

Magnetic Earth

Modelling the magnetic field of the Earth

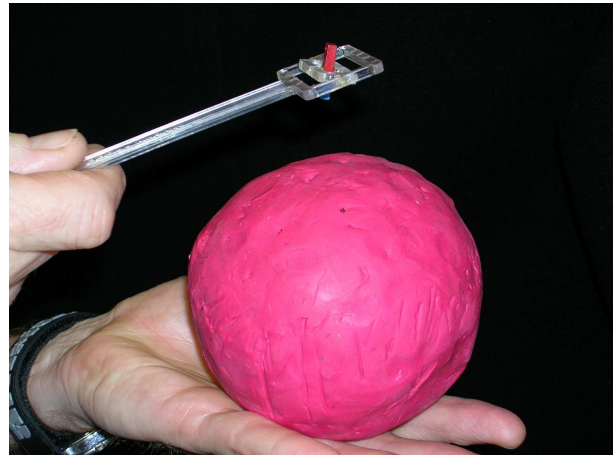
Use a compass to show pupils that the Earth has a magnetic field which causes the magnetised needle in the compass to align itself north-south. Use the Magnaprobe™ (or a sewing needle that you have magnetised) to demonstrate that the Earth's magnetic field is also three-dimensional. In the U.K. the tiny magnet in the Magnaprobe™ will settle at an angle of more than 60° from the horizontal.

Show pupils the large sphere of Plasticine™ and state that it represents the Earth. Ask a pupil to move the Magnaprobe™ around near the sphere and see if s/he can locate the two magnetic poles. Given that unlike poles attract each other, can the pupil say which pole is North and which is South?

Using the Magnaprobe™, locate and mark the magnetic equator, (i.e. the line where the magnetised needle lies parallel to the surface of the sphere).

Move the Magnaprobe™ from pole to pole along a line of longitude and mark the angle of dip of the tiny bar magnet at various points along this line, using used matchsticks.

Explain that these angles may be “frozen” into ancient rocks, especially rocks like lavas, of igneous origin. Such ancient magnetisation may be measured and can show the latitude at which the rocks were formed. This provides vital evidence for the plate tectonic movement of continents over time.



A Magnaprobe™ hovering above the North pole of a bar magnet, hidden inside a sphere of Plasticine™.
(Photo: Peter Kennett)

The back up:

Title: Magnetic Earth

Subtitle: Modelling the magnetic field of the Earth

Topic: Finding out the location and magnetic field lines of a bar magnet hidden inside a sphere of Plasticine™, as an analogy for the magnetic field of the Earth.

Age range of pupils: 14 – 18 years

Time needed to complete activity: 10 mins

Pupil learning outcomes: Pupils can:

- locate the North and South poles of a hidden bar magnet;
- identify which pole is North and which is South;
- plot the three dimensional field of the magnet;
- relate the model to the bipolar magnetic field of the Earth;
- describe how, when rocks retain the direction of the magnetic field at the time they formed, this information can be used to work out the latitude of the region at that time.

Context: This modelling activity is a useful prelude to an understanding of the magnetic field of the Earth, albeit due to a very different magnetic source. It can assist in pupils' understanding of the magnetic evidence for the movement of continents and for sea-floor spreading (when remanent magnetisation is

preserved in rocks), and hence a major part of plate tectonic theory.

Following up the activity:

- Use the internet to find a map of the Earth's magnetic field, and show that it is more complex than a simple dipole field.
- Use maps of the changing value and distribution of the Earth's magnetic field to show that it must be caused by something moving within the Earth and is clearly NOT the result of a bar magnet in the Earth's interior!

Underlying principles:

- In magnetism, 'like' poles (e.g. South and South) repel and 'unlike' poles (i.e. North and South) attract.
- If the North end of the Magnaprobe™ points vertically downward, the pole beneath it must be a South pole.
- The Earth has a magnetic field which is essentially bipolar.
- The Earth's magnetic field is probably caused by movements within the liquid iron-rich part of the outer core of the Earth and NOT by a bar magnet inside it.
- When some rocks (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'. This information can then be used to work out the

latitude of formation of geologically ancient rocks, at the time when they formed, in relation to the magnetic pole of the day.

- The Earth's magnetic field reverses at irregular intervals, so that South becomes North and North becomes South. The reasons for this are not fully understood, but magnetic evidence of such reversals preserved in rocks of the ocean floors as remanent magnetisation have enabled us to formulate the hypothesis of sea floor spreading.

Thinking skill development:

Pupils find the magnetic pattern marked by the matchsticks. Finding the magnetic equator provides a challenge. Relating the model to the real Earth is a bridging activity.

Resource list:

- strong bar magnet, (e.g. 7 cm long), previously hidden centrally in a....

- sphere of Plasticine™ of approximately 12 cm diameter
- a Magnaprobe™ (a tiny magnet suspended in gimbals in a plastic frame) **or** a sewing needle, magnetised by stroking it in one direction with the North end of a bar magnet, and suspended on a piece of cotton thread
- used matchsticks.

Useful links:

http://www.cochranes.co.uk/show_category.asp?id=50 for the supply of the Magnaprobe™.

Source: Based on an idea by Peter Kennett of the Earthlearningidea team and incorporated into the workshop titled "The Earth and plate tectonics", Earth Science Education Unit, <http://www.earthscienceeducation.com>

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