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From the Editor

Fascinated by achievements of contemporary geospatial technology, oriented at the use value of geoinformation and its measurable quantity and quality, we forget that a man is not only a thinking creature, but also a feeling one and having aesthetic needs. Therefore, it is worthwhile to take advantage of rich cultural achievements in the field of geoinformation, recorded throughout the course of history in cartographic works combining research and artistic values.

A few months ago the Editorial Board decided to include cultural aspects of geoinformation to the subjects of "Annals of Geomatics". The article of professor Lechthaler, submitted entirely independently, perfectly responds to this initiative of the magazine.

Jerzy Gaździcki

FROM CLAY PLATE MAPS TO THE FIRST ATLAS OF THE WORLD
Cartographic Maps As a Cultural Heritage

OD MAP NA GLINIANYCH TABLICACH DO PIERWSZEGO ATLASU ŚWIATA
Mapy kartograficzne jako dziedzictwo kulturowe

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Keywords: history of cartography, cartographic visualization, maps as a cultural heritage work
Słowa kluczowe: historia kartografii, wizualizacja kartograficzna, mapy jako dzieło dziedzictwa kulturowego

Introduction

Maps combine yesterday's, today's, and tomorrow's view of our world, other planets, and the whole universe – from the perspective of humans, sciences, and arts. The history of mapmaking, i.e. cartography, resembles the history of mankind.

Map contents are expressed by means of graphical language. From the beginnings of cartography until now, this language remained similar: clearly perceptible symbols represent

real world objects and abstract phenomena, resulting in a map that is easy to read. Only techniques changed over the years – from cuneiform writing to modern digital techniques.

The article features brief and concise history of appearance and development of topographic representations from the *clay plate maps* (Old Ages 6th century B.C.) to the first *World atlas* from Gerhard Mercator (1512–1594), and historical importance of the cartographic maps as a cultural heritage.

A walk through the history of cartographic representations

Long before people were able to write, maps have been used to visualize reality or phantasm. Their content influences people in how they see the world. We can draw conclusions on how visualized regions are experienced, imagined, or meant to be perceived. Often this is influenced by social and political objectives. Each presented map is acting as a substitute for its era making us relive the circumstances at that time.

From the Stone Age to Greek Antique

No traces are known, i.e. preserved from the ancient Stone Age that could be related to attempts of representing an area. Cartography historians, on basis of material traces of certain old cultures at lower developmental level which were found by European in newly discovered parts of the world, assumed what it was like in certain historical periods of the Old World in Europe, Asia and Africa. The oldest preserved presentation of the world from the 6th century B.C. (Fig. 1) was carved into a clay plate. The world represented schematically as a circle, i.e. the Babylon Empire, is surrounded by an ocean. The river Euphrates is of central importance, flowing through the city of Babylon and into the Persian Gulf.

Geography and Cartography became scientific disciplines in Greek Antique. Leading scientists consider and ponder the shape, circumference and volume of the Earth. Philosopher, astronomer and astrophysicist Anaximander of Miletus (611–546 B.C.) gives a representation of the position of land and sea known at the time in the first known map of the world, which unfortunately was not preserved (Fig. 2).

Claudius Ptolemy

Claudius Ptolemy (87–150), one of the greatest Antique scientists, presented in his lifetime work *Megale syntaxis* the Earth in the center of the planetary system, relying on the theory by Plato and Aristotle. Furthermore, in his lifetime work *Geographia* (eight volumes), Ptolemy provides a list of all known settlements, their position in geographic coordinates as well as maps of various areas. The first printed edition of Ptolemy's *Geographia* with maps was published in Bologna in 1477 and the prettiest one in Ulm in 1482 (Fig. 3). Unfortunately, no Ptolemy's originals were preserved.

From Ptolemy and Marin of Tyre sprang the revolutionary idea of introducing a geographical grid into cartographic representations (around year 100 A.D.), as well as the notion how important is mapping adjusted to scale.

His *Map of the World* was the first attempt to project the surface of a sphere onto a plane – the mantle of a cone. The projection grid consisted of meridians which cut the equator in equal segments and converge to the North Pole, while parallels as circles of varying circumferences have a mutual center in the same pole. He drew three continents: Asia, Europe and Libya to the best of his knowledge, within this grid, using auxiliary lines.

Ptolemy's scientific works have affected cartographic activities authoritatively for centuries. Namely, in lack of knowledge and verification of mathematical sources and computing technique, the author didn't compute needed values himself and didn't use the correct value of the Earth's circumference given by Antique geographer and historian Eratosthenes, but employed measurement, i.e. computation results by the voyager, geographer and historian Strabo of Amaseia (60–20 B.C.).

Ptolemy's degree was shorter by almost a third. By consequence, his world image is a third shorter in direction north-south, and the equator drawn too high. Due to incorrect length of the Mediterranean Sea (62 degrees instead of 42) and east stretching of Asia (50 degrees more than true value), there was not enough space left between European western and Asian eastern coast. This would later deceive Columbus in his conclusions that he could reach Asia relatively quickly by sea, sailing in west direction from Europe.

Roman Antique Age

The mathematical background of the maps stagnated during the Roman period. The Romans primarily cared about applying maps, and not particularly about their geometric accuracy. They were satisfied with maps with approximate geometry and accurate object, road and path names. Only *Tabula Peutingeriana* (Fig. 4) was preserved among all Roman maps.

After carefully considering this unique witness of the past, it was concluded that the map was produced around the year 250 (Leithäuser, 1958) and that it was most likely a copy of a detailed road map of the Roman Empire from the first century. *Tabula Peutingeriana* consists of 11 maps, which are put together to form a strap. Therefore, the whole painted area is stretched in the direction west-east. Its special value lies in 3.500 toponyms which describe the world of that time.

The Middle Ages

During the Middle Ages, cartographic issues were addressed in particular by the Arabs, who directed Christian scientists to antique knowledge and Aristotle's works. The humanist, geographer and cartographer Abu Abdallah Mohammad al-Sharif al-Idrisi (1100–1172) contributed to the development of cartography with his works. His globe (400 kg heavy silver ball) represents all seven continents, as well as a river and lake network, important settlements and trade routes (Clark et al., 2005). Unfortunately, the globe wasn't preserved. However, its detailed description is featured in the work *Tabula Rogeriana*, whose collection also contains a world map (Fig. 5).

Application of circular parallels is a great novelty in cartography of that time. Ptolemy's influence in the works is undoubtedly.

During that time in the west, primarily monks in monasteries dealt with cartography. The so-called T-O maps (Fig. 6) represent the known world in the form of the letter *T* (Asia, Europe, Africa, Mediterranean Sea and the rivers Don and Nile). Geographically and cartographically, works produced during this period do not possess great value.

Centuries of great discoveries and the development of cartography

Under the influence of newly-discovered lands in the late 14th, 15th and 16th centuries – time of great discoveries – and new natural-scientific understandings the survival of Christian image of the world, where the Earth is like a plate became doubtful. Sailors believed the Earth had the shape of a ball. They often used globes for orientation in absence of good maritime chartsMartin Behaim (1459–1506) constructed 1492 a globe of the Earth (Fig. 7) – the *Behaim's Apple*. He acquired all content he needed by sailing, inspecting books of various geographers, scientist Ptolemy (87–150) as well as Venetian world traveler and writer Marco Polo (1254–1324). Circumference of the globe at the equator is 159.5 cm, diameter 50.7 cm, and scale 1: 25.2 mil. The poles are connected with a metal bar which is a sign that people of that time thought the Earth rotated around its axis.

Behaim's Globe is unique and surpassingly valuable historical and cultural document, the oldest document representing the Earth as a globe and at the same time the last one produced before America was discovered.

Sailors, surveyors and scientists sail with so-called *Portolan* charts (Fig. 8) and investigate the unknown areas exposing themselves and their crew to unbelievable strains, wishing to explore newly discovered parts of the world.

They were used alongside compasses (dated from 12th century) and written navigation directions. Grid of compass directions was first drawn on a sheep or goat skin. Capes and bays, especially important objects for navigation, are disproportional large against the coastline. Names are positioned clockwise on the land perpendicular to the coastline. Geometry resulted from measuring lengths and directions obtained from astronomic observations.

In 1487–1488 Bartolomeo Diaz (1450–1500), a Portuguese sailor was the first who sailed the south of the African continent – The Cape of Good Hope. Those discoveries enabled to include new geographical content in the maps but still refuting the theory and authority of Ptolemy (Fig. 9).

In August 1492, Columbus set sail with his Spanish fleet west to the Atlantic, seeking a nautical way to magically described India. In the same year, he discovered a land in the far west – the Bahamas. Debarking, he thought that it was just an island in front of the Indian coast. Thus Columbus was the first Spaniard who stepped on American soil.

Vasco da Gama (1469–1524), a Portuguese sailor and captain, discovered a nautical way to India in 1497–1498 by sailing around the Cape of Good Hope.

When Italian sailor Amerigo Vespucci (1451–1512) returned from the west in 1504, he wrote for the first time that Columbus' discovery wasn't related to India and Asia, already known continents, but to a new continent.

Thus in a brief period, in only a few years, the world doubled in size and lost its old borders. The need for correct and detailed survey grew daily. Cartography was disentangled

from the model of Ptolemy, whose theory and cartographic representations of the world deceived cartographers for centuries. During this period, a young scientist, humanist, astronomer and cartographer appeared, desiring knowledge and full of new ideas which revolutionized cartography as science.

Gerhard Mercator – ingenious cartographer

Gerhard Mercator, actually Gerhard Kremer, was born in the small town Rupelmonde in Belgium in 1512. With 20, he became a master of philosophy. He quickly changed his profession, wanted to work on map production, globe construction and astronomic instruments for surveying the Earth, using his great knowledge of mathematics. Mercator was a cartographer drawer and copper-engraver, penman, publisher, printer of his maps, constructor of his own globes of the Earth and the celestial sphere and a precise machinist in production of measuring instruments.

Lifetime opus of Gerhard Mercator

In 1538, under the influence of Frisius' school and his work *Cosmography* (Leithäuser, 1958), Mercator published his first *Map of the World* in a very complex "heart like projection"(Fig. 10), dividing the whole world into two hearts like representations by the equator.

In 1554 he published his first *Map of Europe*, the first ever to deserve that name. He had been working on it since 1538, precisely drawing positions of cities according to his calculations, carefully correcting incorrect city positions according to Ptolemy, which were still present on maps.

In 1569, he finished working on his great *Map of the World* – „*ad usum navigantium*" (Fig. 11), which started another new period in cartography, the period of mathematically correct set, so called *Mercator's projection*, which formed the foundations of modern cartography.

Mercator's cylindrical conformal projection is represented by a grid of meridians and parallels which intersect under the angle of 90°. Distance between the parallels gets larger the closer they are to the poles. The poles can't be mapped. This projection was the first one could use to connect two points on the surface of the Earth represented on a map by a straight line – rhumb line. It is not difficult to imagine what kind of help that was in navigation. Even today, maritime and navigation charts of all kinds are produced in that projection. But almost a hundred years had to pass until Mercator's projection gained required credibility.

In the *Map of the World*, with great verification, detail and precision, Mercator inserted the newest continent border geometry, i.e. coasts of seas and oceans. For its production, he employed all his past works, for example his and not Ptolemy's geometry of the *Map of Europe*, and therefore the Mediterranean. He also included a huge, imaginary south continent *Continens australis*. The map is 1.31 x 2.08 m in size and consists of 18 relatively large sheets, an unpractical format for sailors. An unknown sailor prepared three Mercator's maps reducing them to 29 sheets for his route. This opened the way for the first printed maritime atlas in shape of a book.

Many cartographers adopted the idea. The first among them was Abraham Oertel (1527–1598), Mercator's friend. His published atlas *Theatrum Orbis Terrarum* comprised 70 maps on 53 sheets (Fig. 12). This work was supplemented even after the author's death.

During that time, when Oertel's atlas gained one recognition after another, Mercator worked relentlessly and in detail on his idea for years. He wanted to realize his lifetime idea, his *Opus magnum* in five parts. In the third one, he wanted to represent all known countries and seas. For the whole work, he chose the name of the mythological Maori king Atlas, who was interested in astronomy and allegedly produced the first celestial sphere globe (Leithäuser, 1958). In reality, however, regardless of the model, the term "atlas" as a collection of maps has its true source in Mercator's lifetime work (Lechthaler and Stadler, 2006). He engraved a total of 102 new maps in copper, all in the same format, and all with newest geographical data. In 1590, weak from a heart attack, he couldn't work on maps any more, being paralyzed. He worked on his atlas without pause from 1568 to his death on December 2, 1594. Unfortunately, his *Opus magnum* with 123 books wasn't completed.

In 1595, his son Rumold published the complete work – Mercator's atlas with tied maps in form of a book (Fig. 13), titled *Atlas sive Cosmographicae Meditationes de Fabrica Mundi et Fabricati Figura* (*Atlas or Cosmographic Contemplations about the Creation of the World and the Form of Created* o.a.)

Concluding thoughts

Maps combine yesterday's, today's, and tomorrow's view of our world, other planets, and the whole universe – from the perspective of humans, sciences, and arts. The history of mapmaking, i.e. cartography, resembles the history of mankind. Long before people were able to write, maps have been used to visualize human reality or phantasm. The centuries of great expeditions led to today's view and mapping of the world. One of the greatest cartographers of all times was undoubtedly Gerhard Mercator. His extraordinary live-work became famous and influenced the entire development of *new cartography*.

Casually, cartographical works present an enormous cultural heritage. Each presented map is an artwork acting as a substitute for its era making us relive the circumstances at that time.

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Abstract

Long before people were able to write, maps have been used to visualize reality or phantasy. Their content influences people in how they see the world. It might even evoke strong emotions like aspirations or fears. Often this is influenced by social and political objectives.
Determining the coordinates of an arbitrary position anywhere on the Earth's surface was a utopia of many astronomers, geographers and cartographers for centuries. This journey, up to the present day, the century of satellite navigation, which brings results of meter accuracy, was long and difficult, accompanied by speculation, delusions and ingenious inventions. Cartographers played undoubtedly significant role in that area.
The article features brief and concise history of appearance and challenges of topographic representations of geo-space data. The essential works of cartography-pioneers from the Old ages to Mercator (1512–1594) as well as the historical importance of his lifetime opus for the development of cartography will be presented in this paper.

Streszczenie

Na długo przed wynalezieniem przez ludzi pisma, mapy wykorzystywane były do obrazowania rzeczywistości bądź fikcji. Ich treść wpływa na to, w jaki sposób ludzie postrzegają świat. Taka treść może wywoływać wręcz silne emocje, takie jak pragnienia czy obawy. Częstokroć wpływ na to mają społeczne i polityczne uwarunkowania.
Ustalenie współrzędnych bezwzględnego położenia gdziekolwiek na powierzchni ziemi przez wieki było utopijnym celem dla wielu astronomów, geografów oraz kartografów. Droga do osiągnięcia tego celu, aż do dnia dzisiejszego, czyli czasów nawigacji satelitarnej, której dokładność oscyluje na poziomie metra, było długa i trudna, a towarzyszyły jej domysły, złudzenia oraz pomysłowe wynalazki. Kartografowie odegrali niewątpliwie znaczącą rolę na tym polu.
Artykuł przedstawia zwięzłą, a zarazem treściwą historię powstania topograficznego obrazowania danych geoprzestrzennych oraz wyzwań jakie przed nim stały. Zaprezentowane w nim zostaną zasadnicze prace pionierów kartografii od starożytności do czasów Merkatora (1512–1594) oraz znaczenie dzieła jego życia dla rozwoju kartografii.

VON TONTAFEL-KARTEN BIS ZU DEM ERSTEN WELTATLAS

Karten als Kulturerbe

Schlüsselwörter: Geschichte der Kartographie, Kartographische Visualisierung, Karten als Kulturerbe

Zusammenfassung

Karten, die die reale oder imaginäre Welt dargestellt haben, existierten schon bevor es das geschriebene Wort gab. Deren Inhalt, oft beeinflusst durch soziale und politische Ziele, leitete die menschliche Wahrnehmung der Welt und brachte Hoffnungen und Ängste zum Ausdruck.
Koordinative Bestimmung beliebiger Punkte auf der Erdoberfläche war einst die Utopie für viele Astronomen, Geographen und Kartographen. Der Streifzug durch die Geschichte der Kartographie bis ins Zeitalter der Satellitennavigation zeigt, dass der Weg bis dahin lang und mühsam war, begleitet von Spekulationen, Irrtümern und genialen Erfindungen. Zweifellos spielten dabei Kartographen eine entscheidende Rolle.

In dieser Arbeit wird eine kurze Geschichte und Entwicklung der topographischen Visualisierung von Geo-Daten gegeben. Dabei werden in einer freien Wahl wesentliche Werke der Kartographiebahnbrecher, von der Steinzeit bis zu Mercator (1512–1594), mit dem Hinweis auf die Bedeutung Mercator's Werke für die Kartographie, dargestellt.

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Figure 1. The whole world on an old-Babylonian clay plate, size of 10 cm (Leithäuser, 1958)

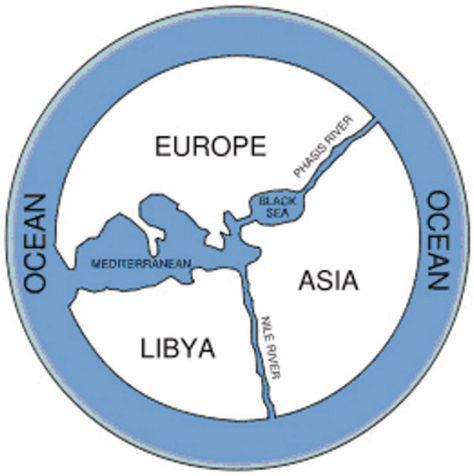

Figure 2. Possible rendering of Anaximander's world map (Robinson, 1968)

Figure 3. First edition of Ptolemy's *Map of the World*, Ulm 1482 (Clark et al., 2005)
There is no Cape of Good Hope in the map.

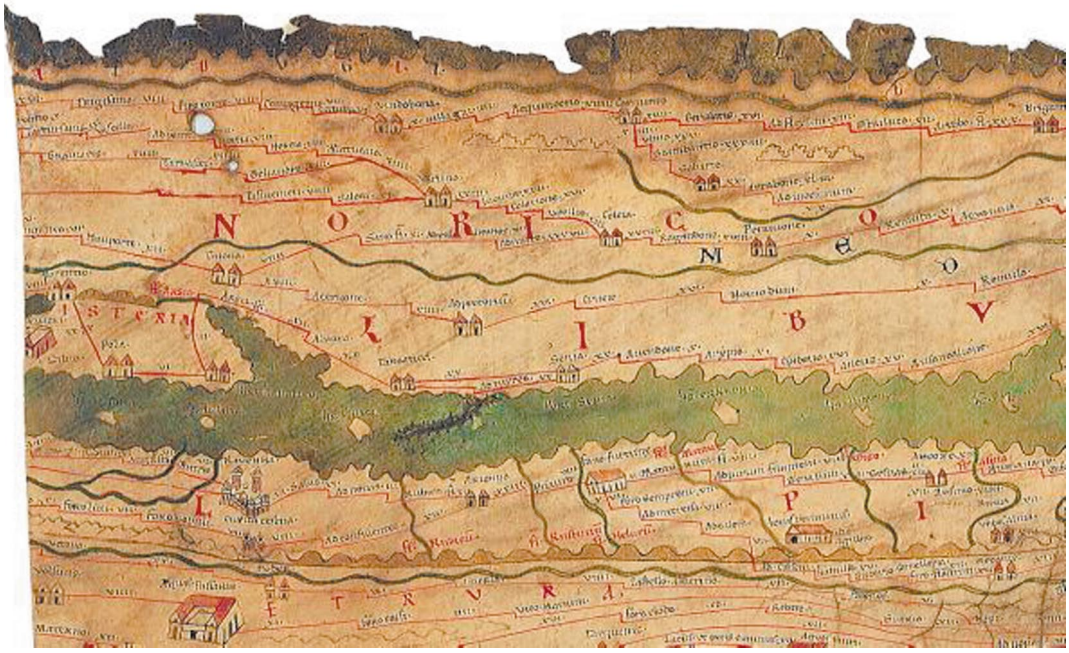

Figure 4. Section of the map *Tabula Peuntingeriana* – Istria and the Adriatic Sea (Clark et al., 2005)

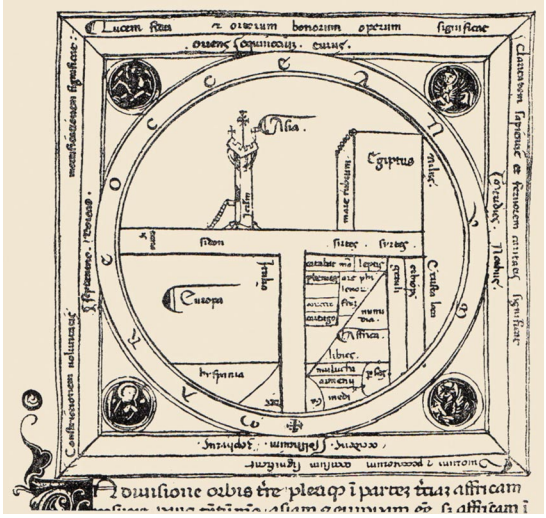

Figure 5. Al-Idrisi's world map from 1154 (the map is rotated 180 degrees to the north clockwise) (Clark et al., 2005)

Figure 6. World map from Sallust's manuscript from the 14th century (Leithäuser, 1958)

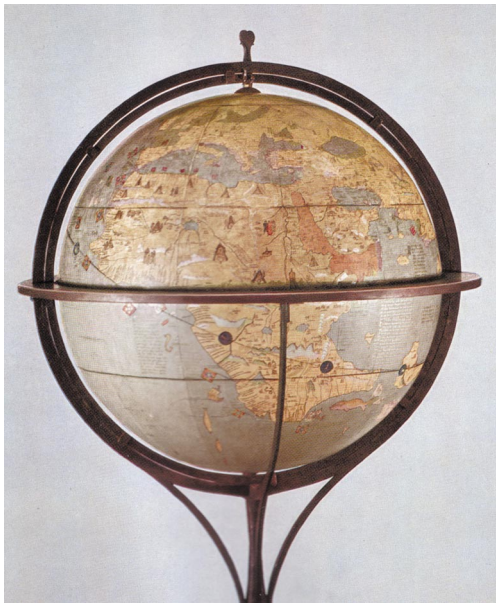

Figure 7. *Behaim's Apple*, globe from 1492 (Muris and Saarman, 1961)

Figure 8. *Fragment of the Portolan* chart by Mateo Prunes from 1559 (Clark et al., 2005)

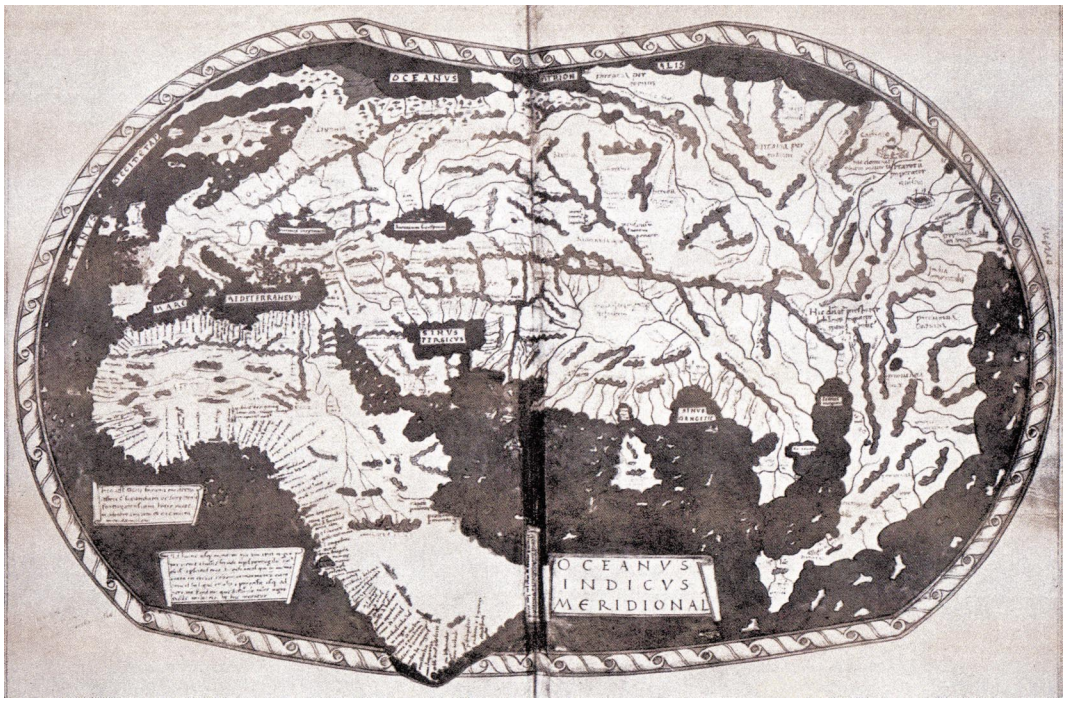

Figure 9. Map of the world from 1489 by Henricus Martellus Germanus. Ptolemy's influence is obvious, but there is also Diaz' discovery of the Cape of Good Hope (Leithäuser, 1958)

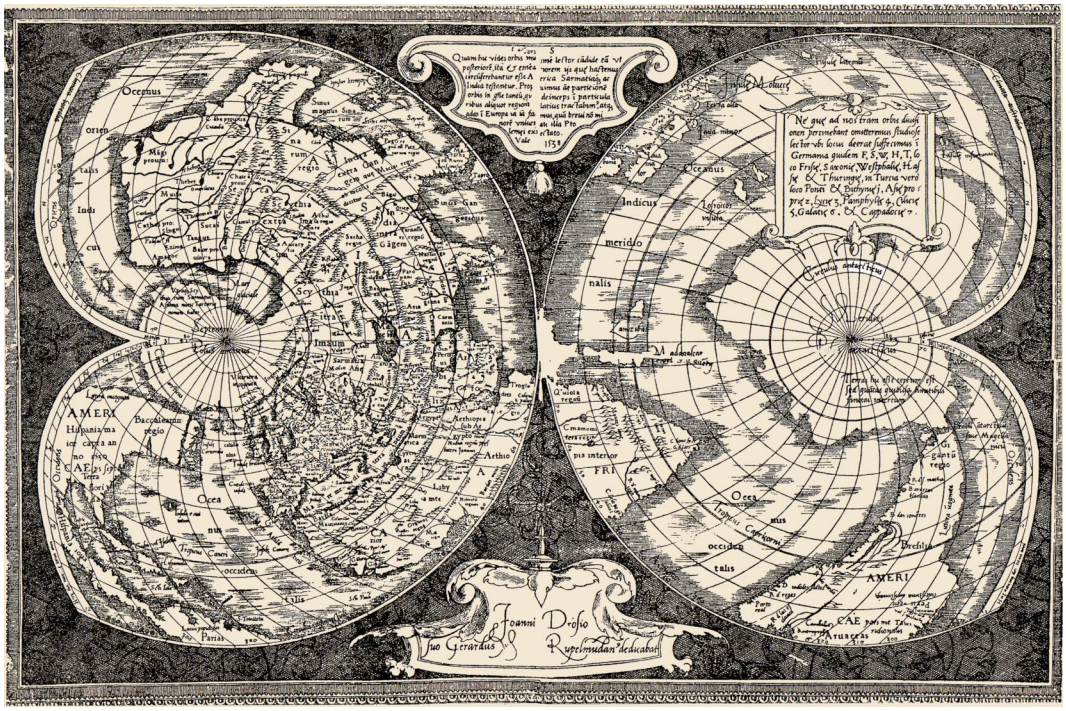

Figure 10. *Map of the World* from 1538 by Gerhard Mercator (Leithäuser, 1958)

Figure 11. *Map of the World* by Gerhard Mercator from 1569 produced in normal aspect cylindrical conformal projection – *Mercator's projection* (Leithäuser, 1958)

Figure 12. *Map of the World* 1570 by Abraham Oertel from his atlas *Theatrum Orbis Terrarum* (Clark et al., 2005)

Figure 13. Mercator's atlas *Atlas sive Cosmographicae Meditationes de Fabrica Mundi et Fabricati Figura* from 1595 (Clark et al., 2005)