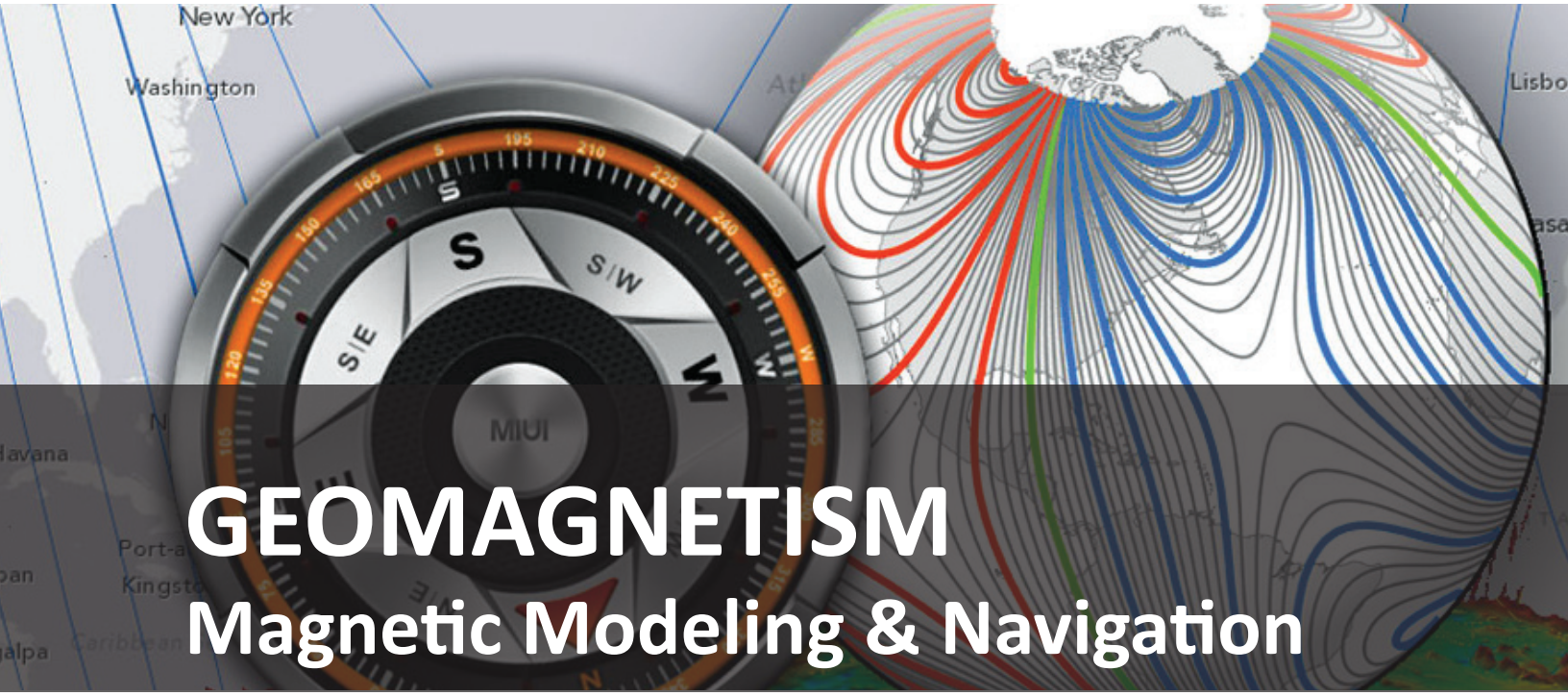


GEOMAGNETISM
Magnetic Modeling & Navigation

GEOMAGNETISM

The study of geomagnetism is one of the oldest of the geophysical sciences. Geomagnetic fields have been observed and used from ancient times. Modern uses of geomagnetic data include navigation and mineral exploration. The National Centers for Environmental Information develops and distributes models of the geomagnetic field and maintains archives of geomagnetic data to further the understanding of Earth magnetism and the Sun–Earth environment.

Integrated–databases of surface, ocean, airborne, and satellite measurements are used to create models that depict Earth's magnetic field and its annual change. These data and models are used in many diverse applications , including:

- Navigation on land, sea, and air;
- Exploration natural resources;
- Properly orienting satellites in space;
- Orienting antennas and solar panels;
- Surveying property boundaries; and
- Conduct basic research.

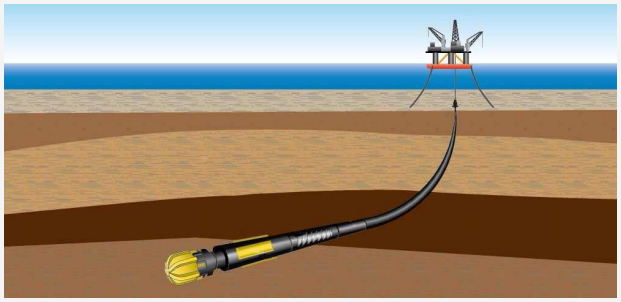
MAGNETISM & MIGRATION

Migratory animals are thought to use the geomagnetic field as an important aspect of orienting themselves and navigating to their seasonal homes. Experiments suggest that migratory birds sense subtle changes in the local geomagnetic field and use that to know their location along their route when other land marks or the sun may be obscured. Some migrating butterflies are known to use the field for a sense of direction. In the ocean, spiny lobsters, dolphins, and whales are also known to use the geomagnetic field to orient themselves for long travels.

Q Does a compass needle point towards the magnetic pole?

No. A compass points in the direction of the horizontal component of the magnetic field where the compass is located , and not to any single point. Knowing the magnetic declination (the angle between true north and horizontal trace of the magnetic field) for your location allows you to correct your compass for the magnetic field in your area. NCEI has an online magnetic declination calculator where you can enter your location (or zip code for the USA) and get the declination value.

RESOURCE EXPLORATION & DIRECTIONAL DRILLING



Directional drillers use the Earth's magnetic field as a natural reference frame to orient the drill bit kilometers underground. The azimuth of the bottom-hole assembly is inferred by comparing the magnetic field measured while drilling (MWD) with a geomagnetic reference field. Crustal magnetic anomalies constitute a significant source of error in directional drilling if not accounted for in the geomagnetic reference field. To meet increasing demand for accurate geomagnetic referencing, NCEI produces the High Definition Geomagnetic Model (HDGM) which accounts for long-wavelength crustal magnetic anomalies. HDGM significantly reduces geomagnetic referencing errors. Scientists at NCEI use a combination of marine and aeromagetic trackline geophysical data, as well as data from satellites and ground observatories to create an accurate model with global resolution.

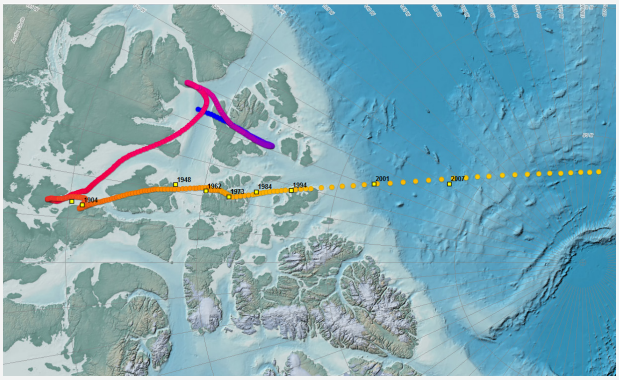
THE WORLD MAGNETIC MODEL

The World Magnetic Model (WMM) is a joint product of the United States National Geospatial-Intelligence Agency and the United Kingdom's Defense Geographic Centre. The WMM is a data-based, mathematical representation of the Earth's internal magnetic field and its temporal variation down to wavelengths of about 3000 km. It is the standard model used by the U.S. Department of Defense, NOAA, the U.K. Ministry of Defense, the North Atlantic Treaty Organization (NATO), and the International Hydrographic Organization (IHO), for navigation, orientation, and heading references. It is also widely used throughout the smartphone community by GPS instruments, web applications, and heading systems.

ONLINE CALCULATORS

NCEI provides web and mobile based calculators that are accessed over 11 million times per year, by citizens and scientists alike, to explore and correct for Earth's magnetic field across the globe. These applications include a declination calculator, magnetic field calculator, the U.S. historic declination calculator, and CrowdMag (a cell phone app developed at NCEI). All values are calculated from geomagnetic models such as the World Magnetic Model (WMM) or the International Geomagnetic Reference Field (IGRF). The IGRF is derived by an international group of scientists, including NCEI scientists, under the auspices of the International Association of Geomagnetism and Aeronomy (IAGA).

WANDERING GEOMAGNETIC POLES



The Earth's magnetic field has been slowly changing throughout its existence. When tectonic plates form along oceanic ridges, the magnetic field is imprinted on the rock as it cools below about 700°C. The slowly moving plates act as a kind of tape recorder, marking information about the strength and direction of past magnetic fields. By sampling these rocks and using radiometric dating techniques it has been possible to reconstruct the history of the Earth's magnetic field for the last 160 million years. If one "plays the tape backwards" the record shows the Earth's magnetic field strengthening, weakening, and often changing polarity (reversing North and South magnetic Poles).

FOR ADDITIONAL INFORMATION

ngdc.noaa.gov/geomag