4.6: Convergent Plate Boundaries

Convergent boundaries, where two plates are moving toward each other, are of three types, depending on the type of crust present on either side of the boundary — oceanic or continental. The types are ocean-ocean, ocean-continent, and continent-continent.

At an ocean-ocean convergent boundary, one of the plates (oceanic crust and lithospheric mantle) is pushed, or subducted, under the other (Figure \(\PageIndex{1}\)). Often it is the older and colder plate that is denser and subducts beneath the younger and warmer plate. There is commonly an ocean trench along the boundary as the crust bends downwards. The subducted lithosphere descends into the hot mantle at a relatively shallow angle close to the subduction zone, but at steeper angles farther down (up to about 45°). The significant volume of water within the subducting material is released as the subducting crust is heated. It mixes with the overlying mantle, and the addition of water to the hot mantle lowers the crust’s melting point and leads to the formation of magma (flux melting). The magma, which is lighter than the surrounding mantle material, rises through the mantle and the overlying oceanic crust to the ocean floor where it creates a chain of volcanic islands known as an island arc. A mature island arc develops into a chain of relatively large islands (such as Japan or Indonesia) as more and more volcanic material is extruded and sedimentary rocks accumulate around the islands. Earthquakes occur relatively deep below the seafloor, where the subducting crust moves against the overriding crust.
Examples of ocean-ocean convergent zones are subduction of the Pacific Plate south of Alaska (creating the Aleutian Islands) and under the Philippine Plate, where it creates the Marianas Trench, the deepest part of the ocean.

At an ocean-continent convergent boundary, the denser oceanic plate is pushed under the less dense continental plate in the same manner as at an ocean-ocean boundary. Sediment that has accumulated on the seafloor is thrust up into an accretionary wedge, and compression leads to thrusting within the continental plate (Figure 2). The magma produced adjacent to the subduction zone rises to the base of the continental crust and leads to partial melting of the crustal rock. The resulting magma ascends through the crust, producing a mountain chain with many volcanoes. As with an ocean-ocean boundary, the subducting crust can produce a deep trench running parallel to the coastline.

Examples of ocean-continent convergent boundaries are subduction of the Nazca Plate under South America (which has created the Andes Mountains and the Peru Trench) and subduction of the Juan de Fuca Plate under North America (creating the Cascade Range).

A continent-continent collision occurs when a continent or large island that has been moved along with subducting oceanic crust collides with another continent (Figure 3). The colliding continental material will not be subducted because it is too light (i.e., because it is composed largely of light continental rocks), but the root of the oceanic plate will eventually break off and sink into the mantle. There is tremendous deformation of the pre-existing continental rocks, forcing the material upwards and creating mountains.
Examples of continent-continent convergent boundaries are the collision of the India Plate with the Eurasian Plate, creating the Himalaya Mountains, and the collision of the African Plate with the Eurasian Plate, creating the series of ranges extending from the Alps in Europe to the Zagros Mountains in Iran. The Rocky Mountains in North America are also a result of continent-continent collisions.

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