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"A NEEDLE TO THE STAR"

By

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There is one instrument that man has used above all others in the exploration of this planet. We do not know when or who discovered it. An early mention in classical literature is a passage in Dante's **Inferno**

" Out of one of these flames there sounded
A voice, and like the needle turning to its star,
Straightway to the voice I harkened."

Another early reference to this device is in a Chinese chronicle which tells how the great King Hoang-Ti, who lived in the third millennium B.C. defeated his enemy when the armies were enveloped in a dense fog. He used his "point south carriage" to indicate the direction of the enemy.

The "point south carriage " was a carriage used by the Chinese nobles with a small figure mounted on it containing a magnet, and pivoted so that the figure always pointed south. South was the noble direction for the Chinese. However, it is believed that the " South Pointer" was on the carriage more as a curiosity than for practical use . Indications are that the Chinese did use the compass for navigation at sea around 1000 A. D.

Not until 1187 do we hear about the compass in Europe. A book by an Englishman, Alexander Neckam, mentions that sailors use a magnetic needle which swings and shows the direction of the north when the

weather is overcast. We have the description of a simple compass used by the sailors at that time in a poem written by a Frenchman, Guyot de Provins;

"There is a star that never moves,
And an art that never deceives
By virtue of the magnet.
An ugly brownish stone
Which always attracts iron,
And which always points straight,
With this a needle they touched,
And on a bit of straw they set it,
Along the middle they put it,
And the straw supports it.
Then its point it turns,
Toward this star without a doubt,
When the night is so extremely dark,
That neither stars nor moon can be seen,
Then looking at the needle with a light,
Are they not certain,
To see it pointing towards that star?
Upon this the mariners depend
For the right or proper course to keep,
This is an art that never deceives."

This poem illustrates how simple the early compasses were as well as the trust placed in them.

During the middle ages the compass was principally used as a part of a time piece. The nobles of the day took their gnomons with them on their travels in order to tell the time of day. The gnomon was essentially a portable sun dial equipped with a compass so it could be set due North and South in order for the sun's shadow to show the correct time. Around the fifteenth century the gnomons began to have a little mark to one side of the north. This indicates that they had discovered the existance of magnetic variation. The needle did not point to the north star, but some other point.

In 1269 Peter Peregrinus in his book **Epistole de Magnete** wrote that the North Star was not the source of the attraction for the compass as it did not always point towards it. Furthermore he rejected the idea that the needle pointed towards a large deposit of lodestone. He believed that it pointed to the pole of the heavens about which the entire universe rotated.

In 1600, the famous scientist William Gilbert, wrote in his book *De Magnete*:

" Of more modern authors a great number have striven to show what is the cause of this direction and movement of the compass needle to the North and South and to understand this great miracle of nature, and to disclose to others: but they have lost both their oil and their pains; for not being practiced in the subjects of nature, and being misled by certain false physical systems, they adopted as theirs, from books only, without magnetical experiments, certain inferences based upon vain opinions, and many things that are not, dreaming old wives tales. "

As you may gather from this statement Gilbert was an experimental

scientist. Interestingly, Galileo, who has been considered the first experimental scientist, had not yet started his famous experiments.

Gilbert experimented with the way a single magnet and multiple magnets acted. He reasoned that the earth acted like a single magnet with its north and south poles . To further prove his reasoning he fashioned a spherical lodestone which he called a "terrella ", a little earth. With this he experimented with a small magnetized needle moving it over the surface and noting the needle's action. With his "little earth" he examined two phenomena and attempted to explain them.

One of these was that of magnetic variation . The difference in angle between where the compass should point, namely due north, and where it actually points is the magnetic variation. At different places on the surface of the earth this variation changes both in direction and amount. Gilbert's explanation for this behavior was unfortunately not correct. He reasoned it was due to the uneveness of the earth's surface. He made a "little earth " model with irregularities representing mountains and oceans. The needle responded with variations and he thought he had proved his theory. Unfortunately the earth is not made of magnetic material and is much more complex. Scientists today are still having this problem with their modeling of natural phenomena even with the tremendous capabilities of the computer to help them.

Magnetic variation is very important to the mariner. There is a story that Columbus, on his second voyage to America, had problems with the crew when they discovered that the compass showed a variation in the

opposite direction from that which they were familiar with. We do know that Columbus had two compasses on board. A compass made in Genoa and one made in Flanders. The Flanders compass was corrected for magnet variation existing in Flanders, not the Mid-Atlantic.

All navigational maps indicated this magnetic variation. The first of these was made by Christopher Burrus around 1654. The first modern worldwide chart was made by Sabine in 1845. This varation is continously changing at a slow rate and the varations shown on charts must be updated on a regular basis

Gilbert's investigation of the second phenomena , that of the dip of the compass needle, was some what more successful. As he moved his little needle around his model earth, it was parallel with the surface at the equator, stood on its head at the one pole and on its feet at the other. He reasoned that this phenomena of dip could be used to determine the latitude by measuring the angle of dip. Again he did not realize that the earth and its magnetic field was much more complex than his model and there would be difficulties in using it to accurately determine latitude..

All in all the compass set man free to roam the surface of the seas and still find his way back to home port. It is true that he needed one more measurement to accurately locate his position and that was accurate time, however that is a story for another time.

With man free to explore the seas , Columbus, Magellan, De Gama, to mention the principals, maps were drawn showing the continents or suspected continents. By the 1500's the Flemish geographer Gerhardus

Mercator published recognizable maps of the entire earth. These global charts showed the coasts of the New World and of Africa in considerable detail.

Sir Francis Bacon noted, in his *Novanum Organum*, published in 1620 , the remarkable fit between the coasts of South America and Africa. He commented that such similarities could hardly be accidental. However he did not offer any explanation.

In 1658, a Frenchman, R.P. Francois Placet, wrote a memoir in which he suggested that the Old and New World became separated following the Biblical Flood . As late as 1800 Alexander von Humbolt, the pioneer explorer of Mexico and the Western United States, wrote that the Atlantic was a huge river valley whose sides had been separated by the water from the Flood.

These early geologists had not yet escaped the intellectual prison of Christian dogma and turned to the Bible for explanations of how the earth was formed. These early earth scientists became known as the "Flood geologists" and their ideas were based on the theory that the features of the earth were formed by catastrophic happenings such as the Flood. Using the Scriptures as their calendar they also placed the age of the earth at 6000 years.

In 1749 a French naturalist, G. L. de Buffon, was brave enough to challenge the biblical date by estimating the earth to be at least 75,000 year's old. He based it on his observations of fossil-bearing rocks. It had begun to dawn on those early geologists that the earth was much older

than the Bible suggested and furthermore it was changing at a slower than catastrophic rate.

In 1785, a Scotsman , James Hutton, expounded the theory of uniformitarianism whose central thought was that the earth's surface is being changed uniformly, rather than catastrophically, over great spans of time. In his lecture at the Royal Society of Edinbrugh he pointed out that the changes are so slow that they cannot be observed in one lifetime or even several life times but only over periods of thousands of years. Furthermore the agents of change were not sudden catastrophes but such slow, steady forces such as the pounding of the waves, the hammering of the rain and wind, and the washing of mud and rocks by rivers. Hutton with his theory of Uniformitarianism is considered the father of modern geology.

Hutton's theory, however , could not explain all of the geological mysteries and many scientists like von Humbolt turned back to versions of catastrophism for their explainations. In 1858 an American , Antonioi Snider, surpassed all of them by picturing a whole series of catastrophic events to explain the position of the continents. He wrote that when the earth was first formed most of the material of the future continents gathered in a single clump at one side of the globe, the then unbalanced earth developed such internal stresses that the single land mass developed cracks and lava boiled up between them. At the same time Noah's flood poured down such torrents of rain that the raging water pushed a portion of the cracked continent to the other side of the globe forming the Americas hence balancing the wobbling globe.

There were many other proposals on the formation and positions of the continents, all of which were rejected by the uniformitarians and it was not until Alfred Wegener in 1915 published his famous book, *The Origin of the Continents and the Oceans* that this changed. For the first time a scientist tried to explain the drift of continents by modern geological evidence . Wegener amassed an impressive amount of evidence to show that the continental drift was slow, gradual and uniform. Unfortunately Wegener was not a geologist but a meteorologist and it was many years before his theories were seriously considered. In fact as late as the 1940's , his theory of continental drift was so discredited in the United States that any geologist who argued for it was ridiculed by his colleagues.

Wegener's hypothesis was that all of the continents were once part of a single , primordial super continent which he called Pangaea. The rest of the globe was covered by a vast ocean. At least 200 million years ago he postulated some unknown force began to disintegrate this supercontinent and slowly its fragments started drifting apart. Fragments heading west became the Americas, those heading north became Asia, the one going east became Australia and one to the south became Antarctica. Only Europe and Africa remained essentially stationary.

Wegener's theory answered many of the geological and biological questions. The various continents fitted together because they were once part of a single continent. There were related plants and animals found on widely scattered continents for the same reason. Tropical fossils were found in extremely cold climates because the continents

moved from one climate zone to another in their drifting about the globe. He also answered the question of why the great mountain chains seem to be related like the Andes and the Rocky mountains . He proposed that they were the result of the continent's movement against the resistance of the ocean floor causing the crumpled leading edge of the continent to fold back and form the mountain chain.

As one would expect from such an all encompassing theory there were many criticisms of it, the strongest one seemed to be the fact that scientists questioned what the force was that could move the continents through the hard ocean floor to their new locations.

In 1930 Wegener went on an Arctic expedition to measure the thickness of the Greenland ice cap. He died there in a severe blizzard. After his tragic death a few scientists continued to argue in favor of his theory ,but it was hopeless. College professors even held it to up their students as a classic example of poor science.

More than twenty years after Wegener's tragic death suddenly there was renewed interest coming from the study of paleomagnetism. In the early 1950s , a British Nobel laureate in physics, P.M.S. Blackett, invented the magnetometer which could detect the direction of extremely weak magentic fields. It was the key that unlocked the secrets of the magnetic compasses contained in ancient rocks . Igneous or basaltic molten rock contains small grains of magnetite which, as it cools reaches a certain critical temperature at which time it acquires a strong stable magnetic polarization from the earth's magnetic field. Sedimentary rocks also acquire a similar directional magnetic field. As

they settle their magnite fragments align themselves with the existing earth's field.

A British palomagnetist, Stanley K .Runcorn, on studying rocks from the English countryside which had been formed some 200 million year ago, discovered by using Blackett's magnetometer that England was located at 30 degrees north then as compared to 60 degrees north at the present time. Runcorn and his associates then went to India where they obtained data on a series of rocks from 150 million, 100 million ,50 million and 25 million years ago. This data showed that India had been at 64 degrees south, then 60 degrees ,then 26 degrees south and finally 17 degrees north. There were two possible answers, the magnetic poles had wandered by these large distances or the continents had drifted as Wegener had proposed. There were quite a number of geologists who believed in the theory of the pole wandering and even as late as 1972 there were books being written arguing this point of view even though experiments had been made which confirmed the fact that the pole had remained within 15 degrees of the earth's rotational pole for at least 250 million years.

Another important discovery of the paleomagnetists was they found that the earth's magnetic field reversed itself approximately every 700, 000 years. and they were able to develop a time scale of the polarity reversals extending back millions of years.

The real problem was that the geologists who were trying to solve these mysteries of the earth's surface were ignoring an important three quarters of the surface ,that which was submerged under the seas. It was here beneath the waves that the answers lay hidden and again it was