

hailed from an ex-Byzantine territory. All of them were either the Hijāzian Arabs or belonged to Persian families which had lived as Muslims for at least two generations. Even al-Auzā'i was not of Syrian origin for his father was among the captives brought from Sind.³⁵ And, therefore, he could not be suspected of having inherited any part of the Byzantine traditions.

J

FURTHER POSSIBILITIES

A modest yet practical procedure to adapt Muslim Law to present conditions has been suggested in the colloquium recently published by the "Law Number" of the Karachi monthly *Chirāgh-i Rāh*. Muslims should not remain content with their past, however glorious that past. The *raison d'être* of their existence is their constant struggle to become the very best community, a model for the whole of humanity—the community enjoining the good (*ma'rūf*), interdicting the evil (*munkar*), and believing in God.³⁶

"Influence of Roman Law on Muslim Law," *Hyderabad Academy Journal*, Vol. VI, 1943, and *Imām Abu Ḥanīfah ki Tadwīn-i Qānūn-i Islāmī* (Urdu), Karachi.

³⁵ Al-Dhahabi, *Tabaqāt al-Ḥuffāz*, s.v. "Auzā'i."

³⁶ Al-Qur'ān, iii, 110.

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Part 4. The Sciences

Chapter LXII

GEOGRAPHY

Philosophy in the past ages was not merely an academic subject studied by specialists; it was a living influence which guided men in their ideas about the universe and it included a variety of fields covering theology,

law, society, and the sciences. To the Muslims during the Middle Ages philosophy and its various disciplines were all-embracing. Geographic ideas were inseparable from philosophic thinking as they were basic to a widening of horizons. Indeed, interest in geography is as old as recorded human history. This had its roots in ancient folklore, poetry, and travel. The geographical instinct in one form or another developed early among organized human communities, and the people of the ancient civilizations possessed a variety of geographic knowledge.

It is well known to historians that the culture of Greece was preceded by a continuous and composite culture in Western Asia and Egypt and that this culture in its turn was not the product of the genius of any one people, but was shaped by an ever-increasing human intercourse and was the fructification of a long evolution. Thus, Greek geographical ideas too had a basis in the past and in the experience of other peoples. Philosophy and poetry formed the tap-roots of the geographic knowledge of the Greeks. Similarly, in Arab times both Greek ideas and Islamic philosophy and literature were potent factors in the evolution of geographic concepts.

Early Greek contributions to geography were as varied as they were brilliant. Later on, Alexander's campaigns were of the nature of geographical exploration under arms. In the course of time the centre of scientific activity shifted to Alexandria. Science and geography continued to flourish in the Graeco-Roman age, though under somewhat different cultural atmosphere. In fact, the Graeco-Roman culture was subjected to a terrible ordeal. It witnessed one of the greatest intellectual conflicts in history, the clash between Greek ideals and the various oriental religions, chiefly Judaism and Christianity.

But before Christianity could triumph, the great geographer Ptolemy (c. 150 A.D.) had accomplished his work of co-ordinating the sum total of geographic knowledge up to his time, though a little earlier Strabo (c. 19 A.D.) had contributed even more brilliantly in terms of geographic analysis. He had also indicated the extent of the knowledge of the Romans about the land and people of Arabia. Describing Gellus' expedition in 25 B.C. to Haura on the Red Sea coast to the borders of Ḥaḍramaut, Strabo says that the Emperor Augustus was also influenced by reports of the wealth of the Arabs and their trading activity in spices, aromatics, and precious stones, and that he desired either to befriend or subdue such opulent people.¹

By the third century A.D. distinct changes had taken place in the political, cultural, and religious spheres. The Roman Empire came near to utter breakdown. The legions, never too many for the long frontiers and made increasingly heterogeneous by local recruiting, lost their sense of mutual cohesion and failed to check stronger outside attacks. Many emperors rose and fell like ninepins, unmourned, unsung. Rome was sacked by Goths in 410 A.D. By

¹ Baker, *A History of Geographical Discovery and Exploration*, p. 26.

the middle of the sixth century A.D., Justinian's final efforts at consolidation of the Roman power had failed.

The commencement of the Middle Ages is important in the history of science in general and geography in particular. A general retrogression is witnessed and gradually the so-called "Dark Age" of geography set in. It is common to begin the Middle Ages from Constantine, but Paganism was tolerated almost until the division of the Roman Empire in 395 A.D. The tradition of pagan literature and science, however, continued much longer, at least until Justinian closed the school of Athens. The triumph of Christianity led its adherents to consider scientific research not only a useless occupation but also a pernicious one. Alexandria had lost its noble place as the centre of scientific activity, and Egypt for the Christians had become a land of new wonders as the first home of hermits or desert men or monks; some visitors had no interest in anything else and dismissed the pyramids as mere "Granaries of the Kings."² A sailor turned monk took a hand at geographical writing and produced the most cranky of books, the famous *Christian Topography*, in 547 A.D. The main purpose of this erudition was to disprove the pagan notion that the earth is a globe. Cosmas hailed from Alexandria and had in his younger days traded in the Red Sea and even beyond. Cosmas' earth was flat, rectangular, and oblong, twice as long from east to west as from north to south, and was surrounded by ocean. A high mountain rose in the north behind which the tiny sun played hide and seek to bring forth days and nights. Beazley rightly called Cosmas' work a "systematic nonsense." Saint Ambrose saw no profit in investigations about the earth. Science, geography, and all such pursuits were dubbed as magic art. The spherical shape of the earth and the existence of antipodes were favourite subjects of ridicule.

Thus, the geography of the early centuries of the Christian era was a fascinating mixture. Perhaps it seldom represented the full amount of contemporary knowledge and was largely made up of traditional elements, Christian and classical, blended in various proportions. The first came from a literal reading of the Scriptures and other-worldly attitude of the protagonists of the Church. It appears that Christianity spread first through the urban commercial population round the Mediterranean, whose *lingua franca* was Greek. It was only later on that it penetrated into the hinterland and overspread into the vast rural areas of outer provinces. Thus, Greek science received a frontal attack in its most important centres. In this refutation of earlier knowledge, interest in science and rational geographic concepts could be retained only by a handful of people in Christendom. Only the Nestorians, the Monophysites, and some of their adherents kept a semblance of Greek science preserved.

During the first/seventh century there arose an epochmaking movement from the depths of the Arabian Peninsula. It was Islam. It brought about the establishment of one of the greatest empires the world has seen. The

² Thomson, *History of Ancient Geography*, p. 360.

Arabs conquered a large number of peoples who were superior to them in culture. Nevertheless, the conquerors did not lose their national characteristics and subjected Syria, Mesopotamia, Egypt, and North Africa to their ethnographical influences.

As soon as early conquests were over and cultural contact was established with Greek and Indian knowledge, Muslims became imbued with tremendous curiosity and took up the cause of science with enthusiasm at different centres of their culture. Early Islamic attitude to science was one of tolerance, even enlightened interest. It is evidenced by the continuance of the academy at Jundi-Shāpūr as a scientific centre in the Muslim Empire. Scientists from this centre in Persia were welcomed at Damascus, the capital of the Umayyad Caliphate. These men were mostly Christians and Jews.³ Further, the Arabs were traders, travellers, and lawyers, and they had somewhat positive minds and, therefore, practical sciences appealed to them. Arabic was suitable for exact and precise sciences and lent itself more easily to the formation of technical terms. Geography especially appealed to them because of its utility to serve the needs of commerce, the division of land, travel through the deserts, knowledge of the plants and animals, and to find the azimuth of Mecca and the phases of the moon.

The Arabs had a traditional interest in matters concerning geographical knowledge. Even before the birth of Christ and after, they were among the foremost traders and navigators of the Arabian sea, Indian Ocean, and Chinese waters. The Arabic language of that period abounds in words for ships, boats, condition of the sea surface, storms, heavenly bodies, and commodities of exchange and trade. These activities were greatly influenced by the geography of the Arabian Peninsula and its midway position between the East and the West and the littoral situation of all its fertile lands in Yamāmah, Oman, Bahrain, the Yemen, etc. Even the Hijāz, though largely arid, lay along the trade-routes from the Arabian and Red Seas to the Mediterranean world.

Pre-Islamic poetry contains references to navigation and sailings, and the Holy Qur'ān itself abounds in navigational terminology and descriptions of conditions of the sea and ships and boats used. There was a close relationship between land journeys as well as between sea voyages and the knowledge of stars and other heavenly bodies. The inland Arabs with scanty agriculture and nomadic economy were always face to face with such problems as sources and extent of grazing opportunities, distribution of desert plants and animals, and the nature of geomorphological features. Therefore, Arab interest in geographical matters was a deep one. It needed various stimuli such as extension of territorial influence, expanded trading opportunities, greater cultural contacts, and a vigorous religious zeal to widen the frontiers of geographic knowledge.⁴

³ Max Meyerhof, "Science and Medicine," *The Legacy of Islam*, p. 314.

⁴ Sulaimān Nadawī, 'Arbōn ki Jahāzrāni (Urdu), p. 165.

Within a century of the advent of Islam, the Arab victories brought them a rich reward in the conquest of prosperous lands and cultured communities, from the Mediterranean to India and Central Asia. On the one hand, the Arabs became the heirs to the Hellenistic culture for which a way was earlier opened by the conquest of Alexander. On the other, they reached the homeland of Indian culture and Buddhist and Indian thought. It is rightly assumed that the Arabs became the pupils of and successors to the Greeks in science and, through their own efforts and ingenuity, perfected it for the future protagonists.

Indian influence in the first instance was the product of a continuing commercial contact *via* the sea-route from Ujjain, the town of Brahmagupta (c. 6/628), the famous writer of the astronomical manual *Brahma Siddhānta*. Muslim conquest of Central Asia brought them into touch with Buddhism and old Greek colonies in the regions of Bactria, Sogdiana, Farghanah, and Merv.

The establishment of the 'Abbāside Caliphate in 132/750 A.D. ushered in an age of glory, power, pomp, splendour, culture, and prosperity for the peoples under Muslim rule. Scientific activity took its birth and in this process the inauguration of translation activity in Baghdad, systematically organized under a Translation Bureau (*Bait al-Hikmah*), was a tremendous step forward. The Bureau had a library and permanent personnel, and translators were commissioned from far and wide. Manuscripts were even paid for their weight in gold. The main aim was to make available in the Arabic language the wisdom and the science of the Greeks and others. Translations also included works in many sciences by an array of able translators. Among the sciences which received special attention were physics, meteorology, mineralogy, botany, astronomy, and geography. The early phase of translations was concerned more with medical and philosophical works, but later on mathematical, astronomical, and geographical subjects received more attention. The Caliph al-Māmūn took active interest in the work of his translators and scientists. Among his great achievements were the measurement of a degree of the earth's arc on the plains of Sinjar, west of Mosul, and the construction of a world map. Both the tasks were of great geographical significance and were accomplished by a team of scientists.

The period of early translations was of great importance to the developing intellectual and scientific life of Muslim society. The Greek writers who influenced the Arab scholars most were not poets, historians, or orators, but largely the scientists in various fields such as mathematics, astronomy, medicine, philosophy, and geography. For instance, the scientific works of Aristotle received far greater attention than did the writings of Plato and Socrates.

Before the content of Muslim contributions to geography is examined, a few points must be clarified. The birth of scientific activity under Islam has indispensable relevance to Muslim geographic thinking. The passage of Greek science to the Arabs revealed to them Hellenistic geographic concepts which

had received slashing denunciations from orthodox Christian writers. Therefore, the first task of Arab geographers was the revival of the older science.

Muslim geographers held Ptolemy in high regard and greatly valued his monumental work. But he did not escape their criticism, and numerous improvements in his concepts were suggested. Even Ptolemy was not able to combine the mathematical with the descriptive and statistical methods in geography. As regards the latter, Strabo was far more alive and was more critical in his writings than Ptolemy. These traditions were passed on to Arab writers and, therefore, quite a number of Muslim geographers can be categorized under them. But Arab geographers branched out into so many new directions and were so prolific in their output that a somewhat broader classification of their contributions is called for. Muslim interest in geography was stimulated by a variety of factors such as environmental, religious or spiritual, administrative, political, and commercial.

Muslim military campaigns were well planned and superbly executed and the generals and commanders collected much geographical data before conducting their operations. The organization of administration, collection of revenue, and appraisal of resources of the newly conquered territories required detailed geographical information. It is said that the great Caliph 'Umar, hearing of the conquest of new lands, asked a scholar to describe to him the lands of the earth, their climates and positions, and the influence which land and climate exert upon their inhabitants.⁵ Both scholars and religious leaders considered geography a laudable pursuit, as is borne out by the remark of Yāqūt that as a science geography was pleasing in the eyes of God. Even the orthodox al-Qhazālī believed that the votaries of science will find the road to paradise easy. Muslim religious interest in the determination of latitude and longitude of places and in the diurnal movement of the sun was indispensable both in connection with the time for daily prayers and the geographical co-ordinates of Mecca. With the expansion of the dominions of the Muslim Empire, commercial activity increased and geographical information of different types became vital for its growth and development.

Regional geography received early attention and contained an enormous wealth of details and information. It developed its own traditions, and the variety in approach to it and the ingenuity of the individual geographers make many contributions to it a fascinating reading. The writings of notable travellers, the specialist studies of the topographers, and the critical works of the socio-geographers lend an immense variety and colour to Muslim geography. Therefore, it may be convenient to examine the Muslim contribution to geography under the following headings:

- (A) General and Regional Geography.
- (B) General Treatises and Scientific Geography.

⁵ C. Schoy, "The Geography of the Muslims of the Middle Ages," *The Geographical Review*, Vol. XIV, No. 2, 1924, p. 258, (quoting Mas'ūdi).

- (C) Mathematical Geography.
(D) Cartography and Map-making.

A

GENERAL AND REGIONAL GEOGRAPHY

Muslim interest in general geographical writing developed early. This class of geographical writing has a wide range and includes some of the earliest contributions in this field. General geographical descriptions of the Muslim world were a favourite theme and in view of the needs of administration and extension of the postal services many works were written as "Route Books." Diaries and travel accounts were yet another category of geographical writing. As a result of the unsatisfactory basis of descriptions in relation to hypothetical "Climatic Divisions" in parallel latitudinal strips (a Greek legacy) many Muslim geographers felt the necessity of describing the dominions of Islam on the basis of regions of which they possessed more specific knowledge. It may be said to be the beginning of a regional consciousness.

Among the earliest known works dealing with geographical matters are those of 'Abd al-Mālik ibn Quraib al-Aṣma'i and Hishām ibn Muḥammad al-Kalbi. Al-Aṣma'i of Baṣrah (123-216/740-831) wrote on plants, animals, and the evolution of human society. Al-Kalbi (d. 205/820) was an authority on the history of pre-Islamic Arabia and it is said that his work *Kitāb al-Nawādir*⁶ contained observations on many geographical topics. Similarly, one of the early treatises on agriculture was ibn Wahshiyyah's (c. 288/900) book on Nabataean agriculture. Abu Yūsuf Ya'qūb al-Kindi (c. 260/873-874), though primarily a philosopher and physicist, wrote a geographical work called *Rasm al-Ma'mūr min al-Ard* (Description of the Inhabited Part of the Earth). But the work of Muḥammad ibn Mūsā al-Khwarizmi (d. 236/850) laid the foundation of Arab geographical science. By writing *Kitāb Sūrat al-Ard* (Treatise on the Face of the Earth) he syncretized Greek and Hindu knowledge. He was a mathematician of great repute and is said to have collaborated in the degree measurements ordered by Caliph al-Māmūn. He improved Ptolemy's geography, both as regards the text and the maps. His scientific attainments are universally acknowledged by the Orientalists. Another early geographical work which was concerned with Arabia was that of Arrām ibn al-Asbaj al-Sulami (c. 231/845) who wrote *Kitāb Asmā' Jibāl Tihāmah wa Makāniha* dealing with the mountains of Tihāmah in Arabia. This work was mentioned by al-Sirāfi, and another book by the same author bearing the title *Jazīrat al-'Arab* was mentioned by Yāqūt in his "Dictionary of Learned Men" (*Mu'jam al-Udabā'*).⁷

⁶ Sulaimān Nadawī, *Ard al-Qur'ān* (Urdu), Vol. I, p. 16.

⁷ Nafis Aḥmad, *Muslim Contribution to Geography*, p. 19.

1. The Route Books

After the early geographical writings mentioned above had appeared and the initial phase of translations had come to an end, an interesting class of geographical literature was produced which is contained in the so-called "Route Books" (*Kutub al-Masālik w-al-Mamālik*). Quite a tradition developed in the writing of these route books and many later authors copied the technique of the earlier masters. In this respect, ibn Khurdādhbih (c. 300/912) blazed a new trail with his famous *Kitāb al-Masālik wa-al-Mamālik* (A Book on Routes and Kingdoms). He provided an excellent summary of the main trade-routes of the Arab world and also wrote descriptions of China, Korea, and Japan. The work served almost as a source for later writers. Unfortunately, only an abridged version of the book is extant. Al-Marwazi (d. 274/887) also wrote a route book which was mentioned by ibn al-Nadīm and Ya'qūb. Sarakhṣi (d. 286/899), who was a pupil of al-Kindi, gave the same title to his geographical work and abu al-Faraj al-Baḥdādī (d. 310/922) compiled *Kitāb al-Kharāj* (Revenue Book) dealing with land tax and postal services in the context of the geography of the Arab Empire. Al-Jaiḥānī (fl. c. 280-295/893-907), the learned minister at the Sāmānīd Court, wrote another revenue book replete with geographical explanations, and it is surmised⁸ that it was one of the source materials for al-Idrīsī. Abu Zaid al-Balkhī (d. 322/933) produced another route book along the traditional lines, but his real fame as a geographer rests on his somewhat more scientific contribution, namely, *Kitāb al-Ashkāl or Suwar al-Aqālīm* (Figures of the Climates). Al-Iṣṭakhri (fl. c. 339/950) followed in the footsteps of his senior contemporary al-Balkhī by writing a similar book and using the technique of explaining maps by the accompanying text. Ibn Ḥauqal revised and rewrote Iṣṭakhri's book with considerable additional information in 367/977. These three geographers form an important group who combined their writings of descriptive geography with cartographic work and scientific analysis and, therefore, this category of their work will receive mention later on.

In Spain, al-Bakrī (d. 487/1094) of Cordova used the same technique and method to write his route book and geographical dictionary notable for their useful information about Europe and North Africa.

2. Books of Countries and Dictionaries

The route books were written from an administrative angle but they invariably developed into geographical treatises. They were generally concrete, accurate, and detailed.⁹ Closely related to the route books, yet enlarging on their scope and subject-matter, were the large number of "Books of Countries" and geographical dictionaries and gazetteers. Among the early writers of such

⁸ *Ibid.*, p. 23.

⁹ Sarton, *Introduction to the History of Science*, Vol. I, p. 587.

tracts and a notable Arab geographer and historian was al-Ya'qūbi who wrote *Kitāb al-Buldān* (Book of Countries) in 278/891, giving a wide range of topographical and economic details and occasionally bringing out the relationship between physical factors and human activity. Topographical details about the cities of Kūfah, Baghdād, Sāmarrah, and Baṣrah and regional descriptions of many areas in Arabia, Syria, Egypt, Nubia, and North Africa, are some of the outstanding features of this book. His pioneer work as a geographer deserves high praise, and it is not surprising that modern European writers often call him the father of Muslim geography. Shortly before Ya'qūbi an outstanding historical work with many geographical observations had been written by al-Balādhuri (in 256/869) under the title *Futūḥ al-Buldān* (Conquests of Countries). This work typifies Muslim interest in the history and geography of the newly acquired territories. Al-Hamadāni's "Book of Countries" written in 290/902 was utilized by notable geographers like Mas'ūdi and Yāqūt; unfortunately, it is lost. A contemporary of al-Hamadāni was ibn Rustah (fl. c. 291/903); his encyclopedia *al-A'lāq al-Nafisah* dealt with geographical matters in its seventh volume. He discussed a variety of topics including the extent of the earth, seas, rivers, climate, founding of Mecca and Medina, and the regional geography of Iran. Ibn Rustah's account of the road system of the empire and particularly of the great Khurāsān road remains outstanding for its clear details and geographic implications. A few years later ibn al-Hā'ik (d. 334/945) presented his regional geography of Arabia in *Kitāb Jazīrat al-'Arab* dealing with physical features, minerals, races, tribes, and settlements. He also contributed a semi-geographical work *al-Iklil* on the archaeological aspects of the Yemen. Muhallabi (375/985) was the author of an outstanding geographical work dealing with the Sudan. It was the first work of its kind for this remote region and formed Yāqūt's main source for the geography of the Sudan.

An interesting geographical work of the fourth/tenth century written in Persian was entitled *Hudūd al-'Ālam* (c. 372/982) by an unknown author. It is meant to be a world geography on a regional basis and was probably written as a preface to a map. Minorsky has produced an excellently edited and annotated version of this notable work.¹⁰

The western wing of Islam in Spain also produced many contemporary geographers who wrote route books, books of countries, and works of regional descriptions. Al-Ṭarīqī (d. 363/973) wrote on North Africa. Al-Bakri of Cordova (d. 487/1094) was a celebrated geographer who compiled a geographical dictionary, *Mu'jam ma Ista'jam* as well as a route book. These works incorporate fresh material on Central and Eastern Europe and North Africa. Al-Zuhri of Granada (c. 532/1137) was the writer of a notable work, *Kitāb al-Jaghārfia* (Book of Geography). It appears that al-Zuhri was able to utilize the work of the team of geographers of the reign of Caliph al-Māmūn. Al-Munajjim (d. 456/1068)

was the compiler of a geographical dictionary which both al-Idrisi and ibn Khaldūn mention as one of their source materials. And there were many lesser lights who followed these masters in compilation.

But the art of depicting geographical and associated information in the form of a dictionary attained its highest form from the pen of Ya'qūb Ḥamawī. His work was done almost at the crossroads of history, shortly before the Tartar invasion engulfed the eastern lands of Islam. After considerable travel in his younger days and study in several libraries, he produced his monumental geographical dictionary known as *Mu'jam al-Buldān* in 621/1224. This great work contains a geographical gazetteer, a regional world geography, and much topographical, historical, and archaeological information. It deals with geography in the broadest manner. His other well-known work *Mu'jam al-Udabā'*, dealing with lives of learned men, is also replete with geographical information. Yāqūt utilized a variety of sources including many of those which are now extinct. His dictionary contains a treatise dealing with geography in general from many points of view.

3. Diaries and Travel Accounts

Travel has always been the easiest and the most natural means of acquiring and propagating geographic knowledge. In the medieval period of Islam travel was promoted in many ways. Religio-cultural affiliations with far-flung parts of the world, curiosity, commercial enterprise, and above all the urge for pilgrimage excited widespread interest in travel. Thus, Muslim travel literature in the shape of diaries and descriptions and experiences of journeys contains a treasure-house of geographical information.

For Muslims, the pilgrimage to Mecca was not a matter of choice; it was their positive duty within the limits of possibility to undertake it. Mecca was the ever-present magnet to attract their thoughts and thus there ran into Arabia a constant stream of visitors from all parts of the Islamic world. The *hajj* every year was a unique international assemblage by which people from distant lands, diverse environments, and varied experiences exchanged ideas and acquired knowledge of countries and inhabitants of the world. It was a tremendous incentive to the spread of geographical knowledge.

With the spread of Islam and the extension of its political influence, trade and commerce greatly expanded resulting in the knowledge of new lands. In the Euro-Asian continent these regions were the Volga-Caspian, Northern Europe, and Siberia on the one hand and Central and South-East Asia on the other. The African continent received far more attention from the Muslims than from their predecessors. The East African coast up to Madagascar, Egypt, Nubia, Abyssinia, the Sudan, Equatorial Africa, the Sahara, land of the Niger, and West Africa, all came within the range of their commercial, cultural, and religious activities.

Travel and commerce walked hand in hand. Each geographical discovery

¹⁰ Minoroky (Ed.), *Hudūd al-'Ālam*, Preface, p. vii.

created new commercial opportunities, and these, with attendant competition and inherent ambitions, led to more travel and discoveries. At a later period the Crusades, besides their sordid side, provided for generations a great and prolonged avenue for contact between the East and the West for exchange of ideas and cultural assimilation. Trade, commerce, and travel were promoted and helped the circulation of geographical information.

Ibn Faḍlān went as an envoy of Caliph al-Muqtadir to the Court of the Volga Bulghar in 309/921 and is credited with the first reliable account of Russia. He may, in fact, be regarded as one of the earliest Muslim traveller-geographers. His *Risālah* or diary is of great geographic significance. His description is the earliest reliable account of Russia and was incorporated into the works of many later geographers including Yāqūt.¹¹ Another experienced early traveller was abu Dulaf who hailed from Yanbū' near Medina. He combined poetic talents with a wander-lust. After a stay at the Sāmānid Court at Bukhāra, he went to South India across Tibet with a returning Indian embassy and the journey back was made *via* Kashmīr, Afghānistān, and Sijistān (c. 331/942). His narrative of journeys was entitled '*ʿAjā'ib al-Buldān* (Marvels of Countries). Abu Dulaf's geographical impressions of the Indo-Pakistan sub-continent and the adjoining areas were utilized by Yāqūt and Qazwini. Among early Muslim travellers, al-Idrisi mentioned Sallām who visited the region north of the Caspian Sea, Armenia, Georgia, land of the Khazars, and the Ural and Altai areas in the middle of the third/ninth century at the command of Caliph al-Wāthiq.¹²

With increasing Muslim influence in Indian littoral areas and expanding commerce in South-East Asian waters and on the Chinese mainland, more detailed and somewhat accurate geographical information was in demand. The busiest and flourishing ports on the Arabian coast and Persian Gulf were Aden, Oman, Suhar, Jeddah, Sirāf, and Baṣrah. Their commerce and overseas relations were mainly with East Africa, Indian coasts, South-East Asia, and China. Sirāf especially occupied a pre-eminent position and grew into a port-city of merchants, princes, and experienced sailors.

One of the early writings on trade and commerce and navigational matters in these regions was that on the journeys of Sulaimān the Merchant by an anonymous author (237/851) with the additional comments on it by abu Zaid al-Sirāfi. The work gives us information with regard to duration of the journey, its various stages, ports of call, nature of commodity exchange, wind and weather, and conditions of the seas. The descriptions display an excellent geographical sense and an understanding of physical and human aspects. Sulaimān's description of the Chinese mainland, its products and economic resources is realistic. He also mentions the Chinese use of tea. Interest in the Indian Ocean and its bordering lands continued for generations and Muslim

¹¹ Brockelmann, *Gesch. arab. Litt.*, Vol. I, p. 227.

¹² Ziauddin Alvi and Ali Muzaffer, "Arab Geography in the Ninth and Tenth Centuries A.D.," *The Indian Geographical Journal*, Vol. XXII, No. 3, p. 144.

sailors and travellers wrote on many topics which encompass geography. Abu Zaid al-Ḥasan of Sirāf edited accounts of Muslim travellers and sailors in c. 308/920 in order to supplement Sulaimān's narratives. According to him, ibn Wahb travelled to China in 257/870 and there were other voyages in that direction. Abu Zaid's compilation was probably entitled *Akhbār al-Sin w-al-Hind* (Information about China and India). It may be said to be the most important work of its kind before that of Marco Polo or of ibn Baṭṭūṭah. Besides the Far East, it deals with the Arabian and the East African coasts. From such voyages and confirming somewhat earlier traditions also, gradually developed the stories and fascinating fables around the name of "Sindbad the Sailor" found in the *Alf Lailah wa-Lailah*. Another writer about the trade, commerce, navigation, peoples, and products of the Indian Ocean area from Arabia to Ceylon and beyond was Buzurg ibn *Shahryār* who compiled the interesting book '*ʿAjā'ib al-Hind*'¹³ (Wonders of India) in about 342/953-954.

The famous "sea lions" (expert writers on nautical instructions), mentioned by Aḥmad ibn Mājid in the second half of the ninth/fifteenth century, were not mere expert navigators, but also writers on sea voyages and route books. Muḥammad ibn *Shādhān* and Sahl ibn Abān belonged to the fifth/eleventh and sixth/twelfth centuries. Perhaps there were many more such writers; at any rate, later on, their successors were Aḥmad ibn Mājid (895/1489), Sulaimān al-Mahri (early tenth/sixteenth century), Piri Rais, Sidi 'Ali, and al-Sifaqsi (959/1551) who displayed a remarkable knowledge of the geography of the Indian Ocean.

The scene in the Mediterranean was somewhat different to that in the Indian Ocean. In the latter, trade, commerce, and adventure were the impelling factors in Muslim enterprise, but in the former prolonged political struggle, religious wars, commerce, and pilgrimages were motivating features behind sailings and voyages. There is record,¹⁴ however, of the close co-operation between Muslims and Christians in the formation of joint partnerships and of commercial treaties, carriage of passengers in ships irrespective of their religion, and the transport of products of skilled industry and luxury goods from the Islamic world to Europe.¹⁵

Before mention is made of the well-known traveller-geographers in the western lands of Islam, those in the east deserve attention. Among these intelligent globe-trotters and geographers, al-Mas'ūdi (d. 346/957) deserves pride of place. He was born in Baghdad towards the end of the third/ninth century. Mas'ūdi acquired his knowledge through painstaking study of the existing sources as well as through extensive travels. His travels carried him to many parts of Arabia, Levantine coast, Caspian shores, Asia Minor, Iran, Iraq, India, South-East Asia, East African coasts, and Egypt. He met common

¹³ Nafis Aḥmad, "The Arab's Knowledge of Ceylon," *Islamic Culture*, July 1945, pp. 227-29; also '*ʿAjā'ib al-Hind*', pp. 156-57 and pp. 265 *et seq.*

¹⁴ Kramers, "Geography and Commerce," *The Legacy of Islam*, pp. 97-103.

¹⁵ *Ibid.*, pp. 104-05.

men possessing practical knowledge and scholars of repute. Mas'ūdi's acute observations and views depicting a keen geographical sense are contained in his famous book, *Murāj al-Dhahab wa Ma'ādin al-Jawāhir* (Meadows of Gold and Mines of Precious Stones), a historico-geographical encyclopedia written in about 336/947 and revised ten years later. It seems to be an age of great travellers, as not many years later ibn Ḥauqal (fl. c. 332–367/943–977) completed a travel of thirty years which excited his interest in geography. His meeting with the celebrated geographer al-Iṣṭakhri was significant, as at the latter's request he re-wrote his geography and revised the accompanying maps. Ibn Ḥauqal called this improved version, *Kitāb al-Masālik w-al-Mamālik* (Book of Roads and Provinces), and added maps of each country to this remarkable treatise.

Yet another outstanding geographer and traveller was al-Maqdisi or al-Muqaddisi, a native of Jerusalem. He travelled through many Islamic lands except perhaps Spain, Sijistān, and Sind. By all standards he was a careful observer and had an inborn geographical sense. On the culmination of his travels he wrote his famous geography *Aḥsan al-Taqāsīm fi Ma'rifat al-Aqālīm* (Best of Divisions as Regards Climates) at Shīrāz in Fars in 375–376/985–986. His writings reveal much original information and are an attempt at analysis of physical and human factors. His sources include several earlier geographers like Khurdādhbih, Jaihāni, Balkhi, Hamadāni, and Jāhiz. But he subjects his authorities to considerable criticism.

The tradition of travel and that as a medium for geographical work continued. One of the junior contemporaries of al-Birūni was Nāṣir Khusrau from Balkh, where he was born in 394/1003. Starting his travels from Egypt, he visited a large part of the Middle East including the Ḥijāz, Palestine, Syria, and Iran. Earlier, he had travelled in India¹⁶ and lived at the Court of Sultān Maḥmūd. His travel diary, the famous *Safar-Nāmeḥ*, was written in Persian. He gives the best account of Jerusalem before the Crusades, and his description of Egypt is of high geographic value. Shaikh 'Alī al-Harawī (d. 611/1214) wrote a travel book dealing not only with the frequented places of pilgrimage in the eastern part of the Islamic world, but also of Byzantine Empire, North Africa, and Abyssinia. He was in Jerusalem in 569/1173 when it was in Christian hands. He visited the Christian parts of the world on several occasions.

The western world of Islam produced several traveller-geographers who also made journeys to the east to perform the pilgrimage to Mecca. Al-Māzini al-Andalusī (d. 565/1169) was an intrepid traveller who came from Granada and journeyed through Spain, North Africa, Egypt, Iraq, Khurāsān, and Russia. He travelled in the Volga region and in Hungary and gave information unobtainable elsewhere, such as the Russian trade in fossil bones or ivory.¹⁷

¹⁶ Nafis Ahmad, *Muslim Contribution to Geography*, p. 36.

¹⁷ Sarton, *op. cit.*, Vol. II, Part I, p. 300.

He was the writer of at least four important geographical works.¹⁸ Another celebrated geographer ibn Jubair of Valencia (d. 625/1217) wrote a valuable account of his journey to the east. His accounts throw an interesting light on the geography as well as the commercial activity and culture of the Muslim communities of the Mediterranean lands. Ibn Jubair's writings were a source book for many later Muslim geographers and historians. His *Riḥlah* (Travel Account) remains one of the best works of its kind in Arabic literature.¹⁹ Ibn Jubair's fellow townsman al-'Abdari (fl. c. 688/1289) commenced a memorable journey to accomplish the pilgrimage. Starting from Mogadore on the west African coast of Morocco he made the journey both ways by land and thus crossed North Africa twice. His travel geography *al-Riḥlah al-Maghribiyyah* contains valuable topographical information.²⁰ Al-Mausili wrote *Uyun al-Akhbār* (a book of travels) at Ceuta after his travels through Syria, Palestine, and Egypt during 537–585/1142–1189.

Though al-Idrisi was an all-round geographer and his proper place is among the writers of scientific geography, his travels were an indispensable part of his geographic experience. He was born at Ceuta in 493/1099 and educated at Cordova. His travels covered a vast compass stretching from Muslim Spain and North Africa to Christian Europe as well as other parts of the Islamic world. Rich in experience and mature in his outlook, al-Idrisi settled down at Palermo in Sicily at the Court of his worthy patron King Roger II. He died in 562/1166. His famous geography *Nuzhat al-Mushṭāq fi Ikhtirāq al-Āfāq* (known as *al-Kitāb al-Rujārī*), written shortly before 549/1154 is the most elaborate description of the world of medieval times. According to Sarton,²¹ al-Idrisi was the author of another geographical work entitled *Rauḍ al-Uns wa Nuzhat al-Nafs* (Pleasure of Men and Delight of Soul), a kind of a route book which the author compiled for William I, King of Sicily, in 557/1161. This geographical work was said to be larger than the *Kitāb al-Rujārī* but unfortunately it has been entirely lost.

Abu al-'Abbās al-Nabāṭi of Seville and his pupil ibn al-Baitār of Malaga were biographers and they travelled in Spain, North Africa, and along the shores of Red Sea with the purpose of scientific exploration in connection with their work.

Ibn Sa'id al-Maghribi was another indefatigable traveller, profoundly interested in geography. He was born near Granada in 611/1214 and died in Damascus in 674/1275. His *Kitāb al-Jaghṛāfiyya* embodies the experience of his extensive travels in the Muslim world, and the geographical information and views in it added to al-Idrisi's knowledge. He also gives an account of parts of northern Europe including Iceland. Ibn Sa'id visited Armenia also and was at the Court of Hulāgu from 654/1256 to 664/1265.

¹⁸ Nafis Ahmad, *Muslim Contribution to Geography*, p. 37.

¹⁹ Wright, *Travels of Ibn Jubair*, p. 14.

²⁰ Cheneb, *Encyclopaedia of Islam*, Vol. I, p. 67.

²¹ Sarton, *op. cit.*, Vol. II, Part I, p. 410.

Half a century later, in 704/1304, was born ibn Baṭṭūṭah, one of the outstanding travellers of all times. Starting from his home town, Tangier, in 726/1325, when he was barely twenty-two years old, he travelled in Africa, Asia, and Europe for thirty years. His journeys included several pilgrimages to Mecca and travel to and residence in many parts of the Middle East, India, Ceylon, Maldives, Bengal, China, North Africa, Spain, and the lands of the Niger. The extent of his wanderings is estimated at about 75,000 miles²² without allowing for deviations, a figure which surpasses Marco Polo's travels. Ibn Baṭṭūṭah's dictated accounts of his experience to ibn Juzaiy at the Court of Sulṭān abu 'Inān at Fez constitute his *Riḥlah* (Travels). The book contains references to the economic and human geography of the areas visited, trade, commerce, ports, navigation, and numerous physical facts with occasional analysis of causes and effects. His memory was astounding and geographical sense remarkable. Ibn Baṭṭūṭah died in Fez in 779/1377. In the western world of Islam, the tradition of travel leading to geographic writings was handed down to ibn Khaldūn who was born in Tunis in 733/1332 and died in 809/1406. Much of his well-known writings as a geographer, historian, and sociologist was based on his travels in Spain and North Africa. The scientific significance of his "Introduction to Universal History" (*Kitāb al-'Ibar*) will be discussed later.

In the East, Muslim travel-cum-geographical accounts from the eighth/fourteenth century to the tenth/sixteenth century are represented by Ḥāfiẓ Abru, 'Abd al-Razzāq Samarqandi, abu al-Faḍl 'Allāmi, and Amin Aḥmad Rāzi of Rayy. Ḥāfiẓ Abru wrote his regional geography in Persian, entitled *Zubdat al-Tawārīkh*, which was modelled on the earlier Arabic classical style. Barthold²³ has a high opinion of the material in it relating to the author's time. 'Abd al-Razzāq was born in Herāt in 816/1413 and died there in 887/1482. He travelled to India and enjoyed a diplomatic career; on his return he wrote an excellent diary *Maṭla' al-Sa'dain wa Majma' al-Bahrain* in Persian. In the generations that followed the advent of the Europeans into the Indian Ocean, Muslim interest in geography and travel was not dimmed. Abu al-Faḍl, born at Agra in 958/1551, was a leading light at the Court of Akbar the Great. His *Ā'in-i Akbari* written in Persian remains an outstanding geographic contribution of his age, a parallel to which is hard to find in the contemporary West.²⁴ Amin Aḥmad Rāzi of Rayy visited India in Akbar's time and later in 1002/1593 produced his *Haft Iqlīm* (Seven Climates), an exhaustive geographical dictionary in Persian. Another contemporary author who wrote at Damascus in 1007/1598 on the basis of personal travels was al-'Āshiq, the writer of *Manāẓir al-'Ālam* (Description of the World).

²² Gibb, *Ibn Baṭṭūṭa*, Introduction, p. 9.

²³ *Encyclopaedia of Islam*, Vol. II, p. 213.

²⁴ *Ā'in-i Akbari*, tr. Jarret, Preface, p. 1.

B

GENERAL TREATISES AND SCIENTIFIC GEOGRAPHY

The climax of Muslim geographical contribution is represented by the formulation of geographical theories and the compilation of treatises in which attempts were often made to assemble facts and put forward theories. Indeed, their level and scientific value are unequal; none the less, the attempts as such are interesting and praiseworthy. The later half of the fourth/tenth century was productive of many such efforts and it would not be too much to assert that such abundant activity in science and geography had never occurred before, not even in the best days of Alexandria. The "Keys of the Sciences" (*Maṣāṭih al-'Ulūm*) of al-Khwārizmī, the "Encyclopedia" (*Fihrist*) of ibn al-Nadīm and the "Tracts of the Brethren of Purity" (*Rasā'il Ikhwān al-Ṣafa*) remain the monumental examples of these efforts.

Throughout the ages arm-chair geographers have made mistakes which have been easily recognized by practical men. Ptolemy was no exception and so were many Arab literary geographers, but, on the other hand, many Muslim geographers, rich in their personal experience and deep in learning, pointed out flaws in the works of their predecessors. Mas'ūdi,²⁵ for example, is well known for such criticism as sprang from his universal outlook, and al-Bīrūnī, Maqdisi, abu al-Fidā', and others expressed opinions contrary to established notions.

In their geographical writings, new methods were evolved and new shape was given to traditional treatment. The arbitrary division of the then known world on the basis of "climates" originated by the Greeks was quite often copied by Muslim geographers. But the careful and discerning ones like al-Iṣṭakhri, al-Balkhi, Maqdisi, and several others found this method unsatisfactory and somewhat confusing and felt that these divisions in geometrical strips, more or less along the latitudes, were without consideration of the geographical factors. The need of some other method of treatment was realized. Al-Iṣṭakhri initiated a regional approach to his descriptive geography by selecting either geographical units or political divisions closely corresponding them. His own words explain his technique:²⁶ "I do not take the 'seven climates' as a basis for the division of the earth because the geometrical shapes, even though correct intrinsically, lead to great confusion; so I have resorted to the study of the earth countrywise." In fact, most of the leading Muslim geographers of the fourth/tenth century on the basis of their writings would have done credit to any period.

Arab regional geography developed a tradition of its own by describing the physical environment of an area as well as its people and their cultural and social activities, though sometimes the treatment of cultural

²⁵ Sulaimān Nadawī, *'Arbūn ki Jahāzrāni*, p. 121.

²⁶ *Kitāb al-Masālik w-al-Mamālik*, ed. de Goeje, Leiden, p. 2.

matters led to rather deterministic generalizations, reflecting on people's characters and peculiarities. Surprisingly enough, many modern geographers, historians, and sociologists are not immune from this weakness; they often build their cultural theories on foundations of sand. The method and technique of geographic descriptions of diverse lands evolved by al-Iṣṭakhri, ibn Ḥauqal, al-Maqdisi, al-Mas'ūdi, and others was later adopted by al-Qazwini, abu al-Fidā', and ibn Khaldūn, especially the last named who, by his analysis and interpretation, anticipated modern sociology and human geography.

A few examples of scientific geographical writing deserve mention. The tracts produced by the Ikhwān al-Ṣafa (Brethren of Purity) had considerable geographical information and views. Theirs was a rationalist approach to many problems. Their secret association was founded at Baṣrah in about 373/983. This encyclopedic effort by several anonymous writers, many of whom were interested in scientific geography, is noteworthy. Their treatises include numerous references to the then current geographical conceptions and attempt to explain them for popular understanding. Among their physical treatises meteorology receives much attention, and explanations are offered for the occurrence of rain, the march of seasons, and layers of the atmosphere.²⁷ Geological processes are explained and attention is devoted to weathering and denudation. Plant-geography, distribution of animals, and a general consideration of ecological conditions does not escape their notice.²⁸

The influence of physical environment on human activity and animal behaviour and their relationship with health and material well-being were subjected to somewhat critical analysis by several fourth/tenth-century writers on geography. Al-Jāhiz (d. 254/868) of Baṣrah had a real interest in the natural and anthropological sciences. In his "Book of Animals" (*Kitāb al-Ḥayawān*), besides writing on a variety of subjects, he interestingly tackled questions of evolution, struggle for existence, and adaptation. Abu Zaid al-Balkhi writing in 309/921 was a maker as well as an interpreter of maps. His remarkable work *Ṣuwar al-Aqālīm* (Figures of Climates) was a critical study based on maps. A few years later Mas'ūdi (d. 345/956) used his vast experience and critical abilities remarkably well in dealing with geographical matters. Mas'ūdi has often been designated²⁹ as the Muslim Pliny, but he displayed far greater critical ability and scientific curiosity³⁰ than Pliny in his description of earthquakes, waters of the Dead Sea, geological phenomena, navigational problems, and ebb and flow of tides. He also made the first mention of wind power and windmills in Sijistān. Another work of al-Mas'ūdi's, *Kitāb al-Tanbīh w-al-Ishrāf* (Book of Indication and Revision), sets forth his views on evolution. *Akhbār al-Zamān* contains discussion on the origin of seas,

cycle of river erosion, etc. Al-Maqdisi (375/985) was yet another scientifically minded geographer who derided the arm-chair conceptions of some of his great predecessors³¹ and took upon himself the task of writing a geography of the Islamic world based on travel and observation. The result was one of the finest geographical treatments of regions and provinces of the Muslim domains in medieval Arabic literature.³² He stressed the point that geography was a subject of great usefulness and was, therefore, of interest to people in all walks of life. "The Model City" (*al-Madīnat al-Fāḍilah*) of al-Fārābi (d. 339/950) is a fine sociological study of urban conditions of his time in which he envisages better future town-planning.

Ibn Sina (370–428/980–1037) expressed views and expounded ideas on almost all subjects with equal clarity. He made a profound study of various physical questions. His views on the origin of mountains and valleys have a flare of modern concepts and his treatise on minerals remained one of the chief sources of geological knowledge in western Europe until the Renaissance. Ibn Sina's *al-Urjuzat al-Ṣinā'iyyah* (Cantica) displayed an excellent understanding of human and environmental factors. But ibn Sina's contemporary abu Raiḥān al-Birūni (363–440/973–1048) who has his place among world scientists of all times was a traveller, philosopher, mathematician, astronomer, geographer, and encyclopedist. Sarton rightly remarks³³ that his critical spirit, toleration, love of truth, and intellectual courage were almost without parallel in medieval times. His works were written in Arabic, partly in Khwārizm, the town of his birth, and largely in Ghazni and India where he spent the rest of his life. Through the patronage of Sulṭān Maḥmūd and his two successors Mas'ūd and Maudūd he was able to visit India, learn Sanskrit, and acquire knowledge of Indian sciences. His *Kitāb al-Hind* (Book of India), written in 421–22/1030, provides numerous instances of his geographical concepts covering such matters as the origin of the plains of Northern India, nature of rainfall, commercial activity, roads, frontiers, and boundaries.³⁴ Among his many other writings the "Chronology of Ancient Nations" (*al-Āthār al-Bāqiyah*) was written at Khwārizm in 391/1000, "Canon Masudicus" (*al-Qānūn al-Mas'ūdi*) at Ghazni in 421/1030, and the "Book on Mathematics" (*Kitāb al-Taḥḥīm*) like the one on stones³⁵ (*Kitāb al-Jamāhir fī al-Ma'rīfat al-Jawāhir*) towards the later years of his life, during the reign of Sulṭān Maudūd. Al-Birūni was truly a scientific geographer and discussed all matters from a critical point of view.³⁶

Yet another contemporary was ibn Sa'īd al-Qarṭabi al-Andalusi (420–463/1029–1070) who lived and worked in Toledo. Though he was a leading

²⁷ Levy, *The Sociology of Islam*, Vol. II, pp. 370–94.

²⁸ *Ibid.*, pp. 291–96.

²⁹ Sarton, *op. cit.*, Vol. I, p. 620.

³⁰ Murūj, tr. Sprenger, pp. 270–78.

³¹ Maqdisi, pp. 2–3.

³² Le Strange, *The Lands of the Eastern Caliphate*, p. 13.

³³ Sarton, *op. cit.*, Vol. I, p. 707.

³⁴ Sachau, *Al-Birūni's India*, Vol. I, p. 210 and Vol. II, pp. 152–53.

³⁵ F. Krenkow, "Al-Birūni," *Islamic Culture*, Vol. XV, No. 4, 1941.

³⁶ Nafis Ahmad, *Muslim Contribution to Geography*, pp. 29–35.

astronomer and historian, he tackled geographical problems scientifically. His *Ṭabaqāt al-Umam* paid special attention to the history of science. The ethnographical and sociological views expressed by him in this work were based on environmental considerations. A few generations later, al-Idrisi, with a background of Andalusian education, extensive travels, and cultural contact with Christendom, produced his elaborate geographical works. His work can be said to be the most notable example of the fusion of ancient, Arab, and medieval geography. He was critical of Ptolemy's ideas. Ibn Jāmi described Alexandria and discussed its climate. 'Abd al-Laṭīf's book on Egypt may be considered to be one of the most important topographical works of the Middle Ages. In this work attempts at analysis on the basis of known facts and theories are discernible though they are not necessarily geographical. Al-Zamakḥsharī's (d. 539/1144) *Kitāb al-Amkinah w-al-Jibāl w-al-Miyāh* was a worthy geographical dictionary. Ibn Sa'īd al-Maghribī's main work was a geographical treatise entitled *Kitāb al-Jaḡhrāfiya*. Though it was based upon Ptolemy and al-Idrisi, it contained many facts which had been discovered since then and included the geographical co-ordinates of every important place. His extensive travels and long residence in the east and later the patronage of Hulāgu gave him the opportunity to become a connecting link between his predecessors and the mathematical geographers led by Naṣīr al-Dīn al-Ṭūsī at Marāghah. Some of his ideas were derived from al-Ḥasan al-Marrākushī (627/1229).

A notable writer of scientific geography was Zakariya al-Qazwini (600-682/1203-1283). He is noted for his two works,³⁷ namely, *'Ajā'ib al-Makhlūqāt wa Ḡharā'ib al-Mawjūdāt* (Cosmography, or Marvels of Created Things) and *'Ajā'ib al-Buldān* (Marvels of Countries). A later enlarged edition of his geography was called *Āthār al-Bilād*. Qazwini's works exerted a deep influence upon the Arabic-speaking people as well as on those reading Persian and Turkish. Muḥammad ibn Maḥmūd al-Ṭūsī also wrote a cosmography in Persian. A notable treatise on commercial geography was written by 'Abd al-Raḥmān ibn Naṣr under the title *Nihāyat al-Rutbat al-Zarīfah*.

In the seventh/thirteenth century, abu al-Fidā' al-Ayyūbi (b. 672/1273) was an outstanding geographer who had thoroughly assimilated the earlier geographical contributions, especially those of Ptolemy, al-Idrisi, and ibn Sa'īd. His main geographical work *Taqwīm al-Buldān* displays extensive knowledge and balance in the selection of information. Abu al-Fidā's geographical work has earned high recognition among modern European geographers.³⁸ The geographical work of Ḥamd Allah Mustaufi, *Nuzhat al-Qulūb*, written in 741/1340 in Persian is a comprehensive geography of the Islamic world. Iran and Central Asia receive special treatment, changes in the course of the Oxus are mentioned, and descriptions are given of the hot springs and oil-wells of

³⁷ *Encyclopaedia of Islam*, Vol. II, pp. 841-44.

³⁸ Reinaud, "Introduction Generale a la Geographie des Orientaux," *Géographie d'Abouljéda*, Paris, 1848.

Baku and the islands of South-East Asia.³⁹ His historical work, *Tārīkh-i Guzīdeh* (Select History) also contains useful geographical interpretations. A contemporary of Mustaufi was al-Dimashqī (d. 728/1327). His cosmographical work, *Nukhbat al-Dahr fi 'Ajā'ib al-Barr w-al-Baḥr*, was in the traditional style, but is remarkable for its knowledge about the Coromandal Coast of South India.⁴⁰

Ibn Khaldūn's "Universal History" (*Kitāb al-'Ibar*) with its masterly Prolegomena raised the art of geographic interpretation to new heights and made him the forerunner of modern human geography and sociology. He not only wrote a critical history but combined ethnography and geography with it.⁴¹ Ibn Khaldūn recognized different types of habitats and explained the influence of environment on human development. He marked the rise and growth of cities and noted examples of bad siting leading to rapid decay.⁴² He also gave a critical appraisal of the industrial and agricultural resources of Andalusia.

Though the ninth/fifteenth and the tenth/sixteenth centuries witnessed epoch-making geographical discoveries and the frontiers of knowledge of the European people were rapidly widened, yet the scientific traditions of Muslim geography did not cease abruptly. The Turkish school of geography achieved much by way of prolific writing as well as scientific treatment. Some of these works are al-'Ashiq's *Manāẓir al-'Ālam* (Descriptions of the World) written at Damascus in 1007/1598, Ḥāji Khalīfah's encyclopedia, *Kashf al-Zunūn*, and Auliya Chelebi's travel book, *Tārīkh-i Saiyāh*. Before an evaluation of Muslim geographical conceptions is made and its influence on European mind and thought briefly indicated, two other aspects of their work may be briefly outlined, namely, mathematical geography, and map-making and cartography.

C

MATHEMATICAL GEOGRAPHY

Muslim astronomical and mathematical work extends over several centuries and is enormous in its content and commendable in quality. Here only a brief outline is presented in so far as it concerns geographical matters, i.e., latitudes, longitudes, eclipses, and tides; shape, size, and the movements of the earth; and the general mathematical implications in geodetic work.

Historically, Muslims devoted early attention to astronomy and mathematics; the first period of translations led to contributions in these fields. Eventually certain centres and areas developed strong traditions of their own. For example, Baghdād in particular and Iraq in general got an early start in this respect. But later on, with the decline in the influence and prestige of

³⁹ *Nuzhat al-Qulūb*, Chap. XX.

⁴⁰ Nainar, *Arab's Knowledge of South India*, p. 19.

⁴¹ *Murūj*, tr. Sprenger.

⁴² *Muqaddimah*, tr. Franz Rosenthal, Vol. II, Chap. IV, Sec. 5.

Baghdād, many other parts of the eastern world of Islam became centres of mathematical work and its application in associated fields. The Ghaznawids, Buwaihids, and Mongol princes patronized these sciences. Similarly, works and traditions in North Africa from Egypt to Maghrib and in Andalusia achieved their own characteristics.

The Indian, Iranian, and Greek influences played their part in stimulating early attempts. Al-Fazārī's *Kitāb al-Zij* (Tables) reflects strong Indian influence. The first series of regular observations with accurate instruments were conducted at Jundi-Shāhpūr during the first half of the third/ninth century and were utilized by Ahmad al-Nahāwandi and others. Ya'qūb al-Kindi's works and those of others such as Yahya ibn Mansūr, Sanad ibn 'Alī, and al-Marwarīzi were concerned with the preparation of astronomical tables. Earlier, Ptolemy's *Almagest* had also been translated by al-Nairizi.

But the outstanding event in the field of mathematical geography was the measurement of a degree, under the orders of Caliph al-Māmūn, to determine the size of the earth, in latitude 36° North.⁴³ An observatory was built on the plain of Tadmur (Palmyra) for geodetic as well as astronomical work. On the Caliph's instructions two degree measurements were made near Tadmur and Raqqah under the supervision of the sons of Mūsā ibn Shākir. The result of these two measurements was the calculation of the earth's circumference as 20,400 miles and the diameter 6,500 miles⁴⁴ respectively. A large map of the world was also drawn. The three sons of Mūsā ibn Shākir, besides being men of means, were practical scientists. One of their books was concerned with the measurement of the sphere and the trisection of the angle. Besides al-Khwārizmī and al-Kindi, the great astronomer abu Ma'shar of Balkh (d. c. 272/836) was specially interested in celestial phenomena. Al-Māhāni (fl. 240–254/854–868) studied the eclipses of the sun and the moon and also the conjunction of the planets. In later generations, particularly under the patronage of the Buwaihīd Court, a great deal of astronomical and mathematical work was done and the making of observations with better designed and perfected instruments became common. A glorious period in this respect was the time of 'Adud al-Daulah and Sharaf al-Daulah, when measurements and observations relating to equinoxes, solstices, eclipses, and the form of the earth were undertaken. Ibn al-'Ālam, al-Rāzi, al-Kūhi, and abu al-Wafā' were among the leading lights of this wonderful age.

In the course of time, Cairo also developed into an important centre for work in mathematical geography. The Caliph al-'Aziz (365–386/975–996) founded an observatory near Cairo and al-Hākim continued to patronize it. Ibn Yūnus (d. 399/1009) was a great mathematician and astronomer and ibn

al-Haitham a notable physicist. In point of time, al-Bīrūnī's work again needs a mention here, for his monumental work "Canon Masudicus" was written in 421/1030. He was a great mathematical geographer and devoted himself to many problems, including the accurate determination of latitudes and longitudes, geodetic measurements, simple method of stereographic projections, earth's shape, axis and rotation, and laws of hydrostatics. Al-Bīrūnī's contemporary, ibn Sīna, the celebrated philosopher, produced treatises on astronomical instruments, earth's position in the universe, and heavenly bodies.

In North Africa, Tangier, Ceuta, Fez, and Morocco became centres of scientific work relating to mathematics. An outstanding scholar and practical geographer was al-Marrākushī, the writer of *Jāmi' al-Mabādi w-al-Ghāyah* (The Uniter of the Beginning and the End) which is considered to be one of the greatest scientific contributions of the seventh/thirteenth century. It includes terrestrial co-ordinates of 135 places of which thirty-four were conducted by the author himself. Al-Marrākushī was fully conversant with scientific methods and made use of many instruments. In Spain, mathematical geography flourished like the other sciences. Among outstanding votaries was Maslamah al-Majriti (d. 398/1007) of Madrid who made a synopsis of al-Battānī's tables. His works were translated into Latin under Alfonso. Al-Zarqālī (420/1029–481/1088), besides being well up in theoretical ideas, was a maker and designer of many instruments and astrolabes. He also became well known in Europe through profuse Latin translations of his treatises. The philosophers and rationalists Jābir (Geber), ibn Aflāḥ (d. 535/1140), ibn Rushd (Averroës) (d. 595/1198), and ibn Bājjaḥ (Avempace) (d. 533/1138) were all interested in the mathematical side of geography.

In the eastern Islamic lands, in later generations, the Saljūq period was productive of much scientific work in mathematical geography, particularly the reign of Jalāl al-Dīn Malik Shāh (r. 465–485/1072–1092). The Mongol princes turned out to be great patrons of scientific activity. Hulāgu Khān (d. 664/1265) had many mathematicians at his Court and a great observatory was set up at Marāghah on the shores of lake Urūniyeh, fifty miles from Tabriz. Naṣir al-Dīn Tūsī was the leading light. The Marāghah astronomers were greatly interested in geography. For example, al-Tūsī's *Tadhkirah* (History) in its third chapter deals with geodetic matters and seas and winds. Qūṭb al-Dīn al-Shīrāzī's (634–711/1236–1311) *Nihāyat al-Idrāk* is devoted to astronomical, meteorological, and geographical questions. Al-Qazwīnī and al-Waṭwāt also wrote on cosmogeographical and geographical matters.

1. Instruments and Their Use

The work in the field of mathematical geography would not have been possible without instruments and observatories. Therefore, it is not surprising to find the mathematicians and geographers working in observatories and using self-made as well as standard instruments and devices. Some of the

⁴³ Naillino, *Encyclopaedia of Islam*, Vol. I, p. 498.

⁴⁴ The degree near Tadmur was measured and computed at 56.2/3 miles. But the measurements were in Arabian miles and one Arabian mile is equal to 6472.4 English feet. Hence the circumference of the earth, 20,400 Arabian miles, is equal to 24,847.2 English miles which is remarkably near the actual figure.

common needs and requirements included measurement of distance between two points, determination of latitude and longitude, levelling and measurement of heights, geodetic measurements, and co-ordinates of Mecca. An account of the instruments devised, developed, and used will be given in the next chapter on "Mathematics and Astronomy" of this work.

2. Determination of Latitudes and Longitudes

Muslim efforts in the measurement and determination of latitudes and longitudes were considerable. They contrived methods as original as the results which were often accurate. The view that the work of Muslim geographers and astronomers in no way surpassed the *Almagest* of Ptolemy, is undoubtedly without any basis.⁴⁵ The early Arab astronomers, al-Khwārizmī, al-Farghānī, Ḥabash al-Ḥasib, and al-Battānī, made use of Indian and Greek methods of finding latitude. But better techniques soon began to be employed. The sons of Mūsā ibn Shākir at Baghdād determined the city's latitude, accurate within a minute, and ibn Yūnus at Fustāt (near Cairo) did remarkably accurate work. He drew attention to the fact that while reckoning latitude from the shadow of the gnomon, errors up to 15 minutes crept in as the shadows were cast from the upper edge of the sun and not from the central point. Ibn al-Haiṭham (355–430/965–1038), known in Europe as Alhazen, wrote a notable work on the calculation of latitudes. He recommended the method of taking a fixed star for the precise determination of the altitude of the pole, and he was fully aware of the errors due to refraction. Al-Birūnī suggested the method of determining latitude by reference to the relation of the circumpolar stars to the sun. But in the measurement of longitude, he advocated as well as demonstrated the use of the terrestrial calculation. By this method he presented a correction in the distance in longitude between Alexandria and Ghazni. The difference in longitude between Baghdād and Ghazni found by al-Birūnī by the terrestrial method was remarkably accurate. *Qānūn al-Mas'ūdi*, *Kitāb al-Hind*, and *Kitāb al-Taḥīm* are the repositories of calculations. Other almost exact calculations were those of the three sons of Mūsā ibn Shākir at their observatory in Baghdād, of al-Māhānī at Surra Man-Ra'a, of ibn Yūnus at al-Muqattam, and of Ulugh Beg at Samarqand. An outstanding correction as a result of Muslim calculation was the elimination of the Ptolemaic exaggeration of about 17 degrees in the length of the Mediterranean.

3. The Earth's Shape, Size, and Movements

Opinion on the sphericity of the earth was divided in the early Middle Ages. Cosmas' fantasies were opposed to it, while St. Augustine reluctantly conceded the globular shape, but vehemently rejected the concept of people

⁴⁵ Schoy, *op. cit.*, pp. 263–68.

inhabiting the antipodes. Muslim geographers and other scientists had a firmer belief in the sphericity of the earth as they continued to support, in general, the Eratosthenian theory of climate. Probably, the majority held the idea of an earth globe floating in space. Outstanding examples of Muslim experiments based on belief in the sphericity of the earth and the measurement of a degree were those conducted by the geodetists of al-Māmūn in the plains of Sinjār, and al-Birūnī's measurement of 56 miles 0' 50" 6" for a degree conducted in India was remarkable for its accuracy.⁴⁶ Early Muslim opinions on the question of the earth's shape are summarized by the geographer ibn Rustah in his famous treatise "Work of Costly Treasures" (c. 291/903).

As regards the movements of the earth, the position was somewhat different. The question whether the earth was at rest or not, was not discussed in Europe either in the early or later Middle Ages. Generally, the earth was assumed to be at rest in the centre of space. Al-Birūnī, assuming the vague Babylonian and Indian conceptions, believed in the turning of the earth on its own axis. He also believed in the movement of the sun round the earth, though he did not reject the suggestion of abu Sa'id Sinjari regarding the possible movement of the earth round the sun.

In the second half of the seventh/thirteenth century the question of rotation was taken up by 'Umar al-Kātibī al-Qazwīnī (d. 676/1277), who was connected with the Marāghah observatory and prepared an edition of the *Almagest*. His work *Hikmat al-'Ain* contains argument for the heliocentric theory. Unfortunately, he finally rejected the idea of the circular motion of the earth and, therefore, failed to anticipate Kepler and Galileo. Among others, who took up this question, was Quṭb al-Dīn, a pupil of Naṣīr al-Dīn Ṭūsī. His semi-geographical work, *Nihāyat al-Idrāk*, contains a discussion of these questions. Thus, Muslim mathematical geographers often expressed doubts on Greek and Ptolemaic concepts about the earth. Sarton⁴⁷ rightly emphasizes that the doubts expressed in Arabic writings were not sterile as they eventually paved the way for the Copernican reform in 1543.

D

CARTOGRAPHY AND MAP-MAKING

Muslims inherited the Greek and Babylonian traditions in map-making. In the past, there had existed a close relationship between extension of maritime activity and navigation and the development of cartographic skill.

The Arab and Muslim knowledge of the seas far surpassed that of their predecessors. It encompassed familiar areas from the Mediterranean to the Atlantic and from the Red Sea, Arabian Sea, and Persian Gulf to the Indian Ocean and the Pacific. Their extensive sailings on these waters were not

⁴⁶ *Ibid.*, p. 269.

⁴⁷ Sarton, *op. cit.*, Vol. I, p. 674.

merely naval expeditions, but were made in pursuit of an extensive commercial and maritime activity in which the crossings of the Mediterranean formed but a small part. This necessitated the use of sea charts, coastal information, and knowledge of wind and weather. Therefore, one class of Muslim map-making was devoted to these objectives, while geographers and others made many maps to depict land information and the political and regional composition of the Islamic world as well as of the then known inhabited areas.

On the whole, Muslim map-making and cartography generally advanced the older knowledge and techniques. The traditions of Roman cartography were poor. Even Ptolemy had made a fundamental error in underestimating the earth's size. He had accepted the figures of Posidonius (1 degree = 500 stadia) on the basis of which Europe and Asia were supposed to extend over one-half of the surface of the globe, while their extension covered only 130 degrees. He had also estimated the length of the Mediterranean to be 62 degrees instead of 42 degrees. The Muslim geographers had corrected this error, but European cartography persisted with this mistake up to the end of the tenth/sixteenth century.⁴⁸

Muslim geographers constructed celestial and terrestrial globes and studied the problem of projections. Their maps were superior to those of Ptolemy, and it became a somewhat general practice to draft maps to accompany the geographical treatises. This is borne out by many examples. Al-Khwarizmi's *Kitāb Sūrat al-Arḍ* was written in explanation of maps which might have been based on Syriac versions of Ptolemy. The world map, prepared at the behest of Caliph al-Māmūn and embodying the collaboration of no less than seventy experts, can be considered to be a notable example of scientific map-making. Unfortunately, this map is not extant. It has also been suggested⁴⁹ that there was a collection of maps of Iran including a pre-'Abbāsīd world map, which may very well be called "Iran Atlas." In order to indicate the possibility of such a series of maps, it may be pointed out that ibn al-Faḡīh mentions a map of Dailam which was made for Ḥajjāj ibn Yūsuf, and al-Balādhuri notes in his *Futūḥ al-Bulḍān* that a petition to Caliph al-Manṣūr was supported by a map of the canals of the Baṣrah area.

In the evolution of Muslim cartography, the Balkhī School represents a distinct advance. Al-Balkhī's atlas included, besides a map of the world, maps of Arabia, the Indian Ocean (Baḥr Fars), Maḡhrib, Egypt, Syria, the Mediterranean Sea, and several other parts of the Islamic world. This atlas was devoted to the geographic description of the areas covered by the maps and also presented a division of the world into the so-called "Climatic Zones." Konrad Miller in his *Mappae Arabicae* fittingly calls it "An Islam Atlas." It is most unfortunate that the fruits of Balkhī's effort have been lost and only the copied material by al-Iṣṭakhri and ibn Ḥauqal has been handed

down to posterity. A follower of these traditions was al-Maqdisi who explained the basis of the drawings of al-Iṣṭakhri and then made his own regional maps of the world, using symbols and a colour scheme for physical features which made his maps almost similar to modern maps.⁵⁰

Al-Birūnī made a round map of the world in *Kitāb al-Taḥfīm* to illustrate the position of seas, and in *al-Āthār al-Bāqiyah* (Chronology of Ancient Nations) he discussed methods of celestial and terrestrial projections. Al-Idrisi's fame as a map-maker has found universal recognition. He is said to have made seventy maps of climatic divisions, a celestial sphere, a globe of silver, and a world map on a silver plate with great cartographic skill. His maps give a better representation of the western world of Islam than that of the eastern. His cartographic effort influenced his European contemporaries and successors in many ways. In later generations, al-Qazwini and al-Wardi made maps based on the lingering traditions of the Balkhī School. Two celestial globes were made by 'Abd al-Raḥmān al-Ṣūfī in Cairo in about 432/1040; a bronze globe was made by ibn Hula of Mausi in 674/1275. Maḥmūd Kāshghari, in his *Diwān Luḡat al-Turk*, made a world map in 734/1333.

Finally, a brief mention of the Arab sea charts, navigation manuals, and the early development of the portolani (European sea charts) is relevant to the subject. The most extensive Arab navigational activity was from the Red Sea and the Persian Gulf to the various parts of the Indian Ocean along East Africa and South-East Asia. Sailing ships were exposed to the hazards of wind and weather and were directly influenced by the sub-tropical and equatorial changes in meteorological conditions. The monsoons were a great factor in these sailings. Therefore, it is not only a fair guess but has a basis in fact that safe sailings were conducted with the accumulated experience of generations of seamanship as well as sea charts and instruments. As regards instruments, the compass may be considered fairly certain, and the greatly perfected astrolabe was also put to use. In the East, the peak of Muslim navigational achievement was reached on the eve of the Portuguese incursion into these waters. In the West, the Mediterranean sailings were most common. There are also on record some attempts to probe into the mysteries of the Atlantic.

The dream to reach the riches of India and China by sailing round Africa was an ancient one, but the Muslims' mastery of North Africa, their dominion in the Iberian Peninsula, and the urge to spread Islam and commerce to yet newer lands, revived a new interest in the venture. The sailors and navigators of Muslim Spain were the first in the field, the Genoese sailors came after them. The Portuguese maritime activity took a still later place in history. Among Muslim writers, al-Mas'ūdi and al-Idrisi have mentioned the attempts of their co-religionists. Al-Mas'ūdi mentions in his *Murūj al-Dhahab* the venture into the Atlantic before 346/957 by Khashkhāf of Cordova, and

⁴⁸ Raisz, *General Cartography*, p. 21.

⁴⁹ Kramers, *Encyclopaedia of Islam*, Sup., p. 65.

⁵⁰ Maqdisi (Constantinople MS.), p. 8.

al-Idrisi relates the story of the *Maghrūrīn* (the deceived ones). These sailors were eight cousins who set out from Lisbon (before 439/1147) and sailed westward for about eleven days, then in a southerly direction for twelve days when they reached the inhabited Isle of Sheep (*Jazīrat al-Ġhanam*); after further navigation of twelve days they landed on another island where they were made prisoners. It may be a fair surmise that the first island was the Madeira and the second the Canaries.

To turn once again to the East, there were successive generations of professional Muslim pilots and writers of nautical instructions throughout the fourth/tenth to the sixth/twelfth century. The pilots (*mu'allim* or *musta'mil al-markab*) and "Lions of the Sea" acquired great fame from the first half of the sixth/twelfth century onward. To this period belong Sahl ibn Abān, Muḥammad ibn *Shādhān*, and *Laith* ibn Kablān. Later, Aḥmad ibn Mājid wrote *Kitāb al-Fawā'id fī Uṣūl al-Baḥr* in 895–896/1489–1490 and Sulaimān al-Mahri produced his *'Ulūm al-Baḥriyyah* in the early tenth/sixteenth century. *Shihāb* al-Dīn Aḥmad ibn Mājid was an expert sailor as well as a writer of nautical instructions and his role in guiding Vasco da Gama's ship across the Arabian Sea in 904/1498 is well recognized. According to Barros, ibn Mājid showed the Portuguese admiral a map of the whole coast of India indicating meridians and parallels. He also expressed no surprise or sense of admiration on seeing the Portuguese navigational instruments and is said to have commented that Muslim sailors in the Indian Ocean possessed more efficient devices and instruments. In fact, ibn Mājid and al-Mahri may be regarded among the early modern writers on nautical matters. Their knowledge of the geography and meteorology of the Red Sea and the Indian Ocean was extensive.

Between 867/1462 and 896/1490, ibn Mājid wrote thirty nautical texts. Of these, the most important work was *Kitāb al-Fawā'id*. The book is a compendium of knowledge relating to the principles of navigation both theoretical and practical. It deals with matters connected with the origin of navigation, use of magnetic needle, routes across the Indian Ocean, latitudes of harbours in that ocean, the China Sea, regional description of large islands, monsoons and their dates, and banks and reefs of the Red Sea. This work was of great use to those engaged in navigation and preceded the European navigation in Eastern waters.⁵¹

Sulaimān al-Mahri was a younger contemporary of ibn Mājid. He wrote five treatises on sailing instructions. Of these the third was entitled *al-'Umdat al-Mahriyyah fī Ḍabṭ al-'Ulūm al-Baḥriyyah*. This work deals with nautical astronomy, sea-routes in the Arabian Sea and Indian Ocean, monsoons, and some outstanding voyages.

One of the main cartographical achievements of the Middle Ages was the preparation of sea charts which were extensively used by seamen and sailors

in the Mediterranean and the Black Sea, from the end of the seventh/thirteenth century onward. These are known as "portolani" and were largely produced by the Genoese, Pisans, and Italians. The languages used in these early Western maps are Latin, Catalan, Italian, or a sort of Mediterranean *lingua franca* composed of various Romance elements.⁵² Their origin appears to be debatable, though many Western scholars stick to a single source theory, namely, European Christian. Perhaps the Western portolani owed their development to sailors and cartographers in their own area. But it is almost certain that the Arab pilots, guiding ships across the Indian Ocean and South-East Asian waters, must have very keenly felt the need of such maps. In the form in which Western portolani have been handed down, it is not possible to say which ones were earlier. But as related above, Muslims had been actively engaged in navigating the extensive and dangerous Eastern seas up to China and across the mesh of islands in South-East Asia since the third/ninth century onward; they had sea charts as mentioned by al-Maqdisi in the later part of the fourth/tenth century. While writing about his extensive sea journey over the Indian Ocean, he says⁵³ that he was often in the company of ship-masters and pilots and other experts who had long experience of sailings in these areas and possessed a detailed knowledge of wind and weather and the physical and commercial geography of these seas and their adjoining lands. He adds that he had seen in their possession sailing charts, directories, and nautical instructions, many of which he himself utilized to compile his own work.

Marco Polo also refers to the Arabs' use of sea charts and maps. It is said that Qutb al-Dīn *Shirāzi*, the geographer of the *Ilkhāns* of Persia, used one such map to mark the progress of the Mongol envoy to Christendom. Indeed, it is quite conceivable that the early portolani were made after centuries of experience before their Mediterranean and Atlantic samples came to be drafted. It is, however, true that the number of Muslim portolani is small as compared with the Western ones.

As a criticism of the quality of Muslim cartography it may be admitted that often it overemphasized decoration at the expense of accuracy. But it will be well to remember that contemporary Western cartography was most rudimentary by comparison and the latter *mappae mundi* were a mixture of fact and fancy. Much has been written in recent years to throw light on the achievement of Muslim map-makers. The labours of Konrad Miller, Prince Youssouf Kamal, and Kramers have been very rewarding and have presented Muslim cartography in a new light.⁵⁴

⁵² Sarton, *op. cit.*, Vol. II, Part II, p. 1047.

⁵³ Maqdisi, *Aḥsan al-Taḳāsim*, p. 14.

⁵⁴ *Monumenta Cartographica Africae et Aegypti*.

⁵¹ G. Ferrand, *Introduction à l'astronomie nautique*, p. 228.

E

INFLUENCE OF MUSLIM GEOGRAPHY

The question of the extent of the influence of Muslim geography on the European mind is an interesting one. Usually it is claimed that the development of medieval European as well as that of early modern geography was somewhat independent. This view appears to be untenable and is rather out of date, as its basis is emotional and it disregards the inevitable links of history. Moreover, a brilliant galaxy of European scholars including many Orientalists, through their painstaking researches into the sources of modern science, have produced indisputable evidence of the transmission of Muslim science to European communities. Here it is possible to present only the main points of the transmission of Muslim geographical knowledge and concepts to the West.

Even during the first half of the fifth/eleventh century, necessary conditions for scientific work did not exist in the Latin West, or for that matter in the whole of Christendom, as they did in the Islamic world. It was only Jewish thought which was moving forward due to direct contact with Muslim culture and under the stimulus of its progressive impulses. No doubt, some Christians in the Muslim world did contribute to these efforts.

There were two important sources of the transmission of Muslim science and geography to Latin Europe and other areas in the West. The points of cultural and physical contact in Spain, Italy, Sicily, and the Aegean Islands were strengthened by intermixing of people during the prolonged period of the Crusades. Secondly, as an earlier translation activity at Baghdād had paved the way for a fruitful synthesis, so the numerous translations of Arabic works in Spain, Italy, and Sicily proved to be harbingers of scientific advance.

Latin geography before the early sixth/twelfth century was on a much lower level than the Muslim. It was too simple and childish. This remark applies especially to those writers who were not influenced by Arab ideas and continued to follow the Roman and early medieval traditions, e.g., Henry of Mayence, Guido, and Lambert of Saint Omer. On the other hand, those who showed a somewhat better geographical sense like Herman the Dalmatian, Bernard Sylvester, and William of Conches had been influenced by Arab ideas.

The major proportion of European geographical writings of sixth/twelfth century in the West consisted of Latin and other Christian pilgrim literature, though there were also a few other contributions. John of Wurzburg was a German pilgrim in the late sixth/twelfth century, Joannes Phocas was a soldier turned monk who wrote of castles and cities from Antioch to Jerusalem, and Richard the Lion-hearted was a crusader king. Sigurd, King of Norway and a crusader, made a remarkable journey to Palestine and back between 501/1107 and 505/1111. The outward journey was a fighting cruise through the North Sea, the Mediterranean, and the Aegean waters. He fought the Muslims around Spain and visited the cultured Court of Roger II of Sicily

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before his return home by an overland route through Europe. His saga is somewhat geographical in its content and bears traces of contact with the Orient.

Pedro Alfonso made a sketch-map of the world clearly derived from Muslim models, copying the seven climates and putting south on the top. Henry of Mayence compiled a treatise in 504/1110 which included a map. A geographic encyclopedia was prepared in 513/1119 by Guido who was probably an Italian geographer. Lambert of Saint Omer compiled another encyclopedia with maps; in this work he propounded his belief in the sphericity of the earth. Herman the Dalmatian in 538/1143 prepared his cosmographical compilation, which included astronomical and geographical information, and Bernard Sylvester produced his *De Mundi*.

Nearly all the above-named writers and their contemporaries who dealt with geographical matters were steeped in patristic and Latin traditions. But by the middle of the seventh/thirteenth century, a distinct change was perceptible, as by that time the full impact of the translations was evident in the more readily available Arab knowledge in Europe. Scholars were not only aware of it, but were beginning to feel the need of it. The new knowledge, of which Muslim geographical information and notions were an indispensable part, began to work as a great stimulus to new ideas in the Latin world.

Henceforward, the level of geographic thinking and writings was definitely raised. Vincent of Beauvais, Albert the Great, Roger Bacon, and others were all sufficiently influenced by Arab knowledge of geography and its associated fields.⁵⁵ Joannes Sacrobosco (John of Hollywood), the English astronomer and mathematician, wrote his *Sphaera Mundi* in about 631/1233. This work was slavishly based upon al-Farghāni and al-Battāni; it became immensely popular in the West, was translated several times, and remained in use in schools up to the eleventh/seventeenth century. William the Englishman in 629/1231 mainly interpreted al-Zarqālī and al-Bītrūjī. Vincent of Beauvais, the French Dominican scholar who died in 663/1264, compiled an encyclopedia. It was a monumental work and much of its geographical and geological information was derived from Arab sources. Albert the Great (d. 679/1280) was another outstanding Dominican intellectual and prolific writer. He knew neither Greek nor Arabic, but acquired vast knowledge through Latin translations, seriously studied Muslim thought, and was considerably influenced by their geographical ideas. Roger Bacon's *Opus Majus* is replete with geographical references⁵⁶ to Arab sources. Gossuin of Metz or Walters' *L'image du monde*, written in about 644/1246, was derived from existing sources largely based on Muslim knowledge. *Konungs Skuggsjá* is an outstanding geographical and encyclopedic treatise in old Norwegian written by an unknown author between 614/1217 and 659/1260 or about 647/1247. The

⁵⁵ Beazley, *Dawn of Modern Geography*, Vol. II, p. 8.

⁵⁶ Roger Bacon, *Opus Majus*, Vol. I, p. 318.

author was either a priest or a Court chaplain and a good deal of his material was based upon the accounts of returned crusaders and pilgrims. It displays good geographical sense, particularly in physical geography. He believed in the sphericity of the earth. The work is not entirely without Arab influence. The travel accounts of the Englishman Sir John Mandeville, though verging on the fantastic, are a rehashing of common Arab knowledge in geography.

The fact remains that gradually most of the basic and current geographical ideas of the Muslims were passed on to the West. These were with regard to the size of the earth and its sphericity, oceans, geological processes, climate, vegetational and zoological distributions, knowledge of new lands in Africa, Far East, and Central Asia, techniques of cartography, and uses of instruments.⁵⁷ All this knowledge in various degrees of assimilation is depicted in the leading geographical works and forms the background of the so-called *mappae mundi*, and also in some of the maps of later generations preceding the Columbian era, viz., the Psalter map (c. 597/1200), Hereford map (c. 679/1280), the world map of Marino Sanuto (721/1321), the Borgian world map (c. 854/1450), Este world map⁵⁸ (c. 854/1450), Fra Mauro's Africa (864/1459), and the diagrams of *L'image du Monde* (885/1480). Though these maps were far from being real maps and mirrored more the shadows of patristic and traditional notions, yet acquaintance with Arab cartography and geographic information is revealed in them.⁵⁹

On the whole, the period from the sixth/twelfth to the ninth/fifteenth century was a period of transition and compromise, a time of absorption and fusion, because it was during this period that the conflicting Muslim and Christian cultures were brought most closely together. The result was the creation of the core of new Europe. This was essentially Graeco-Arabic-Latin. After the invention of the art of printing in the second half of the ninth/fifteenth century, many Graeco-Arabic scientific works were eagerly and repeatedly printed. In fact, the influence of Arab science remained paramount in Europe, till, towards the middle of the tenth/sixteenth century, Copernicus published his revolutionary concepts, and experimental science emerged. But Arab science as a factor in European thinking lingered on much longer, almost up to the eve of the Industrial Revolution.

The lesson of history is clear. In the ages following the voyages of Columbus and the intellectual ferment at the end of the Middle Ages, Europe surged forward to penetrate through the barriers of ignorance and acquired a cultural and material leadership. But Europe learnt its lessons from those who were at one time masters of the world. The Muslims were its cultural ancestors in the domain of science, geographical knowledge, discovery, and world commerce.

⁵⁷ G. Ferrand, *op. cit.*, p. 225.

⁵⁸ Kimble, *Geography in the Middle Ages*, p. 197.

⁵⁹ Keane, *The Evolution of Geography*, p. 48.

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Chapter LXIII

MATHEMATICS AND ASTRONOMY

A

INTRODUCTION

It is generally recognized that human knowledge took its organized and systematic form with the Greeks. It is equally well known that the Greeks inherited a considerable body of knowledge from their Eastern predecessors, especially the Egyptians, Babylonians, Chinese, and Indians.

The histories of science and culture, written by some Western writers, however, show a gap between the period of the Greeks and the Renaissance. They give the impression that the history of science was blank for nearly one thousand years, and scientific knowledge made a sudden leap, taking a millennium in its stride. These histories ignore the fact that the intervening ages from the first/seventh to the eighth/fourteenth century constituted the era of the Arab and other Muslim peoples.

The latest researches of Muslim and non-Muslim scholars are bringing to light the work of the Muslims in the various branches of knowledge throughout the Middle Ages. These researches are, however, scattered in various journals and books which are not easily accessible to the average educated person. Two good works of reference published are the *Encyclopaedia of Islam* and George Sarton's *Introduction to the History of Science*. On a thorough study of the information available on the subject, one is struck by the magnitude as well as importance of the contributions made by the Muslims to the various branches of science, especially to mathematics and astronomy.

The magnitude of these achievements is so vast that it is giving rise to another tendency among the historians of science. It is incomprehensible to them that the Arabs who were so backward and ignorant in the centuries preceding the advent of Islam could have become so enlightened and scholarly in such a short time after adopting the new faith. One of the great exponents of this line of thought is Moritz Cantor who has written an encyclopedic history of mathematics in the German language. The chapter on the Arabs in Cantor's book begins as follows:

"That a people who for centuries together were closed to all the cultural influences from their neighbours, who themselves did not influence others