

GEOGRAPHY IN THE MIDDLE AGES

Afterwards they went to the country of Paris, to King Francis (i.e., Philippe IV, le Bel). And the king sent out a large company of men to meet them, and they brought them into the city with great honor and ceremony. Now the territories of the French king were in extent more than a month's journey. And the king of France assigned to Rabban Sauma a place wherein to dwell, and three days later sent one of his amirs to him and summoned him to his presence. And when he had come the king stood up before him and paid him honor, and said unto him, "Why hast thou come? And who sent thee?" And Rabban Sauma said unto him, "King Arghun and the Catholics of the East have sent me concerning the matter of Jerusalem."

During the fifth century after Christ, the Roman world with its system of centralized administration fell apart. For the Greeks the geographic horizons (the limits of the area that was known at least to scholars and merchants) had been extended from the Indus River to the Atlantic and from the Russian steppes north of the Black Sea to Ethiopia. For the Romans the geographic horizons included the vast area brought under Roman jurisdiction. But now geographic horizons closed in again until many of those who lived in Christian Europe after the fifth century were really familiar only with their immediate surroundings. The worlds beyond were peopled with fantastic creatures conjured up by imaginations unfet-

The report above of the discovery of France is taken from a Chinese account of the visit of the Nestorian Christian Rabban Bar Sauma of Peking to the French king in 1287. *The Great Chinese Travelers*, ed. J. Mirsky (New York: Pantheon Books, 1964), p. 190.

tered by facts. Only in the shelter of monasteries were the flickering flames of the intellectual life preserved.

But this is not a complete picture of the medieval period, which extended from the fifth to the fifteenth centuries. In Christian Europe, although the word *geography* disappeared from the ordinary vocabulary, the study and writing of geography did not entirely cease (Tillman, 1971). Little by little, curiosity concerning other possible worlds that might lie beyond the horizon again prompted some adventuresome people to travel and explore. The crusades, organized to wrest the Holy Land from the control of the Muslims, took many people out of their localities and then brought them back again to tell of the strange people and landscapes that had been seen. From the thirteenth century on, there were extended travels by missionaries and merchants that reached all the way to China.

We must ask the question about this period: Who was discovering whom? Although the geographic horizons had closed in around the communities of Christian Europe, this was a period of greatly widened horizons for the Muslims. Not only did the Muslim conquests, which started with the conquest of Palestine and Syria in 632, carry the followers of Islam eastward to the islands of Southeast Asia, westward to the Atlantic and into Europe, and southward across the Sahara, but also Muslim missionaries and merchants traveled far beyond the limits of Muslim control. Furthermore, Muslim scholars in the great centers of learning were busily engaged in translating the works of the Greek writers into Arabic. It was through the Arabic that Greek learning eventually became known to the Latin world of the Christians.

Meanwhile, in the far north of Europe the intrepid Norsemen were sailing across the stormy North Atlantic to Iceland, Greenland, and the continent of North America. Since the Norsemen did not write books, news of these discoveries was a long time getting back to the rest of the world.

Of the greatest importance were the accomplishments of the Chinese. Actually, Europe and India were "discovered" by Chinese missionaries long before the Christian travelers reached the Orient. According to Joseph Needham (Needham, 1963:117), in the period between the second century before Christ and the fifteenth century after Christ, the Chinese culture "was the most efficient in the world in applying knowledge of nature to useful purposes." The study of geography in China, as a part of a wider scholarly tradition, was well advanced beyond anything known in Christian Europe at this time.

GEOGRAPHY IN THE CHRISTIAN WORLD

The scholars who gathered together in monasteries in Christian Europe were not studying the earth as observers or experimenters. Rather, they were compilers of information from documentary sources and commentators, whose primary effort was to reconcile the geographic ideas recorded in

documents with the authority of the Scriptures, especially the Book of Genesis. In the early medieval period, the European scholars could work only with Latin documents; only in the latter part of this period did a few of them master the Arabic language. The Greek materials remained entirely unknown, except in translation.

John K. Wright, in his masterly study of the geographical ideas available to the Christian scholars of this period, points out the kinds of information that could be found in Latin (Wright, 1925:88–126). The Roman geographers, such as Pomponius Mela and Pliny the Elder, were widely used sources. Both of these writers, as we have seen, compiled their books from Greek sources, and through them the medieval scholars had a kind of secondhand and quite incomplete access to Greek concepts (Kimble, 1938). Two medieval scholars—Marianus Capella and Ambrosius Theodosius Macrobius—provided translations of Plato as early as the fifth century. Through the writings of Capella and Macrobius, the medieval Christian scholars had access to the concept of a spherical earth. Although many, like Cosmas, conceived of the world as a round disc rather than as a sphere, there were always a few scholars who accepted the idea of a spherical earth as demonstrated beyond dispute.

Ptolemy became the major authority in the medieval Christian world for matters pertaining to astrology and astronomy. His work dealing with the effect of the positions of the celestial bodies on human affairs—the *Quadripartitum*—was translated from the Arabic into Latin by Plato of Tivoli in 1138; his *Almagest*—the great work on astronomy—was made available in Latin by Gerard of Cremona in 1175 (Kimble, 1938:75–76). As a result, Ptolemy's geocentric model of the celestial universe remained the accepted model for many centuries, and most of the ideas still used by astrologers can be traced back to him.

The geographical ideas of Aristotle were first made available in Christian Europe by translation from the Arabic in the twelfth century. The first medieval writer to make use of Aristotle was Albertus Magnus (Tillman, 1971), whose book on the nature of places combined astrology with environmental determinism. The Greek theory of equating habitability with latitude became strongly implanted in medieval writings. Albertus even went beyond the Greeks: from them he accepted the idea that people who live too close to the limits of the habitable earth turned black, but then he insisted that if black-skinned people should move into the temperate latitudes they would gradually turn white (Glacken, 1967:265–271).

There was no really good way to evaluate the conflicting ideas that these translations from the Arabic made available. Furthermore, it was almost impossible to trace the sources of the ideas since in those times it was standard practice to include in one's own writings whole passages taken verbatim from earlier writers without any kind of credit. Isidore of Seville, who compiled a sort of geographic encyclopedia during the seventh century,

took long passages from Solinus,¹ who, in turn, had taken them from Pliny. When the medieval scholars did seek explanations for natural events, the kinds of events with which they were concerned were spectacular ones, such as earthquakes, volcanic eruptions, or floods. No hypotheses from the Greeks had been presented in Latin concerning the slower and less obvious natural processes, such as the erosion of mountains or the building of deltas. In the absence of a background of theory, these slower processes were not perceived.

Another characteristic of this period in Christian Europe was the deterioration of mapping. The once fairly accurate delineations of the better known coastlines were lost, and instead maps became pure fancy. This was the period of the so-called T-O maps. The inhabited world was represented by a circular figure surrounded by the ocean. The figure was "oriented" toward the east (Wright, 1925:66–68). In the midst of the land area was a T-shaped arrangement of waterbodies. The stem of the T represented the Mediterranean. The top of the T represented the Aegean and Black Seas on the one hand, and the Nile River and Red Sea on the other. The three divisions—Europe, Asia, and Africa—were accepted as standard. The center of the inhabited world, just above the center of the T, was Jerusalem. At the far east, beyond the limit of the inhabited world, was paradise (Fig. 5).

MEDIEVAL CHRISTIAN TRAVELERS

Meanwhile, outside the monasteries some Christians did travel and make observations, but they had no knowledge of the existence of theoretical concepts regarding the nature of the earth as the home of humankind. In A.D. 326, Helena, the mother of the Emperor Constantine, made one of the earliest pilgrimages from Rome to the Holy Land. Silvia of Aquitaine, a Roman lady, was one of the earliest woman geographers. She traveled overland to Jerusalem and then on to Egypt, Arabia, and Mesopotamia; eventually, she wrote an account of her travels. As the number of pilgrims increased, itineraries were compiled to guide them on the routes to Jerusalem (Beazley, 1897–1906/1949).

By the eleventh century, the passage of pilgrims overland through what is today Turkey and Syria had become more and more difficult and dangerous. As a result, the Christians of Europe organized a series of military invasions of the Holy Land. Between 1096 and 1270 there were eight separate crusades, each with the objective of recapturing the Holy Sepulcher at Jerusalem from the Muslims. Some went by sea, some by land; one crusade was even successful in occupying Jerusalem for a short period before the Muslims drove out the invaders. After the eighth formal crusade, there were other

¹Solinus was the first to describe these seas as "mediterranean" (in the midst of the land), and Isidore was the first to use the descriptive term as a proper name (Wright, 1925:307).

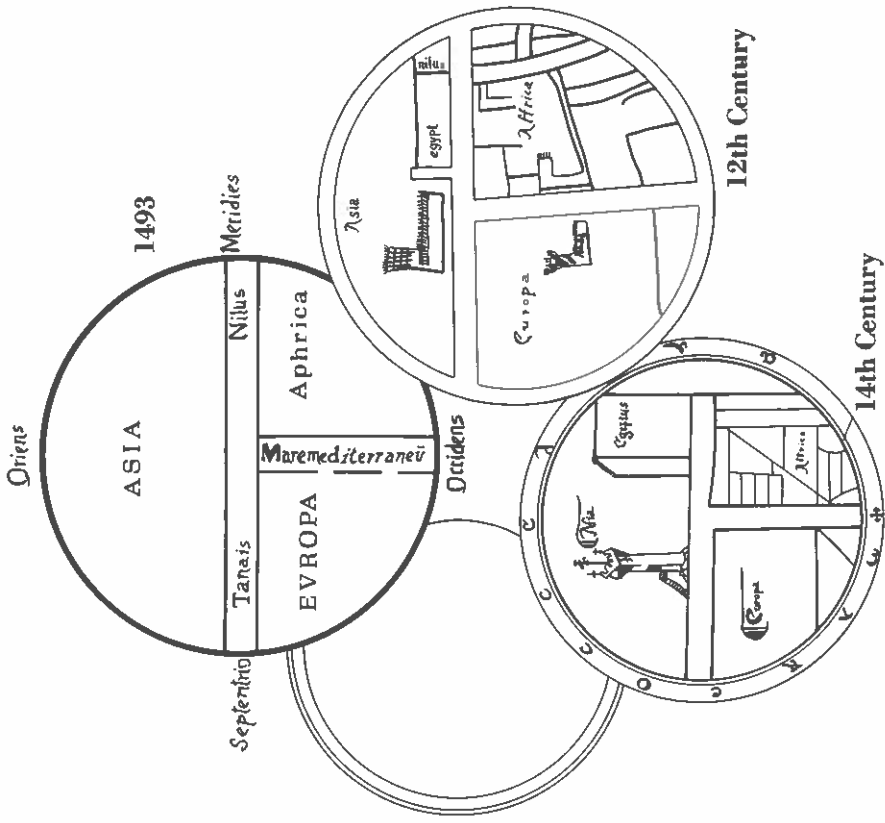


FIGURE 5. T-O maps.

military invasions of Muslim-held territory, one of which in 1365 sacked Alexandria and burned the famous library, where Eratosthenes and other Greek geographers had worked.²

The crusades had a major impact not only on Christian Europe but also on the Muslims. From almost all parts of Europe, men had been recruited for the war against the infidels and had made the trip to the Holy Land. When they returned to Europe, they not only brought with them many new kinds of machines—such as the windmills, later adopted by the Dutch for pumping water—but also exciting stories about strange people and strange landscapes

²It is believed, however, that the collection of manuscripts that constituted the major record of Greek geography had long since been ruined due to lack of care even before the destruction of the library by the Christian invaders.

beyond the geographic horizons. The result was a great stimulation of interest in the description of unfamiliar places, which is still preserved in our library catalogues as “popular description and travel.” For people who knew nothing about geographic theory, popular description and travel became, in essence, geography. Meanwhile, the Muslims, who at first were notably tolerant of people of other faiths, reacted to the violence of the crusaders by becoming aggressively intolerant of unbelievers. One result was the closing of the routes across North Africa—Southwest Asia by which the merchants of Venice and Genoa could make contact with the traders of the East.

MARCO POLO

In spite of the blocking of the eastern sea routes, Christian Europe did, in fact, make contact by land with the centers of Chinese culture by following a route to the north of the main Muslim strongholds. The route was followed both by missionaries sent out from Rome and by merchants. The most celebrated of these travelers were the Polo brothers and the son of one of them, Marco Polo. In 1271, when Marco was 17, he started out from Venice with his father and uncle to make the long journey to China (Fig. 6). The Polo brothers had already visited China on a trip that lasted from 1260 to 1269, and the Great Khan, the Mongol emperor of China, had invited them to return. The return journey to China took 4 years, and the Polos remained there for 17 years. Marco served the Khan as ambassador to various parts of China and in various other official capacities, as a result of which he was able to gain intimate knowledge of Chinese culture. In fact, the Polos were so useful to the Khan that he was reluctant to permit their departure. Finally, in 1292 the Khan provided the Polos with a fleet of 14 large ships, some so large that they required a crew of more than 100 sailors. Along with the Polos there were some 600 other passengers. The fleet set sail from a port in southern China, probably the modern Lungch'i, and took three months to reach Java and Sumatra, where it was held up for five months. The expedition then continued to Ceylon and southern India and thence along the west coast to the ancient port of Hormuz on the Persian Gulf. Of the 600 passengers, only 18 survived the voyage. Most of the ships were lost. But the Polos finally returned safely to Venice in 1295 after an absence of 25 years.

Marco Polo, while being held a prisoner in Genoa some years later, dictated his book of travels to a fellow prisoner (Polo, 1930). His descriptions of life in China and of the perils encountered on the route to and from China were vivid—so vivid, in fact, that they were commonly regarded as the products of a heated imagination. In addition to descriptions of the places he actually visited, he included reports on Cipangu, or Japan, and on the island of Madagascar, which, he said, was near the southern limit of the habitable earth. Since Madagascar is well south of the equator, here was abundant evidence that the torrid zone was not torrid and was actually inhabited.

It is important, however, that Marco Polo was not a geographer and had

Europe it seemed much like many other books of the time, filled with wild but interesting stories. Columbus had a copy of it, marked with notations in his own writing.

BRIGHTER SPOTS IN MEDIEVAL SCHOLARSHIP

Toward the end of the medieval period of Christian Europe, a few scholars began to insist on the need to confront authority with reason. If God gave us the gift of reason, they insisted, there could be no excuse for refusing the use of it. William of Conches, who died in about 1150, was one of the earliest to portray a universe governed by law rather than by the unpredictable acts of a divine authority (Kimble, 1938:79). He presented some remarkably modern ideas concerning the heating of the atmosphere from below and the formation of clouds by the cooling of air. Robert Grosseteste, the bishop of Lincoln, was one of the earliest Christian scholars to master the Arabic language and who, therefore, had access to a much wider range of geographic materials than those written in Latin. As the teacher of Roger Bacon, he was at least in part responsible for confronting the notion of a torrid zone that was uninhabitable through his access to Arabic reports on an inhabited coast of Africa extending at least as far as 20°S (Wright, 1925:163–165).

Cardinal Pierre d'Ailly, writing in the early fifteenth century, is one of the later medieval scholars who had a major influence on the age that followed. Although he derived his material chiefly from Latin sources, his book *Tractatus de imago mundi* did represent a kind of summary of the work of the period. In a second edition of his book in 1414, he is one of the first to make use of the Latin translation of Ptolemy's *Geography* (published in 1406). He repeats the different opinions concerning the habitability of the torrid zone but without taking any stand on the matter. But he does dispute Ptolemy's idea of an enclosed Indian Ocean. He quotes numerous reports that indicate the existence of an open ocean around southern Africa. This notion had great influence on the Portuguese geographers and navigators, who soon thereafter began to seek a way to India that could avoid the Arabic territory. D'Ailly also accepts the smaller estimate of the earth's circumference, and he was among the first to insist that India could be reached by sailing west, which was influential in building up Columbus's determination to do just this (Kimble, 1938:208–211). It is important, too, that the invention of movable type in about the middle of fifteenth century made possible the publication of books in large editions. The works of Pierre d'Ailly were popular, as were all the geographic writings then available in manuscript form.

Another Christian geographer whose writings belong in this period was Pope Pius II (Aeneas Silvius). While he was pope between 1458 and 1464, he wrote a book on Europe and Asia in which he suggests the possibility that the torrid zone is inhabited. He also agrees with Pierre d'Ailly that there is abundant evidence that the Indian Ocean is not enclosed on the south, as reported by Ptolemy.

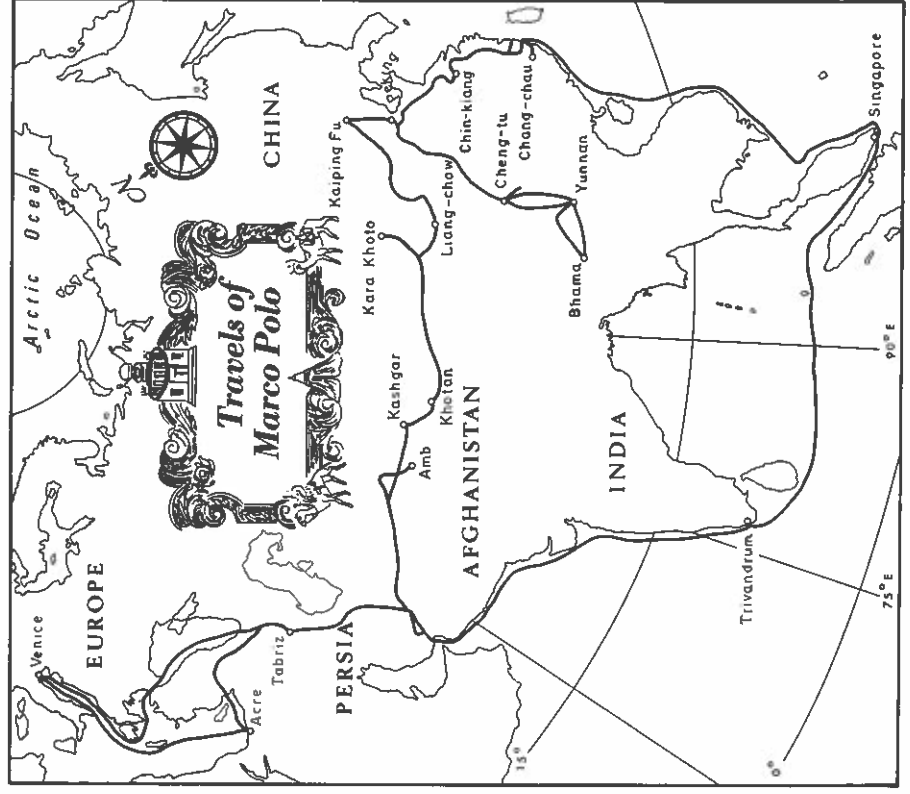


FIGURE 6. Travels of Marco Polo.

no knowledge of the existence of such a field of learning. Nor was he aware of the major disputes then going on (1) among those who believed in a torrid zone that was not habitable and those who disagreed with this notion or (2) among those who accepted the smaller estimate of the earth's circumference derived from Posidonius, Marinus, and Ptolemy and those who preferred the larger figure of Eratosthenes. Nor was Marco Polo aware that the Greek geographers thought that the eastern end of the ekumene was near the mouth of the Ganges. Nor was he aware that Ptolemy had said that the Indian Ocean was enclosed by land to the south. It is doubtful if Marco ever thought of measuring the latitude and certainly not the longitude of the places he visited, but he did report that to reach a place required a journey of a certain number of days in such and such a direction. He makes no comments concerning previous geographic ideas. Today we can see that his book must stand among the great records of geographic exploration; yet in medieval

NAVIGATION AND CARTOGRAPHY

During this period several important advances were made in the arts of navigation at sea. Some of these new skills were first developed, as we will see, at the University in Palermo in Sicily, where the Norman King Roger II and the Muslim geographer Edrisi were beginning to learn how to navigate away from the land. The first mention of the magnetic compass occurs in Christian Europe in the writings of Alexander Neckam in about 1187. The earliest Arabic reference to a compass was in 1230. Yet there is some evidence that this instrument was in use much earlier and was perhaps independently invented by the Vikings (Kimble, 1938:223). It was certainly in wide use by the fifteenth century and had become indispensable for long voyages away from the land. In this period, too, the astrolabe had been improved, and it came into common use as an aid to navigation by making possible a more accurate fix on the altitude of the polestar (Kimble, 1938:223–225).

The late fourteenth century also witnessed a notable improvement in the art of mapping. The Portolano charts, of which the earliest is about 1300, became standard equipment for sea captains. The term *Portolano* means handy or easily available. Instead of a grid of latitude and longitude, the Portolano charts were covered by a network of overlapping lines radiating from several centers in different parts of the chart (Fig. 7). The radiating lines conform to the eight or 16 principal directions of the compass, each corresponding to a wind direction (Bagrow and Skelton, 1964:62–66). Sailors laid out compass courses along these lines (Taylor, 1957:112–114). With the lines to indicate directions from key points, the coastlines, especially around the Mediterranean, were drawn with considerable accuracy.³

The famous Catalan map of the world, made in 1375, incorporates the material from numerous Portolano charts. It also includes the west coast of Africa to the south of Cape Bojador, which had not been reached by European sailors. It also shows East and Southeast Asia based on reports by Marco Polo. This was the first map ever to give a proper outline to Ceylon and the Indian peninsula (Kimble, 1938:193). But the scholars in the monasteries, who were still gathering their information from written documents, had little connection with the map-makers, whose purposes were strictly practical rather than theoretical. The map-makers were working for the merchants, and perhaps they were not even aware of the differences of opinion regarding such questions as the habitability of the torrid zone or even the existence of a torrid zone.

³With the use of the magnetic compass, it became the usual practice to draw maps with north at the top. When a map is laid on the ground so that directions on the map correspond with compass directions, the map is still said to be "oriented." In the year 800 Charlemagne, hoping to end the confusion about directions, decreed that henceforth in France there would be only four cardinal directions: north, east, south, and west. North was indicated with the *fleur de lis*, as it still is.



FIGURE 7. A Portolano chart of the Mediterranean, after Juan de la Cosa, 1500.

GEOGRAPHY IN THE MUSLIM WORLD

One of the events of far-reaching importance in the medieval period was the spread of the Muslims. Muhammad, the prophet who died in 632, was the founder of the religion of Islam, whose followers are known as Muslims. These Arabic-speaking people from Arabia were previously grouped in small, isolated tribes and had no feeling of unity. They were given a common purpose, if not complete unity, by the teaching of the prophet and by the holy book—the Koran. This was the first book written in the Arabic language. It not only provided a religious orientation, but it also gave detailed prescriptions concerning all aspects of life—how to govern, how to carry on commercial transactions (including a prohibition against the payment of interest on loans), how to organize family life, and many other matters. The Koran describes the world in detail, providing explanations for natural phenomena that all "true believers" accept without question.

The followers of Islam embarked on a conquest of the world outside of Arabia. In 641 they conquered Persia, and in 642 they took control of Egypt. The Muslims swept westward across the Sahara, and by 732 all of the Great Desert was under Muslim control. They crossed through the Iberian Peninsula into France and were defeated and turned back only in the battle of Tours (732). For some nine centuries the Muslims ruled most of Spain and Portugal. Muslim rule was also extended eastward into India and eventually to some of the islands of Southeast Asia.

BAGHDAD

In 762 the Muslims founded the new city of Baghdad near the ruins of Babylon, and for more than a century Baghdad was the center of the intellec-

tual world. With the patronage of the Caliph Harun al-Rashid, a project was started for the translation of the works of the Greek philosophers and scholars in Arabic. The project was continued under Caliph al-Mamun (813-833), who employed learned men of all faiths to make the translations. Books were collected from all available sources, and the translators were paid the weight of their books in gold (Ahmad, 1947:5). From Baghdad, therefore, a flood of new ideas from varied sources began to spread throughout the Muslim world. Eventually, the innovations were brought into Christian Europe as a result of Latin translations from the Arabic. Among other innovations was the use of the decimal system in arithmetic, which was brought into Baghdad from the Hindus, who had adopted it from the Chinese.

Al-Mamun directed his scholars to recalculate the circumference of the earth. They made use of the same method devised by Eratosthenes some 10 centuries before. On the level plain of the Euphrates, they established a north-south line and fixed the latitude at either end by observations of the stars. They then measured the distance between the fixed points and decided that the length of a degree was 56½ Arabic miles. The scholars made several other measurements, one near Palmyra in Syria, and arrived at almost the same results. These values were much too small, owing to errors in the linear measurements (Wright, 1925:395).

MUSLIM CONTRIBUTIONS TO CLIMATOLOGY AND GEOMORPHOLOGY

The Arabic geographical writings in the period between 800 and 1400 were based on a much greater variety of sources than were those of Christian scholars in the same period. The Muslims had access not only to their translations from the Greek but also to the reports of their own travelers. As a result, they had a much more accurate knowledge about the world than the Christian scholars had. One of the earliest of the great Arab travelers was ibn-Haukal, who spent the last 30 years of his life between 943 and 973 visiting some of the most remote parts of Africa and Asia. On his voyage along the African east coast to a point some 20 degrees south of the equator, he observed that considerable numbers of people were living in those latitudes that the Greeks thought to be uninhabitable. Yet the Greek theory persisted and keeps appearing in different form again and again, even in modern times.

The Arabic scholars made some important observations regarding climate. In 921 al-Balkhi gathered the observations of climate features made by Arab travelers in the world's first climate atlas—the *Kitab al-Ashkal*. Al-Masudi, who died about 956, had gone south as far as modern-day Mozambique and wrote a very good description of the monsoons. He described the evaporation of moisture from water surfaces and the condensation of the moisture in the form of clouds—this, in the tenth century. In 985 al-Maqdisi offered a new division of the world into 14 climatic regions. He recognized that climate

was not only by latitude but also by position east and west. He also presented the idea that the Southern Hemisphere was mostly open ocean and that most of the world's land area was in the Northern Hemisphere.

Two Arab geographers offered important observations regarding the processes shaping the world's landforms. Al-Biruni wrote his great geography of India (*Kitab al-Hind*) in 1030. In this book he recognized the significance of the rounded stones he found in the alluvial deposits south of the Himalayas. The stones became rounded, he pointed out, as they were rolled along in the torrential mountain streams. Furthermore, he recognized that the alluvial material dropped close to the mountains was relatively coarse in texture and that alluvium became finer in texture farther away from the mountains. He quotes the Hindus as believing that the tides are caused by the moon. He also includes the interesting observation that toward the South Pole night ceases to exist—which suggests that some explorers had voyaged to the far south before the eleventh century.

The other contributor to a knowledge of landforms was Avicenna, or Ibn-Sina, who observed how mountain streams in central Asia cut down the mountain to form valleys. He formulated the idea that mountains were being constantly worn down by streams and that the highest peaks occurred where the rocks were especially resistant to erosion. Mountains are raised up, he pointed out, and are immediately exposed to this process of wearing down, a process that goes on slowly but steadily. Eight more centuries would pass before James Hutton presented similar ideas concerning the process of erosion; he had never heard of Avicenna and could not read Arabic. Avicenna also noted the presence of fossils in the rocks in high mountains, which he interpreted as examples of nature's effort to create living plants or animals that had ended in failure.

EDRISI AND PALERMO

The most extensive corrections of the erroneous ideas handed down from Ptolemy were made by the Muslim geographer Edrisi, or al-Idrisi. Educated at the University of Cordoba in Spain, Edrisi was one of the scholars that Roger II of Sicily brought to Palermo. King Roger dispatched observers to many parts of the world where Edrisi said there were uncertainties concerning the actual arrangement of mountains, rivers, or coastlines. The observers brought back much new information to Palermo. As a result, Edrisi was able to write a "new geography" that was really new. In 1154 he completed a book with the title *Amusement for Him Who Desires to Travel Around the World*. He corrects the idea of an enclosed Indian Ocean and the idea of the Caspian Sea as a gulf of the world ocean. He also corrects the courses of numerous rivers, including the Danube and the Niger, and the position of several major mountain ranges. As Kimble points out, it is strange that such an important book was not translated into Latin until 1619, at which time the translator did not even know the name of the author (Ahmad, 1947:39; Kimble, 1938:59).

Other important innovations were made at Palermo. Improvements were made in the methods of navigation, including the wide use of coast charts, which were the forerunners of the Portolano charts of the fourteenth century. It is said that the sailors of Genoa learned the arts of navigation from the Sicilians and that the Genoese passed on this knowledge to the Portuguese at Sagres in the fifteenth century. The first steps leading to the Age of Exploration were taken in Sicily in the eleventh and twelfth centuries (Wright, 1925:81).

IBN-BATUTA

One of the great travelers of all time was the Muslim ibn-Batuta. He was born at Tangier in 1304 to a family whose members had traditionally served as judges. In 1325, at the age of 21, he set out to make the usual pilgrimage to Mecca, where he proposed to complete his studies of the law. But on the way across North Africa and through Egypt he found himself fascinated more by the people and lands he passed through than by the law. After reaching Mecca, he decided to devote himself to travel, and, in his comings and goings through Muslim territory, he carefully avoided following the same route twice. His travels took him to many parts of Arabia never before visited by one person. He sailed along the Red Sea, visited Ethiopia, and then continued southward along the coast of East Africa as far as Kilwa, nearly 10° S of the equator. At Kilwa he learned of the Arab trading post at Sofala in Mozambique, south of the modern port of Beira and more than 20 degrees south of the equator. Ibn-Batuta confirmed what ibn-Haukal had implied—that the torrid zone in East Africa was not torrid and that it was occupied by a numerous native population that justified the establishment of Arab trading posts.

After returning to Mecca, ibn-Batuta set out again to visit Baghdad and Persia and the land around the Black Sea. He traveled in the Russian steppes and thence eventually to Bukhara and Samarkand. Then he crossed the mountains through Afghanistan into India. He served the Mongol emperor in Delhi for several years, traveling widely in India during this time. The emperor appointed him as ambassador to China. But delays kept him from reaching China for several more years, during which time he visited the Maldiv Islands, Ceylon, Sumatra, and, eventually, China. In 1350 he returned to Fez, the capital of Morocco. But his travels did not end. He made a trip into Spain and then crossed the Sahara to Timbuktu on the Niger River, gathering important information about the Muslim Negro tribes living in that part of the world. In 1353 he settled in Fez, where at the Sultan's command he dictated a lengthy account of his travels (ibn-Batuta, 1958). During some 30 years he covered a linear distance of about 75,000 miles, which in the fourteenth century was a world record. Unfortunately, his book, written in Arabic, made little impact on the Christian world. Even today, when some of

our schools teach children about the intense heat of the torrid zone, reference could be made to ibn-Batuta, who, six centuries ago, pointed out that the climate along the equator was less extreme than the climate in the so-called temperate zone in North Africa.

IBN-KHALDUN

The last of the Muslim scholars to make a major contribution to geography was the great Arabic historian, ibn-Khaldun. Like ibn-Batuta, he was born on the Mediterranean coast of northwest Africa. He lived most of his life in the cities of what is today Algeria and Tunisia and also for a time in the Muslim part of Spain. He spent his later years in Egypt. In 1377 when he was 45 he completed a voluminous introduction to his world history—known as the *Muqaddimah*. This work begins with a discussion of man's physical environment and its influence and with man's characteristics that are related to his culture or way of living rather than to the environment. He discusses various stages of social organization, identifying the desert nomad as the most primitive and purest, and he suggests that the sedentary city dweller is dependent on luxuries and becomes morally soft. He discusses the forms of government, describing a sequence of stages that mark the rise of a dynasty to power, followed by its decline through corruption to its fall. Ibn-Khaldun discusses cities and their proper location. Finally, he discusses the various ways of making a living—commerce, the crafts, the sciences—all of which are shown as both conditions and consequences of urban life. Many of the ideas he develops in his effort to provide a theoretical model of national growth and national decay were ideas that appeared later in nineteenth-century Europe. Yet only recently have the writings of ibn-Khaldun appeared in English (ibn-Khaldun, 1958).

Although ibn-Kaldun, according to Kimble, "may be considered to have discovered—as he himself claimed—the true scope and nature of geographic inquiry," the fact remains that his knowledge of the physical earth is based largely on Greek theory; and his ideas about environmental influence are not highly sophisticated (Kimble, 1938:180). He accepts the traditional seven zones of climate running parallel to the equator. Strangely, for an Arabic scholar, he repeats the idea concerning an uninhabitable zone along the equator and an uninhabitable polar zone. He repeats the old idea that people turn black when they live too close to the sun and that when black people move to the temperate zone they gradually turn white or produce white children. The physical environment impressed its characteristics on people in many subtle ways. Such naïve environmentalism is somewhat modified by the recognition of different cultural traditions.

It can be said that ibn-Khaldun was the first scholar to turn his attention specifically to man-environment relations.

GEOGRAPHY IN THE SCANDINAVIAN WORLD

The Scandinavians had never heard of Aristotle, or Strabo, or Ptolemy, or Isidore, or ibn-Khaldun. They had no idea that the lands they inhabited were uninhabitable. Among the Scandinavians, the Swedes sent exploring parties far to the east into what is now the central part of Russia. In the ninth century Othar of Helgoland sailed in a Viking ship around the northern tip of Norway and far eastward into the White Sea.

But the greatest accomplishment of the Scandinavians from Norway—the Vikings—was the crossing of the North Atlantic Ocean to the American mainland. In 874 the Vikings reached Iceland and established a settlement there that grew and prospered. In 930 the world's first parliament was organized in Iceland.

Among the people of the Iceland colony was one especially violent and disturbing character named Eric the Red. In 982 he and his family and retainers were banished. Having learned of the existence of land farther west, Eric set sail across the stormy North Atlantic and came upon the southern part of Greenland. In fact, the name, Greenland, which he gave to this new land, was perhaps one of the world's earliest examples of real estate promotion—for there was nothing very green about it. Nevertheless, Eric's colony attracted additional settlers from Iceland. Regular voyages were made back and forth between Greenland, Iceland, and the mainland of Norway.

About the year 1000 Eric's son, Leif Ericson, returning to Greenland from a trip to Norway, encountered a severe storm that blew him far off his course. When the skies cleared, he found himself off a strange coast that extended as far as he could see to the north and south. He landed and found fine stands of timber as well as vines on which wild grapes grew. Returning to Greenland, he described this new land farther to the west.

In the year 1003 a man named Karlsefni organized an expedition to take another look at this new land. He set sail with a crew of 160 people—men and women—together with cattle and food supplies. There is no doubt that he reached the coast of North America. The large bay with a strong current of water coming out of it was probably the Saint Lawrence estuary, and somewhere along its shore the party made a landing and spent the winter. Here the first European child was born in the Americas. The next summer the party sailed southward, certainly as far as Nova Scotia, probably as far as Cape Cod, and possibly even as far south as Chesapeake Bay. They liked the land they found, but the Indians proved warlike. Their attacks were such a nuisance that eventually the Vikings gave up the effort to settle on the strange shore and sailed back to Greenland. The story was passed on by word of mouth as *The Saga of Eric the Red*. To this day efforts are still being made to identify the places where Karlsefni and his people landed. It is quite possible that there were other expeditions even before the eleventh century, but geographical scholars in the European world heard only rumors of such

voyages for several centuries (Cassidy, 1968; Morison, 1963, 1971; Sauer, 1908; Sykes, 1961).

GEOGRAPHY IN THE CHINESE WORLD

During all the time that the study of the earth as the home of man was being pursued in ancient Greece and Rome and later in Christian Europe, among the Muslims, and by the remote Scandinavians, there was another major center of geographic study in the world. This was China. Essentially the European and Chinese worlds remained isolated, each discovering the other step by step. Yet there are certain fascinating parallels in the concepts and methods of study that seem to require the existence of contacts, however indirect and remote.

Students steeped in Western history must keep in mind that, from about the second century before Christ until at least the fifteenth century after Christ, the people of China enjoyed the highest standard of living of any people on earth (Needham, 1963:117). The Chinese mathematicians had discovered the use of zero and had developed the decimal system, which was vastly superior to the sexagesimal system of Mesopotamia and Egypt. The decimal system was introduced into Baghdad in about 800 from the Hindus, but it is generally believed that the Hindus derived their decimal system from the Chinese.

The Chinese philosophers had a basically different attitude toward the natural world than that held by the Greeks. To the Chinese the individual is not separate from nature—he or she is a part of nature. There is no law-giving deity who created the universe for human use in accordance with a preconceived plan. Death in China is not followed by life in a new paradise or punishment in a hell; rather, the individual hopes to be absorbed in the all-pervading universe of which he or she is an inseparable part. Confucianism developed a way of life that was highly effective in minimizing the frictions among individuals, but it remained relatively indifferent to the development of scientific knowledge.

Joseph Needham repeats the following story to illustrate this attitude:

When Confucius was travelling in the east, he came upon two boys who were disputing, and he asked them why. One said "I believe that the rising sun is nearer to us and that the midday sun is further away." The other said "On the contrary, I believe that the rising sun and setting sun is further away from us, and that at midday it is nearest." The first replied, "The rising sun is as big as a chariot-roof, while at midday the sun is no bigger than a plate. That which is large must be near us, while that which is small must be further away." But the second said, "At dawn the sun is cool but at midday it burns, and the hotter it gets the nearer it must be to us." Confucius was unable to solve their problem. So the two boys laughed him to scorn saying "Why do people pretend that you are so learned?" (Needham and Ling, 1959:225-226).

Consider what Socrates might have done in this situation, and a very fundamental difference in cultural attitude becomes clear. But this does not mean that there was no interest in finding out what it was like beyond the horizon or in developing methods of recording what was discovered. In fact, the record of geographical work in China is impressive, but it is concerned more with observable things and processes and less with the formulation of theory.

GEOGRAPHICAL WORK

Chinese geographical work was based on the development of methods for making accurate observations and for using these in constructing useful inventories. For example, there are weather records that date back to thirteen centuries before Christ. The oldest piece of geographical writing is a survey of the resources and products of the nine provinces into which ancient China was divided in the fifth century B.C. For each province the nature of the soil, the kinds of products, and the waterways that provide routes of transportation are described (Needham and Ling, 1959:500). In the second century B.C. the Chinese engineers were making accurate measurements of the silt carried by the rivers. In A.D. 2 the Chinese carried out the world's first census of population. Other technical inventions included the making of paper, the printing of books, the use of rain and snow gauges to measure precipitation, and the use of the magnetic compass for navigation.

There was also a record of progress in the understanding of processes. By the fourth century B.C. the nature of the hydrological cycle was understood. At about the same time that Plato was observing the effects of forest clearing in Attica, the Chinese philosopher Mencius (Meng-tzu), who lived two centuries after Confucius, was pointing out that forests once cleared from mountain slopes could not reseed themselves as long as the slopes were grazed by cattle or goats (Glacken, 1956:70).

The Chinese had also learned much about the work of running water in wearing down mountains and forming alluvial plains. At about the same time that Avicenna was writing down his ideas about the erosion of mountains, the Chinese scholar Shen Kua was presenting the same idea (in 1070). Referring to a rugged mountain range with jagged peaks and steep-sided valleys, he wrote:

Considering the reasons for these shapes, I think that (for centuries) the mountain torrents have rushed down, carrying away all sand and earth, thus leaving the hard rocks standing alone.

... Standing at the bottom of the ravines and looking upwards, the cliff face seems perpendicular, but when you are on top, the other tops seem on a level with where you are standing. Similar formations are found right up to the highest summits.

... Now the Great River (i.e., the Yellow River) ... (and certain others) are all muddy, silt-bearing rivers. In the west of Shensi and Shansi the waters run

through gorges as deep as a hundred feet. Naturally mud and silt will be carried eastwards by the streams year after year, and in this way the substance of the whole continent must have been laid down. These principles must certainly be true (Needham and Ling, 1959:603-604).

Chinese geographical writings, according to Needham, were of eight major kinds: (1) studies of people, which we might classify as human geography; (2) descriptions of the regions of China; (3) descriptions of foreign countries; (4) accounts of travels; (5) books about the Chinese rivers; (6) descriptions of the Chinese coast, of special value to ship captains; (7) local topographies, including special descriptions of areas tributary to and controlled by walled cities, or famous mountains, or certain cities and palaces; and (8) geographical encyclopedias. Considerable attention was given to the origin of and changes in Chinese place-names (Needham and Ling, 1959:608).

CHINESE EXPLORATION

The discovery of the rest of the world by Chinese travelers is an aspect of the history of geography that is often overlooked in Western writings. Travels beyond the far Chinese horizons were undertaken by orders of an emperor or by missionaries and traders (Fig. 8).

The earliest record of Chinese travels is a book of uncertain age that was probably composed sometime between the fifth century and the third century B.C. It was found in the tomb of a man who ruled a part of the Wei Ho Valley in about 245 B.C. The books found in this tomb were written on strips of white silk pasted on bamboo slips and because of their bad condition were occupied in the late third century B.C. The travel books are known as *The Travels of Emperor Mu*, who ruled from 1001 to 945 B.C. Emperor Mu, it is recorded, had the ambition to travel all around the world and to leave the marks of his chariot wheels on every land. Like the *Odyssey* of Homer, this is a story of high adventure, surely embroidered by the imagination of the writer but with details that could scarcely have been invented by fancy. The emperor traveled in forested mountains, encountered snow, and engaged in hunting expeditions. On his return he crossed a wide desert where water was so scarce that he had to drink the blood of a horse. There can be no doubt that at a very early date the Chinese travelers had gone far beyond the original culture hearth in the Wei Ho Valley (Mirsky, 1964:3-10).

The discovery of the Mediterranean civilizations is credited to the geographer Chang Ch'ien in 128 B.C. (Mirsky, 1964:13-25; Needham, 1963; Sykes, 1961:21; Thomson, 1965:177-178). The book he wrote describes the land route across inner Asia to Bukhara and thence to Persia and the Mediterranean shore. Over this route traders traveled regularly and had probably made contacts with the west long before the West was discovered officially. The Chinese products that were carried westward included peaches, almonds,

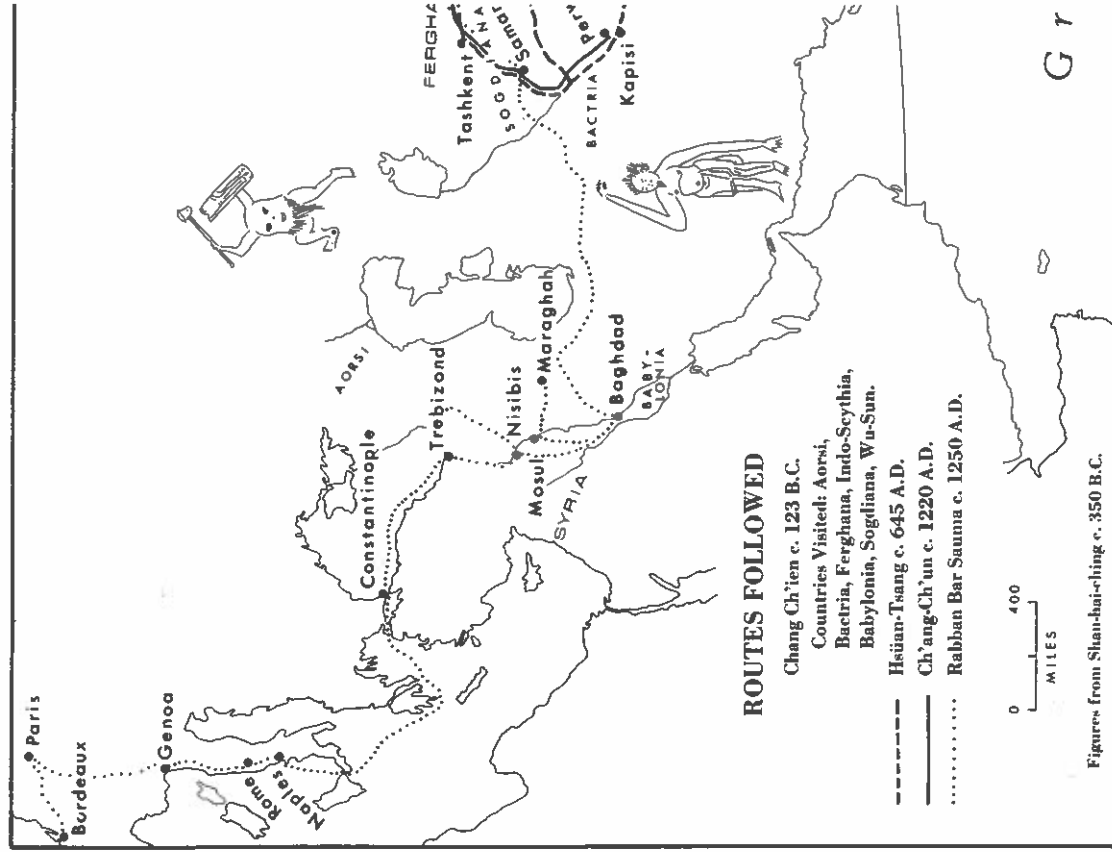
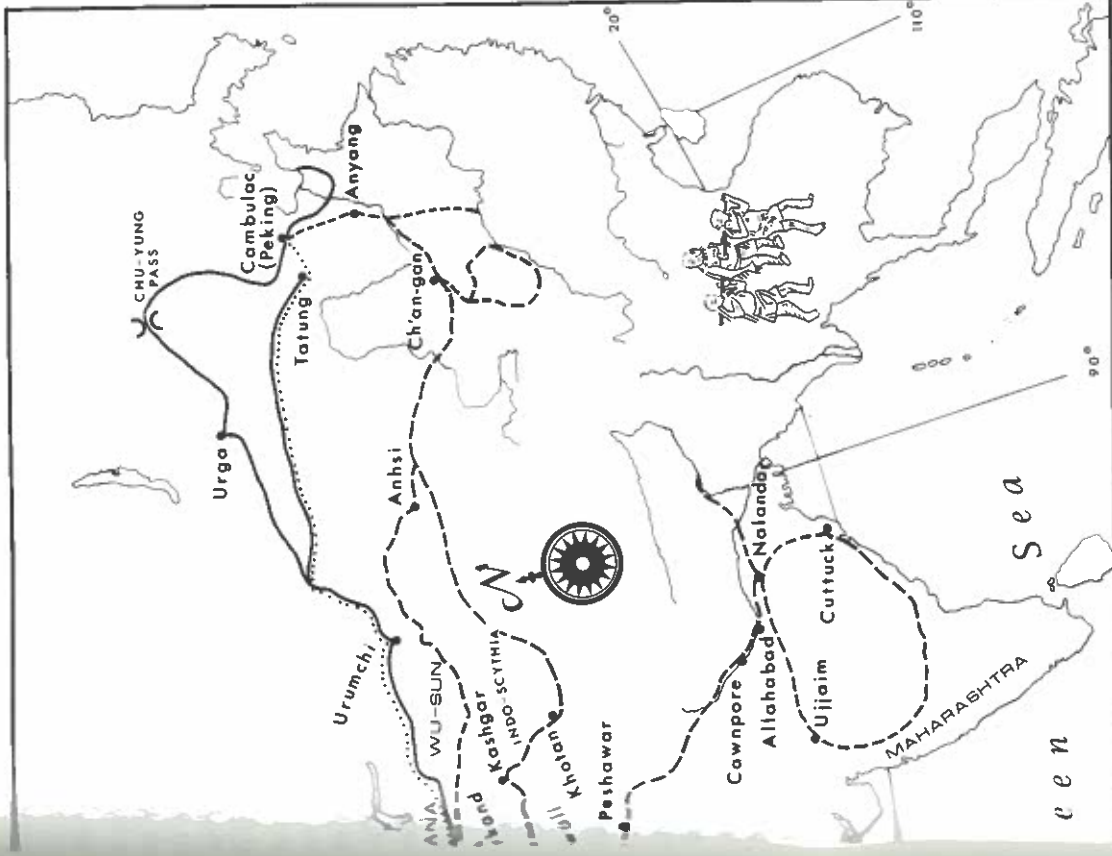


FIGURE 8. Early Chinese explorers.

plums, apricots, silk, and, eventually, silkworms. The Mediterranean products that were carried back to China included alfalfa, wheat, and the grapevine.

There were a number of other Chinese travelers whose records are complete enough to insure their place in history. One of the most distinguished was the Buddhist monk, Hsüan-Tsang (Sykes, 1961:24-30). In the seventh century after Christ he was able to cross the high, windswept plateaus



of Tibet and the world's highest mountains on the way to India. After studying in the centers of the Buddhist faith for several years, he returned to China, carrying on the backs of animals a large collection of Buddhist relics and manuscripts. He was the Chinese discoverer of India (Mirsky, 1964). In that same century another Buddhist monk, I-Ching, reached India by sea, stopping first for eight months in Sumatra in 671. When he returned to

China, he carried with him more than 10,000 rolls of Sanskrit Buddhist texts, which he undertook to translate into Chinese (Sykes, 1961:30). Several centuries later another Chinese traveler crossed the deserts of inner Asia, encountered endless difficulties, and finally made contact with the Mongol leader, Genghis Khan, in Samarkand, in 1220. And there was the Nestorian Christian monk, Rabban Bar Sauma, who in 1287-88 made a pilgrimage to Rome. Finding the pope dead and the new pope not yet selected, he went on through Genoa to Paris and Bordeaux, meeting the kings of France and England. Imagine the amazement of people in thirteenth-century France when they found themselves being discovered by a Christian from China. In 1288 he returned to Rome and received the blessing of the new pope and thereafter journeyed back to Peking. This was several decades before the similar journeys of the Polo brothers to China. And in 1296 the Chinese traveler, Chou Ta-kuan, visited Cambodia and wrote a detailed account of the strange customs of the Cambodians.

Other Chinese explorers also went by sea. There was never any recorded effort to go far out into the Pacific, although Chinese expeditions did reach Japan and Taiwan. By the thirteenth century, Chinese merchants were sailing their junks to Java and Malaya and even as far as India. Marco Polo found them in the Persian Gulf port of Hormuz. But the major work of exploration in this direction was carried out by Cheng Ho, a Chinese admiral, between 1405 and 1433. He led seven separate expeditions, each including a fleet of vessels. His voyages opened regular trade routes to Java, Sumatra, Malaya, Ceylon, and the west coast of India. He also reached the Persian Gulf, the Red Sea, and the east coast of Africa south of the equator. In the east he went as far as Taiwan. On his last expedition, from 1431 to 1433, Cheng Ho returned with ambassadors to China from more than 10 countries. It is even possible that he sent one of his ships to the north coast of Australia (Hsieh, 1968).

CARTOGRAPHY

The Chinese were also expert in the making of maps. The engineer, Chang Heng, in the second century after Christ, was probably the first to introduce the grid system into China, although the maps he made have not survived. There is a reference to him, however, in which he is identified as one who "cast a network [of coordinates] about heaven and earth, and reckoned on the basis of it" (Needham and Ling, 1959:538).

The father of Chinese cartography was Phei Hsiu, who was appointed minister of public works by the Chinese emperor in A.D. 267. He produced a map of the politically organized part of China on 18 rolls of silk. To make the surveys on which the map was based, he measured several base lines and then located places distant from the base lines by the intersection of lines of sight, just as the Egyptians had done long before. He made use of a grid of east-west and north-south lines crossing at right angles to provide the frame

on which to plot the rivers, the coastline, the mountain ranges, the cities, and other features. Did he, or Chang Heng, or someone much earlier get the idea of using triangulation to locate places and of using a grid of lines from contacts with the Greeks and, perhaps, through them with the Egyptians? It is entirely possible, although no such transmission has ever been established. And it is by no means impossible that many of these methods were devised much earlier in China and diffused westward, as the decimal form of arithmetic certainly was.

Two beautiful examples of Chinese maps were carved in stone in A.D. 1137 based on data that probably had been surveyed before 1100 (Needham and Ling, 1959:547-549). One, "A Map of China and the Barbarian Countries," extended from the Great Wall of China north of Peking southward to the island of Hainan and westward to the mountains of inner Asia. The other, entitled "The Map of the Tracks of Yü the Great," covers essentially the same area but is even more accurate in showing the courses of the great rivers and the coastline from the Gulf of Chihli, north of the Shantung Peninsula, to the island of Hainan. Neither of these maps shows Taiwan. Both maps—like other Chinese maps—were drawn with north at the top. The geographers who made them are not known.

THE MEDIEVAL WORLD IN RETROSPECT

The period from the fifth to the fifteenth centuries was remarkable. In various parts of the world important new data were being collected by direct observation, but the lack of close contacts among different peoples, in large part resulting from the barrier of language, meant that geographic knowledge gained by one group was diffused only slowly to others. No rumor of the Viking voyages reached Christian Europe. But Christian Europe did have a variety of documents that contradicted each other. Those who could read Arabic were aware that people were living along the equator and beyond it and that people with white skins had visited these regions without turning black. But there were also reputable authorities, ranging from Aristotle to Ibn-Khaldun, who insisted that one would turn black at these very low latitudes. The basic Greek theory, which equated habitability with latitude, seemed firmly established, in spite of the evidence of direct observation. But who could be sure which documents were sober and reliable descriptions of actual conditions and which ones were purely imaginative?

In 1410 two important books appeared. One was the *Imago mundi* of Pierre d'Ailly, which summarized much of the writing of Christian Europe in this period. The other was the Latin translation from the Arabic of Ptolemy's *Geography*, which included a large number of errors. Ptolemy did present one important idea: that maps should be based on the precise location by latitude and longitude of specific points. The trouble was that none of the places he

located were correctly placed; he gave the weight of authority to several major errors, including the enclosed Indian Ocean.

Starting with Edrisi in Sicily, there had been definite improvement in the arts of navigation, including the wide adoption of the magnetic compass. The Genoese made use of the compass when they rediscovered some of the groups of islands in the Atlantic off Africa, which had been known to the Phoenicians and then lost.

The stage was set for the next step in the discovery of the world. Scholars knew that the earth was a sphere and some of them insisted that no part of it was beyond human reach. The estimates of the circumference differed considerably, and those who wanted to believe that India was only a short distance west of Spain could find ample authority (Goldstein, 1965). If one could believe Marco Polo, China and Japan were well east of India, which would place them even closer to Spain. Pierre d'Ailly said you could sail westward to reach the East. It was the Florentine physician and scholar, Paolo Toscanelli, who sent the following remarks to Columbus in 1474:

On another occasion I spoke with you about a shorter sea route to the lands of spices than that which you take for Guinea. And now the Most Serene King requests of me some statement, whereby that route might become understandable and comprehensible, even to men of slight education.

Although I know that this can be done in a spherical form like that of the earth, I have nevertheless decided, in order to gain clarity and to save trouble, to represent (that route) in the manner that charts of navigation do.

Accordingly I am sending His Majesty a chart done with my own hands in which are designated your shores and islands from which you should begin to sail ever westwards, and the lands you should touch at and how much you should deviate from the pole or from the equator and after what distance, that is, after how many miles, you should reach the most fertile lands of all spices and gems, and you must not be surprised that I call the regions in which the spices are found "western" although they are usually called "eastern," for those who sail in the other hemisphere always find these regions in the west. But if you should go overland and by the higher routes we should come upon these places in the east.

The straight lines, therefore, drawn vertically in the chart, indicate distance from east to west; but those drawn horizontally, indicate spaces from south to north.

From the city of Lisbon westward in a straight line to the very noble and splendid city of Quinsay 26 spaces are indicated on the chart, each of which covers 250 miles. (The city) is 100 miles in circumference and has 10 bridges. Its name means City of Heaven; and many marvelous tales are told of it and of the multitude of its handicrafts and treasures. It (China) has an area of approximately one third of the entire globe. The city is in the province of Katay, in which is the royal residence of the country.

But from the island of Antilia, known to you, to the far-famed island of Cippangu (Japan), there are 10 spaces. The island is very rich in gold, pearls, and gems; they roof the temples and royal houses with solid gold. So there is not a great space to be traversed over unknown waters. More details should, perhaps, be set forth with greater clarity but the diligent reader will be able from this to infer the rest by himself (Morison, 1963:12-14).

CHAPTER

4

THE AGE OF EXPLORATION

Terra Incognita: these words stir the imagination. Through the ages men have been drawn to unknown regions by Siren voices, shores of which ring in our ears today when on modern maps we see spaces labelled "unexplored," rivers shown by broken lines, islands marked "existence doubtful. . . ."

The Sirens, of course, sing of different things to different folk. Some they tempt with material rewards: gold, furs, ivory, petroleum, land to settle and exploit. Some they allure with the prospect of scientific discovery. Others they call to adventure or escape. Geographers they invite more especially to map the configuration of their domain and the distribution of the various phenomena that it contains, and set the perplexing riddle of putting together the parts to form a coherent conception of the whole. But upon all alike who hear their call they lay a poetic spell.

The sudden increase in exploring activity in Europe in the fifteenth century was a major turning point in world history. In China exploration supported by the emperor ceased after the seventh expedition of Cheng Ho (1431-33); and there was no great Muslim traveler after ibn-Batuta in the fourteenth century. But in Europe exploration for the first time was planned and supported by governments or by merchant companies and, for the first time, was directed to the open oceans. What were the motives? In this case the challenge of the unknown—the

The quotation above is from John K. Wright's presidential address to the Association of American Geographers, 1946, "Terra Incognita: The Place of the Imagination in Geography," *Annals AAG*, 37 (1947): 1-15; ref. pp. 1-2.

T h i r d E d i t i o n

ALL POSSIBLE WORLDS

A HISTORY OF GEOGRAPHICAL IDEAS

GEOFFREY J. MARTIN
Southern Connecticut
State University

PRESTON E. JAMES

maps and illustrations by
Eileen W. James

*The optimist proclaims that we live in the
best of all possible worlds; and the pessimist fears this is true.*



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P R E F A C E

The history of geography constitutes an investigation into the way in which geographic subject matter was recognized, perceived, thought about, and evaluated over the course of centuries. Ideas evolved; some were correct, some were erroneous, but all were part of a long-developing body of ideas that helped humankind comprehend its surroundings. Out of this, a discipline and profession evolved. This pattern emerged in several countries, each independent of the other, until recent times, when ease of transport and circulation of the written and spoken word has facilitated the exchange of ideas.

Each national geography has its own necessities, and each country produces its own sages, each with their own inimitable point of view that naturally influences students. Nevertheless, since approximately the middle of the nineteenth century an ever-increasing exchange of thought has taken place that permits international recognition of a geographical point of view. The history of this point of view is offered as an account of the successive images scholars have developed concerning arrangements and patterns on the face of the earth. Long before the dawn of written history, men who explored even just a short distance from home were aware of differences that distinguished one place from another. The concept of areal differentiation had been born. Some people were drawn to the challenge of forming mental images of what it was like beyond the horizon and communicating these images to others. The differentiation of the face of the earth is what John K. Wright called "geodiversity." This is what geography is all about.

How can a mental image of geodiversity be formed with sufficient clarity that it can be communicated to others? What things are combined in different places on the earth to produce the complex characteristics of the world's landscapes? In the first place, the world is much larger than humans are, and on its curved surface our range of vision is narrowly restricted. Most of the fields of study in modern science seek to form mental images of things and events that are much too small to observe directly; but to form a mental image of a world that is too big to see, it is necessary to generalize, to select certain features to build into the image, and to reject other features as not relevant. Furthermore, no coherent image of our world could be put together unless the observed features are located in relation to a known point. One of the distinctive characteristics of a geographer is a consistent concern about the relative location of things.

Along with the formation of a mental image of geodiversity, however, has existed our need to explain it. Scholars formulated many different explanations to make the mental images seem plausible or acceptable. Their explanations