Investigation #4

The Earth's Lithosphere

In the previous activity you learned that the rock of the Earth's mantle flows slowly in gigantic convection cells. The uppermost part of the mantle, however, does not take part in the convection. That's because its rock is not as hot, and it remains rigid while the rest of the mantle flows. Here's a similar example, on a much smaller scale. If you squeeze Silly Putty® at room temperature, it flows as you squeeze it in your hand. If you cool it in the refrigerator, it stays hard and rigid when you try to squeeze it. In **Investigation 3**, you found that this outermost rigid part of the Earth is called the lithosphere. The thickness of the lithosphere varies from place to place, but mostly it is a hundred or so kilometers. That's still fairly thin, compared to the thickness of the whole mantle, which is about 3000 km. The lithosphere has two parts: the Earth's crust, and the uppermost part of the mantle. The material below the lithosphere is called the asthenosphere ("weak sphere"). Unlike the lithosphere, the asthenosphere does take part in the convection of the mantle. The boundary between the lithosphere and the asthenosphere is really a temperature boundary. Below the boundary the rocks are hot enough to flow. Above the boundary they are cooler and rigid.

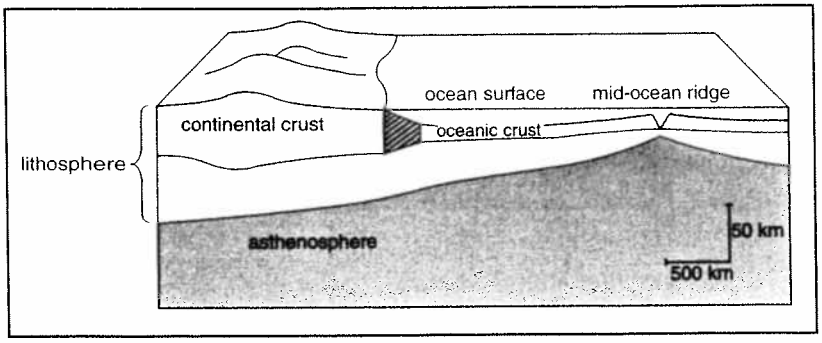
In the ocean basins the uppermost part of the lithosphere consists of the basalt that is formed by volcanoes along the mid-ocean ridges. This material is called the oceanic crust. It's only 4 to 8 km thick. The oceanic lithosphere gradually thickens as it moves away from the hot mid-ocean ridge. This is because the temperature boundary where the lithosphere turns into asthenosphere gets deeper in the Earth (see the diagram on the following page).

The Earth's continents form another part of the crust. The continental crust is very different from the oceanic crust.

As You Read...
Think about:

1. *What is the difference between crust and lithosphere?*
2. *What is the difference between oceanic crust and continental crust?*
3. *What is the difference between a subduction zone and a continent-continent collision zone?*
4. *Why do continents not go down subduction zones?*

It's thicker (mostly 30 to 50 km), its rock is less dense, and it's mostly very much older than the oceanic crust.



Lithospheric Plates

The lithosphere is not one continuous piece. Instead, it's made up of several very large pieces and a lot of smaller pieces. These pieces are called lithospheric plates (or just plates, for short). They fit together a bit like the pieces of a jigsaw puzzle. The line on the Earth's surface where two plates are in contact with each other is called a plate boundary.

Everywhere on Earth, the plates are in motion relative to one another. Along some boundaries, called divergent boundaries, plates are moving away from each other. Along other boundaries, called convergent boundaries, plates are moving toward one another.

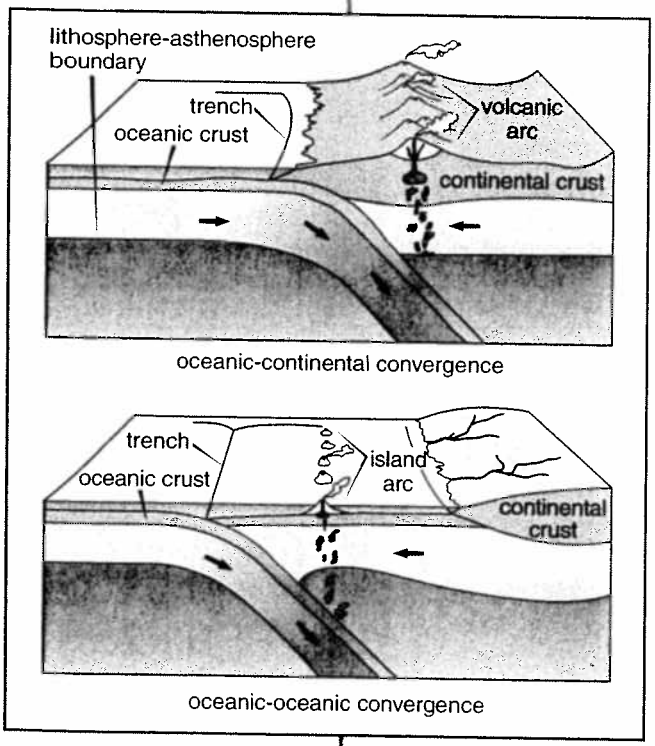
The mid-ocean ridges, which you learned about in the last investigation, are divergent plate boundaries. As the plates move away from each other, new plate material is produced on either side of the ridge.

There is also a third kind of boundary, called a transform boundary, where the plates are moving neither towards one another nor away from one another. Instead, they are simply moving past one another like two cars in different lanes on the highway (only much slower!).

An example of a transform boundary is the San Andreas Fault in California. It appears as a line in the aerial photo to the right. There, the Pacific Plate is moving northwest relative to the North American Plate. Lithosphere is neither created nor destroyed at transform boundaries. For this reason, transform boundaries are sometimes called conservative.

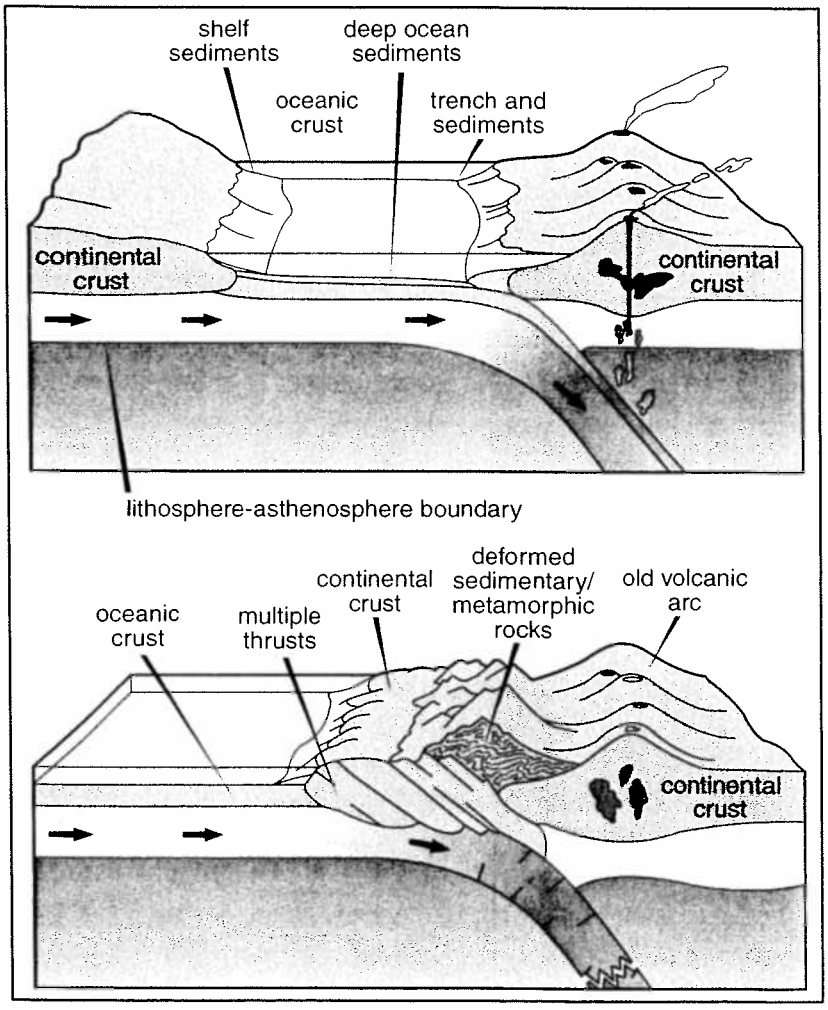
Subduction

Scientists have determined that the surface area of the Earth is not changing over time. Therefore, there must be plate boundaries where plates are consumed, as well as plate boundaries where plates are created. Plate boundaries where one plate dives down underneath another are called subduction zones. The downgoing plate consists of oceanic lithosphere. The other plate, the one that stays at the surface, can also consist of oceanic lithosphere, or it can be a continent. The place where the downgoing plate bends downward is marked by a deep trench on the ocean floor. Earthquakes and volcanoes are very common along subduction zones. The downgoing plate is eventually absorbed into the mantle, but scientists are just beginning to understand how that happens.



Continent–Continent Collision

Subduction zones can make an ocean basin close up completely. When that happens, two continents meet at the subduction zone. Continents are less dense than the mantle, so they do not go down the subduction zone. It is like pushing a wooden board down into the water: the board tries to float up to the surface again. When the two continents meet, one of the continents is pushed horizontally beneath the other continent. The movement eventually stops, when the force of friction between the continents becomes large enough.



Continent–continent collision zones are places where continents are thickest. Where a continent is thicker, it extends deeper down in the mantle, and its surface stands higher above sea level. There is one place on the Earth today where continent–continent collision is happening: India is slowly being pushed under southern Asia. That collision has produced the Himalayas, which are the highest mountains on Earth, and the Tibetan Plateau, which is the highest large plateau on Earth.