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DOCUMENT TITLE
AIRCRAFT GENERAL KNOWLEDGE

CHAPTER 13 – MAGNETISM

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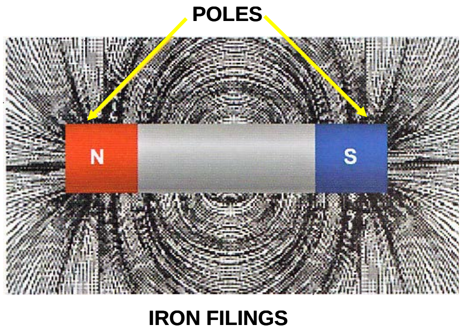
TERRESTRIAL MAGNETISM

13.1 Introduction

For thousands of years the oxide of iron called magnetite has been observed to attract small pieces of iron. This property is known as 'magnetism'. Another property for which magnetite was known was its north-seeking capability: if mounted on wood and floated in water it would swing round and align itself in a roughly north-south direction, so acting as a primitive compass. In more recent history it was found that some metallic elements and alloys (mainly 'ferrous' iron and steel) could be given these properties. Bars of such magnetised material are now known as 'magnets'.

13.2 Magnetic Field

The field of a magnet is the space around it in which its magnetic influence is felt. This may be illustrated by placing a card over a bar magnet and scattering iron filings on it. When the card is shaken or tapped the filings will take up the field pattern as shown below.



Magnetic Field

13.2.1 Poles of a Magnet

From the diagram it can be seen that the 'lines of force' traced by the iron filings converge towards small areas near (but not exactly at) the ends of the magnet. These two areas are called the 'poles' of the magnet and are where the properties of magnetism are most strongly displayed.

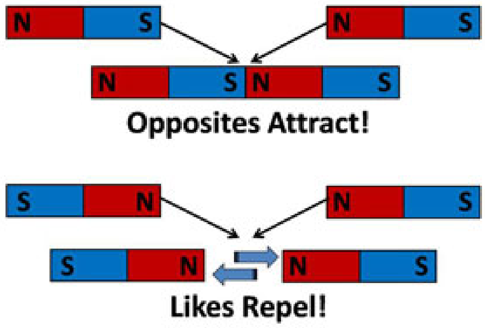
Magnets are made in various shapes but each magnet always has two poles. By convention these poles are described as RED (NORTH) and BLUE (SOUTH). If a magnet is cut into two pieces, each piece will have two poles, RED at one end and BLUE at the other. If two such magnets are placed close together, it is found that:

Like poles repel each other

RED repels **RED**

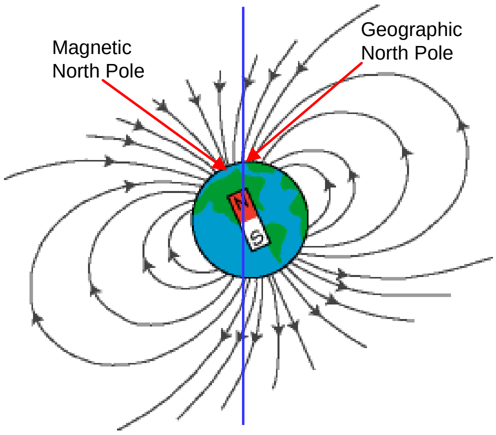
Unlike poles attract each other

RED attracts **BLUE**



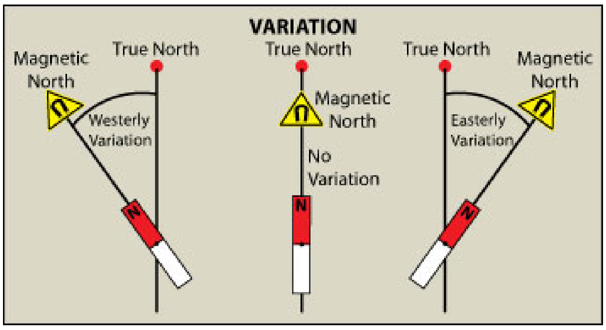
13.3 The Earth's Magnetic Field

The Earth behaves as though a huge permanent magnet were situated near the centre, producing a magnetic field over the surface. Of the many theories put forward to explain this magnetism, none has met with universal acceptance. The poles of this hypothetical Earth-magnet do not lie on the Earth's spin axis (this unfortunate lack of symmetry giving rise to magnetic variation). The Earth's magnetic north pole lies at present beneath northern Canada in the area around 70°N 95°W. The magnetic south pole being below Antarctica at about 72°S 155°E. By convention, the north magnetic pole is **BLUE** and attracts the **RED** pole (north -seeking end) of the compass needle.



13.3.1 Magnetic Variation

The direction of the Earth's field at any given point can be indicated by a freely suspended magnet. Such a magnet will align itself roughly in a north-south direction, except in some polar regions where the direction of the Earth's magnetic pole can be up to 180° removed from that of the geographic pole. The magnetic meridian is the direction of the horizontal component of the Earth's field at a point on the Earth's surface. The angle measured in the horizontal plane between the magnetic meridian at a point and the true meridian at the point, is known as the magnetic variation. Variation is designated west or east, depending on whether the magnetic meridian lies to the west or to the east of true north. Variation can have any value from zero to 180°, the latter occurring on the true meridian linking north geographical with north magnetic poles. The application of variation to headings and bearings is detailed in the navigation lectures.



13.3.2 Magnetic and Non-Magnetic Materials

The important magnetic materials are the 'ferrous' metals, iron and steel, steel being iron alloyed with substances such as carbon, cobalt, nickel, chromium and tungsten. These metals are called 'ferromagnetic' and in an aircraft they may be magnetised and produce deviation in the aircraft's compasses.

Many materials used in aircraft construction are non-magnetic and do not affect the compass. Examples of such non-ferrous substances are aluminium, duralumin, brass, copper, plastic and paint.

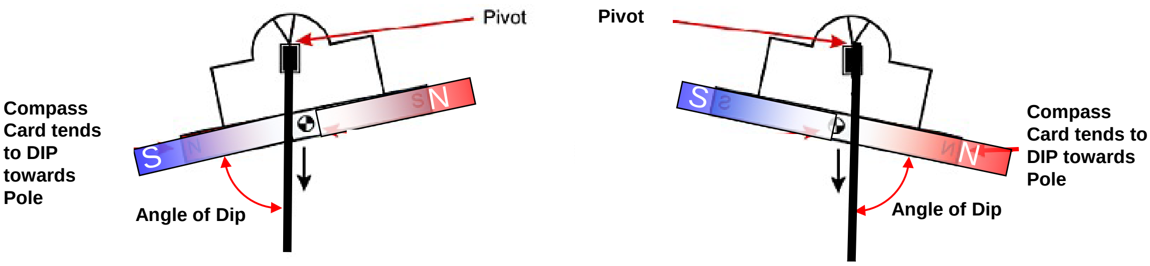
13.3.3 Magnetic Dip

Except near the 'magnetic equator' where the lines of force are parallel to the surface, one end of the freely-suspended magnet will dip below the horizontal, pointing to the nearer pole. To the north of the magnetic equator, the magnet's north seeking pole will be lower, whereas to the south the magnet's south seeking pole will be lower. The angle measured in the vertical plane between the axis of the magnet and the horizontal is called the **'angle of dip'.**

The 'magnetic equator' is represented by a line on a chart where the magnetic dip is zero. The magnetic equator is within 10° of latitude of the geographical equator.

If the freely suspended magnet is moved either north or south of the magnetic equator the dip gradually increases, reaching about 66° in the United Kingdom (latitude 50°00N) and about 52° at Adelaide in South Australia (latitude 35°00S). Over the Earth's magnetic pole, the dip is 90° and the magnet is then vertical.

MAGNETIC DIP



13.3.4 Regular Changes in Earth Magnetism

The Earth's field lacks symmetry and is also subject to several known periodic changes. Of these the secular changes are the most significant and are produced by the slow movement of the magnetic poles about the geographic poles. The period of this cycle is apparently about 960 years. The north magnetic pole is moving slowly westward; this movement mainly affecting magnetic variation.

In Australia this change means that the Agonic Line through Western Australia is slowly moving west. The current variation in Perth is 3W and will reduce to zero over the next 20–30 years. The variation in Adelaide (7E) and Sydney (12E) will increase at about at the same rate. The annual rate of change of variation is shown on navigation charts so that the variation printed against the isogonals can be readily up-dated.

Other regular changes occur diurnally, annually and over an eleven year period. The latter cycle is apparently related to the eleven year cycle of sunspot activity. These changes, unlike the secular type mentioned earlier, are not of sufficient magnitude to affect normal navigation.