From Stars to a Map

Pioneers of cartography - from the old ages to Mercator

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One who wants to know and understand the world and people has to consciously search in "the book of their origin".

Abstract: *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. Essential works of pioneers of cartography from the old ages to Mercator are presented in this paper. With his proposal of conformal cylindrical projection, Mercator left as heritage a work on which all navigation (maritime and aerial) maps and state coordinate systems of numerous European and non-European countries are based on.*

Key words: *history of cartography, big inventions, topographic maps, globes, Mercator cylindrical projection*

1 Introduction

Owing to the global positioning system (GPS), it is possible to accurately determine coordinates of a position, regardless of it being in a deep jungle, an abandoned desert or in open ocean, far from infrastructure objects man has gotten used to in everyday life.

The journey through the history of cartography to the present day, the century of satellite navigation, was long and difficult, accompanied by speculation, delusions and ingenious inventions.

Today, it can be said with certainty that the leading role in the history of cartography belonged to Gerhard Kremer – Gerhard Mercator or Gerhardus Mercator Rupelmundanus (1512–1594).

With his suggestion of conformal cylindrical projection, he left as heritage a work on which all navigation (maritime and aerial) maps are based on. And that is not all! State coordinate systems of numerous European and non-European countries are based on the Gauß-Krüger and UTM projection. Both mentioned projections are modified versions of Mercator's projection.

The article features brief and concise history of appearance and development of topographic representations to the time Mercator lived in and historical importance of the author's lifetime opus for the development of cartography.

2 A Walk Through the History of Map Representations

Determination of coordinates of an arbitrary position anywhere on the surface of the Earth in an area of one-meter accuracy was a utopia of many astronomers, geographers and cartographers for centuries. Activities such as, e.g. topographic survey of the Earth's surface (terrestric and aerial), mapping gathered data and production of cartographic representations in the form of various topographic and thematic maps and atlases and maps of related representations (globes, space models, block representations, panorama views, profiles) in various spatial dimensions (2,5D, 3D, 4D) of analogous and

Od zvijezda do karte

Pioniri kartografije - od starog vijeka do pojave Mercatora

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Tko želi upoznati i shvatiti svijet i ljude,
mora svjesno pretraživati u "knjizi
njihovog postanka".

Sažetak: *Određivanje koordinata proizvoljnog stajališta bilo gdje na površini Zemlje bila je stoljećima utopija mnogih astronoma, geografa i kartografa. Taj put, sve do današnjih dana, do razdoblja satelitske navigacije, koje donosi rezultate na području metarske točnosti, bio je dug i težak, praćen špekulacijama, zabludama i genijalnim izumima. Nedvojbeno značajnu ulogu odigrali su na tom području kartografi. U radu su prikazani ključni radovi pionira kartografije od staroga vijeka do pojave Mercatora. Svojim prijedlogom konformne cilindrične projekcije Mercator je ostavio čovječanstvu u naslijeđe djelo, na kojem se temelje sve navigacijske (pomorske i zračne) karte, te državni koordinatni sustavi mnogih europskih i izvaneuropskih zemalja.*

Ključne riječi: *povijest kartografije, velika otkrića, topografske karte, globusi, Mercatorova cilindrična projekcija*

1. Uvod

Zahvaljujući globalnom sustavu pozicioniranja (Global Positioning System – GPS) moguće je točno odrediti koordinate stajališta, bilo da se nalazimo u dubokoj džungli, u napuštenoj pustinji ili na otvorenom oceanu, daleko od objekata infrastrukture, na koje je čovjek u svojem svakidašnjem životu navikao.

Put kroz povijest kartografije sve do današnjih dana, do stoljeća satelitske navigacije, bio je dug i težak, praćen špekulacijama, zabludama i genijalnim izumima.

Danas se sa sigurnošću može reći da je vodeću ulogu u povijesti kartografije odigrao Gerhard Kremer – Gerhard Mercator ili Gerhardus Mercator Rupelmundanus (1512–1594).

Svojim prijedlogom konformne cilindrične projekcije ostavio je čovječanstvu u naslijeđe djelo na kojem se temelje sve navigacijske (pomorske i zračne) karte. I ne samo to! Državni koordinatni sustavi mnogih europskih i izvaneuropskih zemalja temelje se na Gauß-Krügerovoj i UTM projekciji. Obje su spomenute projekcije modificirane verzije Mercatorove projekcije, koju je autor za života primjenjivao.

U članku će biti predočena kratka i sažeta povijest nastanka i razvoja topografskih prikaza do vremena u kojem je živio Mercator te povijesno značenje njegova životnog opusa za razvoj kartografije.

2. Šetnja kroz povijest kartografskih prikaza

Određivanje koordinata proizvoljnog stajališta bilo gdje na Zemljinoj površini u području metarske točnosti, stoljećima je bila utopija mnogih astronoma, geografa i kartografa. Aktivnosti kao što su, npr., topografska izmjera Zemljine površine (terestrička i iz zraka), kartiranje skupljenih podataka i izrada kartografskih prikaza u obliku najrazličitijih topografskih i tematskih karata i atlasa te kartama srodnih prikaza (globusa, modela prostora, blok-prikaza, panorama, profila) u različitim prostornim dimenzijama (2,5D, 3D, 4D) analognoga i digitalnog oblika te definiranje položaja stajališta s pomoću GPS-a

Fig. 1. Geographic environment of the Eskimos carved or modelled in wood (Leithäuser 1958)
Slika 1. Geografski okoliš Eskima urezan ili modeliran u drvu (Leithäuser 1958)

digital form and defining the position by means of GPS today belong to everyday life today. However, their cradle lies centuries backwards[1].

2.1 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 the basis of material traces of certain old cultures at lower developmental level and 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.

Later graphical representations of imposing and vital environment can be found engraved in caves, etched in wood, stone, bones, leather or horns (Fig. 1).

The oldest preserved old-Babylonian map of the world[2] from about 5th century B.C. was carved into a clay plate (Fig. 2). 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.

[1] Author's choice
[2] British Museum, London

2.1.1 Claudius Ptolemy

Several centuries later, all-round scientist Eratosthenes of Alexandria (276 – 195 B.C.) introduces geography as a scientific discipline to scholarly circles, associating it closely with mathematics. He determined the circumference of the Earth using astronomic measurements. Measuring the distance from Alexandria to Assuan in an ingenious way, he reached a result that is very similar to the one known today. He believed that measuring only the length of a single degree (out of total 360 degrees in a sphere) would be sufficient.

Claudius Ptolemy (87–150), one of the greatest Antique scientists, presented in his lifetime work *Megale syntaxis* the Earth in the centre of the planetary system, relying on the theory by Plato and Aristotle. *Ptolemy's System* is going to be replaced by the heliocentric in the 15th century (Nicolaus Copernicus, 1473–1543). Furthermore, in his lifetime work *Geographike hyphegesis – Introduction to Geography* (eight volumes), Ptolemy provides a list of all known settlements, their position in geographic coordinates and maps of various areas. Ptolemy's *Geography* had over fifty editions. At first, those were manual copies. The first printed edition without maps was published in Venice in 1475, and the first printed edition with maps in Bologna in 1477. The prettiest version of Ptolemy's *Geography* was published in Ulm in 1482 (Fig. 3). Unfortunately, no Ptolemy's originals were preserved. From Ptolemy and Marinus of Tyre sprang the revolutionary idea of introducing a geographical grid into cartographic representations (around year 100), as well as the notion how important is mapping adjusted to scale. Ptolemy continuously warned the cartographers

pripadaju danas svakidašnjem životu. Međutim, njihova kolijevka leži stoljećima unazad[1].

2.1. Od kamenoga doba do grčke antike

Iz davnoga kamenog doba nisu poznati tj. sačuvani nikakvi tragovi koji bi se mogli povezati s pokušajem prikaza određenog prostora. Povjesničari kartografije dedukcijom pokušavaju iz materijalnih tragova pojedinih starih kultura na nižem razvojnom stupnju, koje su Europljani zatekli u novo otkrivenim dijelovima svijeta, pretpostaviti kako je moglo biti u određenim povijesnim razdobljima Starog svijeta u Europi, Aziji i Africi.

Kasniji grafički prikazi markantnog i za život važnog okoliša nalaze se uklesani u špiljama urezani u drvo, kamen, kosti, kožu ili rogove (slika 1).

Najstarija sačuvana starobabilonska karta svijeta[2] iz oko 5. st. pr. Kr. (slika 2) urezana je u glinenu pločicu. Shematski kružno prikazan svijet, tj. Babilonsko Carstvo, okruženo je oceanom. Središnje značenje ima rijeka Eufrat, koja protječe gradom Babilonom i utječe u Perzijski zaljev.

U grčkoj antici geografija i kartografija postaju znanstvene discipline. Vodeći znanstvenici postavljali su si pitanja i razmišljali o obliku, opsegu i volumenu Zemlje. Filozof, astronom i astrofizičar Anaksimandar iz grada Mileta (611–546. pr. Kr.) na prvoj poznatoj karti svijeta daje prikaz razmještaja tada poznatoga kopna i mora.

2.1.1. Klaudije Ptolemej

Nekoliko stoljeća nakon njega svestrani znanstvenik Eratosten iz Aleksandrije (276–195. pr. Kr.) uvodi u učenim krugovima geografiju kao znanstvenu disciplinu, povezujući ju usko s matematikom. Astronomskim mjerenjima odredio je opseg Zemlje. Mjereći na genijalan način udaljenost od Aleksandrije do Assuana, došao je do rezultata koji se neznatno razlikuje od danas poznatoga. Smatrao je da je mjerenje dužine jednog stupnja (od ukupno 360 stupnjeva koji opisuju kuglu) dovoljno.

Klaudije Ptolemej (87–150), jedan od najvećih antičkih znanstvenika, prikazao je u svojem životnom djelu *Megale syntaxis* Zemlju u središtu planetarnog sustava oslanjajući se na teoriju Platona i Aristotela. *Ptolomejev sustav* bit će zamijenjen heliocentričkim tek u 16. st. (Nikola Kopernik, 1473–1543). Nadalje, u svojem životnom djelu *Geographike hyphegesis – Uvod u geografiju* (osam knjiga) Ptolemej daje popis svih do tada poznatih mjesta, njihov položaj u geografskim koordinatama te karte različitih područja. Ptolemejeva *Geographia* doživjela je više od pedeset izdanja. Na početku su to bile ručne kopije. Godine 1475. izlazi u Veneciji prvo tiskano izdanje bez karata, a 1477. godine u Bologni prvo tiskano izdanje s kartama. Najljepša verzija Ptolemejeve *Geographiae* izašla je 1482. godine u Ulmu (slika 3).

[1] Autoričin povijesni izbor
[2] British Museum, London

Fig 2. The whole world on an old-Babylonian clay plate, size of 10 cm (Leithäuser 1958)

Slika 2. Cijeli svijet na starobabilonskoj glinenoj pločici, veličine 10 cm (Leithäuser 1958)

Nažalost nije sačuvan niti jedan Ptolemejev original. Od Ptolemeja i Marina iz Tira potječe revolucionarna ideja uvođenja geografske mreže u kartografske prikaze (oko godine 100.), kao i spoznaja koliko je važno mjerilu vjerno kartiranje. Kartografe svojega doba Ptolemej je neprestano upozoravao na važnost prikaza "cjeline u pravom odnosu". Njegova je *Karta svijeta* prvi pokušaj projiciranja površine kugle u ravninu – na plašt stošca. Projekcijska mreža sastojala se od meridijana, koji u jednakim odsječcima sijeku ekvator i konvergiraju k sjevernom polu, dok paralele kao krugovi različita polumjera imaju u spomenutom polu zajedničko središte. Promjenom smjera meridijana na južnoj hemisferi autor je pokušao predočiti ekvator (slika 3). U toj mreži pomoćnih linija ucrtao je, kako je najbolje znao, tri kontinenta: Aziju, Europu i Libiju. Nadalje su prikazani Indijski ocean, Sredozemno i Kaspijsko more. Dugi niz stoljeća Ptolemejeva znanstvena djela autoritativno su utjecala na kartografsku djelatnost. Njegove su spoznaje, s jedne strane, nesumnjivo unaprijedile kartografiju, no s druge strane, njegove su ju zablude sputavale. Sve do kraja srednjeg vijeka geografi i kartografi preuzimali su njegovu fatalnu pogrešku. Naime, u nedostatku znanja i provjere matematičkih izvora te računske tehnike, autor nije sam računao potrebne veličine i nije posegnuo za ispravnom vrijednosti opsega Zemlje koju je dao antički geograf i povjesničar Eratosten, već se koristio rezultatima mjerenja, tj. računanja svjetskog putnika, geografa i povjesničara Strabona iz Amaseje (60– 20. pr. Kr.). Ptolemejev je stupanj gotovo za trećinu kraći. Time je i njegova slika

Fig 3. First edition of Ptolemy's Map of the World, Ulm 1482 (Clark et al. 2005). The southern part of Africa is not represented because it was not known at the time.

Slika 3. Prvo njemačko izdanje Ptolemejeve Karte svijeta, Ulm 1482 (Clark i dr. 2005). Južni dio Afrike nije prikazan jer još nije poznat.

of his time of the importance of representing the "entirety in true relation". 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 that cut into the equator in equal segments and converge to the North Pole, while parallels as circles of varying circumferences have a mutual centre in the same pole. By changing the direction of meridians on the southern hemisphere, the author attempted to represent the equator (Fig. 3). He drew three continents: Asia, Europe and Libya to the best of his knowledge, within this grid, using auxiliary lines. Furthermore, the Indian Ocean, Mediterranean and Caspian Sea are also shown. Ptolemy's scientific works have affected cartographic activities authoritatively for centuries. On the one hand, it's no doubt his understandings advanced cartography, however, his delusions inhibited its development. To the end of the middle ages, geographers and cartographers took over his fatal error. Namely, in lack of knowledge and verification of mathematical sources and computing technique, the author didn't compute needed values himself and did not use the correct value of the Earth's circumference given by Antique geographer and historian Eratosthenes, but employed measurement, i.e. computation results by a 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 from west from Europe.

2.2 Roman Antique Age

Development of a mathematical basis of maps was not of primary interest in the Roman age. 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. Emperor August was specially interested in a detailed survey of all roads and paths of his empire. Marcus Vipsanius Agrippa (30 B.C. – 12 A.D.) was in charge of the survey and started producing the general map of the world *Orbis terrarum*, which encompassed the Mediterranean. Only *Tabula Peutingeriana* was preserved of all Roman maps. Vienna humanist Konrad Celtis (1459–1508) found it at end of 15th century in the library of a Benedictine abbey in Tegernsee and gave it as a gift to his colleague antiquary Konrad Peutinger (1465–1547) who collected old maps and manuscripts. After carefully considering this unique witness of the past, it was concluded that the map was produced around 250 and that it was most likely a copy of a detailed road map of the Roman Empire from the first century (Leithäuser 1958). It was thought for a long time that Agrippa's large map of the world was the template. Unfortunately, it was lost. During that time, it undoubtedly

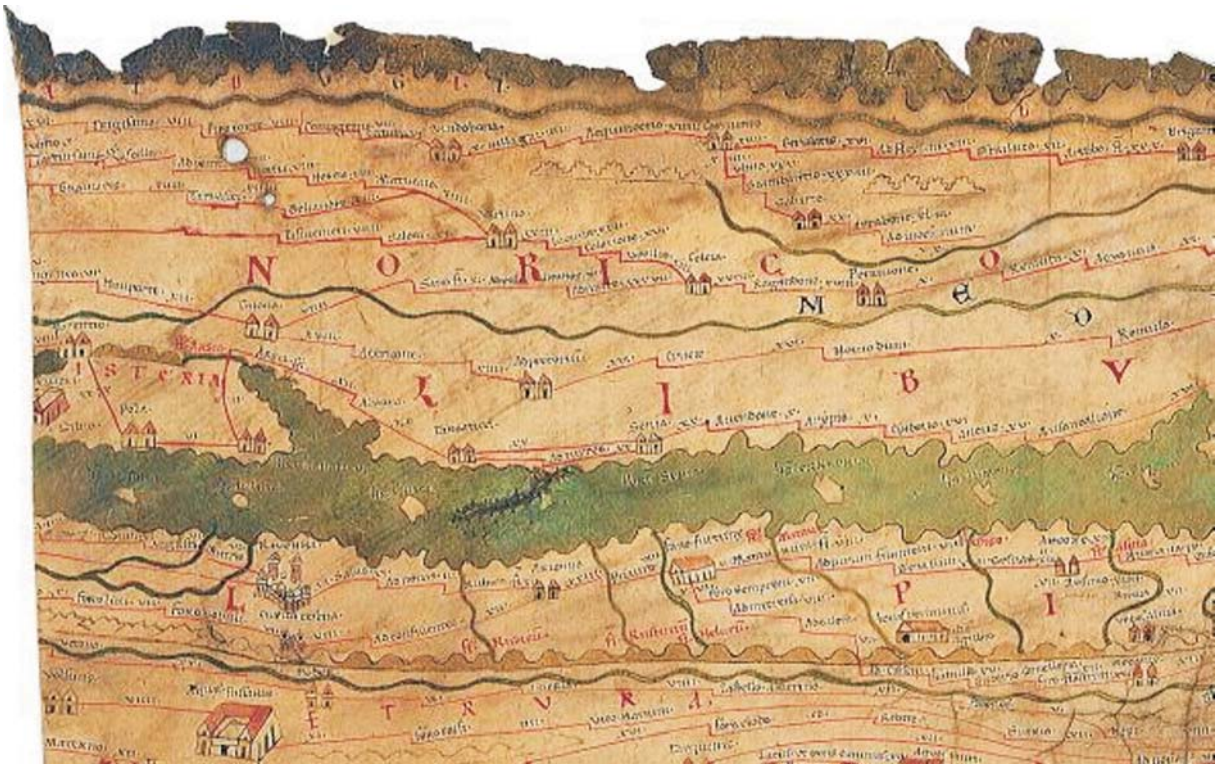

Fig 4. A detail of the map Tabula Peutingeriana – Istria and the Adriatic Sea (Clark et al. 2005)
Slika 4. Isječak iz karte Tabula Peutingeriana – Istra i Jadransko more (Clark i dr. 2005)

svijeta za trećinu uža u pravcu sjever-jug, a ekvator je preslikan previsoko. Zbog pogrešne dužine Sredozemnoga mora (62 stupnja umjesto 42) i istočnoga protezanja Azije (50 stupnjeva više od prave vrijednosti), nije ostalo dovoljno mjesta između europske zapadne i azijske istočne obale. To je poslije zavelo Kolumba u njegovim zaključcima da bi do Azije mogao morskim putem doći relativno brzo, jedreći od Europe na zapad.

2.2. Rimsko doba antike

U rimsko doba razvoj matematičke osnove karata nije primaran. Rimljanima je ponajprije stalo do primjene karata, a ne osobito do njihove geometrijske točnosti. Zadovoljavaju se približnom geometrijom unesenom u kartama te točnim imenima objekata, cesta i putova. Car August posebno je bio zainteresiran za detaljnu izmjeru svih cesta i putova svojega carstva. Marko Vipsanije Agripa (30. pr. Kr. – 12. nakon Kr.) bio je zadužen za izmjeru i započeo je izradu pregledne karte svijeta *Orbis terrarum*, koja je zahvaćala područje Sredozemlja. Od rimskih karata sačuvana je samo *Tabula Peutingeriana*. Bečki humanist Konrad Celtis (1459–1508) našao ju je potkraj 15. st. u knjižnici benediktinskog samostana u Tegernseeu i poklonio svojem kolegi antikvaru Konradu Peutingeru (1465–1547) koji se bavio skupljanjem starih karata i rukopisa. Nakon vrlo pažljiva proučavanja tog jedinstvenog svjedoka prošlosti zaključeno je da je karta izrađena oko godine 250. i da je riječ najvjerojatnije o kopiji detaljne karte cesta Rimskoga Carstva iz 1. st. (Leithäuser 1958). Dugo se mislilo da je predložak bila Agripina velika karta svijeta. Ona je, na žalost, izgubljena. U ono doba nedvojbeno je utjecala na razvoj rimske kartografije i neizravno bila uzor pri izradi karte *Tabula Peutingeriana*. *Tabula Peutingeriana* sastoji se od 11 karata, koje se slijedno nadovezuju i čine traku (slika 4). Stoga je cijelo oslikano područje istegnuto u pravcu zapad-istok. Ta je karta svijeta od posebne važnosti za geografiju, ne toliko za kartografiju, jer joj geometrija riječne i cestovne mreže te naselja i najvažnijih planinskih lanaca ne odgovara stvarnosti. Posebna joj je vrijednost u 3500 toponima, koji opisuju tadanji svijet.

2.3. Srednji vijek

Tijekom srednjeg vijeka kartografskim su se pitanjima posebno posvetili Arapski geografi i kartografi. Velik dio antičkog znanja očuvao se u kasnijim stoljećima zahvaljujući islamskim znanstvenicima iz razdoblja od 9. do 12. stoljeća koji su živjeli i djelovali u Španjolskoj. Oni su, primjerice, uputili kršćanske znanstvenike na Aristotelova djela. U 9. st. izračunali su opseg Zemlje još preciznije od Eratostena. Za proširenje Arapskog Carstva i uspješnu trgovinu bile su im potrebne dobre karte, koje su u relativno velikom broju i realizirali. Humanist, geograf i kartograf Abu Abdallah Mohamed al-Sharif al-Idrisi (1100–1172) svojim je djelima pridonio razvoju kartografije. Njegovo veliko djelo bio je na segmente podijeljen globus s tada najnovijim spoznajama ugraviranim u 400 kg teškoj srebrnoj kugli (Clark i dr. 2005). Prikazano je svih sedam kontinenata, riječna mreža, jezera, važna naselja i trgovačke rute. Na žalost, globus nije sačuvan. No njegov detaljan opis nalazi se u djelu *Tabula Rogeriana*, u kojem je i karta svijeta (slika 5). Primjena kružnih paralela velika je

Fig 5. Al-Idrisi's world map from 1154 (the map is rotated 180 degrees, author's comment) (Clark et al. 2005)

Slika 5. Al-Idrisijeva karta svijeta iz 1154. godine (karta je zaokrenuta za 180 stupnjeva o.a.) (Clark i dr. 2005)

influenced the development of Roman cartography and was indirectly a model in the production of the map *Tabula Peutingeriana*. *Tabula Peutingeriana* consists of 11 maps, which are put together to form a strap (Fig. 4). Therefore, the whole painted area is stretched in the direction west-east. That map of the world is exceptionally important for geography, and not so much for cartography, because its geometry of river and road network and settlements and most important mountain chains do not reflect reality. Its special value lies in 3500 toponyms that describe the world of that time.

2.3 The Middle Ages

During the Middle Ages, cartographic issues were addressed in particular by the Arab geographers and cartographers. Great deal of Antique knowledge was preserved in later centuries thanks to Islamic scientists who lived and worked from 9th to 12th century in Spain. For example, they directed Christian scientists to Aristotle's works. They calculated the circumference of the Earth in 9th century more precisely than Eratosthenes. They required good maps in order to expand the Arabian Empire and trade successfully, and they produced quite a large number of them. The humanist, geographer and cartographer Abu Abdallah Mohamed al-Sharif al-Idrisi (1100–1172) contributed to the development of cartography with his works. His great work was a globe divided into segments with newest understandings of that time, engraved into a 400 kg heavy silver ball (Clarke et al. 2005). All seven continents are represented, as well as a river and lake network, important settlements and trade routes. 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. Some inaccuracies are unnecessary, such as placing larger islands into the Atlantic or representing Scandinavia as an island. He measured topographic information about object position, altitude and stretch by himself or took over from Spanish travellers or navigators. Ptolemy's influence in the works is indubitable, his works translated to Arabic in the 9th century.

During that time in the west, primarily monks in monasteries dealt with cartography. This resulted in works of high artistic value, in order to reinforce and strengthen the Christian world image. The so-called T-O maps (Fig. 6) date from that period. On these maps, the Mediterranean Sea and the rivers Don and Nile are represented in the form of letter *T*, which divided the world known at the time in three continents. As the largest one, Asia lies to the north, Europe and Africa west and east from *T*. The *O* shape symbolizes the border of known space of the Earth enclosed by the ocean. The Christian Europe identifies itself with such a world image during the next few centuries. Theologically, God Father, Son and the Holy Spirit represent three continents, and in the centre is the city of Jerusalem. Geographically and cartographically, works produced during this period do not possess great value.

2.4 Centuries of Great Discoveries and the Development of Cartography

The survival of Christian image of the world became doubtful under the influence of newly discovered lands and new natural-scientific understandings in the 15th and 16th century. Sailors believed the Earth had the shape of a ball.

2.4.1 Martin Behaim

After king Alfonso X of Castile (1221–1284) wrote about how and using which materials to produce a globe, many scientists tried to model the known world in that form. They left the unexplored areas empty. Sailors of-

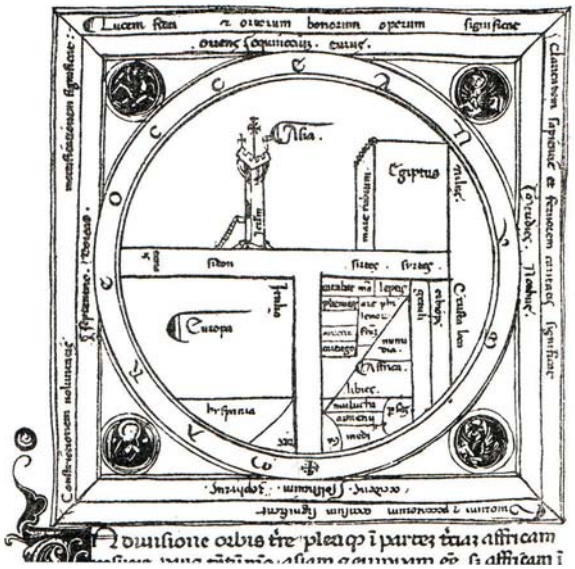

Fig 6. World map from Sallust's manuscript from the 14th century (Leithäuser 1958)

Slika 6. Karta svijeta iz Sallustova rukopisa iz 14. st. (Leithäuser 1958)

novost u tadanjoj kartografiji. Neizbježne su netočnosti poput, primjerice, smještanja većih otoka u Atlantik ili prikazivanje Skandinavije kao otoka. Topografske informacije o položaju, visini i protezanju objekata mjerio je sam ili preuzeo od španjolskih putnika i pomoraca. U djelima je nesumnjiv Ptolemejev utjecaj, čija su djela u 9. st. prevedena na arapski.

U to su se doba na Zapadu kartografijom bavili ponajprije redovnici u samostanima, što je rezultiralo djelima visoke umjetničke vrijednosti, sa svrhom podupiranja i jačanja kršćanske slike svijeta. Iz tog razdoblja datiraju tzv. T-O karte (slika 6). Na njima su Sredozemno more i rijeke Don i Nil prikazani u obliku slova *T*, koje do tada poznati svijet dijeli na tri kontinenta. Azija kao najveći leži sjeverno, Europa i Afrika zapadno i istočno od *T*. Oblik *O* simbolizira granicu poznatog prostora Zemlje opasanog oceanom. S takvom slikom svijeta identificira se kršćanska Europa sljedećih nekoliko stoljeća. Teološki gledano, Bog Otac, Sin i Duh Sveti predstavljaju tri kontinenta u sredini kojih leži grad Jeruzalem. U geografskom i kartografskom smislu, djela nastala u to doba nemaju veliku važnost.

2.4. Stoljeća velikih otkrića i razvoj kartografije

U 15. i 16. stoljeću, pod utjecajem novootkrivenih zemalja i novih prirodoznanstvenih spoznaja, opstanak kršćanski utemeljene slike svijeta sve više dolazi u pitanje. Pomorci vjeruju u oblik Zemlje kao kugle.

2.4.1. Martin Behaim

Nakon što je kralj Alfons X. od Kastilje (1221–1284) napisao djelo o tome kako se i iz kojeg materijala dade izraditi globus, mnogi znanstvenici pokušavaju modelirati poznati svijet u tom obliku. Neistražena područja ostavljaju praznima. U nedostatku dobrih pomorskih karata pomorci se često za orijentaciju koriste globusima (Leithäuser 1958). Papa Siksto IV. godine 1475. zadužuje Martina Behaima, onodobnoga poznatoga kartografa i astronoma, da izradi model Zemlje u obliku globusa. Treba napomenuti da je taj Papin nalog dan pedeset godina prije nego što je pomorac Ferdinand Magellan svojim pomorskim putem obišao svijet i došao do saznanja da Zemlja nije ploča nego kugla. Na takozvanoj *Behaimovoj jabuci*, tj. globusu Zemlje prikazao je autor tada poznati, tj. nastanjeni svijet – Euroaziju, koja se proteže 234 stupnja geografske dužine od zapada na istok. U stvarnosti protezanje kontinenata iznosi samo 131 stupanj. Ta je pogreška poslije zavarala Kolumba, koji je do svoje smrti bio uvjeren da je otkrio pomorski put do istočne Azije.

No vratimo se ponovno Martinu Behaimu. Autor, i sam pomorac, prikupio je informacije oplovivši trećinu tada poznatog svijeta. Sav ostali sadržaj koji mu je bio potreban za prikaz Zemlje s pomoću globusa (slika 7) našao je u knjigama različitih geografa, aleksandrijskog znanstvenika Ptolemeja i venecijanskog svjetskog putnika i književnika Marka Pola (1254–1324). Za prikaz nepoznatih područja Behaim ne koristi prazne površine, te ne piše "neistraženo područje", kao što su to činili drugi graditelji globusa, već te dijelove ispunjavaju grbovi i likovi iz različitih bajki, priča i legendi. Unatoč nesavršenosti i pogreškama, *Behaimova jabuka* smatra se najstarijim sačuvanim geografskim modelom Zemlje kao kugle[3]. Opseg globusa na ekvatoru iznosi 159,5 cm, slijedom toga promjer je 50,7 cm, a mjerilo prikaza 1:25,2 mil. Oba su pola povezana metalnom šipkom, što je znak da se već u to doba slutilo kako se Zemlja okreće oko svoje osi. Behaimov je globus jedinstven i neusporedivo vrijedan povijesno-kulturni dokument, najstariji dokument koji prikazuje Zemlju kao kuglu, ujedno i posljednji prije otkrića Amerike.

2.4.2. Portulani

Kasno 14. te 15. i 16. stoljeće doba je velikih otkrića. Pomorci, mjernici i znanstvenici (astronomi, geografi, kartografi, humanisti) plove i istražuju nepoznate krajeve izlažući sebe i svoje posade nevjerojatnim naporima u želji da istraže novootkrivene dijelove svijeta, donesu egzotične predmete i za male novce ispune „bijele" površine na postojećim portulanima. One su se koristile uz pomoć kompasa (koji je već u 12. st. bio poznat) i pisanih uputa za navigaciju. Na ovčjoj ili kozjoj koži bila je prvo ucrtana mreža smjerova. Rtovi i uvale, posebno važni objekti pri plovidbi, neproporcionalno su veliki prema ostaloj obalnoj liniji. Nazivi su smješteni na kopnu okomito na obalnu liniju u smjeru kazaljke na satu. Geometrija je dobivena izmjerom dužina i pravaca dobivenih iz astronomskih opažanja. Kartu su krasili grbovi, ruže vjetrova i stilizirane slike za poznate gradove (slika 8 i 9).

[3] Behaimov globus nalazi se u Germanisches Museum, Nürenberg.

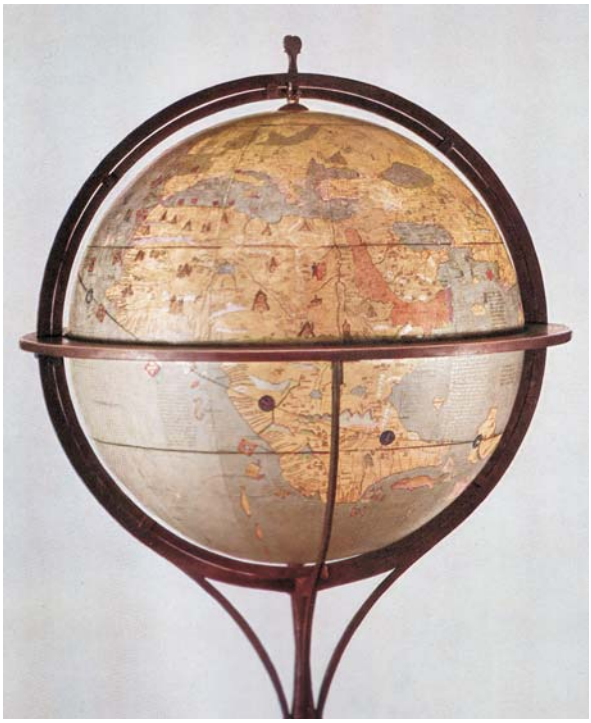

Fig 7. Behaim's Apple, globe from 1492 (Muris et al. 1961)

Slika 7. Behaimova jabuka, globus iz 1492. godine (Muris i dr. 1961)

Fig 8. Portolan chart by Vesconto Maggiolo from 1512 (Leithäuser 1958)

Slika 8. Portulan Vesconta Maggiola iz 1512. (Leithäuser 1958)

ten used globes for orientation in absence of good maritime charts (Leithäuser 1958). In 1475, Pope Sixto IV entrusted Martin Behaim, a renowned cartographer and astronomer, to produce a globe-shaped model of the Earth. It has to be said that this errand was given fifty years after the navigator Ferdinand Magellan travelled around the world at sea and found out the Earth was a ball rather than a plate. The so-called *Behaim's Apple*, i.e. a globe of the Earth, features the then-known, i.e. inhabited world – Eurasia, which stretches 234 degrees of longitude from west to east. The real value is only 131 degrees. This error would later deceive Columbus, who died believing he discovered a nautical way to eastern Asia.

But let's get back to Martin Behaim. The author, a sailor himself, gathered his information by sailing a third of the world known at the time. He acquired all other content he needed for representing the Earth by means of a globe by inspecting books of various geographers, Alexandrian scientist Ptolemy and Venetian world traveller and writer Marko Polo (1254–1324). To represent unknown areas, Behaim didn't use empty surfaces or write "unexplored area" like other globe manufacturers, but filled those areas with emblems and characters from fairy tales, stories and legends. Despite imperfections and errors, *Behaim's Apple* is considered the oldest preserved geographic model of the Earth as a globe[3]. 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 that is a sign that people of the time thought the Earth rotated around its axis. Behaim's Globe is unique and surpassingly valuable historical-cultural document, the oldest document representing the Earth as a globe and at the same time the last produced before America was discovered.

[3] Behaim's Globe of the Earth is kept at Germanisches Museum, Nürenberg.

2.4.2 Portolan Charts

Late 14th century and 15th and 16th centuries are time of great discoveries. Sailors, surveyors and scientists (astronomers, geographers, cartographers, humanists) sail and explore the unknown areas exposing themselves and their crew to unbelievable strains, wishing to explore newly discovered parts of the world, bring back exotic objects and not earn much money by filling in "white" areas on existing, so-called *Portolan* charts. They were used alongside compasses (which was known already in 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 disproportionally large against the coastline. Names are positioned on the land perpendicular to the coastline, clockwise. Geometry resulted from measuring lengths and directions obtained from astronomic observations. The map was decorated with emblems, compass roses and stylised paintings for known cities (Fig. 8 and 9).

Fig 9. Portolan chart by Mateo Prunes from 1559 (Clark et al. 2005)

Slika 9. Portulan Mateja Prunesa iz 1559. (Clark i dr. 2005)

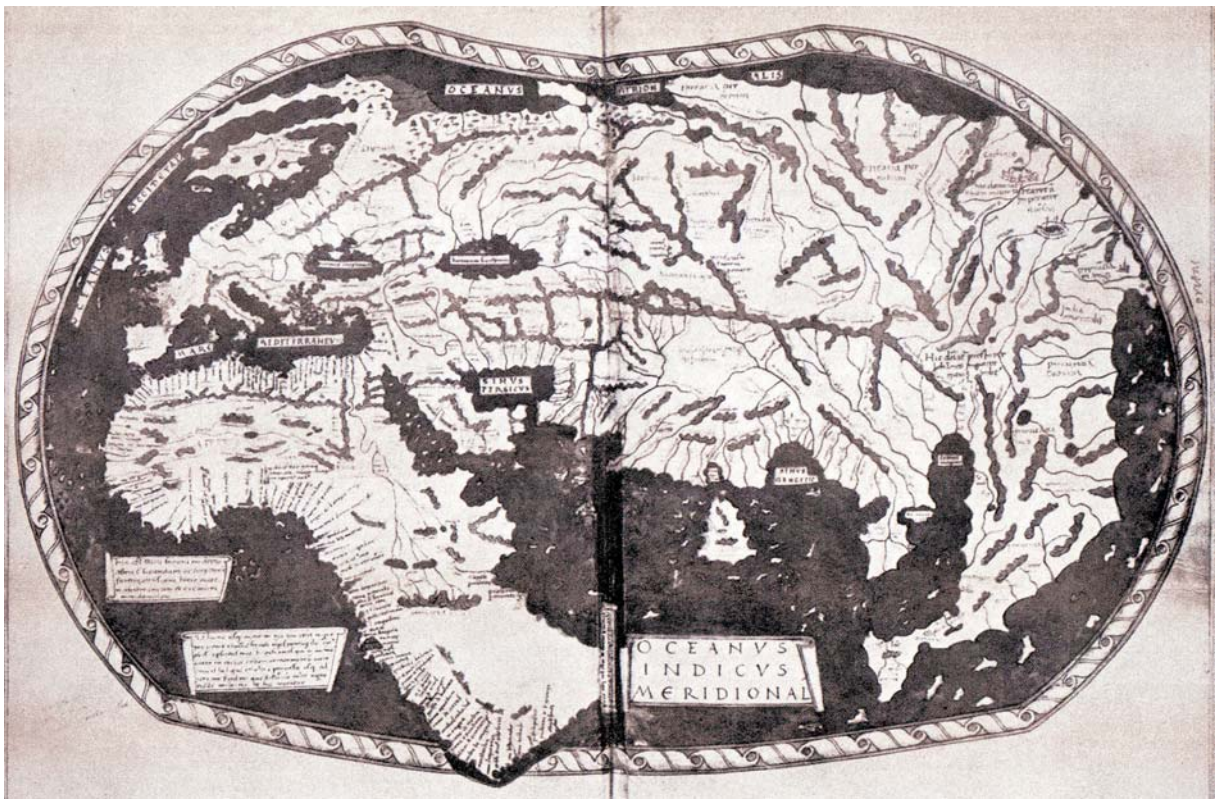

Fig 10. Map of the world from 1489 by Henricus Martellus Germanus. Ptolemy's influence is obvious, but there is also Diaz's discovery of the Cape of Good Hope (Leithäuser 1958)

Slika 10. Martelusova (Henricus Martellus Germanus) karta svijeta iz 1489. godine. Vidljiv je utjecaj Ptolemeja, ali je uneseno Diazovo otkriće Rta dobre nade (Leithäuser 1958)

2.4.3. Kristof Kolumbo

Španjolci i Portugalci, koji su tada dijelili i dalje osvajali svijet, bili su neobično zainteresirani za putopise, zapise, premjer i posebno za karte. Kristof Kolumbo (1451–1506), znameniti pomorac koji je otkrio Ameriku, i njegov brat Bartolomej Kolumbo (1460–1514), također pomorac i kartograf, koristili su za svoje karte vlastita mjerenja ali i saznanja, putopise, reportaže i fantaziju drugih pomoraca, primjerice Marka Pola (1254–1324), o nečuvenim i do tada neviđenim dragocjenostima Azije i Kine (srebru, zlatu, dragom kamenju, hramovima, palačama, ...) te Bartholomeua Diaza (1450–1500), portugalskog pomorca koji je 1487/88. prvi oplovio jug afričkoga kontinenta – Rt dobre nade. Tim otkrićem otvorio je vrata novom sadržaju u kartografiji, odnosno kartama, pobivši Ptolemejevu teoriju i autoritet (slika 10).

U kolovozu 1492. isplovljava Kolumbo sa svojom španjolskom flotom u pravcu zapada na Atlantik tražeći pomorski put prema čarobno opisanoj Indiji. Već iste godine otkriva na dalekom zapadu kopno – Bahame.

Iskrcavši se na kopno, mislio je da je to samo jedan otok pred indijskom obalom. Tako je Kolumbo kao prvi španjolac kročio na američko tlo.

Godine 1498. jedri po treći put na zapad. Oplovljuje Karipsko otočje i slijedi istočnu obalu južne Amerike. Na slici 11 prikazana je skica Atlantika i srednjoamerička odnosno južnoamerička obala, koja najvjerojatnije potječe od njegova brata Bartolomeja. Opijen viđenim i doživljenim, duboko religiozni Kolumbo misli da je otkrio raj. Tako želi pobiti tezu o Zemlji kao kugli, uvjeren da je oblika kruške ili oblika ženskih grudi.

2.4.4. Quarta orbis pars

Vasco da Gama (1469–1524), portugalski pomorac i kapetan, oplovivši Rt dobre nade, otkriva 1497/98. pomorski put do Indije. Time je ispunio nalog portugalskoga kralja Manuela I. te otkrio i istražio posljednji dio rute k mirodijama Indije. Time je započelo kolonijalno carstvo Portugala u Aziji i njegova pomorska nadmoć u zapadnom dijelu Indijskog oceana.

Vrlo brzo nakon toga španjolski konkvistadori[4] osvajački jedre na zapad, nastavljajući istraživanje koje je započeo Kolumbo.

Talijanski pomorac Amerigo Vespucci (1451–1512), vrativši se sa zapada 1504. godine, prvi put piše da u Kolumbovu otkriću nije riječ o Indiji i Aziji, koje su već poznati kontinenti, nego da je riječ o novom kontinentu. Godine 1507. kartograf Martin Waldseemüller prvi je put upotrijebio ime *America* u svojim izdanjima karte svijeta *Universalis Cosmographia* i karte koja je poslužila pri izradi globusa (slika 12), slaveći time Vespuccijevo otkriće.

Ta se slika svijeta nije dugo održala. Početak 16. stoljeća donio je velike proturječnosti, koje su se odrazile

[4] Španjolski konkvistadori grubo su se odnosili prema domaćem stanovništvu u Srednjoj i dijelu Južne Amerike krajem 15. i početkom 16. stoljeća (o.a.)

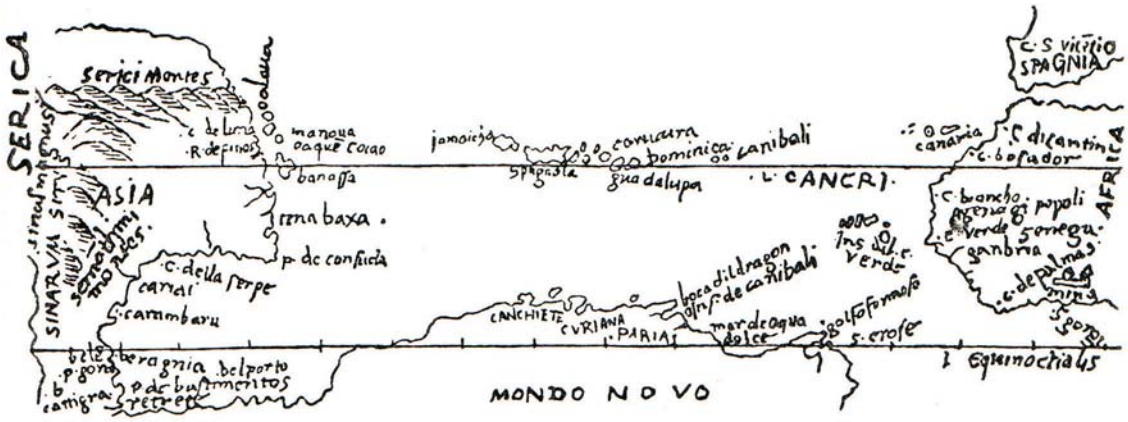

Fig 11. A sketch of the Atlantic and coast of America by Bartholomew Columbus from 1503 (Leithäuser 1958)

Slika 11. Skica Atlantika i obale Amerike Bartolomeja Kolumba iz 1503. godine (Leithäuser 1958)

2.4.3 Christopher Columbus

The Spanish and the Portuguese, who shared and continued to conquer the world at the time were very interested in itineraries, records, surveys and especially for maps. Christopher Columbus (1451–1506), eminent sailor who discovered America, and his brother Bartholomew Columbus (1460–1514), also a sailor and cartographer, employed their own measurements for their maps, but also discoveries, itineraries, reports and fantasies of other sailors, for example Marko Polo (1254–1324) about unheard of and unseen valuables of Asia and China (silver, gold, precious stones, temples, palaces, ...) and Bartolomeo Diaz (1450–1500), a Portuguese sailor who was the first to sail the south of the African continent – The Cape of Good Hope, in 1487/88. This discovery enabled new content in geography, that is maps, refuting the theory and authority of Ptolemy (Fig. 10).

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 to step on American soil.

He set sail west for the third time in 1498. He sailed around the Caribbean Islands and followed the eastern coast of South America. Fig. 11 shows a sketch of the Atlantic and the middle, that is south-American coast, which was most probably produced by his brother Bartholomew. Seduced by what he saw and experienced, the religious Columbus thought he discovered heaven. That way he wanted to refute the thesis that it was shaped like a ball, convinced it was shaped like a pear or a woman's breasts.

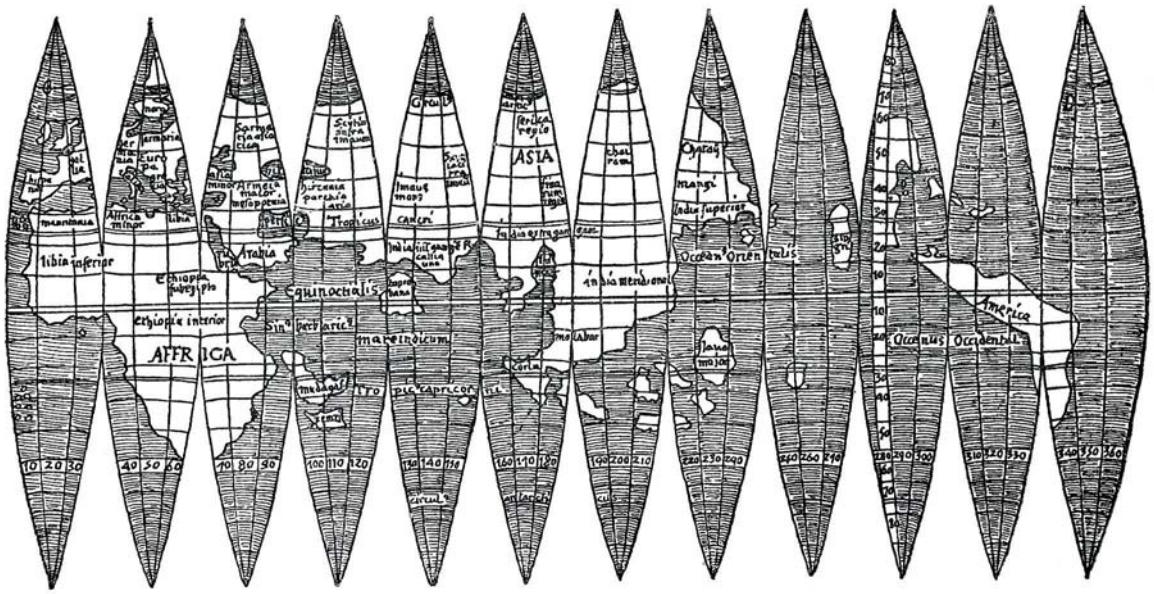

Fig 12. Globe-map of the world by Martin Waldseemüller from 1507 with America drawn (Leithäuser 1958)

Slika 12. Globus-karta svijeta Waldseemüllera iz 1507. godine s ucrtanom Amerikom (Leithäuser 1958)

i na kartama. Vespuccijeva slika svijeta potpada opet pod Ptolemejev utjecaj. Tako Amerika nije više novi kontinent nego *Terra Nova* – novootkriveni dio Azije (slika 13). Slika svijeta promijenit će se tek nakon otkrića Pacifika.

Fig 13. Map of the World by Hieronymus Marini from 1512. India Nova and Brasil represent the already discovered America (Leithäuser 1958)

Slika 13. Marinijeva Karta svijeta (Hieronymus Marini) iz 1512. India Nova i Brasil zastupaju već otkrivenu Ameriku (Leithäuser 1958)

Tome su pridonijela otkrića portugalskog pomorca Ferdinanda Magellana (1480–1521), koji je jedrio pod španjolskom krunom (poslije cara Karla V.). Rivalstvo između Španjolske i Portugala za vlast nad otocima Indijskog oceana, posebno nad arhipelagom mirodija Indonezijom, pridonijelo je bržem razvoju geografskih spoznaja i izradi boljih kartografskih prikaza tog prostora. Godine 1519–21. ploveći na zapad, s relativno malom flotom oplovljuje Južnu Ameriku (slika 14), stiže u nepregledni morski pojas Pacifika i nalazi traženo otočje. Preostali članovi njegove izmučene posade plove 1522. dalje na zapad preko Indijskog oceana, oplovljuju Rt dobre nade i, potpuno iscrpljeni, na kraju snaga stižu u Sevillu dokazavši prije svega da „tamo iza horizonta“ postoji još jedan novi ocean, koji nijedan kartograf nije do tada unio u karte, te da je Zemlja okrugla. Ujedno je dokazao da *Terra Nova*, *Terra Incognita* ili *Brasil* nije dio Azije, već uistinu novi kontinent *Amerika*. Time je otkriće Kolumba (1492.) dobilo svoje pravo značenje.

Već sljedeće godine, 1523., Johannes Schöner, profesor matematike na Sveučilištu u Nürnbergu, gravira u bakru kartu za globus svijeta (slika 15) na kojoj je ucrtao Magellanovu rutu. Njegova *Karta svijeta* (Leithäuser 1958) prekretnica je u povijesti kartografije. Na karti je prikazan cjeli tadanji svijet, s time da je na lijevoj i na desnoj strani karte ucrtan istočni indijski arhipelag. Amerika s ucrtanom neprekinutom obalnom linijom poprima oblik kontinenta, a veličina Pacifika postaje uočljiva.

I tako se u vrlo kratkom vremenu, samo u nekoliko godina, veličina svijeta podvostručila,

Fig 14. „Yesterday and Today“; left: Map of Magellan's Strait from 1652 (Berhorst et al. 2006), right: section of a map Topography and Population (Hölzel 2002)

Slika 14. „Jučer i danas“; lijevo: Karta Magellanova prolaza iz 1652. (Berhorst i dr. 2006), desno: isječak iz karte Topografija i stanovništvo (Hölzel 2002)

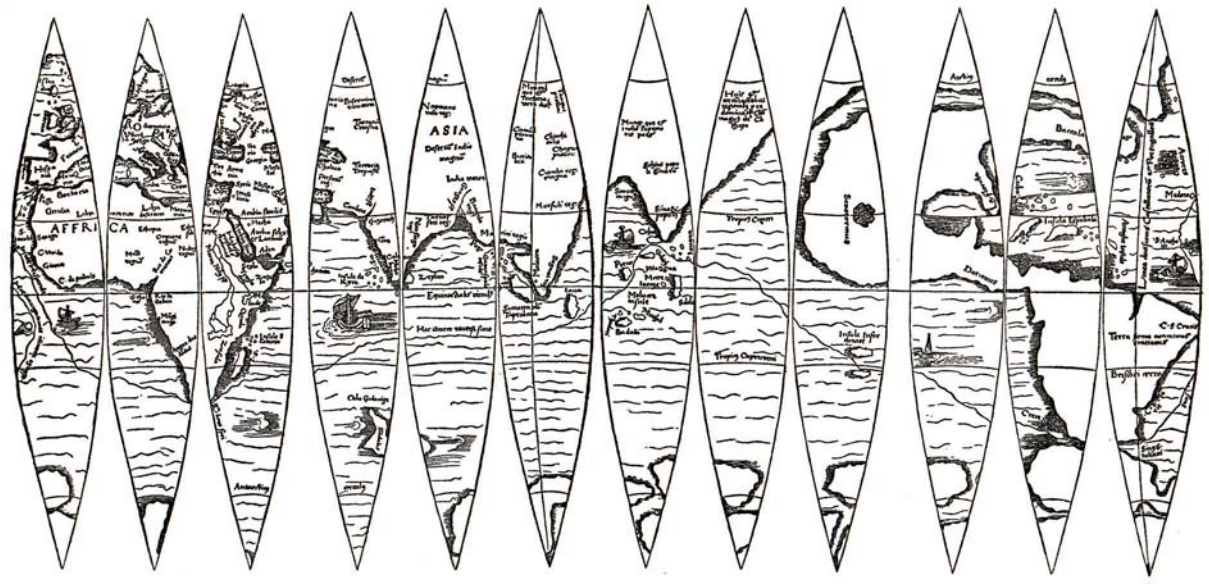

Fig 15. Globe-map of the world by Johannes Schöner from 1523 with drawn route and parts of the world newly discovered by Ferdinand Magellan (Leithäuser 1958)

Slika 15. Globus-karta svijeta Johannesa Schönera iz 1523. s ucrtanom rutom i novootkrivenim dijelovima svijeta Ferdinanda Magellana (Leithäuser 1958)

2.4.4 Quarta orbis pars

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. Thus he completed the errand given to him by Portuguese king Manuela the First and discovered and explored the last part of the route to India's spices. Thus started the colonial empire of Portugal in Asia and its nautical supremacy in the western part of the Indian Ocean.

Fig 16. Gerhard Mercator, an ingenious cartographer of all times (Muris et al. 1961)

Slika 16. Gerhard Mercator, genijalni kartograf svih vremena (Muris i dr. 1961)

Soon afterwards, Spanish conquistadors[4] sailed to the west in order to conquest explored areas, which were first explored by Columbus.

When Italian sailor Amerigo Vespucci (1451–1512) returned from the west in 1504, he wrote for the first time that Columbo's discovery wasn't related to India and Asia, already known continents, but a new continent he named *America.* In 1507, cartographer Martin Waldseemüller was the first to use the name *America* in his editions of the world map *Universalis Cosmographia* and the map used for production of the globe (Fig. 12), thereby celebrating Vespucci's discovery.

That image of the world did not stick around for a long time. The beginning of the 16th century brought great contradictions that also affected maps. Vespucci's image of the world was again overshadowed by Ptolemy's influence. Thus America was not a new continent anymore but *Terra Nova* – a newly discovered part of Asia (Fig. 13). The image of the world was changed when the Pacific was discovered.

This was contributed to by discoveries of Portuguese sailor Ferdinand Magellan (1480–1521) who sailed under the Spanish crown (later emperor Carl V). Rivalry between Spain and Portugal for power over island of the Indian Ocean, especially the spice archipelago in Indonesia, contributed to rapid development of geographical understandings and production of better map representations of that area. Sailing to the west with a relatively small fleet in 1519-1521, he sailed around the South America (Fig. 14), arrived in the vas sea belt of the Pacific and reached the islands he sought. In 1522, remaining members of his battered crew sail further to the west

[4] Spanish conquerors of Middle and part of South America, who treated the native inhabitants roughly at the end of 15th and at the beginning of the 16th century (author's comment).

Fig 17. Map of the World by Gerhard Mercator from 1569 produced in normal aspect cylindrical conformal projection – Mercator's projection (Leithäuser 1958)

Slika 17. Karta svijeta Gerharda Mercatora iz 1569. godine izrađena u uspravnoj cilindričnoj konformnoj projekciji – Mercatorovoj projekciji (Leithäuser 1958)

izgubila svoje stare granice. Potreba za ispravnim i detaljnim premjerom raste iz dana u dan. Kartografija se oslobodila Ptolemejeva uzora, čiji su teorija i kartografski prikazi svijeta stoljećima zavodili kartografe. Kapetani na svojim plovidbama traže potpunije i točne karte, mjernici nove i efikasnije mjerne instrumente. U to doba pojavljuje se mladi znanstvenik, humanist, astronom i kartograf željan novog znanja i pun novih ideja, koje su revolucionirale kartografiju kao znanost.

2.4.5. Gerhard Mercator – genijalni kartograf

Gerhard Mercator, zapravo Gerhard Kremer (slika 16) rođen je 5. ožujka 1512. u malom gradiću Rupelmonde u Belgiji. Već s 18 godina upisuje se na poznato veliko Sveučilište u Löwenu, gdje dobiva izvanrednu naobrazbu u matematici od profesora Reinera Gemme, poznatog pod imenom Gemma-Frisius (1508–1555). S 20 godina postiže akademski status magistra filozofije. Ubrzo mijenja zvanje želeći raditi na izradi karata, konstrukciji globusa i astronomskih instrumenata za izmjeru Zemlje. Na početku je crpio znanje od svojega učitelja Gemma-Frisiusa, koji je i sam bio graditelj globusa Zemlje i imao veliko iskustvo u konstrukciji geometrije karata. Godine 1544. u djelu *Kosmografija* prvi je opisao metodu triangulacije koristeći ju u izmjeri i geografskom određivanju stajališta (Leithäuser 1958).

Kartometrijsko prikupljanje podataka s Mercatorove *Mappae mundi* (*Karta svijeta*) ukazuje na izuzetnu točnost kojom je autor izveo mjerenja, računanje i kartiranje geografske mreže s obzirom na postojeća matematička saznanja i računske mogućnosti 16. stoljeća (Messenburg 2004). Prikaz obalne linije, tj. granica kontinenata Mercatorove *Karte svijeta* upućuje na nehomogene izvore za koje se autor pri kartiranju odlučio. Naime, vjerujući i oslanjajući se na znanstveni autoritet svojega prethodnika Klaudija Ptolemeja iz Aleksandrije (87–150), koristio se

Fig 18. Mercator's projection – normal aspect cylindrical conformal projection of the world (Kühn 2007)

Slika 18. Mercatorova projekcija – uspravna cilindrična konformna projekcija svijeta (Kühn 2007)

across the Indian Ocean, sail around the Cape of Good Hope and, completely exhausted, arrive in Seville without any strength left, proving that „beyond the horizon" there is another new ocean not one cartographer had included in a map, and that the Earth was round. He also proved that *Terra Nova*, *Terra Incognita* or *Brasil* wasn't a part of Asia, but indeed a new continent, *America*. This gave true meaning to Columbus's discovery (1492).

The next year, 1523, Johannes Schöner, a mathematics professor at the university of Nuremberg engraved into copper for the world globe a map (Fig. 15) in which he drew Magellan's route. His *Map of the World* represents the turning point in the history of cartography (Leithäuser 1958). The map features the whole known at the point, and the eastern Indian archipelago drawn on left and right sides of the map. A full line gave America the shape of a continent, and the size of the Pacific became evident.

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 by day. Cartography was disentangled from the model of Ptolemy, whose theory and cartographic representations of the world deceived cartographers for centuries. Captains request more complete and accurate maps for their journeys, surveyors request new and more efficient measuring instruments. During this period, a young scientist, humanist, astronomer and cartographer appeared, desiring knowledge and full of new ideas that revolutionized cartography as science.

2.4.5 Gerhard Mercator – ingenious cartographer

Gerhard Mercator, actually Gerhard Kremer (Fig. 16) was born on March 5, 1512 in the small town Rupelmonde in Belgium. At just 18, he enrolled the famous and large University of Löwen, where he gained extraordinary education in mathematics from professor Reiner Gemma, known as Gemma Frisius (1508–1555). At 20, he became a master of philosophy. He quickly changed his profession, wanting to work on map production, globe construction and astronomic instruments for surveying the Earth. At the beginning, he was tutored by Gemma Frisius, who was a globe constructor himself and had great experience in constructing map geometry. In *Cosmography* in 1544, he was the first to describe the triangulation method in surveying and geographic position determination (Leithäuser 1958).

Cartometric data gathering from Mercator's *Mappae mundi* (*Map of the World*) points to extraordinary accuracy whereby the author carried out surveys, computing and mapping of geographical network with regard to existing mathematical notions and computing possibilities of the 16th century (Messenburg 2004). Coastline representation, i.e. continent boundaries of Mercator's *Map of the World* imply heterogeneous sources the author decided on in mapping. Trusting and leaning on scientific authority of his predecessor Claudius Ptolemy from Alexandria (87–150), he employed the coastline representation from his maps instead of taking relatively precise geometry from portolan maps, which had been used together with compasses since 12th century. Despite this fact, Mercator's maritime maps and the *Map of the World*, which the author published named as *as usum navigantium*, and his main and greatest work – *Atlas*, (Lechthaler et al. 2006), which was published after author's death, contain numerous analogous information of the time they were produced in. His works are historical documents about technical skills of that time, which were used to produce cartographic originals, as well as to copy them.

He worked on his atlas without pause from 1568 to his death. Unfortunately, the atlas was not completed, at 123 books.

3 Concluding Thoughts

The historical development of cartography from the old age to the 16th century – to the time that was marked in cartography by Gerhard Mercator with his cartographic works, was long and hard, accompanied by speculations, delusions and ingenious inventions.

With his suggestion of conformal cylindrical projection, he left as heritage a work on which all navigation (maritime and aerial) maps are based on. And that is not all! State coordinate systems of numerous European and non-European countries are based on the Gauß-Krüger projection. Political and economical union of countries into the European Union, besides order regulations, obliges its members to apply a single coordinate system for topographic representation, regardless of their territorial borders. Universal Transversal Mercator Projection (UTM) was suggested and introduced for this purpose. Both mentioned projections are modified versions of Mercator's projection, which he used.

Undoubtedly, Gerhard Mercator was, alongside Marinus of Tyre and Claudius Ptolemy one of the greatest cartographers of all times.

Dedication

On the occasion of anniversary, to my cartography teacher Prof. Dr. Nedjeljko Frančula. The Author

prikazom obalne linije s njegovih karata umjesto da je preuzeo relativno preciznu geometriju s portulana koji su se od 12. stoljeća upotrebljavali zajedno s kompasom. Usprkos toj činjenici, Mercatorove pomorske karte i *Karta svijeta* (slika 17), koje je on pri izdavanju nazvao *as usum navigantium*, te njegovo glavno i najveće djelo – *Atlas* (Lechthaler i dr. 2006), koji je izdan nakon autorove smrti, sadrže mnogobrojne analogne informacije vremena u kojem su nastale. Njegova su djela povijesni dokumenti o tadanjem tehničkom umijeću, koje je korišteno pri izradi kartografskih originala, jednako kao i pri njihovu umnožavanju.

Od 1568. godine sve do svoje smrti (2. prosinca 1594. u 82. godini starosti) radio je bez predaha na svom atlasu, koji je, nažalost, sa 123 knjige ostao torzo.

3. Završne misli

Povijesni razvoj kartografije od staroga vijeka do 16. stoljeća – do vremena koje je posebice u kartografiji zacrtao Gerhard Mercator svojim kartografskim djelima, bio je dug i težak, praćen špekulacijama, zabludama i genijalnim izumima.

Svojim prijedlogom konformne cilindrične projekcije (slika 18) ostavio je Gerhard Mercator čovječanstvu u naslijeđe djelo, na kojem se temelje sve navigacijske (pomorske i zračne) karte. I ne samo to! Državni koordinatni sustavi mnogih europskih i izvaneuropskih zemalja temelje se na Gauß-Krügerovoj projekciji. Političko i gospodarsko ujedinjenje zemalja u Europsku uniju, među ostalim odredbama, obvezuje članice na primjenu jedinstvenoga koordinatnog sustava za topografski prikaz bez obzira na njihove teritorijalne granice. S tom je svrhom predložena i uvedena univerzalna poprečna Mercatorova projekcija (Universal Transversal Mercator – UTM). Obje su spomenute projekcije modificirane verzije Mercatorove projekcije, koju je autor za života primjenjivao.

Gerhard Mercator je nesumnjivo, uz Marina iz Tira i Klaudija Ptolemeja sve do današnjih dana jedan od najznamenitijih kartografa svih vremena.

Posveta

U povodu jubilarnog datuma mojem učitelju kartografije prof. dr. sc. Nedjeljku Frančuli. Autorica

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(Wikipedia) http://cs.wikipedia.org/wiki Gerhard_Mercator (ožujak / March 2007)