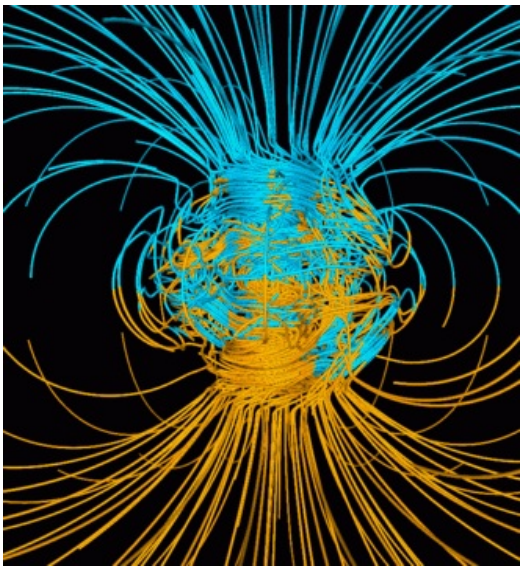
EARTH'S EVOLVING MAGNETIC FIELD AND LIFE



Earth's magnetic field, also known as the geomagnetic field, is the magnetic field that extends from the Earth's interior out into space, where it meets the solar wind, a stream of charged particles emanating from the Sun. Its magnitude at the Earth's surface ranges from 25 to 65 microteslas (0.25 to 0.65 gauss). **Roughly speaking it is the field of a magnetic dipole currently tilted at an angle of about 11 degrees with respect to Earth's rotational axis, as if there were a bar magnet placed at that angle at the centre of the Earth**. **The North geomagnetic pole, located near Greenland in the northern hemisphere, is actually the south pole of the Earth's magnetic field, and the South geomagnetic pole is the north pole.** The magnetic field is generated by electric currents due to the motion of convection currents of molten iron in the Earth's outer core driven by heat escaping from the core, a natural process called a geodynamo.

While the North and South magnetic poles are usually located near the geographic poles, they can wander widely over geological time scales, but sufficiently slowly for ordinary compasses to remain useful for navigation. However, at irregular intervals averaging several hundred thousand years, the Earth's field reverses and the North and South Magnetic Poles relatively abruptly switch places. These reversals of the geomagnetic poles leave a record in rocks that are of value to paleomagnetists in calculating geomagnetic fields in the past. **Such information in turn is helpful in studying the motions of continents and ocean floors in the process of plate tectonics**.

The magnetosphere is the region above the ionosphere that is defined by the extent of the Earth's magnetic field in space. It extends several tens of thousands of kilometres into space, protecting the Earth from the charged particles of the solar wind and cosmic rays that would otherwise strip away the upper atmosphere, including the ozone layer that protects the Earth from harmful ultraviolet radiation.

Although Earth's magnetic field is considerably weaker than those of the gas giants of our solar planets Jupiter, Saturn, Neptune and Uranus, it stands alone as the Solar Systems only terrestrial planet with a strong global magnetic field. The innermost planet Mercury has a very weak dipolar field, with only about 1% that of the Earth. Venus has no measurable field at all. Mars and the Moon have only some magnetic stripes in rock features, indications of a magnetic field that shut down eons ago. Probably when the molten material inside cooled and became solid, stopping the generation of convection currents. **Plate tectonics might also be a critical factor in explaining the longevity of magnetism on Earth.** In a process known as subduction, which occurs where crustal plates collide, slabs of cold oceanic crust sink all the way down to the core-mantle boundary, making it easy for heat to escape the core. This cooling mechanism drives the churning convective motion in the outer core that keeps the Earth's dynamo going.

MAGNETIC FIELDS AND LIFE.

We have known for some time that our planet's magnetic influence provides an invisible force field that at least partially shields us from damaging cosmic radiation and the ravages of solar wind. But new realisation shows that this field actually plays a critical role in keeping liquid water stable on the surface of our planet for the billions of years needed for primitive life to evolve into more complex forms. It is thus easy to draw the conclusion that having a respectable magnetic field was essential to preserve Earth atmosphere and nurturing the evolution of complex life. It is believed that on Mars, lacking a global magnetic field for most of its history, this had dire consequences for its atmosphere. NASA's MAVEN orbiter on Mars has documented how the solar wind still slowly erodes the little gas there still is at high altitudes, especially the lighter atomic species such as hydrogen.

NASA's Magnetospheric Multiscale Mission, or MMS, was launched in March 2015 to observe the electron physics of magnetic reconnection for the first time. Bristling with energetic particle detectors and magnetic sensors, the four MMS spacecraft flew in close formation to areas on the front side of Earth's magnetosphere where magnetic reconnection occurs. MMS has since been conducting a similar hunt in the magnetosphere's tail.

AK, with EarthSky and Wikipedia Notes