

# The Cartography and the Spatial Representations: Search by Perfect Map

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## Abstract

The activities of the professionals working on cartographic products have been highlighted especially in recent years. The history, the concepts and categories of cartography cannot be neglected in using this type of tool since the use of elements that make a cartographic product, as an example: map, chart, plan, globe, and a scale model should be used since the unawareness of techniques of cartography and the absence of the components of a map may hinder the understanding of what is intended to represent cartographically. This text is a contribution to the discussion of advances in cartography including errors and absence of maps, including a brief discussion of the characteristics of cartographic language nowadays and the search for perfection in cartography.

## Keywords

Cartography, Cartographic Evolution, Geographic Space, Spatial Representations, Perfect Map

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## 1. Introduction

Since ancient times man has always tried to represent/map the space in which he lived, either as an artistic form or in search to represent living places or for food. Throughout the years, techniques and tools were aggregated to these attempts to read and understand the geographic space, improving the readings on the places of planet Earth. For example, one can mention the invention of equipment that helps us in our location as the compass, the astrolabe, the Global Positioning System (GPS) and other instruments that helped at some point or still facilitate the location of objects and the representation of the terrestrial surface.

Over the last decades this representation became more “fast” and common due to, mainly, the advancement of information technology that put on computer screens information of objects and phenomena that were previously only shown on one sheet of paper, in other words, on a printed map. However, despite the computational

development is important to remind that even if one uses the printed maps and globes in all school subjects and not only in geography, but also in biology, history, mathematics, etc., because all the facts and objects originate and are in any place of our planet where the inseparability of the categories of time and space occurs (since every event occurs in a place). Thus, it is possible to construct an economic map from the knowledge of mathematics and economics; or the development of a vegetation map based on the knowledge of biology and so on, emphasizing these elaborations techniques of thematic cartography.

In this sense, Cartography, which is the art, science and art of drawing maps, globes, scale models, etc., through their knowledge gathered over centuries of human history, enables human beings to detail analysis of the reality of which they are part. This understanding of the places is made easier by reading and interpreting maps, which should be understood as a form of communication that contributes to the idea and the perception of reality that everyone has. Therefore, considering that we are all able to locate ourselves and transmit our location we can be considered as “builders of maps” because we read and represent space, but it is only by means of the techniques of cartography we can produce maps with all the necessary elements for its reading, so that other people can understand what we try to present the maps we have developed.

The present article tries to make a brief discussion on the use of cartographic products and their progress over time, in this case, focusing on the role of cartographic representations as an important tool in understanding the geographical space. Accordingly, by means of a literature review on the topic and the analysis of some examples of cartographic products produced by other authors and available on the worldwide computer network—internet also proposes the analysis of some cartographic products presented throughout the text seeking to present the main errors and absences in a cartographic product [1]. Finally, some important points to consider in the pursuit of “perfection” of the maps will be presented.

## 2. Progress in Cartography and the Basic Question of: Where Am I?

Since the earliest times, humans have been interfering in the places of their abode and their work, and for this reason always tried to better understand the best places for them to act. However, in order to understand all areas of Earth, these individuals represented their everyday variously, for example, when made the paintings in caves that sought to present the lifestyle of that time. Nowadays, this form of representation has changed since the advancement of technology—with emphasis on IT, it is possible the representation of all the living spaces of the globe through the computer. Thus, what has changed from past times to today is the way the technology is available but interest in mapping the locations remains the same to humans.

Over the years, the vast majority of sciences used the maps to their research and scientific evidence, as the location of objects or phenomena is an important fact to consider in the understanding of processes that one wants to understand. It could not be otherwise, given that the geographical space or interfere with studies is an important part of them.

In this sense, the question WHERE AM I? (**Figure 1**), always motivated human beings, that trying to



**Figure 1.** The basic question for mapping: Where am I? (source: [2] adapted by the authors).

represent their work space. Therefore, according to the type of technology employed by society (coal, brush, pen, computer, etc.), the cartographic product that can be developed will also be varied, manifesting itself as a simple sketch, a globe, or as a thematic map of a specified region [3]. Whereas, sketches, globes, maps, charts, models and plants are nothing more than a simplification of reality, in other words, an attempt to represent graphically and symbolically the actual space that humans inhabit.

Learn to locate and accurately convey their own location in map format is a characteristic of cartographic communication that only human beings have and that it is a universal way of communication, where the reader, regardless of language or country, recognize the shapes of the rivers, roads, cities, and other objects, according to common perceptions that everyone has of the terrestrial surface, namely, in accordance with the shapes, colors, orientations, by standardizing symbols, etc.

However no map is perfect, since perfection never reach all objects that are on Earth's surface, the way they are and how they can actually be represented. What makers of maps (all of us) should do is make them more understandable if possible, so that all readers who handle a given map can identify the place being represented (where is it?) making sure that the map being read refers to a particular place, in a certain time, because every map reflects the time it was made, representing the locations at that moment and may give suggestions for future scenarios.

### The Spatial Representations and the Development of Maps

The spatial representation, namely, the way in which man symbolically represent the locations of their experience are present throughout the history of mankind, even before the literate writing and articulation of language. An obvious way to communicate this example can be observed in the children's process that even before talking, when trying to represent the space in which they live, try to draw what they see through the risks with pencil or ink. It was even so with the prehistoric men, using the symbols and designs tried by means of technology available at the time, represent their first real apprehensions on the walls of caves approximately 40 thousand years ago (Figure 2).

Nevertheless, with the advancement of tools built by societies using more modern features (pencil, brush, etc.), which may be represented symbolically been gaining more similarity than in the real space. Therefore, places, towns, houses and other objects were more precise forms for gaining symbolic representations, from the moment that the evolution in the means where the symbols were also represented an important step, since before the primitive man performed his paintings on cave walls, over time began to paint on clay tablets later on papyrus, on sheets of paper, until reaching the representation in computers, as we know, with specialized *software* and *websites* for mapping.



Figure 2. Cave paintings prepared by Cro-Magnon man (primitive man) (source: <http://migre.me/mmuyY>).

As an example of antique map, one sees in **Figure 3** the so-called Map of Ga-Sur, what is a “map” on a plate made of baked clay of  $8 \times 7$  cm, prepared by people who lived in Mesopotamia and is meant to represent a region of the valley, which is presumed to be the Euphrates River in the Middle East. This map is considered one of the oldest maps already prepared by humanity, its antiquity is estimated between 2400 and 2200 A.C, being at that moment, different from Cro-Magnon Man (**Figure 2**), during this period already had another form of support for the spatial representation, in this case a clay plate.

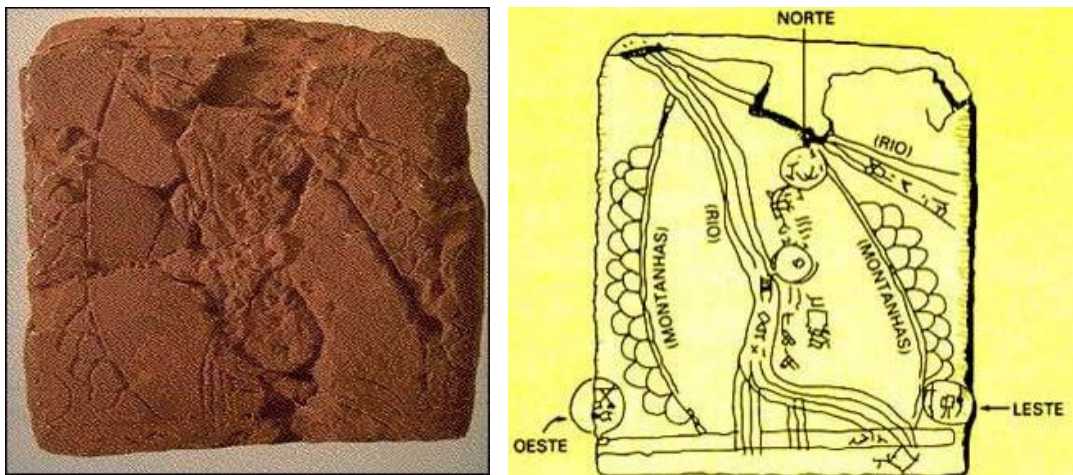
It is important to understand that many people have contributed to the advancement of what today is called cartography. The Greeks, Egyptians, Romans, Chinese, French, English among others, were people who made a significant contribution to the way we represent the places nowadays, since the geometric shapes drawn by these people are part of a set of knowledge and perceptions taken nowadays as universal. This knowledge acquired by the ancient peoples, resulting from the mapping of the places that we knew or that conquered were saved and transferred through an exchange or wars for conquest, where conquistadors received besides jewelry and economic resources, knowledge contained in libraries and maps.

Based on the changes caused by advances in communication techniques, as well as cartographic representation with the advent of nautical technology, mainly developed during the European maritime expansion in the fifteenth and sixteenth centuries that intensified trade to the West, allowing the recognition of new continents, maps were being disseminated and standardized especially the so-called Portulano maps, which showed the location of the main ports of the world (**Figure 4**) that allowed a closer representation of reality and enabled man to meet previously unknown or inaccessible places.

It can be seen that the maps throughout their history began to be used for various purposes, not just for the “discoveries”, conquests and demarcations of new territories but also later for teaching and passing on knowledge of the Earth’s surface for a greater number of people, because before the maps were drawn by hand, one by one and passed on to a few people with the invention of printing by Johannes Gutenberg in the fifteenth century, maps became accessible to a larger segment of the population.

With the accumulation of information, created by the volume of maps drawn with the development of tools and techniques after the European maritime expansion and the industrial revolution were needed most accurate cartographic standardization, where the representation and map reading required the creation of so-called international conventions, designed mainly in the twentieth century, which enabled the improvement of spatial representations. This fact was not possible in past times, where the cartographic production was handmade.

Thus, all peoples in some way, always tried to symbolically and cartographically represent their place of abode, work and leisure, but there was a jump in instrumental quality in recent decades, caused by the advance of the forms of collecting images for remote sensing, in the progress of computer and Internet development. The creation and development of these tools should be considered major progress for cartography, due to the fact that they facilitated the perception of larger regions, as well as the handling and printing of new cartographic products. In addition to the remote sensing images and the internet has provided thousands of people viewing their places of residence and work viewed “from above” as if the user were flying everywhere and mapping the



**Figure 3.** Map of Ga-Sur: the oldest map ever seen (source: [4] and <http://migre.me/mmuyY>).



**Figure 4.** Fragment of the Piri Reis map, drawn in 1513 (source: [5]).

places he knows.

**Figure 5** is the view of some streets of the city Belém, in the state of Pará and also demonstrates a tool of popularizing for cartography that can be used for the planner or another individual to be located on the Earth's surface. This type of besides other applications of GIS (computerized spatial data processing), are freely available on the internet and is becoming increasingly common. These software, specialized in handling spatial information in computer are easy to access and handling are free and can be used to produce maps by anyone. As an example of program *OpenGis* (Free GIS program and open to modifications/adaptations), one can mention Quantum Gis (**Figure 6**), which has a community of developers creating new plugins (new functions) for the user to be able to access. This type of program has a wide variety of tutorials that teach the use and can also be accessed for free by anyone with internet access.

In this way, previously experienced a moment of initiation of the design learning with the discoveries of the first prints and spatial representations (in the case of primitive man), going through the cartography without norms and standards where through the restricted period of a handful people who held the knowledge of places (ancient civilizations until the great voyages). Shortly thereafter, and reaching nowadays in which cartography has been experiencing greater popularization, enabling multiple users and professional the knowledge that has been considered “interdisciplinary”, because it is contributing to a wide variety of sciences and enabling scientific progress not only in cartography, but all forms of knowledge that these tools contribute.

### 3. Errors in Maps<sup>1</sup>

Despite advances in the collection of spatial information and the preparation of cartographic products, errors and/or absences are still present. Thus, during the analysis of some maps, arranged in textbooks or geographical atlas, is possible to identify absences of cartographic elements such as: orientation scale, projection, source caption and title, among others, in addition to errors in the localization of places or symbolic presentation of objects and phenomena, not following the regulations that the mapping techniques suggest what may ultimately contribute to the improper seizure of representations of geographic space by students/users. For example, the explanatory text contained in the map of **Figure 7**, it was found that there is a tendency to the production of stereotypes

<sup>1</sup>The analyzes presented here were conducted with undergraduate students of geography course at the Federal University of Pará (UFPA), during the discipline “Introduction to Teaching Cartography” in the years 2013 and 2014.

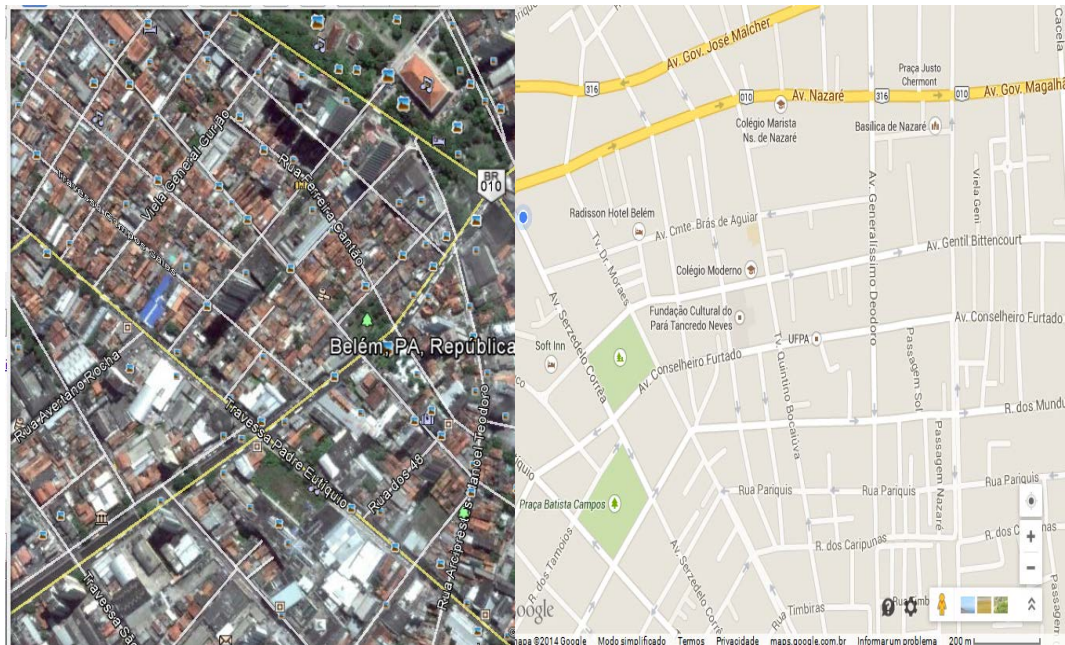


Figure 5. Visualization of a remote sensing picture (Google Earth) and the streets of Belém (Google Maps) (source: <http://migre.me/mmuBo> adapted by the authors).

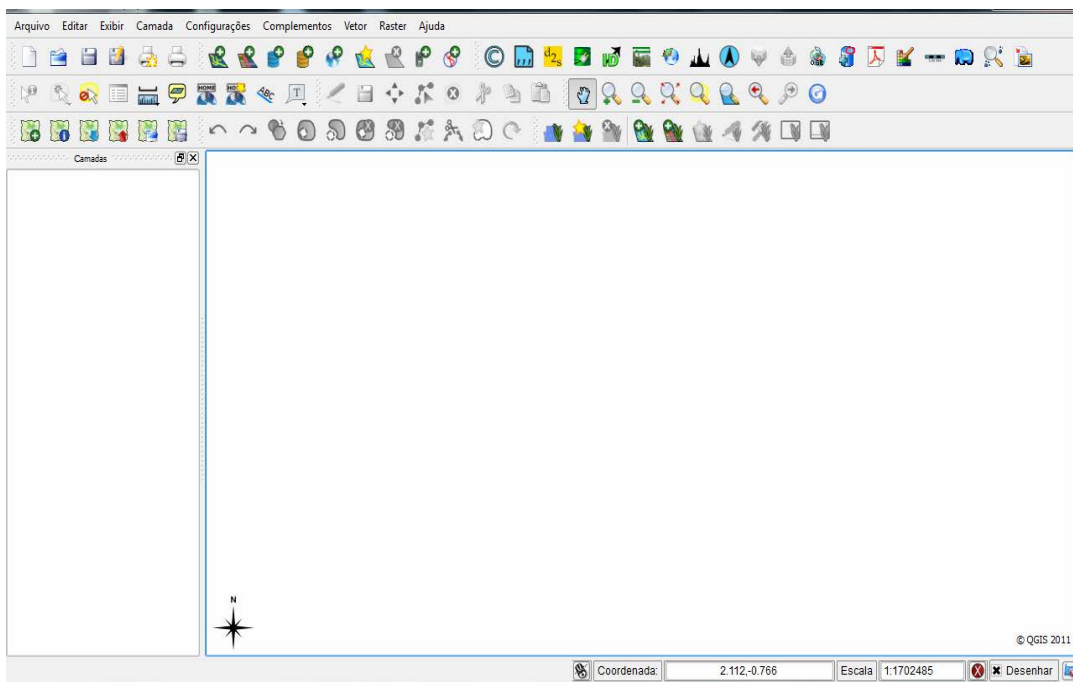


Figure 6. Screen viewing of software OpenGis/Quantum Gis (source: <http://www.qgis.org/wiki/Download>).

and regionalisms by the author who, through texts and figures (highlighted by the red circle), may induce the reader to misunderstanding of the realities found in the Brazilian regions, where the depreciation of regions (north and northeast) occurs at the expense of other (south-central).

Already in visualization of other maps [7], it is observed that there is an icon of instruction, as the rose of the winds, nor information on the type of projection used in mapping. It is noticed that there is a map of location/situation in the upper right corner of the figure, however, when analyzing the observations of this element it



Figure 7. Brazil: Economic regions (source: [6]).

is found that it does not have new information to supplement the main map, but repeats the information from the main map, which is unnecessary. In another analysis, it was observed that some of the atlas do not follow patterns of colors for thematic maps (geomorphology, geology, pedology, for example) and the colors used do not depict the symbols found in these elements actually, according to international conventions that exist.

Concerning the introduction of these tools, it was observed that some atlases start with texts on the teaching of geography or cartography, others with the general approach of the universe and planet Earth, showing the processes that formed the continents. This introduction in all atlases appear to be random, strictly following the professional experiences of the authors, as it happens with Atlas of Ciranda [7], where the sequence is: Continents-World-Brazil-Regions of Brazil. Martinelli [8] indicates that the atlas should follow a general aspect of standardization for the specific, the universe to the place, which otherwise can be applied. This lack of standardization may incur obstacles to the teaching-learning process, because the absence of a hierarchy of ideas could mean among other things, doubts to students, as to the content offered, simultaneously, also the textbook, which can be formatted differently.

In the case of the title, that must be one of the first information shown on maps, atlases analyzed in some, observed that some of them have minimal information, and do not respond: “What?”, “Where?” and “When?” are

not explanatory or directed to the main theme of the map are general, for example, as seen with the title “Physi-cal planispheric” or “Physical Map” [9] where it show areas with higher and lower altitude, but restrict the main theme to a single element, demonstrating the “physical” just as it was related to geomorphology [10], which applies the correct title according to the main theme of the map, such as informing the question of relief as in **Figure 8**.

When analyzing the caption element that should enable readers to interpret and knowledge of the geographical area and/or phenomenon manifested in the body of the map and by this fact should be explaining, it is noted that many of the legends contained—when existed no help the reader in interpreting the cartographic product. In this way, in a “polluted” map, with lots of information, lots of figures, inappropriate colors and shapes, the legend, which must be inseparable and reference the main map, have impaired understanding, as displayed in **Figure 9**.

From these maps, the interpretation is complicated because they are “polluted” with words in different sizes and shapes due, mainly, to the small print space (usually on A4 paper), making the chosen scale inappropriate for the phenomenon intended to be submitted. Still, there is always the possibility of presentation of the symbol with visual variables (shape, color, tint, orientation, etc.) divers that when used incorrectly may “pollute” the map, due to overlapping or agglomeration of information in the same space, as in **Figure 10**, where the symbols are confused between them with different colors and shapes or with a same color which overlaps and makes it difficult to distinguish the elements.

In addition to the above presented figures, in these atlases, it gives much importance to the presentation of flags of countries, states or provinces, object that could be disregarded to occupy a significant space in the final pages of the atlas or that could be presented along with the maps on the same page in thumbnail view and according to what is noticed in the geometries. In addition, most atlases analyzed do not innovate as the presentation of the cartographic product not presenting “new forms” of cartographic representations, that became more common with the development of computer and with the progress of geoprocessing, for example, anamorphosis, cartograms, graphs pyramid-age, flow maps, etc., except for the atlas of Scoffham [12], in which some of these representations are noted.

Thus generally, besides the problems encountered in school atlases analyzed in this work, other shortcomings were still detected among them is the issue related to non-contribution between the textual part and the content in this maps, where it is unclear the dynamics of natural phenomena and anthropogenic that fall short in the

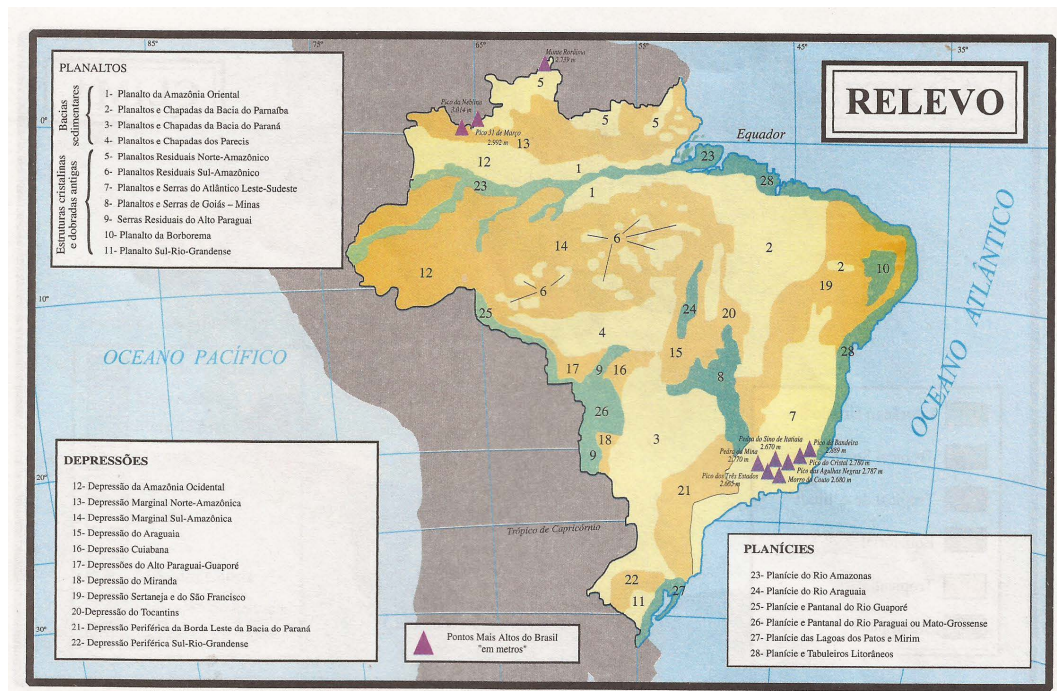


Figure 8. Relief (source: [10]).



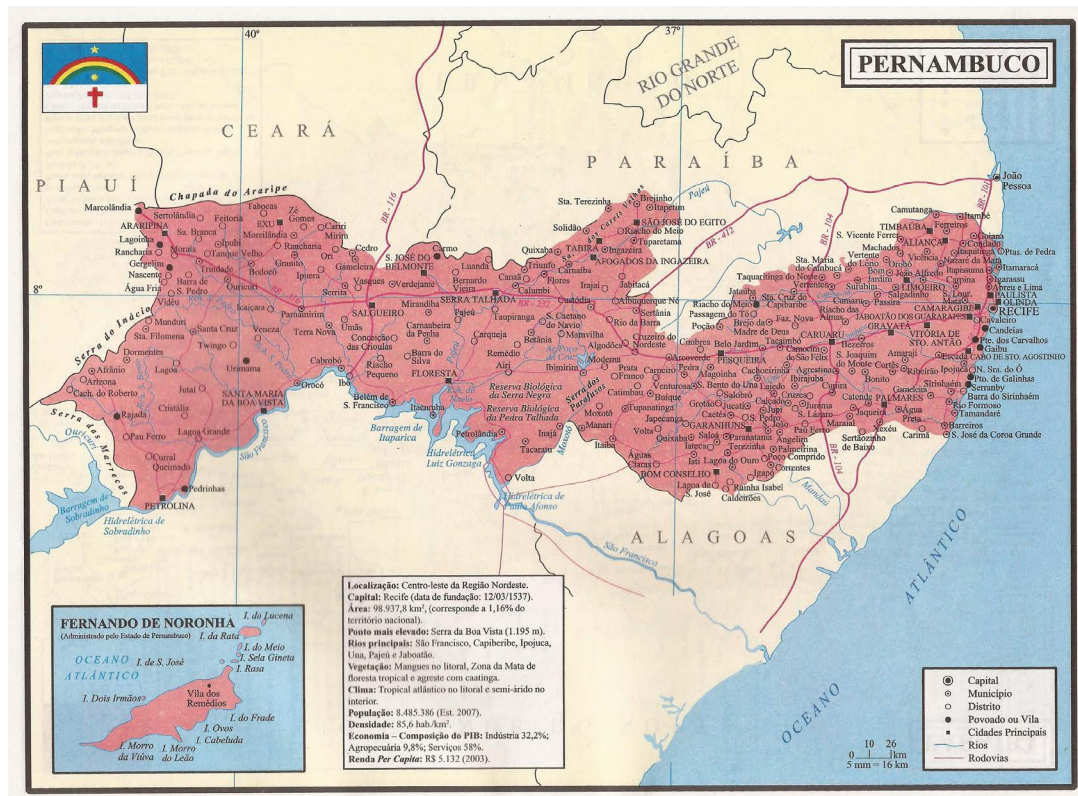


Figure 9. Pernambuco (source: [10]).

content of this tool, directly and indirectly affecting student learning.

#### 4. Looking for the Perfect Map

It is important that before making a map—or other spatial representation it is necessary to know what the use for this product will be and which individuals use the cartographic product designed. The possibilities are great: environmental monitoring, public safety, transport, natural resource management, urban spatial analysis, etc. Using the map, the makers express, through drawing techniques and a knowledge of the geometry of the places, the representation of objects and phenomena that present themselves in geographic space, which occurs in accordance with a work schedule, in other words, according to a particular “place” where one sees the phenomenon [13].

All cartographic products (sketches, globes, maps, charts, models, plants, pictures, etc.) are nothing more than a generalization, reduction and simplification of reality, trying to represent graphically and symbolically the actual space that is known or which pretends to explore. Learn to locate and accurately convey its own location in map format, it is a characteristic of cartographic communication that only humans possess. This form of communication is universal to humans, where the reader of the map, regardless of language or country recognize the shapes of the rivers, roads, cities, and other objects, according to common perceptions that everyone has of the terrestrial surface, therefore, according to the shapes, colors, textures, guidelines, that were created by using standardized symbols that mimic what one sees in geographic space.

As discussed earlier, the elaborated maps must have minimum information of the objects or phenomena that are represented. They should answer basic questions for the reader (What? Where? and When?), so that they become self-explanatory since these are independent publications or that are directed to understanding a main theme, which facilitates its reading. However, since before starting to prepare a map is important to know that in cartography there is no perfect map, because the representation of reality will never be complete since it depends on detailed knowledge of a place, which is viewed in different ways by their users and the more information one puts on the map, trying to cover the whole complexity of reality, the more one is “polluting it”, in such a way

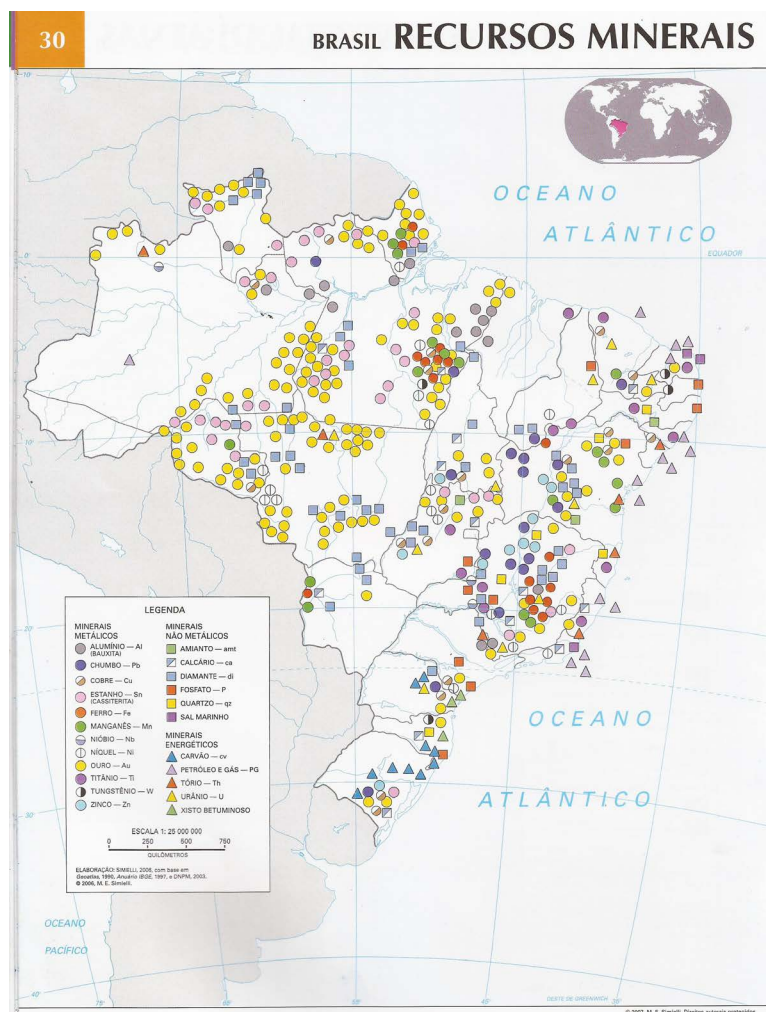


Figure 10. Mineral resources (source: [11]).

that will become unreadable by the accumulation of information and excessive symbolization.

In this sense, the geographical area is dynamic and not static, the map is always out of date, from its print, because new phenomena, objects, perceptions and understanding arise according to the standpoint of the user and its relationship with the landscape charted. Thus, the analysis of a map when one notices absences or inaccuracies regarding the main elements, to be more precisely, the problems: scale, orientation, projection, font, caption, title, on the “body map” or in other elements; because the curvature of the earth itself directs us to errors in locating places or in symbolic presentation of objects and phenomena, which not perfectly follow the regulations that the mapping techniques suggest, which may contribute to the incorrect apprehension of representations of geographic space by students/readers/user.

The complexity or facility that the map will depend on mainly on some specifics:

- **The cognitive level or educational background of the user:** this is, the specialty of each mapper to distinguish the map produced. In this way, a biologist will understand the map different than a geologist, geographer, engineer and so on. The (multi, inter, trans) disciplinarity of the maps reflect the knowledge of their makers. Thus, the more “trained” the vision of the mapper/map makers, the more complex the cartographic product vice versa, there we will have simple and complex maps for different audiences;
- **Of the institutions, organizations and ideologies of the maker:** Somehow, directly or not, all individuals are linked to institutions/political and ideological organizations that influence their practices and consequently, impacting in the products and/or activities. The makers of the map should cultivate the practice of impartiality, so that their maps are not tendentious and partisan, but that stimulate a critical sense of their

readers in search of a proper understanding of the phenomena;

- **Of the (geo) technology tools (software and hardware) available for drawing of the map:** It is necessary to emphasize that there are many programs and equipment aimed at the development and dissemination of maps. If the user needed before the field study to understand the phenomenon studied, nowadays the remote sensing images give us the ability to perceive objects in geographic space without leaving the lab, just simply technical training for handling technology. The improvement in accuracy and resolutions (radiometric, temporal, spectral and spatial) possible by advances of computer technology in recent years and also the aeronautical (with satellites, aircraft and Unmanned Aerial Vehicles, UAV), become significant allies that were incorporated into the knowledge already produced by the oldest so-called geotechnologies (compass, astrolabe, etc.) and that comes directly influencing the quality of maps produced and the training of professionals working in the (geo) cartographic area;
- **The phenomenon or object being represented:** An ideal (and not perfect) map will reflect the amount of information already collected on a thematic analysis. Thus, the more one knows a certain topic, more one finds new applications for the gathered knowledge, in other words, if little is known about a particular subject then will be more limited cartographic production on this topic. When choosing themes that are already known by the scientific community, for example, it becomes simplified the intersection of diverse information for the construction of new knowledge, in which the formation of the maker has a direct influence on the complexity of the product designed;
- **The ability to read and understand users':** The maps produced are not made to the makers/mapper to read, but to a targeted audience of users, which has specific needs, the latter must be able to read the maps available, according to their cognitive level (age, level of education, life experience, etc.), because, depending on the complexity map cannot meet the needs of those for which it was made, or it may be too simple for a better prepared player. It is important to emphasize that technological advancement which passes by the cartography—and other sciences, should not weaken the critical analysis in maps, therefore so-called geotechnologies—the computational processing spatial information technologies, has the facility to produce maps in a mechanical way, without the critical examination of their makers and/or reader.

These five characteristics are essential for the map is ideal or suitable for any particular use. Perfection is not for the makers of maps, because reality and its attributes are much larger than can be put on a sheet of paper or computer screen. The mapper remains constant quest for a “more beautiful” product, accurate and that aggregates more knowledge, as well as the cartography should be understood as art, technique and science.

## 5. Conclusions

To finalize this text, it is important to remember that, despite the advances one sees in cartography, from ancient times to today, the concepts, categories and elements that represent the sphericity of the planet and composing a map been slightly changed, namely, techniques to reduce the actual space for the paper (scale), maintenance of forms or to represent distances in the plane/paper (projection), the title, the orientation and the legend are still elements that cannot fail to understand what a map wants to show. So, regardless to know how to handle a *GIS software* in order to construct a map, it is necessary to understand that behind those functions of the program there is a series of techniques and knowledge that have been built for centuries and should be understood so that the construction activity of the cartographic product does not become only a practice of “pushing buttons”.

As one has seen, despite the progress that mapping had in recent years its main features still remain the same. The type and the user's need, the way information and the geographic area that will be represented are key elements to be taken into consideration when drafting a cartographic product. In this way, one cannot forget that every cartographic product is the result of an evolution/technological progress that has been occurring for centuries, and remains in “motion in the present day”, but there are characteristics and principles (projection, scale, orientation, legend, etc.), which cannot be neglected. We, as map makers and mappers for excellence, see, abstract, understand and adequately represent the maps to make “others” read.

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