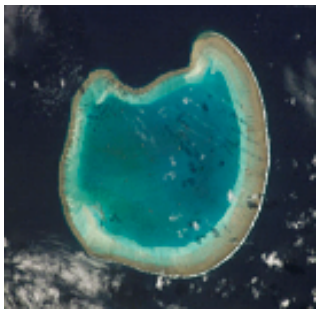
Darwin's 'big coral atoll idea'

Try thinking like Darwin did to solve the coral atoll mystery

When Darwin sailed round the world on the '*Beagle*' in the 1830s he noticed small islands made of low circular coral reefs like those in the photos. These circular reefs were scattered across the deep oceans of the tropics. Try 'thinking like Darwin did' to work out how they formed.

The atoll of Nukuoro in the Pacific Ocean (about 7 km in diameter).



Bassas da India Atoll in the Indian Ocean (about 15 km in diameter).

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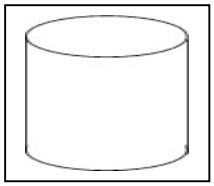
The first idea – the 3D shape

If these islands are circular or nearly circular at the surface, Darwin thought about what shape they must have in three dimensions.

Ask the pupils what 3D shape a circle must make, then invite them to make a shape like that using a piece of paper. They should realise that the 3D shape of the atolls must be cylindrical and make and stick together a paper cylinder.

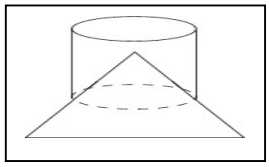


The second idea – the column

Darwin knew that coral reefs are living things that begin growing in shallow waters and grow upwards to the surface, where they stop (since coral cannot live above sea level). So, what must have happened to make a tall column of coral reef?

Ask the pupils how a column like this might have formed over a very long time. They may realise that, although the reefs must have begun growing in shallow water, the base of the reefs must have sunk steadily while the coral continued to grow – producing the column over time. We now know that time was millions of years.

The third idea – the circular shape



Darwin asked himself, what could have caused the coral reef to grow in a circular shape in the first place. He realised that the reef must have started growing on a circular landform, and then asked himself what circular landforms are found in oceanic areas.

Ask the pupils to use another sheet of paper to make a landform with a circular shape. There are only two ways to do this simply, by cutting and sticking the paper to make either a cone or an inverted cone. Ask them to make a cone shape and then discuss whether cone-shaped or inverted-cone-shaped landforms are most likely to be found in ocean areas. They may realise that some of the most common islands found in ocean areas are volcanic islands – that often have cone-shapes. When they have made their cone-shaped 'sunken volcano' they should stand their paper cylinder on top to make a 3D model of a coral atoll.

Mount Asphyxia (1800m), Zavadovski Island, South Sandwich Islands. (about 6 km in diameter)

Photo: Peter Kennett

The fourth idea – the sinking

Lastly, Darwin asked himself what might have caused sea level to rise steadily, or the sea floor to sink steadily, over a very long time, so that volcanic islands sank steadily beneath the sea.

Darwin didn't know. He just realised that there was lots of evidence showing that some land areas rose and others subsided – but he didn't know why. Nowadays, plate tectonic evidence tells us that when volcanic areas are active, they are very warm and so have low density. In oceanic areas, they often reach the surface to form islands. However, as volcanic regions cool, they become more dense and sink, carrying the volcanoes steadily downwards as they do so.

Testing the theory

Ask the pupils how Darwin's theory could be checked. The simple answer (not available to Darwin) is to drill a hole to find out if there are volcanic rocks at the base of the coral reef atolls. The idea wasn't tested until 1947 when a hole was drilled into Bikini Atoll and went through exactly the sequence that Darwin had predicted, before hitting volcanic rock at the bottom. This provided excellent evidence in support of Darwin's 'big coral atoll idea'.

The back up

Title: Darwin's 'big coral atoll idea'

Subtitle: Try thinking like Darwin did to solve the coral atoll mystery

Topic: A paper-folding activity to help pupils to visualise how Darwin developed his theory of how coral atolls formed.

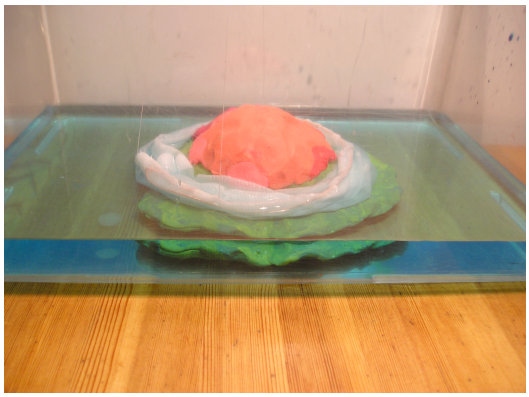
Age range of pupils: 11 – 18 years

Time needed to complete activity: 15 mins

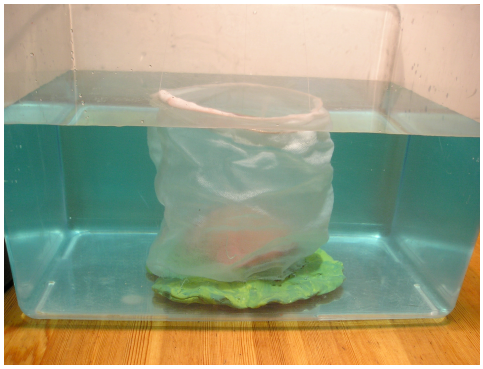
Pupil learning outcomes: Pupils can:
- describe and explain how Darwin developed his coral atoll theory;
- make a simple model using paper of a submerged volcano (cone) beneath a coral reef (cylinder).

Context:
After his round the world voyage on the *Beagle*, Charles Darwin first published his ideas on how coral atolls formed in 1837 - but it wasn't until 100 years later that his ideas were tested by US Navy scientists drilling on the Bikini and Enewetak atolls of the Marshall Islands in the Pacific Ocean.

Following up the activity - DIY atoll model:
Make your own working model of 'Darwin's big coral atoll idea' by making a conical volcano in a tank like the one shown in the first photo. Then make a cylinder of fabric to fit over the cone, with a wire circle attached to the top. Then, if you add water to the tank (simulating rise in sea level seen from the sinking volcano), the fabric cylinder will rise up like the coral reef grew upward. Finally you will have an empty wire circle of material at the 'surface' of the water, representing the island atoll, as in the second photo.



DIY atoll model - before the sinking of the volcano



DIY atoll model - after the sinking volcano has resulted in a rise in sea level

DIY atoll photos – Elizabeth Devon

Underlying principles:
- Colonial corals can only grow near the surface of the ocean; this is because the coral polyps (the living part of coral reefs) live in symbiosis with a form of algae (symbiosis = relationship between two organisms where each supports the other). Since the alga is a plant, it needs sunlight for photosynthesis. Sunlight only penetrates shallow waters.
- Volcanoes form over 'hot spots' or oceanic ridges. As plate movement moves them away from the 'hot spots', they and the surrounding plate cool, become more dense and sink steadily.

Thinking skill development:
Picturing the development of a cylindrical coral reef over a sinking conical volcano involves construction. Working out ways of testing this idea involves cognitive conflict. There is bridging between the model and reality.

Resource list:
- two sheets of A4 paper and some tape per individual or group

For extension:
- a cone made of cardboard or other material, as shown in the photos
- enough fabric to make a cylinder
- wire to make a wire circle at the top of the fabric
- needle and thread to sew, or tape to tape the fabric

Useful links:
The Marshall Islands visitor leaflet at: http://www.visitmarshallislands.com/pdf/CoralAtolls.pdf
The Darwin Online website has exhaustive information about Darwin – at: http://darwin-online.org.uk/

Source: Activity devised by Chris King, extension activity by Elizabeth Devon - both of the Earthlearningidea Team.