

Convection Currents and the Mantle

Guide for Reading

- ◆ How is heat transferred?
- ◆ What causes convection currents?

The movement of energy from a warmer object to a cooler object is called **heat transfer**. Heat is always transferred from a warmer substance to a cooler substance. **There are three types of heat transfer: radiation, conduction, and convection.**

The transfer of energy through empty space is called **radiation**. Heat transfer by radiation takes place with no direct contact between a heat source and an object. For example, radiation enables sunlight to warm Earth's surface.

Heat transfer by direct contact of particles of matter is called **conduction**. In conduction, the heated particles of a substance transfer heat to other particles through direct contact. An example is when a spoon heats up in a hot pot of soup.

The transfer of heat by the movement of a heated fluid is called **convection**. Fluids include liquids and gases. During convection, heated particles of a fluid begin to flow, transferring heat energy from one part of the fluid to another.

Heat transfer by convection is caused by differences in temperature and density within a fluid. **Density** is a measure of how much mass there is in a volume of a substance. When a liquid or gas is heated, the particles move faster. As they move faster, they spread apart. Because the particles of the heated fluid are farther apart, they occupy more space. The fluid's density decreases. But when a fluid cools, the particles move closer together and density increases.

An example of convection occurs in heating a pot of soup on a stove. As soup at the bottom of the pot gets hot, it expands and becomes less dense. The warm, less dense soup moves upward, floating over cooler, denser soup. At the surface, the warm soup spreads out and cools, becoming denser. Then gravity pulls this cooler, denser soup down to the bottom, where it is heated again and begins to rise. This flow that transfers heat within a fluid is called a convection current. The heating and cooling of the fluid, changes in the fluid's density, and the force of gravity combine to set convection currents in motion. Convection currents continue as long as heat is added to the fluid.

Convection currents flow in the asthenosphere. The heat source for these currents is heat from Earth's core and from the mantle itself. Hot columns of mantle material rise slowly. At the top of the asthenosphere, the hot material spreads out and pushes the cooler material out of the way. This cooler material sinks back into the asthenosphere. Convection currents like these have been moving inside Earth for more than four billion years!

Name: _____
Date: _____ Period: _____

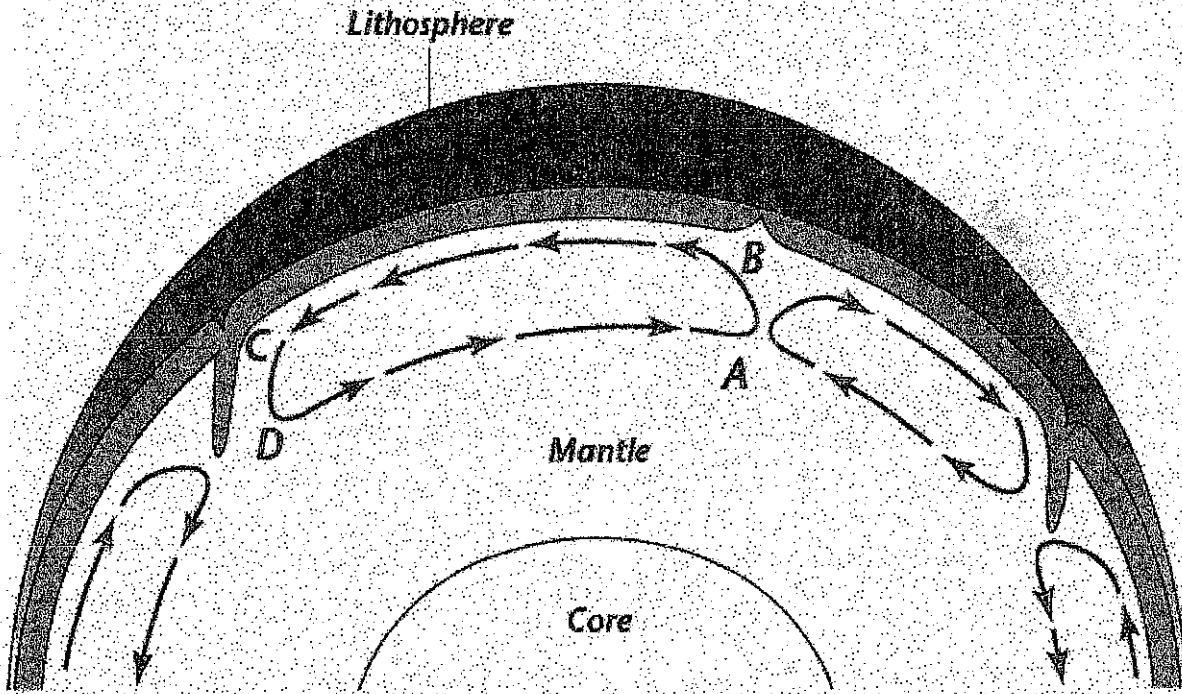
CONVECTION CURRENTS

The figure below shows a convection cell in Earth's mantle. A **convection cell** is one complete loop of a convection current.

1. On the figure below label the *source* of the heat for this figure by writing "source."
2. Objects that are _____ dense rise above things that are _____ dense.
3. Objects that are _____ are denser than those that are _____.

Circle the right answer:

4. The (*Lithosphere*) (*Mantle*) is very rigid while the (*Lithosphere*) (*Mantle*) is plastic and flows easily.
5. The (*warm*) (*cold*) mantle is less dense than the (*warm*) (*cold*) mantle and will rise up towards the Lithosphere.



6. Where does the heat come from that drives this convection current in the mantle?
7. Where is the temperature of the mantle material greater, at point B or point C? Explain why.
8. Where is the density of the material greater, at point A or point B? Explain why.
9. What causes the convection cell to turn to the left at point B?
10. What happens to the temperature and density of the material between points B and C?
11. What force causes the convection cell to turn down at point C?
12. What happens to the temperature and density of the material between points D and A?
13. What causes the convection cell to turn up at point A?
14. How do you think this convection cell might affect the crust material above it?