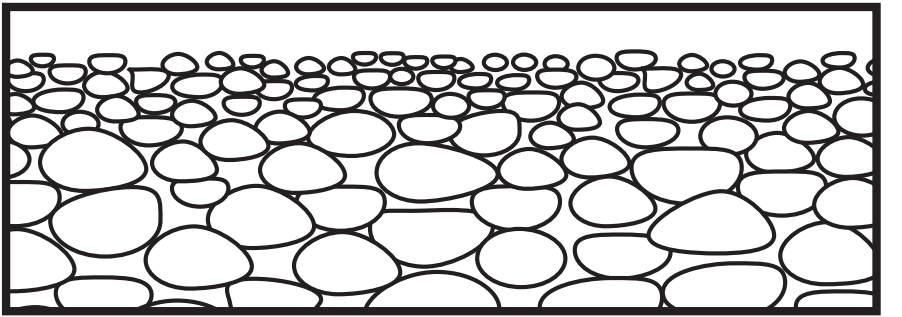




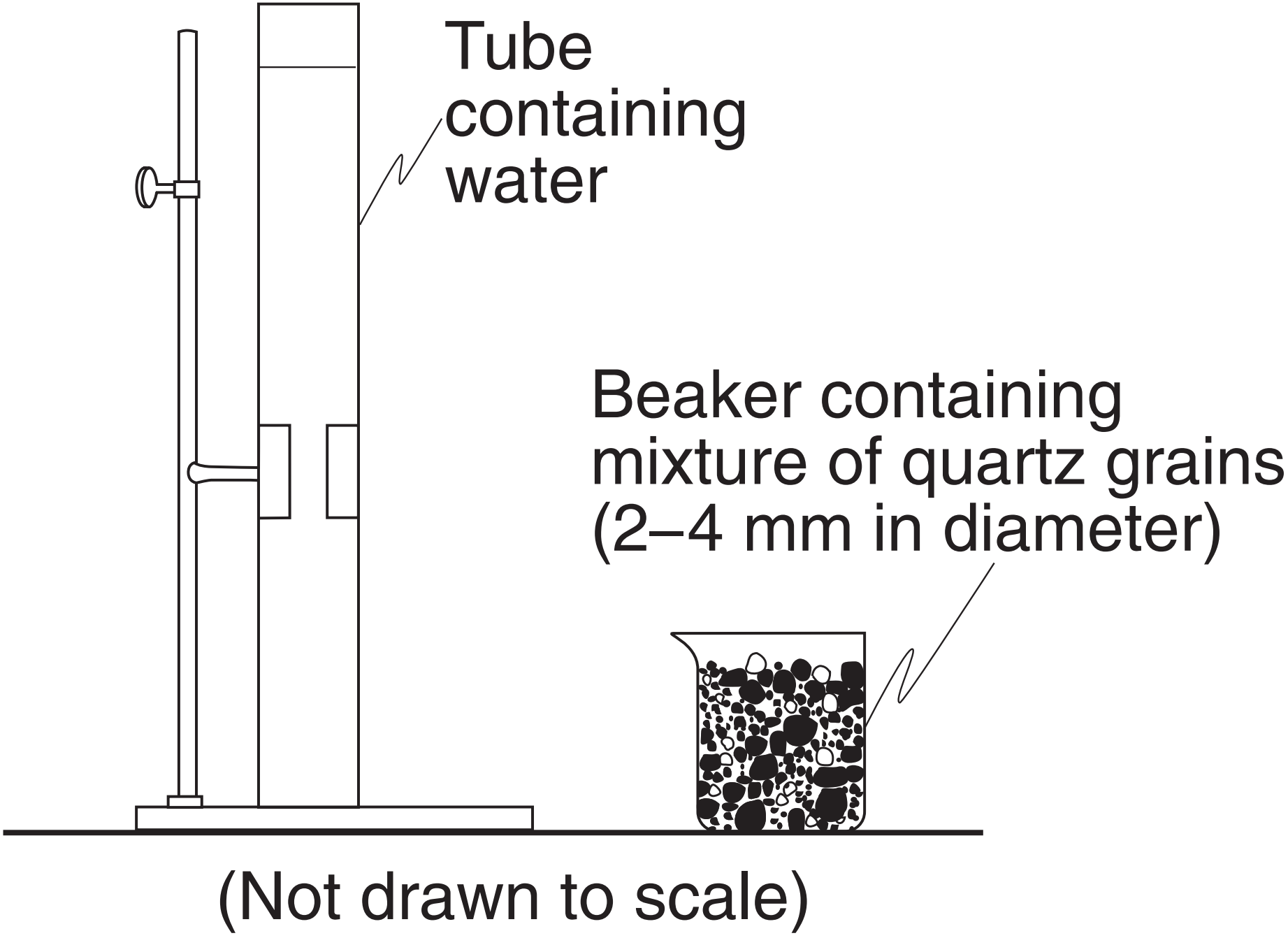

Stream
River
Landslide

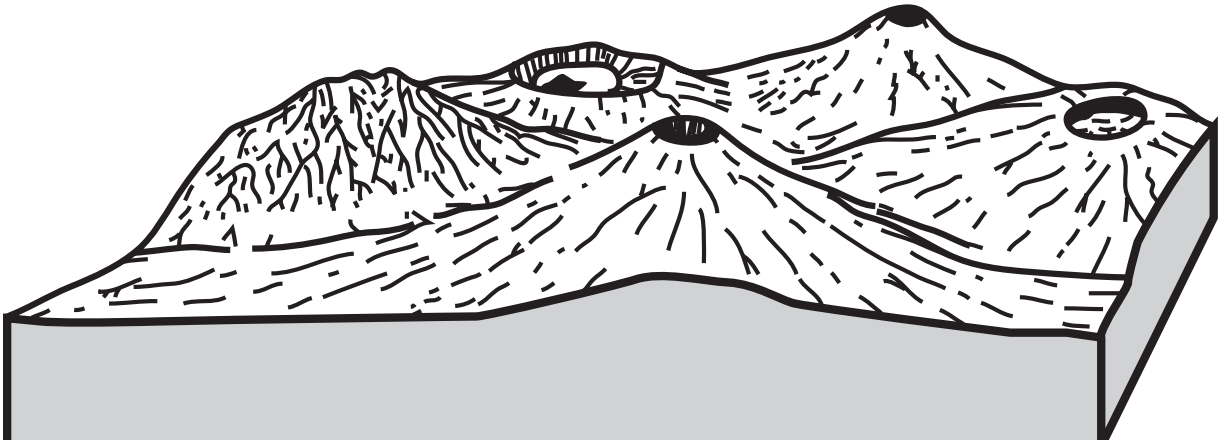

Soil

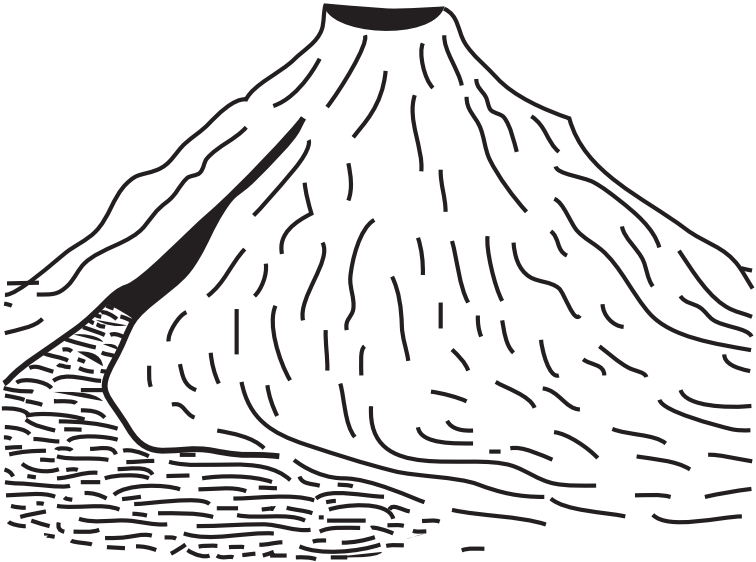

Velocity
Discharge

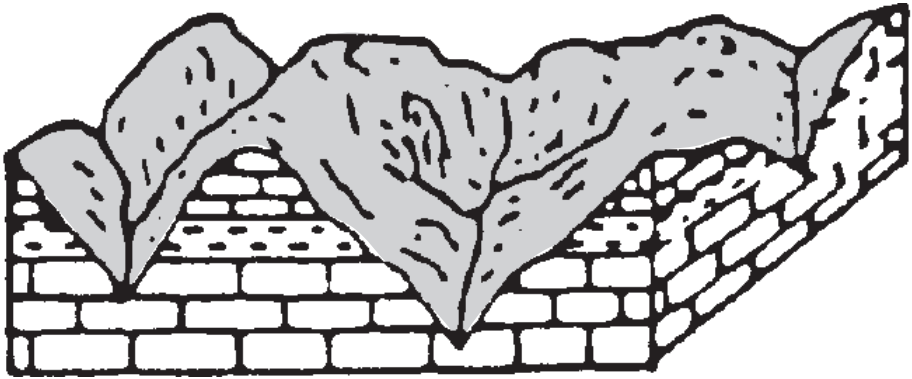


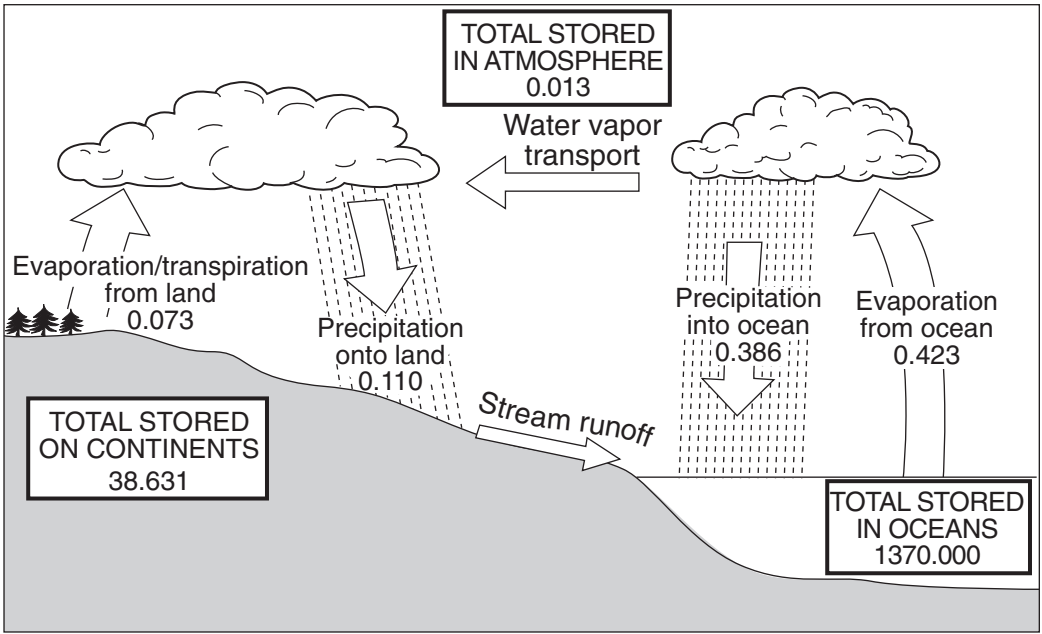
(Drawn to scale)

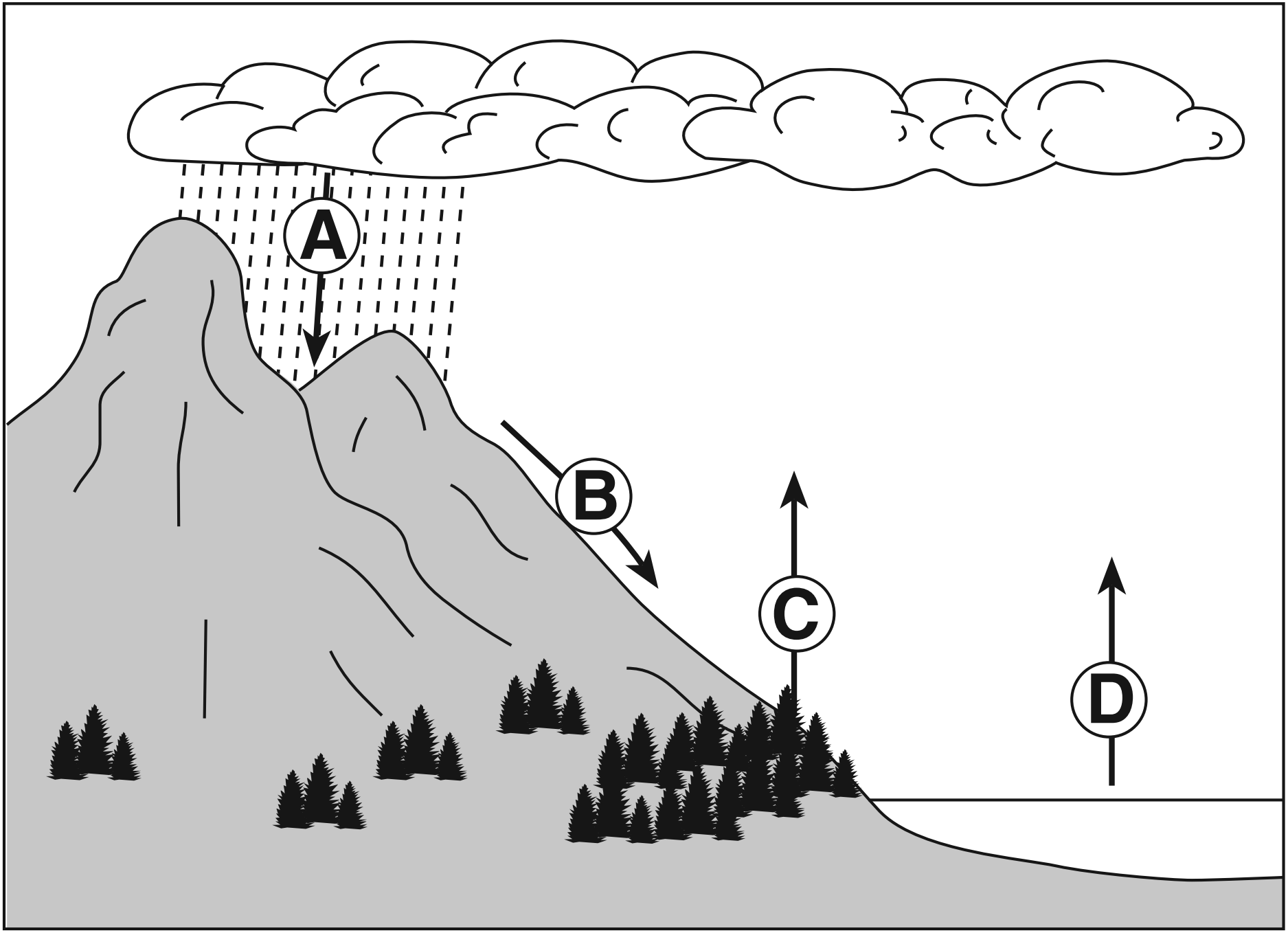

Tube
containing
water
Beaker containing
mixture of quartz grains
(2–4 mm in diameter)
(Not drawn to scale)

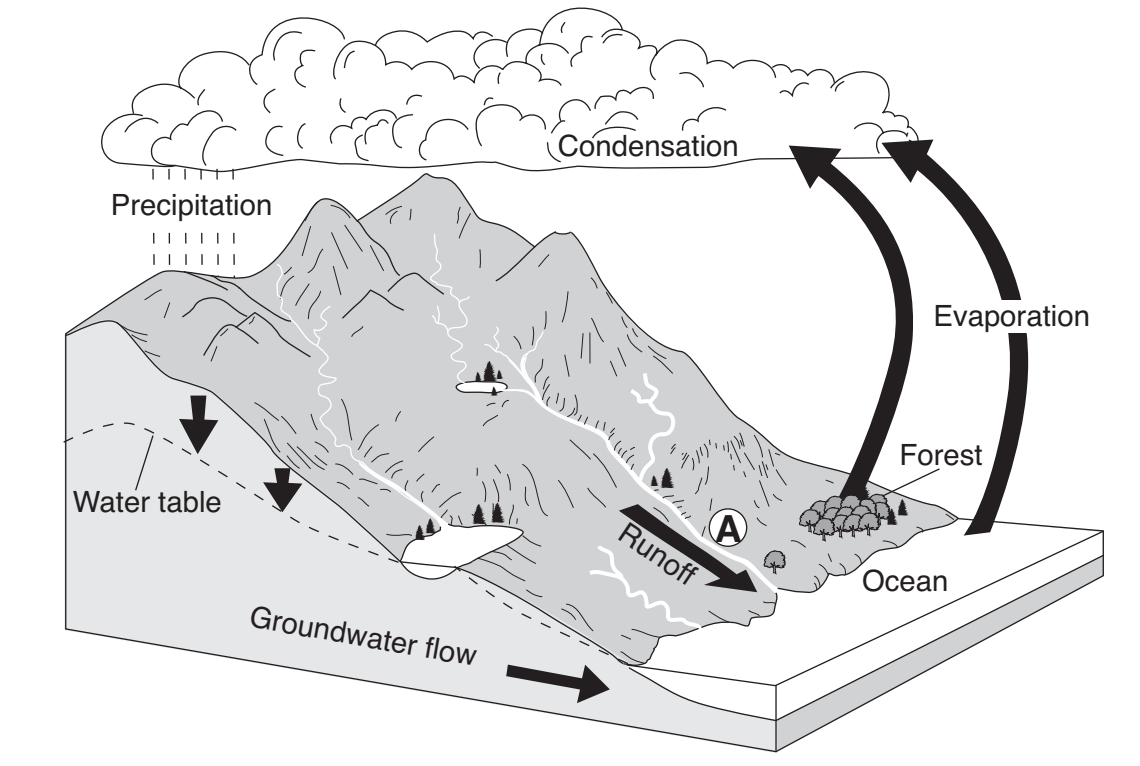




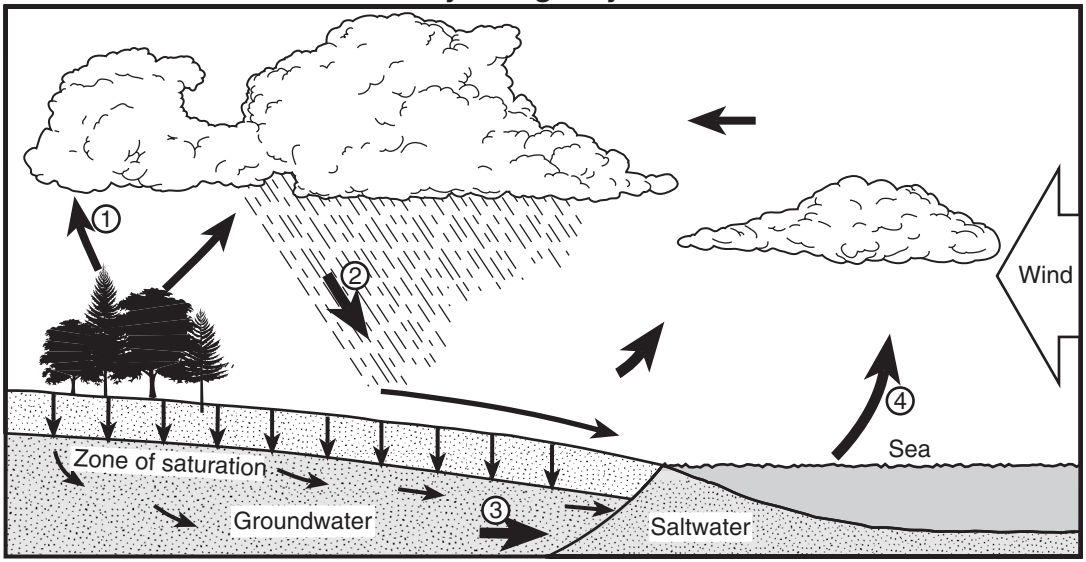


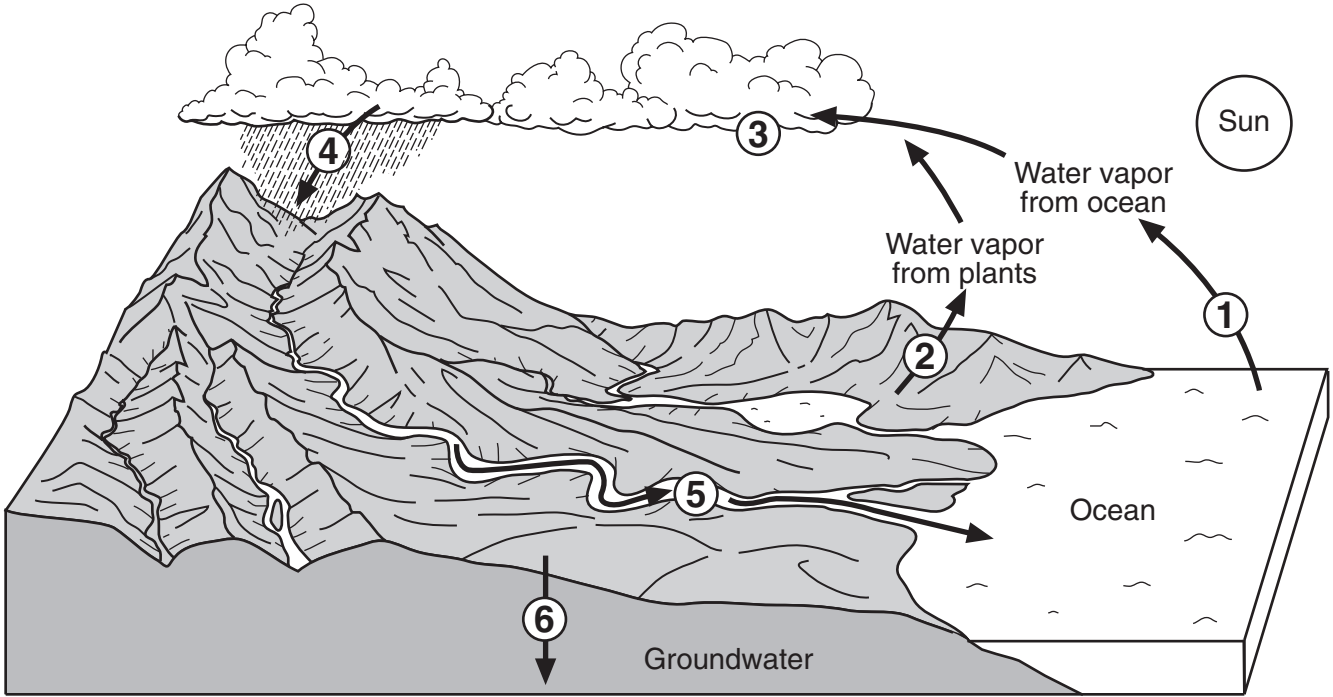

TOTAL STORED IN ATMOSPHERE 0.013
Water vapor transport
Evaporation/transpiration from land 0.073
Precipitation onto land 0.110
Precipitation into ocean 0.386
Evaporation from ocean 0.423
Stream runoff
TOTAL STORED ON CONTINENTS 38.631
TOTAL STORED IN OCEANS 1370.000

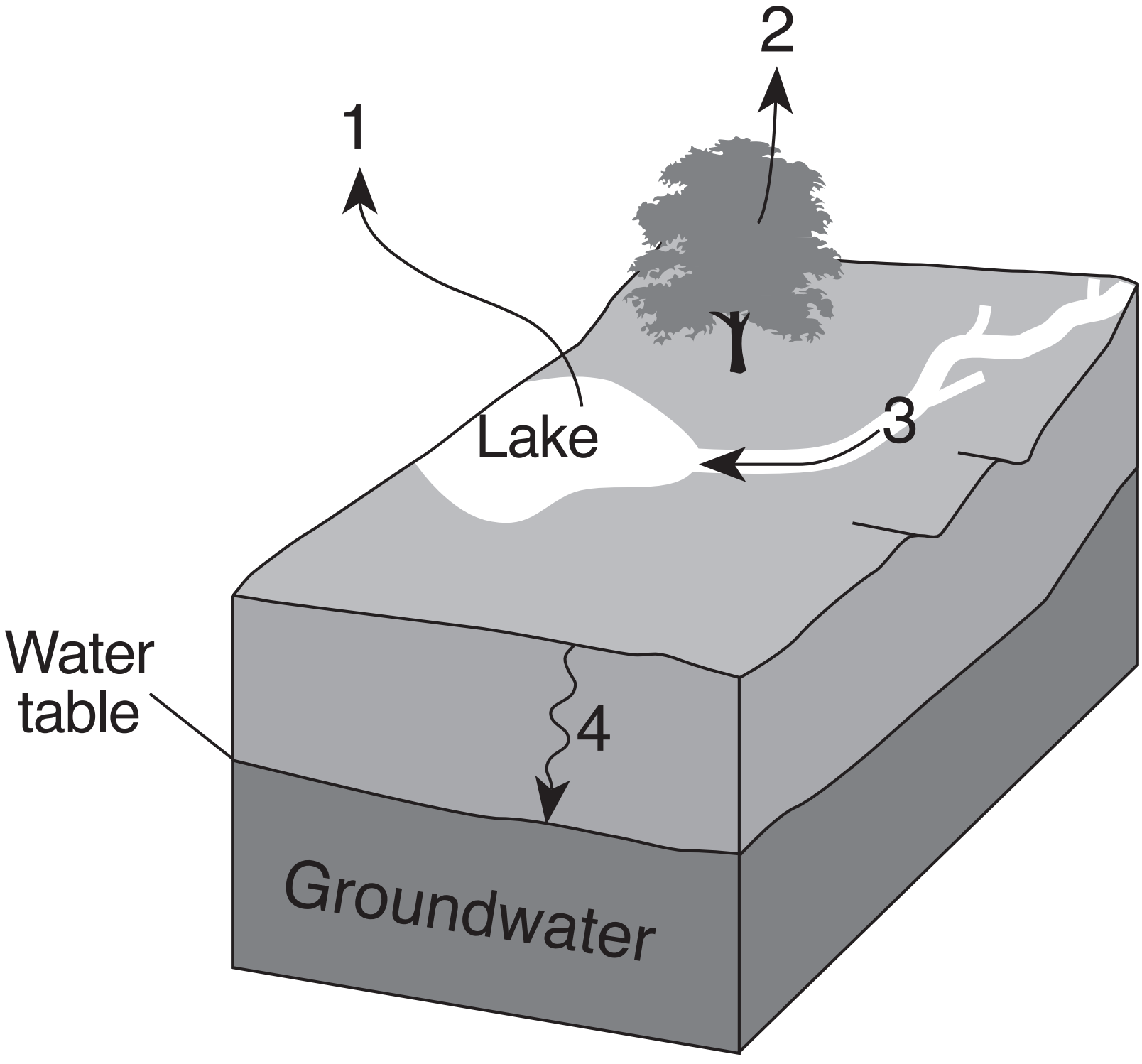

A
B
C
D

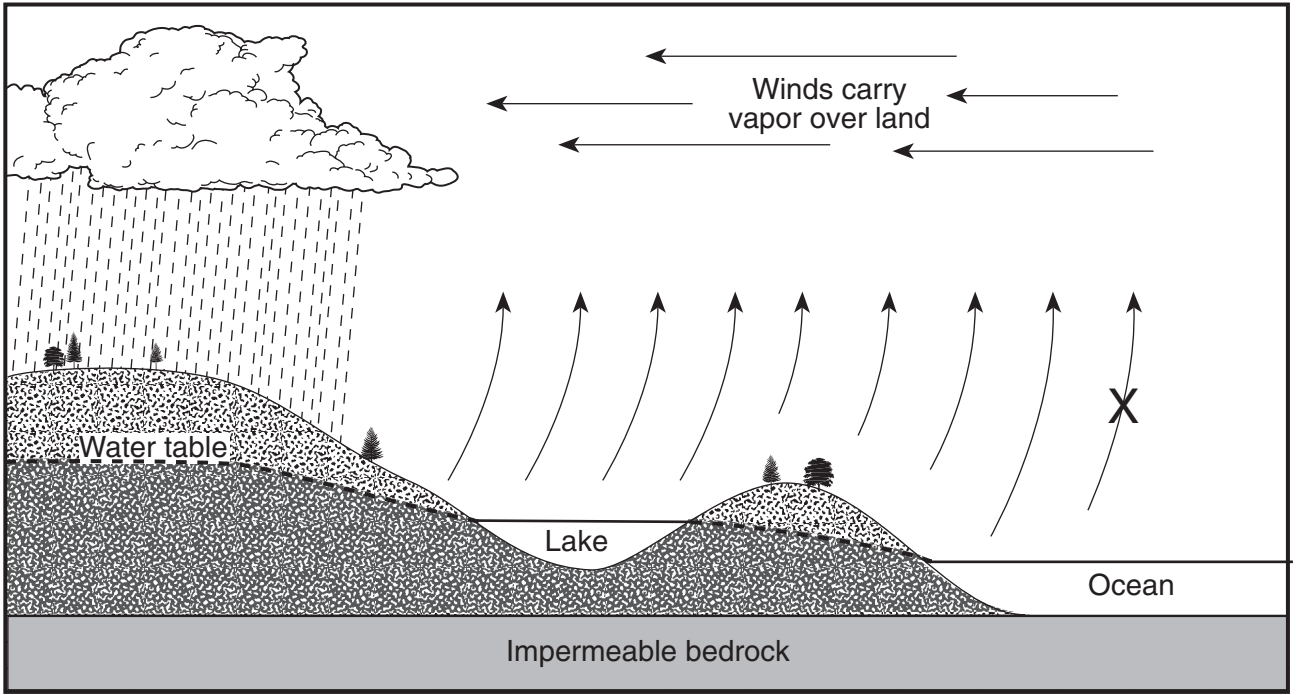

Condensation
Precipitation
Evaporation
Forest
Water table
A
Runoff
Ocean
Groundwater flow

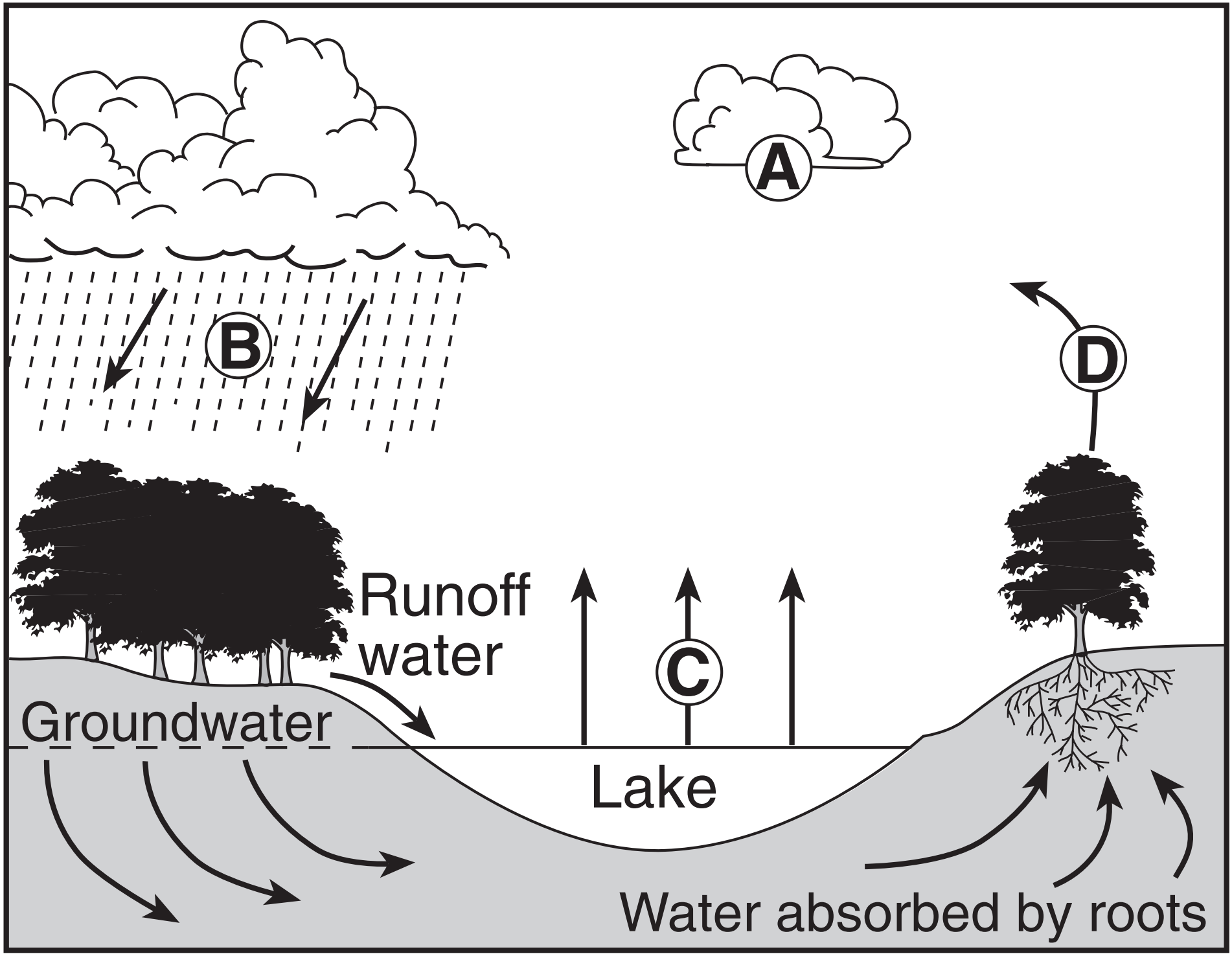
# Hydrologic Cycle



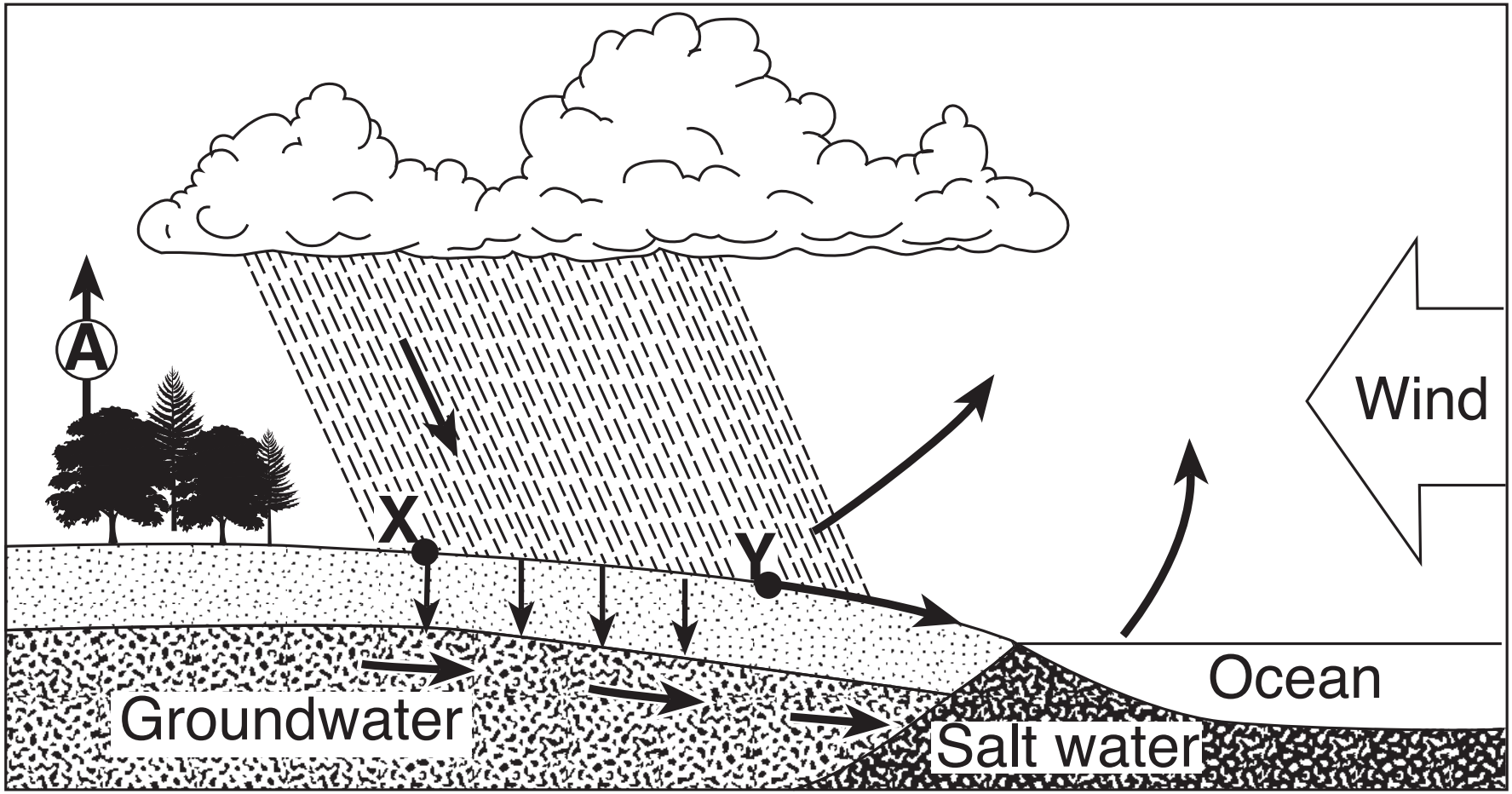

Sun
Water vapor from ocean
Water vapor from plants
1
2
3
4
5
6
Ocean
Groundwater

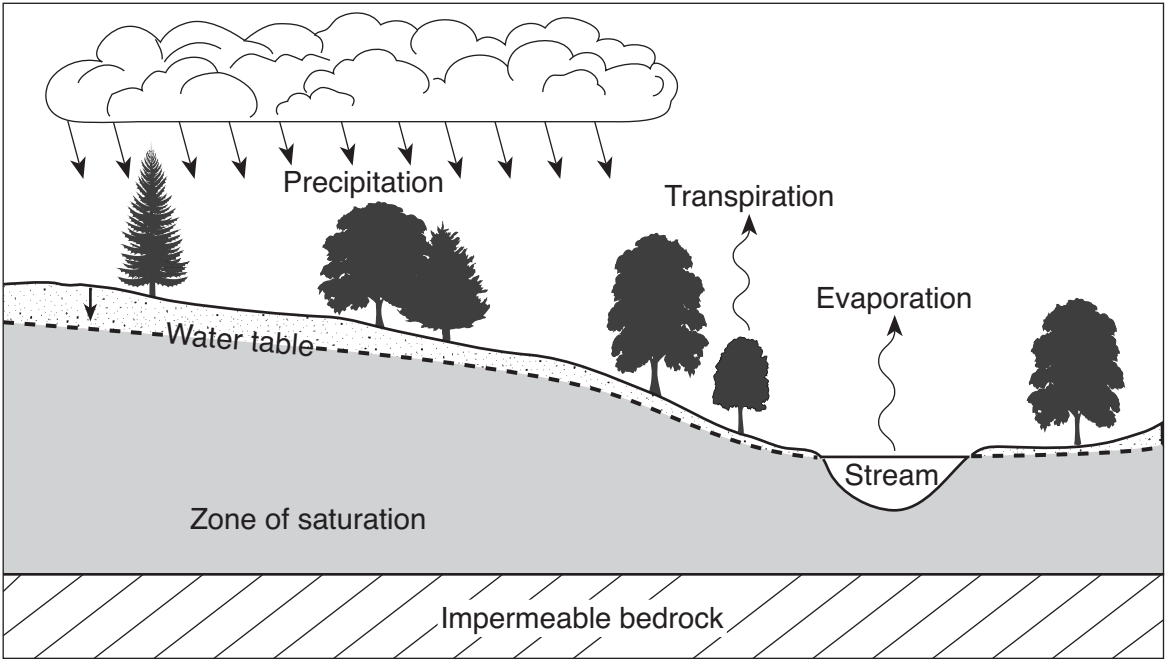

1
2
Lake
3
Water
table
4
Groundwater

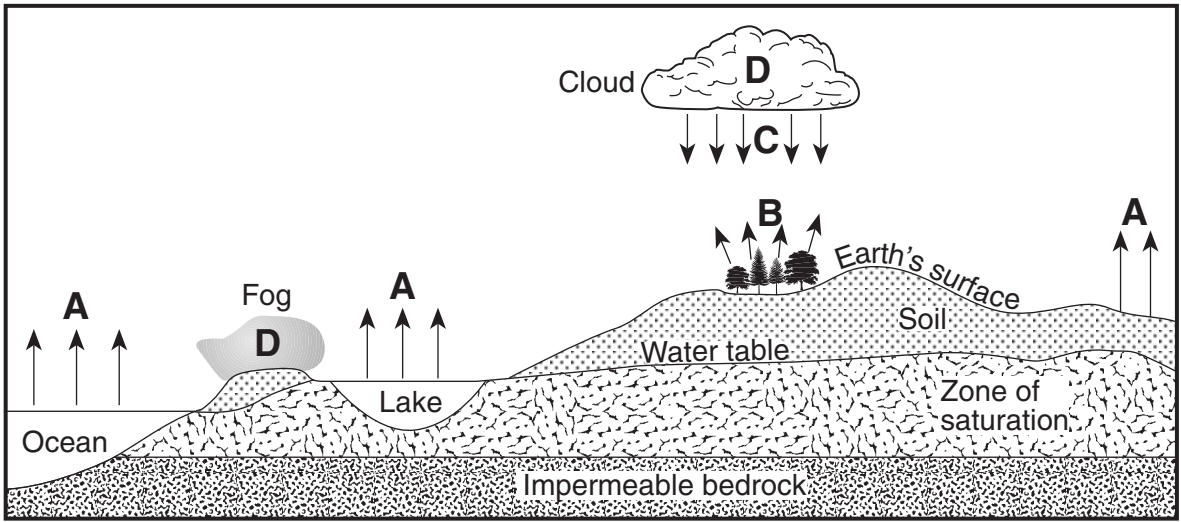

Winds carry
vapor over land
Water table
Lake
Ocean
Impermeable bedrock


A
B
C
D
Runoff
water
Groundwater
Lake
Water absorbed by roots

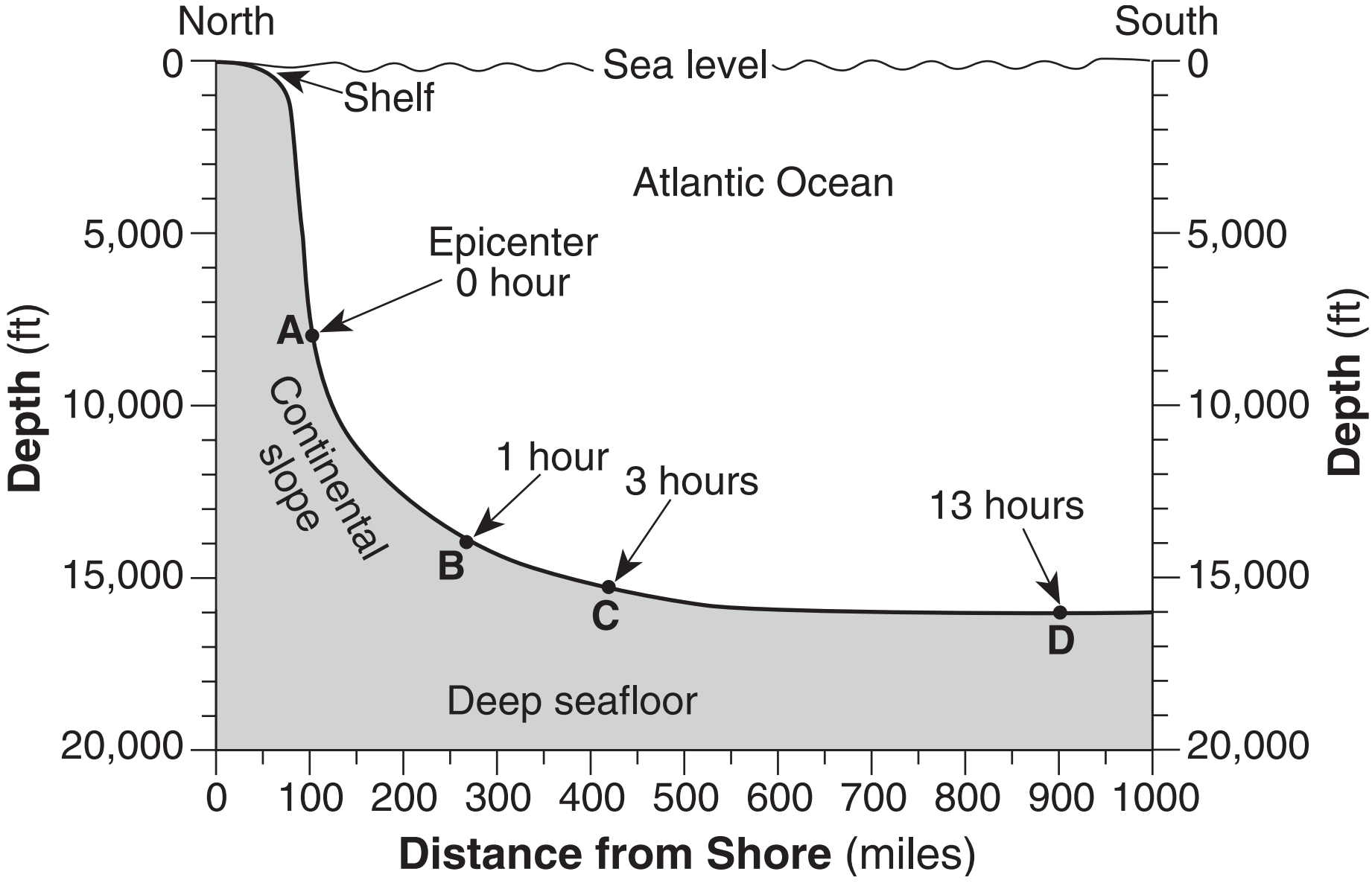
# Water Cycle

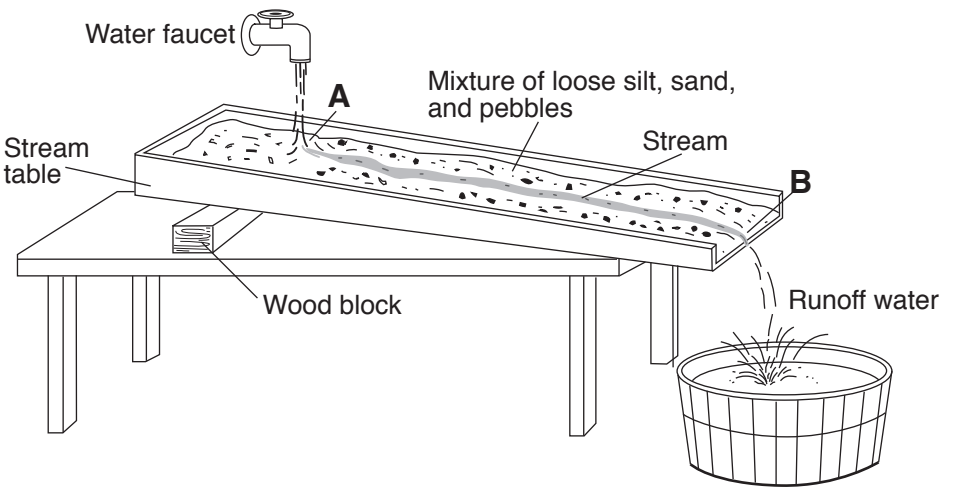


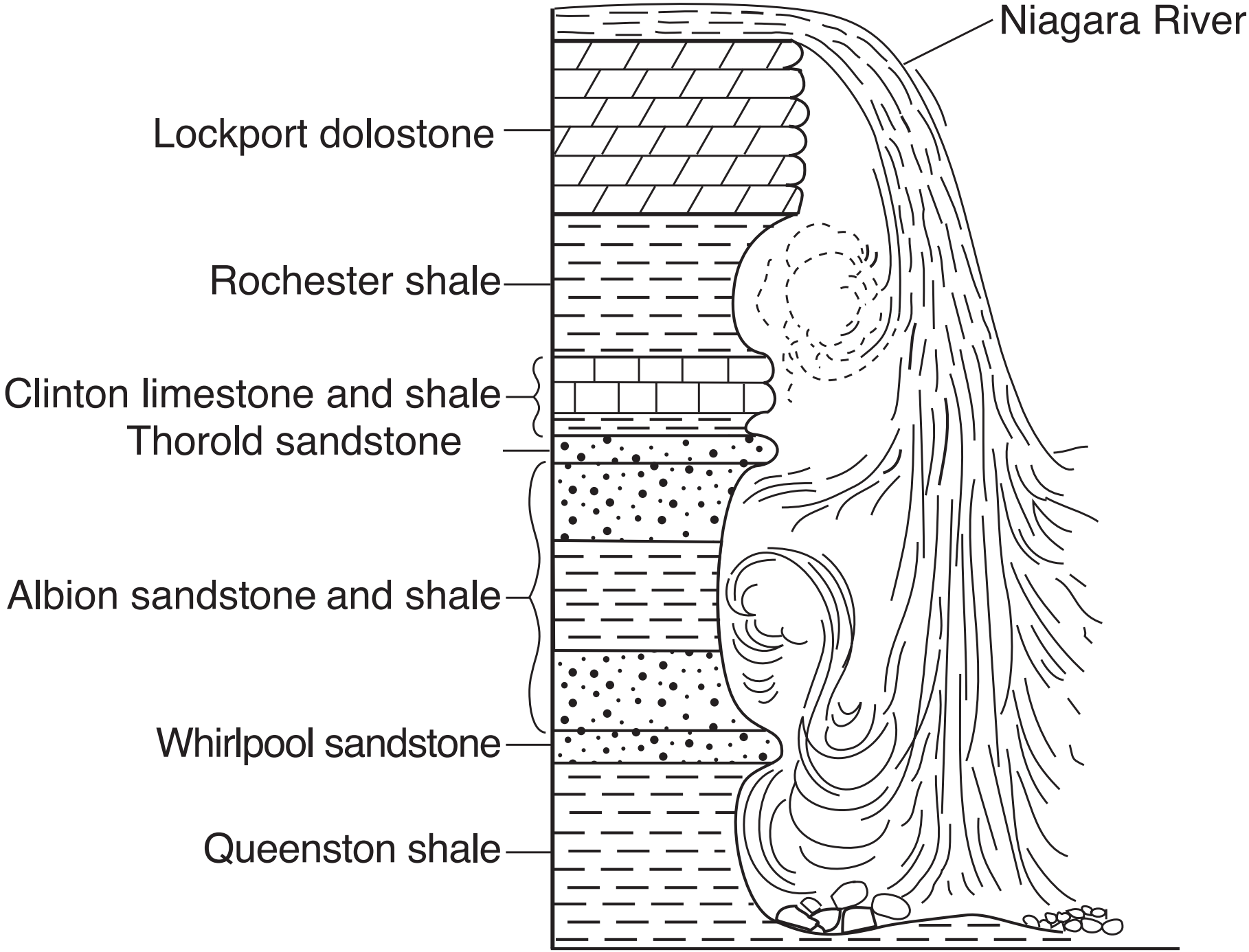

Precipitation
Transpiration
Evaporation
Water table
Stream
Zone of saturation
Impermeable bedrock

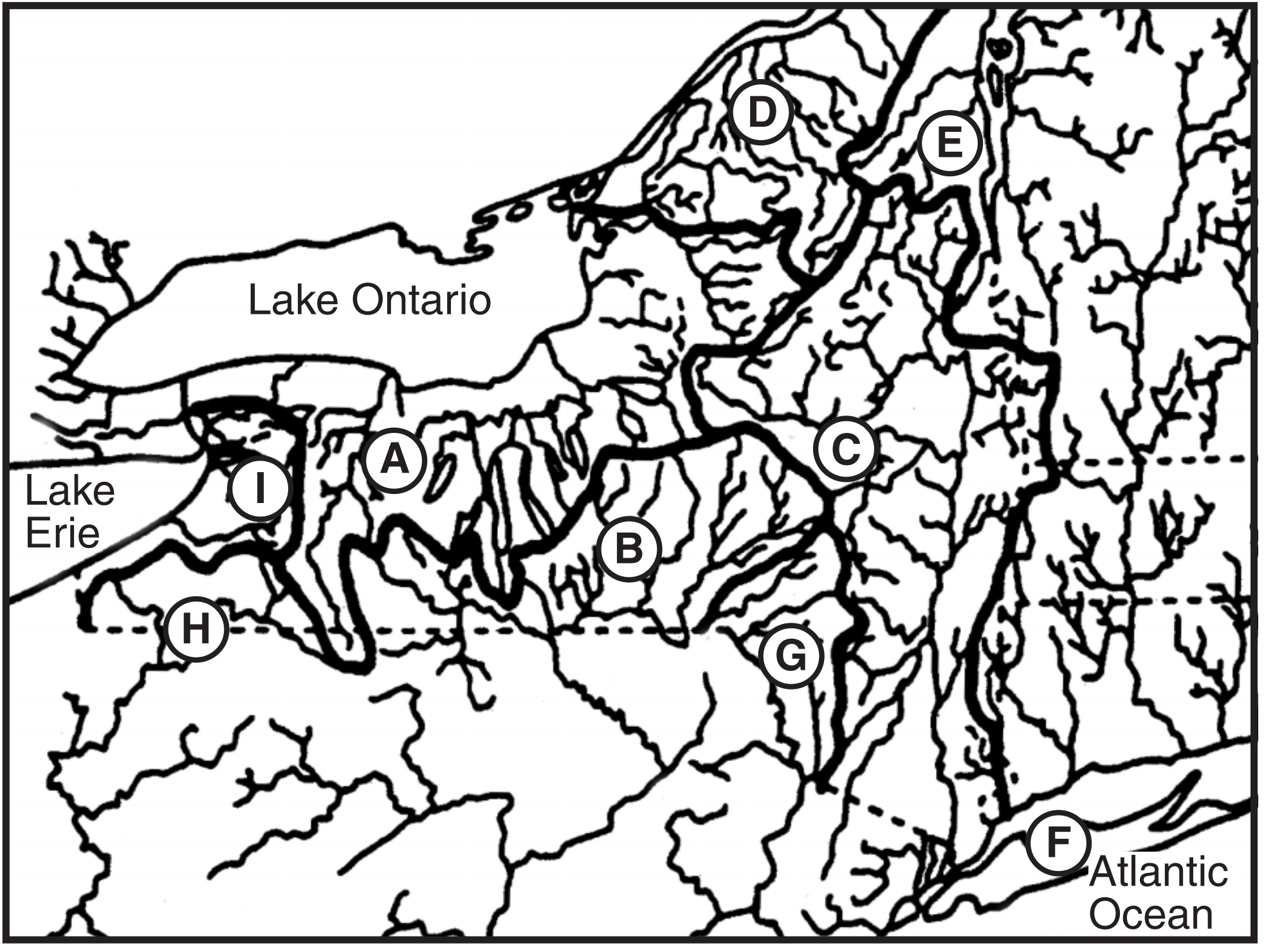

Cloud
D
C
B
A
A
Fog
D
A
Earth's surface
Soil
Water table
Lake
Zone of saturation
Ocean
Impermeable bedrock

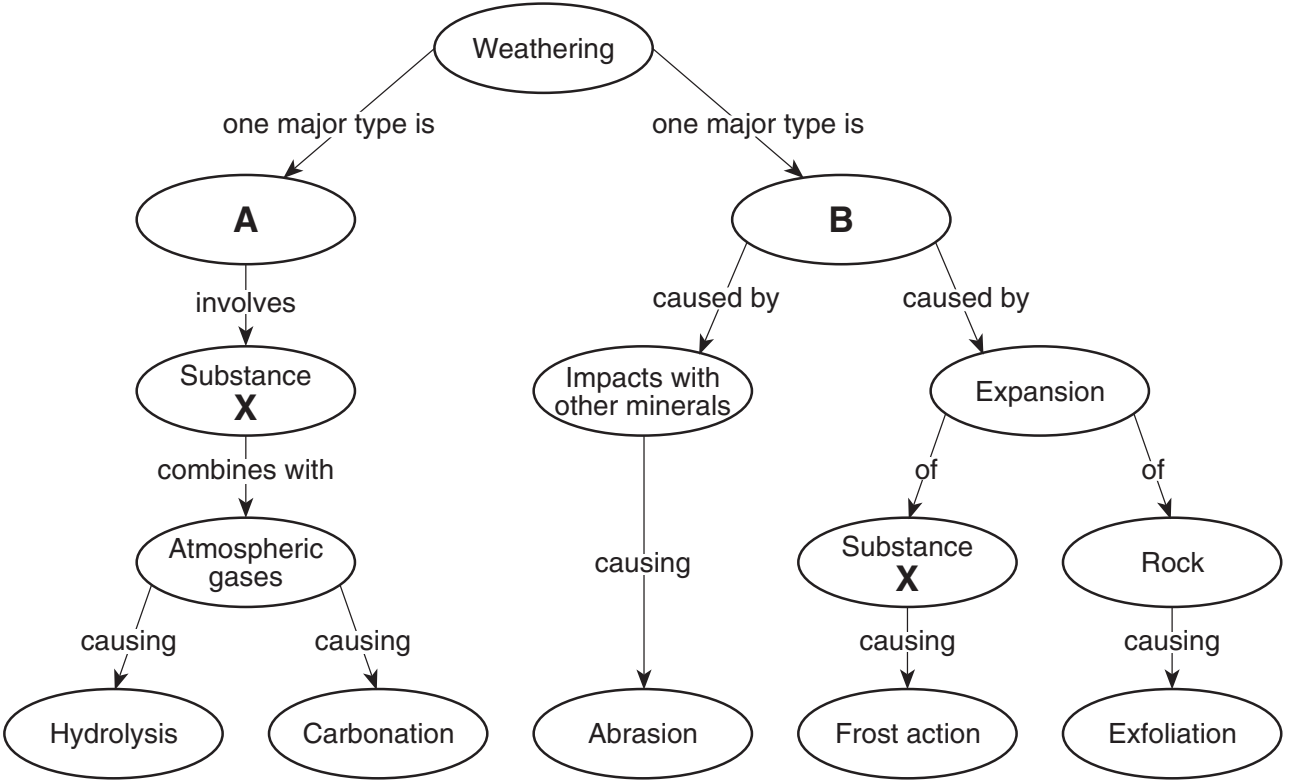
Precipitation
Runoff
Ocean
???
Water vapor

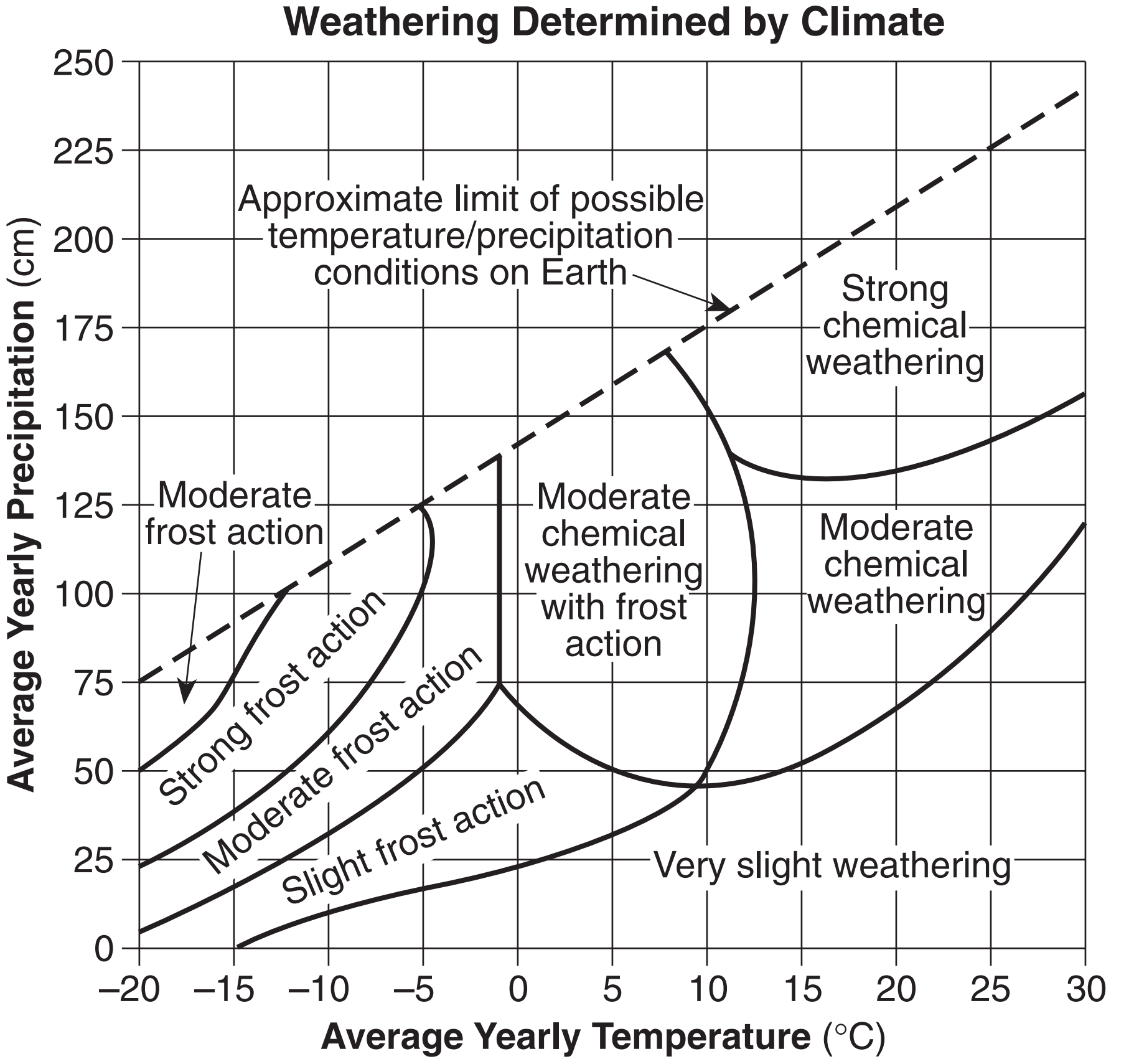

North
South
0
Sea level
0
Shelf
Atlantic Ocean
5,000
Epicenter
0 hour
5,000
A
Depth (ft)
10,000
Continental slope
1 hour
3 hours
13 hours
10,000
Depth (ft)
B
15,000
C
D
15,000
Deep seafloor
20,000
20,000
0 100 200 300 400 500 600 700 800 900 1000
Distance from Shore (miles)

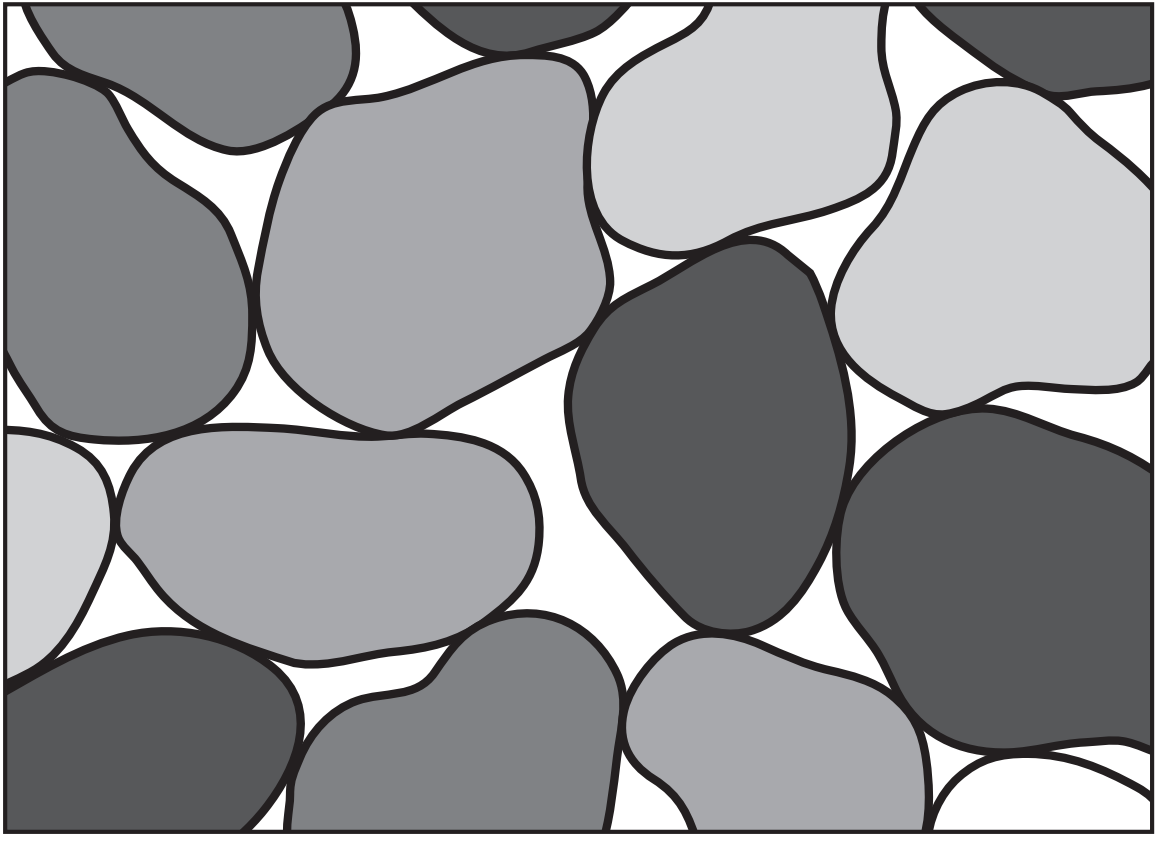

Water faucet
A
Mixture of loose silt, sand, and pebbles
Stream
Stream table
B
Wood block
Runoff water

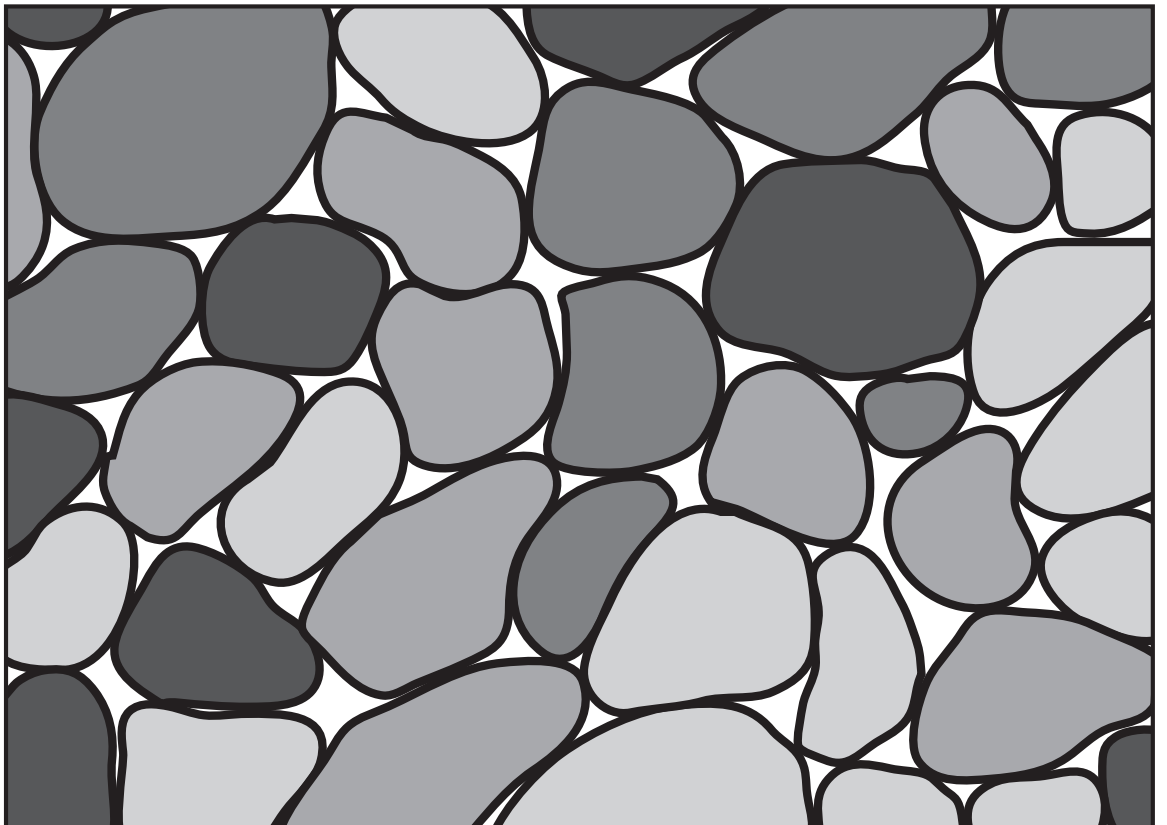

Niagara River
Lockport dolostone
Rochester shale
Clinton limestone and shale
Thorold sandstone
Albion sandstone and shale
Whirlpool sandstone
Queenston shale

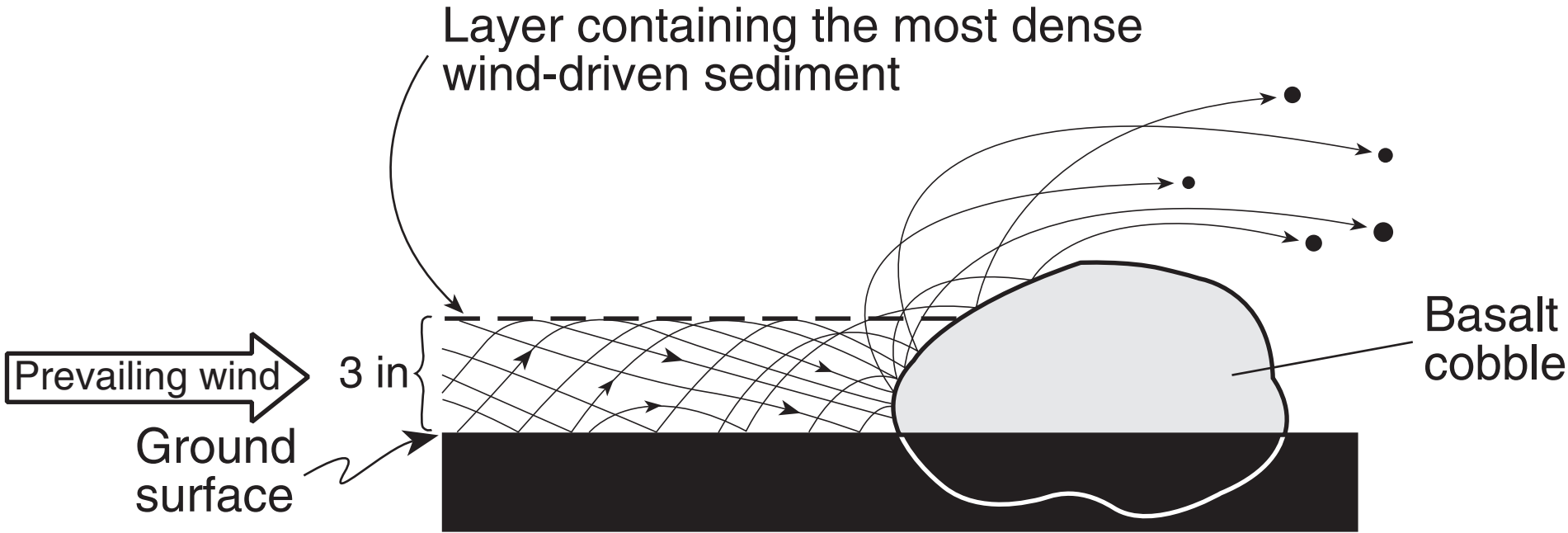

Lake Ontario
Lake Erie
Atlantic Ocean
A
B
C
D
E
F
G
H
I

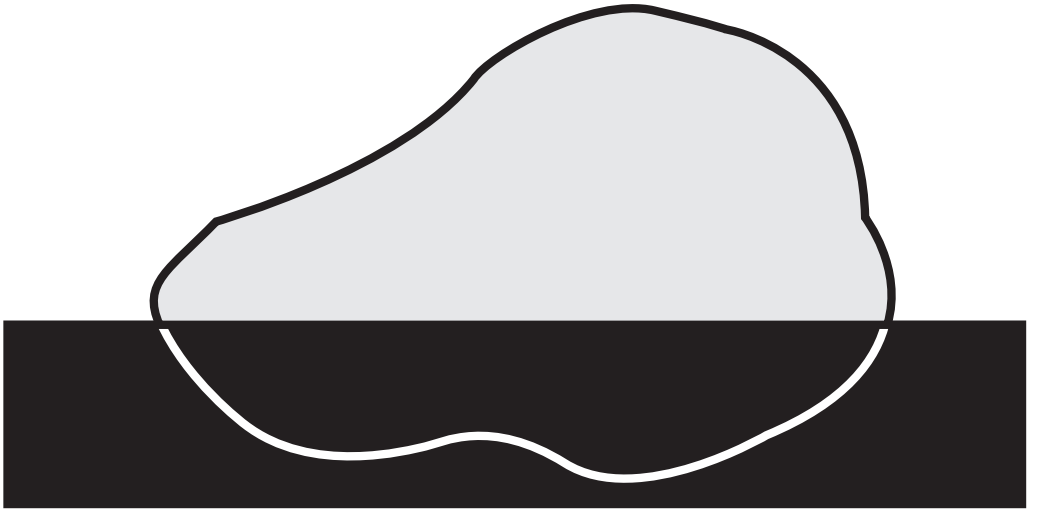

Weathering
one major type is
one major type is
A
B
involves
caused by
caused by
Substance X
Impacts with other minerals
Expansion
combines with
of
of
Atmospheric gases
causing
Substance X
Rock
causing
causing
causing
causing
Hydrolysis
Carbonation
Abrasion
Frost action
Exfoliation

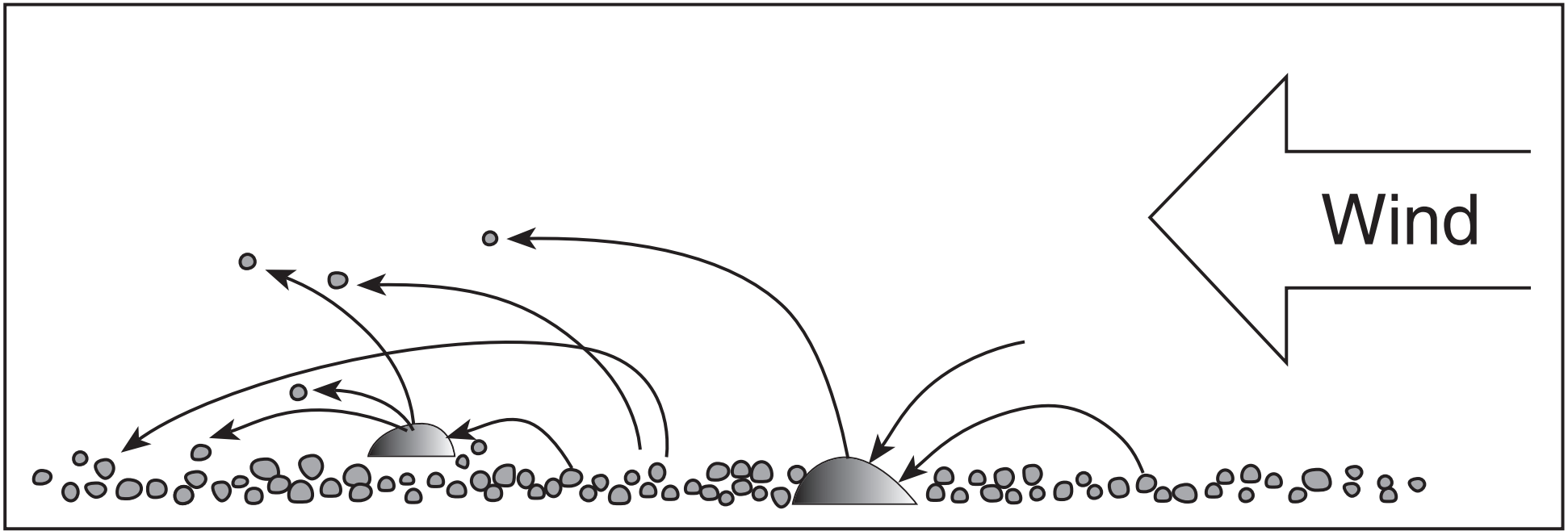

Weathering Determined by Climate
Average Yearly Precipitation (cm)
250
225
200
175
150
125
100
75
50
25
0
Approximate limit of possible temperature/precipitation conditions on Earth
Strong chemical weathering
Moderate frost action
Moderate chemical weathering with frost action
Moderate chemical weathering
Strong frost action
Moderate frost action
Slight frost action
Very slight weathering
–20
–15
–10
–5
0
5
10
15
20
25
30
Average Yearly Temperature (°C)






Layer containing the most dense wind-driven sediment
Prevailing wind
3 in
Ground surface
Basalt cobble




Wind