

Magnetic Manchester

Measuring changes in magnetic declination to investigate the Earth's core.

This activity provides novel evidence for the movement of the Earth's magnetic field with time, that affects magnetic **declination**, and relates this to the characteristics and composition of the Earth's core.

1. Provide students with the map and data for Manchester Airport (Appendices 1-3)

Point out the following:

- Manchester Airport was opened in 1938 with Runway 1.
- In 1938, Runway 1 (officially Runway 24R/06L) was named according to its compass bearing. This meant the runway was aligned along a bearing of 240 degrees (**R**ight or westerly) and 060 degrees (**L**eft or easterly) as viewed from the control tower which looks southwards over the runways.
- Runway orientation information is still important to accurately align some aircraft with the runway during landing. (Note: modern aircraft GPS systems don't rely on magnetic compasses to determine these directions).

2. Ask students to:

- draw a line along the centre of Runway 1 as in 2007 (through the midpoint of the compass rose) and record its orientation - *If this is done accurately it is ~231-051.*
- draw a second line through the midpoint of the compass (in a contrasting colour) to represent the orientation of the runway that was correct in 1938 (240-060). (Figure 1).

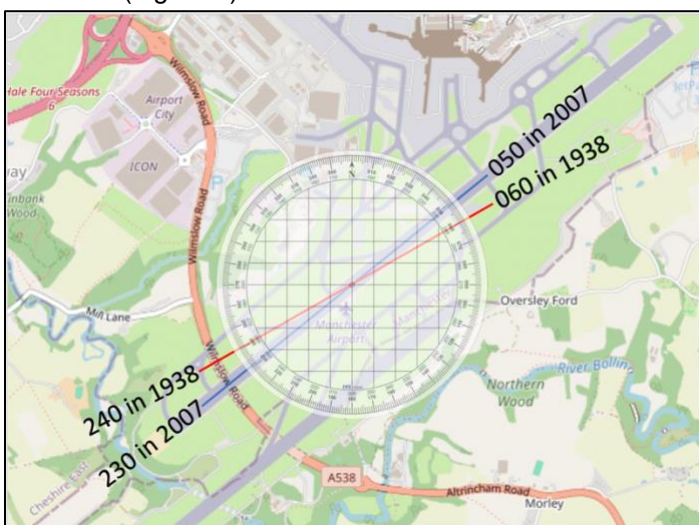


Figure 1: Alignment of Runway 1(Manchester Airport) in 1938 and 2007. (OpenStreetMap® - under ODbL).

3. Show students the official notification from Manchester Airport, posted in local papers in **2007** (Appendix 2), about temporarily closing Runway 1 to rename it 23R-05L (023-050).

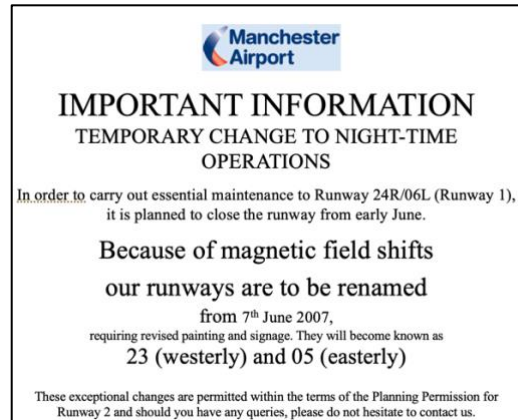


Figure 2: Public Notice from Manchester Airport Authority. (Stockport Times West 31st May 2007 - with permission).

4. The orientation of Runway 1 in 2007 was ~10 degrees different from its original orientation in 1938.
 - Ask students to discuss if Manchester Airport could have moved since 1938? Is it possible for the European plate, upon which Manchester Airport is situated, to have moved sufficiently during those 69 years? *Unlikely! Continents don't significantly move on that time scale! (The European plate has moved <1 metre eastwards in that time).*
 - Ask for other suggestions for the difference and direct the discussion to changes in **magnetic declination**.
5. Using Figure 3 (Appendix 3), ask students to explain 'magnetic declination' and discuss the changes in declination for different **latitudes** at any one time. – *the angle increases with higher latitudes.*
 - Based on the Manchester data ask students to calculate the rate of change in declination at Manchester Airport between 1938 and 2007. *~ 1 degree/7 years*
 - Ask them to explain the cause of this change at Manchester Airport over time – *The magnetic poles have moved as the Earth's magnetic field changes with time.*
 - Assuming that the present rate and direction of change continues, suggest a year when the runways might be expected to again be 10 degrees out and need renaming. *~ 2077.*
6. What does the change in declination of the Earth's magnetic field suggest about the probable composition and nature of the Earth's core? *It is probably made of iron which generates a magnetic field when moving, providing evidence of movement of a liquid, iron outer core which changes with time affecting magnetic declination.*

The back up

Title: Magnetic Manchester

Subtitle: Measuring changes in magnetic declination to investigate the Earth's core

Topic: The Earth's changing magnetic declination, recorded at the world's airports, can be used as evidence for the composition and nature of the Earth's core.

Age range of pupils: 14 - 18 years

Time needed to complete activity: 20 minutes

Pupil learning outcomes: Pupils can:

- read a map and measure orientation on a compass;
- evaluate data based on a novel situation and relate to their previous knowledge of Earth's magnetism;
- make simple calculations of rates of change and extend to further predictions;
- synthesise data and project to make conclusions about the composition and nature of the Earth's core.

Context: Magnetic **declination** is often taught in association with polar wandering curves to demonstrate the movement of continents over time. This activity provides documented evidence that the magnetic Earth's magnetic field is constantly changing and leads to the thought experiment that this is the result of a convecting liquid, outer core composed mainly of iron. It could be used as part of a lesson into evidence for the structure of the Earth.

Following up the activity:

Compare the changes in declination for other airports from different latitudes. Look out for runway signs on your next flight.

Underlying principles:

- An airport runway is named according to its heading or compass orientation; a runway numbered 09 points east (90°), and also 270° west.
- Magnetic declination, or magnetic variation, is the angle between Magnetic North and True North for any location on the Earth's surface at any time.

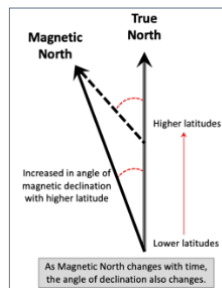


Figure 3: Magnetic declination

- The angle of declination changes over time and with latitude as a result of the constant change in position of the North and South Poles (polar wandering). At higher latitudes the angle of declination is greater than nearer the Equator, along the same line of longitude.
- At Manchester the current rate of change is $\sim 1^\circ$ every 7 years.
- As magnetic declination changes, runways have to be renamed at to keep their names in line with the runway's magnetic heading. (At Manchester this happened when the difference was 10°).
- The Earth's magnetic field is evidence that the core is mainly made of iron moving in an electric field of a self-exciting dynamo.
- Changes in declination suggest the Earth's magnetic field is constantly moving providing evidence of the liquid nature of the convecting outer core.

Thinking skill development: Students are presented with cognitive conflict when confronted with the changing orientations of a supposedly fixed location on the Earth's surface, over such a short period of time. Metacognition comes through discussion which leads to bridging skills extending reasoning to understand the implication for the nature and composition of the Earth's core.

Resource list:

- handouts (appendices 1 and 3)
- protractor
- ruler

Useful links:

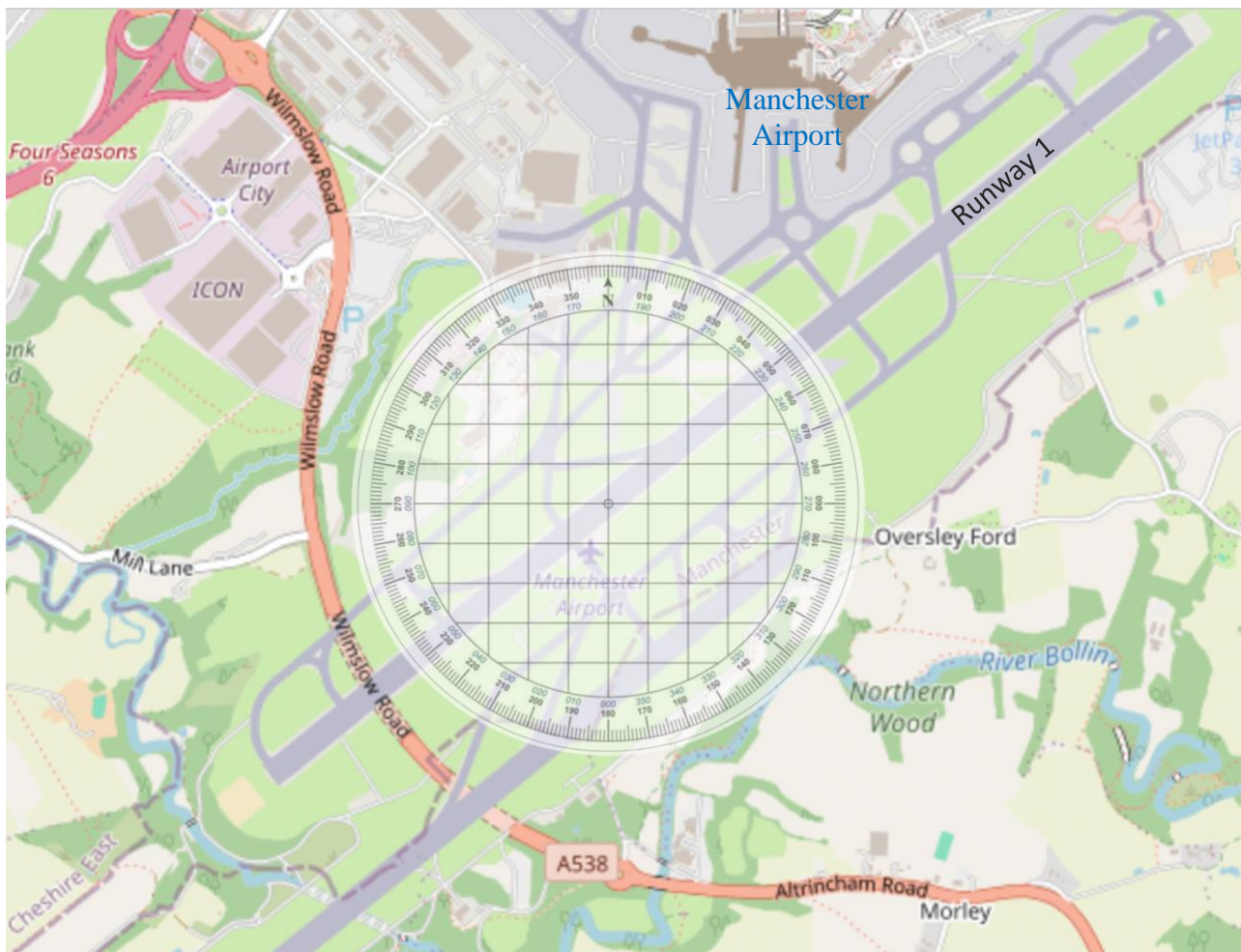
<https://nbaa.org/aircraft-operations/airports/how-changes-in-magnetic-north-are-impacting-airports/>

Source: Written by Pete Loader of the Earthlearningidea Team

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Appendix 1



Base map

Appendix 2



IMPORTANT INFORMATION
TEMPORARY CHANGE TO NIGHT-TIME OPERATIONS

In order to carry out essential maintenance to Runway 24R/06L (Runway 1), it is planned to close the runway from early June.

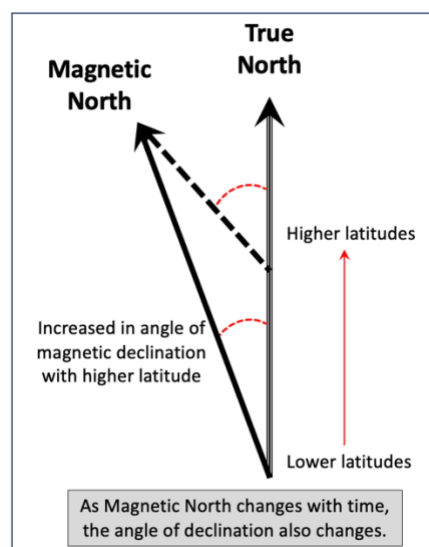
Because of magnetic field shifts our runways are to be renamed

from 7th June 2007,
requiring revised painting and signage. They will become known as
23 (westerly) and 05 (easterly)

These exceptional changes are permitted within the terms of the Planning Permission for Runway 2 and should you have any queries, please do not hesitate to contact us.

Newspaper notification

Appendix 3



Magnetic declination