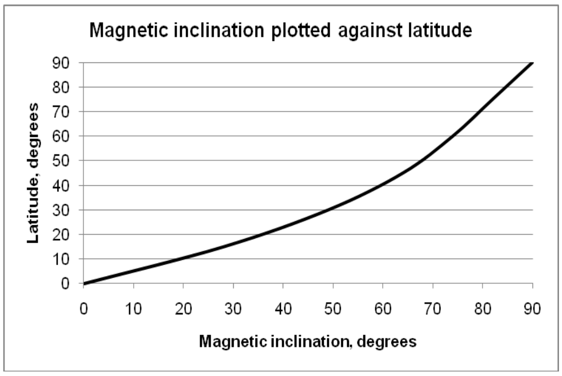
Human magnets!
Modelling ancient and modern magnetic fields, using your pupils

Some materials become magnetised as they cool down as shown in the YouTube video clips 'Curie temperature demonstration' –
https://www.youtube.com/watch?v=haVX24hOwQI
and 'Nickel Curie Point Engine' –
https://www.youtube.com/watch?v=YzwGzJm41_o
In a similar way, iron-rich minerals in igneous rocks, such as magnetite, may become magnetised as the rock crystallises from the molten state, and then cools down below a critical temperature. This temperature is known as the Curie Point. The direction of magnetisation is induced in the solid rock and records the direction of' the magnetic field of the Earth, at that place and at that time.
Show the class the graph showing how the angle of inclination (magnetic dip) of the Earth's field is related to geographical latitude, and point out the angle on the Equator (*horizontal*), at the poles (*vertical)* and at the latitude of your own school. (If you have a dip circle, or a Magnaprobe™, use it to demonstrate the magnetic dip at your latitude directly).



Take the class somewhere where there is plenty of space, eg. outside, or into a sports hall. Ask the pupils to pretend that they are crystals of magnetite, which are becoming magnetised as they cool down. Their left arms are north-seeking poles and their right arms are south-seeking poles. The class should stand facing east.
Ask the class to demonstrate the angle of inclination (magnetic dip) of the Earth's field (and therefore the magnetisation in the magnetite crystals) at various latitudes, as follows:

- On the Equator – *arms horizontal, left arm pointing north;*
- At the North Pole – *left arm vertically downwards: right arm vertically upwards;*
- At the South Pole – *right arm vertically downwards: left arm vertically upwards;*
- At the South Pole, at a time of magnetic reversal - *left arm vertically downwards: right arm vertically upwards;*
- At the latitude of your school, at a time of normal polarity (*See graph for this. For the UK, at a latitude of about 53º N, the magnetic dip is about 70º, left arm downwards)*.

Human magnets at their home latitude

Human magnets on the Equator (Photos: *Abigail Brown*)

Now move the class some distance away from you. They are on a continent located on the Equator, 300 million years ago. A lava erupts and crystallises. Pupils should demonstrate the magnetic dip of the magnetite crystals, acquired as the rock cools below its Curie Point (*arms horizontal, left arm pointing north*).
Now, plate movements occur and their continent drifts steadily to the current latitude of your school, i.e. towards you. Remind them of the magnetic dip at your own school by using your own arms (or ask one of the pupils to do it). Should pupils move their arms, or should they keep them horizontal as they move towards you and the present day? (*Keep them horizontal, because the magnetisation is locked into the rock)*.
Point out that the class has been demonstrating some of the best evidence for 'continental drift' – an essential part of plate tectonics.
Return to the classroom and relax after the unaccustomed exercise!

The back up

Title: Human magnets

Subtitle: Modelling ancient and modern magnetic fields, using your pupils

Topic: Pupils use their own bodies to model the magnetisation induced in magnetite mineral particles by the Earth's field of today: also the magnetic evidence within ancient rocks for 'continental drift'.

Age range of pupils: 14 – 18 years

Time needed to complete activity: 10 minutes

Pupil learning outcomes: Pupils can:
- describe how it is that some iron-rich minerals may acquire a magnetisation as they cool below a certain temperature in a magnetic field;
- explain how, as igneous rocks containing magnetite cool down, the rock may become magnetised in the direction and inclination of the Earth's magnetic field at that time;
- note that evidence for a former magnetic field can be retained, after the source of the magnetic field has been removed;
- explain how a rock may retain its original magnetisation, even though the continent of which it is a part has drifted to a totally different latitude.

Context:
The activity can be used to aid the understanding of remanent magnetisation in rocks. This in turn provides evidence of past magnetic fields of the Earth and is of great value in demonstrating the former latitudes of the continents, before their plate tectonic movement.

Following up the activity:
- Invent a few magnetic games of your own, involving the pupils modelling different situations, and speed up their times for adopting the positions with their arms, or in moving to a new location.
- Use the Earthlearningidea activity "Frozen magnetism", either as preparation for, or follow up to this activity.
- Test a large piece of dark basaltic lava against a magnetic compass to see if a north and a south pole can be located. (An offcut of "black granite". i.e. gabbro, from a worktop manufacturer may sometimes exhibit north and south magnetic poles).

Underlying principles:
- The Earth has a magnetic field which is essentially bipolar.
- 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'. 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.

Thinking skill development:
Realising that their arms should <u>not</u> change position when they "drift" with their "continent" is a cognitive conflict for some pupils. Relating their human magnetite crystals to the real world is a bridging activity.

Resource list:
- access to YouTube clips 'Curie temperature demonstration' and 'Nickel Curie Point Engine' and a means of showing them
- access to an open area such as an outside yard or a sports hall

Optional:
- a Magnaprobe™, obtainable from http://www.cochranes.co.uk/show_category.asp?id=50
- a large specimen of a basaltic lava, or possibly an offcut of gabbro, to search for magnetic poles
- a magnetic compass.

Useful links:
'*Magnetic Earth – modelling the magnetic field of the Earth*' activity from Earthlearningidea, www.earthlearningidea.com

Source: The original activity was demonstrated (with some hilarity!) by Abigail Brown of Hagley Catholic High School, at the 2014 Conference of the Earth Science Teachers' Association.