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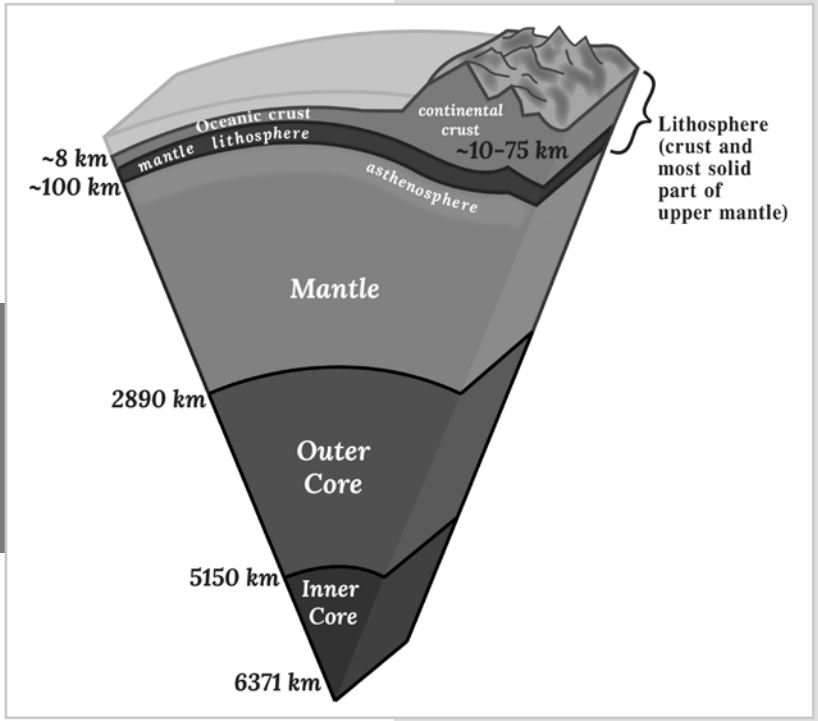
Earth's Two Crusts



This cross section of Earth's interior is not to scale, but it illustrates the difference in the thicknesses of the two varieties of crust on Earth's surface: oceanic crust (left) and continental crust (right). These two end members have fundamentally different compositions that influence interactions between tectonic plates at their boundaries.

Credit: Derivative work: Jamie Coggin/Bureau of Economic Geology; original: Volcan26, CC BY-SA 4.0, via Wikimedia Commons

Two of the most important geologic features of our planet, that shape our oceans and continents, are Earth's two types of crusts—oceanic and continental.

Both types float on Earth's asthenosphere—its semi-molten mantle.

Oceanic crust is thin, averaging just 5 miles thick. It rises out of the mantle at mid-oceanic ridges and sinks below continents at subduction zones.

It's constantly being recycled like this, and is therefore relatively young. Our most ancient oceanic crust is just 180 million years old.

But the defining quality of oceanic crust is that it's dense. The minerals that form it are heavier than those of continental crust, meaning it floats *lower* on Earth's mantle. The average elevation of oceanic crust is 16,000 feet below sea level.

Continental crust is less dense, so it floats higher. When it contacts oceanic crust, it tends to ride up over it, pushing oceanic crust under and back into the mantle.

As a result, continental crust is recycled much less frequently. It's much older, piles up much higher, and is 10 times thicker than oceanic crust in places.

Continental crust forms Earth's land masses, from sea shores to mountain ranges, where land-dwelling creatures live. Without it, Earth might have only sea life.

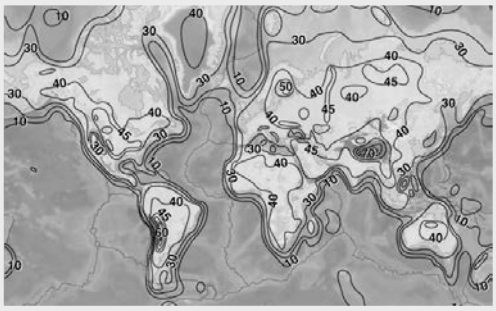
Earth's two mobile crusts are unique in our solar system, geologic features that shape life as we know it.

Bureau of Economic Geology

Background: Earth's Two Crusts

Synopsis: Earth is unique in our solar system because of its two distinct types of crust that move dynamically over its surface. Oceanic crust has a more uniform thickness and consists of denser minerals, while thicker continental crustal materials are less dense, allowing them to protrude to variable elevations as they float on Earth's viscous asthenosphere.

- Earth's crust is made up of relatively thin plates that account for less than 0.6% of Earth's 3,959 mi (6,371 km) average radius.
  - Earth's brittle plates are made of two different types of crust that float dynamically on the hot semisolid mantle asthenosphere, which acts as a viscous fluid conveyor belt over geological time frames.



A contour map of the thickness of Earth's crust in kilometers (10 kilometers is 6 miles, 40 kilometers is 25 miles, 75 kilometers is 46 miles).

Credit: USGS, public domain, via Wikimedia Commons

  - Earth's thinnest **oceanic crust** can be found where it forms along Mid-Ocean Ridges. Elsewhere it averages 4 to 6 mi (7–10 km) in thickness.
  - **Continental crust** ranges from 16 to 46 mi (25–75 km) and is thickest in the area of the Himalayas where a deep keel extends into Earth's mantle.
  - Earth's two types of crust have distinctly different compositions that produce their starkly different appearances, while their differing densities result in large elevation differences across its surfaces.

A dark mafic basalt boulder, typical of oceanic crust, stands out among light-colored felsic boulders, typical of continental crust, on the Isle of Skye in northwestern Scotland.

Credit: Rudi Winter, CC BY-SA 2.0, via Wikimedia Commons

- Denser iron-magnesium-silicate rich oceanic crust floors most of Earth's oceans with an average elevation of -16,400 ft (-5,000 m) (*below* sea level).
  - Oceanic crust consists of dark-colored "mafic" rocks (like basalts) that are created from mantle material at spreading ridges and constantly recycled back into the mantle at subduction zones.
  - The most common elements in Earth's mantle are oxygen 45%, magnesium 23%, silicon 22% and iron 5.8%. When you combine these and cool them quickly, basaltic rocks form (if you cool them slowly you get coarser-grained gabbros).

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References: Earth's Two Crusts

Unraveling the Tapestry of Ocean Crust | WHOI
Crust | National Geographic
Oceanic Crust and Continental Crust: the Difference | GeologyIn
Earth Crust: Oceanic Crust vs. Continental Crust | EarthHow
Thin Crust or Thick? | YaleNews

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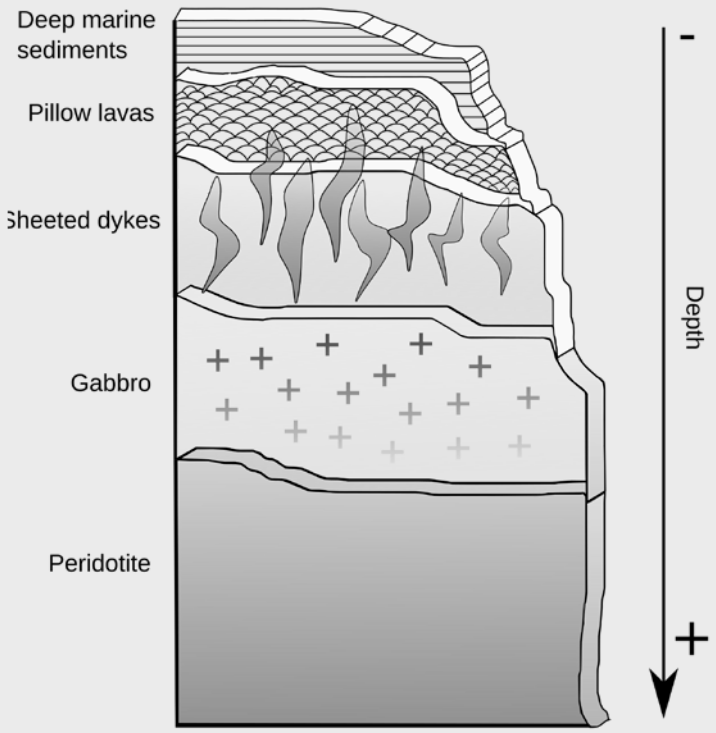

Oceanic crust has a layered structure that forms at spreading ridges. In places like Oman, where oceanic crust has been forced up onto the edge of the continent during plate collisions, scientists have been able to study and document at as much as 7 miles (11 kilometers) of ancient oceanic crust, with 2 to 5 miles (3–8 kilometers) of that thickness being the mineral-rich mantle peridotite layer.

- Oceanic crust has a predictable structure, with sediments on top of basaltic pillow lavas that formed at the seawater-lava interface, fed by underlying sheeted (parallel) dike feeders that delivered magma from large, deep chambers, that later crystallized into mafic gabbros and mineral-rich ultramafic peridotites.
- Oceanic crust has an average density of about 3.0 g/cc, and this makes it ride lower on the underlying mantle. Because of this higher density, oceanic crust usually dives beneath lighter continental crust when plates collide.
- Earth's oldest oceanic crust is less than 180 million years old.

- Continental crust, with its greater proportion of lower density aluminosilicate rocks, floats on Earth's mantle with an average thickness of 22 mi (35 km) and an average surface elevation of 2625 ft (800 m) *above* sea level.
  - While it is more variable and forms in a variety of situations, continental crust is ultimately created at subduction zones where crustal slabs melt and fractionate (separate), freeing lower density fractions to ascend to become incorporated into preexisting continental crust, while denser fractions descend into the mantle.
  - The next four most common elements on the rocky planets are calcium 2.3%, aluminum 2.2%, sodium 0.3%, and potassium 0.3%. If you add silicon and oxygen to those, you get minerals known as feldspars, and those are the most abundant minerals in continental crust.
  - These light-colored "felsic" rocks (like granites) have an average density of 2.7 g/cc, so they ride higher on the mantle.
  - Since it is too buoyant to subduct, continental crust just piles up through time and includes the oldest rock on Earth's surface at around 4 billion years old.
  - Today, continental crust only covers about 40% of Earth's surface, with a quarter of that located under water on continental shelves. However, 70% of the volume of Earth's crust is continental crust because it is three to eight times thicker than oceanic crust.

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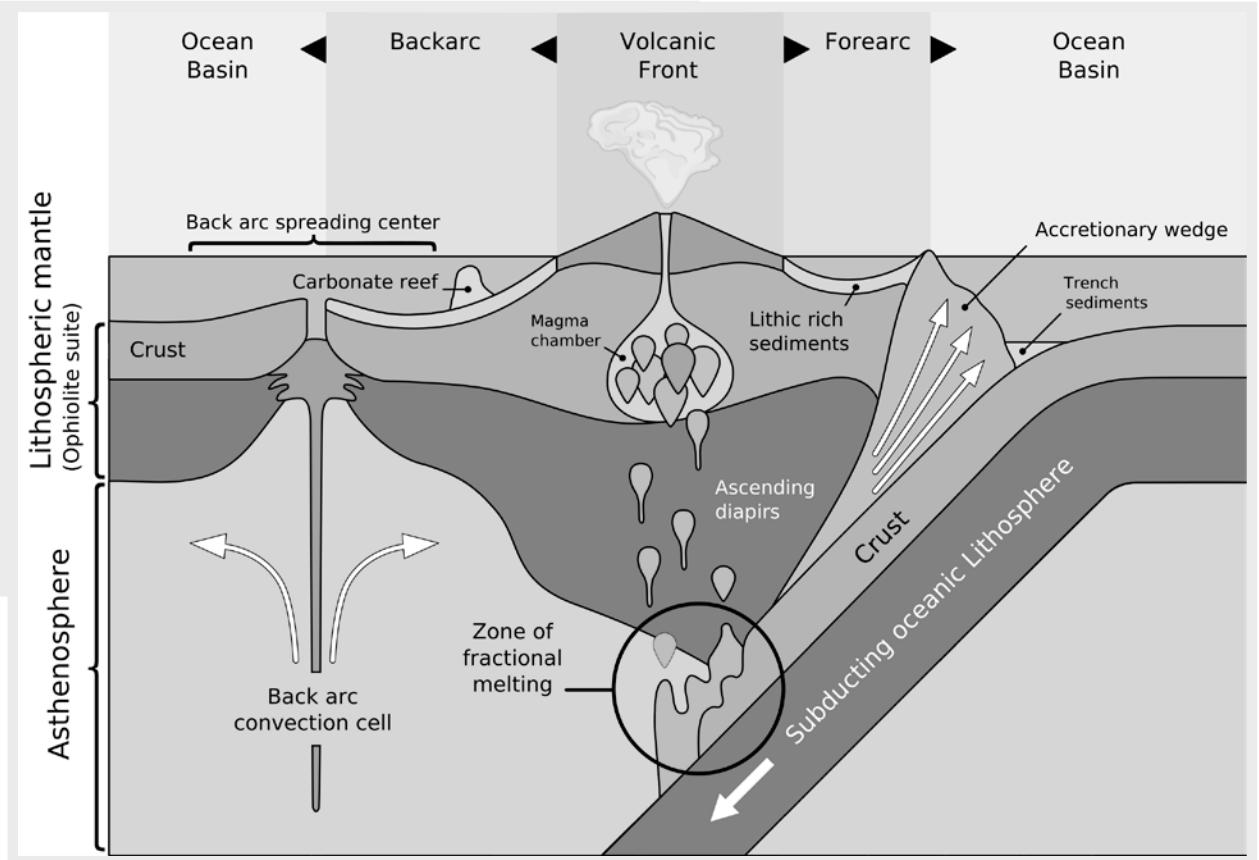

Convergence of plates resulting in the formation of a volcanic arc and a back arc basin with a spreading convection cell. Ultimately, fractionation of magma builds continental crust.

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