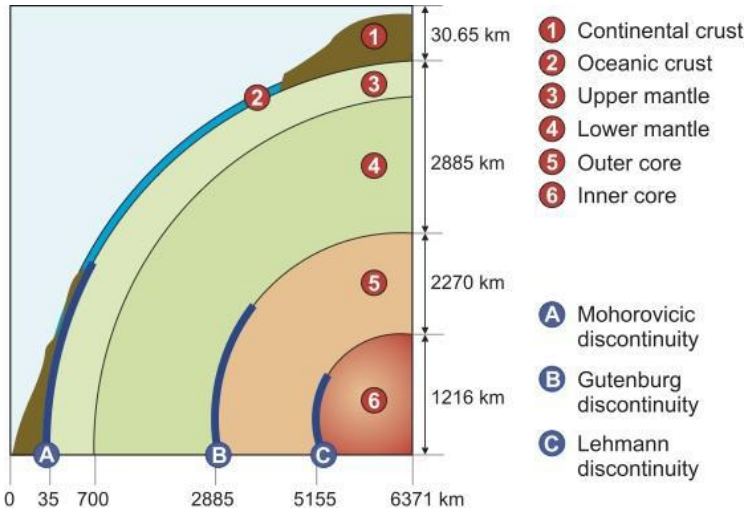
Spinning Spirals – Teachers' Notes

Our planet is layered like an old-fashioned trifle pudding. The lightest, or more correctly least dense rocks "float" to form the crust while denser rocks sink downward. Earths crust is made from low-density silica rich minerals, which form rocks such as granite and sandstone. Underlying this is a mantle of iron, magnesium and silica rich minerals that is denser. Dark heavy igneous rocks such as gabbro and peridotite lie below. The densest minerals form the core, which is rich in iron and nickel and has hardly any silica.

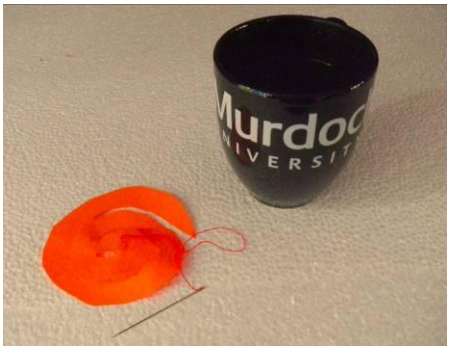


These layers have differentiated due to heat driven convection currents and to density separation. ***A common student misconception*** is that rocks below the crust are always molten and flow easily like a liquid. Apart from the outer core, rocks under the crust act as solids most of the time. They can become molten and flow like sticky toffee in places if the conditions are right. This is particularly true at the asthenosphere, which is the interface between the crust and mantle.

Spinning spirals - Convection (heat driven) currents.

I suggest that this be carried out as a teacher demonstration as heat sources in a classroom can be hazardous. (Versions of this on the Internet suggest using candles or gas burners as a heat source). However, using a cup of hot water instead can make this activity quite manageable in an ordinary classroom. Why not use a hot cup of tea or coffee and enjoy the experiment even more!

Heat creates moving currents called convection currents. Heat causes molecules within any material to move further apart increasing the material's volume and decreasing its density. Heated solids, liquids and gasses form upward moving currents which stream away from the heat source. Students may have observed upward rising convection currents of smoke above a hot fire and observed peas or potatoes being moved about by currents of hot water when they are being cooked by heat from below.



Materials

- A source of hot water. An electric kettle is ideal as the hotter water is the faster and stronger the convection current of rising air above it will become
- A sheet of ordinary paper (not card). Use light materials

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- A mug or beaker to contain the hot water
- A piece of knotted thread or lightweight string
- Scissors
- Pen or pencil

Method

1. Place the mug face down on the paper and draw a circle around it.
2. Cut the circle into a spiral and pierce the centre for the thread.
3. Thread the string through the centre of the spiral and knot it.
4. Fill the mug with hot water and hang the spiral directly over the mug.

After about 30 seconds the spiral should begin turning as the current of heated air above the hot liquid starts rising through it.

Observation

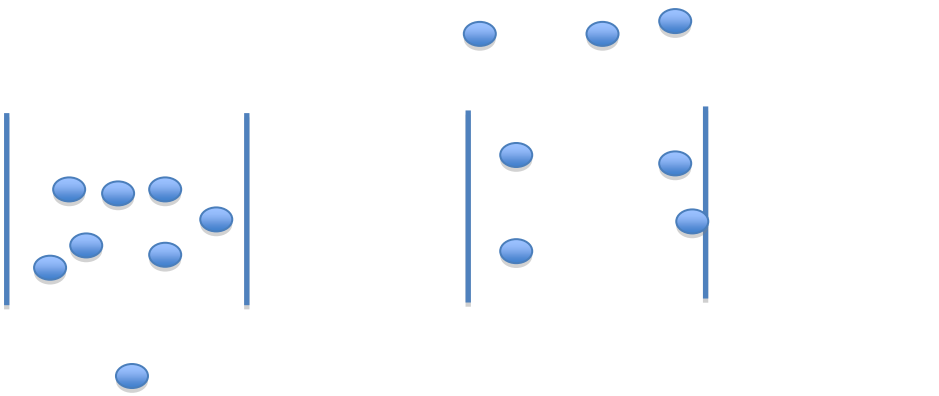
When the spiral is placed over the hot water it begins to spin. If it is moved away from the hot liquid it ceases to spin.
What happens to the air above the hot liquid? It becomes heated and rises causing the spiral to spin.

Conclusion

Heat below creates a convection current/a rising current of hot air.

Teacher explanation of density

Density is a measure of space (volume) matter takes up. When air is heated its molecules have more energy to bounce off each other and the same number of molecules take up more space.



Cold air
8 molecules fill the beaker

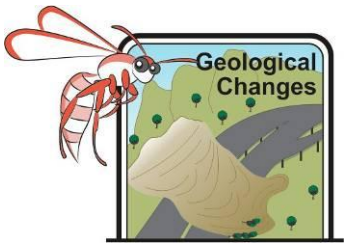
4 molecules fill the beaker

Hot air

"HEAT" and "COLD" are just descriptions of the amount of movement of molecules in a substance.
What would happen if rocks within the Earth got hotter? They would rise towards the surface.

Explanation of heat and cold causing movement to and from the surface of the Earth

Heat from within the Earth can cause local melting, particularly near the boundary of the crust and mantle. These hot currents rise towards the surface bringing melted rock with them and pushing cold crust away on either side. This is a divergent boundary between tectonic plates. Moving away from a divergent boundary plates may crash into others at a convergent boundary. As the rock cools it can become denser and sink down into the planet again. On a human timescale, this moves incredibly slowly perhaps taking millions of years. The tectonic plate that Australia lies within is



being pushed northwards at a speed of about 9cm every 100 years. This is roughly the same rate at which your fingernails grow.

Early Earth was much hotter than it is at present allowing materials to move around more easily and to separate into layers because of differing density. At this time plumes of hot rock from the core could rise to the cooler surface. This is why dense minerals from the core are found in very ancient rocks such as the nickel and gold deposits in Kalgoorlie. The Earth has cooled since then and this process occurs extremely rarely. In Hawaii, the progression of volcanic islands that appears to be moving slowly northwards is probably the Pacific tectonic plate moving southwards over such a hot spot. These islands have been built up from magma brought up to the surface by convection currents above mantle hot spots.