NO PREP

# Divergent Boundaries

## Where Plates Pull Apart

**Includes:** Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

# Divergent Boundaries: Where Plates Pull Apart

### Nature of Divergence

Earth's surface is divided into tectonic plates that drift atop the viscous upper mantle. Among the various plate interactions, divergent boundaries stand out for their creative force: they generate new crust. As two plates pull apart, magma emerges from below, solidifying to form oceanic ridges or continental rifts. Though the motion can be as slow as a few centimeters per year, these expansions have sculpted oceans and even helped split continents. One of the most expansive examples is the mid-ocean ridge network, an underwater system stretching across the globe like the seams of a baseball. Magma wells up through these ridges, cooling rapidly when it contacts cold seawater. This results in fresh layers of basalt, gradually pushing older crust aside. On land, divergent zones can form dramatic rift valleys like the East African Rift, where the African Plate is slowly separating, hinting that a future ocean basin may someday emerge in this area.

### Formation of Mid-Ocean Ridges

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## Nature of Divergence

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## Formation of Mid-Ocean Ridges

In the mid-20th century, scientists gathering seafloor data noticed that rocks near the ridges were surprisingly young, while those farther away were older. This led to the theory of seafloor spreading. Along these submarine mountain chains, magma seeps from the mantle and crystallizes. The ridges aren't just static bumps; they often feature a central rift valley where the seafloor splits. Hydrothermal vents, or "black smokers," dot some areas, spewing superheated, mineral-laden water that supports exotic chemosynthetic life forms. These hydrothermal ecosystems surprised biologists, as they rely on chemical energy rather than sunlight. Tube worms, giant clams, and specialized bacteria flourish around these vents, offering insight into how life might exist in extreme environments beyond Earth. Geophysicists and marine geologists deploy submersibles and robotic vehicles to

study these depths, tracing how the entire ocean floor renews itself over tens of millions of years.

**Continental Rifts**

While most divergent boundaries lie beneath oceans, some occur on land. When a continent begins to break apart, the crust thins and stretches, forming a rift valley. The East African Rift provides a compelling case, showcasing volcanic mountains such as Mount Kilimanjaro, hot springs, and repeated earthquakes. Over millions of years, water may invade these rifts, transforming them into narrow seas and, potentially, new oceans. Local communities in rift zones face both opportunities and challenges. Geothermal energy is abundant, offering a cleaner power source compared to fossil fuels. On the flip side, faulting can damage infrastructure and farmland, while volcanic hazards threaten towns. Understanding rift dynamics helps governments implement building codes, disaster preparedness, and sustainable energy projects.

**Influence on Climate and Ecology**

Divergent boundaries affect global climate primarily through volcanic outgassing of carbon dioxide and other gases, although the contribution is small compared to human emissions. Changes in ocean basin size can modify ocean currents, which, in turn, influence temperature and precipitation patterns. Newly formed ocean floors can also shape marine ecosystems, altering the habitats of fish and other sea life. Mantle plumes associated with rift zones sometimes bring unusual hotspots—regions where volcanism persists for millions of years. These hotspots can form entire island chains, like Hawaii, although that chain is over a hotspot unrelated to a major plate boundary. Meanwhile, in areas such as Iceland—where a divergent boundary emerges above sea level—the interplay of fire and ice creates a geologically active wonderland. By studying these unique sites, scientists gain a deeper understanding of how Earth's plates, oceans, and climate co-evolve.

**Key Information: Table**

| Divergent Boundary | Primary Feature | Key Process |
|---|---|---|
| Mid-Ocean Ridge | Undersea mountain range | Seafloor spreading |
| Continental Rift | Rift valleys on land | Crustal thinning, volcanism |

**Case Study Excerpt (Iceland on the Mid-Atlantic Ridge)**

**Perched squarely atop the Mid-Atlantic Ridge, Iceland is a living exhibit of divergent boundary processes. Visitors see geysers blasting superheated water into the air, lava fields still warm to the touch, and tectonic rifts that cut across the countryside. As the Eurasian and North American plates separate beneath Iceland, magma rises to fill the gap. Successive eruptions have gradually built the island up over eons. In 2010, the Eyjafjallajökull volcano erupted beneath an ice cap, generating steam explosions that propelled ash into the upper atmosphere. Air travel across Europe halted for days, as airports shut down under drifting ash clouds. Meanwhile, Iceland's residents tapped the same geothermal sources for energy—using hot water to heat homes, power turbines, and warm greenhouses throughout frigid winters. Beyond geologic spectacle, Iceland's economy benefits from tourism drawn by its dramatic scenery: erupting fissures, ice caves, and rugged coastlines. Locals remain ever aware that these volcanic forces can disrupt daily life, but they also celebrate the island's bountiful geothermal power. This duality—risk from frequent seismic and volcanic events, paired with near-limitless clean energy—defines Iceland's identity as a nation shaped by divergent geology.**

1. How do Icelanders harness geothermal energy linked to their divergent boundary setting?

2. Why did Eyjafjallajökull's 2010 eruption disrupt global travel, even though Iceland is relatively small?

**Multiple Choice**

1. Seafloor spreading is driven by:

    a) Earth's rotation splitting the oceanic crust into pieces

    b) Storm systems eroding undersea canyons and sediment

    c) Magma rising at mid-ocean ridges to create new crust

    d) Subduction forcing continents upward

2. A continental rift indicates:

    a) A hotspot forming in the ocean floor region

    b) Plates pulling apart within a landmass

    c) Immediate mountain building

    d) Two continents colliding at a boundary

3. Hydrothermal vents near mid-ocean ridges:

    a) Support life through sunlight-based photosynthesis

    b) Provide chemical energy for unique marine organisms

    c) Release cold freshwater into the ocean

    d) Have no ecological importance

**Matching**

Write the letter of the correct definition on the line next to each term.

| Term | Definition |
|---|---|
| 1. ___ Rift Valley | A) Seafloor feature ejecting hot, mineral-rich fluids |
| 2. ___ Seafloor Spreading | B) Undersea mountain chain formed by rising magma |
| 3. ___ Mid-Ocean Ridge | C) Elongated depression where continental crust splits |
| 4. ___ Hydrothermal Vent | D) Divergent boundary appearing above sea level |
| 5. ___ Iceland | E) Solidification of new oceanic crust at ridges |

**Fill-in-the-Blank**

1. _____ boundaries pull plates apart, allowing magma to rise.

2. _____ is where new oceanic crust forms at mid-ocean ridges.

3. A _____ develops on land when continental plates begin to diverge.

**Short Answer**

Answer each question in 2-4 complete sentences.

1. How does seafloor spreading help us understand plate movement?

_____

_____

_____

2. In what ways are continental rifts different from mid-ocean ridges?

_____

_____

_____

3. Why might communities in rift zones be interested in geothermal energy?

_____

_____

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