INTRODUCTION

Before the establishment of Islam in the seventh century A.D., there is no evidence that the early Arabs accepted the idea of representing the landscape in a systematic way. Practical use of maps is documented in only the slightest manner: even the tribesmen facing in the direction of their sacred tribal enclosure when praying do not seem to have needed a mnemonic for the purpose. Arabs seem to have taken up the idea of mapping only when absorbing the cultures of the peoples they conquered.

Toward the end of the first century of Islam we do find a few literary references to military maps. A map was prepared (ca. 83/702) of the country of Daylam, south of the Caspian Sea, for al-Ḥajjāj ibn Yūsuf (d. 95/714), the governor of the eastern part of the empire, so that he could understand the military situation from his capital in Iraq (fig. 4.1). Similarly, he ordered a plan of Bukhara so that he could acquaint himself with the layout of the city while preparing for its siege (89/707). A map of the swamps of al-Baṭīḥah near Basra was also said to be available in the time of the Abbasid caliph al-Manṣūr (d. 158/775), seemingly this time because of a dispute over the provision of fresh water. A plan was also reputedly drawn in 141/758 for the round city of Baghdad planned for the caliph al-Manṣūr. Since this was virtually a strongly walled fortress in which only the privileged lived, the drawing was less a city plan than an architect’s site plan, but since the city had a diameter of two kilometers or more, the plan may have been a substantial cartographic attempt. What it was like we have no idea, since nothing of the plan or of the original round city has survived, and literary accounts are so much at variance that we cannot conjecture the form or extent of the cartography involved.

We have no more information about these obviously practical maps, nor is there any link to later Muslim cartography. Mapping during the period I am discussing seems to have first appeared and then continued only as an adjunct to geographical literature: surviving maps occur only as illustrations to geographical texts (table 4.1).

EARLY GEOGRAPHICAL LITERATURE

Arab geographical literature began in much the same way as other Arab literature, from a mixture of folk literature and the tradition formed by Islamic religious writing. The Qur’ān and hadith, besides having a cosmological basis that pervades most of the later geographical literature, also contained a factual geographical element. Telling stories and reciting poetry about desert life augmented this. Early in Islamic history a corpus of geographical lore must have developed based on ḥikāyat (narrated historical traditions) and ʿajāʾīb (stories about marvelous events and things), two genres of narrated information that were written down at an early stage. Texts like the ʿAjāʾīb al-Hind (Wonders of India) and the Akhbār al-ṣīn wa al-Hind (Traditions about China and India) have survived as some of the earliest written Arab literary texts, but no doubt there were other early collections that have been lost.

An example of early lore that has a bearing on cartography is a concept of the world landmass in the shape of a bird. This idea may come from early Islamic times, since the information, first given by Ibn ʿAbd al-Hakam (d. 257/871), is mentioned as a tradition emanating from a prominent Arab of the late seventh century. Ibn ʿAbd al-Hakam reports that the head of the bird represented...
China, the right wing India, the left wing al-Khazar (North Caucasus), and the tail North Africa. The tradition may be Iranian. However, the world maps of the al-Balkhi school (tenth century A.D.) show this bird clearly with Arabia as the head, Asia and Africa as the wings, and Europe as the tail, so the tradition may be a much later idea gained from looking at a map of this sort.

The earliest nonliterary geographical source materials were lists of pilgrimage and post stages throughout the Islamic world, giving the distances between the stages. Though compiled for administrative purposes, these were soon adopted by writers with a geographical bent and appear in literary works. These lists and the two previous sources make up the content of early Islamic geographical literature. Works of this nature were often titled Kitâb al-masâlik wa-al-mamâlik (Book of routes and provinces), and the earliest to survive is that of Ibn Khurradadhbih, written about 231/846.9 The bare bones of this book consist of the post or pilgrimage routes and distances throughout the Islamic world. Ibn Khurradadhbih, however, does extend the routes through known non-Islamic areas; for instance, he gives the sea route to China

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8. For the Balkhi school maps, see below, chapter 5.

9. Abû al-Qâsim 'Ubayd Allah ibn 'Abdallah ibn Khurradadhbih (or Khurâdâdhbih) lived about 204-300/820-911, so his geographical work was written in his youth if this date (de Goeje) is correct. He was a government administrator by profession and held the positions of director of posts and intelligence in the province of Jibal and director general of the same in Baghdad and Samarra. His writings ranged over several subjects, but the geographical work was the most quoted. This importance was recognized by both Arabs and modern scholars. The text of Ibn Khurradadhbih’s *Kitâb al-masâlik wa-al-mamâlik* was edited by Michael Jan de Goeje, *Kitâb al-masâlik wa’l-mamâlik* (Liber viarum et regnorum), Bibliotheca Geographorum Arabicorum, vol. 6 (Leiden: E. J. Brill, 1889; reprinted, 1967).
<table>
<thead>
<tr>
<th>A.H.</th>
<th>A.D.</th>
<th>Event</th>
<th>A.H.</th>
<th>A.D.</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>622</td>
<td>The Hijrah; Muhammad migrates to Medina</td>
<td>290</td>
<td>903</td>
<td>Ibn al-Faqih and Ibn Rustah, geographical writers, flourish</td>
</tr>
<tr>
<td>8</td>
<td>630</td>
<td>Muhammad captures Mecca</td>
<td>ca. 316</td>
<td>ca. 928</td>
<td>Qudamah, geographical writer, flourishes</td>
</tr>
<tr>
<td>11</td>
<td>632</td>
<td>Muhammad dies</td>
<td>317</td>
<td>929</td>
<td>al-Battani, astronomer, dies</td>
</tr>
<tr>
<td>11-40</td>
<td>632-61</td>
<td>The four orthodox caliphs</td>
<td>ca. 320</td>
<td>ca. 930</td>
<td>al-Jahani, Samanid waizir, flourishes</td>
</tr>
<tr>
<td>13</td>
<td>634</td>
<td>Palestine and Iraq taken by the Muslims</td>
<td>322</td>
<td>934</td>
<td>al-Balkhi, scholar and geographer, dies</td>
</tr>
<tr>
<td>13-21</td>
<td>634-44</td>
<td>Umar, caliph; Yazdigird III, shah of Persia</td>
<td>334</td>
<td>945</td>
<td>al-Hamdani (Sifat Juzrat al-Arab) dies</td>
</tr>
<tr>
<td>14</td>
<td>635</td>
<td>Battle of Qadisiya; defeat of Sassanid army</td>
<td>331-62</td>
<td>943-73</td>
<td>Ibn Hawqal’s travels</td>
</tr>
<tr>
<td>22</td>
<td>642-43</td>
<td>Muslims reach Carthage in Africa; Makran and Baluchistan in Asia</td>
<td>340</td>
<td>950</td>
<td>Suhrab (Ibn Sarabiyyun), geographical writer, flourishes</td>
</tr>
<tr>
<td>31</td>
<td>652</td>
<td>Muslims take Armenia; enter Khurasan</td>
<td>340</td>
<td>951</td>
<td>al-Iskhaki’s Kitab al-masalik wa-al-mamalik</td>
</tr>
<tr>
<td>41-132</td>
<td>661-750</td>
<td>Umayyad dynasty of caliphs based in Damascus</td>
<td>341-65</td>
<td>952-75</td>
<td>al-Mu’izz, Fatimid caliph in Cairo</td>
</tr>
<tr>
<td>73</td>
<td>692</td>
<td>al-Hajjaj becomes governor of Iraq</td>
<td>345</td>
<td>956</td>
<td>al-Mas’udi, historian, dies</td>
</tr>
<tr>
<td>76</td>
<td>695</td>
<td>Muslim postal service inaugurated</td>
<td>ca. 350</td>
<td>ca. 961</td>
<td>al-Khazin, astronomer, dies</td>
</tr>
<tr>
<td>86</td>
<td>704</td>
<td>Quraybah, governor of Khurasan (d. 714)</td>
<td>356</td>
<td>967</td>
<td>Sayf al-Dawlah, Hamdanid sultan of Syria, dies</td>
</tr>
<tr>
<td>90-93</td>
<td>708-12</td>
<td>Bukhara, Samarkand, and Khwarazm captured; also Sind</td>
<td>365-86</td>
<td>975-96</td>
<td>al-‘Aziz, Fatimid caliph in Cairo</td>
</tr>
<tr>
<td>92</td>
<td>711</td>
<td>Muslims enter Spain</td>
<td>372</td>
<td>982</td>
<td>Husayn, Fatimid caliph in Cairo</td>
</tr>
<tr>
<td>95</td>
<td>714</td>
<td>al-Hajjaj, governor of the eastern empire, dies</td>
<td>377</td>
<td>987</td>
<td>al-Fihrist</td>
</tr>
<tr>
<td>132-36</td>
<td>750-54</td>
<td>al-Saffah, first Abbasid caliph</td>
<td>378</td>
<td>988</td>
<td>Last recension of Ibn Hawqal’s Kitab surat al-ard</td>
</tr>
<tr>
<td>132</td>
<td>750</td>
<td>al-Fazari, astronomer, flourishes</td>
<td>386</td>
<td>990</td>
<td>al-Qummi, astronomer, dies</td>
</tr>
<tr>
<td>136-58</td>
<td>754-75</td>
<td>al-Mansur, second Abbasid caliph</td>
<td>ca. 390</td>
<td>ca. 1000</td>
<td>al-Muqaddasi dies</td>
</tr>
<tr>
<td>170-93</td>
<td>786-809</td>
<td>Harun al-Rashid, fifth Abbasid caliph</td>
<td>399</td>
<td>1009</td>
<td>Ibn Yunus, geographer and astronomer, dies</td>
</tr>
<tr>
<td>198-218</td>
<td>813-33</td>
<td>al-Mu’min, seventh Abbasid caliph</td>
<td>428</td>
<td>1037</td>
<td>Strasbourg manuscript of al-Khwarazmi</td>
</tr>
<tr>
<td>231</td>
<td>846</td>
<td>Ibn Khurradadhbih’s Kitab al-masalik wa-al-mamalik</td>
<td>479</td>
<td>1086</td>
<td>Earliest Ibn Hawqal manuscript</td>
</tr>
<tr>
<td>232-47</td>
<td>847-61</td>
<td>al-Mutawakkil, tenth Abbasid caliph</td>
<td>480</td>
<td>1087</td>
<td>al-Zarqollo, astronomer, flourishes (Toledo tables)</td>
</tr>
<tr>
<td>ca. 240</td>
<td>ca. 850</td>
<td>Habash al-Hasib, astronomer, flourishes</td>
<td>530</td>
<td>1140</td>
<td>al-Zuhri flourishes</td>
</tr>
<tr>
<td>247</td>
<td>861</td>
<td>al-Farghani, astronomer, flourishes</td>
<td>548</td>
<td>1154</td>
<td>Roger II of Sicily dies</td>
</tr>
<tr>
<td>256-79</td>
<td>870-92</td>
<td>al-Mu’tamid, fifteenth Abbasid caliph</td>
<td>560</td>
<td>1165</td>
<td>al-Idrisi dies</td>
</tr>
<tr>
<td>260</td>
<td>874</td>
<td>al-Kindi, philosopher, dies</td>
<td>569</td>
<td>1173</td>
<td>Earliest manuscript of al-Isakhri</td>
</tr>
<tr>
<td>274</td>
<td>887</td>
<td>al-Marwazi dies</td>
<td>590</td>
<td>1190</td>
<td>Aḥmad al-Tusi flourishes</td>
</tr>
<tr>
<td>284</td>
<td>897</td>
<td>al-Ya’qubi, geographical writer, dies</td>
<td>626</td>
<td>1229</td>
<td>Yaqut dies</td>
</tr>
<tr>
<td>286</td>
<td>899</td>
<td>al-Sarakhsi dies</td>
<td>685</td>
<td>1286</td>
<td>Ibn Sa’d dies</td>
</tr>
<tr>
<td>288</td>
<td>901</td>
<td>Thabit ibn Qurrah dies</td>
<td>732</td>
<td>1331</td>
<td>Abū al-Fida’ dies</td>
</tr>
</tbody>
</table>

This type of work called *al-Masalik wa-al-mamalik* became a tradition. Other authors who wrote in a similar vein and with the same title were al-Marwazi (d. 274/887), al-Sarakhsi (d. 286/899), and al-Jahani (tenth century A.D.). Abū Ḥabīb Aḥmad Muḥammad ibn Aḥmad al-
Jayhání was a Samanid wazír whose work most writers regarded as a serious contribution to geographical literature, and he was a forerunner, according to al-Muqaddasi, of the later al-Balkhi school. None of these works, however, has survived.10

Ibn Khurradádhbih is also followed by a series of authors who write in a more stylistic way by dropping the official framework that held his book together. Such writers were al-Ya‘qúbi (d. 284/897), Ibn Rustah (fl. ca. 290/903), and Qudámah (early tenth century A.D.), who produced geographical works that have survived and are quite important yet are valueless from a cartographic point of view.11 There are others whose works are lost, although judging from their titles they have been similar in content. Probably the culmination of this early geographical tradition was the work of al-Mas‘údí (d. 345/956). His main works were histories, but he believed in prefacing history with a description of the world where the events occurred.12 He was a traveler, an invertebrate collector of information, and a good critic. Since much of his information was gained firsthand, he gives us an excellent sketch of the physical world as well as good criticism of Arab geographical literature.

FOREIGN GEOGRAPHICAL INFLUENCE

With the formation of the Abbasid court in Iraq, especially under the caliphate of al-Ma‘núr (r. 136–58/754–75), literature and science were encouraged and it was realized that the conquered nations, Sassanids and Byzantines, had much to offer. It was soon discovered, probably through Pahlevi scholars and texts, that to the east of Islam the Hindu cultures had a wealth of knowledge that could be tapped by the new elite of the Islamic world. Attempts were made to understand Indian astronomical texts, Indian scholars were invited to Baghdad, and translations were made into Arabic from the siddhánta literature, a word that became sindhind in Arabic. Several Arabic works are based on siddhánta texts, but it was mainly astronomical concepts that were taken from them.13 A few geographical concepts were derived from India, the most important being the concept of the Cupola of the Earth and the use of the meridian of Ujjain (Arln) as the prime meridian, ideas that crept from Arabic into medieval European literature.14 A prime meridian in the extreme east based on a locality called Jamághird or Kangdiz, with longitudes ranging west from it, appears in some early Arab tables of longitude. The Arabs themselves thought this system was of Indian or Chinese origin.15

As the Arabs were absorbing Indian scientific information, they also took in many Persian ideas, as well as Greek ideas that had reached Persia. There is little obvious Persian influence in Arab geographical literature, however, except for general topographical descriptions and the concept of the division of the inhabited world into kishvars.16

The Persian kishvars or “regions” were seven, the same number as the Greek climata, so the Arabs called both iqlim (pl. aqálim), causing a certain amount of confusion. They consist geographically of six regions encircling a central region that represents the central Iranian area, usually called in Islamic times by the name Bábil (fig. 4.2).17 There is a possibility that the idea was ultimately

10. Al-Marwázi’s work was mentioned only by title by other authors (e.g., Muḥammad ibn Isḥáq ibn al-Nadim, al-Fihrist; see The Fihrist of al-Nadim: A Tenth-Century Survey of Muslim Culture, 2 vols., ed. and trans. Bayard Dodge [New York: Columbia University Press, 1970], 1:329, and Shiḥáh al-D̄in Abū‘Abdalláh Yaqūt ibn ‘Abdalláh al-Ḥamawi al-Rámi al-Baghdádi; see The Irshád al-ard ila ma‘rifat al-adháb, or, Dictionary of Learned Men of Yaqût, 7 vols., ed. D. S. Margoliouth [Leiden: E. J. Brill, 1907–27], 2:400). It was said in the latter source to be the earliest work of this nature. Al-Sarakhsí’s work is just as obscure, though al-Sarakhsí himself is better known. He was a general litterateur with other lost works to his credit.

11. The works of these writers are published as volumes 6 and 7 of Bibliotheca Geographorum Arabicorum. For Ibn Khurradádhbih see note 9 above, and for al-Ya‘qúbi see note 4 above. For Abú ‘Ali Aḥmad ibn ‘Umar ibn Rustah’s Kitáb al-‘álaq al-nafisah, see de Goeje’s edition, Kitáb al-‘álaq an-nafisah VII, Bibliotheca Geographorum Arabicorum, vol. 7 (Leiden: E. J. Brill, 1892), 1896). Qudámah ibn Ja‘far al-Baghdádi was another geographical writer who was also an administrative official in Baghdad; his Kitáb al-khárár is in de Goeje’s vol. 6 (note 9 above): Kitáb al-Khárár.


13. There were various siddhántas, and which ones found their way into Arabic is in some dispute. But since they were probably received through the intermediary of Pahlevi texts, the exact provenance of the Arabic works was never clear. Examples of Arabic texts based on Indian siddhántas, or those of al-Scháva, and which ones found their way into Arabic is in some dispute. But since they were probably received through the intermediary of Pahlevi texts, the exact provenance of the Arabic works was never clear. Examples of Arabic texts based on Indian materials are the Kitáb al-Ẓi‘ of Muḥammad ibn Ibráhím al-Fazáří and Zíj al-Sindhind al-ṣágir by Abú Ja‘far Muḥammad ibn Músá al-Kháwár-azím. The former is well known from quoted fragments (David Pingree, “The Fragments of the Works of al-Fázáří,” Journal of Near Eastern Studies 29 [1970]: 103–23), while the latter exists as a whole and was translated into Latin by Adelard of Bath in medieval times. See also p. 97 n.31.

14. Arín is a misreading of Ujjain in the Arabic script. For more detail, see below, p. 103 and p. 175 n.6.

15. See below, p. 103.

16. Nothing is known to be specifically geographical, but the astronomical tables Zi‘-i Shabriyār, translated into Arabic as the Zi‘ al-Shah, which had a great influence on Arab astronomers, may have had geographical tables similar to Ptolemy’s Handy Tables or those of al-Battáni discussed below.

17. A clear account of the kishvar system with diagrams can be found in N. Levitzon and J. F. P. Hopkins, eds. and trans., Corpus of Early
derived from Babylonian sources, although there are
 resemblances to the Indian cosmographic concept of
 Mount Meru and the lotus petals.18
 Greek geography, by contrast, influenced the early
 Arabs considerably. Greek ideas again came via Pahlavi
texts, but scholars acquainted with Syriac and Greek
introduced directly from the former Byzantine provinces
a greater knowledge of Greek geographical material,
including the works of Claudius Ptolemy.19 Ptolemy's
Geography was more purely geographical than anything
the Arabs had yet encountered. The lists of latitude and
longitude values and the mathematical side of Ptolemy
values are more accurate to some extent, but by no means in every
case. Longitudes are just so much guesswork. In no case do we know
how the Arabs arrived at their values except by playing with the figures
required was a vast organization of measurers, and we have no sign of
that. Even if Ma'mun as Commander of the Faithful managed to orga­
nize this in the Abbasid Empire, a large number of places with coor­
dinates where they could.20 For instance, one of the projects of this time was remeasuring
the length of a degree of latitude on the earth's surface
using the method originally attributed to Eratosthenes.21
One thing not taken up by Arab scholars was Ptolemy's
chapter on the construction of geographical map projec­
tions. In view of their interest in projections for celestial
mapping (chap. 2 above) this is surprising, and perhaps it

Arabic Sources for West African History (Cambridge: Cambridge Uni­

18. This Indian concept is probably also derived from the Persian
kishvar system that appears in the Avesta; see part 2 below on South
Asian cartography. The concept is not old in India; George Rusby Kaye,
Hindu Astronomy: Ancient Science of the Hindus, Memoirs of the
Archaeological Survey of India, no. 18 (Calcutta: Government of India
Central Publications Branch, 1924; reprinted New Delhi: Cosmo, 1981),

38. Lotus petal maps are discussed and illustrated below, see figs. 15.3,
16.1, 16.8, 16.14, 16.18, 17.20, 17.21, and related text.
19. Carlo Alfonso Nallino, “Al-Huwarizmi e il suo rifacimento della
Geografia di Tolomeo,” Atti della R. Accademia dei Lincei: Classe di
Scienze Morali, Storiche e Filologiche, 5th ser., 2 (1894), pt. 1 (Mem­
orie), 3-53; republished in Raccolta di scritti editi e inediti, 6 vols.,
ed. Maria Nallino (Rome: Istituto per l'Oriente, 1939-48), 5:458-532,
esp. 459-63; Ernst Honigmann, Die sieben Klimata und die nörd­
lichen Erdteile, 6 vols., ed. Maria Nallino (Rome: Istituto per l'Oriente,
1939-48), 5:408-57; and see below, pp. 178-81.

20. Seghin, in a recent work I saw after this chapter was written, dis­
cusses “Ma'munic mathematical geography” and compares it favor­
ably with “Ptolemaic geography”; Fuat Seghin, The Contribution of the
Arabic-Islamic Geographers to the Formation of the World Map
(Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissen­
schaften, 1987). What he does is to compare the values given in the
figures. Except for knowledge of the length of a degree of latitude,
there can have been little mathematics involved. What it would have
required was a vast organization of measurers, and we have no sign of
that. Even if Ma'mun as Commander of the Faithful managed to orga­
nize this in the Abbasid Empire, a large number of places with coor­
dinates were found outside his domains.
21. Carlo Alfonso Nallino has dealt in detail with this in “Il valore
metrico del grado di meridiano secondo i geografi arabi,” Cosmos 11
(1892-93): 20-27, 50-63, 105-21; republished in Raccolta di scritti editi
ed. Maria Nallino (Rome: Istituto per l'Oriente, 1939-
vols., ed. Maria Nallino (Rome: Istituto per l'Oriente, 1939-
and related text.
19. Carlo Alfonso Nallino, “Al-Huwarizmi e il suo rifacimento della
Geografia di Tolomeo,” Atti della R. Accademia dei Lincei: Classe di
Scienze Morali, Storiche e Filologiche, 5th ser., 2 (1894), pt. 1 (Mem­
orie), 3-53; republished in Raccolta di scritti editi e inediti, 6 vols.,
ed. Maria Nallino (Rome: Istituto per l'Oriente, 1939-48), 5:458-532,
esp. 459-63; Ernst Honigmann, Die sieben Klimata und die nörd­
lichen Erdteile, 6 vols., ed. Maria Nallino (Rome: Istituto per l'Oriente,
1939-48), 5:408-57; and see below, pp. 178-81.
affected all future Arab cartography. The link between Ptolemy's mathematics and actual map production seems never to have been made. The impetus Ptolemy's work gave to the Arabs, however, does seem to have aroused interest in map production, as is illustrated by the importance later geographers gave to the map of the caliph al-Ma'mūn.

**The Map of the Caliph al-Ma’mūn**

Under the caliph al-Ma’mūn (r. 198–218/813–33), science flourished at the court, and the caliph surrounded himself with scholars. One of the achievements of the group of scholars working at his instigation was a large map of the world. Al-Ma’mūn’s map, however, is likely to have been prompted as much by a political motive as by a purely scholarly one, since various early rulers (Sassanid, Fatimid, and Sicilian Norman) were said to have had similar maps constructed to show that they ruled everything in the world that mattered.

This map has not survived. The only knowledge we have of it comes from a number of contradictory references in the works of later authors. The earliest and probably most detailed reference to it and also suggesting a contemporary interest in cartography is the well-known passage from al-Mas’ūdi that runs,

> I have seen these climates represented [muṣawwarāt] in various colors, without a text, and the best that I have seen has been in the book *Jughrāfiyā* [Geography] of Marinus and the commentary to *Jughrāfiyā* of the divisions of the earth and in *al-ṣūrah al-ma’mūniyah* that al-Ma’mūn ordered to be constructed by a group of contemporary scholars to represent the world with its spheres, stars, land, and seas, the inhabited and uninhabited regions, settlements of peoples, cities, etc. This was better than anything that preceded it, either the Geography of Ptolemy, the Geography of Marinus, or any other.

This reference is vague, but the representation “in various colors” must mean that he had seen maps reputed to be made by or derived from the Greeks and also that this special map created by al-Ma’mūn’s scholars was known to him. The word used for map, *ṣūrah*, is not a technical term. It means “representation” or “picture” and can refer equally well to a written illustration or representation. Nevertheless, it is the term used for those maps of Daylam and Bukhara that were mentioned above, and it came to be regarded as the word for map throughout the geographical literature of the classical period.

Al-Ma’mūn’s map was presumably seen by the twelfth-century geographer al-Zuhrī, who states that his own work *Ja’raḥfiyā* is a copy of a copy (made by al-Fazārī) of the *Ja’raḥfiyā* al-Ma’mūn. The description makes it clear that a map is understood by the word *ja’raḥfiyā*. Unfortunately al-Zuhrī has not left a map, but only a text that describes the world according to the Persian *kishtvar* system.

The actual form of al-Ma’mūn’s map is an enigma. Al-Mas’ūdi’s reference to Marinus and Ptolemy in the same breath with al-Ma’mūn makes one immediately think that the map made for al-Ma’mūn was built up from longitude and latitude tables on a projection similar to that used by the Greeks. Both al-Mas’ūdi and al-Zuhrī, however (and we must not forget that the latter claims to have based his work on al-Ma’mūn’s map), base their surviving geographical texts on the Persian system of *kishtvars*, which they call *ašālm* or climates, and this confuses the issue. It is not known if the scholars of al-Ma’mūn really used mathematical geography to produce their map. If they did, we might envisage something resembling a Ptolemaic world map or a world map on a rectangular grid such as Marinus was supposed to have used. This form is supported in that al-Khwārazmī, one of the scholars of al-Ma’mūn’s court, produced tables of longitude and latitude of which a manuscript has survived to this day, albeit from the early eleventh century (discussed below). Suhrāb, a later scholar who produced another set of tables that has also survived, gives directions for producing a map on such a rectangular grid. His tables were almost certainly derived from those of al-Khwārazmī and are nearly as long.

If al-Zuhrī used al-Ma’mūn’s map and that map was based on a Greek model, why did al-Zuhrī base his work on the Persian *kishtvar* system? Furthermore, al-Mas’ūdi, after claiming that al-Ma’mūn’s map was so good, also based his descriptive geography on this Persian system. It is difficult to read much into the latter’s writing, however, for his knowledge of Ptolemy and Greek geography was very superficial, and he was probably aware of them only at second hand from Arabic material like al-Khwārazmī and al-Farghānī.

Al-Mas’ūdi’s statement that all towns in the same Ptolemaic climate have the same latitude is a misinterpretation of al-Farghānī’s climatic lists, and al-Mas’ūdi’s use of the Greek word “climate” (as...
aqdir) for the Persian kishvar also shows his misunderstanding.26

Of actual maps (apart from that of al-Ma’mūn) that come from the early period or might have originated before the time of al-Balkhī’s school, we also have the map said to be made by Abū al-Ḥasan ʿAli ibn ʿAbd al-Raḥmān ibn Yūnūs for the Fatimid caliph jointly with al-Ḥasan ibn ʿAḥmad al-Muhallabī. Since Ibn Yūnūs compiled tables of coordinates similar to those of al-Khwārazmī, one might expect his map to differ considerably from those of the Balkhī school. Reinaud states that Ibn Yūnūs compiled a map for a Buyid ruler that was in various colors but had no graticule. The source of this statement is not given.27

There is also a curious reference in the Fihrist, the general bibliographic compilation of Ibn al-Nadīm (d. ca. 385/995). Qurrah ibn Qamīta, a Sabean from Harran, compiled tables of coordinates similar to those of al-Khwārazmī, one might expect his map to differ considerably from those of the Balkhī school. Reinaud states that Ibn Yūnūs compiled a map for a Buyid ruler that was in various colors but had no graticule. The source of this statement is not given.27

The best example of this category, and one of the earliest maps themselves. A considerable number of lists of geographical place-names exist in Arabic literature. Some are meant to be all-inclusive lists covering the whole of the known world, some cover specific parts of the world, and some give only an unspecified selection of names. Some lists are found directly in original works, but some appear only as extracts in the works of other writers. They are generally of two types: those that list places under climates, not always in any order, giving no longitudes and only the latitudes of the climate boundaries, and those that give longitude and latitude values individually for each place.

The first type are usually included in the works of astronomers, where they appear as a separate chapter. The best example of this category, and one of the earliest extant, appears in the work of Abū ʿAbdābāḥ Aḥmad ibn Muḥammad al-Farghānī (fl. 247/861).29 Al-Farghānī’s text gives only the climate boundaries in degrees (mid-climate and maximum latitude). He also gives the length of the longest day in hours and fractions and the length of the gnomon shadow. Having delineated the climate thus, he lists geographical features inside each climate, thus giving only a range of latitude where the feature is situated. No longitudes at all are given, but the features are listed approximately in order from east to west as if he had seen and copied some more detailed list. This arrangement also shows possible signs of an eastern meridian. According to Honigmann, al-Farghānī’s astronomical tables bear a close resemblance to those of Ptolemy’s Prokheira kanones (Handy Tables), which was translated into Arabic by ‘Ayyūb and Sim‘ān as the Zīj Batlamiyūs.30 This is not so; there seems to be no Greek origin for the arrangement of towns and climates as given by al-Farghānī, and Ptolemy’s tables are arranged by geographical regions and are similar to the fuller tables in his Geography. The only Greek connection of al-Farghānī is the Greek toponymy he used in areas beyond the bounds of Islam. Nor does there seem to be any precedent in Eastern works for this arrangement. It seems to be a simpler form of the arrangement used by al-Khwārazmī, who was of course al-Farghānī’s contemporary. However, this form of table never has actual coordinates, and in each climate the order is east to west and not vice versa as in al-Khwārazmī. Thus there was never sufficient information in this sort of list for the

26. Al-Ma’sūdī, al-Tanbih; see the edition by de Goeje, 25, 32, 44 (note 12); and al-Ma’sūdī, Marsūf al-dhahab; see the translation by Barbier de Meynard and de Costeille, Les prairies d’or, 1:182–83, 185, 205 (note 12).


30. Honigmann, Die sieben Klimata, 116–17, 137 (note 19). The only available edition of this work of Ptolemy is that edited and translated by Nicholas B. Halma, Θεωμος Αλεξανδρεως Υπoρηματα ες τον Πολυμανον Πρωγέρνος κανόνας Commentaire de Théon d’Alexandrie, sur les Tables manuelles astronomiques de Ptolémée, 3 vols. (Paris: Merlin, 1822–25), 1:109–31. This shows that the tables of latitude and longitude are very much the same as those in Ptolemy’s Geography, although considerably reduced in number of entries.
scientific construction of a map, although information derived from this type has filtered through into later geographical works and then into later maps.

Lists of the second type, which give longitudes and latitudes for individual places, are exemplified by the sets of tables given by al-Khwârazmi and by al-Battâni as well as by several later authors.

LONGITUDE AND LATITUDE TABLES: AL-KHWâRAZMI, AL-BATTâNI, AND PTOLEMY

Al-Khwârazmi's tables consist of simple lists of names arranged under several classified heads—for example, towns, mountains, seas, islands, springs, and rivers (fig. 4.3). Under each of these heads names are listed in climates, beginning south of the equator and working north. Under each climate entries are given in order of longitude (west to east), so that each place as it occurs is given first longitude and then latitude in degrees and minutes.

The tables of al-Battâni (who is considerably later than al-Khwârazmi) are not so systematically arranged (fig. 4.4). Al-Battâni's main work was a textbook on astronomy, and in his work the tables of coordinates for important places were included with his tables for coordinates of important stars among the general astronomical tables. First he lists the "center points" of each geographical region to the number of ninety-four, taken from book 8, chapter 29 of Ptolemy's Geography with their respective longitudes and latitudes, and he then lists towns and other miscellaneous features in the same way (180 all together). There is no logical order of places, though the lists drift from west to east so that places in the same region appear together. However, several of these drifts occur successively throughout the total list. A final sequence lists towns and so forth in Spain and North Africa. Other astronomers followed al-Battâni's work instead of a geographical listing after the manner of al-Farghani. Also, when later geographers selected

31. Al-Khwârazmi (d. ca. 232/847) was well known to both Arabs and medieval Europeans. His fame was established by his book on algebra, but his astronomical work, Zij al-Sindhind al-saghir, was also well known. His geographical work was known only from quotations until a manuscript was discovered in the late nineteenth century. The fullest account of al-Khwârazmi's contribution to Arab geography appears in Nallino's article "Al-Huwârizmi e il suo rifacimento" (note 19). Also see G. J. Toomer, "al-Khwârizmi," in Dictionary of Scientific Biography, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970-80), 7:338-65. The unique manuscript of al-Khwarazmi's geographical work, Kitâb surat al-ârd (Picture of the earth), was discovered in Cairo by W. Spitta and deposited in the Bibliothèque Nationale et Universitaire, Strasbourg, Cod. 4247. It was edited by Hans von Mzik, Das Kitâb surat al-ârd des Abu Gâfar Muhammmd ibn Mûsâ al-Huwârizmi, Bibliothek Arabischer Historiker und Geographen, vol. 3 (Leipzig: Otto Harrassowitz, 1926). There are 2,402 entries in this work. Edward S. Kennedy and Mary Helen Kennedy, Geographical Coordinates of Localities from Islamic Sources (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987), presents the coordinate lists from some seventy-four sources including al-Khwârazmi.


33. Ibn Yunus (d. 399/1009) is the best example, with approximately 290 entries (these are mentioned by Lelewel, Géographie du Moyen
the coordinate values of previous writers, they frequently used al-Battānī's values in preference to those of others.

Another similar list of place-names probably earlier than al-Battānī's may have been that of the Kitāb al-malḥamah (Book of the battle), which was one of the sources for longitude and latitude of places that the later author Ya’qūb (d. 626/1229) used in his geographical dictionary Mu’jam al-buldān (Dictionary of countries). Because of the format of his work, the form of the Kitāb al-malḥamah was completely broken up, and we are left with a series of sixty-four separate places.34

Tables of this sort often give variations of the same place-names or even assign different names to the same place as well as different coordinate values. Later authors tend to pick and choose. They combine or duplicate material in a completely arbitrary manner, so that as time goes on the tables become impossible to use in any scientific way.

The tables of both al-Khwārazmī and al-Battānī strongly resemble those of Ptolemy, and the name Ptolemy (Baṭlamīyūs in Arabic) is associated with both.35 However, the actual values of longitude and latitude in these two sets of tables frequently vary (fig. 4.5). Al-Battānī is very close to Ptolemy, especially in those values he gives for cities, where there is almost always agreement. The Kitāb al-malḥamah quoted by Ya’qūb is also reasonably close to Ptolemy, although about a third of his localities are not in Ptolemy at all. Al-Khwārazmī lists many places that are not in Ptolemy, his latitudes vary considerably, and of course his longitudes are mainly about ten degrees less than those of Ptolemy because of his different position for the prime meridian. The differences between these Arab texts suggest that they are derived from different sources, and some explanation ought to be possible. It is therefore necessary to investigate the matter in more detail.

It is not known exactly when and where Ptolemy's Geography (Γεωγραφία) reached Arab scholars. The date usually given for its arrival is during the reign of the caliph al-Ma’mūn, and the translation is attributed originally to Abū Yusuf Ya’qūb ibn Ishaq al-Kindī and later to Thābit ibn Qurrah.36 Since al-Kindī did not die until 260/874, he must have been quite young if he was translating Ptolemy in the reign of al-Ma’mūn. Thābit ibn Qurrah’s dates are 222–88/836–901, so his translation would not have appeared until much later in the century. Both these authors were younger than al-Khwārazmī, who was certainly working under al-Ma’mūn as an astronomer and astrologer and probably died about

34. A list of these places is given in Honigmann, Die sieben Klimata, 126–31 (note 19).
35. Ptolemy is mentioned in the title of the Strasbourg manuscript of al-Khwārazmī (see von Miik’s edition, Kitāb sūrat al-ard [note 31], and Nallino, “Al-Ḥuwārizmī e il suo rifacimento,” 477 [note 19]). Ptolemy is mentioned by al-Battānī in his sixth chapter on longitudes and latitudes (Nallino’s edition, Opus astronomi, 2:640 [note 10]). Al-Battānī also states that his ninety-four regional divisions are derived from Ptolemy: they come, as I have already mentioned, from bk. 8, chap. 29 of the Geography.
36. See appendix 1.1, pp. 10–11. The translation of Ptolemy’s geographical work into Arabic is mentioned in the Fihrist; see the Dodge edition, 2:640 (note 10). Translations are also discussed in Kramers, “Die sieben Klimata,” 63 (note 19); Honigmann, Die sieben Klimata, 112–18 (note 19); and Nallino, “Al-Ḥuwārizmī e il suo rifacimento,” 459–63 (note 19).
<table>
<thead>
<tr>
<th>Yāqūt</th>
<th>Ptolemy</th>
<th>al-Khwārazmī</th>
<th>al-Battānī</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adana (‘Adana)</td>
<td>68° 15'</td>
<td>–</td>
<td>68° 15'</td>
</tr>
<tr>
<td>Greater Armenia (Khilāt)</td>
<td>78°</td>
<td>38° 20'</td>
<td>V</td>
</tr>
<tr>
<td>Lesser Armenia (Tiflis/Tbilisi)</td>
<td>75° 50'</td>
<td>45°</td>
<td>–</td>
</tr>
<tr>
<td>Antioch (‘Antīnūkha)</td>
<td>69°</td>
<td>35° 30'</td>
<td>IV</td>
</tr>
<tr>
<td>Ankara (‘Aŋkura)</td>
<td>58°</td>
<td>49° 40'</td>
<td>–</td>
</tr>
<tr>
<td>Ahwaz (Zūnā)</td>
<td>84°</td>
<td>35° 04'</td>
<td>–</td>
</tr>
<tr>
<td>Bukhara</td>
<td>87°</td>
<td>41°</td>
<td>V</td>
</tr>
<tr>
<td>Baghdad</td>
<td>75°</td>
<td>34°</td>
<td>IV</td>
</tr>
<tr>
<td>Balkh (Bākhtā)</td>
<td>115°</td>
<td>37°</td>
<td>V</td>
</tr>
<tr>
<td>Beirut (Bīrūtūtūs)</td>
<td>68° 45'</td>
<td>33° 20'</td>
<td>–</td>
</tr>
<tr>
<td>Palmyra (Tadmur) (Pālmyra)</td>
<td>71° 30'</td>
<td>–</td>
<td>IV</td>
</tr>
<tr>
<td>Tikrit (Bīrītā)</td>
<td>98° 40'</td>
<td>37° 30'</td>
<td>–</td>
</tr>
<tr>
<td>Gurgan (‘Yrkanū)</td>
<td>86° 30'</td>
<td>40'</td>
<td>V</td>
</tr>
<tr>
<td>Haran (Kāṟāū)</td>
<td>72° 30'</td>
<td>37° 30'</td>
<td>IV</td>
</tr>
<tr>
<td>Aleppo (Halab) (Bērūsī)</td>
<td>69° 30'</td>
<td>35° 25'</td>
<td>IV</td>
</tr>
<tr>
<td>Hulwan</td>
<td>71° 45'</td>
<td>34°</td>
<td>IV</td>
</tr>
<tr>
<td>Homs (‘Imsīsī)</td>
<td>69°</td>
<td>34° 45'</td>
<td>IV</td>
</tr>
<tr>
<td>Khiva (Khwārazm) (‘Hikīzīnā)</td>
<td>117° 30'</td>
<td>45°</td>
<td>VI</td>
</tr>
<tr>
<td>Raqqā (Raqqīdūrin)</td>
<td>73° 06'</td>
<td>35° 20'</td>
<td>IV</td>
</tr>
<tr>
<td>Rome (Rūmī) (Raqī)</td>
<td>35° 20'</td>
<td>41° 50'</td>
<td>V</td>
</tr>
<tr>
<td>Edessa (Ruha) (‘Eṣāsī)</td>
<td>72° 30'</td>
<td>37° 30'</td>
<td>IV</td>
</tr>
<tr>
<td>Rayy (Rāyāsī)</td>
<td>85°</td>
<td>37° 36'</td>
<td>IV</td>
</tr>
<tr>
<td>Zaurā</td>
<td>105°</td>
<td>39'</td>
<td>V</td>
</tr>
<tr>
<td>Syracuse (Συρακούση)</td>
<td>39° 18'</td>
<td>39°</td>
<td>V</td>
</tr>
<tr>
<td>Salamiya</td>
<td>68° 20'</td>
<td>37° 05'</td>
<td>IV</td>
</tr>
</tbody>
</table>

**Fig. 4.5. A Comparison of Some of the Coordinates of Al-Khwārazmī, Al-Battānī, and the Kitāb al-Malāḥamāh (Yāqūt) with Those of Ptolemy.** The first column lists the coordinates from the Kitāb al-malāḥamāh, as given in the printed edition of Yāqūt’s *Muṣjam al-buldān,* and the climate where given. This is followed by the coordinates given by the other authors.


232/847. Ibn Khurrahdādhbiḥ (fl. 231/846), another scholar and the nearest contemporary of al-Khwārazmī, claims to have made a translation of Ptolemy’s description of the earth from barbaric (d’jamīyah) into pure (ṣahīth) speech. What this means is not clear. That he made a translation into Arabic is dubious, and in any case he may be referring not to tables but to other parts of Ptolemy’s work. However, it is clear that Ibn Khurrahdādhbiḥ’s translation was for private use, and it does not seem to have been used by later writers. It therefore appears likely that the full translation of Ptolemy’s Geography into Arabic did not come until much later in the ninth century, certainly after the death of al-Mā’mūn. It is thus probable that al-Khwārazmī and Ibn Khurrahdādhbiḥ had to take the work straight from the Greek, or more likely from a Syriac version, and they may have had to translate themselves those parts they wished to use. Because of the difficulties of transmission, references in Arabic literature to Ptolemy and his work that come from this early period before there was a complete translation are short and often erroneous. The orthography of place-names suffers, and figures are corrupted throughout Arabic literature by the inaccurate rendering of Greek and Syriac letters into the Arabic script. In all these languages, numbers are represented by alphabetic signs, and Semitic alphabets have many letters that are identical except for diacritical points, which are often omitted.

37. See de Goeje’s edition of Ibn Khurrahdādhbiḥ’s *Kitāb al-masalik wa-al-mamlak,* 3 (note 9); also Nallino, “Al-Ḥuwārizmī e il suo rifacimento,” 462 (note 19).

38. There are many references to the peculiarities of Semitic scripts and the misinterpretations due to similar letters’ being used for different numbers. Works I have been consulting that have relevant passages are Lelewel, *Geographie du Moyen Age,* epilogue, 62–63 (note 32), and von Mīk in the introduction to his edition of the Strasbourg manuscripts, *Kitāb ṣ̲aṭr al-arḍ,* ṹ̲i–XXX (note 31).
Thus al-Ma’mūn’s map and any tables used for it (or even derived from it) would have been very much subject to the inadequate research and rudimentary translation work available at the time.39 This helps reveal the difference between the work of al-Khwārazmi and that of al-Battānī. Al-Battānī’s work, which was produced after translations of Ptolemy were available, is much closer to Ptolemy’s and as such can easily be compared with it. If the locality occurs in Ptolemy, most of al-Battānī’s figures are identical with his. The ninety-four geographical regions are also a Ptolemaic feature. There is no doubt that al-Battānī is extracting his material from an Arabic translation of Ptolemy’s work. According to Honigmann, his source is the translation of al-Kindī, but Nallino has suggested the translation of Thābit ibn Qurrah is the most likely, since Thābit came from Harran and was Sabaean and thus had the same origins as al-Battānī.40

The Kitāb al-malāhah, which is quoted frequently by Yaḥyā, has coordinate values very much like those of Ptolemy. Although probably earlier than al-Battānī, it must have been produced after Ptolemy’s Geography had been translated into Arabic.41 Al-Khwārazmi differs considerably from Ptolemy in both his arrangement and the content of his material. Here we can see a completely independent work based on Ptolemaic (as well as other) material. In fact, this sort of work was the only kind it was possible to produce before an adequate translation was available, and it is surprising how much of Ptolemy’s detail has been used.

The important point about al-Khwārazmi’s work is that it is systematically presented but differs from that of Ptolemy in latitude and longitude values and the arrangement of places.42 Ptolemy’s information has been selected, abstracted, and re-presented, although it is not quite clear whether this had to be done because of the resources available at the time or whether it was done deliberately for a specific purpose. Certainly Arabic names were introduced wherever possible, but the Greek (or Syriac) names were retained where needed. This was the system adopted by all Arab scholars, although in al-Khwārazmi and al-Battānī Greek words were interspersed with the Arabic ones, whereas it has been pointed out that the lists of al-Farghānī have no Greek names preserved in the Islamic homeland (probably because they are much shorter and more selective lists).43

AL-KHWĀRAZMI’S METHODS AND PURPOSE

Nallino has examined al-Khwārazmi’s coordinate values in detail and has come to conclusions on the method of compilation.44 He states that al-Khwārazmi obtained his values by placing a grid over a map and extracting the values in what seems to be a most arbitrary way. Because of the Syriac spelling of the Greek names, the map would have to have been a Syriac version from the Ptolemy corpus. Presumably this would have been done only if this Syriac Ptolemy he used consisted of only a map with no accompanying tables, and the map would have had no graticule (otherwise the readings could have been taken directly). The result is that the latitudes are all approximately ten degrees less than those of Ptolemy, simply because the grid was superimposed with its origin ten degrees to the east of Ptolemy’s prime meridian of the Fortunate Isles. The latitudes are more or less the same as Ptolemy’s. Most of the other discrepancies between the two could be accounted for by irregularities in the underlying map. A further corroboration of this idea is the fact mentioned above that some places (especially mountains) have no names but have only coordinates for both ends. Mountains are also given a color that may be their color on the original map; this use of colors seems important to the Arab geographers, and we can compare al-Ma’sūdī’s mention of colors above.45 Quite a number of places have no names, and in some of these al-Khwārazmi expressly states that he has not named them because no name was given “on the map.”46 This sounds like a rather haphazard and unscientific method of obtaining results, however, especially for a mathematician and astronomer of the caliber of al-Khwārazmi. The prime meridian ten degrees east of the Fortunate Isles may be based on the most westerly point.

39. Scholars have produced several references from Arab literature to tables commissioned by al-Ma’mūn, known as al-Zīj al-muntahan (The proved tables). Generally these refer to astronomical tables, but there is no reason why tables of geographical coordinates and even chronological tables should not have been included similar to those of Ptolemy’s Handy Tables and the tables of al-Battānī.
41. It is possible that this may represent the translation of al-Kindī, whereas al-Battānī represents that of Thābit ibn Qurrah.
42. The two main sources of information on this are Nallino, “Al-Ḥuwārizmi e il suo rifacimento” (note 19), and Hans von Māk, “Ptolemaeus und die Karten der arabischen Geographen,” Mitteilungen der Kaiserlich-Königlichen Geographischen Gesellschaft in Wien 58 (1915): 152–76, esp. 162–63.
43. Honigmann, Die sieben Klimata, 154 (note 19).
45. The colors al-Khwārazmi mentions are actually thirty-three in number and seem to include various subtle shades; not what one would expect for clear cartographic differentiation.
46. These references appear on fols. 18v, 40r, 41r of the Strasbourg manuscript. The phrase is fil-sūrah; see Nallino, “Al-Ḥuwārizmi e il suo rifacimento,” 484 (note 19).
of Africa, but the difference from Ptolemy in the length of the Mediterranean and the individual variations in latitude and longitude need some explanation. There is no doubt, however, that al-Khwārizmī's figures are thought out independently of Ptolemy's, and that al-Khwārizmī completely reworked the Greek author's tables. That Nallino calls al-Khwārizmī's work a "rifacimento" and Reinaud calls it an "imitation" spells out the truth, though the Arabic word used in the title to the Strasbourg manuscript is istikhrāj, "extraction." Al-Khwārizmī's coordinate values are followed by Suhrāb, whose work is more or less an edition of that of al-Khwārizmī, and by quite a few later geographers including Abū al-Fidāʾ quoting Kitāb rasm al-rubāʾ al-maʿmūr (Book of the picture of the inhabited quarter). 48

For what reason were these tables produced? Al-Farghānī regarded a certain amount of description of the inhabited areas of the earth as a useful part of his astronomical work. Al-Battānī and those astronomers who followed him presumably thought the same. Al-Battānī included other tables that were not strictly astronomical, such as a historical time chart. In this he was following the example of Ptolemy in his Handy Tables. This seems to be the only reason for these tables. Al-Khwārizmī's tables are a different matter altogether. 49

If al-Khwārizmī copied his tables from a Syriac map, he presumably did so to make the information available in Arabic so that it could be transferred back onto an Arab map. Did al-Khwārizmī's work really constitute notes for the compilation of al-Maʿmūn's map, about which there is so much talk? Or was it just a convenient way of preserving the information from any map because an actual map was not easily preserved? Were al-Khwārizmī's tables actually taken from al-Maʿmūn's map, especially to preserve its information and enable copies to be made from it when necessary? There is ample evidence in al-Khwārizmī's work that he was conscious of the map form, and as I have already pointed out, in two or three places he actually mentions a map. The systematic method of al-Khwārizmī is a more cartographic approach than are the astronomers' tables. This, together with the fact that some coordinates have no geographical names and that the mountain ranges are given colors as well as coordinates, has led some scholars to suggest that al-Khwārizmī's figures were actually abstracted from a map rather than from other tables. The colors given to the mountains and so forth are all pointed out by Nallino, while Suhrāb, whose tables are taken directly from al-Khwārizmī, actually gives us the directions for compiling such a map. 50 In spite of all these questions, we have no definite answer and can only continue to conjecture the reasons for this work.

Why the Arabs did not have maps with graticules at this time is not known; it is not just a case of loss of relevant artifacts. The idea of longitude and latitude tables came to the Arabs from the Greeks and essentially from Ptolemy, but translating these into a map by plotting them onto paper does not seem to have generally appealed to the Arabs, and it is possible they found it difficult to adjust to the idea of maps constructed in this way. 51 Thus, while there is no doubt that Suhrāb understood how a map could be constructed from coordinates, no one else actually describes the system. Even as late as the fourteenth century A.D., attempts to apply this part of Ptolemy's material were only partially successful. With Ptolemy's coordinates for place-names we have his coordinates for star positions, and these seem to have been regarded as more useful than the former because stars, being visible to the eye all at the same time, could be fixed in a sphere by their coordinates. As we have seen, placing the stars on a celestial globe was commonplace for Muslim scholars, and projecting star positions onto the rete of the astrolabe was also normal. 52 The geographical equivalent was more difficult to understand. There are no surviving examples of terrestrial globes, and those maps that have survived are not based on a graticule. Only very late (thirteenth or fourteenth century) were attempts made to fit the world onto a graticule, which I will describe in due course. 53

TheLength of the Mediterranean

A point where Arab geographers are given credit by many writers is their correction of the length of the Mediterranean. It is well known that Ptolemy stretched the Mediterranean longitudinally by about twenty degrees, giving the distance between Tangier (Tingis) (at 6°30'E) and Alexandria (at 60°30') as 35° (the actual distance is 35°39'). He is thought to have done this in order to make the inhabited part of the world reach the total distance of 180°, although Toomer suggests this may be due to

47. Nallino, "Al-Ḥuwarizmi e il suo rifacimento" (note 19), and Reinaud, Introduction générale, xliii n. 3 (note 27).
48. These extracts from Aba al-Fidā' were mentioned by Lelewel as coming from al-Khwārizmī's work before the Strasbourg manuscript was discovered; there are ninety-four locations all together in these extracts; see Lelewel, Géographie du Moyen Age, epilogue, 48–61 (note 32). Suhrāb's Aṣaʿīb al-aqālim al-saḥā'ah is edited by Hans von Mīzēk, Das Kitāb aṣaʿīb al-aqālim as-saḥā'ah des Suhrāb, Bibliothek Arabischer Historiker und Geographen, vol. 5 (Leipzig: Otto Harrassowitz, 1930).
49. One of the most important differences is the number of entries. Most tables have under 100 entries, though al-Battānī has 273 and Ibn Yūnus has about 290. Al-Khwārizmī, however, has about 2,400 entries (Suhrāb, 2,200). Ptolemy has about 8,000 entries in his Geography.
51. In spite of the various translations of and quotations from Ptolemy, there is no indication in Arab geographical texts of the first chapter of the Geography, in which Ptolemy describes map projections. 52. See chapter 2 above, on Islamic celestial cartography.
53. See below under Ḥāfeẓ-ı Abru and Ḥamd Allāh Mustawfī.
error in the one longitudinal interval that he measured by means of an eclipse.\textsuperscript{54} Al-Khwārazmī, in contrast, reduced the length of the Mediterranean to 43°20' (Tangier being at 8° and Alexandria at 51°20'). He made up the 180° to the east of the inhabited world, however, by adding material that comes mainly from the Alexander romance.\textsuperscript{55} This difference in the length of the Mediterranean probably means very little and does not demonstrate a significant cartographic improvement of the Arabs over the Greeks. Al-Battānī restored Alexandria to its Ptolemaic longitude, and later authors used various arbitrary values somewhere between the two given above.

It is important to stress the arbitrariness of these values. For instance, Ibn Yūnus has Alexandria at 55°, and Abū al-Fidāʾ puts it at 52°. Abū al-Ḥasan al-Marrakāshi actually increases the longitude of Alexandria to 63° but also increases the longitudes at the Spanish end, as did al-Battānī before him. Thus Al-Battānī’s length for the Mediterranean was 33°20' (with Tangier at 25°10'), while Abū al-Ḥasan placed Cadiz and Tangier at 24° and Toledo at 28° (10° according to Ptolemy).\textsuperscript{56} Taken as a whole, these coordinates are unsystematic, and this becomes clear when one tries to use them for any specific purpose. Even when errors of transmission have been eliminated, none of the figures given can be used with any mathematical precision. The Balkhi school and some other later geographers reverted to stating the distances between towns in parasangs (about four miles) or days’ journeys (marhalah). These figures may have been converted into degrees to produce some of the strange coordinates that appear in very late texts.

### THE SEVEN CLIMATES AND THEIR BOUNDARIES

Most Arab writers divided the inhabitable part of the world into horizontal bands known as climata or climates (aqalim), of which there were seven. In this they followed the Greek tradition that permeated later Syriac and Byzantine writings, although Ptolemy himself produced twenty-four climates based on the length of the shadow of the gnomon or on the length of the midsummer day.\textsuperscript{57} Each climate had a center band where the midsummer day was an exact number of half hours in length, so that there was half an hour’s difference between the center of each climate. Similarly with the boundaries between climates that were at the quarters. Thus the centers of climates 1-7 went from thirteen to sixteen hours, which went from 12°30' to 50°30' or a total of 38° according to al-Farghanī and a total of 2,140 miles on the earth’s surface (fig. 4.6).\textsuperscript{58} Most authors agree with al-Farghanī to within a minute or two if the figures have been miscalculated or misread in the Arabic. Al-Khwārazmī differs most by making his first climate begin at the equator and takes his inhabitable world from south of the equator to 63°N.\textsuperscript{59} In spite of boundary latitudes for climates, places were sometimes included in a climate when their latitude was actually outside the boundary. It was these lines of climate boundary that were later superimposed upon Arab maps from the time of al-Idrisī, either as straight lines across a semicircular inhabited world or as arcs of a circle concentric with the equator, but at this early stage these climate boundaries appear only in written texts and not on maps.\textsuperscript{60}

#### Prime Meridians

The attempt to produce a standard prime meridian for Arabic works was another complicated problem. Basing himself ultimately on Ptolemy, al-Khwārazmī used a westward extension of the "Prime Meridian of the Greeks, 0°, which was the point where the sun crossed the horizon at sunset at the equinox, 21° of which there were twenty-four" (Ptolemaeus und die Kanen,” in The History of Cartography, ed. J. B. Harley and David Woodward [Chicago: University of Chicago Press, 1987–1], 1:177–200, esp. 186). After Ernst Honigmann, Die sieben Klimata und die πόλεις, 172–202. (Heidelberg: Winter, 1929), 137, 163.


59. Al-Farghanī makes the limits of the oikoumene 0° and 66°, but he mentions no places outside the actual climate boundaries.
60. Al-Idrisī also divides his text into climates and describes the first climate completely before returning to those parts of countries that overlap the boundaries and are therefore in the second climate. In this he is followed by some later geographers such as Zakariya’ ibn Muhammad al-Qazwini, Åshār al-bilad, and ‘Ali ibn Mūsā ibn Sā′īd al-Maghribī, Kitāb bāṣt al-aʿrād fi tālhā wa-al-ʿard.
terly meridian, but not the same one Ptolemy used. Ptolemy’s own figures for latitude and longitude were used, on the whole, by al-Battānī, whose longitude figures therefore seem based on Ptolemy’s own prime meridian of the Fortunate Isles (Jazā’ir al-Khālīdāt in Arabic), which was approximately ten degrees west of al-Khwārizmī’s meridian, with the resulting difference of longitudinal values throughout.61 Al-Battānī is followed in this by many later astronomers.62 A second set of Ptolemaic figures, not quite as accurate but also based on the Fortunate Isles meridian, is given by the later encyclopedist Yaqūt when he quotes as his source the otherwise unknown work Kitāb al-malhamah. Yaqūt also gives longitudes supplementary to the normal ones based on a meridian on the east, with degrees running in the opposite direction. There are other traces of this system in Arabic texts. Al-Hamdānī (d. 334/945) used it, and so did Ḥasan ibn ’Ali al-Qummī (d. 386/990) and Abū Ma’shar (d. 272/886). According to al-Hamdānī, the eastern meridian was used by the Indians and the Chinese, and there was a difference of 13 ½ degrees of longitude between them and the Greek system. Al-Hamdānī quotes al-Fazārī (fl. 132/750) and Ḥabash al-Ḥāsib (fl. 240/850) as his sources.63

The ancient Indians had used a central meridian that they based on Laṅkā (Ceylon) for calculating sidereal and planetary motions, and it is possible that they used the same meridian as a basis for comparative longitude observations. The famous observatory at Ujjain was presumed to be on the same meridian. At 90° west and east of the Ujjain (and Laṅkā) meridian on the equator (they assumed also that Laṅkā was on the equator) they placed the cities of Romāka (Yavanapura) and Yamakotī, and to make the arrangement symmetrical on a spherical earth there was a city of Siddhāpurā at the antipodes of Laṅkā. The inhabitable world existed north of the equator between Yavanapura and Yamakotī.64 The Arabs adopted this information and equated the point 90° west of Ujjain with Ptolemy’s origin in the Fortunate Isles and Yamakotī as the 180° point or 90° east of Ujjain.65 Laṅkā became known to the Arabs as Qubbat al-Ard, the Cupola of the Earth or the Cupola of Ujjain Qubbat al-Arin, by which name it appears in medieval European texts. This system was well known to the Arabs but never had any practical use, although attempts were made to use both Ujjain and Yamakotī (or Jamāgīrī) as prime meridians.66 India was more than 90°E according to Ptolemy, and therefore the meridian of Ujjain remained entirely theoretical and was never used practically.

Finally, in a more realistic manner, longitudes were based comparatively on convenient cities in the Islamic heartland like Basra and Baghdad. Baghdad was never considered the origin of a system but was always given a rounded figure for its longitude coordinate. Thus Yaqūt (Kitāb al-malhamah) gives 75°, al-Battānī gives 80° (Baghdad was of course not mentioned by Ptolemy), and even al-Khwārizmī makes Baghdad 70° exactly.67

61. Reinaud, *Introduction générale*, CCXXXIV (note 27). Lelewel, *Géographie du Moyen Age*, epilogue, 64–93 (note 32), includes a table copied from al-Battānī’s text giving all 273 of al-Battānī’s values together with the equivalent values from Ptolemy, if possible. Some values are given by Honigmann, *Die sieben Klimata*, 126–31 (note 19). More of al-Battānī’s figures are given on pp. 144–51, but without the figures from Ptolemy. See also von Mäzik, “Ptolemaeus und die Karten,” 164–65 (note 42).

62. A list of authors following one or the other is given by Kennedy and Regier, “Prime Meridians” (note 33).


64. See Kaye, *Hindu Astronomy*, 52 (note 18).


66. Yamakotī appears in the Persian form Jamāgīrī in Arab texts. Abū al-Rayḥān Muḥammad ibn Ḥamdānā al-Bīrūnī shows that the latter stands for Jamakotī. Al-Bīrūnī also shows that Yamakotī means “castle of the Angel of Death,” and the Persian for this is the term Kandīzd of Abū Ma’shar and others, which appears as an island where the town of Tārā or Bāra is situated. All seem to be used for the eastern prime meridian. Arab authors mentioning this Indian cosmological arrangement are usually using al-Bīrūnī (362/973 to after 442/1050) as a source, for this system is described in detail in his Taʾrīkh al-Ḥind; see Alberuni’s *India: An Account of the Religion, Philosophy, Literature, Geography, Chronology, Astronomy, Customs, Laws and Astrology of India about A.D. 1030*, 2 vols., ed. Eduard Sachau (London: Trübner, 1888; Delhi: S. Chand, [1964]), 1:303–4. However, Abū Ma’shar used Kandīzd for his eastern meridian; the Cupola of the Earth appears in al-Battānī (d. 317/929) and in al-Maṣʿūdī (d. 345/956), *Munāj al-dhabab* (see *Les prairies d’or*, 1:181 [note 12]), while Arin occurs in Ibn Rustah (see J. H. Kramers, “Geography and Commerce,” in *The Legacy of Islam*, ed. Thomas Arnold and Alfred Guillaume [Oxford: Oxford University Press, 1931], 78–107, esp. 93). Al-Hamdānī also mentions the Cupola of the Earth in his *Ṣifat Jazārat al-ʿArab*; see Müller’s edition, *Geographie der arabischen Halbinsel*, 27 (note 63).

67. Honigmann, *Die sieben Klimata*, 126–27, 143, 153 (note 19). Comparative longitude could be measured using eclipses of the moon. Ptolemy knew this, as did Hipparchus before him, and al-Battānī was conversant with this method. The practical difficulties were considerable, however, and exactly how much work was done in this way is impossible to know; see Reinaud, *Introduction générale*, CCXLVIII (note 27); Sprenger, *Die Post- und Reiserouten*, XII (note 63). Al-Battānī’s efforts to determine longitude by eclipses are mentioned by Lelewel,
FIG. 4.7. SUHRĀB’S DIAGRAM FOR A WORLD MAP. This is from the manuscript in the British Library of the `Ajdib al-aqālim al-sab'ah. On the left is a diagram showing the way the threads are used to indicate the latitude and longitude, thereby finding the exact spot desired for the location on the map. The right side shows how the edges of the map are marked in divisions of ten degrees of latitude and longitude, the former from the equator poleward and the latter from the edges of the map to 90° in the center (this system disagrees with the values given in the tables). This diagram also indicates the equator and the climate boundaries.


This ability of the Arabs to measure latitude and in some cases comparative longitude (from somewhere like Baghdad) enabled them—rightly or wrongly—to change in a haphazard manner values they had received from other sources, causing ultimate confusion in some of the later tables. Only when an author (like al-Bīrūnī) quoted several values for a place and named his actual sources was the confusion cleared up, but readers were left to choose their own values from the various ones provided.

The problem with most of the prime meridians is that they were situated in mythical places. Only Baghdad and the west point of Africa could actually be pinpointed, and the last was not known accurately by the Arabs.

SUHRĀB’S CONSTRUCTION OF A MAP

Al-Khwārazmi’s tables are given in the extant manuscript without any form of explanation, but the tables are repeated in almost exactly the same form in the work of Suhrāb nearly one hundred years later.68 Suhrāb gives an introduction in which he explains in detail how to draw a map of the world, and the tables that follow are linked to the introduction, showing that they are given in the form indicated for the precise purpose of drawing the map. That al-Khwārazmi’s tables are in the same form shows the connection here between al-Khwārazmi and a similarly drawn map and is a strong indication that al-Ma’mūn’s map was also of this form.

who points out that the corrected values do not appear in his tables; see Lelewel, Géographie du Moyen Age, epilogue, 97 (note 32).

Suhrāb’s construction of the map is illuminating. First he draws a rectangle, “the larger the better,” and then he divides the edges into degrees and marks the equator and then the horizontal lines dividing the climates (fig. 4.7). But he makes no attempt to produce a more detailed graticule. The dimensions given for the map are 20°S to 80°N and 0° to 180°E. To pinpoint his features on the map he uses a thread stretched due north and south at the longitude required, with another thread stretched due east and west at the required latitude. The feature could then be placed at the intersection of the threads. Features were inserted climate by climate down the map, but features on islands were to be left until the island itself had been inserted. According to the text, when drawing, east should be to the right and west to the left—that is, the north should be at the top—but the illustration in the text shows that most of the script is written as if north were nearest the reader. This may show that when Suhrāb originally wrote the text the Greek orientation with north at the top was regarded as the norm but that by the time of the actual manuscript, written in Arabic in the tenth century, the normal Islamic orientation had south at the top.

The rectangular projection is what one expects from Marinus and is the very form Ptolemy criticizes in the introduction to his Geography, the one part of Ptolemy’s work that, as I mentioned before, for some reason never reached the Arabs. In the same way that Ptolemy criticized Marinus, both al-Bīrūnī and al-Zuhri criticized the use of the rectangular projection, though al-Bīrūnī, like all Arab authors, remained unaware of Ptolemy’s refinements.70

THE MAPS FROM THE AL-KHWĀRĀZMĪ MANUSCRIPT

The manuscript of al-Khwārazmī is accompanied by four maps.71 Though they are only sketch maps and show limited areas of the world, they do appear in the manuscript against the relative texts and thus obviously belong. Most of the work consists of tables, but it breaks out occasionally into continuous prose, and the maps are of areas described in these continuous passages. It seems, therefore, that this particular manuscript was meant to have only four maps. It is never stated why these sketch maps are the only ones included. Were they regarded as sufficient examples to instruct the cartographer? They are also four blank pages in the text, and maps might have been available for these but were never drawn. However, they would most likely have been sketch maps of the same sort as those already there.72

The first map is the island of Yaqūt (sapphire)—Jawhar (jewel) on the map—in the Far East (fig. 4.8). This is a non-Ptolemaic feature that appears in al-Khwārazmī. The

FIG. 4.8. THE ISLAND OF THE JEWEL, JAZĪRAT AL-JAWHAR, BY AL-KHWĀRAZMĪ. The equator runs through the right end.
Size of the folio: 33.5 x 20.5 cm. By permission of the Bibliothèque Nationale et Universitaire, Strasbourg (Cod. 4247, fol. 11b).

69. Suhrāb’s text has the same dimensional limits as the text of al-Khwārazmī, that is, 23°S to 63°N and 5°E to 176°E. On figure 4.7, the meridians are strangely marked from 0° to 90° from east and west toward the center.


71. The maps appear in the Strasbourg manuscript of al-Khwārazmī on fols. 11v, 21r, 30v–31r, and 47r and are all reproduced by von Mīk, Kitāb surat al-arḍ, pls. 1–4 (note 31). All except the second are drawn with transcription in Konrad Miller, Mappae arabicae: Arabische Welt- und Länderkarten des 9. –13. Jahrhunderts, 6 vols. (Stuttgart, 1926–31), Band 1, Heft 1 (Bild 3, 4, and 5), with Miller’s comments.

72. The four pages that are blank in the text are fols. 9v–10r, which make a double-page spread; 21v, which is the verso of one of the maps; and 29v. There is no continuous text near these pages.
The second map deals with al-Bahr al-Mu'lim, the World Ocean, and probably represents Ptolemy's Indian Ocean (fig. 4.9). No specific features are given, however. The words appearing on the map—each repeated several times—are of Persian origin and explain “convexities,” “concavities,” and similar terms. The next two maps are more realistic. The first of these is of the Nile (plate 4). The only place-names taken from Ptolemy are the Mountains of the Moon at the source and Alexandria at the mouth; the rest of the nomenclature is contemporary with al-Khwarazmi. There is no doubt that this representation of the Nile has affinities with that shown on Ptolemy’s map.74 The boundaries of the climates are also marked, but the distances between them do not agree with the figures given by Ptolemy or Suhrab.75 The final map is of the Sea of Azov, and this resembles Ptolemy’s sea (Palus Maeotis) only vaguely (plate 5). Nevertheless, it does give the Greek toponyms—or rather, corruptions of them. The map, however, allowing again for corruptions, does give a fair, but not accurate, representation of the sea as given by al-Khwarazmi’s tables.

CONCLUSION

In spite of all this activity, we have few artifacts to show, and it is doubtful there was much to show at the time. The ultimate outcome of all these tables of longitude and latitude was virtually nothing cartographic. We are given an inkling of cartographic production in the accounts of the map of al-Ma'mun. We are shown in a roundabout way by al-Khwarazmi and in a more direct way by Suhrab that some of the compilers of tables had a map in mind as the ultimate aim. Moreover, the tables may have been compiled from maps, so that the idea of a detailed map of the world was there even though there are no surviving examples from this early period up to the ninth century. The problem is that at a slightly later period, when maps were known to be used more by the Islamic literary public and when manuscript maps of the Balkhi school were popular, there is no sign that this earlier activity had any influence at all on the form of the map. Projections were not used, exact location of places was not desired, and the many non-Arab names that appear in all the tables are never shown on maps. Tables of coordinates continued to be copied and revised

73. See Tibbetts, Arabic Texts Containing Material on South-east Asia, 68 (note 5).
74. Al-Khwarazmi’s map appears in the von Miik edition, Kitab surat al-ard, pl. 3 (note 31); it is also reproduced as a sketch in Miller, Mappae arabicae, Band 1, Heft 1, p. 12 (Bild 4) (note 71). Any early printed world map of Ptolemy can be used for comparison.
75. The terms Syene and Meroe connected with the climate boundaries in the Greek appear only as Aswan and Bilad al-Nuba in this map, but like Alexandria, they have no connection with the climate lines.
by astronomers and even by geographers throughout the whole period of classical Islamic literature, but no attempt to collate maps with tables has ever been found in the early period.