Magnetism

Magnets

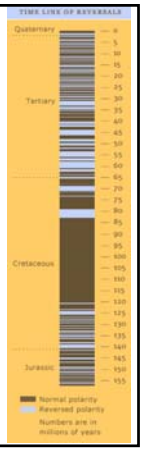
- All magnets have a **North pole** and a **South Pole**.
- If you cut a magnet in half you have two smaller magnets, each with a **North** and **South** Pole.
- The poles are named due to the geographic direction that they will point if a magnet is freely suspended and allowed to align with the Earth's magnetic field.
- The **North Pole** of a magnet will point northward geographically.
- **It is NORTH SEEKING**.

Geographic North vs Magnetic North

- Since the **North Pole** of one magnet will be attracted by the **South Pole** of another magnet, it must be true that the magnetic pole in the Northern Hemisphere is in actuality the **SOUTH MAGNETIC** pole of the Earth's magnetic field.
- **THE NORTH GEOGRAPHIC POLE IS NEAR THE SOUTH MAGNETIC POLE OF THE EARTH. (and vice versa)**
- The Earth's magnetic pole is located at 85.0°N 132.6°W
  - It is changing position by 7' W/yr.
  - Current declination for Austin, Tx: 4^0 14' E

Location of the Physical Magnetic South Pole

Reversals of the Earth's Magnetic Field



Natural Magnets

- Only substances that are **Ferromagnetic** can be magnetized.

- The four Ferromagnetic elements are:
- Iron (Fe)
- Gadolinium (Gd)
- Cobalt (Co)
- Nickel (Ni)

Rare Earth Magnets

- **Rare-earth magnets** are strong permanent magnets made from alloys of rare earth elements.
- Developed in the 1970s and 80s, rare-earth magnets are the strongest type of permanent magnets made.
- The magnetic field typically produced by rare-earth magnets can be in excess of 1.4 teslas (Ns/Cm), whereas ferrite or ceramic magnets typically exhibit fields of 0.5 to 1 tesla

Rare Earth Magnets

- There are two types: neodymium magnets and samarium-cobalt magnets.
- Rare earth magnets are extremely brittle and also vulnerable to corrosion, so they are usually plated or coated to protect them from breaking and chipping.
- The term "rare earth" can be misleading as these metals are not particularly rare or precious; they are about as abundant as tin or lead

Magnetism

- **ALL MAGNETISM ARISES FROM MOVING ELECTRIC CHARGES!!!**
- In an atom the spin of the electrons creates a **magnetic domain**.
- If the magnetic domains are aligned, then the material is magnetic.
- You can ruin a magnet by causing the magnetic domains to become unaligned.
- Dropping, heating, and exposing a magnet to another magnetic field are ways to destroy a magnet.
- You can create a temporary magnet by placing an object that is made of a ferromagnetic substance in a larger magnetic field, or by rubbing the object over and over again in the same direction.

Earth's Magnetic Field

- The field is similar to that of a bar magnet.
- The Earth's core is hotter than 1043 K, the Curie point temperature, above which the orientations of spins within iron become randomized.
- Such randomization causes the substance to lose its magnetization.

Earth's Magnetic Field, cont.

- The Earth's magnetic field is mostly caused by electric currents in the liquid outer core.
- Convection of molten iron within the outer liquid core, along with a Coriolis effect caused by the overall planetary rotation, tends to organize these "electric currents" in rolls aligned along the north-south polar axis.

Magnetic Field Lines

- Magnetic Field lines are drawn pointing **from NORTH to SOUTH.**
- If you were drawing magnetic field lines for the Earth's magnetic field then they would need to point **UP** from the **southern hemisphere** (magnetic North) toward the **northern hemisphere** (magnetic south).