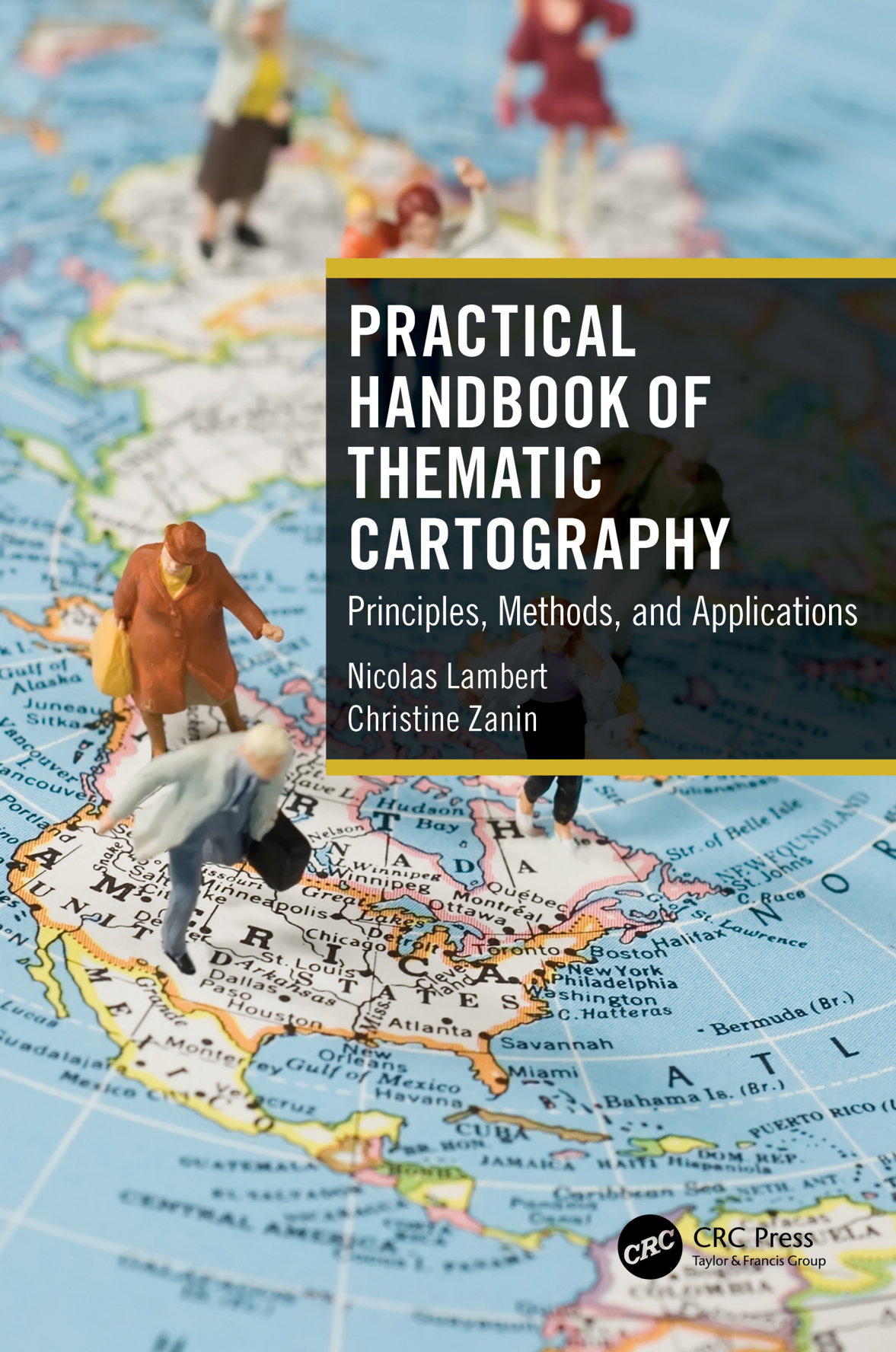




# PRACTICAL HANDBOOK OF THEMATIC CARTOGRAPHY

Principles, Methods, and Applications

Nicolas Lambert  
Christine Zanin



CRC Press  
Taylor & Francis Group

# Practical Handbook of Thematic Cartography



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Nicolas Lambert and Christine Zanin



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## Foreword

In the geospatial domains, we can witness that more spatial data than ever is produced currently. We need to make more and more efforts to deal with all those data in an efficient sense, mining the relevant information and link and select the appropriate information for a particular scenario.

However, how can we unleash the big potential of spatial data in truly interdisciplinary approaches better? How can we make sure that spatial data is applicable for governments, for decision-makers, for planners, and for citizens in an easy-to-use and efficient manner, so that the human user benefits?

In this respect, maps and cartography play a key role. Maps are most efficient in enabling human users to understand complex situations. Maps can be understood as tools to order information by their spatial context. Maps can be seen as the perfect interface between a human user and all those data, and thus they enable human users to answer location-related questions, to support spatial behavior, to enable spatial problem solving, or simply to be able to become aware of space.

Today maps can be created and used by any individual stocked with just modest computing skills from virtually any location on Earth and for almost any purpose. In this new mapmaking paradigm, users are often present at the location of interest and produce maps that address needs that arise instantaneously. Cartographic data may be digitally and wirelessly delivered in finalized form to the device in the hands of the user or he may derive the requested visualization from downloaded data in situ. Rapid advances in technologies have enabled this revolution in mapmaking by the millions. One such prominent advance includes the possibility to derive maps very quickly immediately after the data has been acquired by accessing and disseminating maps through the Internet. Real-time data handling and visualization are other significant developments as well as location-based services, mobile cartography, and augmented reality.

While the above advances have enabled significant progress on the design and implementation of new ways of map production over the past decade, many cartographic principles remain unchanged, the most important one being that maps are an abstraction of reality. Visualization of selected information means that some features present in reality are depicted more prominently than others, while many features might not even be depicted at all. Abstracting reality makes a map powerful, as it helps humans to understand and interpret very complex situations very efficiently.

However, as geodata and mapmaking software instruments become available to many, the need for understanding background, fundamentals, and methods of successful cartographic modeling processes raises significantly. It is rather interesting to witness how many maps are produced nowadays lacking fundamental rules of cartographic practice, thus demonstrating a lack of knowledge.

It is this context which makes every contemporary handbook or manual on cartography highly relevant. What is the fundamental knowledge I should have when dealing with maps, when trying to depict spatial information by graphical means and convey a story, a message for the benefit of human map users? Can there be a manual that describes all the theoretical and methodological underpinnings of cartography but gives at the same time easy-to-understand examples as well as discussing on a holistic level the consequences, limitations and constraints of maps and cartographic processes?

Of course, there are several textbooks, guidebooks, and introduction materials to cartography available, some of them quite old and some of them more technologically focused. The excellent *Manuel de cartographie* published in 2016 by Nicolas Lambert and Christine Zanin in French offered everything needed to gain a mutual understanding of modern cartography. It is a real benefit to the non-French-speaking world that this book is now available in English as well.

It demonstrates a holistic understanding of cartography in the tradition of the famous “Sémiologie Graphique” from Jacques Bertin. This book is divided into a logical “stack”, starting with fundamentals on the “input” for mapmaking (basemaps and statistical data), on the methods and concepts of transforming data into graphics and finally, in a more critical approach on looking beyond the visual variables, thus giving insight on how to go even further in cartographic design. With this, interested readers get something like a profound compass in their hand, which can guide them through the amazing world of cartography and help to ensure, that not only spatial data and geotechnologies become available on the fingertips of many but also the theoretical and methodological underpinnings of cartography. As a result, I expect many better maps being produced in future!

As former president of the International Cartographic Association, I claimed always that

1. Cartography is relevant
2. Cartography is modern
3. Cartography is attractive

and that it is therefore “OK, to be a cartographer!”.

This book demonstrates why cartography is relevant, modern, and attractive. *Félicitations*, Christine et Nicolas!

Georg Gartner, Vienna

---

## Authors

**Nicolas Lambert** is a research engineer in geographic information sciences at the CNRS (French National Centre for Scientific Research). Passionate about cartography and dataviz, he has made this activity his core work. He designs geographical maps to decrypt the world but also “protests” maps to try to transform it. As a political and associative activist, he has been involved for nearly 10 years in the cause of migrants within the Migreurop network. He regularly shares his maps and works on the blog [neocarto.hypotheses.org](http://neocarto.hypotheses.org). He is known on twitter as “cartographe encarté” (@nico\_lambert).

**Christine Zanin** is a professor and researcher in geography and cartography at the University of Paris Diderot and the UMR Géographie-Cités. Her passion for maps and the graphic world leads her to think of a pedagogy committed to cartographic design that respects visual rules but is in search of the innovation made possible by new digital tools. How to think about the spatial organization of territories through the cartographic prism is the meaning of her research.

Nicolas Lambert and Christine Zanin have been working together for more than 10 years to advance cartographic expression in all aspects of their professional or personal commitments. They were jointly awarded the 2009 Paris Diderot University Innovation Prize and published in 2016 the *Manuel de Cartographie* in French to understand and apply the different ingredients for effective mapping. In 2019, they also published *Mad Maps*, an atlas of 60 unpublished maps for the general public to help disseminate mapping.



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*A map of the world that does not include Utopia is not worth even glancing at, for it leaves out the one country at which Humanity is always landing. And when Humanity lands there, it looks out, and, seeing a better country, sets sail. Progress is the realisation of Utopias.*

*Oscar Wilde, The Soul of Man under Socialism*



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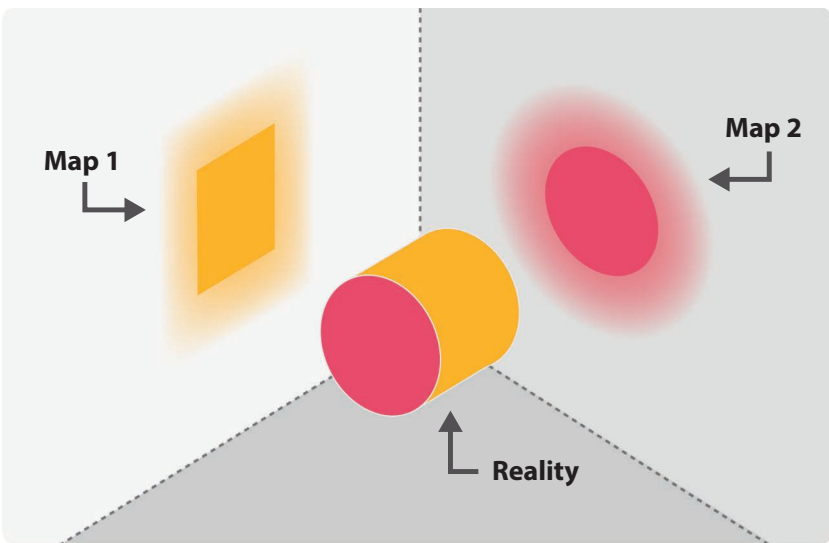
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## General Introduction

“La trahison des images” (The Treachery of Images), one of René Magritte’s most famous works, painted in 1929, depicts a realistic-looking pipe in profile, resting on a caption painted in the picture “Ceci n’est pas une pipe” (This is not a pipe). With this picture, Magritte wanted to demonstrate that, even if it is the most faithful representation of a pipe, its representation is never really a pipe: it cannot be smoked; it cannot be touched or handled. According to Magritte, a picture is always a representation of an object, but not the object itself. This painting is therefore not reality, but a representation of it, according to hypotheses, intentions, and technical know-how.

**Figure GI.01** Any map is a point of view on reality.



Long considered as an impartial, neutral scientific representation of geographical space, “a map is not a territory” (Korzybski, 1931). Resulting from choices and simplification, a map is “a” representation of reality and not reality itself. It is “the production of something concrete and unfamiliar that is converted into an abstract representation” (Lacoste, 1976). Indeed, a map is the “result of a set of technical gestures materializing an idea” (Jacob, 1992). All maps are therefore subjective. They offer a particular proposition, and they do not reflect the world objectively (Brotton, 2014). The possible designs are infinite.

### ● FOCUS: The Cartographer’s Eye

- Behind a map, there is always a cartographer. If you have 100 cartographers
- on the top of Empire State Building and ask them to map Manhattan, you will
- get 100 different map representations. The discrepancy between reality and
- the image representing it is inevitable. It is all the more true when the phe-
- nomena to be mapped are not visible to the naked eye, as it is often the case
- with human geography. A cartographer is therefore someone who, through
- his eye, shows to our eye what cannot be seen, a magical eye capable of
- making the invisible, visible.

## I.1 WHAT IS A MAP?

The term “map” can be declined in several entities. There is a multitude of geographical maps: weather maps, geology maps, vegetation maps, climate maps, tourist attractions maps, road maps, location maps, animated maps, interactive maps, etc.

It’s possible to classify all maps in two main categories:

**Topographic maps** are maps that mainly show results of direct observation: relief, water courses, human constructions, etc. These maps represent concrete elements that are durably established on a portion of terrestrial space at a given time.

**Thematic maps** are maps on which localizable qualitative or quantitative phenomena of all kinds are represented. Information is represented according to the rules of graphic semiology. These maps are designed, laid out, and “staged” to produce an intelligible image of the geographical phenomenon at hand.

### Definitions

A **map** is a simplified and codified image of geographical space, representing its characteristics and/or its organization. It is the result of a creative action and of the choices made by its author.

**Cartography** is an artistic, scientific, and technical discipline that aims to conceive and draw up maps.

A **cartographer** is someone who masters the methods, techniques, and concepts of converting geographical information into images.

## I.2 WHY DO WE HAVE MAPS?

Maps are the starting point and culmination of a geographer's work. They are his specific tools. To put it simply, maps are used to understand space, physical, and human organizations, etc. They enable information to be spatially represented, visualized, and analyzed. Maps allow discovering territories, carrying out and testing hypotheses, and learning about spatial organization. But above all, they are used for communication. Conceived as a way to communicate, they let to transmission of information or ideas, and help to understand geographical analysis.

Geography textbooks are full of maps giving students explanations about different phenomena. The more pedagogical is a map, the more effective it is. All in all, a map serves to tell us about a territory. For it, and to do this, we need to choose words, colors, and curves for the layout, and to adapt to the population targeted. Each map should be designed specifically for a particular group of people and should expound a subject that is thoroughly thought-through.

### ● FOCUS: Where Does the Word Cartography Come From?

- The word “cartography” stems from the Greek word *khartes* and the Latin
- word *carta*. It comes from the designation of the medium that was used:
- parchment. More recently in Europe, it was the German geographer, Karl
- Ritter of the Berlin Geographical Society, who used the word *Kartograph*
- for the first time, in 1828. A year later, the French Cartographic Society fol-
- lowed suit by using the word *cartographie*. In 1859, the British also took over
- the word “cartography”. In addition, the word “map” comes from *mappa*,
- which is a piece of fabric. It should also be noted that the word “chart”,
- phonetically close to the French word *carte*, refers more to a statistical
- nonspatial representation (pie chart, diagram).

## I.3 WHAT IS THE PURPOSE OF THIS HANDBOOK?

This handbook is about thematic cartography. It has been designed as a practical and fully illustrated tool for students to use in geography or infographics. It contains more than 130 figures. It can be read from beginning to end like an essay or read by dipping into it for the information needed.

### ● **FOCUS: Cartography, Mapping, or Geoviz?**

- These three words seem to mean the same thing and seem to be used to
- describe the process of designing maps nowadays. However, their meanings
- are not exactly the same. The term “mapping” refers more to the world of
- GIS and to the display and overlaying of layers of geographic information.
- The word “cartography” is most often used to designate a meaningful repre-
- sentation (map with message) by combining geographical and statistical data
- (e.g., thematic or statistical cartography). Finally, the term “Geoviz” (for
- Geovisualization) always requires a digital and interactive support. Three
- words, three different worlds.

This handbook is composed of three parts. Part 1 gives details on how to use, construct, and manage the raw material at the cartographer’s disposal, i.e., basemaps (Chapter 1) and statistical information (Chapter 2).

Part 2 looks more specifically at the methods and concepts of transforming data into graphic form. The representation of different types of data is introduced: nominal qualitative data (Chapter 3), ordinate data (Chapter 4), and absolute quantitative data (Chapter 5). In addition, Chapter 6 gives information on the use of cartography in particular contexts: temporal data, comparisons, typologies, multivariate analyses, etc.

And finally, in a more critical approach, Part 3, entitled “Beyond visual variables”, gives details on how to go even further in cartographic design. Innovative cartography methods are presented (Chapter 7). The choice of the layout and general “staging” (in a theatrical sense) of the map are described in detail (Chapter 8). To conclude, Chapter 9 demonstrates the subjectivity of cartographic images enabling the description of geographical space.

With this handbook, we hope to rehabilitate the term “cartography”. Often taken, wrongly, as old-fashioned, in favor of the more contemporary term “geomatics”, cartography has nonetheless some advantages. It is a rich and abundant discipline. When we design maps, we become at the same time explorers and pedagogues. Spatial structures are explored, we strive to understand how geographical space works, we analyze it, and we dissect it. Once the analysis has been carried out, results have to be shared. To do this, cartographers design images to tell us about territories. They formalize and depict space and build a world by materializing the imperceptible.

Any map is an invitation ... to see, dream, think, and act. So let us dream, imagine, create, and make maps. And proclaim its legitimacy!

## MAP GAMES

At the end of every section, there are exercises to put into practice the notions that have been presented. With what you learn in the different stages described in this handbook, the objective is step by step to enable you to design a map in accordance with your own particular choices. Your homework will be to produce an interesting and communicative image. The imposed theme, in this game, is the distribution of the US population, but it can naturally be applied to any spatial theme.

The game consists of three parts.

**Part 1:** You will focus on acquiring a coherent set of data, structured and exploitable in a mapmaking approach (basemap, statistical data). In this part, it is important, if required, to process and convert the acquired data (generalization of basemaps, data discretization, etc.)

**Part 2:** You will produce the chosen map using graphic ways suited to the nature of the data acquired during Part 1.

**Part 3:** This concerns the final development phase of the map: you will choose the layout and the “staging” of the cartographic image.

Be aware that the proposed theme (or any other theme) can be addressed in a number of different approaches you are free to choose from total population, density, young people, the elderly, men, women, demographic projections, life expectancy, birth rate, death rate, etc. You also have a free choice of techniques and software you are used to.

A BRIEF HISTORY OF CARTOGRAPHY...

*“Writing history makes a mess of geography!”*  
Daniel Pennac, *La fée carabine*, 1987

...just to have some important cartographic steps in mind!

THE EARLY MAPS

Geography precedes history. To appropriate their environment, humans have long sought to represent the space around them. Certain maps actually pre-date the invention of writing.

|          |                                                                                                                                                                   |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2200 BCE | <b>The Nuzi tablet</b><br>On one of the Nuzi tables found in Mesopotamia near Kirkuk is a map engraved in clay. It is the oldest map ever found.                  |
| 2000 BCE | <b>The Belinda map</b><br>A map found on the walls of Belinda cave in northern Italy.                                                                             |
| 600 BCE  | <b>The Babylonian map of the world</b><br>A map engraved on a clay tablet found near the town of Sippar, southern Iraq. It is the first attempt to map the world. |

GREEK SCIENTIFIC CARTOGRAPHY

The Greeks were pioneers of scientific cartography, representing the shape of the Earth and inventing systems of projection.

|         |                                                                                                                                                                                                                                             |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 650 BCE | <b>The Earth is a disc</b><br>Thales of Miletus saw the earth as a flat disc floating on water.                                                                                                                                             |
| 550 BCE | <b>The Earth is a sphere</b><br>For Pythagoras, the Earth was necessarily the most perfect geometrical shape – a sphere.                                                                                                                    |
| 500 BCE | <b>The first map of the Ecumene</b><br>Anaximander and Hecataeus drew up the first map of the known world, seen as a flat disc centered on the Mediterranean.<br>Three continents can be seen: Europe, Asia, and Africa (Libya).            |
| 200 BCE | <b>The first estimation of the circumference of the Earth</b><br>Eratosthenes, curator of the Great Library of Alexandria, performed the first measurement of a meridian arc and made the first estimate of the circumference of the Earth. |

|        |                                                                                                                                                                                                                                                                                |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 120 CE | <b>Ptolemy's geography</b><br>Ptolemy is considered to be the last great academics of Antiquity. In his <i>Geography</i> , he compiled all the geographical knowledge of the time. This work includes 27 maps: 12 maps of Asia, 10 of Europe, 4 of Africa, and 1 of the world. |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

THE UTILITARIAN MAPS OF THE ROMANS

Drawing away from the Greek scientific approach, the Roman maps were restricted to practical and utilitarian aspects – military maps, property maps, and routes.

|        |                                                                                                                                                                                            |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 300 CE | <b>Peutinger's Tabula</b><br>This itinerarium comprises eleven rolled parchments accounting for 200,000 km of road, surviving in a 13th-century copy. It is the ancestor of our road maps. |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

THE MIDDLE AGES

In the Middle Ages, European cartography went through a period of virtual vacuum. The medieval mapmaker seems to have been dominated by the church, reflecting in his work the ecclesiastical dogmas and interpretations of scripture. Maps were more symbolic than geographical. The church adapted maps to a mystical and contemplative ideology.

|                      |                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| From the 8th century | <b>T-O maps</b><br>The cartographic representations of the Earth to the form of a T inside an O. Oriented east, these maps return to the three continents (Europe, Asia, and Libya) discovered by the Greeks. They are separated by two perpendicular rivers: the Nile and the Don (Tanais).                                                                                                            |
| 1240                 | <b>Ebstorf's world map</b><br>The Ebstorf mappa mundi divides the world into three zones corresponding to the sharing out of the world by Noah's sons after the flood. In the center of the map, we find Jerusalem. Christ dominates the top of the map. On this particular map, on account of the complexity of the information included; the T-O structure is less prominent, although still present. |

THE ARAB AND ASIAN WORLDS

While scientific mapping was set aside in the West, it re-emerged from the 8th century in the Arab world. By re-appropriating Greek geography, the Arab academics renewed the somewhat forgotten discipline. Arab maps served as a link between West and East.

|      |                                                                                                                                                                                                                                                                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 950  | <p><b>The Istakhri map</b></p> <p>The Istakhri map, centered on the Moslem world, is oriented southwards towards Mecca. Here, Europe is reduced to a triangle to the bottom right.</p>                                                                                                                                                                              |
| 1154 | <p><b>The Al-Idrisi world map</b></p> <p>Al-Idrisi was the geographer and physician of king Roger II of Sicily, and was also a great traveler. He visited China, Tibet, and Europe as far as Scandinavia. Although the maps are circular, for Al-Idrisi the Earth was indeed spherical. His maps served as a basis for the first marine maps (portolan charts).</p> |
| 1402 | <p><b>The Kangnido map</b></p> <p>Korean world map where European and African continents are designed. China and Korea are oversized. Unlike European or Arabian maps, the Kangnido map presents a square shape.</p>                                                                                                                                                |

THE REVIVAL OF CARTOGRAPHY  
(THE GREAT DISCOVERIES)

From the 13th century, mapmaking saw an unprecedented rise, at a time when the conquest of new territories primarily required a mastery of sea navigation. The maps were now oriented towards the magnetic north indicated by the compass. Progress in technologies such as navigation, ship design and construction, instruments for observation and astronomy, and general use of the compass tended continuously to improve existing map information, as well as to encourage further exploration and discovery.

|      |                                                                                                                                                                                                                                                                                                                                                                                 |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1290 | <p><b>The Carta Pisana</b></p> <p>The Carta Pisana is the earliest marine map known. It is the first of a series of maps produced from the 13th to the 18th century – the portolan charts. On these maps, only coastal cities are marked. Portolan charts are based on the compass rose or wind rose, and on rhomb lines, and they have no reference system of coordinates.</p> |
| 1492 | <p><b>The first terrestrial globe</b></p> <p>The first known terrestrial globe was made by Martin Behaim in Nürnberg.</p>                                                                                                                                                                                                                                                       |