The Erdapfel

This is the first of two articles on the history of the Terrestrial Globe.

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The Nuremberg Germanic Museum houses one of the world's most cherished and consequential navigation artifacts. It is called the Erdapfel. The Erdapfel (Earth apple), is the earliest known surviving terrestrial globe. Made just prior to the discovery of the Americas, it gives a fascinating insight into the geographic knowledge base of 15th century western civilization.

Although the Erdapfel is only 523 years old, the story of the Erdapfel might be said to begin 2,500 years ago in the 6th century B.C. The Greek philosopher/mathematician Pythagoras is the first person who taught that the Earth is a sphere in the center of the Kosmos (Universe), and that the planets, stars, and the universe were spherical because the sphere was the most perfect solid figure. Aristotle, who lived in Greece in the 4th century BC, was the first to offer evidence, albeit qualitative, that the Earth is spherical. His empirical observations to support his thesis that the Earth was spherical were:

1. Matter is drawn to the center of the Earth by gravity which would only be true for a sphere.
2. As one moves from north to south, new constellations are seen rising above the southern horizon.
3. During a lunar eclipse, the Earth's shadow on the Moon is always round.

Behaim's Erdapfel

During the Middle Ages and pre-Renaissance, Aristotle was the standard scientific authority in the Christian and Muslim worlds. Literate individuals (who were, of course, the minority during those times) subscribed to the Aristotelian theory of a spherical earth, as well as to the erroneous posit of a geocentric cosmology. Not only did ancient and medieval intellectuals know the shape of the Earth, there were relatively accurate estimates of the Earth's size. Beginning with Erastophenes, the head librarian of the eminent Library of Alexandria, in the 2nd century BC, the circumference of the Earth was estimated to be 39,300 kilometers, or only two percent smaller than the actual value. The Greco-Egyptian Ptolemy, who lived from AD 90 to AD 168, was a writer, a patron of the Library of Alexandria, and a renowned mathematician, astronomer, geographer, and astrologer. One of Ptolemy's main treatises is his *Geography* which includes a compilation of geographical coordinates, using a spherical coordinate system, similar to the modern latitude and longitude coordinate system. Ptolemy also devised and provided instructions on how to create maps both of the Roman empire and the known inhabited world spanning 180 degrees of longitude from the Canary Islands in the Atlantic Ocean to the middle of China and about 77 degrees of latitude from the Shetland Islands at about 60 degrees north latitude to anti-Meroe (the name Ptolemy gave to a yet undiscovered point at the same numerical south latitude (-16.5°) as the north latitude (+16.5°) of the ancient city of Meroe in present day Sudan). The destruction by fire of the Alexandria Library in the third century AD ushered in the Dark Ages and resulted in backwards steps in Western civilization's knowledge of the shape of the earth and its relationship to the universe.

The rediscovery of Ptolemy's maps at the beginning of the 14th century AD by Maximus Planudes, a Byzantine Greek monk scholar, might be cited as the event which triggered, from a geographical perspective, the end of the Dark Ages. By the early 1400s, new navigation tools and mapping advances ushered in the Age of Discovery. Alone among the European and Middle Eastern maritime powers, Portugal faced the Atlantic Ocean yet had no direct access to the strategic Mediterranean Sea. Thus, by necessity, if the Portuguese monarchy wanted to fulfill its goals of economic and religious expansion, it must turn towards the open waters of the Atlantic Ocean. S, the Portuguese sailed the great ocean, hundreds of miles from land and made many of the navigational advancements of the era. Led by Prince Henry the Navigator, Portugal was the hub of advanced navigational development which led to the discoveries of Canary and Cape Verde Islands as well as the colonization of much of the west coast of Africa. The exploration of the African coast was continued by private ventures after Prince Henry's death in 1460 and in 1473 the Portuguese explorer Lopo Goncalves was the first European to cross the equator. In 1487 Bartholomew Dias achieved another first by sailing his ship around the southernmost point, the Cape of Good Hope, of the African continent. Finally, in 1497, another Portuguese expedition commandeered by Vasco de Gama rounded the Cape of Good Hope and in 1498 consummated the Portuguese goal of a maritime passage to India and the Orient that circumvented the dangerous land routes through the Middle East.

Lisboa, 1500-1510

The attraction of wealth from gold and spices in the Orient was an obsessive motivation for explorers and their patrons to find more economical and safer routes to the riches of the Far East. Both Spain and Portugal, the predominant European maritime powers, were convinced that a sea passage from Europe to India and the Orient might be discovered by exploring to the west instead of the east around Africa. This route of course assumed a spherical earth, but the size of the earth was not well known and less than 25% of its surface had been explored.

It was in this tumultuous and heady setting of the European Renaissance, with its rapid reinfusion of knowledge about the earth's shape from the Greeks, and the burgeoning of the Age of Discovery, that Martin Behaim was born in Nuremberg, Germany in 1459. Notwithstanding its dark history of anti-semitism in the 12th to 14th centuries, the cultural flowering of Nuremberg in the 15th and 16th centuries, made it the center of the German Renaissance. Behaim was born to a flourishing family of cloth merchants. The Behaim's had cultivated a strong trading relationship with the Iberian peninsula and, in particular, with the expansionist maritime power of Portugal. While pursuing his family's business, Behaim spent much of his time between the ages of 24 and 31 in Lisbon, Portugal, where he was thought to have acquired an interest in geography and exploration. Behaim displayed an extensive knowledge of mathematics and an intimate familiarity with celestial navigation. Because of his knowledge of mathematics and navigation Behaim received an appointment to the king's council of mathematicians in 1483 and under that auspices assumed responsibility for a variety of research projects as assigned by the king. Among them Behaim was requested to develop improvements to existing navigational instruments. The exact innovations suggested by Behaim remain unclear. It is believed that he demonstrated the use of Levi ben Gerson's cross-staff apparatus as a means of determining ship's altitude. The cross-staff (also called a Jacob's staff or ballestilla) resembles an Arabian *kamal* and works on the principle of coordinating the declination of the sun with the horizon. It is possible that Behaim suggested to the Portuguese to construct astrolabes of brass, to replace the older wooden models in Portugal. According to some scholars the Portuguese already were well versed in the use of solar declension tables and brass instruments by the 1480s when Behaim arrived in Portugal. Regardless, his innovations proved highly satisfactory, and in 1484 King John II dubbed Behaim with the honor of knighthood in the Portuguese Order of Christ. In 1485-86, according to most reports, Behaim was then invited to travel as cosmographer with Diego Cam on a southbound expedition to explore the West Coast of Africa. He married the daughter of the wealthy governor of cities in the Azores Island chain where he lived from about 1486 to 1490.

Martin Behaim

In 1490, Martin Behaim visited his native town of Nuremberg with the main objective of expanding his family's clothing business. Nuremberg in the 15th century was a thriving German city known for its craftsmen and commercial trading enterprise. Based on his reputation in cosmography and connections with the business community, Behaim was awarded a commission by the city of Nuremberg to oversee the construction of the Nuremberg Terrestrial Globe. The production of the globe involved first the compilation of a map of world as a guide for the artist employed in painting the globe; secondly, the manufacture of the Globe, together with its accessories such as the iron stand; and thirdly, the transfer of the map to the Globe. The Globe was completed in 1492 before the discovery of the Americas. The Globe is slightly less than 21 inches in diameter. The surface of the Globe, painted by the renowned artist Georg Glockendon, is covered with over 1100 illustrations and inscriptions taken from sources including Ptolemy, Isidor of Seville, and Marco Polo. Perhaps the most attractive feature of the Globe consists of 111 miniature paintings showing items of geographical interest such as kings seated upon thrones, portraits of missionaries instructing natives, elephants, bears, camels, ostriches, parrots, serpents and mermaids.

It is possible that Behaim met Christopher Columbus during Columbus' residence in Portugal circa 1485. This and other interesting theories about the Erdapfel and terrestrial globes will be discussed in the next Historian article.

Other ION Historian articles that may be of related interest include: "The Shape of the Earth Part I and II", (Summer 2001, Fall 2001), "The Mercator Projection (Summer 2002)", "Henry the Navigator (Winter 2009-2010, Spring 2010)", "Around the World in 1081 Days" (Spring, Summer, Fall 2013). ION

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