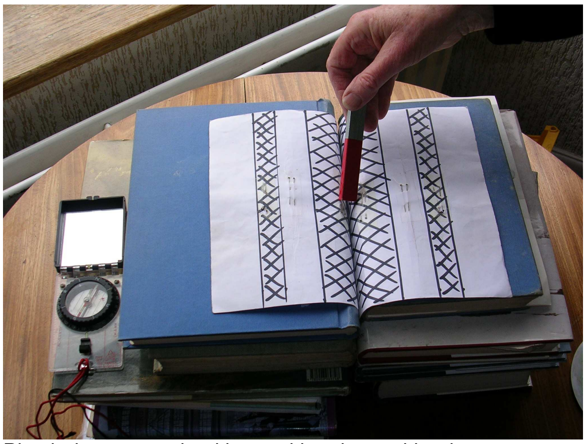
Magnetic stripes
Modelling the symmetrical magnetic pattern of the rocks of the sea floor

The magnetic properties of the rocks below the sea bed have been used to show that the ocean floors are spreading outwards. The principle may be demonstrated as follows:

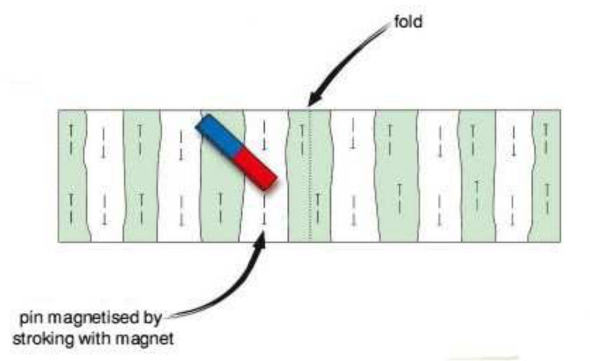
- Prepare a cardboard model of magnetic stripes as described in the "Resource list" and as shown in the diagram.
- Gather the class around the model, where most of it is hidden in the crack between two benches, or between two piles of books. Explain that this represents an oceanic ridge, such as the Mid- Atlantic Ridge, where two plates meet. As the plates are pulled apart, magma rises from below, cools and crystallises. Once the temperature has dropped below a critical point, the solid rocks can become magnetised in the direction of the Earth's magnetic field at the time. You are going to demonstrate what happens by magnetising some pins previously pushed into the card.
- Pull up a few centimetres of the card, symmetrically, and, as the pins appear, magnetise them by stroking them gently with the North end of a bar magnet, **towards the points** of the pins. This simulates the situation when the Earth had a 'normal' magnetic field (the N and S poles of the Earth were in similar positions to those today).



Pins being magnetised by stroking them with a bar magnet
(Photo: Peter Kennett)

- Pull out some more card until another set of pins appears, with the points in the opposite direction to the first set. (This simulates when the Earth's magnetic field was 'reversed' – with the Earth's north magnetic pole being where the south pole is today, and *vice versa*). Magnetise these, again using the North end of the bar magnet, and stroking **towards the points** of the pins.
- Continue the activity for one or two more sets of pins and then pull out the whole card and lay it on the bench.
- Ensure that the bar magnet is placed out of the way and then use a good magnetic compass to test the polarity of the sets of pins, by moving the compass from one side to the other across the 'ocean floor' model. The compass is being used as a simple magnetometer, detecting changes in magnetism, like a magnetometer towed by a ship over the ocean floor. It should be found that the pins have retained the magnetisation and that they are magnetised in opposite directions. The change in direction is symmetrical about the centreline of the model. This represents periodic reversals in the direction of the Earth's magnetic field.

An alternative method is to magnetise the pins as described, and then to push the card back down the crack. If someone holds the compass over the crack and another person pulls the card up gradually, the compass needle should swing backwards and forwards as the sets of oppositely magnetised pins appear.



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The back up

Title: Magnetic stripes

Subtitle: Modelling the symmetrical magnetic pattern of the rocks of the sea floor

Topic: Demonstrating the origin of the symmetrical magnetic anomalies which occur at oceanic spreading centres.

Age range of pupils: 14 -18 years

Time needed to complete activity: 10 minutes plus 30 minutes or so to make the model

Diagram showing how to set up the demonstration

Pupil learning outcomes: Pupils can:

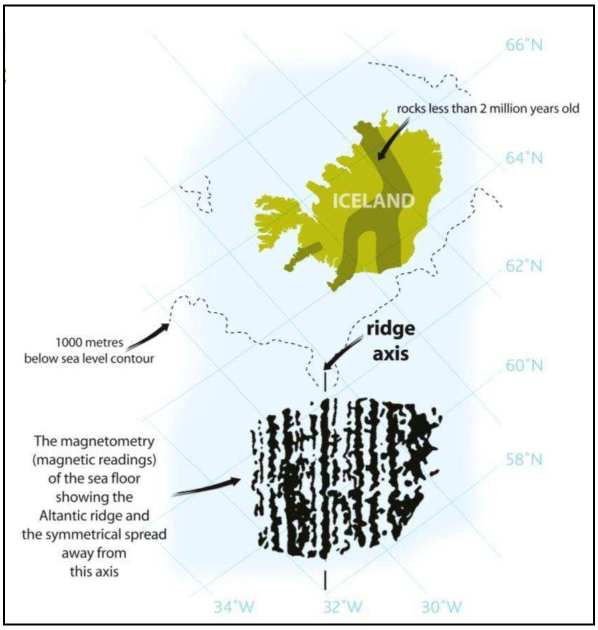
- show that a bar magnet has a North pole and a South pole;
- show that some materials can be magnetised in the presence of a strong magnetic field;

- realise that evidence for the direction of a former magnetic field can be retained, even if the modern magnetic field is different;
- understand that magnetic evidence can be used to demonstrate past sea-floor spreading;

Context: The activity can be used to aid the understanding of remanent magnetisation in rocks. Periodic reversals of the Earth's magnetic field are shown by the remanent magnetisation of rocks of the sea bed, which have been used to demonstrate sea floor spreading.

Following up the activity:

- Study maps of magnetic anomalies as measured over the oceanic ridges and look for the symmetrical patterns.
- Show how dates in hundreds of thousands or millions of years may be assigned to the sea floor 'stripes' by comparison to land-based lavas of known magnetic polarity and age, e.g. from Iceland.
- Ask why the 'magnetic stripes' as mapped do not actually have straight lines, but are much more irregular, as shown in the diagram below. *(A. The map is of magnetised sea floor lava flows – with the typical shapes of lava flows).*



The 'magnetic' sea floor 'stripes' south west of Iceland.

Underlying principles:

- The Earth has a magnetic field which is essentially bipolar (has North and South poles).
- The Earth's magnetic field is probably caused by flows of the liquid iron-rich part of the outer core of the Earth.
- For reasons which are not fully understood, the Earth's magnetic field periodically reverses, i.e. North becomes South and vice versa. The time intervals between reversals are not uniform.
- When some rocks containing magnetic minerals (particularly lavas) cool, they can retain the direction of the Earth's magnetisation at that location and at that time. This is called 'remanent magnetisation'.
- The remanent magnetisation is strong enough to influence the local value of the modern magnetic field of the Earth and can be detected by the use of sensitive magnetometers on board ships or aircraft.
- The remanent magnetisation of the igneous rocks below the oceanic ridges is symmetrical about the ridge crest.
- This observation enabled the 'Sea floor spreading' hypothesis to be developed – that eventually became part of Plate Tectonic theory.

Thinking skill development:
Pupils note the pattern of the magnetic reversals produced by magnetising the pins alternately. Relating the model to the real Earth is a bridging activity.

Resource list:

- bar magnet
- a magnetic compass, e.g. an orienteering compass or a lab plotting compass
- dressmaker's pins
- a sheet of card, e.g. 50 cm by 20 cm and coloured pens or two printed pieces of A4 paper taped together as indicated
- sticky tape
- access to a crack between two benches, or piles of books etc.

The model is prepared by colouring the card in bands, symmetrically about the mid point, to represent normally and reversally magnetised sections of the oceanic crust, or by printing two copies of the A4-sized sheet below and taping them together as indicated. A few pins are pushed into the card in each coloured band, pointing alternately in opposite directions (see diagram). Cover the pins with sticky tape to avoid anyone being hurt. It is useful to surreptitiously magnetise the pins before the lesson, as well as doing it before the pupils!

Useful links: '*Magnetic Earth – modelling the magnetic field of the Earth*' and *'Frozen magnetism – preserving evidence of a past magnetic field in wax'* activities from Earthlearningidea, www.earthlearningidea.com

Source: Based on the workshop titled "The Earth and plate tectonics", Earth Science Education Unit (ESEU), http://www.earthscienceeducation.com. It is based on a 'Crustal Evolution Project' activity originally published by the Missouri State University, USA. The diagrams were redrawn by ESEU and are used with permission.

Print two of these sheets and tape theme together here to form a mirror image of one another.