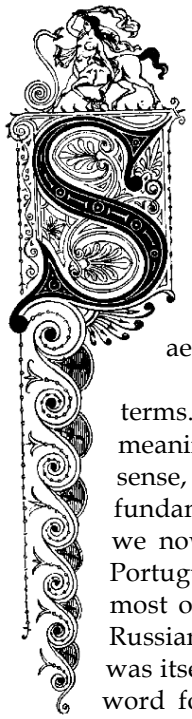


ome of these monographs may be thought of as an anthology of maps, which, like all anthologies, reflects the taste and predilection of the collector. It may also be likened to a book of reproductions of works of art, in the sense that the illustrations, even with the accompanying commentary, cannot really do justice to the originals. In this case, many of the illustrations are in black and white, many are reduced in scale, and some are merely fragments, (re-)interpretations, or reconstructions. But they will have served their purpose if you are encouraged by reading this book to look at maps critically, to comprehend their strengths and limitations, to appreciate them aesthetically, and to use them more intelligently.

Being the first in the series of monographs, it may be worthwhile to define some terms. A conceptual obstacle in the history of cartography has been the confusion over the meaning associated with the word "map" in different time periods and cultural settings. In a sense, according to J.B. Harley, the subject has become a prisoner of its own etymology. The fundamental problem is that in many ancient languages there was no exclusive word for what we now refer to as a map. In European languages such as English, Polish, Spanish, and Portuguese, for example, the word map derives from the Latin word *mappa*, meaning cloth. In most of the other European languages, the words used for map - French *carte*, Italian *carta*, Russian *karta* - derive from the Late Latin *carta*, which meant any sort of formal document and was itself derived from the Greek word meaning *chartes, papyrus*. In most Indian languages the word for map derives from the Arabic *naqshah*, but other meanings attached to it include "picture", "general description", and even "official report". In Chinese, *tu* [or *t'u*] is no less ambiguous; besides "map", it can also mean "a drawing or diagram of any kind". In Russian, for example, the word for picture is *kartina*, and in fact in many early historical societies, those of medieval and Renaissance Europe, for instance, it was common to use words such as "picture" or "description" for what we would today call a map. Thus the apparently simple question, "What is a map?" raises complex problems of interpretation. This problem is most acute in the study of the artifacts from very early societies. The French cartographer J.L. Lagrange wrote in 1770: "A geographical map is a plane figure representing the surface of the earth, or a part of it"; and, in the recent *History of Cartography*, Volume One (1987), "maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world". Of course there are other words besides "map". The specific term "cartography," referring to the drawing of what we now think of as a map, as distinct from other representations of territory and their inhabitants, was not coined until 1839. The term "cartography" was created by a combining the Greek word *chartes* [chart], and *graphein* [to write or draw].

The etymology of the word "chart" *[Karte]* is also interesting. One explanation traces the word back to the Greek words *(ges) periodos, pinax* [meaning "circuit of the earth" or "painting"] which corresponds to the Latin *sculop* [to carve in stone or metal]; although there is also the Latin word *forma* meaning "shape". Although in the ancient world maps were indeed often carved in stone, wood, and metal, and primitive peoples perhaps practiced map-making in their rock-paintings, the word seems rather to have come from the word *cartes* [paper], first used to denote a map in Portugal, whence it passed into Spain and Italy. The Latin word *charta*, which also passed into all Romance languages, is also descended from the Greek word for paper. The word *karte* was introduced into colloquial German by Laurent Fries, a cartographer probably from Alsace, who in 1525 published a little book, *Yslegung der Mercarthen oder Charta Marina*, as the descriptive text for his world map, published in the same year. The word *landcharte* was used in German from the 17th century. In ancient Rome a map was called a *tabula*; in both the Greek and Latin languages this word means "broad, picture representation". The expression *imago mundi* [picture of the world], coined in the Middle Ages, is more explicit. The expression *mappamundi* [*mappa*: patch, cloth, material; *mundi*: world] was also very widely used during this period. The English word "chart" or "card", introduced from Holland with Dutch charts, has been retained exclusively for aeronautical and nautical maps, while the word "map" is used more often for terrestrial maps, and also, in a wider sense, to embrace all types of cartographic delineation.

In the modern world the map performs a number of significant functions, among which are its use as: a necessary tool in the comprehension of spatial phenomena; a most efficient device for the

storage of information, including three-dimensional data; and a fundamental research tool permitting an understanding of distributions and relationships not otherwise known or imperfectly understood. A knowledge of maps and their contents is not automatic, though it is somewhat intuitive – to completely understand all of the modern map conventions it has to be learned; and it is important for educated people to know about maps even though they may not be called upon to make them. Maps have become one of a select group of communications media without which, Marshall McLuhan has suggested, "the world of modern science and technologies would hardly exist."

However a map does not converse in "sentences". Its language is nonlinear. As stated by Arthur H. Robinson in *The Nature of Maps*, it is almost as if one had to read from a page where all the words had been assembled in random order. There is no fixed starting point, or sequence of perception. A map has no vocabulary, no lexicon of precise meanings. It communicates in lines, hues, tones, coded symbols and empty spaces, much like music.

Robert Rundstrom has observed that mapping "is fundamental to the process of lending order to the world." Yet quite clearly there are many ways of world-making. In Denis Wood's vivid formulation: "Every map shows this . . . but not *that*, and every map shows what it shows this *way* . . . but not *the other*." In other words, cartographers construct the world, they do not reproduce it. Places are where they are, but maps represent them where the mapmakers want them (or need them, or think them) to be. Every map, then, has an author, a subject and a purpose(s). ***No map is a neutral document.*** All maps reflect efforts of one kind or another to impose oneself (or one's culture) on physical space. A map is an interpretation that needs, in turn, to be interpreted.

Some of these points also apply to the word "cartography". This word is a neologism, coined by Manuel Francisco de Barros e Sousa, Viscount of Santarem, in 1839 with particular reference to the study of early maps. The meaning of the word "cartography", however, has changed since Santarem's day. It has broadened to include the art and science of contemporary mapmaking, as well as the study of early maps. Therefore, the "history of cartography" has frequently been a source of confusion. For example, for some the distinction between the "history of cartography" and "historical cartography" still remains unclear, often being employed as synonyms by some writers. As a branch of human endeavor, the science or study of mapmaking, cartography, has a long and interesting history which reflects not only man's perception of the world, but also the state of cultural activity in different periods. Viewed in its development through time, the map is a sensitive indicator of the changing thought of man, and few of these works seem to reflect such an excellent mirror of culture and civilization. The maps of early man, which pre-date other forms of written communication, were attempts to depict earth distributions graphically in order to better visualize them; like those of primitive peoples, the earliest maps, like all modern maps, served specific functional or practical needs.

Cartography, like architecture, has attributes of both a scientific and an artistic pursuit, a dichotomy that is certainly not satisfactorily reconciled in all presentations. Some maps are successful in their display of material but are scientifically barren, while in others an important message may be obscured because of the poverty of presentation. An amazing variety of maps exist to serve many different purposes. As representations of belief, politics, propaganda and ideology - rooted in particular cultures and institutions - as well as "factual" images of scientific knowledge, maps are increasingly being recognized as touching the subject matter of a wide range of scholarly disciplines. Cartography cuts across these disciplinary lines to a greater extent than most subjects. No one person or area of study is capable of embracing the whole field; and cartographers, like workers in other activities, have become more and more specialized with the advantages and disadvantages which this inevitably brings.

Many theorists emphasize the use of cartography as a means of asserting political and social control. J. B. Harley writes, for instance: "Both in the selectivity of their content and in their signs and styles of representation, maps are a way of conceiving, articulating and structuring the human world which is biased towards, promoted by, and exerts influence upon particular sets of social relations. By accepting such premises it becomes easier to see how appropriate they are to manipulation by the powerful in society." David Harvey states more succinctly, "command over space is a fundamental and all-pervasive source of social power." As products and symbols of various kinds of authority (moral, "scientific," etc.), maps make distinctions that favor certain interests, "culturalizing the

natural" through the process of identifying and naming, categorizing and containing. Although maps are usually viewed as representations of space, they can also be taken as spaces of representation - fields of opportunity, waiting to be cultivated by acts of physical or intellectual appropriation or both.

The significance of maps - and much of their meaning in the past - derives from the fact that people make them to tell other people about the places or space they have experienced. Maps constitute a specialized graphic language, an instrument of communication that has influenced behavioral characteristics and the social life of humanity throughout history. They have often served as memory banks for spatial data and as mnemonics in societies without the printed word and can speak across the barriers of ordinary language, constituting a common language used by men of different races and tongues to express the relationship of their society to a geographic environment. This implies that throughout history maps have been more than just the sum of technical processes or the craftsmanship in their production and more than just a static image of their content frozen in time. Indeed, any history of maps is compounded by a complex series of interactions, involving their intent, their use and their purpose, as well as the process of their making. The historical study of maps may, therefore, require a knowledge of the real world, or of whatever is being mapped; a knowledge of its explorers or observers; a knowledge of the mapmaker in the narrower sense as the originator of the artifact; a knowledge of the map itself as a physical object; knowledge of the contemporary cultural context (social-political-religious-ideological influences); and a knowledge of the users (or, more than likely, the community of map users).

It is assumed that cartography, like art, pre-dates writing; like pictures, map symbols are apt to be more universally understood than verbal or written ones. Maps produced by contemporary primitive peoples have been likened to so-called prehistoric maps. Certain carvings on bone and petro glyphs have been identified as prehistoric route maps, although according to a strict definition, they might not qualify as "maps". Cartographic artifacts produced by peoples of earlier ages are marked by variety in objectives, symbolism, scales, and materials. Understandably, only a small fraction of the maps produced in earlier ages have survived, but in some instances we know of these lost works through written records. While although maps did not become everyday objects in many areas of the world until the European Renaissance and the advent of printing, there have been relatively few documented mapless societies in the world at large. The map is thus both extremely ancient and extremely widespread. The loss of many early maps can be attributed to the nature of the materials used for their construction, which often militated against their preservation. Thus, valuable metal was often melted down and parchment was recycled to be used for some other purpose. Alternatively, less durable materials quickly deteriorated, especially when taken to a different climate, or were destroyed by war, fire, or other means. The destruction of maps is a continuing problem even today, especially because the information they contain may quickly go out of date so that they are treated as ephemera, or because they have data of a strategic nature which is not to be disseminated.

As previously mentioned, many early maps, especially those prior to the advent of mass production printing techniques, are known only through descriptions or references in the literature (having either perished or disappeared). Obviously these present a problem to historians of cartography. In the present work, reconstruction of those maps that are no longer extant are used in place of originals or assumed originals. The reconstructions of such maps appear in the correct chronology of the originals, irrespective of the date of the reconstruction. All reconstructions are, to a greater or lesser degree, the product of the compiler and the technology of his times. Therefore, reconstructions are used here only to illustrate an *interpretation* of the general geographic concepts of the period in which the lost original map was made. Nevertheless, reconstructions of maps which are known to have existed, and which have been made a long time after the missing originals, can be of great interest and utility to scholars. The possibilities include those for which specific information is available to the compiler and those that are described or merely referred to in the literature. Of a different order, but also of interest, are those maps made in comparatively recent times that are designed to interpret and illustrate the geographical ideas of a particular person or group in the past but are suggested by no known maps.

It is nonetheless the case that many modern school atlases could not (and cannot) resist the temptation to reconstruct ancient maps by combining modern knowledge about the shape of the earth's landmass with data from ancient texts. The 19th century in particular saw many such reconstructions, but even the most recent grand atlas of the ancient world, which accompanies the *Neue Pauly* encyclopedia, presents supposed reconstructions of the world maps of Hecataeus, Herodotus, Eratosthenes and Ptolemy. Such reconstructions introduce a host of unwanted modern concepts into the ancient data: north is on top, for example; the shape of coastlines for which no ancient descriptions are available is the familiar modern one (e.g., Italy reconstructed in the shape of a boot - a modern idea unknown in the ancient world), or color is used to mark the continents and the sea. That said, it is only natural that modern or later historians, in reading geographical writings by ancient philosophers, would attempt to "visualize" these terrestrial descriptions and world concepts. These later-day "graphical translations" would always be influenced by their superior knowledge of the known world, thus giving the shapes of landmasses a rather "modern" look. There is no way we can truly graphically translate or capture the real ancient contemporary mind's eye of what they were envisioning when they wrote their geographical descriptions any more than a blind person imagine what a sighted person sees. So in this book I have assembled as many reconstructions that I could find about each map, although most are originally products of the 19th century and should be viewed accordingly.

These characteristics can be observed in the Greco-Roman world as well. Ancient "educated men" covered huge distances in both place and time to debate scientific questions about geography. They communicated in the same "learned language"— Greek — and discussed "the same body of ideas". Their debate "did not penetrate very deep" within the culture, which is why one should draw a sharp distinction between descriptive geography, with its wide application, and mathematical or scientific geography, for which no such application was envisaged or achieved. The reasons for this divide include the limited quantity of scientific geographic scholarship, the nature of communications and scarcity, and political factors.

It must be said at the outset that we have little contemporary evidence for Greco-Roman maps. In the modern world, the nature of communications allows original texts and graphics to be preserved, transmitted and accessed for extended periods of time. The pre-modern world, on the other hand, had only a series of copies to work with, made over the centuries on organic material. The process was almost manageable for texts, multiple copies of which could be created by copyist teams working from dictation. But it was not feasible for graphics, the copying of which inevitably led to increasing distortion. Copies of copies of copies must generally have been very different from the vanished original, hence the scarcity of scholarly, illustrations transmitted from the ancient world.

Methods for accurately reproducing and eventually printing maps in sufficient quantities to enable cartographical knowledge to 'penetrate very deep' are in fact a feature only of modern times. Gutenberg's invention of moving type did not lead to the multiplication of maps. Only Senefelder's invention of lithography in 1796, and the innovative use of it for the mass printing of graphics, including in color, in the century that followed, allowed maps to be printed and distributed in quantity. This allowed general access to accurate maps and led, *inter alia*, to the introduction of geography as a school subject; the invention of the school atlas in the late 19th century; and the deep penetration of cartographic information to almost all members of industrial societies from the late 19th century on. Any assumption that maps were widely available in the pre-industrial world thus derives from anachronistic thinking based on later developments.

Some of the reconstructed maps/world-views that are found herein have been constructed in modern times using the best available textual references. Other reconstructions are much older, such as the Byzantine monk Maximos Planudes (1260-1310), who, after a long search, discovered a manuscript of the *Geographia* of the Alexandrian astronomer Claudius Ptolemy (second century A.D.), and celebrated his find in verse. Since the maps were missing, he drew them himself from indications in the ancient text, and when the work was finished, he commemorated this too in verse. After the fall of Byzantium in 1453, its conqueror, the Turkish Sultan Mohammed II, found in the library that he inherited from the Byzantine rulers a manuscript of Ptolemy's *Geographia*, which lacked the world-map, and he commissioned Georgios Aminutzes, a philosopher in his entourage, to draw up a world

map based on Ptolemy's text. He knew it would be out of date, but that is precisely what he wanted - an ancient map; to perpetuate it, he also had a carpet woven from the drawing.

Many libraries and collections were not in the habit of preserving maps that they considered "obsolete" and simply discarded them. In earlier times these maps were considered to be ephemeral material, like newspapers and pamphlets, and large wall-maps received particularly careless treatment because they were difficult to store. But what makes early terrestrial maps so interesting? Why should they be collected, studied and preserved? Three main reasons can be suggested:

- maps provide materials for historical research, particularly in the history of civilization and science;
- maps are works of art; and
- maps embody a degree of intellectual effort and attainment that makes them worthy of collection and study.

Old maps, collated with other materials, help us to elucidate the course of human history. When, in 1918, a mosaic floor was discovered in the ancient Trans-Jordanian church of Madaba showing a map of Palestine, Syria and part of Egypt, a whole series of reproductions and treatises were published on the geography of Palestine at that time *(see #121)*. The map answered many hitherto insoluble or disputed questions, for example the question as to where the Virgin Mary met the mother of John Baptist. "*And Mary arose in those days, and went into the hill country with haste, into a city of Juda*" (Luke 1.39). Where was this hill country? It was said that as the Archangel Gabriel appeared to Zacharias in the holy of holies, Zacharias must have been a High Priest and have lived in Jerusalem; John the Baptist would then have been born in Jerusalem. But Jerusalem was not the 'city of Juda'. Some saw in the 'hill country' Hebron, a place that had for a long time been a leading Levitical city, while others held that Juda was the Levitical city concerned. Many solutions to this problem were put forward, but it was solved once and for all by the Madaba map, which showed, between Jerusalem and Hebron, a place called *Beth Zachari*: the house of Zacharias. Excavations on this site revealed the foundations of a little church, with a fragment of a mosaic that contained the name "Zacharias".

A series of maps of one region, arranged in chronological order, can show vividly how it was discovered, explored by travelers and described in detail; this may be seen in facsimile atlases like those of America (K. Kretschner, 1892), Japan (P.Teleki, 1909), Madagascar (Gravier, 1896), Albania (Nopcsa, 1916), Spitzbergen (Wieder, 1919), the northwest of America (Wagner, 1937), and others. A series of maps of a coastal region (for example, that of Holland or Friesland) or of river estuaries (the Po, Mississippi, Volga, or lower Yellow River) gives information on the rate of changes in outline and their causes. Comparison of travelers' maps from various periods show the development and change of routes or road-building and allows us to draw conclusions of every kind about the development or decay of farms, villages and towns.

Early maps are also of great importance as works of art. To begin with, they were generally drawn by hand on parchment or paper, and then painted. Some, fortunately, were even carved in stone or engraved in wood or metal plates. They were artistic treasure-houses, being often decorated with fine miniatures portraying life and customs in distant lands, various types of ships, coats-of-arms, portraits of rulers, animals and so on. If they were to be presents or gifts, then, as in great church paintings, the portraits of the recipients and often the donors too were added. From the second half of the 15th century, maps were printed from woodcuts and from engraved copper plates. During the transitional period, maps were still decorated with artistic vignettes, portraits, views of towns, pictures of various peoples in their national dress, hunting scenes, and so on, and expanses of water were covered with waves, ships and sea monsters. Mountains and forests were depicted as they appear in nature, not by conventional signs/symbols. Artists of note, such as Albrecht Dürer and Hans Holbein, often cooperated in map production and not only executed the plates, but also used their skill in coloring the prints. Maps were also frequently used purely for decoration; they furnished designs for Gobelins tapestries, were engraved on goblets of gold and silver, tables, and jewel-caskets, and used in frescoes, mosaics, etc. It was not until the 18th century, however, that maps were gradually stripped of

their artistic decoration and transformed into plain, specialist sources of information based upon scientific measurement.

As mediators between an inner mental world and an outer physical world, maps are fundamental tools helping the human mind make sense of its universe at various scales. Moreover, as mentioned earlier, they are undoubtedly one of the oldest forms of human communication. There has probably always been a mapping impulse in human consciousness, and the mapping experience - involving the cognitive mapping of space undoubtedly existed long before the physical artifacts we now call maps.

A map appears at first sight as a relatively simple iconic device. Indeed, much of its universal appeal is that the simpler types of map can be read and interpreted with only a little training. Throughout history, though, ways of looking at maps have to be learned even within oral societies, formal literacy has not been a precondition for them to be made or read. An anthropologist has remarked that "the making and reading of two dimensional maps is almost universal among mankind, whereas the reading and writing of linear scripts is a special accomplishment associated with a high level of social and technical sophistication." Thus maps have been associated with cultures that differ widely in social or technological development, while modern psychological research has shown that children can derive meaning from maps (and indeed draw them) from an early age.

G.R. Crone remarked that *"a map can be considered from several aspects, as a scientific report, a historical document, a research tool, and an object of art. Maps represent an excellent mirror of culture and civilization",* but they are also more than a mere reflection: maps in their own right enter the historical process by means of reciprocally structured relationships. The development of the map, whether it occurred in one place or at a number of independent hearths, was clearly a conceptual advance - an important increment to the technology of the intellect - that in some respects may be compared to the emergence of literacy or numeracy.

The history of cartography represents more than a technical and practical history of the artifacts. It may also be viewed as an aspect of the history of human thought, so that while the study of the techniques that influence the medium of that thought is important, it also considers the social significance of cartographic innovation and the way maps have impinged on the many other facets of human history they touch.

The Historical Context: Prehistoric Cartography

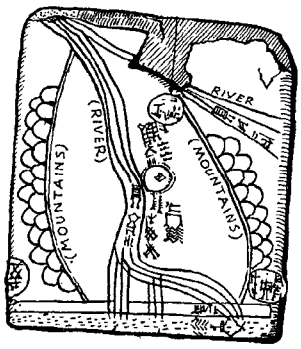
The only evidence we have for the mapmaking inclinations and talents of the inhabitants of Europe and adjacent parts of the Middle East and North Africa during the prehistoric period is the markings and designs on relatively indestructible materials. It is probable, given the prevalence of such activity in historical times among indigenous people, that additional cartographic representations were made by prehistoric man on more ephemeral materials such as sand, hide, bark, and the dust of cave floors. All surviving evidence, however, suggests that cartographic depictions in prehistoric rock art constitute a very minor portion of the total sum of that art. Even in Valcamonica, which is relatively rich in prehistoric rock art and has been well searched, the "topographical figures" number a mere half dozen out of a rough total of 180,000 recorded figures from seventy-six sites. The very rarity of cartographic depictions provokes interest in the motivation behind their production.

Although some questions will always remain unanswered, there can be no doubt that prehistoric rock and mobiliary art as a whole constitutes a major testimony of early man's expression of himself and his world view. It is reasonable to expect some evidence in this art of the society's spatial consciousness. But when it comes to drawing up the balance sheet of evidence for prehistoric maps, we must admit that the evidence is tenuous and certainly inconclusive. The historian of cartography, looking for maps in the art of prehistoric Europe and its adjacent regions, is in exactly the same position as any other scholar seeking to interpret the content, functions, and meanings of that art. Inferences have to be made about states of mind separated from the present not only by millennia but also - where ethnography is called into service to help illuminate the prehistoric evidence - by the geographical distance and different cultural contexts of other continents. For instance, I have not been able to find any such evidence or artifacts of pre-historic mapmaking that originated in Asia, South America or Australia.

Despite all these difficulties, a number of statements can be made with confidence. There is, for example, clear evidence in the prehistoric art of Europe that maps - permanent graphic images epitomizing the spatial distribution of objects and events - were being made as early as the Upper Paleolithic period (20,000 years ago). The same evidence shows, too, that the quintessentially cartographic concept of representation in plan was already in use in that period. Moreover, there is sufficient evidence for the use of cartographic signs from at least the post-Paleolithic period. Two of the basic map styles of the historical period, the picture map (perspective view) and the plan (ichnographic view), also have their prehistoric counterparts. The importance to prehistoric man of his cosmological ideas is reflected in the cartographic record. Less clear, however, is the evidence for celestial mapping. The paucity of evidence of clearly defined representations of constellations in rock art, which should be easily recognized, seems strange in view of the association of celestial features with religious or cosmological beliefs, though it is understandable if stars were used only for practical matters such as navigation or as the agricultural calendar. What is certainly different is the place and prominence of maps in prehistoric times as compared with historical times, an aspect associated with much wider issues of the social organization, values, and philosophies of two very different types of cultures, the oral and the literate.

Babylonian Cartography

Despite the richness of civilization in ancient Babylonia and the recovery of whole archives and libraries, only a handful of Babylonian maps have so far been found. In Mesopotamia the invention by the Sumerians of cuneiform writing in the fourth millennium B.C. paved the way for the production of maps. They are impressed on small clay tablets like those generally used by the Babylonians for cuneiform inscriptions of documents, a medium that must have limited the cartographer's scope. Other cuneiform tablets of the period between 2,500 and 2,200 B.C. include long lists of place-names, rivers and mountains. The text on these tablets, which were drawn from earlier sources that reached back as far as the beginning of the third millennium B.C., may have been used for teaching or perhaps military purposes, but whether they suggest the existence of maps is uncertain. The fact that King Sargon of Akkad was making military expeditions westwards from about 2,330 B.C. would account for the inclusion of places as far west as the Mediterranean. Later we encounter itineraries, referring either to military or to trading expeditions and provide an indication of the extent of Babylonian geographical knowledge at an early date. They do not go so far as to record distances, but they do mention the number of nights spent at each place, and sometimes include notes or drawings of localities passed through. As in Greek and Roman inscriptions, some documents record the boundaries of countries or cities.



The Babylonians were noted mathematicians and astronomers. In the former field, among other things, they attained a remarkably close approximation for $\sqrt{2}$, namely 1.414213. Our divisions into 60 and 360 for minutes, seconds and degrees are a direct inheritance from the Babylonians, who thought in these terms. They had a sexagesimal notation, e.g., 70 was expressed as 1,10.

Babylonia was open to travelers from all directions. The courses of the Tigris and Euphrates rivers offered major routes to and from the north, and the northwest, and the Persian Gulf allowed contact by sea along the coasts of Arabia and east to India. It is no surprise, therefore, to find the urban culture which the Sumerians developed during the fourth millennium B.C. spreading far afield through trade and conquest. Babylonian lore was passed down to the Greeks by Berosus (ca. 290 B.C.) and others. For examples of Babylonian cartography see #*100A* and #*101*.

Although cuneiform maps may not be forerunners from which later Western maps originate, they share characteristics with other cartographic traditions in their graphic imaging of territorial, social, and cosmological space. Cuneiform texts provide several varieties of evidence for the ancient Mesopotamian efforts to express order by describing, delimiting, and measuring the heaven and earth of their experience, producing house, temple, plot, and field plans, city maps, and, with respect to the celestial landscape, diagrammatic depictions of stars. Various orders of power are implicit in the

expression of these aspects of order in the environment. Administrative and economic powers support, or even require, the making of maps, as well as determining overtly the topographies that maps depict.

Where once such maps would not have been admitted within a general history of cartography, a new view of the meaning of the map can embrace them. The historiography of maps and cartography has emerged from criticisms similar in nature to those made against the modernist or presentist historiography of science, namely, that in reifying science or sciences such as cartography, false evolutionary histories are liable to be constructed. Some originating point is identified, such as the origins of science in Greece, or of mapmaking in Babylonia, from which a continuous history may be written from a presentist perspective, a tale of a discipline's inexorable progress from its originating moment to the present. Critical cartographic history, however, has laid aside such ideas, and we no longer look to (in the words of Denis Wood), "a hero saga involving such men as Eratosthenes, Ptolemy, Mercator, and the Cassinis, that tracked cartographic progress from humble origins in Mesopotamia to the putative accomplishments of the Greeks and Romans".

By no means do all ancient Near Eastern maps display metrological finesse or even the use of measurement, though some characteristically do, such as the agrarian field and urban plot cadastral surveys. Concern for orientation is attested in a number of maps, but not always in the same way, although with a tendency toward an oblique orientation northwest to southeast. Ancient Near Eastern maps may not have invariably been meant as exact or direct replications of territory, but there can be little doubt that they distinctively reflect the conceptual terrain of their social community and culture at large. The maps of buildings and fields focus on the urban and agricultural environment, matters of critical importance to whatever political and economic powers prevailed.

The maps of cities with their waterways and surrounding physical landscape combine cartography of sacred space, seen in the temple plans, with that of economic space, seen in the field surveys. The cities of Nippur and Babylon had a religious and cosmological function as well as a political and economic one. In the periods of their supremacy each was viewed as the center of the universe, as the meeting ground between heaven and the netherworld. The map of the principal temple in Babylon, *E-sagil*, which was the earthly abode of the national deity *Marduk*, represents the terrestrial counterpart to the celestial residence of the great god Enlil, designed, figuratively speaking, on the blueprint of the cosmic subterranean sweet watery region of the Apsu.

The Babylonian world map *(#103)* is an attempt to encompass the totality of the earth's surface iconographically: land, ocean, mountain, swamp, and distant uncharted "regions" This said, it represents more of an understanding of what the world is from the viewpoint of historical imagination than an image of its topography against a measured framework. It offers a selective account of the relationship of Babylon to other places, including those that were at the furthest reach of knowledge.

The diversity of cultures that have sought to preserve their maps, putting them on clay, papyrus, parchment, and other writing media, points to a near universality of making maps in human culture. Cognitive psychologists claim that we come into our physical world mentally equipped to perceive and describe space and spatial relationships. The linguistic act of spatial description is perhaps a proto-mapmaking function of our very desire and attempt to place ourselves in relation to the physical world. By extension, we should not doubt that mapmaking too, in all its historical subjectivity, is a universal feature of human culture. The interest of the cuneiform maps lies in their rich articulation of such a feature, uniquely shaped by the particular social norms and forces that emerged and changed within ancient Mesopotamian history.

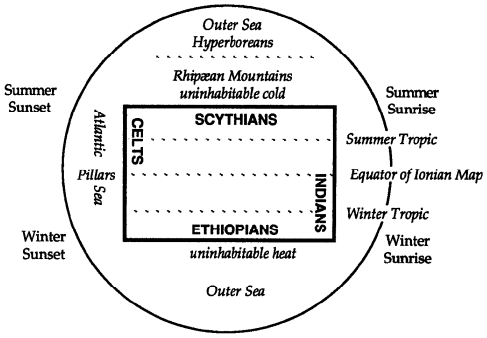
Egyptian Cartography

Egypt, which exercised so strong an influence on the ancient civilizations of southeast Europe and the Near East, has left us no more numerous cartographic documents than her neighbor Babylonia. Geographical knowledge, however, was highly developed in early Egypt. The Pharaohs organized military campaigns, trade missions, and even purely geographical expeditions to explore various countries. One of the earliest of such journeys known to us was undertaken in the years 1,493-92 B.C. by sea to the land of *Punt* [probably Ethiopia/Somaliland]. This is described in an inscription in the Temple of Der-el-Bahri where the ship used for this journey is delineated, but there is no map. Herodotus tells of another voyage, under the Pharaoh Necho (ca. 596-94 B.C.) on which the Egyptians

sailed down the Red Sea, completely circumnavigating Africa, and back to Alexandria by way of the *Pillars of Hercules* [Straits of Gibraltar]. Many other pieces of geographical information are to be found in inscriptions on temple walls and in papyri, but without maps.

There can be no doubt, however, that the ancient Egyptians had cadastral drawings. Egypt was undoubtedly a land of accurate measurement. From earliest times much of the area covered by the annual Nile floods had, upon their retreat, to be re-surveyed in order to establish the exact boundaries of properties. The survey was carried out, mostly in squares, by professional surveyors with knotted ropes. However, the measurement of circular and triangular plots was envisaged: advice on this, and plans, are given in the *Rhind Mathematical Papyrus* of ca. 1,600 B.C. The Great Pyramid, on a square ground plan, was built not only with precise orientation to the four compass points but with very little difference in the dimensions of the sides.

In so far as cartography was concerned, perhaps the greatest extent that Egyptian achievement is represented is by the *Turin Papyrus* (#*102*), collected by Bernardino Drovetti before 1824. It is evident that the Egyptians were very familiar with large-scale cartography and that the makers of these plans treated their subject in a neat and formal way typical of dynastic art. Despite the prevalence of re-surveying, no survey maps have survived from dynastic Egypt. From Ptolemaic Egypt there is a rough rectangular plan of surveyed land accompanying the text of the *Lille Papyrus I,* now in Paris; also two from the estate of Apollonius, minister of Ptolemy II. Sophisticated survey techniques were introduced by Alexandrian applied mathematicians, but to what extent they were used in practice we do not know. Although the Egyptians are credited with the invention of geometry, no geographical maps have survived. Also, to date there have been no surviving examples that indicate that the Egyptians attempted a description, depiction or otherwise tried to convey their concept of the entire or known world.



Greek and Roman Cartography

Greek civilization started in the Minoan-Mycenaean Age (2,100-1,100 B.C.) and arguably continued to the fall of the empires of Byzantium and Trebkond in the 15th century A.D. Within this span of some three thousand years, the main achievements in Greek cartography took place from about the sixth century B.C. to the culminating work of Ptolemy in the second century A.D. This seminal area is conveniently divided by Germaine Aujac (in Harley's *History of Cartography,* Volume One) into several periods: the *Archaic and Classical Period* (to the fourth century B.C.), the *Hellenistic Period* (fourth and third centuries B.C.), the *Early Greco-Roman Period* (second century B.C. to the second century A.D.), and the *Age of Ptolemy* (second century A.D.).

It has often been remarked that the Greek contribution to cartography lay in the speculative and theoretical realms rather than in the practical realm, and nowhere is this truer than in the *Archaic and Classical Period*. Large-scale terrestrial mapping, in particular, lacked a firm empirical tradition of survey and first-hand observation. Even at the end of the period, the geographical outlines of the *oikumeme* [inhabited world] were only delineated as a high level sketch. Moreover, for the historian of cartography, this early period poses particular problems as much through the scanty nature of the evidence as through the difficulty of its interpretation. No cartographic artifacts clearly define a beginning to the period. The links, for example, with the earlier Babylonian and Egyptian cartography can be only tentatively established, and the extent to which the early Greeks were influenced by such knowledge remains a matter for conjecture. While there is some circumstantial evidence for both the transmission and the reception of important mathematical concepts relevant to cartography - and even for the descent of the basic design of the world map - direct documentary proof for such connections is lacking.

Unlike modern geographers, who are interested in all parts of the globe, the ancients investigated only inhabited lands. Uninhabited or desert regions were not surveyed or documented, so that they fell outside the framework of the known world. Continents other than Europe, Asia and

Africa were not sought out, and in known lands the extent of knowledge grew only as a result of demographic growth and military conquest. Some attempts were made to explore unknown areas, and natural curiosity inflamed imagination. But, generally speaking, regions at the edge of the known world were considered not only dangerous and frightening but irrelevant, as empty land without human inhabitants. Thus the Greeks after Herodotus, and later the Romans, referred to the world as an *oikoumene* ("inhabited", modifying an implied *ge*), denoting its human aspect as a place of habitation (*oikia*) and excluding uninhabited portions, hypothetical landmasses and the ocean deemed to surround the *oikoumene*.

According to the scholar E.L. Stevenson, it is not easy to fix, with anything like a satisfactory measure of certainty, the beginning of globe construction; very naturally it was not until a spherical theory concerning the heavens and the earth had been accepted, and for this we are led back quite to Aristotle and beyond, back indeed to the Pythagoreans if not yet farther. We find allusions to celestial globes in the days of Eudoxus and Archimedes, to terrestrial globes in the days of Crates (150 B.C., #*113)* and Hipparchus. We find that the Greek geographer Strabo *(#115)* gives us quite a definite word concerning their value and their construction, and that Ptolemy *(#119)* is so definite in his references to them as to lead to a belief that globes were by no means uncommon instruments in his day, and that they were regarded of much value in the study of geography and astronomy, particularly of the latter science. There is, however, but one example known, which has come down to us from that ancient day, this a celestial globe, briefly described as the *Farnese globe*. It is of marble, and is thought by some to date from the time of Eudoxus, that is, three hundred years before the Christian era. The *Farnese Atlas* is a second century Roman marble copy of a Hellenistic sculpture of Atlas kneeling with the celestial spheres weighing heavily on his shoulders. It is the oldest extant statue of the Titan of Greek mythology, who is represented in earlier vase-painting, and more important, the oldest known representation of the celestial sphere. The sculpture is at the National Archaeological Museum (Museo Archeologico Nazionale) in Naples, Italy. It stands seven feet (2.1 meters) tall, and the globe is 65 cm in diameter.

To the Arab countries belongs chief credit for keeping alive an interest in astronomical studies during the so-called Christian middle ages, and we find them interested in globe construction, that is, in celestial globe construction; so far as we have knowledge, it seems doubtful that they undertook the construction of terrestrial globes.

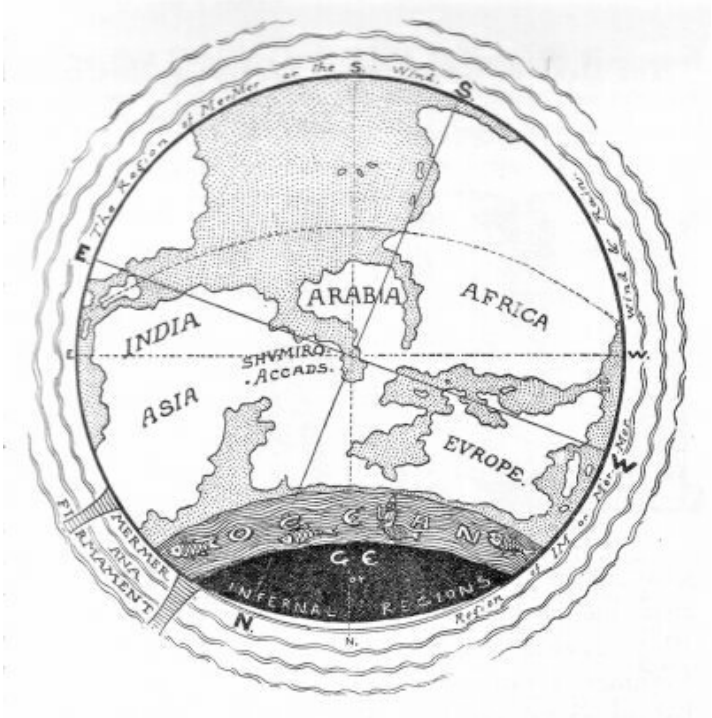
Among the Christian peoples of Europe in this same period there was not wanting an interest in both geography and astronomy. We are now learning that those centuries were not entirely barren of a certain interest in sciences other than theological. In Justinian's day, or near it, one Leontius Mechanicus busied himself in Constantinople with globe construction, and we have left to us his brief descriptive reference to his work. With stress laid, during the many centuries succeeding, upon matters pertaining to the religious life, there naturally was less concern than there had been in the humanistic days of classical antiquity as to whether the earth is spherical in form, or flat like a circular disc, nor was it thought to matter much as to the form of the heavens. Yet there was no century, not even in those ages we happily are learning to call no longer "dark", that geography and astronomy were not studied and taught, and globes celestial as well as armillary spheres, if not terrestrial globes, were constructed. The Venerable Bede, Pope Sylvester I, the Emperor Frederick II, and King Alfonso of Castile, not to name many others of perhaps lesser significance, displayed an interest in globes and making.

Chaldean Conception of the Shape of the Earth. It has now been ascertained and demonstrated beyond doubt that the earliest ideas concerning the laws of the universe and the shape of the earth were, in many respects, more correct and clearer than those of a subsequent period. For instance, Mr. Hyde Clarke has more than once pointed out in *The Legend of the Atlantis of Plato*, Royal Historical Society 1886, etc., that Australia must have been known in the most remote antiquity of the early history of civilization, at a time when the intercourse with America was still maintained. It is certainly

remarkable, as we learn from classic authors, that the school of Pergamos (second century B.C.) taught that the earth was divided into four worlds or regions. These were the *Great World* or *Northern Continent* (Asia, Europe. and Africa), the *Austral* or *Southern World* (Australia), the *Northern World*, opposite from Europe (North America), and the *Southern World*, to balance the Austral World (South America). All these were described as being inhabited.

The author of *Chaldea from the Earliest Times to the Rise of Assyria,* Zenalde A. Ragozin, says the Shumiro-Accads had formed a very elaborate and clever idea of what they supposed the world to be like; they imagined it to have the shape of an inverted round boat or bowl, the thickness of which would represent the mixture of land and water *(ki-a)* which we call the crust of the earth, while the hollow beneath this inhabitable crust was fancied as a bottomless pit or abyss *(ge)*, in which dwelt many powers.

> "Let us imagine then a boat turned over, not such a one as we are in the habit of seeing, but a round skiff like those which are still used, under the name of *Kufa*, on the shores of the lower Tigris and Euphrates, and of which there are many representations in the historical sculptures of the Assyrian palaces, the sides of this round skiff bend upwards from the point of the greatest width, so that they are shaped like a hollow sphere deprived of two-thirds (sic, for one-third, as the context shows) of its height, and showing a circular opening at the point of division. Such was the form of the earth according to the authors of the Accadian magical formulae and the Chaldean astrologers of after years. We should express the same idea in the present day by comparing it to an orange of which the top had been cut off, leaving the orange upright upon the flat surface thus produced."



Above the convex surface of the earth *(ki-a)* spreads the sky *(ana),* itself divided into two regions - the highest heaven or firmament, which, with the fixed stars immovably attached to it, revolved, as round an axis or pivot, around an immensely high mountain, which joined it to the earth as a pillar, and was situated somewhere in the far North-East, some say North, and the lower heaven, where the planets - a sort of resplendent animals, seven in number, of beneficent nature - wandered forever on their appointed path. To these were opposed seven evil demons, sometimes called *The Seven*

Fiery Phantoms. But above all these, higher in rank and greater in power, is the *Spirit (Zi) of heaven (ana), ZI-ANA,* or, as often, simply *ANA--Heaven.* Between the lower heaven and the surface of the earth is the atmospheric region, the realm of *IM* or *MERMER*, the Wind, where he drives the clouds, rouses the storms, and whence he pours down the rain, which is stored in the great reservoir of Ana, in the heavenly ocean. As to the earthly ocean, it is fancied as a broad river, or watery rim, flowing all round the edge of the imaginary inverted bowl; in its waters dwells *EA*, or *The Exalted Fish*, or on a magnificent ship, with which he travels round the earth, guarding and protecting it." Berosus, the priestly historian of Babylon, in reporting the legend concerning the arrival of *EA* from the East, seems to have given the God's name *EA-han* [EA the Fish] under the corrupted Greek form of *Oannes*. See the sketch below of an inverted Chaldean boat transformed into a terrestrial globe, which will give one an idea of the possible appearance of early terrestrial globes.

Now, it is remarkable that the Greeks, adopting the earlier Chaldean ideas concerning the sphericity of the earth, believed also in the circumfluent ocean; but they appear to have removed its position from latitudes encircling the Arctic regions to a latitude in close proximity to the equator.

Notwithstanding this encroachment of the external ocean - encroachment which may have obliterated indications of a certain northern portion of Australia, and which certainly filled those regions with the great earth - surrounding river *Okeanos* - the traditions relating to the existence of an island, of immense extent, beyond the known world, were kept up, for they pervade the writings of many of the authors of antiquity.

In a fragment of the works of Theopompus, preserved by Aelian, is the account of a conversation between Silenus and Midas, King of Phrygia, in which the former says that Europe, Asia, and Africa were lands surrounded by the sea; but that beyond this known world was another island, of immense extent, of which he gives a description. The account of this conversation, which is too lengthy here to give in full, was written three centuries and a half before the Christian era. Not to trouble the reader with Greek, an extract from the English version by Abraham Fleming, printed in 1576, in the amusingly quaint but vivid language of the time:

> "The Thirde Booke of Aelianus. Of the familiaritie of Midas, the Phrigian, and Selenus, and of certaine circumstances which he incredibly reported. Theopompus declareth that Midas, the Phrygian, and Selenus were knit in familiaritie and acquaintance. This Selenus was the sonne of a nymphe inferiour to the gods in condition and degree, but superiour to men concerning mortalytie and death. These twaine mingled communication of sundrye thynges. At length, in processe of talke, Selenus tolde Midas of certaine ilandes, named Europia, Asia, and Libia, which the ocean sea circumscribeth and compasseth round about; and that without this worlde there is a continent or percell of dry lande, which in greatnesse (as hee reported) was infinite and unmeasurable; that it nourished and maintained, by the benefite of the greene medowes and pasture plots, sundrye bigge and mighty beastes; that the men which inhabite the same climats exceede the stature of us twise, and yet the length of their life is not equall to ours; that there be many and divers great citties, manyfold orders and trades of living; that their lawes, statutes, and ordinaunces are different, or rather clean contrary to ours. Such and lyke thinges dyd he rehearce." Major adds: "The remainder of this curious conversation, however apparently fabulous, deserves attention from the thoughtful reader."

The side of the boat curves inwards, so that when reversed the figure of it would be like an orange with a slice taken off the top, and then set on its flat side. The Chaldean conception, thus rudely described, shows a yet nearer approximation to the true doctrine concerning the form of the globe, when we bear in mind that this actually is in shape a flattened sphere, with the vertical diameter the shorter one.

Comparing these early notions, as to the shape and extent of the *habitable* world, with the later ideas which limited the habitable portion of the globe to the equatorial regions, we may surmise how it came to pass that islands--to say nothing of continents which could not be represented for want of

space - belonging to the southern hemisphere were set down as belonging to the northern hemisphere. A curious example of the difficulties that early cartographers of the circumfluent ocean period had to contend with, and of the *sans façon* method of dealing with them, occurs in the celebrated *Fra Mauro mappamundi (Book III, #249),* which is one of the last in which the external ocean is still retained. On this map of the world the islands of the Malay Archipelago follow the shores of Asia from Malacca to Japan. Borneo, Scelebes and the Philippines are left out, and the cartographer, conscious of his omissions, excuses himself naively in these terms: "*In questo Mar Oriental sono molte isole grande e famose che non ho posto per non aver luogo* [In this Oriental sea there are great many large and well-known islands, that I have not set down, because I had no room]."

We have no positive proof of this having been done at a very early period, as the earlier globes and maps have all disappeared; but we may safely conjecture as much, judging from copies that have been handed down. Globes especially - as being more explicit, because not presenting the difficulties of planispheric projection - would have been useful, for they would have shown us exactly what early geographical knowledge must have been in this respect; unfortunately, whereas the earliest recorded mention of an earth globe is of the one made by Crates (200 B.C. – #*113*), ten feet in diameter and described by Strabo, *Geographica*; Book ii. chap. v. paragraph 10 - the earliest one extant dates no further back than the year 1492. This is the well-known globe of Martin Behaim of Nuremberg *(Book III, #258)*.

Early maps of the world, as distinguished from globes, take us back to a somewhat more remote period; they all bear most of the disproportions of the Ptolemaic geography, for none belonging to the pre-Ptolemaic period are known to exist. The influence of the Ptolemaic astronomical and geographical system was very great, and lasted for over thirteen hundred years. Even the Arabs, who, after the fall of the Roman Empire, developed the geographical knowledge of the world during the first period of the middle ages, adopted it along with many of its errors.

We have seen that, according to the earliest geographical notions, the habitable world was represented as having the shape of an inverted round boat, with a broad river or ocean flowing all round its rim, beyond which opened out the Abyss or bottomless pit, which was beneath the habitable crust.

The description is sufficiently clear, and there is no mistaking its general sense, the only point that needs elucidation being that which refers to the position of the earth or globe as viewed by the spectator.

Our modern notions and our way of looking at a terrestrial globe or map with the north at the top, would lead us to conclude that the abyss or bottomless pit of the inverted Chaldean boat, the *Hades* and *Tartaros* of the Greek conception, should be situated to the south, somewhere in the Antarctic regions. There are reasons to believe however, apart from the evidence we gather in the Poems, that these abyssal regions were supposed or believed to be situated around the North Pole.

The internal evidence of the Poems points to a northern as well as a southern location for the entrance to the infernal regions. Homer, *The Outward Geography Eastwards*: "The outer geography eastwards, or wonderland, has for its exterior boundary the great river *Okeanos*, a noble conception, in everlasting flux and reflux, roundabout the territory given to living man. On its farther bank lies the entrance to the *Underworld*; and the passage, which connects the sea (Thalassa, or Pontos) with *Okeanos*, lies in the east: 'where are the abodes of the morning goddess, and the risings of the sun' (Od. 12:3). Here however he makes his hero confess that he is wholly out of his bearings, and cannot well say where the sun is to set or to rise (Od. 10:139). This bewildered state of mind may be reasonably explained. The whole northern region, of sea as he supposed it, from west to east, was known to him only by Phoenician reports. One of these told him of a *Kimmerian* land deprived perpetually of sun or daylight. Another of a land, also in the north, where a man, who could dispense with sleep, might earn double wages, as there was hardly any night. He probably had the first account from some sailor who had visited the northern latitudes in summer; and the second from one who had done the like in winter. They were at once true, and for him irreconcilable. So he assigned the one tale to a northern country *(Kimmerie)* on the ocean-mouth eastwards, near the island of *Kirke*, and the other to the land of the *Laistrugonas w*estwards but also northern, and lying at some days' distance from *Aiolie;* but was

compelled, by the ostensible contradiction, to throw his latitudes into something like purposed confusion."

Another probable source of information: The *Phoinikes* of Homer are the same Phoenicians who as pilots of King Solomon's fleets brought gold and silver, ivory, apes and peacocks from Asia beyond the Ganges and the East Indian islands. The Phoenician reports referred to came most likely therefore, not so much from the north, as from these regions which, tradition tells us (*Fra Mauro's mappamundi #249*), were situated *propinqua ale tenebre*. Volcanoes were supposed to be the entrances to the infernal regions, and towards the southeast the whole region beyond the river *Okeanos* of Homer, from Java to Sumbawa and the Sea of Banda, was sufficiently studded with mighty peaks to warrant the idea they may have originated. Then in a northeasterly direction Homer's great river *Okeanos* would flow along the shores of the Sandwich group, where the volcanic peak of Mt. Kilauea towers three miles above the ocean. Indeed, wherever we look round the margin of the circumfluent ocean for an appropriate entrance to *Hades* and *Tartaros*, we find it, whether in Japan, Iceland, the Azores, or Cape Verde Islands.

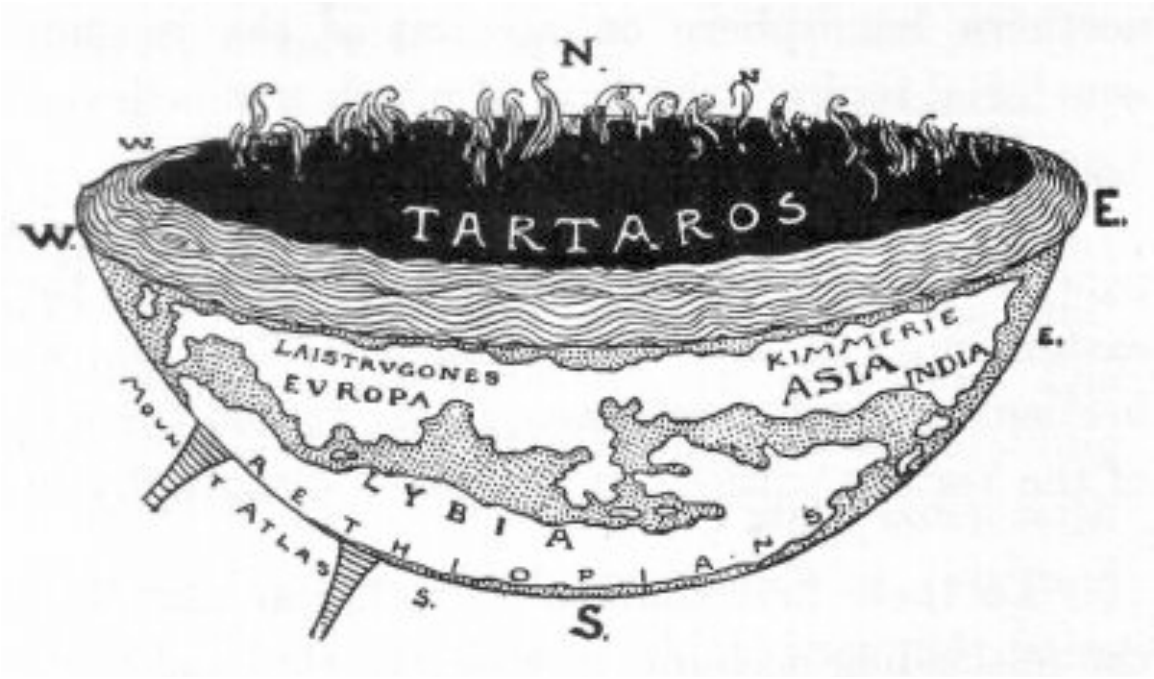
European mariners and geographers of the Homeric period considered the bearing of land and sea only in connection with the rising and setting of the sun and with the four winds *Boreas, Euros, Notos*, and *Sephuros*. These winds covered the arcs intervening between our four cardinal points of the compass, which points were not located exactly as with us; but the north leaning to the east, the east to the south, the south to the west and the west to the north (see Beatus' *Turin* map, *Book II, #207*).

These mariners and geographers adopted the plan - an arbitrary one - of considering the earth as having the north above and the south below, and, after globes or maps had been constructed with the north at the top, and this method had been handed down to us, we took for granted that it had obtained universally and in all times.

Such has not been the case, for the earliest navigators, the Phoenicians, the Arabs, the Chinese, and perhaps all Asiatic nations, considered the south to be above and the north below. The reason for this is plausible, for whereas the northern seaman regulated his navigation by the North Star, the Asiatic sailor turned to southern constellations for his guidance. Many cartographers of the renascence, whose charts indeed we cannot read unless we reverse them, must have followed Asiatic cartographical methods, and this perhaps through copying local charts obtained in the countries visited by them.

It is strange that some historians, in pointing out so cleverly that the Chaldean conception was more in accordance with the true doctrine concerning the form of the globe than had been suspected, fails, at the same time, to notice that Homer in his brain-map reversed the Chaldean terrestrial globe and placed the north at the top. This is all the more strange when we take into consideration that, in the light of his context, the fact is apparent and of great importance as coinciding with other European views concerning the location of the north on terrestrial globes and maps.

> "The surface of the vessel represented is the world which we inhabit. The mouth lies downward. In the hollow of the solid dwell the Earth-genii of *Tartaros* and the Spirits of the dead. Over it extends the compacted mass of Heaven, with its astral bodies. All this seems to have been adopted by Homer. But, moreover, the Chaldean Heaven rested upon columns, about which it revolved; these columns were not at the zenith of the heaven, which was immediately over Accad, but at the Mountain of the East [Northeast or North]. And even so Homer sets his heaven upon columns, but places them with his Atlas in the south."



Greek Conception of the Shape of the Earth

The Chaldeans placed their north below; Homer placed his north above as shown here. The Chaldeans placed their heaven in the east or northeast; Homer placed his heaven in the south or southwest.

During the middle ages, we shall see a reversion take place, and the terrestrial paradise and heavenly paradise placed according to the earlier Chaldean notions; and on maps of this epoch, encircling the known world from the North Pole to the equator, flows the antic Ocean, which in days of yore encircled the infernal regions. In this ocean we find also *EA* the *Exalted Fish*, but, deprived of his ancient grandeur and divinity, he is no doubt considered nothing more than a merman at the period when acquaintance is renewed with him on the Schöner-Frankfort gores of Asiatic origin bearing the date 1515 *(Book IV, #328)*.

At a later period, during which planispheric maps, showing one hemisphere of the world, may have been constructed, the circumfluent ocean must have encircled the world as represented by the geographical exponents of the time being; albeit in a totally different way than expressed in the Shumiro-Accadian records. The divergence was probably owing in a great measure to the inability of representing graphically the perspective appearance of the globe on a plane; but may be also traceable to an erroneous interpretation of the original idea, caused by the reversion of the cardinal points of the compass.

Afterwards came the geographical period, 500 B.C., when Thales drew the equator across the globe; but the original design of this line of demarcation became confused also, and so misapplied that it was made to follow the southern rim of the ocean that girded the world. This extraordinary manner of distorting the equatorial regions was repeated in mediaeval charts, and one of its last representations is nowhere more remarkable than in Fra Mauro's celebrated *mappamundi* of 1459 *(Book III, #249)*.

The zone or climate division of the world was propounded about the same time. According to this division other continents south of the equator were supposed to exist and be inhabited, some said, but not to be approached by those inhabiting the northern hemisphere on account of the presumed impossibility of traversing the equatorial regions, the heat of which was believed to be too intense.

It follows from all this that, as mariners did actually traverse those regions and penetrate south of the equator, the islands they visited most, such as Java, its eastern prolongation of islands,

Sumbawa, etc., were believed to be in the northern hemisphere, and were consequently placed there by geographers, as the earliest maps of the various editions of Ptolemy's *Geography* bear witness.

To these first sources of confusion may be added another that originated with the misleading accounts in which Sri Lanka/Ceylon and Sumatra were indiscriminately described under the Greek name of *Taprobana*, and this confusion of one island with the other led to various forms of distortion; sometimes Sri Lanka/Ceylon was placed in the longitude and latitude of Sumatra; at other times Sumatra was placed where Sri Lanka/Ceylon stands; but, as Sumatra was known by some to be cut in two by the equator, Sri Lanka/Ceylon had to be enlarged so as to extend sufficiently south to allow for it being bisected by the equator as mentioned. Then again islands lying south of the equator came to be taken for Sri Lanka/Ceylon-*Ceram*, for instance. *Taprobana* was the Greek corruption of the *Tamravarna* of Arabian, or even perhaps Phoenician, nomenclature; our modern Sumatra.

These mistakes were the result doubtless of an erroneous interpretation of information received; and the most likely period during which cognizance of these islands was obtained was when Alexandria was the center of the Eastern and Western commerce of the world. About this time Eratosthenes *(#112)* was the chief or great Librarian at Alexandria (230 to 220 B.C.). Geographical science was on the eve of reaching its apogee with the Greeks, were it was doomed to retrograde with the decline of the Roman Empire. The views of the three great Greek astronomers and cartographers, Dicearchus, Eratosthenes and Hipparchus (300 to 125 B.C.), comprising the origin of degrees of longitude and latitude, the inauguration of the principle of stereographic projection and the division of the circle into 360 degrees, give us an idea of the progress made at the time. Although these views were continued and developed to a certain extent by their successors, Strabo and Ptolemy, through the Roman period, and more or less entertained during the Middle Ages, they became obscured as time rolled on.

But to return to the earlier pre-Ptolemaic period and to form an idea of the chances of information which the traffic carried on in the Indian Ocean may have offered to the Greeks and Romans, here is what Antonio Galvano, Governor of Ternate says in 1555, quoting Strabo and Pliny (Strabo, lib. 17; Plinius, lib. 12, cap. 18). The quaint phraseology of his translator runs thus:

> "For the trafficke grew so exceeding great that they sent every yeere into India a hundred and twenty ships laden with wares, which began to set saile from Myos-Hormos about the middle of July, and returned backe againe within one yeere. The marchandise which they did carrie amounted unto one million two hundred thousand crownes; and there was made in returne of every crown an hundred. In so much that, by reason of this increase of wealth the matrones, or noblewomen, of that time and place (Rome) spent infinitely in decking themselves with precious stones, purple, pearles, gum benzoin, frankincense, musk, amber, sandalwood, aloes, and other perfumes, and trinkets, and the like; whereof the writers and historians of that age speake very greatly."

Now as the above articles of commerce, mentioned by Strabo and Pliny, after leaving their original ports in Asia and Austral-Asia, were conveyed from one island to another, any information, when sought for, concerning the location of the islands from which the spices came, must necessarily have been of a very unreliable character, for the different islands at which any stay was made were invariably confounded with those from which the spices originally came. We shall see, when dealing with Ptolemy's map of the world, some of the results of this confusion.

According to the *Lives of the Saints*, St. Thomas, after the dispersion of the Apostles, preached the Gospel to the Parthians and Persians; then went to India, where he gave up his life for Jesus Christ. John III, King of Portugal, ordered his remains to be sought for in a little ruined chapel that was over his tomb, outside *Meliapur* or *Maliapor*. In 1523 a vault was discovered shaped like a chapel. The bones of the holy apostle were found, with some relics that were placed in a rich vase. The Portuguese built near this place a new town that they called St. Thomas or *San-Thome*.

In Strabo's *Geographica* there are these four points of importance:

> 1. That he corroborates Homer's views as to the sphericity of the earth by describing Crates' terrestrial globe (*Geographica*; Book ii. cap. v. section 10).
>
> 2. That he accentuates Homer's views concerning the black races that lived some in the west (the African race) others in the east (the Australian race).
>
> 3. That he shows the four cardinal points of the compass to have been situated somewhat differently than with us, for he says (Book 1, c. iv. section 6): "...So that if the extent of the Atlantic Ocean were not an obstacle, we might easily pass from Iberia to India, still keeping in the same parallel, etc." This is the idea that Columbus endeavored to put into practice; but had he followed the parallel mentioned, instead of reaching the islands now called the West Indies, he would have reached the latitude where New York now stands. Again, if we consider the Atlantic and North Pacific Oceans as devoid of the American Continent, and the Atlantic Ocean as stretching to the shores of Asia, as Strabo did, the parallel of Iberia (Spain) would have taken Columbus' ships to the north of Japan--i.e. much further north than the India of Strabo.
>
> 4. That he appears to be perpetuating an ancient tradition when he supposes the existence of a vast continent or antichthonos in the southern hemisphere to counterbalance the weight of the northern continents.

From these facts, and many others, such as the positions given to the *Mountain of the East* or North-East of the Shumiro-Accads, the *Mountain of the South*, or Southwest, of Homer, and the *Infernal Regions*, we may conclude that the North Pole of the Ancients was situated somewhere in the neighborhood of the Sea of Okhotsk. The relativeness of these positions appears to have been maintained on some mediaeval maps. See the Beatus *Turin (Book II, #207)* and Fra Mauro's maps *(Book III, #249)*.

It is in the *Classical Period* of Greek cartography that we can start to trace a continuous tradition of theoretical concepts about the size and shape of the earth. To appreciate how this period laid the foundations for the developments of the ensuing *Hellenistic Period*, it is necessary to draw on a wide range of Greek writings containing references to maps. In some cases the authors of these texts are not normally thought of in the context of geographic or cartographic science, but nevertheless they reflect a widespread and often critical interest in such questions. Aristotle's writings, for example, provide a summary of the theoretical knowledge that underlay the construction of world maps by the end of the Greek *Classical Period.* At the time when Alexander the Great set off to conquer and explore Asia and when Pytheas of Massalia was exploring northern Europe, therefore, the sum of geographic and cartographic knowledge in the Greek world was already considerable and was demonstrated in a variety of graphic and three-dimensional representations of the heavens and the earth. Terrestrial maps and celestial globes were widely used as instruments of teaching and research. It has been shown how these could have appealed to the imagination not only of an educated minority, for whom they sometimes became the subject of careful scholarly commentary, but also of a wider Greek public that was already learning to think about the world in a physical and social sense through the medium of maps. If a literal interpretation was followed, the cartographic image of the inhabited world, like that of the universe as a whole, was often misleading; it could create confusion or it could help establish and perpetuate false ideas. The celestial globe had reinforced the belief in a spherical and finite universe such as Aristotle had described; the drawing of a circular horizon, however, from a point of observation, might have perpetuated the idea that the inhabited world was circular, as might also the drawing of a sphere on a flat surface. There was, however, evidently no consensus between cartographic theorists, and there seems in particular to have been a gap between the acceptance of the most advanced scientific theories and their translation into map form. In spite of the assertions of Democritus, Ludoxus, and Aristotle, maps of the inhabited world remained circular, with their outer limits very vague. Knowledge even of the Mediterranean was incompletely established. Although just

before the invasion of Sicily (415 B.C.) average Athenians may have been able to sketch the outline of the island and indicate Libya and Carthage in relation to it, they generally knew little about its size. It can be said, with hindsight, that by the end of the Classical Greek era the need to find a means of drawing maps to scale, and of making a systematic study of the inhabited world, was urgent.

Likewise, it should be emphasized that the vast majority of our knowledge about Greek cartography in this early period is known primarily only from second- or third-hand textual accounts. We have no original texts of Anaximander, Pythagoras, or Eratosthenes - all pillars of the development of Greek cartographic thought. In particular, there are relatively few surviving artifacts in the form of graphic representations that may be considered maps. Our cartographic knowledge must, therefore, be gleaned largely from literary descriptions, often couched in poetic language and difficult to interpret. In addition, many other ancient texts alluding to maps are further distorted by being written centuries after the period they record; they too must be viewed with caution because they are similarly interpretative as well as descriptive. Despite what may appear to be reasonable continuity of some aspects of cartographic thought and practice, in this particular era scholars must extrapolate over large gaps to arrive at their conclusions. In the monographs of specific Greek maps that follow, therefore, a largely empirical approach is adopted, so that the maximum amount of information about the maps, collected under the names of individual authors/cartographers, can be extracted in chronological order from what are often the fragments of lost works.

The monographs included within this book that describe maps/mapmakers from the *Archaic and Classical Period* include the following:

- #105, Homer's World View (900 B.C.)
- #106, Earth Views from Thales, Anaximander, and Hecatæus
- #106A, The Frame of Greek World Maps
- #107, Anaximenes of Miletus (600 B.C.)
- #108, Hecatæus' World Map (500 B.C.)

There is no complete break between the development of cartography in *Classical* and in *Hellenistic* Greece. In contrast to many periods in the ancient and medieval world and despite the fragmentary artifacts, we are able to reconstruct throughout the Greek period, and indeed into the Roman, a continuum in cartographic thought and practice. Certainly the achievements of the third century B.C. in Alexandria had been prepared for and made possible by the scientific progress of the fourth century. Eudoxus had already formulated the geocentric hypothesis in mathematical models; and he had also translated his concepts into celestial globes that may be regarded as anticipating the *sphairopoiia* [mechanical spheres]. By the beginning of the Hellenistic Period there had been developed not only the various celestial globes, but also systems of concentric spheres, together with maps of the inhabited world that fostered a scientific curiosity about fundamental cartographic questions. The relative smallness of the inhabited world, for example, later to be proved by Eratosthenes, had already been dimly envisaged. It had been the subject of comment by Plato, while Aristotle had quoted a figure for the circumference of the earth from "the mathematicians" at 400,000 *stades*; he does not explain how he arrived at this figure, which may have been Eudoxus' estimate. Aristotle also believed that only the ocean prevented a passage around the world westward from the Straits of Gibraltar to India.

In spite of these speculations, however, Greek cartography might have remained largely the province of philosophy had it not been for a vigorous and parallel growth of empirical knowledge. Indeed, one of the salient trends in the history of the *Hellenistic Period* of cartography was the growing tendency to relate theories and mathematical models to newly acquired facts about the world - especially those gathered in the course of Greek exploration or embodied in direct observations such as those recorded by Eratosthenes in his scientific measurement of the circumference of the earth. Despite a continuing lack of surviving maps and original texts throughout the period - which continues to limit our understanding of the changing form and content of cartography - it can be shown that, by the period's end, a markedly different cartographic image of the inhabited world had emerged.

That such a change should occur is due both to political and military factors and to cultural developments within Greek society as a whole. With respect to the latter, we can see how Greek

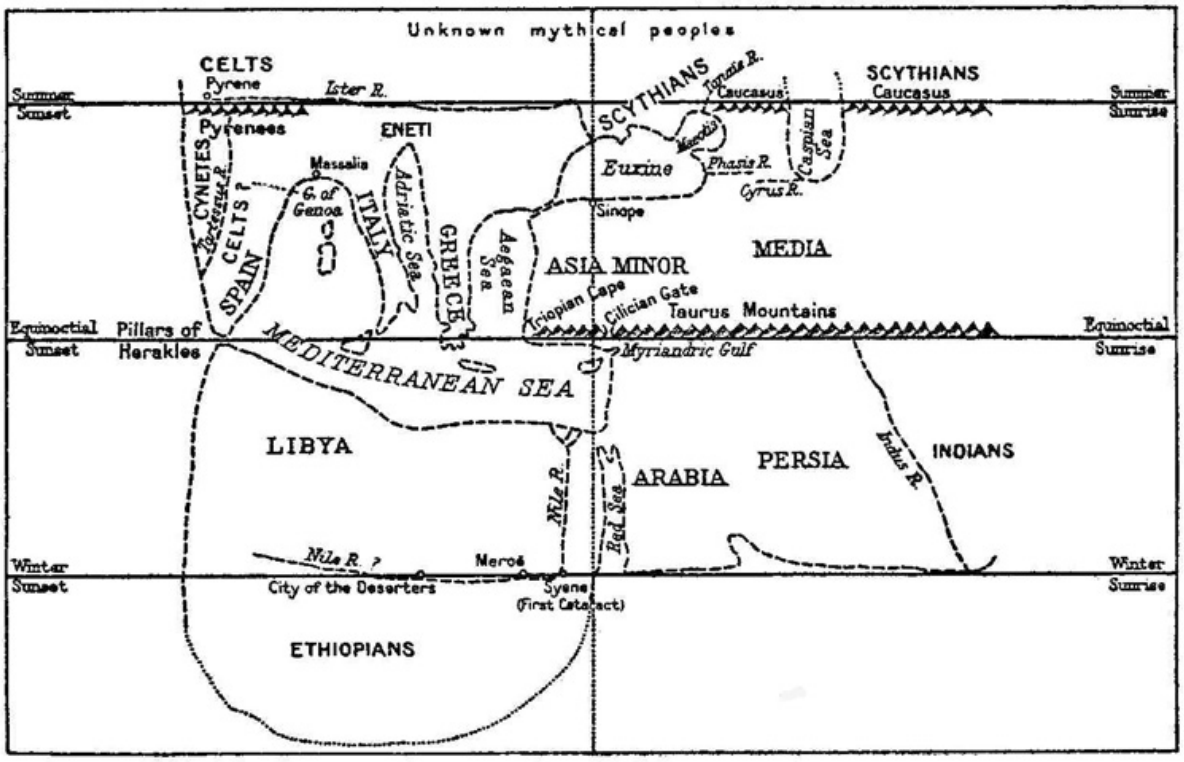
cartography started to be influenced by a new infrastructure for learning that had a profound effect on the growth of formalized knowledge in general. Of particular importance for the history of the map was the growth of Alexandria as a major center of learning, far surpassing in this respect the Macedonian court at Pella. It was at Alexandria that Euclid's famous school of geometry flourished in the reign of Ptolemy II Philadelphus (285-246 B.C.). And it was at Alexandria that this Ptolemy, son of Ptolemy I Soter, a companion of Alexander, had founded the library, soon to become famous through the Mediterranean world. The library not only accumulated the greatest collection of books available anywhere in the *Hellenistic Period* but, together with the museum, likewise founded by Ptolemy II, also constituted a meeting place for the scholars of three continents.

The librarians not only brought together existing texts, they corrected them for publication, listed them in descriptive catalogs, and tried to keep them up to date. Thus Alexandria became a clearing-house for cartographic and geographical knowledge; it was a center where this could be codified and evaluated and where, we may assume, new maps as well as texts could be produced in parallel with the growth of empirical knowledge.

The other great factor underlying the increasing realism of maps of the inhabited world in the *Hellenistic Period* was the expansion of the Greek world through conquest and discovery, with a consequent acquisition of new geographical knowledge. In this process of strengthening the empirical content of maps the conquests of Alexander the Great, King of Macedon (356-323 B.C.), were especially crucial in providing the Greek cartographers/ geographers with a far more detailed knowledge of the East than previously had been possible. Later geographers used the accounts of Alexander's journeys extensively to make maps of Asia and to fill in the outline of the inhabited world. The ambition of Eratosthenes to draw a general map of the *oikumene* based on new discoveries was also partly inspired by Alexander's exploration.

Among the contemporaries of Alexander was Pytheas, a navigator and astronomer from *Massalia* [Marseilles], who as a private citizen embarked upon an exploration of the oceanic coasts of Western Europe. In his treatise *On the Ocean*, Pytheas relates his journey and provides geographical and astronomical information about the countries that he observed. It is difficult to reconstruct from the fragmentary evidence exactly where Pytheas traveled. It seems, though, that having left *Massalia*, Pytheas put into *Gades* [Cadiz], then followed the coasts of *Iberia* [Spain] and France to Brittany, crossing to Cornwall and sailing north along the west coast of England and Scotland to the Orkney Islands. From there, some authors believe, he made an Arctic voyage to *Thule* [probably Iceland] after which he penetrated the Baltic. The confirmation of the sources of tin (in the ancient *Cassiterides or Tin Islands*) and amber (in the Baltic) was of primary interest to him, together with new trade routes for these commodities. It would appear from what is known about Pytheas' journeys and interests that he may have undertaken his voyage to the northern seas partly in order to verify what geometry (or experiments with three dimensional models) had taught him. The result was that his observations served not merely to extend geographical knowledge about the places he had visited, but also to lay the foundation for the scientific use of parallels of latitude in the compilation of maps.

As exemplified by the journeys of Alexander and Pytheas, the combination of theoretical knowledge with direct observation and the fruits of extensive travel gradually provided new data for the compilation of world maps. While we can assume *a priori* that such a linkage was crucial to the development of Hellenistic cartography, again there is no hard evidence, as in so many other aspects of its history, that allows us to reconstruct the technical processes and physical qualities of the maps themselves. Not even the improved maps that resulted from these processes have survived, and the literary references to their existence (enabling a partial reconstruction of their content) can even in their entirety refer only to a tiny fraction of the number of maps once made and once in circulation. In this case too, the generalizations drawn herein by various authorities (ancient and modern scholars, historians, geographers, and cartographers) are founded upon the chance survival of references made to maps by individual authors.



A reconstruction by Heidel of the conceptual frame of the Greeks' view of the oikumene [inhabited world]. His sketch map illustrates the probable Greek concept of the general relationships of the oikumene to the frame at the time of Eratosthenes, and embodying the Persian map at the time of Darius. This is not strictly a reconstruction, since no definite information is available with regards either to the manner in which details of the coastlines appeared on the Greek maps, or to the relative distances separating the various features indicated.

Issues of scale and perspective further obstruct us. Greek mapmakers were prone to exaggerate the size and importance of their own surroundings for more remote regions, the scale grew smaller and the details fewer. Strabo even claims that the need to know about distant places is minimal: "For purposes of government there would be no advantage in knowing such countries and their inhabitants, particularly if the people live in islands which are such that they can neither injure nor benefit us in any way because of their isolation". Moreover, there was no absolute Greek unit of length for measuring distance. To be sure, one *stadion* was reckoned as 600 Greek feet, but a standard "foot" was lacking at Olympia one *stadion* was 192.8 m, the length of the stadium there, while the Athenian *stadion* measured 185 m. and the Egyptian only 157.5 m. In addition, before the time of Alexander the Great (356-323) there were no coordinated efforts to map the Mediterranean world.

Greeks realized that maps and geographic knowledge have political value. Alexander engaged *bematists*, men whose sole job was to measure distances between places. Strabo asserts that maps are useful to governors, who can better manage affairs if they know the size of a country, the lay of the land, the peculiarities of sky and soil, and the local peoples and their customs. In his view, maps also benefit hunters for understanding the character and extent of a terrain, and commanders for pitching camp, setting ambushes, and marching in unfamiliar territory. Even so, Greek interest in mapmaking and in describing the topography and the location of settlements predates the first formal illustrative maps. Indeed, such interest goes all the way back to Homer, whom Strabo called the "father of geography."

The importance of the *Hellenistic Period* in the history of ancient world cartography, however, has been clearly established. Its outstanding characteristic was the fruitful marriage of theoretical and empirical knowledge. It has been demonstrated beyond doubt that the geometric study of the sphere, as expressed in theorems and physical models, had important practical applications and that its principles underlay the development both of mathematical geography and of scientific cartography as applied to celestial and terrestrial phenomena.

In the history of geographical (or terrestrial) mapping, the great practical step forward during this period was to locate the inhabited world exactly on the terrestrial globe. Eratosthenes was apparently the first to accomplish this, and his map was the earliest scientific attempt to give the different parts of the world represented on a plane surface approximately their true proportions. On his map, moreover, one could have distinguished the geometric shapes of the countries, and one could have used the map as a tool to estimate the distances between places.

Thus it was at various scales of mapping, from the purely local to the representation of the cosmos, that the Greeks of the *Hellenistic Period* enhanced and then disseminated a knowledge of maps. By so improving the mimesis or imitation of the world, founded on sound theoretical premises, they made other intellectual advances possible and helped to extend the Greek vision far beyond the Aegean. To Rome, Hellenistic Greece left a seminal cartographic heritage - one that, in the first instance at least, was barely challenged in the intellectual centers of Roman society.

The monographs describing the maps/mapmakers from the *Hellenistic Period* include:

- #109, Herodotus' World Map (450 B.C.)
- #110, Ephorus' Parallelogram (350 B.C.)
- #111, Dicæarchus of Messana 's World Map, (300 B.C.)
- #112, Eratosthenes' World Map (240 B.C.)

The Roman Republic offers a good case for continuing to treat the Greek contribution to mapping as a separate strand in the history of classical cartography. While there was a considerable blending and interdependence of Greek and Roman concepts and skills, the fundamental distinction between the often theoretical nature of the Greek contribution and the increasingly practical uses for maps devised by the Romans forms a familiar but satisfactory division for their respective cartographic influences. Certainly the political expansion of Rome, whose domination was rapidly extending over the Mediterranean, did not lead to an eclipse of Greek influence. It is true that after the death of Ptolemy III Euergetes in 221 B.C. a decline in the cultural supremacy of Alexandria set in. Intellectual life moved to more energetic centers such as Pergamum, Rhodes, and above all Rome, but this promoted the diffusion and development of Greek knowledge about maps rather than its extinction. Indeed, we can see how the conditions of Roman expansion positively favored the growth and applications of cartography in both a theoretical and a practical sense. Not only had the known world been extended considerably through the Roman conquests - so that new empirical knowledge had to be adjusted to existing theories and maps - but Roman society offered a new educational market for the cartographic knowledge codified by the Greeks. Many influential Romans both in the Republic and in the early Empire, from emperors downward, were enthusiastic Philhellenes and were patrons of Greek philosophers and scholars. Throughout the second and first centuries B.C. and beyond, it was thus men of Greek birth and education - such as Polybius, Crates of Mallos, Hipparchus, and Strabo - who continued to make fundamental contributions to the development of scientific mapping and who provided a continuous link with these activities in the Hellenistic world and their culmination in the later syntheses of Claudius Ptolemy.

The extent to which a new generation of scholars in the second century B.C. was familiar with the texts, maps, and globes of the *Hellenistic Period* is a clear pointer to an uninterrupted continuity of cartographic knowledge. Such knowledge, relating to both terrestrial and celestial mapping, had been transmitted through a succession of well-defined master-pupil relationships, and the preservation of texts and three-dimensional models had been aided by the growth of libraries. Yet this evidence should not be interpreted to suggest that the Greek contribution to cartography in the early Roman world was merely a passive recital of the substance of earlier advances. On the contrary, a principal characteristic

of the new age was the extent to which it was openly critical of earlier attempts at mapping. The main texts, whether surviving or whether lost and known only through later writers, were strongly revisionist in their line of argument, so that the historian of cartography has to isolate the substantial challenge to earlier theories and frequently their reformulation of new maps. The monographs describing the maps/mapmakers from the *Early Greco-Roman Period* include:

- #113, Crates' Globe (180 B.C.)
- #114, Posidonius' World Map (150 B.C.)
- #115, Strabo's World Map (A.D. 18)
- #116, Pomponius Mela's World Map (A.D. 37)

The *Age of Ptolemy Period* begins with a short description of Roman cartographic efforts. The profound difference between the Roman and the Greek mind is illustrated with peculiar clarity in their maps. The Romans were indifferent to mathematical geography, with its system of latitudes and longitudes, its astronomical measurements, and its problem of projections. What they wanted was a practical map to be used for military and administrative purposes. Disregarding the elaborate projections of the Greeks, they reverted to the old disk map of the Ionian geographers as being better adapted to their purposes. Within this round frame the Roman cartographers placed the *Orbis Terrarum*, the Circuit of the World.

There are only scanty records of Roman maps of the Republic. The earliest, the Sardinia map of 174 B.C. clearly had a strong pictorial element. But there is some evidence that, as we should expect from a land-based and, at that time, well advanced agricultural people, subsequent mapping development before Julius Caesar was dominated by land survey; the earliest recorded Roman survey map is as early as 167-164 B.C. If land survey did play such an important part, then these plans, being based on centuriation requirements and therefore square or rectangular, may have influenced the shape of smaller-scale maps. This shape was also one that suited the Roman habit of placing a large map on a wall of a temple or colonnade. Varro (116-27 B.C.) in his *De re rustica*, published in 37 B.C., introduces the speakers meeting at the temple of Mother Earth (Tellus) as they look at *Italiam pictam* [Italy painted]. The context shows that he must be talking about a map, since he makes the philosopher among his group start with Eratosthenes' division of the world into North and South. This leads him on to the advantages of the northern half from the point of view of agriculture. The speakers compare Italy with Asia Minor, a country on similar latitudes where Greeks had experience of farming. After this they discuss in more detail the regions of Italy. As a visual aid to this discussion, a temple map could be envisaged as particularly helpful. But whether it was only intended to be imagined by readers or was actually illustrated in the book is not clear. The same applies to possible cartographic illustration of Varro's *Antiquitates rerum humanarum et divinarum*, of which Books VII-XIII dealt with Italy. But at least we know that he was keen on illustration, since his *Hebdomades vel de imaginibus*, a biographical work in fifteen books, was illustrated with as many as seven hundred portraits. Since we are told that this work was widely circulated, some scholars have wondered whether Varro used some mechanical means of duplicating his miniatures; but educated slaves were plentiful, and we should almost certainly have heard about any such device if it had existed.

By the time of Marinus of Tyre (fl. A.D. 100) and Claudius Ptolemy (ca. A.D. 90-168), Greek and Roman influences in cartography had been fused to a considerable extent into one tradition. There is a case, accordingly, for treating them as a history of one already unified stream of thought and practice. Here, however, though such a unity existed, the discussion is focused primarily on the cartographic contributions of Ptolemy, writing in Greek within the institutions of Roman society. Ptolemy owed much to Roman sources of information and to the extension of geographical knowledge under this growing empire: yet he represents a culmination as well as a final synthesis of the scientific tradition in Greek cartography that has been highlighted in this introduction.

The remarkable influence of Ptolemy on the development of European, Arabic, and ultimately world cartography can hardly be denied. Through both the *Mathematical Syntaxis* (a treatise on mathematics and astronomy in thirteen books, also called the *Almagest* and the *Geography* (in eight books), it can be said that Ptolemy tended to dominate both astronomy and geography, and hence their

cartographic manifestations, for over fourteen centuries. It is true that during the period from the second century A.D. to the early 15th century Ptolemy's geographical writings exerted relatively little influence on Western cartography, though they were known to Arab astronomers and geographers. The *Almagest*, although translated into Latin by Gerard of Cremona in the 12th century, appears to have had little direct influence on the development of cartography. With translation of the text of the *Geography* into Latin in the early 15th century, however, the influence of Ptolemy was to structure European cartography directly for over a century. In the history of the transmission of cartographic ideas it is indeed his work, straddling the European Middle Ages, that provides the strongest link in the chain between the knowledge of mapping in the ancient and early modem worlds.

Notwithstanding his immense importance in the study of the history of cartography, Ptolemy remains in many respects a complicated figure to assess. Many questions about his work remain unanswered. Little is known about Ptolemy the man, and neither his birthplace nor his dates have been positively established. Moreover, in relation to the cartographic component in his writings, we must remember that no manuscript earlier than the 12th century A.D. has come down to us, and there is no adequate modern translation and critical edition of the *Geography*. Perhaps most serious of all for the student of mapping, however is the whole debate about the authorship and provenance of the general and regional maps that accompany the several versions of the Byzantine manuscripts.

Still the culmination of Greek cartographic thought is seen in the work of Claudius Ptolemy, who worked within the framework of the early Roman Empire. A modern analysis of Ptolemaic scholarship offers nothing to revise the long-held consensus that he is a key figure in the long-term development of scientific mapping. Yet Ptolemy, as much through the accidental survival and transmission of his texts when so many others perished as through his comprehensive approach to mapping, does nevertheless stride like a colossus over the cartographic knowledge of the later Greco-Roman world and the Renaissance. This is perhaps more remarkable in that his work was primarily instructional and theoretical, and it remains debatable if he bequeathed a set of images that could be automatically copied by an uninterrupted succession of manuscript illuminators. Ptolemy's principal legacy was thus to cartographic method, and both the *Almagest* and the *Geography* may be regarded as among the most influential works in cartographic history. It would be wrong to over emphasize, as so much of the topographical literature has tended to do, a catalog of Ptolemy's "errors": what is vital for the cartographic historian is that his texts were the carriers of the idea of celestial and terrestrial mapping long after the factual content of the coordinates had been made obsolete through new discoveries and exploration. Finally, the interpretation of modern scholars has progressively come down on the side of the opinion that Ptolemy or a contemporary probably did make at least some of the maps so clearly specified in his texts.

When we turn to Roman cartography, it has been shown that by the end of the Augustan era many of its essential characteristics were already in existence. Drawing on the theoretical knowledge of Greek scholars and technicians, both geographical maps at a small scale and large-scale cadastral maps were brought into more regular use. The primary stimulus to the former seems to have been the recognition by the Roman rulers not only that maps were of practical assistance in the military, political, and commercial integration of the empire, but also that a publicly displayed map of its extent could serve for the people as a symbol of its reality and territorial power. Similarly, the cadastral maps, given the force of law by the end of the period, were designed to record and to help uphold a system of property rights and agrarian production in which the state had a vested interest. Maps had thus become the tools of statecraft at a number of territorial scales. It was these motives, rather than disinterested intellectual curiosity, that led to an extension and diversification of mapping as the empire was further consolidated in the period from Tiberius to Caracalla.

In the course of the early empire large-scale maps were harnessed to a number of clearly defined aspects of everyday life. Roman surveyors were capable of constructing complex maps to a consistent scale. These were used particularly in connection with the land attached to colonies, settlements often set up to provide veterans with small holdings. In the countryside, although only a few fragments of stone cadaster have survived, and none of the bronze maps that recorded land ownership, many thousands of such maps must originally have been made for centuriation and other schemes. Similarly, in the towns, although only the *Forma Urbis Romae* is known to us in detail, large-scale maps were

recognized as practical tools recording the lines of public utilities such as aqueducts, displaying the size and shape of imperial and religious buildings, and indicating the layout of streets and private property. Some types of Roman maps had come to possess standard formats as well as regular scales and established conventions for depicting ground detail. Yet it is perhaps in the importance accorded the map as a permanent record of ownership or rights over property, whether held by the state or by individuals, that Roman large-scale mapping most clearly anticipated the modern world. In this respect, Rome had provided a model for the use of maps that was not to be fully exploited in many parts of the world until the 18th and 19th centuries.

Maps in the period of the decline of the empire and its sequel in the Byzantine civilization were of course greatly influenced by Christianity. In its most obvious aspect, the exaggerated size of Jerusalem on the Madaba mosaic map *(# 121)* was no doubt an attempt to make the Holy City not only dominant but also more accurately depicted in this difficult medium. Pilgrims from distant lands obviously needed itineraries like that starting at Bordeaux, giving fairly simple instructions. But more realistic geographical maps were not entirely lacking: the choice in the fifth century A.D. for a depiction of the Roman world would perhaps lie between the map commissioned by Theodosius II, which may have revised that of Agrippa *(#118)*, and one based on the ancestor of the *Peutinger Table (# 120).*

Continuity between the classical period and succeeding ages was interrupted, and there was disruption of the old way of life with its technological achievements, which also involved mapmaking. Some aspects of a partial cartographic heritage, however, may be suggested. When we come to consider the mapping of small areas in medieval Western Europe, it will be shown that the Saint Gall monastery map is very reminiscent of the best Roman large-scale plans. Similarly, it will be made clear in *Book II* of these monographs to what extent the *mappaemundi* were indebted to a number of classical sources, including Greek maps showing *climata* and the simple tripartite *T-O* maps (which may have arisen in Roman works involving Africa in the first century B.C.), together with, probably, the map of Agrippa as a common archetype. However, the maps of Marinus and Ptolemy, one of the latter containing thousands of place-names, were at least partly known to Arabic geographers of the ninth to the 10th century. But the transmission of Ptolemy's *Geography* to the West came about first through reconstruction by Byzantine scholars and only second through its translation into Latin (1406) and its diffusion in Florence and elsewhere. In the case of the sea charts of the Mediterranean, it is still unresolved whether the earliest *portolan* [nautical] charts of the 13th century had a classical antecedent. If they had, one would suppose it to be a map connected with the *periploi* [sea itineraries]. But none of these either has a map or, in the present state of our knowledge, can be shown to have ever had one. The monographs in this book that describe maps/mapmakers from the *Age of Ptolemy* include the following:

- #117, Dionysius Periegetes' World Map (A.D. 124)
- #118, Agrippa's Orbis Terrarum (A.D. 100)
- #119, Ptolemaic Maps, (1482-1561)
- #120, Tabula Peutingeriana (A.D. 100)

The Byzantine Empire, though providing essential links in the chain, remains something of an enigma for the history of the long-term transmission of cartographic knowledge from the ancient to the modern world. In both Western Europe and Byzantium relatively little that was new in cartography developed during the early Middle Ages, although monks were assiduously copying out and preserving the written work of many past centuries available to them. Some maps, along with other illustrations, were transmitted by this process, but too few have survived to indicate the overall level of cartographic awareness in Byzantine society. While almost certainly fewer maps were made than in the *Greco-Roman Period*, nevertheless the key concepts of mapping that had been developed in the classical world were preserved in the Byzantine Empire. The most accomplished Byzantine map to survive, the mosaic at Madaba *(#121)*, is clearly closer to the classical tradition than to maps of any subsequent period. But as the dichotomy increased between the use of Greek in the East and Latin in the West, the particular role of Byzantine scholars in perpetuating Greek texts of cartographic interest becomes

clearer. Byzantine institutions, particularly as they developed in Constantinople, facilitated the flow of cartographic knowledge both to and from Western Europe and to the Arab world and beyond. Our sources point to only a few late glimpses of these transfers, as when Planudes took the lead in Ptolemaic research, for example. But in order to reach an understanding of the historical processes involved in the period, we must examine the broader channels for Christian, humanistic, and scientific ideas rather than a single map, or even the whole corpus of Byzantine cartography. Viewed in this context, some of the essential cartographic impulses of the 15th century Renaissance in Italy are seen to have been already active in late Byzantine society.

As mentioned earlier, it is necessary to emphasize that the ancient Greek maps presented in this volume are "reconstructions" by modern scholars based upon interpretations of the textual descriptions of the general outline of the geographical systems formed by each of the successive Greek writers so far as it is possible to extract these from their writings alone. No actual ancient Greek maps have survived. We cannot know how many Greek maps were produced, or what exactly their content and purpose may have been. The different materials on which they were presented have rarely survived. Papyrus and vellum are perishable; bronze and other metals were frequently melted down; stonework and mosaics were stolen, defaced, or buried. Modern reconstructions must therefore depend upon later descriptions by authors sometimes removed from the original artifacts by centuries: Strabo, for example, lived three centuries after Eratosthenes (ft. ca. 276-194), whose work he described. Texts preserve merely a selection of descriptions of the original maps, and their authors often interpret as much as they describe. They employ similes and evoke familiar geometric shapes and objects: Sicily is triangular, Attica crescent shaped; the Peloponnese resembles the leaf of a plane tree, Italy an oak leaf. Further, how accurately writers quote their sources we cannot say. Geographic reconstructions are by their very nature interpretative and speculative. Because the textual descriptions reflect the knowledge and theoretical initiatives of the culture which created them, our understanding of this material and our resulting images are reliant upon an adequate grasp of it. As with translating literary texts, there is ample room here for misrepresentation, factual distortion, and philosophical misinterpretation of geographic texts. Moreover, geographic data are easily garbled in copying. Maps too large to be incorporated into papyrus rolls and vellum codices were liable to be separated from their manuscripts and then further damaged or lost. Although maps were useful, artistic, and of immense symbolic and practical value, they may also have suffered from intellectual prejudices against material artifacts, which some considered to be second-hand imitations of life appealing to humanity's less rational nature.

Maps are an important expression of Greek culture. In their shape and deployment are embedded social, cultural, and political prejudices: the superiority of Greek over non-Greek, of one city-state over a rival. Cartographic data were derived from political, commercial, and military sources, and successive advances came in the wake of increased interaction with other peoples in the Mediterranean and beyond. The flat-earth theory and Anaximander's column drum map were abandoned for a spherical earth organized into zones of latitude as set by Parmenides and advanced by Aristotle and Eratosthenes. Anaximander's vision of a circular and tripartite landmass grew into a complex conception of lands arranged and ordered by a scientifically informed system of coordinates, as found in Pytheas, Eratosthenes, Hipparchus, and, later, Ptolemy. The philosophy of symmetry was never entirely abandoned. Descriptive maps were included in a wide variety of writings. Maps were never primarily intended just to show precise spatial relationships between places. Early Greek maps, in particular, had no practical application, but they stimulated the imagination and enriched Greek ideas about humans' relationship to the natural world; they also reflected the Greek zest for adventure and exploration. Ultimately these maps and their successors served to impose order and reason upon the physical landscape.

Chinese Cartography

China is Asia's oldest civilization, and the center from which cultural disciplines spread to the rest of the continent. China can also claim primacy in cartography. The Chinese anticipated the peoples of the West in knowledge of the compass, said to be invented in 1100 B .C., the gnomon and the water-level, and they understood the science of leveling. Astronomical methods were early used to

determine the position of points. Chinese tradition places the first maps in about 2,000 B.C., when nine copper or bronze vases on tripods are said to have been made, being representations of nine provinces of the current Hsia Dynasty and showing mountains, rivers and local products. In 327 or 255 B.C., on the overthrow of the Chou Dynasty, they fell into the hands of the new Ch'in Dynasty and were thrown into a river.

From ancient times maps have served a variety of purposes in China. Many were designed as practical educational tools for scholar-officials, to guide, instruct and edify in times of both peace and war. They were also employed as a concrete means of asserting the emperor's territorial claims, whether local, empire-wide, or world-wide. Maps became symbolic tokens of exchange in China's domestic and foreign relations, and were even used to depict a perceived link between the realms of heaven and earth. Significantly, they also provided a means by which viewers could take "spiritual" journeys to distant lands - the cartographic equivalent of "travelling [through a landscape painting] while remaining at rest [*woyou*]".

Traditional Chinese maps tend not to be drawn to scale, include a great deal of text and are sometimes pictorial. This generalization is accurate in so far as one acknowledges that a number of kinds of mapping practices, reflecting various epistemologies, did coexist. Distinct technologies and map styles were suited to different audiences and purposes.

An ancient wooden map discovered by Chinese archaeologists in northwest China's Gansu Province has been confirmed as the country's oldest one at an age of more than 2,200 years *(see #111.1).* The map was drawn on four pine plates, 23 cm long, 17 cm wide and 1.5 cm thick each, and includes a drawing of Guixian County of the Qin Kingdom, one of the seven major warlords in the era of the Warring States (475-221 B.C.). The map, believed to have been completed in 239 B.C., is more than 1,300 years older than the *Hua Yi Tu* and *Yu Chi Tu* (see *Book II, #218, #218.1*), both unearthed in the Forest of Steles in Xi'an, capital of northwest China's Shaanxi Province. It is 300 years older than the map of Western Han (206 B.C.- 24 A.D.), excavated from Mawangdui in central China's Hunan Province in 1973, according to the State Bureau of Surveying and Mapping *(#112.1).* He Shuangquan, a research fellow with the Gansu Provincial Archaeological Research Institute, has made an in-depth study of the map and confirmed its drawing time to be 239 B.C. "This map provided material evidence of the developed cartology of ancient China and was a precious artifact in the study of China's map-drawing technologies", said Li Wanru, a research fellow with the ancient maps laboratory of the Natural Science Research Institute under the Chinese Academy of Sciences.

The map of Guixian *(#111.1)* was unearthed from tombs of the Qin Kingdom at Fangmatan in Tianshui City of Gansu Province in 1986 and was listed as a national treasure in 1994. Researcher He said that the map, drawn in black on four pine wood plates of almost the same size (1.1 cm thick by 26.7 cm in length, and their widths run from 15 to 18.1 cm), had clear and complete graphics depicting the administrative division, a general picture of local geography and the economic situation in Guixian County in the Warring States era. Eighty-two places are marked with their respective names, locations of rivers, mountains and forested areas on the map. What is more surprising is that the map marks the location of *Wei Shui*, now known as the Weihe River, and many canyons in the area. The location of the Weihe River marked on the map agrees with the record in the *Waterways Classic*, a book by an unknown author of the Three Kingdoms period (220-280 A.D.), giving a brief account of the country's 137 major waterways. Forested areas marked on the map also tallies with the distribution of various plants and the natural environment in the area today.

Unlike modern maps, place names on these maps were written within big or small square frames, while the names of rivers, roads, major mountains, water systems and forested areas were marked directly with Chinese characters. The distances of some roadways were also marked clearly on the map. Experts said that graphics, symbols, scales, locations, longitude and latitude are key elements of a map. The map of Guixian County has all these elements except longitude and latitude, according to historians.

Whoever sets out to write on the history of geography in China faces a quandary, however, for while it is indispensable to give the reader some appreciation of the immense mass of literature which Chinese scholars have produced on the subject, it is necessary to avoid the tedium of listing names of authors and books, some of which indeed have long been lost. Only a few examples can be given, but it

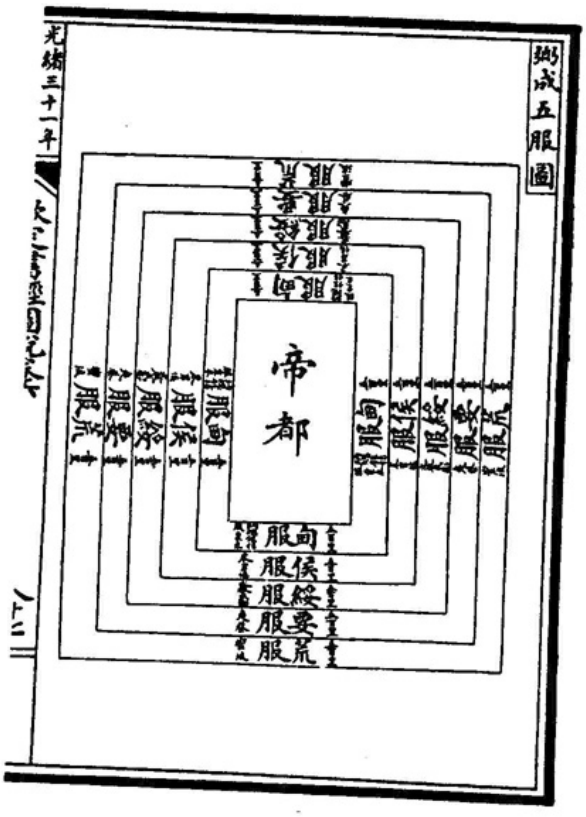
should be understood, even when it is not expressly said, that they must often stand simply as representative of a whole class of works.

As for the ideas about the shape of the earth current in ancient Chinese thought, the prevailing belief was that the heavens were round and the earth square. But there was also always much skepticism about this. Thus in the *Ta Tai Li Chi*, Tseng Shen, replying to the questions of Shanchu Li, admits that it was very hard to see how, on the orthodox view, the four comers of the earth could be properly covered. It was repeatedly stated (as by Yü Sung and Chang Hêng) even as late as the first and second centuries A.D. that the universe was like a hen's egg, and the earth was like the yolk in the midst of it. Chinese thinkers of all ages joined Yü Hsi (ca. A.D. 330) in expressing skepticism about the square and flat earth: if it was square, said Li Yeh, the movements of the heavens would be hindered. In his view, it was spherical, like the heavens, but smaller; and all supporters of the Hun Thien theory must have tended to believe this. The influence of these views on Chinese cartography, however, remained slight, for it revolved around the basic plan of a quantitative rectangular grid, taking no account of the curvature of the earth's surface. At the same time Chinese geography was always thoroughly naturalistic, as witness the passage about rivers and mountains from the *Lü Shih Chhun Chhiu*.

The following attempts to compare rather carefully the parallel march of scientific geography in the West and in China. It may be said at the outset that both in East and West there seem to have been two separate traditions, one which we may call 'scientific, or quantitative, cartography', and one which we may call 'religious, or symbolic, cosmography'. The European tradition of scientific mapmaking was completely interrupted for centuries by a dominance of the latter, though originally it was older than the Chinese, but the parallel Chinese tradition, once it had begun, was not so interrupted. Before taking up these interesting comparisons, however, it is necessary to say something about the geographical classics and treatises of China through the centuries.

By 1125 B.C., the Chinese had a map of the whole kingdom, which must have been the result of many years' work. It seems to have been compiled by Wen-Wang and was certainly based on geographical material in the official description of China, the *Yü-Kung*. Forest-maps and cadastral maps were also in use by this date. Maps were used in religious rituals, such as thanksgivings for success in regulating river waters, when a map engraved on a nephrite tablet would be thrown into the river. During the Chou Dynasty (1122-1255 B.C.), mapmaking was in the hands of particular officials, and we have copies of regulations for them. The decay of this dynasty was accompanied by a decline in cartography, which passed from the hands of officials into those of scholars and writers.

About 450 B.C., one of the early disciples of Confucius prepared an official description of China, including maps that may have been newly made for it; maps were also frequently included in encyclopedias. Presumably the oldest Chinese geographical document which has come down to us is the *Yü Kung* [Tribute of Yü] chapter of the *Shu Ching* [Historical Classic], which after having been granted any date back to the end of the third millennium B.C., is now considered to be probably fifth century B.C., approximately contemporary with the pre-Socratic philosophers in Greece. It will be remembered that Yü the Great was the legendary hero-emperor who mastered the waters and became the patron of hydraulic engineers, irrigation experts and water conservancy workers in after ages. This chapter of the *Shu Ching* is of great interest for many reasons; it lists the traditional nine Chinese provinces, their kinds of soils, their characteristic products, and the waterways running through them. It is thus important for the early history of soil science and hydraulic engineering, and constitutes a primitive economic geography. The accepted view is that the part of China covered by the *Yü Kung* chapter included the lower valleys of the Yangtze and the Yellow Rivers, with the plain between them and the Shantung peninsula; to the west the upper reaches of the Wei and Han Rivers were known, together with the southern parts of the provinces of Shansi and Shensi. This was hardly the half of the region that Chinese civilization was ultimately to occupy.



The traditional conception of the radiation of ancient Chinese culture from its imperial center, from Needham.
Proceeding outwards from the metropolitan area we have, in concentric rectangles, (a) the royal domains; (b) the lands of the tributary feudal princes and lords; (c) the 'zone of pacification', i.e. the marches where Chinese civilization was in course of adoption, (d) the zone of allied barbarians; (e) the zone of cultureless savagery. The systemization can never have been more than schematic but Egypt and Rome might have used a similar image, all unconscious of the equally civilized empire at the eastern end of the Old World.

It is usual to hold that the *Yü Kung* implies a naive map of concentric squares. This is based on the concluding sentences of the chapter, where it is said that throughout a zone 500 *li* (presumably in all directions) from the capital there are the royal domains, within the next concentric zone of 500 *li* are the *princes' domains*, then come the *pacification zone*, the *zone of allied barbarians*, and lastly the *zone of cultureless savagery*. There is nothing in the text, however, to justify the traditional view that these zones were concentric squares; this was probably just assumed on the basis of the cosmological doctrine of the square earth. The point is more important than it may seem, for if the zones were thought of as concentric circles, this ancient gradient system might have been one of the sources of the East Asian discoidal tradition of 'religious cosmography'. On the other hand concentric squares would foreshadow a rectangular grid.

In general, it may be said that the *Yü Kung*, the first naturalistic geographical survey in Chinese history, is approximately contemporary with the first mapmaking in Europe. This is associated with the Greek Anaximander (ca. sixth century B.C. #*107*). But the Chinese document is much more detailed and elaborate than anything which has come down to us from Anaximander's time. Throughout Chinese history the influence of the *Yü Kung* was enormous; all Chinese geographers worked under its aegis, drew the titles of their books from it, and tried unceasingly to reconstruct the topography that it contained.

As mentioned earlier, until this time, Chinese scholars had assumed the world to be a square, the greater portion of which was taken up by their own country. Then, at the end of the fourth century B.C., hints of a new cosmogony began to reach China from India, and the world maps changed their shape in consequence. The Indian doctrine of *Taoism* held that China occupied only 1/81 of the earth's surface and was surrounded by an ocean, beyond which were other countries, separated by concentric rings of ocean. Taoism did not carry all before it in China, but existed alongside other movements. A book about mountains and seas, *Shan-hai-ching*, made about 350 B.C., contains not only maps, but also representations of distant lands and peoples, with pictures of fantastic men, some of them not all unlike those found in European cartography of the Middle Ages and Renaissance.

The first historical reference to a map in China dates to the third century B.C. found in the work of the great Chinese historian Ssu Ma Ch'ien who relates that, in 227 B.C., the crown prince of the State of Yen (Yen Tan Tzu), fearing the territorial ambitions of Prince Cheng, of the state of Qin, later known as Shih Huang Ti, or "First Emperor" of the Qin Dynasty, sent his heir presumptive, a certain Ching Kho, to the court of the latter with the avowed mission of presenting a map of the district of Tu Kang, which was to be handed to Prince Cheng. The real mission, however, was the assassination of the Prince; for the map, which was probably painted on silk, was packed in a box, and when Prince Cheng drew it out, a poisoned dagger lay behind, which the emissary essayed to use. The plot failed, however, and the would-be assassin was arrested. When Shih Huang Ti became emperor, he assembled all available maps of the empire. With the new Qin Dynasty, China was divided into 36 regions instead of the former nine provinces, and it became necessary to produce a revised description of the kingdom with maps of these regions (255—206 B.C.). Some of the new maps were cut in bamboo for greater durability, and many (especially travelers' maps) were painted on silk. During the civil war that followed soon after the death in 210 B.C. of the "First Emperor", the Prince of Han sacked his capital at Hsien-yang city, in Shensi, and many maps were discovered there. These were of inestimable value and advantage to the Han Dynasty. They must have existed until the end of the first century A.D., for Pan Ku, who died in A.D. 92, refers to them at least twice in the *Chhien Han Shu*. But by Phei Hsiu's time (third century A.D.) they had disappeared, they were probably carved on wooden boards.

All through the Han Dynasty there are references to maps. When Chang Chhien had returned from the West in 126 B.C. we are told in the *Chhien Han Shu* that the emperor consulted ancient maps and books and decided that the mountain from which the Yellow River took its source should be called *Khun-Lun*. The first use of the expression *yü ti thu (t'u)*, derived from the conception of the earth as a chariot and heaven as a chariot-roof, comes in 117 B.C., when maps of the whole empire were submitted to Han Wu Ti in connection with the investiture of three of his sons as feudal princes. There was a famous military mapmaking in 99 B.C. when the general Li Ling was campaigning against the Huns. He made a complete chart of the mountains and steppes as far as thirty days' journey north of the frontier, and sent a copy back for presentation to the emperor.

Cartography continued to interest the people of the Later Han Dynasty. In A.D. 26, when Kuang Wu Ti was fighting to establish the new dynasty, he opened a large map, probably painted on silk, on one of the gate-towers of a city which his forces had just taken, and said to Têng Yü, one of his generals: "*Here are all the commanderies and feudal domains of the empire; what we have just taken is only a very small part. How could you have thought it easy to conquer the whole of it?*" After Kuang Wu Ti had become securely established on the throne, a special ceremony was held annually from A.D. 39 at which the Minister of Works (Ta Ssu Khung) presented a map of the empire. Again, in A.D. 69, when Wang Ching was charged with repairing the breaches in the Yellow River dykes at Khaifeng, he was given a set of maps illustrating the treatise of Ssuma Chhien's *Ho Chhü Shu* [on the Rivers and Canals].

This brings us to the time of the famous astronomer and seismologist Chang Hêng. None of the fragments of his writings which survive deals with cartography, but that it was he who originated the rectangular grid system seems very probable from the pregnant phrase used about him by Tshai Yung. He is said to have "*cast a network (of coordinates) about heaven and earth, and reckoned on the basis of it*". The celestrial coordinates must have been the *hsiu*; unfortunately, we cannot tell exactly what the terrestrial ones were. The title of one of his books was *Suan Wang Lun* [Discourse on Net Calculations], and there was also *Fei Niao Li* [Flying Bird Calendar], but if the word *li* were a mistake for *thu* or *t'u*, as some scholars believe, then this latter title may have referred to a "Bird's Eye Map". That Chang Hêng occupied himself with mapmaking is sure, for a *Ti Hsing Thu* [Physical Geography Map] was presented by him in A.D. 116. At a later point the question of possible connections with the Greek cartographers will be raised.

There is ample evidence in the histories of the two Han Dynasties, the Former Han and Later Han, to show that, in addition to bamboo and wood, silk was used for writing and for mapmaking. During the Later Han Dynasty paper was invented in A.D. 105 by a chamberlain of the Emperor Ho Ti, named Ts'ai Lun, an invention which proved an excellent substitute for cumbersome wood and expensive silk. Notwithstanding the invention of paper, map carving in wood, fortunately for its more innate durability, was not abandoned; for, in the annals of the Liu-Sung Dynasty (A.D. 420-473), it is

related that one Hsieh Chuang (A.D. 421-466) carved a map in wood, 10 feet square, showing mountains, rivers, and the general configuration of the country. This map consisted of detachable pieces which could be removed and put together again.

However, maps reached a high point in their development with the availability of paper. The San Kuo and early Qin periods were even more important than the Han Dynasty period for the attainment of the definitive style of Chinese cartography. Henceforth maps were in the hands of the ministry of public works, which had new administrative maps made. The first emperor of the unifying Jin Dynasty (A.D. 265-317), Wu Ti (A. D. 265-290) appointed a very remarkable man, Pei Xiu (A.D. 224-271; Phei Hsiu), as Minister of Public Works in A.D. 267. This young man was destined to be, as Chavannes calls him, "the father of scientific cartography in China". Considering that his office concerned the land and the earth; and finding that the names of mountains, rivers and places, as given in the *Yü Kung*, had suffered numerous changes since ancient times, so that those who discussed their identifications had often proposed rather forced ideas, with the result that obscurity had gradually prevailed. Pei Xiu made a critical study of all existing topographical matter and maps, rejected what was dubious, classified, whenever he could, the ancient names that had disappeared, and he wrote a scientific manual for compilers of geographical descriptions and maps. This work begins with a survey of early cartography, with indications of its shortcomings, and proceeds to expound new methods (Pei Xiu 's *Six Principles of Cartography*) requiring that maps be correctly oriented and divided by a net, not of meridians and parallels, but of lines intersecting at equal intervals to form squares, which were intended to facilitate the measurement of distance (in *li*). A new, eighteen-sheet map of the whole country on a scale of 500 *li* to one inch, was made by Pei Xiu for the official description of China, the recurrent *Yü-Kung*, which the Emperor deposited amongst his secret archives.

The 35th chapter of the *Chin Shu* preserves particulars of the mapmaking in which he then engaged, together with his preface to the maps. The preface said:

> The origin of maps and geographical treatises goes far back into former ages. Under the three dynasties (Hsia, Shang and Chou) there were special officials for this (Kuo Shih). Then, when the Han people sacked Hsien-yang, Hsiao Ho collected all the maps and documents of the Qin. Now it is no longer possible to find the old maps in the secret archives, and even those which Hsiao Ho found are missing; we only have maps, both general and local, from the (Later) Han time. None of these employs a graduated scale and none of them is arranged on a rectangular grid. Moreover, none of them gives anything like a complete representation of the celebrated mountains and the great rivers; their arrangement is very rough and imperfect, and one cannot rely on them. Indeed some of them contain absurdities, irrelevancies, and exaggerations, which are not in accord with reality, and which should be banished by good sense.
>
> The assumption of power by the great Jin Dynasty has unified space in all the six directions. To purify its territory, it began with Yung and Shu (Hupei and Szechuan), and penetrated deeply into their regions, though full of obstacles. The emperor Wen then ordered the appropriate officials to draw up maps of Wu and Shu. After Shu had been conquered and the maps were examined, with regard to the distances from one another of mountains, rivers and places, the positions of plains and declivities, and the lines of the roads, whether straight or curved, which the six armies had followed; it was found that there was not the slightest error. Now, referring back to antiquity, I have examined according to the Yü Kung the mountains and lakes, the courses of the rivers, the plateaus and plains, the slopes and marshes, the limits of the nine ancient provinces and the sixteen modern ones, taking account of commanderies and fiefs, prefectures and cities, and not forgetting the names of places where the ancient

kingdoms concluded treaties or held meetings; and lastly, inserting the roads, paths, and navigable waters, I have made this map in eighteen sheets.

In the making a map there are six principles observable:

(1) The graduated divisions that are the means of determining the scale to which the map is to be drawn.
(2) The rectangular grid (of parallel lines in two dimensions), which is the way of depicting the correct relations between the various parts of the map.
(3) Pacing out the sides of right-angled triangles, which is the way of fixing the lengths of derived distances (i.e., the third side of the triangle which cannot be walked over).
(4) (Measuring) the high and low.
(5) (Measuring) right angles and acute angles.
(6) (Measuring) curves and straight lines. These three principles are used according to the nature of the terrain, and are the means by which one reduces what are really plains and hills (lit. cliffs) to distances on a plane surface.

If one draws a map without having graduated divisions, there is no means of distinguishing between what is near and what is far. One has graduated divisions, but no rectangular grid or network of lines, then while one may attain accuracy in one comer of the map, one will certainly lose it elsewhere (i.e., in the middle, far from guiding marks). If one has a rectangular grid, but has not worked upon the *tao li* principle, then when it is a case of places in difficult country, among mountains, lakes or seas (which cannot be traversed directly by the surveyor), one cannot ascertain who they are related to one another. If one has adopted the *tao li* principle, but has not taken account of the high and low, the right angles and acute angles, and the curves and straight lines, then the figures for distances indicated on the paths and roads will be far from the truth, and one will lose the accuracy of the rectangular grid.

But if we examine a map that has been prepared by the combination of all these principles, we find that a true scale representation of the distances is fixed by the graduated divisions. So also the reality of the relative positions is attained by the use of paced sides of right-angled triangles; and the true scale of degrees and figures is re-produced by the determinations of high and low, angular dimensions, and curved or straight lines. Thus even if there are great obstacles in the shape of high mountains or vast lakes, huge distances or strange places, necessitating climbs and descents, retracing of steps or detours - everything can be taken into account and determined. When the principle of the rectangular grid is properly applied, then the straight and the curved, the near and the far, can conceal nothing of their form from us.

Although Pei Xiu left us so clear an account of his methods, like his Greek counterparts, unfortunately his actual maps did not survive in any form. Modern scholars have made attempts at reconstructing them - Herrmann, for instance, who considers Pei Xiu quite worthy to be compared with Ptolemy. In 1697 Hu Wei had already made such a reconstruction in his *Yü Kung Chui Chih* [A few Points in the Vast Subject of the Yü Kung]. There was a tradition among later scholars that the map of Pei Xiu had been constructed on a scale of 500 *li* equals two inches, which has come under serious question by other researchers in the field of Chinese cartography.

A similar atmosphere pervades the *Shan Hai Ching*, which, however, bears also a resemblance to the *Yü Kung* in that it often mentions the existence of quite reasonable minerals, plants and animals. An elaborate table of these, together with the fabulous animals, plants and semi-human races and peoples, has been drawn up by Ho Kuan Chou and Chêng Tê-Khun. There is a very difficult problem of the date of the book. It was certainly current in some form in the Former Han period (Ssuma Chhien refers to it), and a good deal of the material, on internal evidence, goes back to the time (and probably the school) of Tsou Yen (late fourth century B.C.). Some of the content is likely to be much older even than that, for Wang Kuo-Wei pointed out that one of the personages mentioned in the *Shan Hai Ching*, Wang Hai, was already a god of some kind in the Shang period (13th century B.C.) and appears as such on the oracle-bones. On the other hand, the later chapters (6-18) may be of Later Han or even Chin Dynasty date. As Wang Yung says, many of the topographic features mentioned in the book can be approximately identified, and it forms a veritable mine of information concerning ancient beliefs about natural things such as minerals and drugs.

One of the chief discussion centered round the fabulous beings and peoples described. Taking the view that the *Shan Hai Ching* is the oldest 'traveler's guide' in the world, the scholar Schlegel attempted a number of naturalistic identifications—thus the *wen shen kuo* were probably barbarian tribes of the *Kurles* which practiced tattooing, the *pai min kuo* and *mao jen* [hairy white people] were probably the *Ainu*, the *yü ikuo* must have been the 'malodorous barbarians' of the Siberian coast from whom the Chinese imported fish glue for bows in very early times, and so on. Identifications are fortified by passages from many other ancient and medieval Chinese books. But a large proportion of the peoples mentioned are clearly fabulous, heads that fly about alone, winged men, dog-faced men, bodies with no heads, and the like. Since a great many of these appear also in Greek mythology, the problem of transmission at once presents itself. The scholar De Mely collected from late encyclopedias some seventy kinds of these fabulous beings (nearly all of which appear in the *Shan Hai Ching*), and in all but very few cases could point to their analogues in Greek and Latin authors. Herodotus (fifth century B.C.) is one of the earliest sources, but there is much similar material in Strabo and Pliny. It was assembled and concentrated by Gaius Julius Solinus in the third century A.D. in his *Collectanea Rerum Alemorabilium*, which was essentially a compilation of the 'nonsense' in Pliny, and which, with its title changed to *Polyhistor* in a sixth century A.D. revision, supplied abundant 'marvels' for geographers throughout the European Middle Ages. It is interesting to compare a couple of illustrations from the *Shan Hai Ching* with parallels from Solinus.

Occidental scholars have been strongly inclined to regard this Chinese body of mythical teratology as of Greek origin. In certain cases they may be right. The story of the battles of the pygmies with the cranes, which occurs in many ancient Greek authors, is first found in the *Wei Lüeh* of Yu Huan, a third century A.D. book (the time of Solinus). But it is going too far to derive all the fabulous beings of the *Shan Hai Ching* from Greek sources some of them may well go back in China beyond the time of Herodotus. Attempts, such as that of Wei Chü-Hsien, to trace them to Indian mythology, are not convincing either, yet it may well be that some primary Indian or Iranian (or even Mesopotamian) source may have radiated them in both directions. Babylonian diviners were extremely interested in *terata* and there is evidence that shows fairly convincingly that the passages of the book that describe paradise-like places derive from earlier Indian

legends. Some scholars identify Ctesias (fourth century B.C.) and Megasthenes (third century B.C.) as the chief sources of transmission westwards.

What is curious is that the material has not yet been examined from the point of view of the history of biology. To an embryologist it seems obvious that most of the different abnormalities which form the basis of the corpus of legend could have been derived from human and animal monstrosities naturally occurring. Some scholars have traced the Eastern and Western legends of cynocephali to hirsute-faced human beings, citing living Burmese examples, as well as to cynocephalic monkeys. If this point of view should prevail, there would be no reason to assume any West-East transmission at all, at any rate to account for origins. Such an interpretation would, however, not be inconsistent with the more social appraisal, in which the existence of these myths would be related to a kind of xenophobia present in all ancient peoples.

In view of the great importance of waterways for the Chinese social and economic system at all times, it was natural that close attention should be paid to them. The first treatise of the kind was that of Sang Chhin of the first century B.C., the *Shui Ching* [Waterways Classic], but the text as we now have it is thought to be from the hand of some geographer of the San Kuo period, at any rate before A.D. 265. It gives a brief description of no less than 137 rivers. About the beginning of the sixth century A.D. it was enlarged to nearly forty times its original size by a great geographer Li Tao-Yuan and given the title *Shui Ching Chu* [The Waterways Classic Commented]. This constitutes a work of the first importance. From the titles of several other books *(Chiang Thu),* it would seem that rivers were being mapped from the Qin Dynasty onwards. Among treatises of this kind in the Sung may be mentioned the *Wu Chung Shui Li Shu* [The Water-Conservancy of the Wu District] by Shan O (A.D. 1059). Shan spent more than thirty years exploring the lakes, rivers and canals in the region of Suchow, Chhangchow and Huchow. A hundred years later Fu Yin wrote the *Yü Kung Shuo Tuan* [Discussions and Conclusions regarding the Geography of the Tribute of Yü], in which he dealt mainly with the Yellow River valley. Some diagrammatic charts, presumably of the 12th century A.D., are still included in his book.

The history of scientific geography and cartography is usually presented as containing an unaccountable gap between the time of Ptolemy (second century A.D.) and about A.D. 1400. Most older standard works on the subject seem restricted to certain conventions as to the participation of China, there are discussions of medieval European knowledge of China, what the Arabs said about it, and the stimulus of the visits made by the merchants and the religious-diplomatic envoys in the 13th century A.D., but rarely any in-depth discussion of Chinese cartography itself (Joseph Needham, Wanru Cao, Richard J. Smith, Cordell Yee and Chavannes have the most detailed discussion found to date). Yet during the whole of the millennium when scientific cartography was unknown to Europeans, the Chinese were steadily developing a tradition of their own, not strictly astronomical, but as quantitative and exact as they could make it. The oldest known existing Chinese maps, from 239 B.C., were found in northwest China's Gansu Province, the *Qin* or *Fangmatan* maps *(#111.1)*, followed by the *Han* maps (168 B.C.) from Ma-wang-tui in Ch'ang-sha, capital of Hunan Province *(#112.1).* Two of the most famous very old Chinese maps were discovered in the Forest of Tablets at Hsiafu, the capital of Shensi province, in the far interior. These two maps are engraved on stone tablets in this "forest", which is a collection of most valuable and ancient monuments gathered together in that city. The maps are engraved with the year called *Fou Ch'ang*, which Chavannes estimates to be A.D. 1137 (a complete description is provided in *Book II, #218* and *#218.1* of these monographs). The best sources in English for a discussion of the development of cartography in China are Needham, J. & Wang Ling, "Mathematics and the Sciences of the Heavens and the Earth", S*cience and Civilization in China*, vol. 3, Cambridge University Press, 1959, pp. 497-590, Smith, Richard J., *Chinese Maps, Images of 'all under Heaven'*, Oxford University Press, 1996, and Cordell, D.K. Yee, "Cartography in China", *The History of Cartography*, Volume Two, Book Two, 14994, pp. 35-202

How does this general picture compare with the development of descriptive geography in the West? The Chinese had nothing of the quality of Herodotus or even of Strabo at times contemporary with them, but during the gap between the third and the 13th centuries A.D., when European learning declined considerably, the Chinese were far more advanced, and steadily progressing. The floor was held in Europe by Solinus and his myths, almost as if the *Shan Hai Ching* had continued to dominate in

China without competition from diplomats like Khang Thai, pilgrims like Fa-Hsien, ethnographers like Ying Shao, and trade superintendents like Chao Ju-Kua. In the Tang period, almost the only reasonable representative that the West could produce was the Syrian bishop Jacob of Edessa (A.D. 633 to 708). The Arabs, however, match up better. By the Sung, about A.D. 950, they were laying the foundations of later Western geography, with al-Ya'qubi, Ibn Khurdadhbih, al-Ma'sudi, Ibn al-Faqih, al-lstakhri and Ibn Hawqal *(see Book II of these monographs).* Arabic geography reached its climax with al-Idrisi in the 12th century A. D. but still yields many good names in the 13th. Of course, the West had had its pilgrim literature, analogous to that of the Chinese Buddhists, beginning with 'the first of the Christian guide-books', the *Itinerary from Bordeaux to Jerusalem* of A.D. 333; and its records of trading voyages, such as the *Christian Topography* of Cosmas Indicopleustes written about A.D. 540 (*Book II, #202)*, when the Liang were in power at Nanking. But when one reads the careful chronicles of the Renaissance, such as the *True Story of the Conquest of New Spain* by Bernal Diaz del Castillo about 1520, or the *Relacion de las Cosas de Yucatan of Diego de Landa* (1566), one feels that the West was only now beginning to follow a path of objective description which the Chinese had been treading for the previous millennium and a half.

The development of Greek cartography has so often been expounded that it is only necessary here to remind ourselves of its essential features in very few words. It began with Eratosthenes (276 to 196 B.C.), the contemporary of Lü Pu-Wei, whose application of a coordinate system to the earth's surface originated from his determination of the earth's curvature. The famous observations of the gnomon shadows at summer solstice at Syene and Alexandria led to the approximately correct figure of 25,000 geographical miles for the earth's circumference. It is to be noted that the spherical earth was as much at the basis of Greek cartography as the flat earth was at the basis of Chinese. But in practice it made less difference than would seem at first sight, for the Greeks never developed satisfactory projections for describing the spherical surface on a flat sheet of paper.

The *oikoumene*, or inhabited world, of Eratosthenes was oblong, 78,000 *stadia* [about 7,800 geographical miles] in length, and 38,000 *stadia* from north to south. This was crossed by a series of parallels (of latitude), chosen according to solstitial gnomon shadow-lengths, and another series of meridians, chosen arbitrarily. Dicaearchus suggested a ratio of 3:2, while according to Eratosthenes the length of the *oikoumene* was 77,800 *stadia* (14,393 kilometers), a third o the whole circle by his calculations (Strabo 1.4.5). Posidonius proposed length of 70,000 *stadia* (12,950 kilometers), half of the entire circle on iii, figures (Strabo 2.3.6). Finally, Ptolemy determined that the length of the known world was 1800 east—west or 12 hours, while its breadth was 90° north—south (*Alm*, 2.1), an exact quarter of the entire sphere.

Hipparchus (ca. 162 to 125 B.C.), the contemporary of Liu An and his school, criticized the work of Eratosthenes and introduced various rectifications, including the term *climata* for the areas between parallels. The parallels of Eratosthenes had been arbitrary, but Hipparchus made them equal and astronomically fixed. In the *oikoumene* there were eleven, the southernmost one being half-way between the equator and the tropic, the next corresponding to a solstitial day of 13 hours, the next to one of 13.5 hours, etc. The northernmost one, passing through north Britain, corresponded to a solstitial day of 19 hours. For longitude he made no new advance.

With Ptolemy (ca. A.D. 120 to 170), who was working at the same time as Tshai Yung, the accurate or scientific cartography of the ancient world reached its greatest height. No less than six out of the eight books of his Geography are occupied with tables of latitude and longitude of specific places, given to a precision of one-twelfth of a degree. But the longitudes were really only guesswork. Hipparchus, indeed, had suggested a way of measuring them by observations at different stations of the onset of lunar eclipses, but only one or two experiments of this kind were available to Ptolemy. The ancient world was not able to organize scientific observations on the scale required. However, Ptolemy greatly reduced the estimate of the length of Asia which had been given by Marinus of Tyre (the distance from the *Stone Tower* to *Sera Metropolis*), and in this he was fully justified. On his largest map, which covered 180° of longitude and 80° of latitude, he made an attempt to show the meridians and parallels as curved lines.

The common assumption was that the inhabited world was situated mostly on the northern hemisphere of the globe, with its northern part, touching the cold North Pole and its southern edges

located around the hot regions of the equator. Ptolemy offered a more precise positioning. He showed that the globe was divided into four equal quarters by the equator and by a meridian passing through both poles, and that the *oikoumene* was located in the quarter limited to the south by the equator, to the north by the North Pole, and to the east and west by the meridian circle. He then specified the extreme points on all four ends: *Thule* to the north, *Aigisumba* (south of the Sahara) and *Cape Prason* (on the east coast or Africa) to the south, the Isles of the *Blessed* (Canary Islands) to the west and China to the east.

Accepting the spherical shape of the world and the assumed size of the *oikoumene* upon it, some theorists wondered whether there were other *oikoumenai* or even uninhabited dry lands on the globe. The Ocean excited curiosity among the ancients, because it was immeasurable and thus unlimited. This lack of solid knowledge produced the Platonic myth of *Atlantis*, as presented in the *Timaeus* and the *Critias*. According to this story, *Atlantis* was a powerful kingdom, 'larger than Libya and Asia together', which waged war against Mediterranean people but sank into the sea and was lost forever. The supposed size of *Atlantis* hints at Plato's sense of the enormous size of the Ocean. Scholars today debate whether Plato's legend recalls a real early sunken continent or represents a fictious utopia created in support of philosophic and ethical imaginings. But in any case, *Atlantis* inflamed the imaginations of generations who continued to look for the lost landmass, whether in the form of a solid continent (America) or a sunken one (sought by modern underwater expeditions).

In a different context, Plato's Socrates expresses an awareness of horizons wider than those that are visible:

> I believe that the earth is very large, and that we who dwell between the Pillars of Heracles and the river Phasis [modern Rhone, in Georgia] live in a small part of it about the sea, like ants or hogs about a pond, and that many other people live in many other such regions. (Phaedo 109b)

Plato's motivation for inventing *Atlantis* was perhaps purely ethical, but Aristotle relied on the aesthetic criterion of symmetry in his conjecture that another parallel inhabited world could be found in the southern hemisphere: 'There are two habitable sectors of the earth's surface, one in which we live towards the upper pole, the other towards the other, that is the south pole. These are the only habitable regions'.

Here, however, we have to take notice of a point which will prove of particular interest to us, namely, that in his maps of smaller areas or individual countries, Ptolemy used a simple rectangular grid. In this he followed the example of Marinus of Tyre, whom we have just mentioned. Marinus (ca. A.D. 100) has perhaps had less credit than is his due in the history of cartography, for like that of Eratosthenes, his work is known to us only at second hand. It will be worth remembering that he was especially interested in the extension of geographical knowledge towards the East, and made use of the data supplied by Maës Titianus, a Syrian engaged in the silk trade with the *Seres* [Chinese]. It will also be worthwhile bearing in mind that Marinus of Tyre was an exact contemporary of the astronomer Chang Hêng. Marinus was content, then, to draw his latitude parallels and longitude meridians at right angles to each other.

An essential point to be made is that, just as the scientific cartography of the Greeks was disappearing from the European scene, the same science in different form began to be more intensely cultivated among the Chinese. A tradition that began in earnest with the work of Chang Hêng (A.D. 78-139) and one that was to continue, without interruption, down to the coming of the Jesuits in the 16th century. Acquaintance with the far west and the discovery of a safe route to India brought Buddhism to China. Like Taoism before it, and Jainism, which developed with it, Buddhism influenced Chinese cosmogony and cartography: the earth was represented as a disc centered on *Mount Meru* and entirely surrounded by ocean. However, later Indian geographers no longer placed this mountain at the center of the world, as befitted their growing knowledge of geography, which now included the *Oxus* region (Amu Darya) and China. This Indian influence is visible in only a few Chinese maps, chiefly those in texts originally Indian.

A summary of the history of cartography in China has been severely neglected by historians and other scholars, nevertheless one has been available for Western scholars for nearly half a century in the fundamental paper of Émmanuel-Édouard Chavannes. What approximates a monograph on the history of Chinese cartography has also been contributed by Albert Herrmann, though it was buried in

the reports of an expedition. In the Chinese language we owe a valuable introduction, mainly bibliographical in character, to Wang Yüng, and one may occasionally find shorter articles on the history of geography in China, such as that by Huang Ping-Wei. The efforts of all of these scholars are collated and substantially added to by Joseph Needham in his multi-volume *Science and Civilisation in China*.

It should be noted that the reason why so much discussion has been focused on the development of Chinese cartography in this introduction is due to the very scarce treatment that it receives in most general histories on cartography. For an even more detailed discussion on this subject one can consult Needham, Chavannes, Smith and Hermann, whose works are now accessible online.

Indian Cartography

India (*Sind-Hind* to the Arabs, *Mount Meru* to the Chinese) exercised through its cosmogony a deep influence on other countries, but was itself originally under the influence of Babylon. While in intensely practical Babylon, however, philosophy was the province solely of scholars and priests, in India theories of cosmogony spread from the temples to the common people, and any free development of empirical knowledge was inhibited by religious and caste-bound disputes. A further result was that India had no cartography to speak of. Of course man cannot do entirely without maps, and some kind of representations similar to maps were presumably made, but these, drawn on palm-fiber paper, must either have worn out with use, or be preserved to this day in temple archives inaccessible to Europeans. We do know that Indian seamen had maps and pilot-books; the Turkish cartographer Seidi Ali used some, for example, and so did the Portuguese on their first voyages in Indian waters, as shown by the fact that the earliest Portuguese maps contain information about the countries of the east that they could not otherwise have acquired.

All that remains today however are generalized cosmogonic pictures derived from the theory that the world consists of countless spherical separate worlds. Our earth is one of the concentric rings in a disc detached from a globe, and all or part of the ring is inhabited. At the center is *Mount Maga Meru*, from which flow all rivers. The lists of peoples, cities and countries are pure invention, like later European maps of imaginary countries such as *Cockaigne*. There is a Buddhist map showing the world as a floating lotus-blossom, whose petals, stamens and pistils are covered with the names of countries, rivers, and so on, most of them invented. No one in India seems to have been interested in cartography, though we can surely assume the existence of other maps which answered the real needs of the people in conditions apparently favorable, notably the Indians' remarkable sense of direction. Maps of native origin were brought to Europe from Burma and Nepal, but these were products of European influence, and any native character they may seem to have is due to their artists' unfamiliarity with the pencils and paper provided by Europeans who may have been actually directing their work. India was long a closed country, and even if she did permit foreigners to enter, she herself did not trade with other countries. Indian religion (i.e., non-Muslim religion) did not permit the people to leave their country. Thus Indian geographers knew little about foreign countries, and the Brahman, or Jain cosmographies are full of imaginary peoples and lands.

The Atlantic

> Where the Mediterranean and the Ocean meet are found the lighthouses of stone and bronze built by Hercules, the great king. They are covered with inscriptions and surmounted by statues, which point as if to say: 'There is no way beyond me; beyond me there is no passage for those who enter the ocean from the Mediterranean! 'No ship can enter the ocean. It contains no inhabited land and no rational animals dwell there. Where it begins and where it ends are both unknown. It is the Sea of Shadmus, the Green Sea, the Circumambient Ocean.

For the Latin Middle Ages, the Atlantic was *Mare Tenebrosum*; for the Arabs, *Bahr al-Zulamat*. Both meant *The Sea of Darkness*, and anyone who has looked west from the northern coast of Portugal and saw the heavy cloud banks lying across the horizon will admit the name is well-suited to the Atlantic.

It was ill-omened: For Christians, the word *tenebrosum* suggested evil and evoked the Prince of Darkness. For Muslims, the Arabic word for "darkness," *al-zulumat* could not but call to mind the magnificent Qur'anic passage in *Surah 24, al-Nur*, "The Light," in which the state of the unbeliever is described as being like "*the depths of darkness in a vast deep ocean, overwhelmed with billows, topped by billows, topped by [dark] clouds - depths of darkness, one above the other.*"

This name - and its analogue, *Bahr al-Muzlim [The Dark Sea]*, - sufficiently indicates medieval man's fear and ignorance of the Atlantic Ocean. But the ocean had other, more propitious names as well. Two of these, *The Green Sea* and *The Circumambient Ocean*, appear in the passage just quoted from the famous 10th century Arab historian and geographer al-Mas'udi (*Book II, #212),* whose works are full of fascinating geographical information. The Arabs used other names also, such as the scholarly *Uqiyanus*, directly transliterated from the Greek word *okeanos*, and even, in later sources from the western Islamic world, *Bahr al-Atlasi [The Sea of the Atlas Mountains]* - an exact rendering of the word "Atlantic."

But the most frequent Arabic name for the Atlantic was *al-Bahr al-Muhit*, the Circumambient, or All-Encompassing, Ocean. This name embodied a very ancient notion. The Babylonians, and perhaps the Sumerians before them, envisaged the inhabited portion of the world as an upturned boat, a *gufa,* floating in the sea. This old Sumerian word was used to describe the round-bottomed reed boats used in the marshes of southern Iraq, where they are still known by the same name. Name and concept have proved extraordinarily persistent. The idea passed from Babylonia to the Greeks, and geographers from Herodotus and Hecataeus on described the world as surrounded on all sides by a universal ocean, even when the limits of the known world had been expanded far beyond anything the Babylonians could have imagined.

Long after Aristotle had demonstrated, in the fourth century BC, that the world was a sphere, the old Babylonian image persisted. Writing almost 1400 years after Aristotle, and perfectly aware that the earth is spherical, al-Mas'udi could still compare it to an egg floating in water. The Arab historian Ibn Khaldun, writing 400 years after al-Mas'udi and almost 1900 after Aristotle, compared the inhabited portion of the world to a grape floating in a saucer of water.

The Babylonians had little knowledge of lands beyond Mesopotamia and its immediate surroundings. Their image of the world was rooted in their cosmology, rather than based on observation. That the Babylonians proved to be correct, in the sense that all the great bodies of water that encircle the globe are interconnected, is fortuitous. Yet it was this idea, passed on to the Greeks, then through the Arabs to medieval Europe that contributed to the geographical discoveries of the 15th and 16th centuries.

Hernando Columbus, in his biography of his father Christopher, lists the classical and medieval sources that led the admiral to think he could reach the Indies by sailing westward. One of the most important of these sources was Aristotle's *De Caelo* [On the Heavens], a book known in Arabic translation since the ninth century and often quoted by al-Mas'udi. The original Greek text reached Italy in the 15th century, after the fall of Constantinople in 1453, but was not printed until after the discovery of America. It had been known in Spain, however, since the 12th century through a commentary on it by Ibn Rushd of Cordova, the Averroes of the Latin Middle Ages. Whether Columbus knew *De Caelo* through Latin translations of Averroes or more directly through the new Renaissance translations by Italian humanists with whom he was in contact, is unknown. In any case, here is the passage that fired his imagination:

> There is much change, I mean in the stars that are overhead, and the stars seen are different, as one moves northward or southward. Indeed there are some stars seen in Egypt and in the neighborhood of Cyprus that are not seen in the northerly regions; and stars which, in the north, are never beyond the range of observation, in those regions rise and set. All of which goes to show not only that the earth is circular in shape, but also that it is a sphere of no great size; for otherwise the effect of so slight a change of place would not be so quickly apparent. Hence one should not be too sure of the incredibility of the view of those who conceive that there is continuity between the parts about the Pillars of Hercules and the parts about India, and that in this way the ocean is one. As

> further evidence in favor of this they quote the case of elephants, a species occurring in each of these extreme regions, suggesting that the common characteristic of these extremes is explained by their continuity. Also those mathematicians who try to calculate the size of the earth's circumference arrive at the figure only that the earth's mass is spherical, but also that as compared with the stars it is not of great size, 400,000 stades. This indicates not only that the earth's mass is spherical, but also that as compared with the stars it is not of great size.

Leaving aside Aristotle's estimate of the earth's circumference, which is about twice too large, it is easy to see why Columbus seized upon this passage. Aristotle, the supreme authority for the Middle Ages, suggests that Asia may stretch right around the globe, perhaps joining Africa, or at least that both are washed by the same sea. Hence one could easily reach Asia by setting off westward, across the all-encompassing sea.

This, at least, was the theory. It was buttressed by many more classical references, as well as by medieval legends of islands to the west and even by odd sightings of worked wood cast up on the beaches of the Atlantic islands. But still to be overcome was a tremendous psychological barrier, the ancient belief that nothing lay beyond the *Pillars of Hercules*. This belief was enshrined in the motto ne plus ultra, *there is nothing beyond,* a phrase echoed in al-Mas'udi's account of the statues which point as if to say: *'There is no way beyond me....'*

For the classical world, the *Columnae Herculis*, the *Pillars of Hercules*, were not actual pillars - or light-houses - but two mountainous points on either side of the Strait of Gibraltar, Calpe and Abyla: the Rock of Gibraltar and the mountainous point of al-Mina, where the city of Ceuta now stands on the ruins of Phoenician Abyla. The Phoenicians sailed through the *Pillars of Hercules* around 1100 BC and founded their first Atlantic port, *Gadir* [Fortified Place] where the city of Cádiz now stands. Somewhere in the hinterland lay the fabulous region - or perhaps city - known to the classical world as *Tartessos* and in the Bible as *Tarshish*. The Phoenicians established a rich trade with the eastern Mediterranean world in gold and silver from the rich mines of *Tartessos*. They also opened an Atlantic sea-route to the *Cassiterides*, the "Tin Islands," probably somewhere in Britain, and to the Baltic, where they traded for amber. Tin was a vital component in the making of bronze; amber was used for ornament. The Phoenicians had a virtual monopoly of both, and they jealously guarded it, sinking any rival ships that ventured into the western Mediterranean. They regarded their trade routes as state secrets, and classical sources cite at least one Phoenician trading vessel that ran aground rather than let a rival learn its course.

The Phoenicians and their successors, the Carthaginians, established trading colonies along the coast of north and west Africa. Anticipating Portugal's Prince Henry Navigator by some 2,000 years, they also made a number of efforts to circumnavigate Africa. One of these, sponsored by the Egyptian Pharaoh Necho II, took place about 600 BC. Herodotus, who calls Africa *Libya* and the Red Sea *the Arabian Gulf*, is our only source of information about this voyage. Here is how he describes it.

> As for Libya, we know that it is washed on all sides by the sea except where it joins Asia, as was first demonstrated, so far as our knowledge goes, by the Egyptian king Neco, who, after calling off the construction of the canal between the Nile and the Arabian Gulf, sent out a fleet manned by a Phoenician crew with orders to sail west-about and return to Egypt and the Mediterranean by way of the Straits of Gibraltar. The Phoenicians sailed from the Arabian Gulf into the southern ocean, and every autumn put in at some convenient spot on the Libyan coast, sowed a patch of ground, and waited for next year's harvest. Then, having got their grain, they put to sea again, and after two full years rounded the Pillars of Hercules in the course of the third, and returned to Egypt. These men made a statement - which I do not myself believe, though others may - to the effect that as they sailed on a westerly course round the southern end of Libya, they had the sun on their right - to northward of them. This is how Libya was first discovered to be surrounded by sea....

There is no reason to doubt that this voyage took place. What Herodotus, and the Greek geographers that succeeded him, found difficult to accept was the sheer size of Africa. The consensus of opinion, made orthodox by Ptolemy, was that Africa extended little beyond 17° south latitude. Herodotus appears to have believed the same, hence his disbelief of the assertion that the sun was on the Phoenician voyagers' right.

Most pre-Ptolemaic Greek geographers did accept that Africa was bounded on all sides by the sea, except where it joined Asia. Ptolemy, however, supposed that not far below the Horn of Africa, the continent trended to the east, eventually joining the Chinese mainland and making of the Indian Ocean a landlocked sea. He may have been influenced in this by the passage from *De Caelo*, where Aristotle suggests that the presence of elephants in both Asia and Africa might indicate that the two continents were contiguous. Ptolemy compounded his error by postulating the existence of a huge "Southern Continent," a *Terra Australis*, to the south of Africa. This imaginary continent did not finally disappear from European maps until the early 18th century.

The Phoenician circumnavigators of Africa were practical seamen unhampered by theory. The Carthaginians, as the Phoenician colonists in the western Mediterranean came to be known, must have been aware of their compatriots' clockwise circumnavigation of Africa. Sometime before 480 B.C., the Carthaginians sent a large expedition of their own, under a leader called Hanno, in the opposite direction. A Greek version of the original Punic account of this voyage makes it clear that Hanno reached a long way south, past the volcanic mountain he called *The Chariot of the Gods* - probably the 998-meter-high (3,273-foot) Mt. Kakoulima in present-day Guinea - and as far as Sierra Leone. On the way he discovered both the Canary and Cape Verde Islands, so important later as staging points for trans-Atlantic voyages. The Cape Verde Islands were not rediscovered until 1455.

The Canaries are a classic example of how ancient discoveries were made and then lost. Discovered by Hanno in the fifth century BC, they were explored and colonized in 25 B.C. by Juba II, erudite king of Mauretania and husband of Cleopatra Selene, daughter of Antony and Cleopatra. A passionate art collector, Juba was also interested in science and technology, inventing a new method of making purple dye from the orchil plant - and the export of orchil from the Atlantic islands was of economic importance until early this century. Juba populated the Canaries with Berber-speaking colonists, perhaps the ancestors of the Guanches. Gradually, knowledge of the location of the Canaries was lost, even though Lanzarote, the island nearest the North African coast, lies less than 100 kilometers (60 miles) west of the mainland. The Greeks called the Canary Islands *Tōn Makarōn Nēsoi*, "The Islands of the Blessed," and they were regarded as the furthest known land to the west. Ptolemy drew his 0° longitude line, or prime meridian, through the Canaries; the French continued to do so until the 19th century.

The Canary Islands were rediscovered in the 13th century by a French or Genoese ship blown off course. In 1402 the Normans partially conquered them, meeting stiff resistance from the indigenous Guanches. In the mid-15th century, the Spanish took control of the Canaries and continued the conquest. Fighting was still going on when Columbus used the islands as the first stop on all four of his voyages to the Caribbean. The Guanches were not finally subdued until the end of the 16th century, when they and their language virtually disappeared. From the few words of Guanche preserved in the Spanish chronicles, we know they spoke a form of Berber, and were therefore probably descended from Juba's colonists. Yet when Europeans encountered them, they had no memory of the mainland; having no boats, they were unaware that the other islands in the group were inhabited.

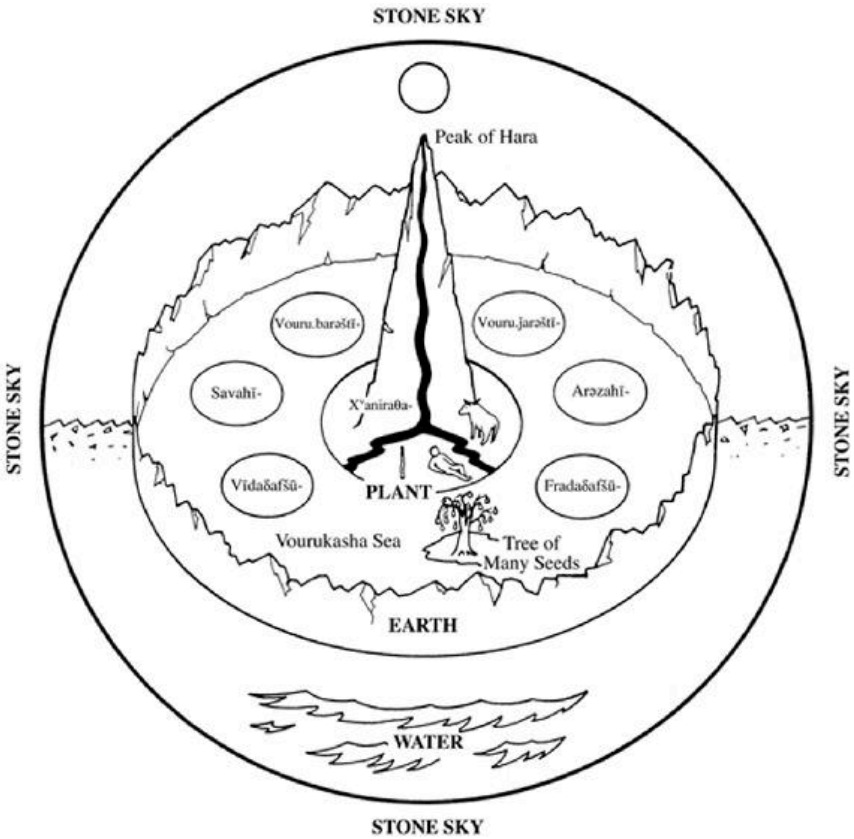
Islamic Cartography.

HAFT KEŠVAR [seven regions] was the usual geographical division of the world in Iranian tradition. Ancient Iranians, who, like the Europeans, may have believed in a tripartite division of the earth, developed an orderly picture of the world, envisioned as vast and round and encircled by a high mountain (*harā bərəzaitī*). The earliest form of the name, *Harā bərəzaitī*, denotes in the *Avesta* and in *Zoroastrian* writings not the existing range, but a mythological mountain chain fulfilling a cosmological function at either end of the world.

According to this tradition, the world was divided into seven (circular) regions (*karšvar*, hence a tract of land bordered by a ploughed line). These regions were imagined as separated from one

another by forests, mountains, or water, six flanking a central one called in *Avesta Xvaniraθa-* [self-made, not resting on anything else], which equaled in size all the rest combined and surpassed them in prosperity and fortune. Originally only this continent was inhabited by man and the fabled home of the Aryans (*Airyō.šayana-*) was located there, but the *Čihrdād nask* had described how men propagated and scattered into other regions and formed different races and rites. Sovereignty over all the seven regions was claimed by Iranian hero-kings. Hence, several expressions denoting "king of the seven regions" came to be used as synonyms for "king of Iran". The concept of the "seven regions" had Indo-Aryan roots and despite some claims, was independent of the Mesopotamian world view, which pictured the earth as forming the middle level of the cosmos and consisting of a highly civilized core surrounded by four regions inhabited by savages with negative characteristics.

The Iranian concept is alluded to in the *Gāθās* of Zoroaster and fully attested in the *Avestan* hymn to Mithra, which describes the god as surveying at dawn the "whole *Airyō.šayana-*" and flying "over all regions *(vīspāhu karšvōhu*)," namely, *Arəzahī-* [east], *Fra-daδafšu-* [southeast], *Vīdaδafšu-* [southwest], *Savahī-* [west], *Vouru.barəštī-* [northwest], *Vouru.-jarəštī-* [northeast], and the splendid region of *Xvaniraθa-* (*Xᵛaniraθa- bāmī-*) in the center. The system influenced Zoroastrian eschatology. A spiritual leader watches over each region, and the six comrades of *Astvat.ərəta* will, according to *Dādestān ī Dēnīg* rise with him to fulfill his mission in the six regions surrounding the *Xvaniraθa-*. Remarkably, they bear names symmetrically corresponding with those of the six *kešvars*. According to the *Māh ī Fravardīn rōz ī Hordād*, the hero Sām will rise again, kill Aži Dahāka, and assume the rulership of the seven regions, but he will deliver it to Kay Ḵosrow, who shall rule for fifty-seven years and then will turn the sovereignty to Vištāspa.



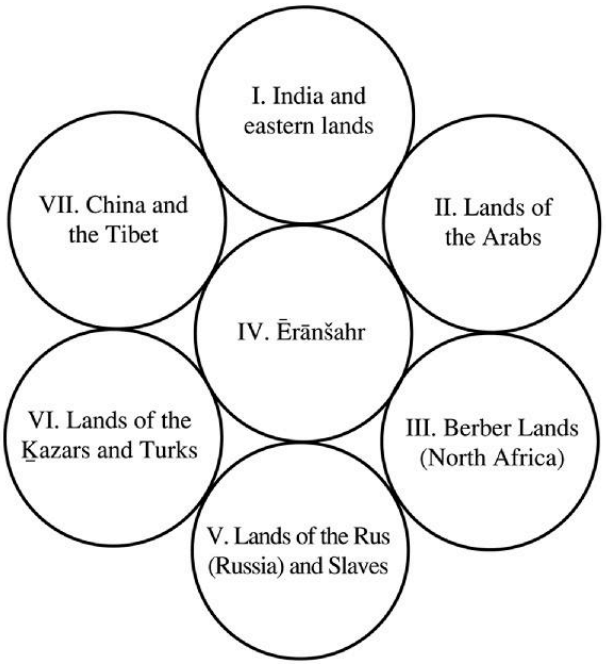
The world according to the Avesta.

The geographical knowledge of the Iranians greatly increased during the Achaemenid period (the First Persian Empire, 550–330 B.C.), when the empire was divided administratively into twenty taxation districts *(satrapies)* and ethnically into some thirty nations. Yet, the notion of the seven-fold division of the earth influenced Persian ideology. Darius the Great was thought to have divided his empire into seven parts and given them to the loyal colleagues who helped him recover the Persian throne; and an Aramaic document from Egypt dated in the reign of Darius II designating a district governor as *hptḥpt'*, from Iranian **haftaxʷapāta* "protector of one-seventh," shows that the division of a region into seven districts was a normal practice patterned after the Iranian cosmology of dividing the earth into seven *kešvars*.

The Parthian and Sasanian empires were also divided into provinces and principalities with no evident regard to the "seven regions" system. The later Sasanians had adopted the (Greek) division of the world into four quarters and administered Ērānšahr in four geographical sections (*kōst*s) of the north (*abāxtar*, identified as Ādur-bādagān), east (*xwarāsān*), south (*nēmrōz*) and the west (*xwarwarān*). The application of the geographical directions likewise influenced the doctrine of the seven-fold division of the earth. Thus the *Bunda-hišn*, while admitting that "there are 33 kinds of land", coordinates the seven regions with the four cardinal points, placing one in the east, one in the west and a pair in both north and south. The same is done by Ḥamza Eṣfahāni and *Tārik̲-e Sistān*.

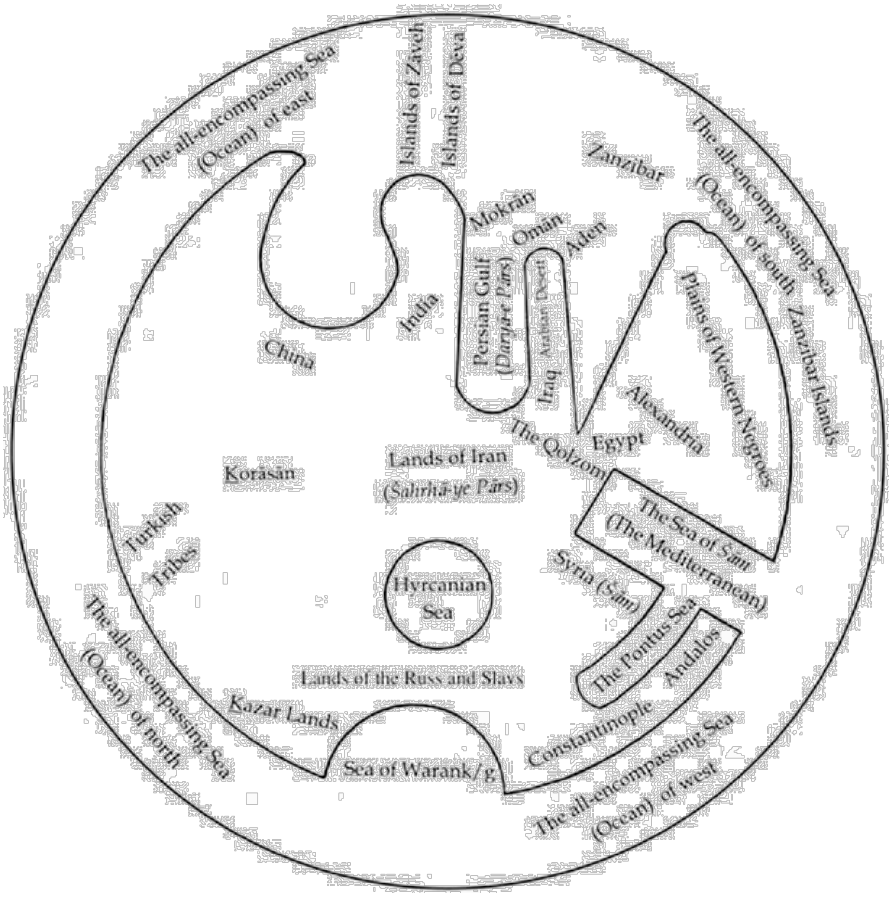
Similarly, the prologue to the *Šāh-nāma* of Abu Manṣur Moḥammad gives the following report by Qazvini from a source datable to about 620, when Sasanian troops had conquered Egypt: "the earth is divided into four directions (*čahār-sūy*) from one end to the other, and (also) into seven parts (*haft bahr*), each part of which they called a *kešvar*. The first is *Arzah*, the second *Ša-bah*, the third *Faradadafš*, the fourth *Vidadafš*, the fifth *Vurubarst*, the sixth *Vurujarst*, (and) the seventh, which is the center of the world, *K̲oniras-e bāmi* (splendid K̲oniras), and it is the one wherein we are, and the kings called it *Ērānšahr*." The same text then enumerates the countries of the world, from China to the Byzantine Empire, in accordance with the four directions, and again comes to *Ērānšahr*, claiming that it "is from the river of Egypt [the Nile] to the Āmuya" and "surpasses in every art the other *kešvars* surrounding it". Another elaborate Iranian scheme of the seven *kešvars*, similarly arranging known nations into six connected circles surrounding the central *Ērānšahr* was given by Abu Rayḥān Biruni, together with a sketch map, both reproduced by Yāqut. The *Ketābal-tafhim*, attributed to Biruni, and the anonymous *Mojmal al-tawārik̲* give a simpler version of the scheme.

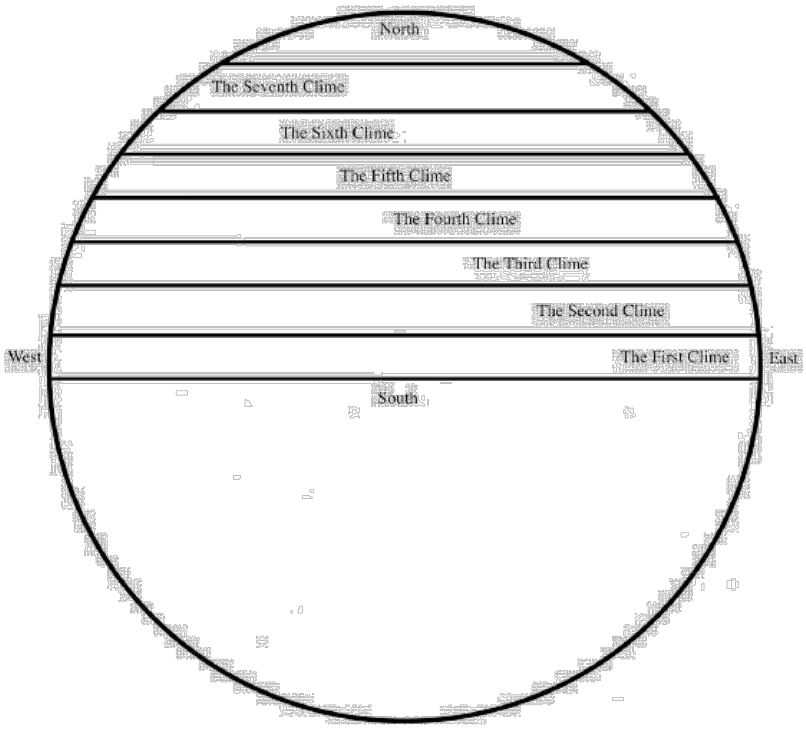
Further developments came as the result of familiarity with the Greek tradition of dividing the terrestrial sphere into four quarters, two above and two below the Equator, and holding that only the



 The Seven Regions according to late Sāsānian and early Islamic scholastic views.

one covering the continents of Asia, Africa and Europe, was habitable. This quarter contained various nations living in a number of *klima*s, "climes" or regions (24 according to Ptolemy but seven in Pliny, *Natural History* 6.34). Muslim scholars adopted this scheme, and recorded quite accurate geographical data and maps. Some such as Yaʿqūbi, the author of the *Ḥodud al-ʿālam*, Iṣṭaḵhri, Ibn Ḥawqal, and Moqaddasi *(see Book II, #211, #213)* rejected the doctrine of the seven *kešvars*; others adapted the system of *klimas* (*aqālim*, sg. *eqlim*) to their factual descriptive geography of administrative and political entities; and some such as Masʿudi *(see Book II #212)* could not escape the influence of the traditions of Iran and Mesopotamia (Miquel). Ibn Kordāḏ-beh starts with a description of the spherical earth divided into four quarters and then explains: "We live in the northern quarter, and the southern quarter is desolate because of heat; the other half, which is below (i.e., on the other side of) us, is uninhabited. Each quarter, whether in the north or south, is divided into seven *eqlims*. Ptolemy mentions in his book 4,200 towns which flourished at his time." Characteristically, Biruni *(see Book II, #214.3)* remarked that restricting the inhabited lands to one quarter was unscientific and that one logically expected inhabited quarters on the other side of the globe as well.



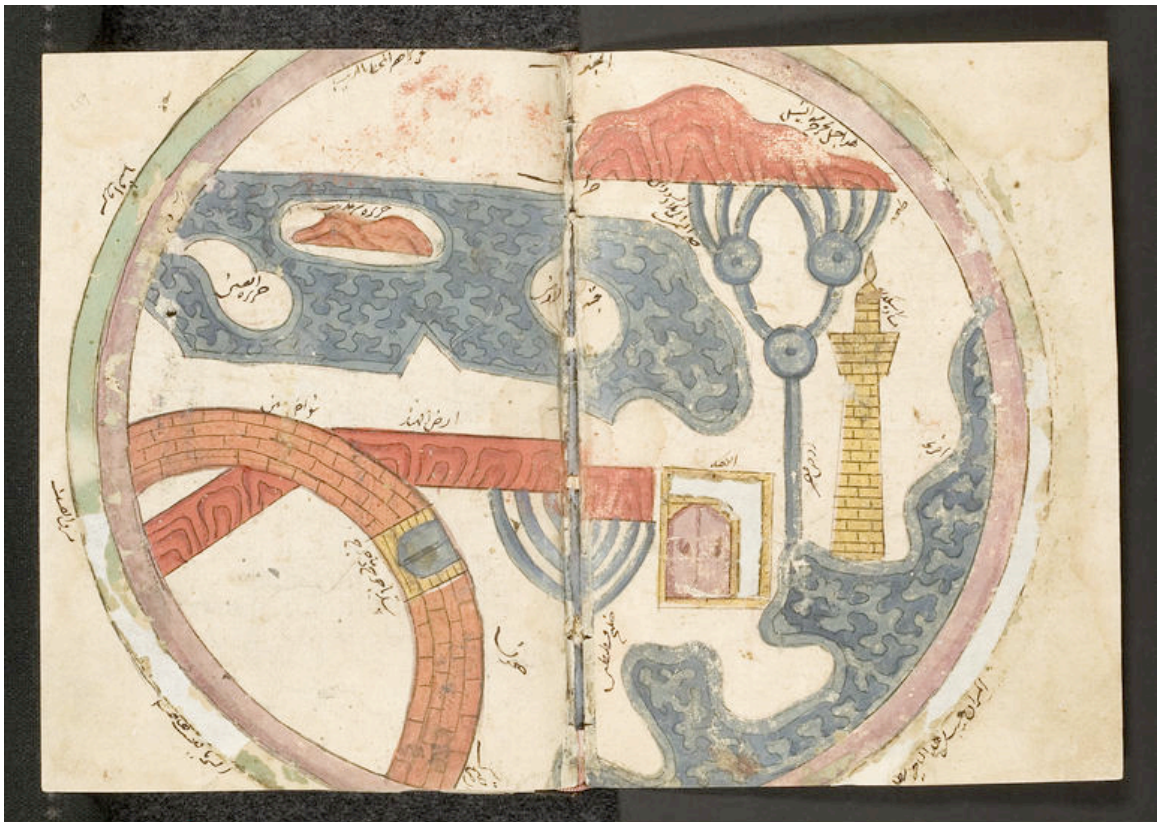


The world according to early Islamic scientists.
The Seven Climes (early Islamic adaptation of the Ptolemaic view).

In due course and under the influence of astronomers, the seven *eqlims* came to be pictured as seven tracts of land above and parallel to the equator, each belonging to a planet and associated with one or two signs of the zodiac (Miquel). The specifically Iranian (as against the Roman) system is given by Yāqut (*Boldān* I), Masʿūdī (*Muruj* I) and Eḵwān al-Ṣafā (*Rasāʾel* I) as follows: The first *eqlim* belonged to *Kayvān* [Saturn] and associated with Capricornius and Aquarius; the second *eqlim* belonged to *Hormoz* [Jupiter] and associated with Sagitarius and Pisces; the third one belonged to *Bahrām* [Mars] and associated with Aries and Cancer; the fourth one belonged to *Ḵaršād* [*ḵoršid* 'sun'] and associated with Leo; the fifth one belonged to *(A)Nāhid* [Venus] and associated with Taurus and Libra; the sixth *eqlim* belonged to *Tir* [Mercury] and associated with Gemini and Virgo; and number seven belonged to *Māh* [the moon] and associated with Cancer. It is this scheme that Nezāmi Ganjavi elaborated in his *Haft-peykar*, describing how Bahrām Gōr married seven princesses from seven lands and built for them seven palaces painted in the colors of the seven planets, who are also the lords of the seven days of the week.

Only in the manuscripts in Paris and Heidelberg (fols. 258b-259a), a map of the world precedes the diagram of the *Haft eqlim*. Within the circle that marks the known parts of the world, the east is located on the left side. The map shows the wall of *Gog and Magog* and the Nile with its sources, as

well as China, India, Sri Lanka (*Jazira-ye Serendib*), Europe (*Afranja*), and some important cities such as Jerusalem, Tangier, Alexandria (tower), and Mecca.



Iranian world map, 16th century, Universitats Bibliothek Heidelberg

Map Orientation

The orientation of a map is the relationship between the directions on the map and the corresponding compass directions in reality. The word "orient" is derived from Latin *oriens*, meaning East. In the Middle Ages many maps, including the T-O maps, were drawn with East at the top (meaning that the direction "up" on the map corresponds to East on the compass). Today, the most common – but far from universal – cartographic convention is that North is at the top of a map. Several kinds of maps are often traditionally not oriented with North at the top:

- Maps from non-Western traditions are oriented a variety of ways. Old maps of Edo show the Japanese imperial palace as the "top", but also at the centre, of the map. Labels on the map are oriented in such a way that you cannot read them properly unless you put the imperial palace above your head.
- Medieval European T and O maps such as the *Hereford mappamundi (Book IIB, #226)* were centered on Jerusalem with East at the top. Indeed, prior to the reintroduction of Ptolemy's *Geography* to Europe around 1400, there was no single convention in the West. *Portolan charts (Book IIIB, #250.1),* for example, are oriented to the shores they describe.
- Maps of cities bordering a sea are often conventionally oriented with the sea at the top.
- Route and channel maps have traditionally been oriented to the road or waterway they describe.
- Polar maps of the Arctic or Antarctic regions are conventionally centered on the pole; the direction North would be towards or away from the centre of the map, respectively. Typical maps of the Arctic have 0° meridian towards the bottom of the page; maps of the Antarctic have the 0° meridian towards the top of the page.
- Reversed maps, also known as Upside-Down maps or South-Up maps, reverse the "North is up" convention and have South at the top.

Maps are usually created from a particular direction. The directionality of a map is known as its orientation. The popularity of online mapping such as Google Maps has conditioned many people to expect due north to always be towards the top of the map and south towards the bottom. Historically, maps have not always been oriented north. Different geographic and religious influences have changed over time how maps are oriented. Aesthetics, political interests, egotism, and navigation are some of the other reasons why cartographers over the ages have used different map orientations.

North Orientation Maps

Claudia Ptolemy (90-168 AD), a classical Greek cartographer was credited with creating the first known atlas. His collection of cartography in Geographia, was an early example of orienting maps towards the north. North orientation came back into favor during the Great Age of Exploration with the need for seafaring explorers to orient themselves with their compasses. The importance of orienting maps towards the north was a reflection of the importance of knowing where magnetic north was. Today, a north orientation is commonplace among many cartographers and almost all online mapping applications.

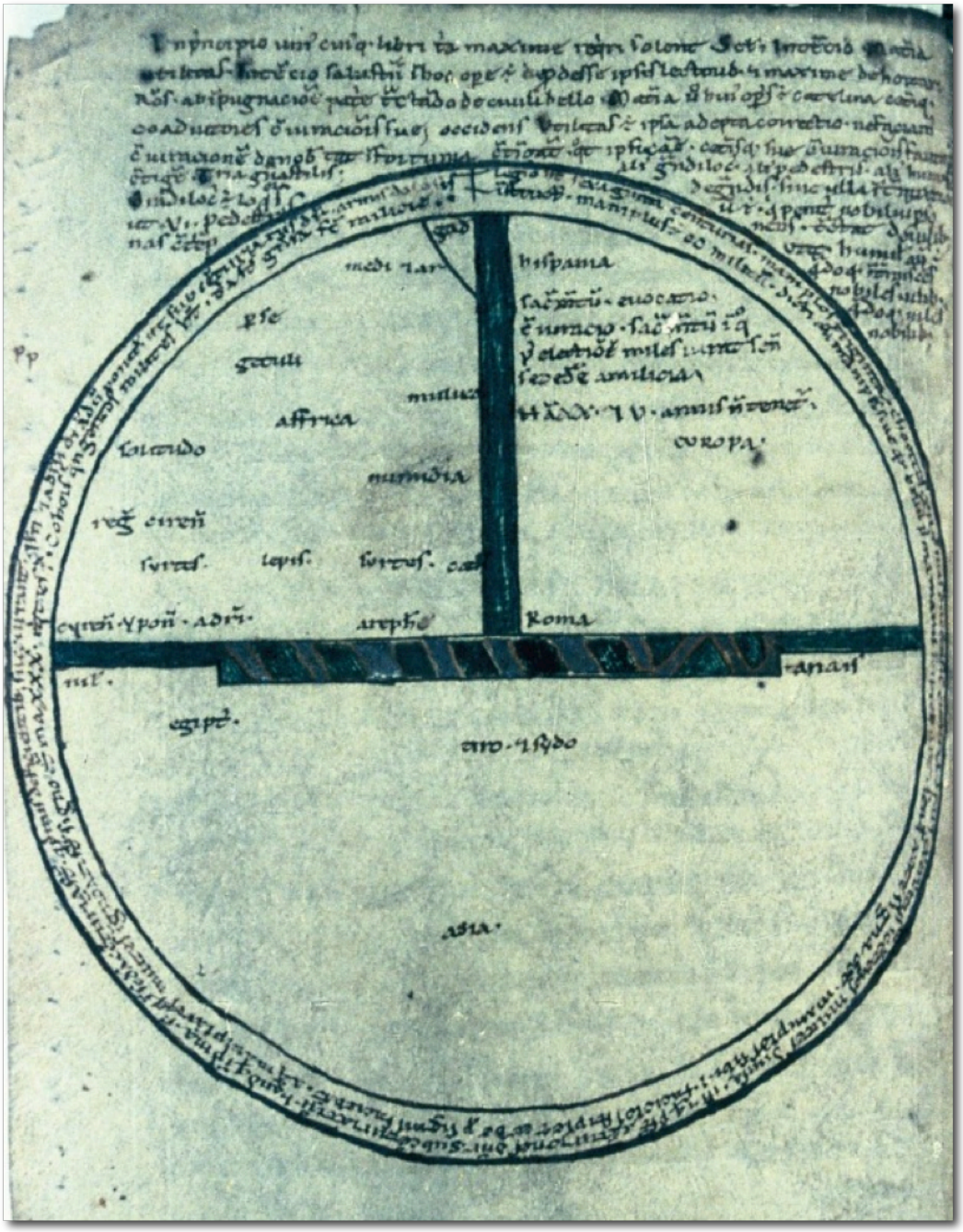
East Orientation Maps

During the medieval age religious doctrine influenced cartography. European cartographers oriented their maps towards the Holy Land since Jerusalem was the place of Christ's death and resurrection. In fact, the world "orient" comes from the Latin word "oriens", meaning East. And there was a long stretch in the medieval era when most European maps were drawn with the East on the top. If there was any doubt about this move's religious significance, they illuminated it with their maps' pious illustrations, whether of Adam and Eve or Christ enthroned. Examples of maps with an east orientation are the *mappamundi* (Medieval European world maps) such as the T-O map. The T-O maps was a symbolic representation of the world, with the O representing boundary of the world, encircled by the earth's oceans. The T nested inside the O divided the world into the Northern Hemispheres' three continents: Asia at the top, Europe to the left, and Africa to the right (the southern hemisphere was ignored as it was considered inhabitable at the time). The horizontal bar of the T represented the

Mediterranean Sea and the vertical portion of the T the Nile and Don Rivers. Heavily influenced by Christianity, European cartographers in medieval times oriented the maps so that east was at the top where the sun rose and the Paradise was thought to lie.

Oriented with East at the top, this map in a state intermediate between a T-O map and a mappamundi. Map with its center Delos, following a Greek tradition; the compass-drawn circle is the Cyclades, in French manuscript of Henry of Huntingdon, Ymago Mundi. The Mare Occeanum is a necklace of red and blue uncials. Late 13th century, 15 cm diameter, Oxford University, MS.e.Mus. 223, fol. 185r. (#205Z16)

West Orientation Maps
There aren't a lot of west orientation maps, below are two examples.



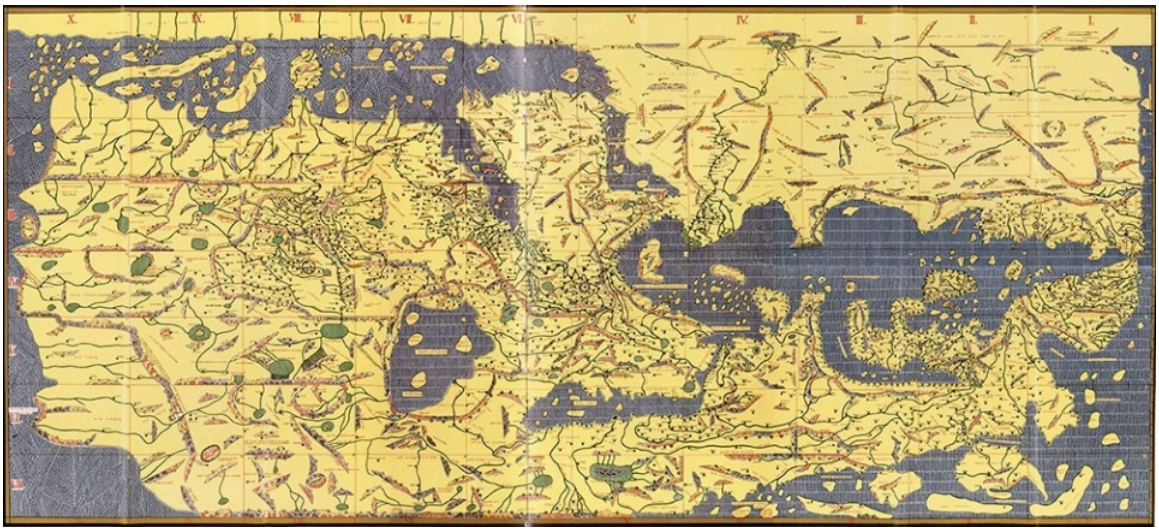
An 11th century Flemish (St. Pierre, Ghent) Sallust map, oriented with West at the top, 11 cm diameter.

A 1635 map of New Netherlands and New England
created by Dutch cartographer Willem Blaeu shows a West orientation.

South Orientation Maps

Maps with south oriented towards the top of the map are known as south-up or reverse maps, since the map appears upside down to those used to a map orientation towards the north. In these maps, South is oriented the top of the map, east is towards the left of the map and west towards the right.

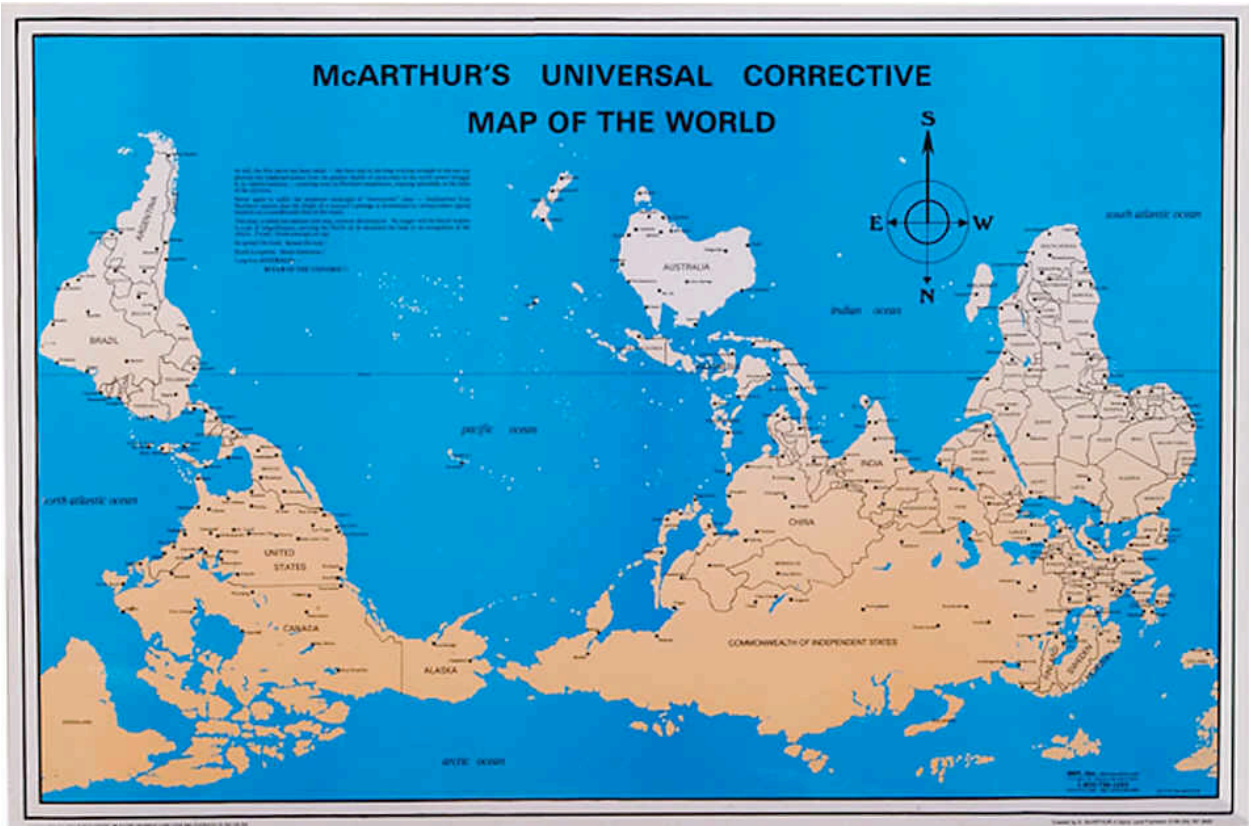
Some of the very earliest Egyptian maps show the South as up, presumably equating the Nile's northward flow with the force of gravity. Arab mapmakers often drew maps with the south facing up, possibly because this was how the Chinese did it. Arab cartographers like Ibn Hawqal *(Book IIB, #213)* commonly use a South map orientation; in the 10th century he created a world map with South at the top. The Moroccan cartographer, Muhammad al-Idrisi, drew a world map in 1154 commonly known as *Tabula Rogeriana* (Book of Roger) for King Roger II of Sicily *(Book IIB, #219),* showing south at the top of the map. In Europe, the famous Fra Mauro world map of 1459 employed a South orientation *(Book IIIB, #249).*



The 1154 map, Tabula Rogeriana (Book of Roger) for King Roger II of Sicily, showing South at the top of the map (Book IIB, #219).

The famous 1459 Fra Mauro mappamundi, Biblioteca Nazionale Marciana, Venice, Italy, 6.3 feet diameter oriented with South at the top (Book IIIB, #249).

Cartographers from the Dieppe School of Cartography in the 16th century produced table maps with a South orientation (shown above is one showing Southeast Asia and Australia). Pierre Desceliers, a French cartographer during the Renaissance creating a world map in 1550 meant to be viewed around a table and showed parts of the world turn towards the south. In 1566 Nicolas Desliens also created a map of the world showing South towards the top. The map is currently housed in the Bibliothèque Nationale in Paris. In contemporary cartography, South-up maps are mostly created to protest Western Hemisphere bias in some world maps. Launched on Australia day, Stuart McArthur premiered his *Universal Corrective Map* that showed a South orientation.



No Unified Orientation

Maps produced during the Golden Age of Japanese Cartography from the 1600's to around 1855 had no standard orientation. Many maps had a center orientation radiating from the palace in Edo or no apparent directional orientation. It wasn't was until the influx of foreign influences starting with Commodore Perry's Expedition in the 1850's that Japanese cartography started to adopt western traditions of orienting maps towards the north.

Custom Orientations

Not all maps are oriented due North, South, East, or West. Some maps have a custom orientation to promote a political purpose or to help with navigation. For example, maps created by the City of Santa Monica have a rotation of 46 degrees so that the beach is always shown at the bottom of maps. This is done for aesthetic purposes and results in an orientation that is northeast instead of due north.

The New York City Department of Transportation places pedestrian friendly maps around the city with the orientation rotated to be "heads-up" or forward-facing so that viewers are facing the map in the same direction they standing for readability. This helps pedestrians to better orient themselves in relationship to the landmarks on the map and to better navigate the city. Polar Maps of the Arctic and Antarctica have custom projections with orientations towards the poles.

Septentrionalium terrarum descriptio (1595), North polar map by Gerard Mercator

There is nothing inevitable or intrinsically correct — not in geographic, cartographic or even philosophical terms — about the North being represented as up, because up on a map is a human construction, not a natural one.

Beginning in the Mediterranean, somewhere between Europe and the Arab world in the 14th and 15th centuries, increasingly precise navigational maps of the Mediterranean Sea and its many ports called *portolan* charts appeared. They were designed for use by mariners navigating the sea's trade routes with the help of a recently adopted technology, the compass. These maps had no real up or down — pictures and words faced in all sorts of directions, generally pointing inward from the edge of the map — but they all included a compass rose with north clearly distinguished from the other directions.

Members of the Italian Cartographic School preferred to mark North with a hat or embellished arrow, while their equally influential colleagues from the Spanish-ruled island of Majorca used an elaborate rendering of Polaris, the North Star. These men, who formed the Majorcan Cartographic School, also established a number of other crucial mapping conventions of the era, including coloring in the Red Sea bright red and drawing the Alps as a giant chicken foot.

But this is only part of the explanation. The arrow of the compass can just as easily point South, since the magnetized metal needle simply aligns with the earth's magnetic field, with a pole at each

end. Indeed, the Chinese supposedly referred to their first compass magnets as South-pointing stones. Crucially, the Chinese developed this convention before they began to use compasses for navigation at sea. By the time Europeans adopted the compass, though, they were already experienced in navigating with reference to the North Star, the one point in the heavens that remains fixed anywhere in the Northern Hemisphere. Many mariners saw the compass as an artificial replacement for the star on cloudy nights and even assumed it was the pull of the star itself that drew the needle North.

Yet even as this North-pointing compass became essential to navigation and navigational charts in the 15th century, less precise land maps showing the entire known Old World continued to offer a disorienting array of perspectives. Some had the East on top, in keeping with European tradition, while others preferred the South, in keeping with Arab tradition, and others went with the North, in keeping with the point on the compass rose. Among other things that stand out in these maps is that, given the extent of the known world, the location of the Mediterranean and a bit of uncertainly about the equator, Italy was more or less centered between the north and the south — meaning that whichever way you turned the map, Italy remained more or less halfway between the top and bottom. Conveniently, Italy was at roughly the same latitude as Jerusalem, which through most of the European medieval mapmakers assumed was at the center of the known world. In fact, the first blow to this pious assumption came with the discovery of just how much of the Old World lies to the East of Jerusalem. Only later did it become apparent just how far North of the equator Jerusalem — and by extension, Italy — really was.

The North's position was ultimately secured by the beginning of the 16th century, thanks to Ptolemy, with another European discovery that, like the New World, others had known about for quite some time. Ptolemy was a Hellenic cartographer from Egypt whose work in the second century A.D. laid out a systematic approach to mapping the world, complete with intersecting lines of longitude and latitude on a half-eaten-doughnut-shaped projection that reflected the curvature of the earth. The cartographers who made the first big, beautiful maps of the entire world, Old and New — men like Gerardus Mercator, Henricus Martellus Germanus and Martin Waldseemüller — were obsessed with Ptolemy. They turned out copies of Ptolemy's *Geography* on the newly invented printing press, put his portrait in the corners of their maps and used his writings to fill in places they had never been, even as their own discoveries were revealing the limitations of his work.

For reasons that have been lost to history, Ptolemy put the North at the top of his maps. Or at least that's the way it appears from the only remaining copies of his work, made by 13th century Byzantine monks. On the one hand, Ptolemy realized that, sitting in Alexandria, he was in the northern half of a very large globe, whose size had been fairly accurately calculated by the ancient Greeks. On the other hand, it put Alexandria at the very bottom of the inhabited world as known to Ptolemy and all the main civilizational centers in the Greco-Roman Mediterranean.

Even if compasses and Ptolemy had both pointed to the south, northerners could still have come along and flipped things around. In fact, with North seemingly settled at the top of the map in the 16th century, there were still some squabbles over who in the Northern Hemisphere would end up left, right or center. The politics of reorientation are anything but simple. For Americans, it's easy to think that our position, at the top-left of most maps, is the intrinsically preferable one; it certainly seems that way if you happen to be from a culture that reads from left to right. But it's unclear why Arabs or Israelis, who read from right to left, would necessarily think so. And while map makers usually like to design maps with the edges running through one of the world's major oceans, it is certainly possible to put North America in the very center by splitting the world in half through Asia.

The orientation of our maps, like so many other features of the modern world, arose from the interplay of chance, technology and politics in a way that defies our desire to impose easy or satisfying narratives.

Borders.

You will notice on the maps/reconstructions from the ancient and medieval periods that country boundaries (and even continental boundaries) were displayed differently than today, even conflicting or confusing as to what area is defined. As today, but even more so in the distant past, country boundaries were "flexible" and constantly changing. To establish and maintain the sovereign boundaries of countries, the ruling power was required to "enforce" the integrity of those boundaries by force. The idea of establishing, recognizing and honoring the integrity of "sovereignty" is a relatively recent concept. Therefore, if country (or continental) boundaries are displayed on these early maps, they are rather vague and/or not universally accepted by all cartographers. Obviously in ancient times there were no "countries" as we define them today, only various size settlements that eventually grew into city-states, controlled territories, etc. Examples include Babylon, Troy, Thrace, Sparta, Phoenicia, Egypt, Bactria, Hyrcania, Sogdiana, etc.

On the ancient and medieval maps place-names are given for general geographical areas/regions, without any explicitly drawn-out borders/boundaries, such as *Gallia, Germania, Hispania, Seres, Scythia, Assyria, Syria, Persia, Ethiopia, Macedonia, Arabia, Albania, Armenia, Phyrgia*, and *India*. On these early maps, such political areas were not much differentiated from the levels given to the "continents" of *Europa*, *Asia* and *Libya* [Africa], especially on the medieval *Macrobian* and *Isidorean T-O* maps *(Book IIA, #201, #205).* Some cities received the same emphasis as these larger entities, such as Rome, Babylon, Constantinople, Jerusalem, Ravenna and Antioch. Many of these political areas became known as "empires" encompassing large, vaguely defined areas.

Some maps were merely trying to identify the race or group of people that occupied a particular area, such as the *Celts* and *Ethiopians*. Also the very fact that country boundaries were/are constantly changing with shifts in political/military power. Other areas, such as the island of *Taprobana*, are not identified as "countries", "continents" or cities. Most recently the issue of Crimea is an example of the rapidly changing world map, not to mention the tremendous changes after the fall of the Soviet Union, World War II, the Ottoman Empire, the European colonization period, the Mongolian invasion, or the Roman Empire. During the decline of the Roman Empire, Europe entered a long period of change arising from what historians call the "Age of Migrations". There were numerous invasions and migrations amongst the Ostrogoths, Visigoths, Goths, Vandals, Huns, Franks, Angles, Saxons, Slavs, Avars, Bulgars and, later on, the Vikings, Pechenegs, Cumans and Magyars.

From the seventh century, Byzantine history was greatly affected by the rise of Islam and the Caliphates. Muslim Arabs first invaded historically Roman territory under Abū Bakr, first Caliph of the Rashidun Caliphate, who entered Roman Syria and Roman Mesopotamia. Under Umar, the second Caliph, the Muslims decisively conquered Syria and Mesopotamia, as well as Roman Palestine, Roman Egypt, and parts of Asia Minor and Roman North Africa. This trend continued under Umar's successors and under the Umayyad Caliphate, which conquered the rest of Mediterranean North Africa and most of the Iberian Peninsula. Over the next centuries Muslim forces were able to take further European territory, including Cyprus, Malta, Crete, Sicily and parts of southern Italy. In the East, Volga Bulgaria became an Islamic state in the 10th century.

In medieval times, due to lack of border demarcations and the rule of force, few borders were fixed for long, or could be even approximately determined. Consequently, most medieval maps lack bordering lines between countries which are shown just by mentioning their names somewhere in the area they occupied.

Conclusion.

In reaching a concluding assessment of the conceptual and practical status of cartography in the ancient world, several themes emerge. Even if allowance is made for the severe lack of map artifacts from the period, it is possible to conclude from literary evidence that no one civilization had a monopoly on a particular variety or function of map and that the number of map functions was considerable. In Mesopotamia and in Egypt, in the Greek and Roman centers and in China, both celestial and terrestrial maps existed. Large-scale maps, fulfilling a multitude of functions, were also found in all these societies, although it must be said that there is more evidence for the use of maps in the Roman Period than in other periods of antiquity. These functions included the use of maps as

cadastral and legal records, as aids to the traveler, to commemorate military and religious events, as strategic documents, as political propaganda, and for academic and educational purposes. Whereas up to about 170 B.C. maps were apparently unfamiliar to most Romans, after that date their use increased steadily. But while the evidence for the use of maps in Roman society is more plentiful, it should not be forgotten that similar uses are likely to have been present in civilizations normally regarded as having a less practical bent, such as classical Greece and China.

Maps varied considerably in scale, from depictions of the cosmos and the universe at one end of the continuum to large-scale plans of rooms or tombs at the other end. The extent to which the makers of maps in the ancient world were aware of the concept of a metrical scale is still not settled. We have apparently accurate Babylonian plans of properties, houses, temples, cities, and fields from about 2300 to 500 B.C., and there is evidence of the use of some sort of graphic scale on the plan on the statue of Gudea (ca. 2,100 B.C.). But it is not until later in the period that a clear concept of ratio is explicit, when an instruction in the *Corpus Agrimensorum* is thought to refer apprentice surveyors to a scale of 1:5,000, corresponding to one Roman foot to a Roman mile, and the *Forma Urbis Romae* may have been consciously planned at a general scale of 1:240 or 1:250.

The orientation of these early maps varied. Unlike one Babylonian map (the clay tablet of Nuzi), classical maps do not contain an explicit indication of the cardinal points, but north must have been at the top in the archetypes of with the inhabited world occupying an upper quadrant and the *climata* in parallel zones perpendicular to the earth's axis, may also have encouraged the early use of north as a primary orienting direction. South and east may also have been favored in the Middle East long before their established use by Arabic and Christian mapmakers.

The accuracy of maps in this early period varied appreciably. The Greeks were great sailors and astronomers whereas the Romans were above all road makers, soldiers, and farmers. Perhaps had more Egyptian maps been preserved, we should find in at least some of them the degree of accuracy manifest in the pyramid measurements. Since calculation of distances on sea routes was always more difficult and astronomical bearings were used rather sporadically, we may expect greater accuracy, where this mattered, in Roman than in Greek maps. Distances given in texts or on maps usually indicated the maximum length and width of a province, region, or island. Marinus, for instance, included some land distances as well as coordinates. His coordinates may have been based on a longitude running east of the Canaries, like Ptolemy's, and a latitude that either was similar to Ptolemy's or was based on Rhodes, though he was never consistent in giving both latitude and longitude. The idea of the use of coordinates was developed first in celestial cartography, itself a Greek rather than a Roman concern, and was later adapted for terrestrial use. It must be pointed out, however, that the precision of Ptolemy's coordinates of places, estuaries, and promontories was largely illusory, since few scientific measurements of longitude or perhaps even latitude had been made. Most of the figures were based on estimates of land or sea distances derived from sources of varying reliability.

The most comprehensive treatment of Greek and Roman cartography can be found in Heidel's *The Frame of Ancient Greek Maps*, Bunbury's *Ancient Geography*, Dilke's *Greek and Roman Maps*, and Harley's *The History of Cartography, Volumes One and Two* and Talbert's *Ancient Perspectives*. For a detailed discussion of Chinese cartographic efforts, see Needham's multi-volume *Science and Civilisation in China* and Smith's *Mapping China's World*.

Cartographic Silence.

In an article by Maria Magdalena Morawiecka (University of Wrocław) entitled "Terra incognita. On cartographic silence on old maps (Middle Ages and the beginning of the Early Modern Period)", Cartographic Silence is defined as "consisting of all that was rejected, undiscovered, withheld and invisible on maps" and exists under various forms. Its character would depend on factors such as its graphical form, origins or mental operations used to their creation. On the risk of sounding overdramatic, one could say that silences never sound the same and that every silence tells about something slightly different. As Christian Jacob (another author writing about a theory of the history of cartography) noted: "A map may display a view but it also provides the viewer with a point of view." Hence the famous blank spaces are simply a part of a much bigger problem.

Obviously no map can display all the possible information (both physical and cultural) and still be useful. Each map (printed or electronic (*Google,* et al) is designed with a "purpose" – navigation, topographic, political, propaganda, commercial, thematic, etc. And each purpose results in the cartographer not only selecting what to display but also what not to display. This process of "selection" and "silence" has always occurred in the mapmaking process. I like to make the analogy of a person responsible for putting together a daily news broadcast, newspaper or writing a book on world history. Obviously one cannot cover all the "news" in one broadcast or newspaper. There must be a selection process and hopefully some "balance" between all the events that have occurred (political, crime, human interest, science, local, national, international, etc.). Likewise, a book on the history of the world has to limit the content (political, military, geologic, technological, etc.). Therefore, authors of newspapers, books and maps need to choose a particular perspective, declare any particular bias, and stay consistent with their objectives. Mark Monmonier has exposed the darker side of mapmaking in his book *How to Lie with Maps* (1996). Some of the examples put forth in this book illustrate the concept of "cartographic silence", both deliberately to deceive, and accidentally by ignorance or mistake.

According to Monmonier not only is it easy to lie with maps, it is essential. To portray meaningful relationships for a complex, three-dimensional world on a flat sheet of paper or a video screen, a map must distort reality. As a scale model, the map must use symbols that almost always are proportionally much bigger or thicker than the features they represent. To avoid hiding critical information in a fog of detail, the map must offer a selective, incomplete view of reality. There is no escape from the cartographic paradox: to present a useful and truthful picture, an accurate map must tell white lies. All mapmakers need generalization and symbolization to highlight critical information and to suppress detail of lower priority. In short, the author warns, all maps must tell white lies.

Because most map users willingly tolerate white lies on maps, it is not difficult for maps also to tell more serious lies. Map users generally are a trusting lot: they understand the need to distort geometry and suppress features, and they believe the cartographer really does know where to draw the line, figuratively as well as literally. As with many things beyond their full understanding, they readily entrust map-making to a priesthood of technically competent designers and drafters working for government agencies and commercial firms. Yet cartographers are not licensed, and many map-makers competent in commercial art or the use of computer workstations have never studied cartography. Map users seldom, if ever, question these authorities, and they often fail to appreciate the map's power as a tool of deliberate falsification or subtle propaganda. In our world of changing political and strategic relationships and devolving nation-states, maps become propaganda tools. Turkish Cypriots, Sri Lankan Tamils, Crimean Russians publish maps that proclaim their political aspirations, fueling nationalisms that spell disaster for the state system. Some national governments even go so far as to commit cartographic aggression, mapping parts of neighboring countries as their own. Well before Iraq invaded Kuwait, official Iraqi maps had shown Kuwait as Baghdad's nineteenth province. Chinese maps today incorporate parts of what, on standard world maps, is northern India. Argentina prints postage stamps with a map showing hegemony over a sector of Antarctica that includes Chilean as well as British claims.

Because of personal computers and electronic publishing, map users can now easily lie to themselves—and be unaware of it. Before the personal computer, folk cartography consisted largely of hand-drawn maps giving directions. The direction giver had full control over pencil and paper and usually had no difficulty transferring routes, landmarks, and other relevant recollections from mind to map. The computer allows programmers, marketing experts, and other anonymous middlemen without cartographic savvy to strongly influence the look of the map and gives modern-day folk maps the crisp type, uniform symbols, and verisimilitude of maps from the cartographic priesthood. Yet software developers commonly have made it easy for the lay cartographer to select an inappropriate projection or a misleading set of symbols. Because of advances in low-cost computer graphics, inadvertent yet serious cartographic lies can appear respectable and accurate.

Cartographers working after the Age of Discovery were much more inclined to leave empty spaces on the maps than their predecessors, who actually knew fewer continents. It was in the 15th century too, when the inscription *terra incognita* becomes popular on the cartographic documents. Although the medieval cartographers debate on the possible existence of the *Antipodes*, short of the

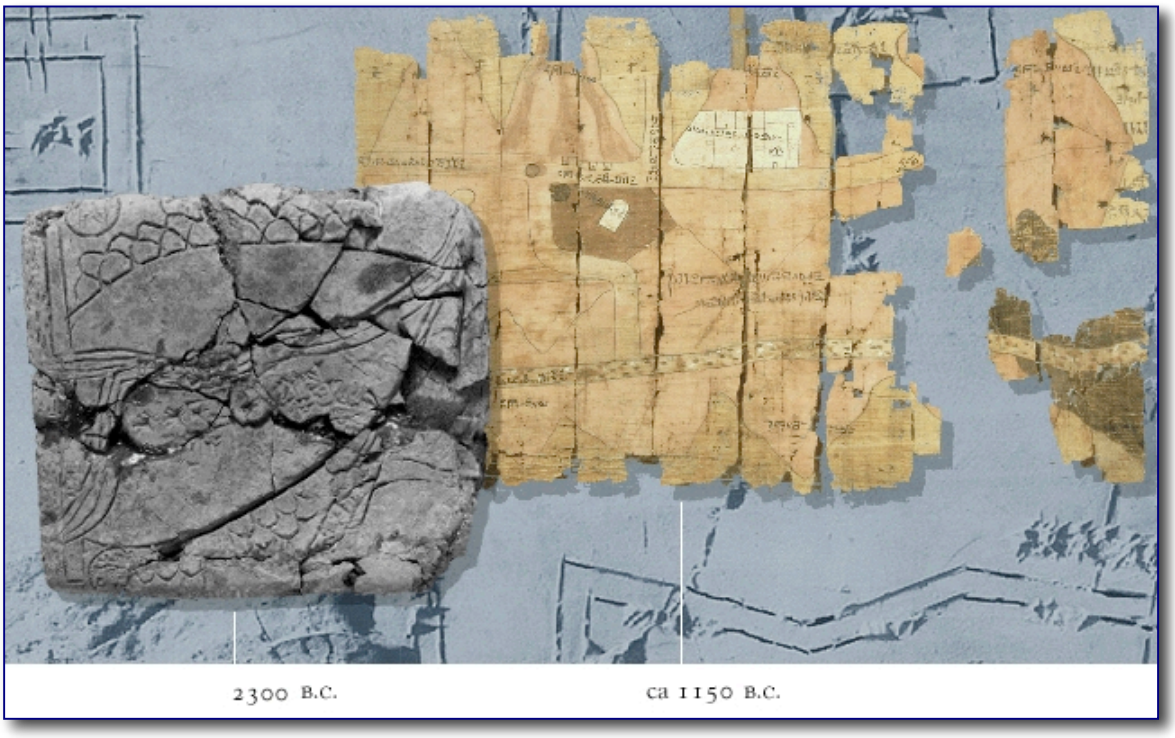
simple *Macrobian* schemes *(Book II, #201)* illustrating the range of climatic zones on the Earth, they do not tend to leave the room for them on the maps. The surface of the great, heavily wrought, detailed maps of this period *(Hereford, Ebstorf, Book II, #224, #226)* is entirely covered with pictures and inscriptions placed next to each other. Every scrap of space within the world's circle is crowded with information (religious and/or historic). The world on the medieval map is organized and finite. That does not mean, however, that there is no room for the unknown and cartographic silence on these maps. It simply appears in another form, possibly the more difficult to point out and recognize. One should take care to remember, that these cartographic images served different purposes than modern maps, focusing rather on the historic, religious and symbolic meaning tied to particular locations than on showing their physical appearance and shapes.

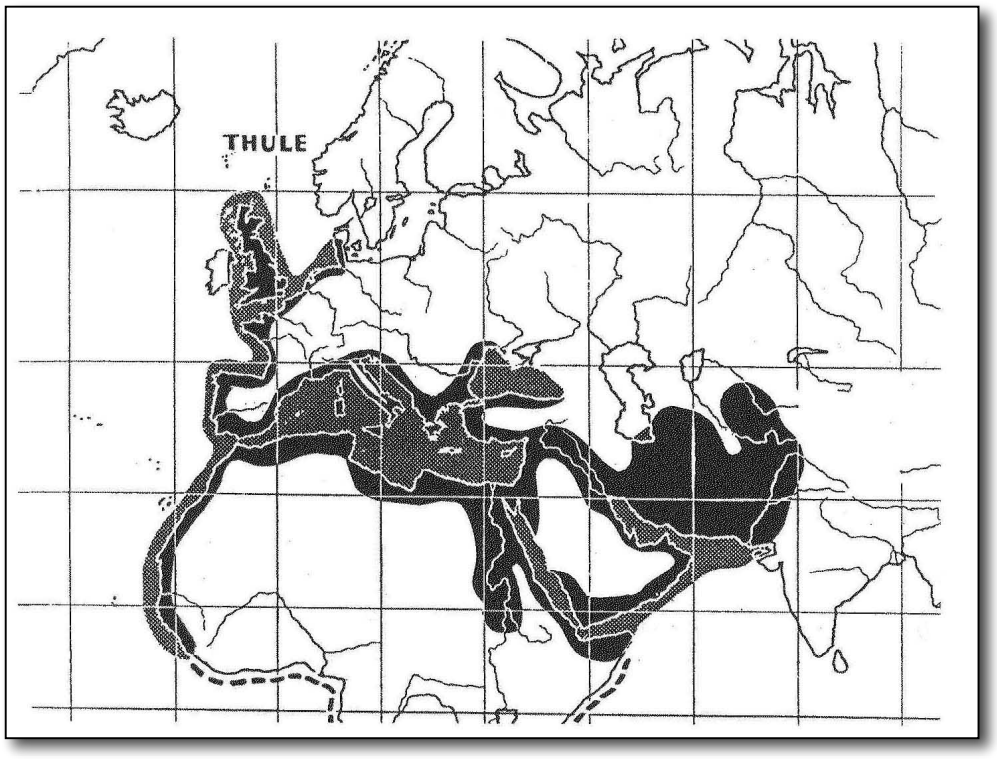
Even so, intentional cartographic silence (because this is the kind of silence blank space is) not always would be something that could be associated with the mapmaker's honesty. The Portuguese royal edict from 13th November 1504 prohibited producing globes and nautical charts that depicted west coast of Africa beyond the river Congo.

According to the new law, maps that did not follow these rules should be delivered to an officer of the hydrographic repository to remove the prohibited/banned secret details. This strict security measures may seem to be surprising today, not so much though, whilst you know that the penalty for selling a map to a foreigner in the same country was a death sentence. Spain's Casa de Contratacion, an institution originating of the same period (first decade of the 16th century), was responsible for oversight of the usage and storage of the secret documentation of the progress of the geographic exploration. The sketches of maps created during Sir Francis Drake's journey were also classified. The Dutch East India Company had developed its own, similar procedures of cartographic control and censorship as well. Colonial empires had been guarding the keys to wealth jealously.

The practices described above make it easy to understand why Brian Harley places cartographic silence in context of the French philosopher Foucault's concept of power-knowledge while interpreting it. There are of course many more examples of cartographic concealments with political undertones. There is not enough space here, nor is it an aim of this book to enumerate them all. Still, to show that not all cases of political silence had to be rooted in a desire to gain money, but in personal sympathies and views as well, let's recall one more (perhaps one of the most spectacular) example – the cartographic attempt to feign total ignorance of the expansion of the Ottoman Empire by persistence in not marking the new territorial divisions on the maps.

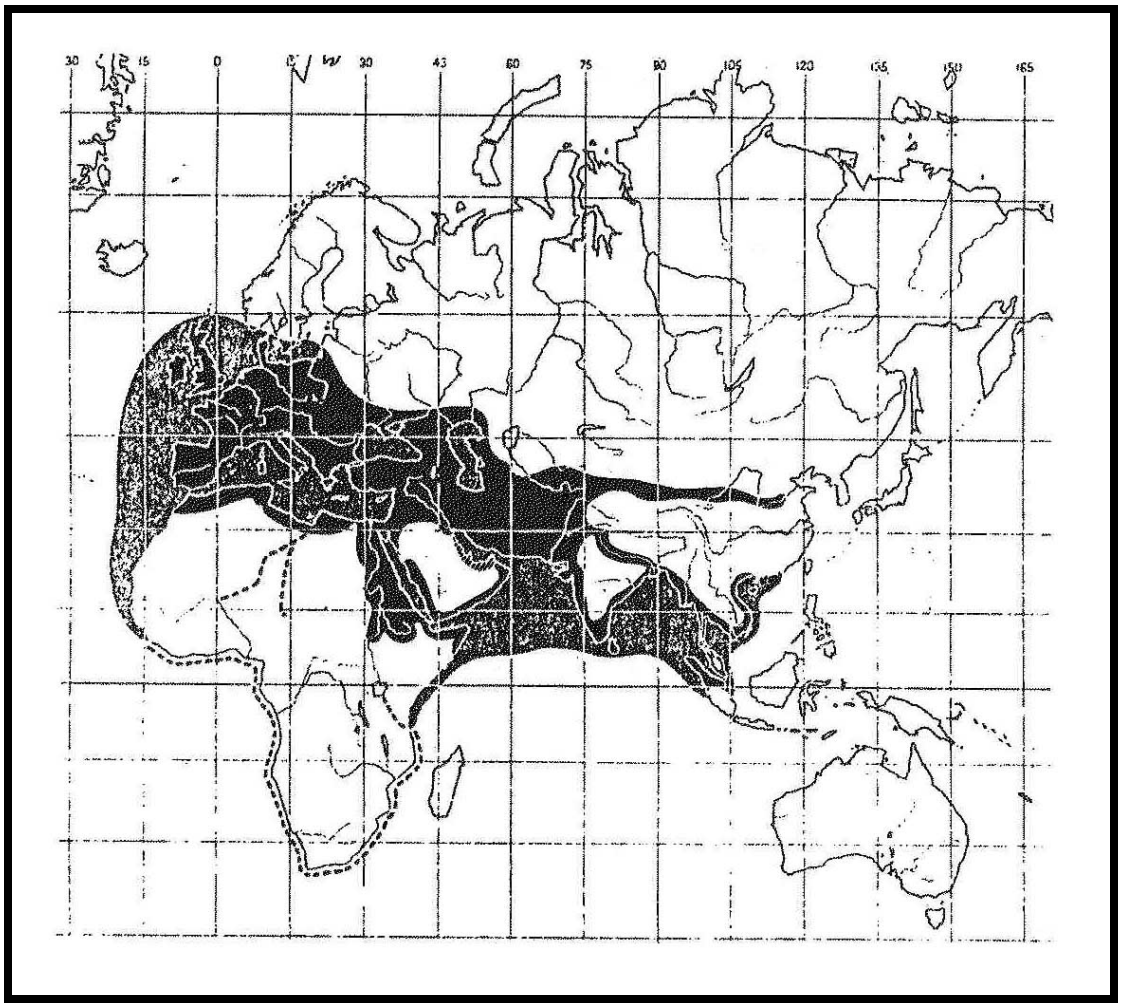
Aside from the intentional cartographic silence, there is a whole huge area of the unintentional silence – often uncontrolled or even unknown to the mapmaker himself. Referring to another Foucault's concept, Harley calls this type of silence *epistemological* [the study or a theory of the nature and grounds of knowledge especially with reference to its limits and validity] as opposed to *political* silence. It includes "the 'unthought' elements in discourse"; everything that has been omitted from the map, not because of a deliberate act of censorship, but simply because they escaped notice or interest of its creator.





The oikoumene [inhabited world], ca. 300 BC (from the West's perspective)


Scythians
H U N S
Great Wall in course of construction
Barbaric Japan
First Punic War
Hellenic world in decay
AREA KNOWN to the WESTERN MIND
Empire of Alexander
Empire of Shih Huang-Ti
AREA KNOWN to the EASTERN MIND
Primitive civilisations emerging from Helicithic culture
Helicithic culture drifting eastward
Carthaginian sailors
The KNOWN WORLD about 250 B.C.
Absolutely unknown .....
Vaguely known .....
E.F.H.



The oikoumene [inhabited world], ca. 150 BC (from the West's perspective)

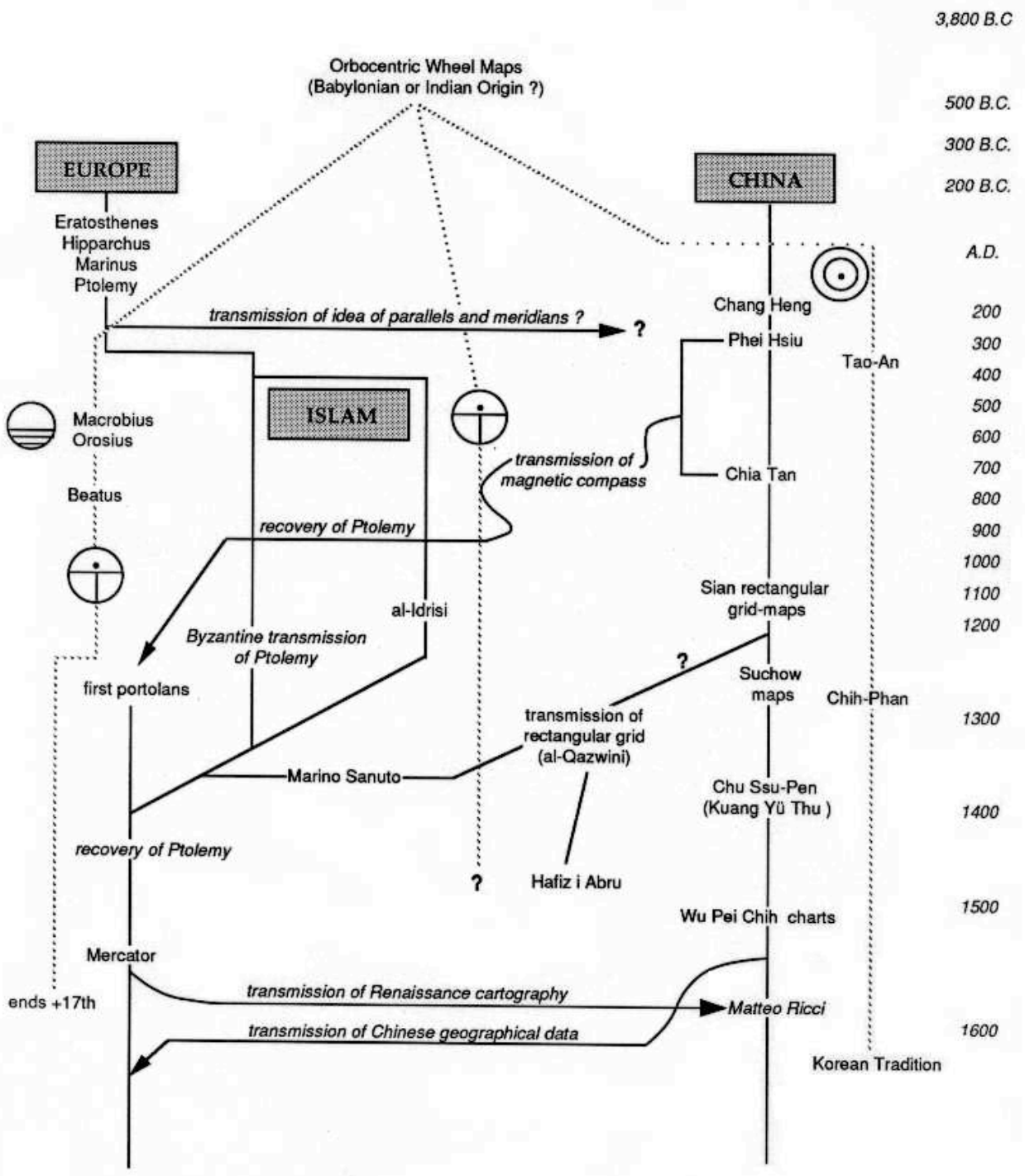


Chart showing the comparative development of cartography in the East and the West (adapted from Needham)