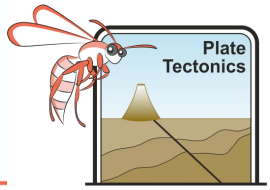
Plate Boundaries - Teacher Background



Convection currents activities provide background for this. Similarly "Folding and Faulting" provide background for how competent (rigid) rocks will break or fault while incompetent (plastic) rocks will bend or fold when stressed tectonically.
Students may wish to visit www.youtube.com/watch?v=GyMLlLxbfa4&feature=related to remind themselves about seafloor spreading and subduction zones.

There are three types of plate boundaries

1. Divergent Boundaries
2. Convergent Boundaries
3. Transform Boundaries

An animation of these three boundaries can be found at:
http://www.learner.org/interactives/dynamicearth/plate.html

1 Divergent (constructive) boundary

Oceanic crust moving apart from oceanic crust

It is thought that where two convection currents rise and cool, seafloor spreading occurs. Hot molten mafic (rich in iron and magnesium) oceanic crust rises and flows outwards from the trench in the mid oceanic ridge.

This can be described as a constructive boundary as the width of the oceanic plate is being increased. It can be likened to a conveyor belt carrying hot rock upwards and pushing earlier flows aside. Of course no new material is created, only older material brought down from elsewhere or brought up from below (Law of Conservation of Mass). Since this magma is mafic and flows easily, low shield volcanoes will form. Spreading movement is not uniform and massive transform (see below) faulting occurs. This process results in submarine earthquakes.

The classic example of a divergent or constructive boundary is the Mid Atlantic Ridge where a band of active undersea and above sea level volcanoes is presently creating fresh mafic extrusive sea floor rocks. Here the seafloor is spreading at a rate of between 2 and 6cm per year.

Evidence for seafloor spreading is found in the increasing age of rocks away from the ridge, the mirrored magnetic banding of these rocks, the relative youth of these rocks compared with continental crust and laser measurement by satellites.

Continental crust moving apart from continental crust

These boundaries are created where a continent is being split apart. A massive fault bounded rift valley forms. With associated volcanism and earthquakes. The Great Rift Valley of eastern Africa is presently being extended as Arabia is moving apart from Africa. Closer to home a zone of divergence formed when the Australian Continental Plate split apart from the Antarctic Continental Plate and is still extending.

Activities and information on divergent boundaries are described under "Evidence for Seafloor Spreading".

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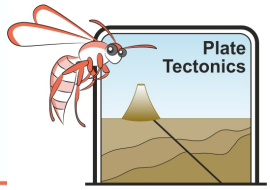

2 Convergent (destructive) boundary

What happens when two convection cells converge at the surface depends on the nature of the plates coming together. Where plates have the same densities they will crumple and form mountains. Where the rocks are of different densities, the denser rock will slip under the less dense crust.

Continental crust converges with continental crust

E.g. Indian plate converging with Eurasian Plate north of India
Less dense incompetent silica rich sediments from the two continental crusts crumple into each other to form high mountains such as the Himalayas. This piling of crust upon crust will cause the continent to thicken increasing pressure and temperature at the base of continental crust resulting in regional metamorphism.

This can be demonstrated by pushing two dishtowels together.

Continental crust converges with oceanic crust

E.g. Australian and Pacific plates to the north east of Australia
The denser oceanic plate will be subducted (it will slip below) the lighter continental crust. This is indicated by a zone of deepening earthquake centers moving away from the convergence overlain by high fold mountains. Often a deep trench forms over the subduction zone and major earthquakes which lift the surface metres at a time. Sediments included in the subducted plate will melt and rise to the surface as explosive silica rich volcanics forming the classic stratovolcano shape. Rock through which the volcanic magma penetrates will suffer contact metamorphism.

This can be modelled by pushing a book (dense oceanic crust) and a dish towel (less dense continental crust) together. The towel will fold over the book.

Oceanic crust with oceanic crust

E.g. the Solomon Islands and trench to the east of Australia
Whichever plate is densest will be subducted (pulled under the other plate) forming a deep oceanic trench above the subduction zone. Since this occurs away from continental crust, any volcanism will be undersea. In time these volcanoes will build up to form island arcs

3 Transform boundaries

These movements occur near the surface where cold hard rocks are required to move against each other.
This can be modelled by a student attempting to push one rock against another, or by pushing two blocks covered with sandpaper against each other. Energy is stored until limiting friction is overcome and one block moves rapidly against another.
Along major zones of movement stress builds up and one major zone of movement/fault is broken into many minor transverse faults. Transform faults are brittle and cause minor earthquakes. Stress within the continental plate is relieved by the occurrence of transform faults and earthquakes.