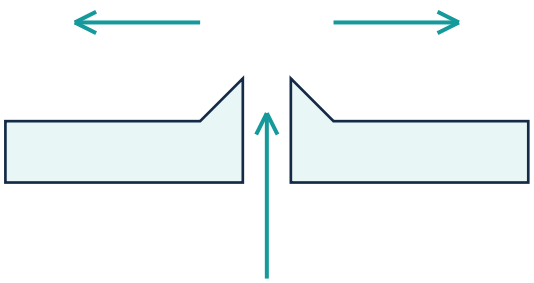
Start with relative plate motion

Earth's lithosphere consists of rigid plates made of crust and uppermost mantle. The underlying asthenosphere is mostly solid rock that can deform and flow slowly, not a global ocean of liquid magma.

1. PLATES ARE NOT THE SAME AS CONTINENTS

One plate can contain both oceanic and continental crust. Internal heat, mantle flow and gravity-related forces such as slab pull help drive motion. At a boundary, identify whether the two plates move apart, together or past each other.

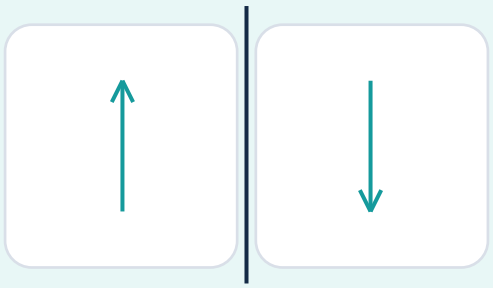
2. DIVERGENT: PLATES MOVE APART



Oceanic ridge: cross-section

As plates separate, mantle material rises and can partially melt as pressure falls. Magma cools to form new oceanic crust at a ridge. Divergence within a continent can form a rift valley. Volcanism and shallow earthquakes are common.

3. TRANSFORM: PLATES SLIDE PAST



View from above

Motion is parallel to the boundary. Crust is neither created nor consumed by this sliding motion. Locked fault sections can store strain and then slip, producing earthquakes. Transform motion does not usually generate magma. Example: the San Andreas Fault.

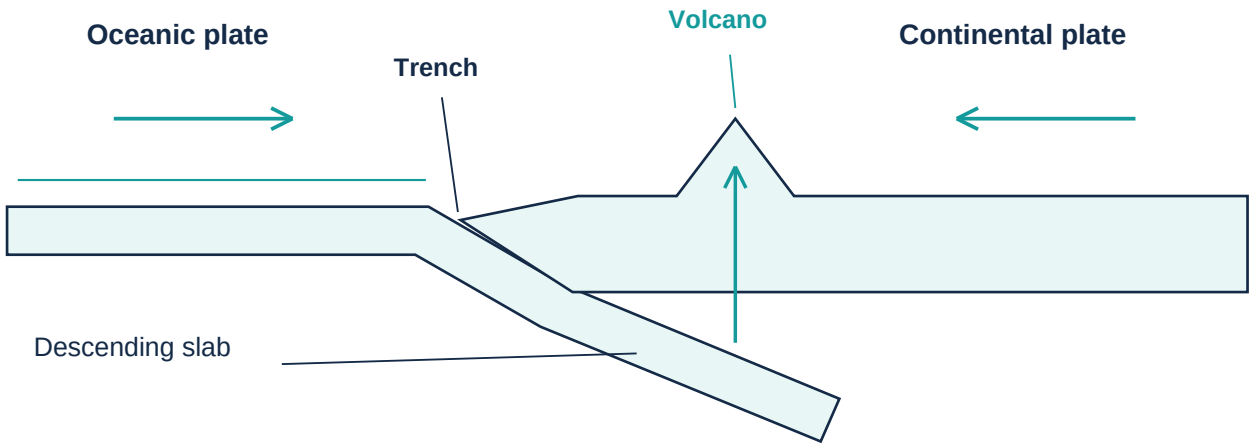
Divergent and transform outcomes: College Board, ERT-4.A.2-3.
Boundary processes and examples: USGS, Understanding plate motions.

Scope: College Board AP Environmental Science CED, Topic 4.1, p. 80.

Convergence: subduct or collide

Convergent plates move toward each other. What happens next depends on the lithosphere involved: dense oceanic lithosphere can descend, while buoyant continental crust tends to resist deep subduction.

1. OCEAN-CONTINENT: SUBDUCTION



Water released from the slab promotes melting in the mantle above it. Magma rises through the overriding plate. This can form an offshore trench and a continental volcanic arc, such as the Andes. Schematic, not to scale.

2. OCEAN-OCEAN: VOLCANIC ISLAND ARC

One oceanic plate subducts beneath another, commonly with older, colder, denser lithosphere sinking. A trench forms at the boundary and magma can build a curved chain of volcanic islands on the overriding plate. The Mariana island arc is an example. Earthquakes occur along the descending slab.

3. CONTINENT-CONTINENT: MOUNTAIN BUILDING

When continents collide, crust compresses, folds and thickens to build large mountain ranges, such as the Himalayas. Strong earthquakes can occur, but this collision does not typically produce a subduction-style volcanic arc. Do not assume that every convergent boundary has volcanoes.

Convergent landforms and events: College Board, ERT-4.A.1.
Subduction and continental collision: USGS, Understanding plate motions.

Scope: College Board AP Environmental Science CED, Topic 4.1, p. 80.

Read patterns, explain the process

Plate maps help locate likely tectonic activity, but they are not precise earthquake forecasts. Combine boundary type, motion arrows, earthquake depth and volcanic patterns.

1. HOW A LOCKED FAULT PRODUCES AN EARTHQUAKE

Fault remains locked → Rock deforms; strain energy builds → Sudden slip releases seismic waves

An earthquake occurs when stress overcomes frictional resistance. The focus is the rupture's starting point underground; the epicenter is directly above it at the surface.

2. MATCH MAP EVIDENCE TO A BOUNDARY

Ridge + shallow quakes

Divergence: seafloor spreading and new crust.

Trench + volcanic arc

Subduction: quakes can deepen along the slab.

Long fault + shallow quakes

Transform motion: mainly horizontal slip.

Many Pacific margins show subduction-related earthquakes and volcanoes. Not all earthquakes or volcanoes occur at plate boundaries.

3. HOT SPOTS ARE AN IMPORTANT EXCEPTION

A hot spot is a localized source of volcanism that may lie within a plate. As a plate moves over a relatively persistent source, it can leave an age-progressive volcanic chain. Hawaii is a key example: older volcanoes lie northwest of the active end, indicating Pacific Plate motion relative to the hot spot.

Environmental effects can include landslides, ash fall and damaged water systems. Some undersea earthquakes generate tsunamis by displacing the seafloor; not every earthquake does so.

Fault locking, slip and energy release: USGS, What is an earthquake?
Intraplate volcanism and Hawaii: USGS, What is a hotspot?

Scope: College Board AP Environmental Science CED, Topic 4.1, p. 80.