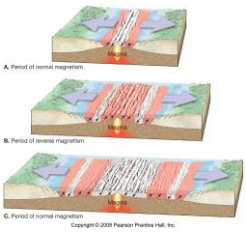
Plate Tectonics (Part 2)

- Seafloor Spreading
- Mantle Convection
- Mid-ocean Ridges
- Transform Faults
- Magnetic Reversals
- Opening Ocean Basins
- Mantle Plumes/Hot Spots
- Quiz



1

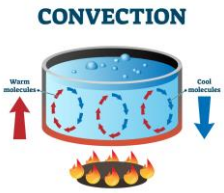
Seafloor Spreading

The Growth and Bathymetry of Ocean Basins

2

Thermal Convection

- Convection is the transfer of heat from one place to another due to the movement of fluid or gas
- Warmer portions are less dense and rise while cooler portions are of higher density and sink
- The overall circulation is an effective way of transferring heat from Earth's interior to the surface



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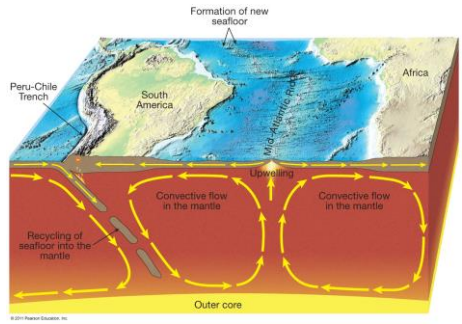
Arthur Holmes (1928) Proposed Thermal Convection As The Driving Force For Continental Drift. Harry Hess In The 1960's Suggested That Convective Motion Of The Mantle Created And Transported Oceanic Lithosphere



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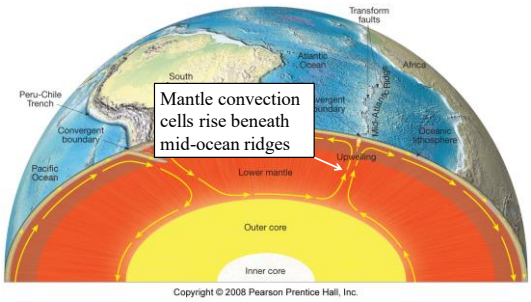

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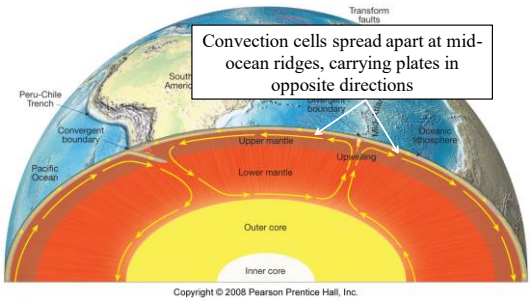

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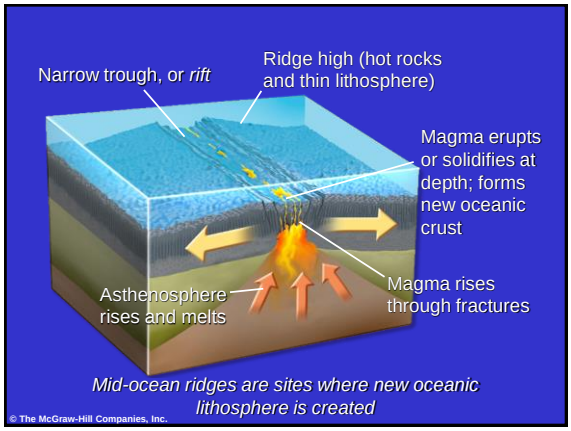
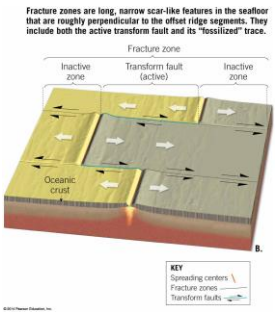


7

Transform Fault Boundaries

- Plates slide past one another so that lithosphere is neither created nor destroyed
- Transform faults are important features in ocean basins:
  - Most join two segments of a mid-ocean ridge along breaks in the oceanic crust known as fracture zones
  - A few (the San Andreas fault and the Alpine Fault of New Zealand) cut through continental crust



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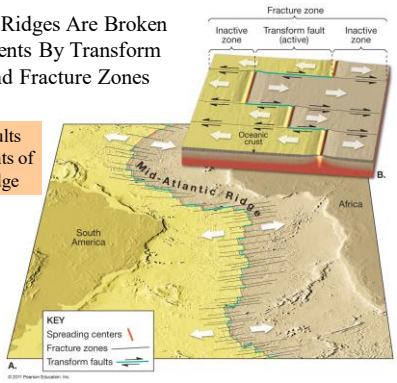
Mid-ocean Ridges Are Broken Into Segments By Transform Faults And Fracture Zones

Transform faults offset segments of mid-ocean ridge



9

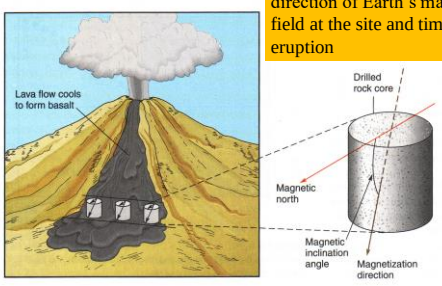
Seafloor Magnetic Anomaly Patterns

Polarity Reversals Throughout Earth History Are Recorded As Magnetic Stripes In Oceanic Crust

10

Measuring Paleomagnetism in Rocks

Lava flows record the direction of Earth's magnetic field at the site and time of eruption



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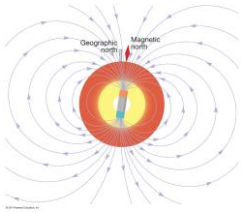
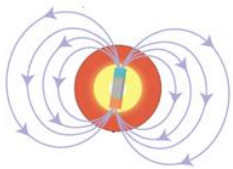
Magnetic Reversals



Earth's present magnetic lines of force travel from the magnetic south to north poles (normal polarity)



Magnetic polarity has flipped many times in the past (reverse polarity) where lines of force traveled from the north to south poles

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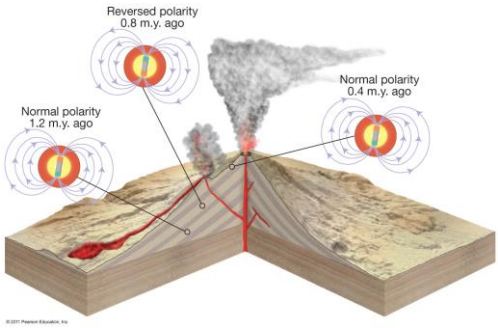
Older Lava Flows Record Reversals in the Earth's Magnetic Field at Various Times in the Past



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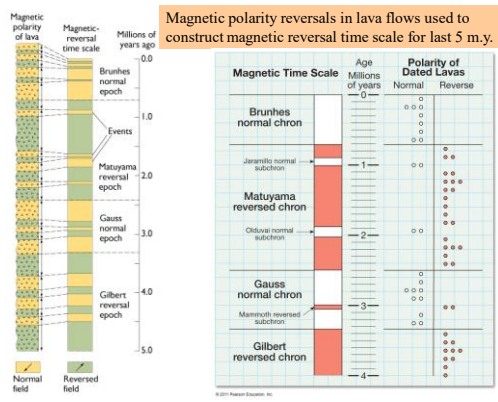
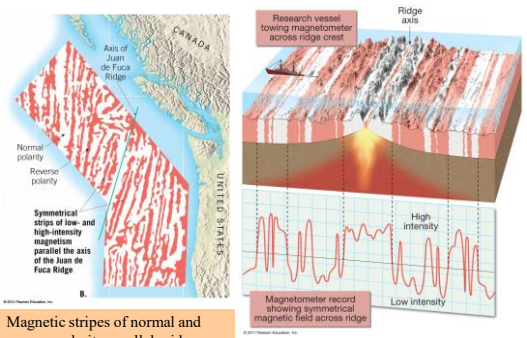


Magnetic polarity reversals in lava flows used to construct magnetic reversal time scale for last 5 m.y.

14



Magnetic stripes of normal and reverse polarity parallel mid-ocean ridges

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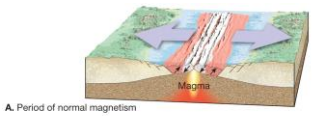

Oceanic crust formed during this time acquires normal polarity

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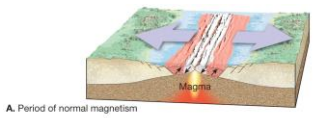

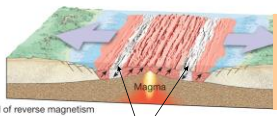

Oceanic crust formed during this time acquires reversed polarity

Previously-formed crust of normal polarity had split apart and move in opposite directions, forming stripes on either side of the mid-ocean ridge

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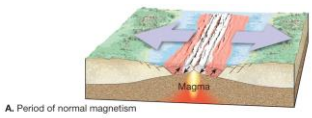
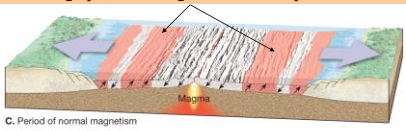


Previously-formed crust of reversed polarity now separated and moving apart, forming additional stripes



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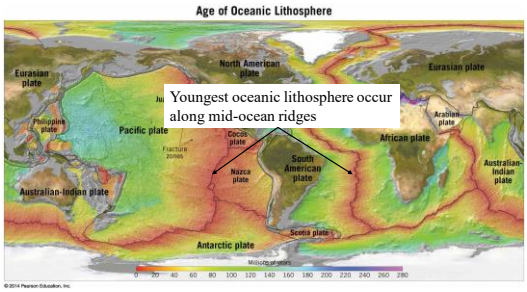

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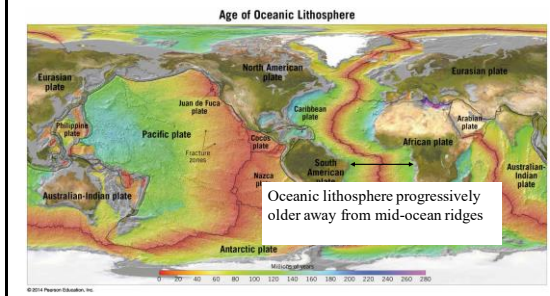

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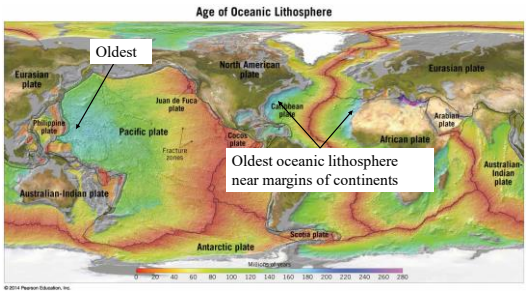

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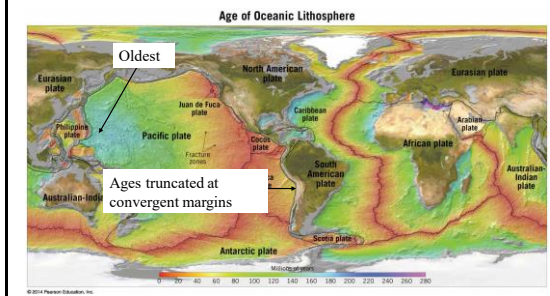

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Oceanic Lithosphere

- **New oceanic lithosphere moves laterally away from spreading ridges at rates ranging from 1 - 18cm/yr:**
  - **Youngest oceanic lithosphere occurs along the ridge axis**
  - **Oceanic lithosphere becomes progressively older away from the ridge axis**
  - **Oldest oceanic lithosphere occurs along the margins of ocean basins, adjacent to a subduction zone and/or continental margin**

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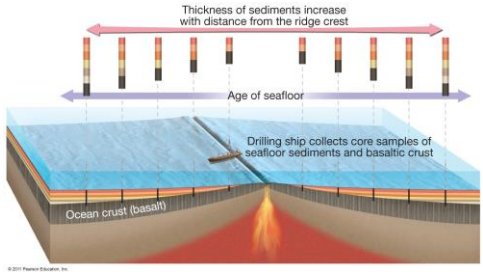

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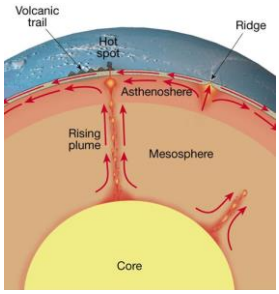
Mantle Plumes and Hot Spots

- Mantle Plumes:
  - Hot conduits of relatively buoyant mantle material rising towards the surface
  - Long-lived structures
  - Some originate at the core-mantle boundary
- Rising plumes imping upon the overlying lithosphere to form hot spots in the crust:
  - Volcanoes can form over them (Hawaiian Islands)



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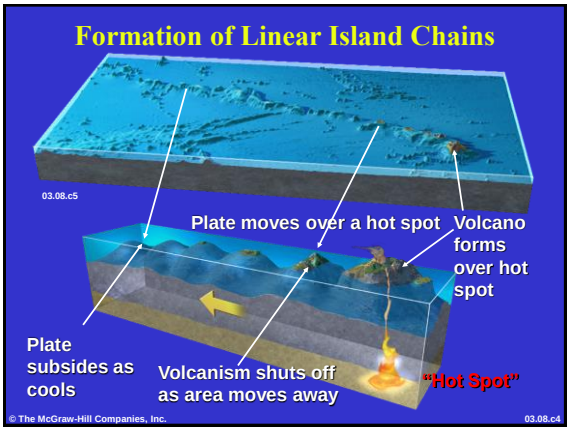

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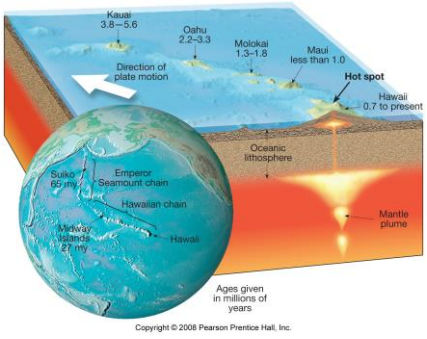
Mantle Plume And Hot Spot Creates A Line Of Volcanic Islands That Become Older Away From The Hot Spot



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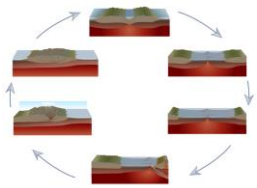
The Wilson Cycle

- J Tuzo Wilson in 1966 proposed the Wilson Cycle to explain the assembly and breakup of supercontinents like Pangea
- Model involves mantle plumes, seafloor spreading, and convergent plate boundaries



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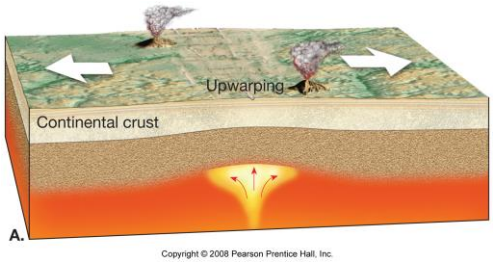
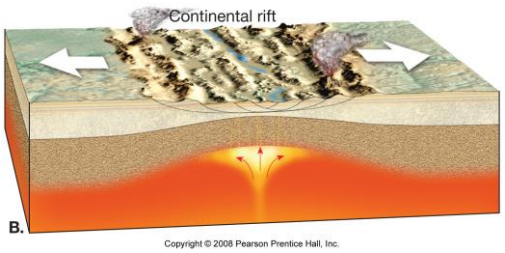
Stages in the Formation of an Ocean Basin



Hot upwelling mantle impinges on the base of continental lithosphere, causing upwarping of crust

29

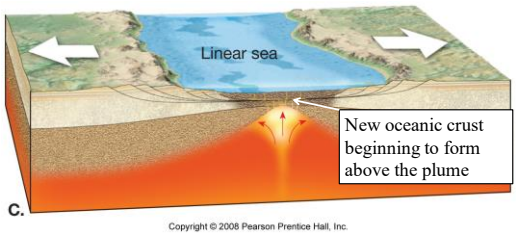
Stages Formation of an Ocean Basin (Continued)



Rifting of continental lithosphere accompanied by volcanism

30

Stages Formation of an Ocean Basin (Continued)



Linear sea opens between separating continents

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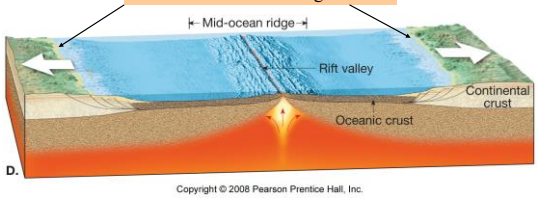
Stages Formation of an Ocean Basin (Continued)

Passive Continental Margins



Linear sea expands to form a mature ocean basin with a mid-ocean ridge at the site of plume activity

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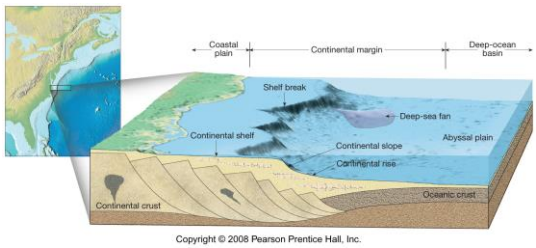
Passive Continental Margins Do Not Occur Along Plate Boundaries and Therefore Are Stable (No Volcanic Nor Earthquake Activity)



Examples: Gulf Coast and East Coast of North America

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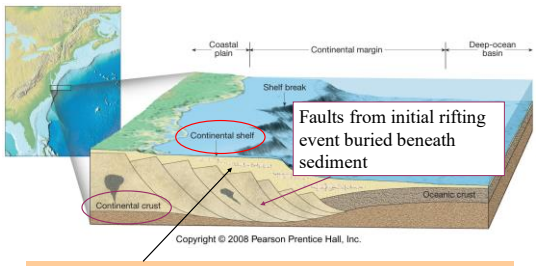
Continental Shelf Slopes Gently Seaward Towards Greater Water Depths



Thick layers of sediment from continent accumulate on shelf

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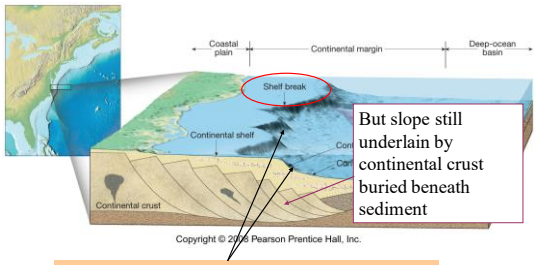
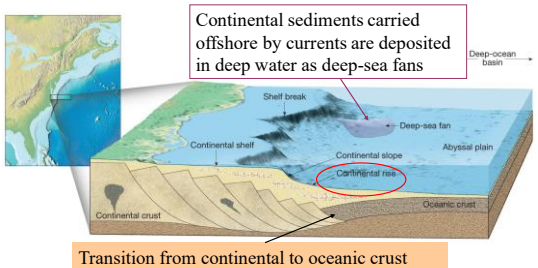
Dramatic Change In Slope At The Shelf Break



Continental slope has steeper dip than the shelf

35

Seafloor Flattens Out At The Continental Rise



Transition from continental to oceanic crust

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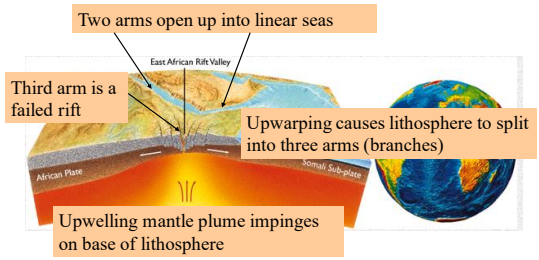
East African (Afar) Triple Junction

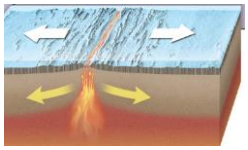


37

Answer Each of the following as True or False

1. New oceanic lithosphere is created along transform plate boundaries
2. Polar wander curves prove that continents remained stationary throughout Earth history while the magnetic north pole wandered about the globe
3. Similar fossils on continents widely separated by oceans is evidence for continental drift
4. Mid-ocean ridges are oriented parallel to the direction of seafloor spreading

False: Mid-ocean ridges are perpendicular to the direction of seafloor spreading

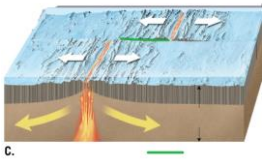


38

Answer Each of the following as True or False

1. Transform faults are oriented parallel to the direction of seafloor spreading

True



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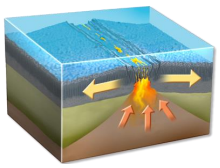
Answer Each of the following as True or False

1. Transform faults are oriented parallel to the direction of seafloor spreading
2. The deepest parts of ocean basins occur along mid-ocean ridges

False: Mid-ocean ridges rise above surrounding seafloor because newly-formed oceanic crust is warmer, less dense, and hence more buoyant than older crust.



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Indicate If Each Of The Following Statements Is True Or False

- Magnetic stripes are parallel to mid-ocean ridges

True

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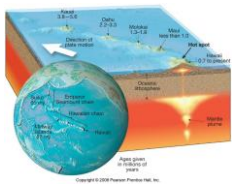
Indicate If Each Of The Following Statements Is True Or False

- Magnetic stripes are parallel to mid-ocean ridges
- In moving farther away from a hot spot, volcanoes become progressively younger

False: Volcanoes become progressively older

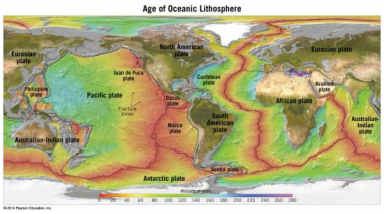


42

Indicate If Each Of The Following Statements Is True Or False

- The oldest oceanic crust is found near the margins of an ocean basin

True



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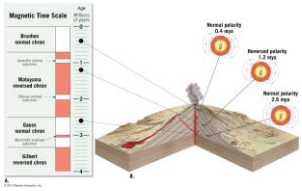
Indicate If Each Of The Following Statements Is True Or False

- The oldest oceanic crust is found near the margins of an ocean basin
- Lithospheric plates are stationary while underlying mantle plumes migrate
- Earth's magnetic field reverses direction every 500,000 to 1 million years

True



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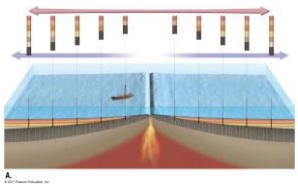
Indicate If Each Of The Following Statements Is True Or False

- Deep-sea sediment that accumulates on the seafloor is thickest along mid-ocean ridges and becomes thinner when moving farther away from the ridge axis

False: Seafloor sediment becomes thicker away from the ridge because older oceanic crust had a longer time to accumulate sediment



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