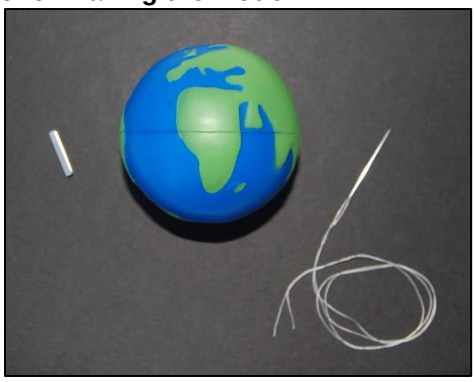
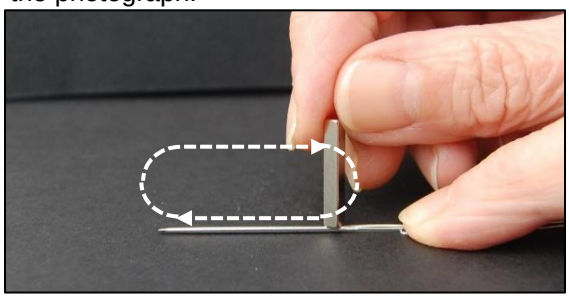
Recipe for a magnetic Earth and a magnetic detector
Using a stress ball and small magnet, with a needle and thread to model magnetic Earth

Recipe for making the model



- Collect a needle and thread, a small magnet and an 'Earth' stress ball.
- Thread the needle with the piece of thread.
- Make the needle into a magnet, by laying it flat on the table, holding a magnet upright, and stroking it in the same direction ten times, as in the photograph.



- Push a sharp pencil or pen into the North Pole of the stress ball until it reaches just over half way
- Remove the pencil/pen and push a small magnet into the same hole until it reaches half way
- You now have a model magnetic Earth and a magnetised needle 'magnetic detector'

Recipe for using the model

- Find one of the magnetic poles of the Earth by hanging the needle from the thread, and finding where the needle is pulled straight down.

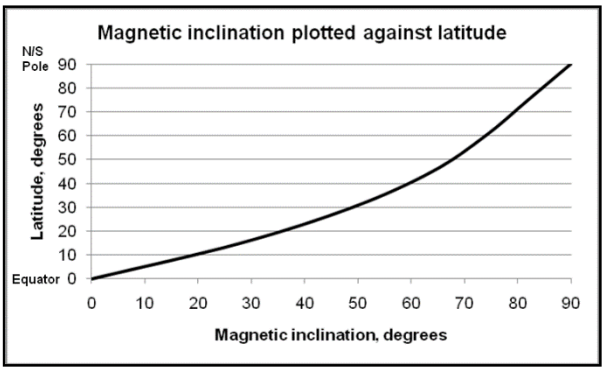
- Find the pole on the other side of the model Earth, where the two magnets (the needle magnet and the one in the Earth) repel, so the needle is pushed away from the pole and circles around it at an angle.

- Find the Equator, where the needle is upright beside the side of the Earth.

- This shows that:
  - at the Earth's magnetic pole a magnet is pulled straight down (dips down at 90º);
  - at the other pole, either a magnet is repelled or, if it were free to swing, the other end would be pulled straight down (dips down at 90º);
  - at the Equator, a magnet lies parallel to the Earth, it is horizontal (a dip of 0º).

Earth's magnetism plotted

Geoscientists have used magnetic detectors to measure Earth's magnetism at different latitudes. These measurements are plotted below, showing that Earth's magnetism has a dip of 0º at the magnetic Equator and the dip steadily steepens towards the poles, where the dip is 90º.



Magnetic inclination plotted against latitude.

The back up

Title: Recipe for a magnetic Earth and a magnetic detector

Subtitle: Using a stress ball and small magnet, with a needle and thread to model magnetic Earth.

Topic: If you want to use the 'Magnetic Earth' Earthlearningidea in your teaching, but would like each group of pupils to try it out for themselves, then this version can be put together very cheaply.

Age range of pupils: 14 years upwards

Time needed to complete activity: 15 minutes

Pupil learning outcomes: Pupils can:

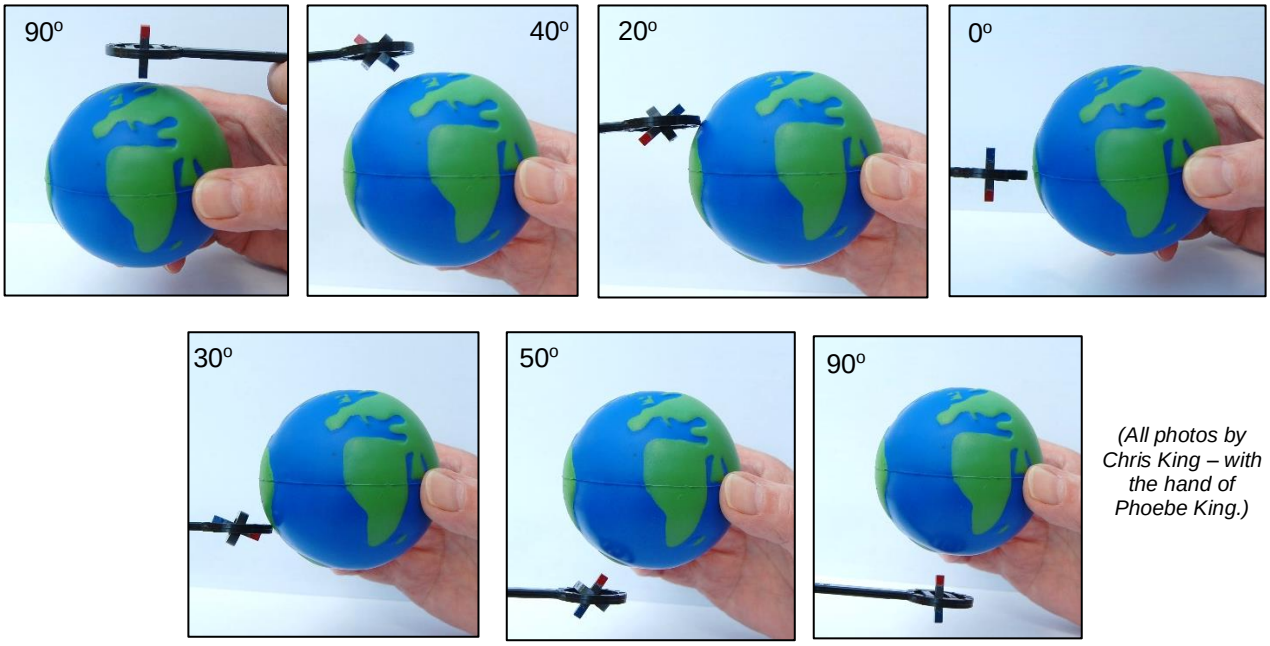
- make their own 'Magnetic Earth' and magnetic detector by following instructions;
- locate the North and South poles of a hidden bar magnet;
- relate the model to the bipolar magnetic field of the Earth.

In the follow up activity, pupils can:

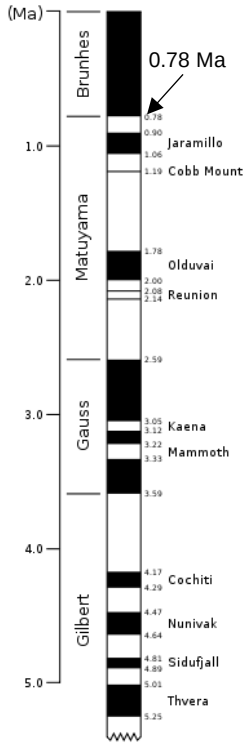
- identify which pole is North and which South;
- relate the direction of a model Earth's magnetism to magnetic reversals in the Earth.

Context:
The model and detector are cheap enough for each group of pupils to make and test their own.

Once they have made their 'magnetic Earth' this can also be tested using a Magnaprobe™ to show the direction of Earth's magnetism at different latitudes, as in the photograph sequence. The figures are the amount of magnetic dip shown by the Magnaprobe™ magnet, related to the Earth's surface.



(All photos by Chris King – with the hand of Phoebe King.)



Following up the activity:
Insert a magnet into a stress ball with the North pole pointing upwards towards the North Pole of the ball, and ask the students to use a Magnaprobe™ to answer the question, 'What is the minimum age this model Earth can be?' They can answer this question only by discovering that the blue (i.e. South-seeking) end of the Magnaprobe™ magnet is attracted to the North Pole of the magnetic Earth. So, the model has a magnetic North Pole where the North Pole is found, and their model Earth therefore has 'reversed magnetism'. By referring to the magnetic chronology chart of the Earth opposite (black is 'normal magnetism'; white is 'reversed magnetism'), they will find that the last time the Earth had reversed magnetism was 0.78 million years ago – so their model Earth must be at least this old.

Earth's geomagnetic reversal diagram, released into the public domain by the US Geological Survey.

Underlying principles:

- In magnetism, 'like' poles (e.g. South and South) repel and 'unlike' poles (i.e. North and South) attract.
- The Earth has a magnetic field which is essentially bipolar
- If the red (North-seeking) end of a Magnaprobe™ is attracted to the North Pole of the globe, then the polarity of magnetic pole within the Earth must be South and *vice versa*.
- 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.
- The Earth's magnetic field reverses at irregular intervals, so that South becomes North and North becomes South.

- The reasons for these reversals 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 by using the magnetised needle or the Magnaprobe™. Realising that the magnetic field is vertical at both poles can cause cognitive conflict. The concept that the magnetic polarity at the North Pole of the Earth is actually South, is a major cognitive conflict as well. Relating the model to the real Earth is a bridging activity.

Resource list:
Per group:
- 'Earth' stress ball (available cheaply on the internet)
- 3 x 3 x 20mm neodymium magnet (packs of 10 available cheaply on the internet)
- steel needle and thread
- pencil or pen
- optional, for further testing and follow up activity, a Magnaprobe™

Useful links:
Try some of the other Earthlearningideas linked to the magnetic Earth at:
http://www.earthlearningidea.com/PDF/75_Magnetic_Earth.pdf
http://www.earthlearningidea.com/PDF/80_Frozen_magnetism.pdf
http://www.earthlearningidea.com/PDF/81_Magnetic_stripes.pdf
http://www.earthlearningidea.com/PDF/197_Compass.pdf
See: https://www.youtube.com/watch?v=B-X-a4sUURM for an animation of Earth's reversing magnetic field.
Check: http://www.cochranes.co.uk/show_category.asp?id=50 for supply of Magnaprobes™.

Source: Original 'Magnetic Earth' model idea, Peter Kennett; stress ball 'Magnetic Earth' idea, David Rowley; needle magnetic detector idea, Chris King; use of the model to demonstrate reversed Earth magnetism, Pete Loader.