The Unseen Force That Shapes The World

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When you think of magnetism what comes to mind? The little grey metal tabs that hold family pictures on the front of your refrigerator? Or maybe the compass you were given when you were in the Boy Scouts or Girl Scouts? Do you think of magnetism as one of the most mysterious and least understood forces in our world? Do you connect those little magnets on your refrigerator with the earth's geomagnetic field, the GMF as science knows it, or know that the story of magnetism and the GMF is the story of an unseen force that has shaped all of human history and continues to do so today?

No one knows who first noticed that some rocks with high iron content attracted other similar rocks as well as pieces of iron. Nor did anyone know why this strange attraction occurred, nor did they understand that magnetite, as this stone is known to today, is magnetized by the Earth's geomagnetic field. The discovery of the GMF lay long centuries into the future. But we do know that one of the earliest references to magnetic power can be found in the 6th century BCE writings of Thales of Miletus, a polymath who is generally acknowledged to be both the father of Greek philosophy and the man who discovered magnetic attraction.[1]

The earliest reference to the practical uses of lodestone, as Magnitite was originally called – a word that meant "way-stone" is found in China in the 4th century BCE *Book of the Devil Valley Master,* [2] and sometime about 2,500 years ago an unknown Chinese created the first primitive lodestone compass. "Fashioned into the shape of a spoon or ladle, the lodestone sat upon a flat, square-shaped plate made of bronze, which served as a representation of Earth. *(see Figure One)*

Ancient Chinese spoon compass *Figure One*
Credit: Dreamstime

In the center of the plate, was a large circle representing the Heavens appeared in which the lodestone was placed. This circle represented the Heavens. The lodestone spoon itself symbolized the constellation the Great Bear (also called Ursa Major), which contains the collection of stars known as the Big Dipper. Because of the properties of lodestone, the handle of the spoon *always pointed towards the south*." (emphasis added) These first compasses were not for geographical navigation though, they were designed for *Feng Shui*, a Chinese theory of design to help people harmonize their lives, their dwellings and their gardens.[3]

It took nearly another century for the Chinese to work out that lodestone could be used as a way to guide travel, because the lodestone consistently oriented itself in the same north-south direction. These compasses were constructed by dangling a piece of the rock and later a magnetized needle on a string. By 300 BCE the Chinese had working navigation compasses and were using them effectively on both ships and land, but they still conceived of them as oriented towards the south.[4]

One of the first individuals we can identify by name in humanity's centuries-long struggle to understand magnetism, and how it could be used is a Chinese military officer, Hsü Ching, who was part of a diplomatic mission sent by China to Korea. In 1123 CE, describing his mission's sea voyage to Korea, he explained why the magnetism of compasses was so important. "During the night it is often not possible to stop because of wind or current drift, so the pilot has to steer by the stars and the Plough (Big Dipper). If the night is overcast then he uses the south-pointing floating needle to determine south and north."[5]

Compasses did not emerge in Europe until later in the 12th century CE. Scholars are unclear whether this was the result of the passage of this knowledge from China to the West, or because of independent discovery. From the beginning Europeans, in contrast to the Chinese, conceived of the compass as pointing to the North. "The sailors, moreover, as they sail over the sea, when in cloudy weather they can no longer profit by the light of the sun, or when the world is wrapped up in the darkness of the shades of night, and they are ignorant to what point of the compass their ship's course is directed, they touch the magnet with a needle. This then whirls round in a circle until, when its motion ceases, its point looks direct to the north."[6]

Pivoting compass needle in a fourteenth-century copy of 'Epistola de magnete' of Peter Peregrinus (1269).

But it would be several hundred more years, before Europeans worked out the difference between magnetic north and true north – what is known today as declination.

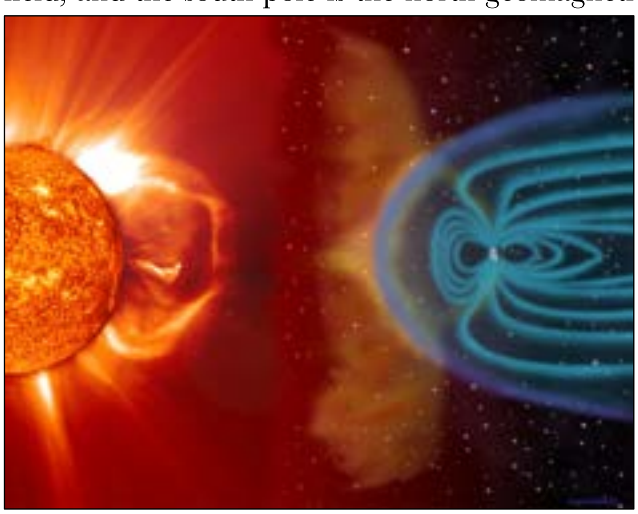
Even as late as medieval times no one, neither East or West, really knew what caused this directional orientation to happen. Some thought the star Polaris was what drew the magnets, others that at the north pole there was some kind of large magnetic island that drew the compasses to it.

It wasn't until 1600 that this mystery began to be clarified. That year William Gilbert, an English physician and natural scientist, published *De Magnete*, in which he presented a proto-modern view arguing that the Earth itself was a planetary magnet, and that compasses responded to the Earth's magnetic field.[7] Gilbert's interest in magnetism arose initially because he observed that when amber was stroked with a piece of silk – creating static electricity – it exerted a force over certain lightweight things. Since amber is called *elektron* in ancient Greek, and *electrum* in Latin, Gilbert coined the term *electricus* to describe the phenomenon, and from that we get the word electricity today.[8]

It would be yet more centuries before scientists moved beyond Gilbert's original model and began to work out to what compasses were really orienting themselves. In 1919, British physicist Sir Joseph Larmor, Fellow of the Royal Society of Great Britain, extended Gilbert's idea arguing that the Earth itself acted as a "self-exciting dynamo." But it was not until the 1940s that German born physicist Walter Maurice Elsasser, who like Einstein and others had immigrated to the U.S., proposed the modern understanding of the GMF. Over 1946 to 47 Elsasser published a series of papers presenting the argument that the Earth had a liquid outer iron core and a solid inner core and that the outer core, spun as the Earth rotated. A few years later his views were seconded by Sir Edward Bullard, a pioneer in the emerging discipline of geophysics[9]

This work by Elsasser and Bullard was subsequently supported by actual physical measurements in seismology and other geosciences, allowing the present day view "of the Earth, as having a solid inner core, a liquid outer core, both with a composition more of metal (mainly iron) than rock, and a rocky mantle, all below a thin crust that is all we can directly see. Energy from radioactivity travels outwards as heat, producing thermal convection in the core. It seems that this convection is the cause of the Earth's magnetic field, although our knowledge of the core and its dynamics is sketchy. "[10]

The strange thing is that what we think of as the Earth's north geomagnetic pole, currently located in the far north near Greenland, is actually the south pole of Earth's geomagnetic field, and the south pole is the north geomagnetic pole and is currently located along the Antarctic coast between Wilkes Land and Adelie Land.[11] What few people realize is that both poles are not fixed; they move, and not at a fixed rate. Since it was first studied in 1831, what we know as the north pole moved around at a rate of a bit over 9 miles per year. Suddenly, in the mid-1990s, for reasons science does not understand, it speeded up to almost 35 miles per year.[12] We do know that in some way these movements are the result of fluctuations in the GMF. And so it has only been within a single living person's lifetime that we have understood that what makes life possible on planet Earth is this geomagnetic field produced by the Earth itself; a field that extends from Earth's deepest interior out to where it meets the solar wind. The magnetosphere is the region of space surrounding Earth where the dominant magnetic field is still the magnetic field of Earth, rather than the magnetic



Earth's Magnetosphere *Figure Two*
Credit: NASA

field of interplanetary space. Charged particles flowing out from the Sun become trapped on the Earth's magnetic field lines, much as iron filings are caught by a child's magnet, thus forming the Earth's magnetosphere.

In the NASA images from space the magnetosphere looks like diaphanous veils of blue that undulate around the Earth, protecting and caressing it. *(see Figure Two)* The pressure of the solar wind, the electrons being thrown off by the roiling activity of the Sun, compresses the field on the dayside of the planet, while on the nightside the field stretches out, a long trailing veil streaming into space. As the Earth is buffeted by the ever-changing solar winds, the magnetosphere is in a state of constant flux, and the GMF itself is also in dynamic flux. Life is only possible on earth because the GMF and the magnetosphere it creates shields us in our Goldilocks position in the solar system, so that we are not fried by the storm of particles that issue from the Sun episodically in epic solar storms.

As NASA describes it: "The interaction between the solar wind and Earth's magnetic field, and the influence of the underlying atmosphere and ionosphere, creates various regions of fields, plasmas, and currents inside the magnetosphere such as the plasmasphere, the ring current, and radiation belts. The consequence is that conditions inside the magnetosphere are highly dynamic and create what we call 'space weather' that can affect technological systems and human activities. For example, the radiation belts can have impacts on the operations of satellites, and particles and currents from the magnetosphere can heat the upper atmosphere and result in satellite drag that can affect the orbits of low-altitude Earth orbiting satellites. Influences from the magnetosphere on the ionosphere can also affect communication and navigations systems."[13]

Very few people outside of the scientific world pay much attention to the GMF, if they know about it at all. Nor, except in the vaguest way, do most people know about the relationship of the GMF, its magnetosphere, and solar wind, the particles streaming off the Sun. Perhaps this is because it is all seen as being on a galactic scale, too big to be of concern to individual humans or their affairs. Outside of a small scientific community no one speaks about the GMF as an unseen force that shapes every aspect of the world from bacterial growth, to butterfly migrations, to human behaviour and events.

The GMF not only makes life possible, it affects all life processes; everything in the biosphere is affected by the fluctuation in the GMF and the magnetosphere produced by solar activity starting at the DNA level and working up through forms of life from bacteria to mammals. There are literally thousands of papers and technical reports showing the effects, from affecting the simplest individual organisms to social effects like the mass migration of animals, birds, and butterflies. Migratory birds use a variety of environmental cues for orientation, but their primary calibration seems to be between celestial observation as they fly and their inner awareness of the GMF. They have built-in compasses and programmed highway maps, just as your car has a GPS. GMF is what makes homing possible.

This ability to sense the GMF is known as magnetoreception, and it is possibly due to two different transduction mechanisms: the first one through magnetic nanoparticles able to respond to the GMF, and the second one through chemical reactions influenced by magnetic fields. GMF even regulates how animals like cows, buffalo, and zebras align their bodies on the ground. How does this play out? It has been observed that the magnetic alignment of cattle can be disrupted near electric power lines around the world

And as much as the GMF directly influences all life forms, so its absence has profound consequences. In the early days of NASA's space program physicians and physiologists began to notice that when astronauts were in space for extended periods their senses degraded; for instance, they stopped being able to see the sweeping second hand on their watches. Why this occurred no one knew, and it took several years before they finally worked out that the problem arose because they were disconnected from the GMF.

What happens when one becomes disconnected from the Earth constitutes an emerging new body of environmental medicine. Gaétan Chevalier of the Developmental and Cell Biology Department, University of California at Irvine, led a team in 2012 – that's how new this research field is -- that reported, "…emerging scientific research has revealed a surprisingly positive and overlooked environmental factor on health: direct physical contact with the vast supply of electrons on the surface of the Earth.

"Modern lifestyle separates humans from such contact. The research suggests that this disconnect may be a major contributor to physiological dysfunction and unwellness. Reconnection with the Earth's electrons has been found to promote intriguing physiological changes and subjective reports of well-being. Earthing (or grounding) refers to the discovery of benefits—including better sleep and reduced pain—from walking barefoot outside or sitting, working, or sleeping indoors connected to conductive systems that transfer the Earth's electrons from the ground into the body. A new area of research is emerging known as Earthing. And the research suggests there is significant clinical importance."[14]

The research to date shows the health effects that result when we lose direct contact with the Earth by the shoes we wear, the buildings we inhabit, and the vehicles we drive, and how we can design this needed contact into our lives. But for all of that, perhaps the most powerful effect of this unseen force is its effect on consciousness and culture.

The late eminent German statistician and psychologist, Professor Emeritus Suitbert Ertel of Georg-August-University in Göttingen, over several decades analysed databases on patents, copyrights, publication dates, music compositions, and famous paintings. His research revealed that "burst(s) of cultural creativity are rare historical anomalies" that have the peculiar characteristic of happening at the same time all over the world, in spurts "lasting for a couple of decades."[15]

Ertel compared these periods and correlated them with the solar activity, and just as was shown in the laboratory, he discovered that when solar activity was calm and the GMF was unperturbed creativity increased. These historical periods, Ertel argued, were directly modulated by the GMFs fluctuations.

The correlations were so strong that Ertel developed a series of what he called "observations," six in all.[16] Here they are:

The First Observation: Bursts of cultural creativity are rare historical anomalies lasting a couple of decades.

The Second Observation: Bursts of creativity co-occur jointly in different cultural fields.

The Third Observation: Bursts of creativity in different fields occur in regular succession.

The Fourth Observation: Bursts of creativity occur simultaneously in independent cultures.

The Fifth Observation: Bursts of creativity are independent of the total numbers of creators.

The Sixth Observation: Bursts of creativity correlate with solar activity.

What science is telling us, based on research from many disciplines, is that this unseen force, the GMF, shapes our world from individual DNA to social culture daily.

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