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THE SACRED DIRECTION AND CITY STRUCTURE: A PRELIMINARY ANALYSIS OF THE ISLAMIC CITIES OF MOROCCO

Turn your face toward the Sacred Mosque [the Kaʿba in Mecca]; wherever you may be, turn your faces toward it.

Qurʾan 2:144.

City planning in Islam appears to have been rather rudimentary compared to planning in the cities of ancient Greece and Rome; public space and buildings were less common, and the strict grid pattern of the classical city was unknown. Yet in most pre-modern cities of the Islamic Middle East a clearly orthogonal structure of housing and streets is manifest. In an earlier analysis of Iranian cities I demonstrated that their orthogonal morphology resulted principally from the rectangular irrigation and field systems into which housing spread and that slope characteristics played the predominant role in the orientation of those systems.[1]

One factor which was investigated as a possible influence on the orientation of Iranian cities was the mosque. In Islam, Muslims pray toward the Kaʿba in Mecca, the sacred direction, or qibla. The mosque had then to have a qibla wall where the mihrab or niche was located that faced toward Mecca, and this almost always rectangular building also ought to have had rectangular streets around it, which would also be orthogonal to the qibla. If the mosque were built first, as it often was in newly established Islamic cities, then the street pattern could be expected to evolve around and from the mosque. In Iran, however, no such correlation between the qibla direction and the street pattern could be established; in those few cities that were oriented to the qibla the relation appeared to be a coincidence of slope and direction to Mecca. Possibly this was because most Iranian cities existed before Islam, and so the basic city structure and orientation were established before the Islamic period.

Some relatively recent scholarship provides new insight into the orientation problem. Work by David King,[2] for instance, based on an analysis of Arabic historical, legal, and astronomical texts, has shown evidence that the qibla was actually determined in several ways and consequently the qibla in a given location could end up being a number of possible different directions. Acceptable ways of determining the qibla included some based on astronomical sighting, such as the rising or setting of the sun or the rising of the star Canopus, and on the prevailing winds. The method of determining the qibla could also change over time at any particularly location, leading to rather different directions for the qibla even within the same city.

Both approximate and exact mathematical methods (based on latitude and estimates of longitudes) for finding the qibla were widely known in the medieval Islamic world from the ninth century onward. Astronomical handbooks (*zijes*) usually included chapters on the determination of the qibla by such mathematical means, tables for latitude and longitude, and sometimes qiblas for important cities.[3] Yet even using these medieval mathematical calculations, many, if not most, medieval mosques are not properly aligned toward Mecca. As King has noted:

> The earliest *qibla* determinations were, in fact, associated with the risings and settings of the sun and fixed stars, and mosque orientations in the seventh and eighth centuries, and even thereafter, were made by astronomical alignments. Thus, for example, some of the earliest mosques in Egypt and Andalusia faced the rising sun at midwinter, and some of the earliest mosques in Iraq, Iran, and Transoxania (Central Asia) faced the setting sun at midwinter. Directions perpendicular to the solstitial directions were also used. Cardinal orientations were popular as well, even where they were really quite inap-

> propriate. Occasionally, of course, mosques were built on the sites of churches and pagan temples, without modification of the orientation of the earlier edifices.[4]

Hence even though the mathematically "correct" qibla might have been available in the medieval Islamic world, many other qiblas were evidently found acceptable in the Middle East at the same time.

What is the significance of all this for the structure of the city? King in fact makes the statement that "entire cities with more-or-less orthogonal street plans were sometimes laid out facing either an accepted astronomical orientation for the *qibla* or a mathematically computed *qibla*. Religious architecture in these cities could thus be aligned with the street patterns."[5] He does note, however, that "more commonly, mosques would be oriented to the *qibla* regardless of the street patterns, or would be aligned externally with the street patterns and internally with the *qibla*."[6] In another publication on medieval Cairo, King states that three sections of Mamluk Cairo are oriented in three different directions corresponding to three distinct ways of determining the qibla.[7]

It remains to be established, then, what the correlation between mosque orientation, street patterns, and city structure really is. Even in the Cairo study, King does not provide any evidence of actual mosque orientations, or of their relationship to street orientations, and neither does he consider the influence of slope on the direction and orientation of the sections of the city.

If Islamic cities, or even some of them, were indeed laid out in relation to the qibla it is most significant. It would mean that Islam played a major role in the actual layout of cities; that a sacred direction and orientation, at least in some instances, was important in city planning. Yet, there still is no real evidence to show that Islamic city structure was influenced by the sacred direction to Mecca.

The Maghreb (northwest Africa) and specifically Morocco provide an area in which these ideas can be tested. This region is especially noted for a great number of cities newly established in early and medieval Islam, and unlike the eastern Islamic region of Southwest Asia with its long pre-Islamic urban heritage, many of these cities of the Maghreb were entirely new settlements. Hence, as Abu-Lughod[8] has pointed out, the Maghreb is a prime area for investigating Islamic urbanism. Equally as important, the medinas (old cities) of many of these towns still exist, partly a result of the "serendipity of conservation" that stemmed from French colonial policies.[9]

The existence of the medinas (actually or archaeologically) means that the structure and orientations of these cities can be fairly well determined, although dating the foundation of particular sections of a city always remains a problem. Doing so, however, assumes that the present orientation is basically the same as the original layout, but that assumption is reasonably sound. Archaeological excavations of cities in the Middle East tend to confirm that the basic street patterns and building orientations have not changed in most instances, particularly with the cultural continuity such as existed during Islamic times. Mosques (or their qibla walls) in some instances have been reoriented in later periods during reconstruction or renovation, a situation which could present major problems for their study. However, this practice seems to have been rather rare in Morocco.

In the summer of 1985 a survey of a number of cities of Morocco and Tunisia was conducted.[10] The qibla direction of mosques and madrasas was determined by compass readings; information was gathered about the history of particular buildings and cities; compass readings and slope determinations of streets were made; and maps and aerial photographs were obtained for many of the cities.[11] In this paper only some of the results of this work in Morocco will be discussed. Although a number of Moroccan cities were surveyed, the paper will concentrate on six of the major medinas: Rabat, Salé, Meknes, Marrakesh, Fez, and Taza. All six of these settlements were founded in Islamic times, providing excellent case studies to test the theses previously mentioned.

MOROCCAN QIBLAS IN TIME AND SPACE

In Morocco the true direction to Mecca (the direction of a great circle route [= shortest distance] to Mecca) varies from an azimuth of 97° in the north of Morocco (e.g., Tangiers and Tétouan) to 91° in the southern city of Marrakesh. Yet, considering only the principal mosques and shrines of each city (generally the jami ʿ or Great Mosque), one can see the great variety of readings (and hence orientations) (table 1, fig. 1).[12] It is readily apparent that the qiblas vary considerably from the "correct" azimuth to Mecca.[13] Although the possible reasons for the various orientations are beyond the scope or purpose of this paper, it can be speculated at this point that the great number of orientations in the mid-to-late 150°'s (adjusted to true north) may be due to the similar alignment of the Kaʿba and the 120°'s and

Table 1. Qiblas of Major Moroccan Mosques and Shrines

City	Name of Building	Date of Founding	Period of Founding	Qibla Direction (Azimuth*)	Correct Direction to Mecca**
Azemmour	Great Mosque	?	?	128°	92° 53′
Casablanca	Great Mosque	?	?	135°	93° 41′
Chechauèn	Great Mosque	?	?	148°	96° 52′
El Jadida	Great Mosque	?	?	131°	92° 45′
Essaouira	Great Mosque	1764 +	Alawite	104°	90° 17′
Fez	Qarawiyyin Mosque	9th c. (859)	Idrisid	163°	95° 47′
Fez	Andalousian Mosque	9th c.	Idrisid	151°	95° 47′
Fez (Jadid)	Great Mosque	13th c. (1289)	Merinid	157°	95° 47′
Marrakesh	Ya'qub al-Mansur Mosque (Qasba Mosque)	late 12th c.	Almohad	159°	91° 21′
Marrakesh	Kutubiya Mosque	1) 1147 2) 1162	1) Almohad 2) Almohad	1) 154° 2) 159°	91° 21′ 91° 21′
Meknes	Great Mosque	mid-14th c.?	Merinid	151°	95° 16′
Mulay Idris	Mausoleum of Idris I	1660/1690	Alawite	124°	95° 28′
Qsar es Seghir	Great Mosque	late 13th c.	Merinid	145°	97° 26′
Quazzane	Great Mosque	1727 or later	Alawite	109°	96° 38′
Rabat	Great Mosque	?	?	139°	94° 36′
Rabat	Hasan Mosque (Tour Hasan)	1195	Almohad	155°	94° 36′
Rabat	Qasba Mosque	12th c.?	Almohad	153°	94° 36′
Salé	Great Mosque	late 12th c.	Almohad	124°	94° 39′
Sefrou	Great Mosque	?	?	151°	95° 39′
Tangier	Great Mosque	late 17th c.	Alawite	137°	97° 12′
Taza	Great Mosque	mid-12th c. (1142–1146)	Almohad	154°	96° 38′
Tétouan	Great Mosque	?	?	126°	97° 15′
Tinmal	Great Mosque	12th c.	Almohad	157°	90° 33′

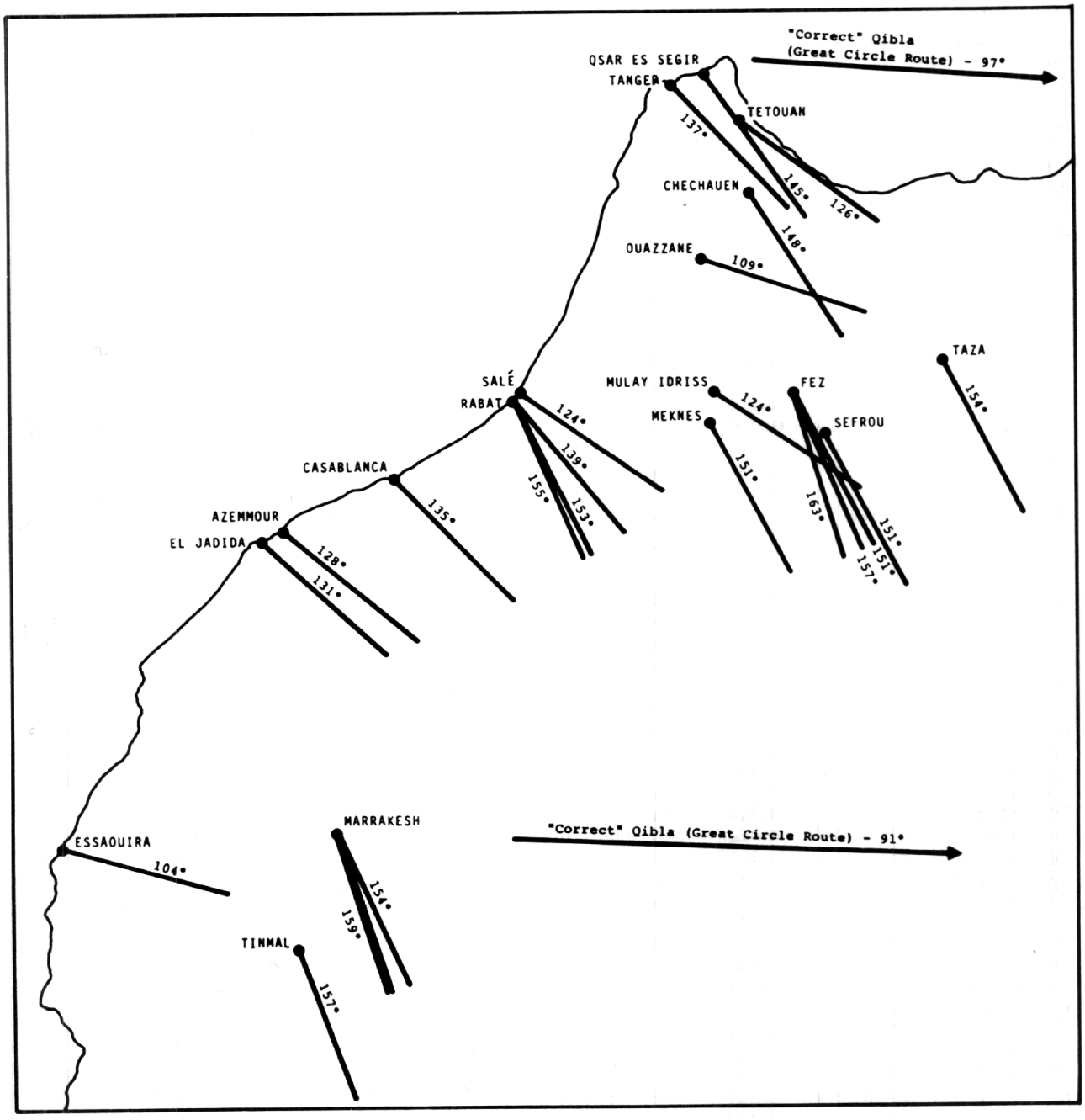
* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from the true north.

** Great Circle Route (i.e., the shortest distance to Mecca).

130°'s based perhaps on the mathematical calculations and tables of the astronomers, or on the winter sunrise, or were simply a mid-point between east and south. It is apparent that in medieval Islamic Morocco the problems of measuring direction on a spherical surface as well as the problem of the correct distance were either not properly understood or, more likely, mathematically calculated qiblas were being ignored in preference to other ways of determining it. In any case, it should be stressed that the modern ("correct") qibla values are basically irrelevant to any discussion of medieval architecture and city planning.

But what are the qibla directions? Are there various orientations by specific dynastic periods? Unfortunately, the paucity of available (and sometimes conflicting) information from the literature on the date of origin of buildings means that only some structures can be compared (table 2).[14] The Almohad period (mid-twelfth–thirteenth century) is the most consistent; all the qibla readings are in the mid-to-late 150°'s except for the Great Mosque in Salé. The Merinid period (mid-thirteenth–early-fifteenth century), on the other hand, shows a greater variety, with some concentrations in the 120°'s as well as the 150°'s and with one building, the Madrasa 'Attarin in Fez, being almost directly south (182°) — a direction found for a few other buildings surveyed (whose dates of origin are unknown), and which also was one of the accepted qiblas in parts of the Islamic Middle East and Spain.

Only the Alawite period (mid-seventeenth century–present) shows a rather significant deviation from the pattern, and this late period's qiblas approach the known "correct" direction of Mecca more closely. It is important, in fact, to note that the cities of Essaouira (formerly named Mogador) and Ouazzane were founded only in the eighteenth century, and Moulay Idris began to grow as a town only after the building of the mausoleum of Idris I in the mid-seventeenth century (even though Idris I had died at the end of the eighth century). One pattern which is discernible over the



1. Qiblas of major Moroccan mosques and shrines. From field data as tabulated in table 1.

Table 2. Qiblas of Moroccan Religious Architecture by Dynastic Period

City	Building	Date of Founding	Qibla Direction (Azimuth*)	Correct Direction to Mecca**
Idrisids (late 8th–early 10th c.)				
Fez	Qarawiyyin Mosque	9th c. (859)	163°	95°47′
Fez	Andalousian Mosque	9th c.	151°	95°47′
Almoravids (late 11th–mid-12th c.)				
(No buildings confirmed)				
Almohads (mid-12th c.–13th c.)				
Marrakesh	Ya'qub al-Mansur Mosque (Qasba Mosque)	late 12th c.	159°	91°21′
Marrakesh	Kutubiya (1 & 2)	1) 1147 2) 1162	1) 154° 2) 159°	91°21′ 91°21′
Rabat	Qasba Mosque	12th c.	153°	94°36′
Rabat	Hasan Mosque (Tour Hasan)	late 12th c. (1195)	155°	94°36′
Salé	Great Mosque	late 12th c.	124°	94°39′
Taza	Great Mosque	mid-12th c. (1142–46)	154°	96°38′
Taza	Sidi Azouz Mosque	12th c.	155°	96°38′
Tinmal	Great Mosque	12th c.	157°	90°33′
Merinids (mid-13th–early 15th c.)				
Fez (Jadid)	Great Mosque	1289	157°	95°47′
Fez (Jadid)	El Hamra Mosque	14th c.	150°	95°47′
Fez	Madrasa Sahrij	1321–23	137°	95°47′
Fez	Madrasa Bu 'Inaniya	1350–55	136°	95°47′
Fez	Madrasa 'Attarin	1325	182°	95°47′
Fez	Madrasa Saffarin	1271	120°	95°47′
Fez	Sherabliyyin Mosque	14th c.	164°	95°47′
Fez	Zawiya Mulay Idris	early 15th c.	172°	95°47′
Fez	Bab Guissa Mosque	14th c	146°	95°47′
Fez	Abu al-Hasan Mosque	1341	160°	95°47′
Meknes	Great Mosque	mid-14th c.?	151°	95°16′
Meknes	Zaituna Mosque	14th c.	145°	95°16′
Meknes	Madrasa Bu 'Inaniya	mid-14th c.	150°	95°16′
Marrakesh	Mu'assin Mosque	?	140°	91°21′
Marrakesh	Ben Salih Mosque	?	147°	91°21′
Rabat	Great Mosque	?	139°	94°36′
Rabat (Chellah)	Abu Yusuf Mosque	early 14th c.	129°	94°36′
Rabat (Chellah)	Zawiya Abu'l Hasan	early 14th c.	127°	94°36′
Salé	Sidi Ben Ashir	14th c.	127°	94°39′
Salé	Madrasa Abu'l-Hasan	1335/1342	129°	
Taza	Madrasa Abu'l-Hasan	1323?	154°	96°38′
Qasr es Seghir	Great Mosque	late 13th c.	145°	97°26′
Sa'dians (early 16th c.–mid-17th c.)				
Marrakesh	Madrasa Ben Yusuf	1562	146°	91°21′
Marrakesh	Bab Dukkala Mosque	1557	125°	91°21′
Marrakesh	Sa'dian Tombs	late 16th c.–early 17th c.	160°	91°21′
Marrakesh	(Badi' Palace)	late 16th c.	165°	91°21′
Marrakesh	Zawiya Sidi Bel-'Abbas	16th c.	165°	91°21′
Alawite (mid-17th c.–present)				
Fez	Madrasa Sharratin	1670	138°	95°47′
Fez	Er-Rsif Mosque	18th c.	94°	95°47′
Meknes	Mausoleum of Mulay Isma'il	1727 +	105°	95°16′

* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from true north.

** Great Circle Route (i.e., the shortest distance to Mecca).

Table 2. (Continued)

City	Building	Date of Founding	Qibla Direction (Azimuth*)	Correct Direction to Mecca**
Meknes	Lalla Auda Mosque	late 17th c.–early 18th c.	136°	95° 16′
Meknes	Berrima Mosque	18th c.	130°	95° 16′
Marrakesh	Madrasa Ben Salah	18th c.	148°	91° 21′
Marrakesh	Ben Yusuf Mosque	19th c.	88°	91° 21′
Marrakesh	Berrima Mosque	?	109°	91° 21′
Rabat	Ahl al-Fahs Mosque	18th c.	107° or 110°	94° 36′
Rabat	Mulay al-Mekki Mosque	18th c.	158°	94° 36′
Essaouira	Great Mosque	18th c.	104°	90° 17′
Mulay Idris	Mausoleum of Idris I	1660/1690	124°	95° 28′
Ouazzane	Great Mosque (Mulay Abdallah Sharif)	18th c.	109°	96° 38′
Tangier	Great Mosque	end of 17th c.	137°	97° 12′

* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from true north.

** Great Circle Route (i.e., the shortest distance to Mecca).

various periods (in some instances) is a consistency of the qiblas for specific cities. Now we should turn to analyzing qiblas and the orientation of these cities.

THE QIBLA AND MOROCCAN CITY STRUCTURE

Fez. Fez was originally a small Berber town constructed at the end of the eighth century by Idris I. However, the real foundation of the city dates from a settlement established by Idris II at the beginning of the ninth century on the left bank of the Oued Fez, a tributary of the Sebou River. Refugees from Qayrawan (Kairouan) in Tunisia constituted a major proportion of the population, and hence the major mosque, which originally was founded in the mid-ninth century, was called the Qarawiyyin Mosque. Meanwhile, at about the same time on the right bank a separate town developed with a population of Andalusians who had been banished from Cordoba in Spain; they called their congregational mosque the Andalusian Mosque. Each of these towns developed separately around their Great Mosque, until they were enclosed within a single wall by the Almoravids (1060–1145). This later became known as Fez el-Bali.

Fez was the capital of Morocco under the Merinids, from 1248 to 1428. They not only built many mosques and madrasas, but also founded a new town (Fez Jadid) in the thirteenth century to the southwest of the old medina (but not to be confused with the French Protectorate modern city, the Ville Nouvelle). A new Great Mosque (est. 1289) and royal palace were founded in the new city. Succeeding dynasties, such as the Saʿdians and Alawites, also added a few more mosques, shrines, and madrasas, as well as renovating a number of buildings.

The qiblas of the surveyed buildings indicate a wide and rather bewildering variety of orientations, ranging from 94° to 182° in Fez el-Bali and from 90° to 157° in Fez Jadid (table 3, figs. 2 and 4). The two major ninth-century Great Mosques are generally in the approximate direction of the 150°'s found for the early mosques of Morocco — Qarawiyyin at 163° and Andalusia at 151°, and the qibla of the thirteenth-century Merinid Great Mosque in Fez Jadid is also at 157°. The Merinid-period mosques and madrasas provide the greatest variety of orientation, confirming that, at least for this one period, either there was no one accepted qibla (at least one which was translated in the siting of the monumental architecture), or there was no attempt to adhere to a particular direction (other than generally the southwest quadrant).

The correspondence with the street and housing pattern also shows a rather confusing pattern (cf. figs. 2 and 3). The irregular street orientations in Fez el-Bali are determined basically by the irregular, hilly topography. The orientation of the houses, particularly evident where field patterns and houses can be observed at the edges of the settlement, confirm this interpretation. The mosques and madrasas fit into this network in a way that is difficult to interpret. The buildings sometimes are oriented in the direction of the streets, which is

Table 3. Qiblas of Religious Architecture in Fez

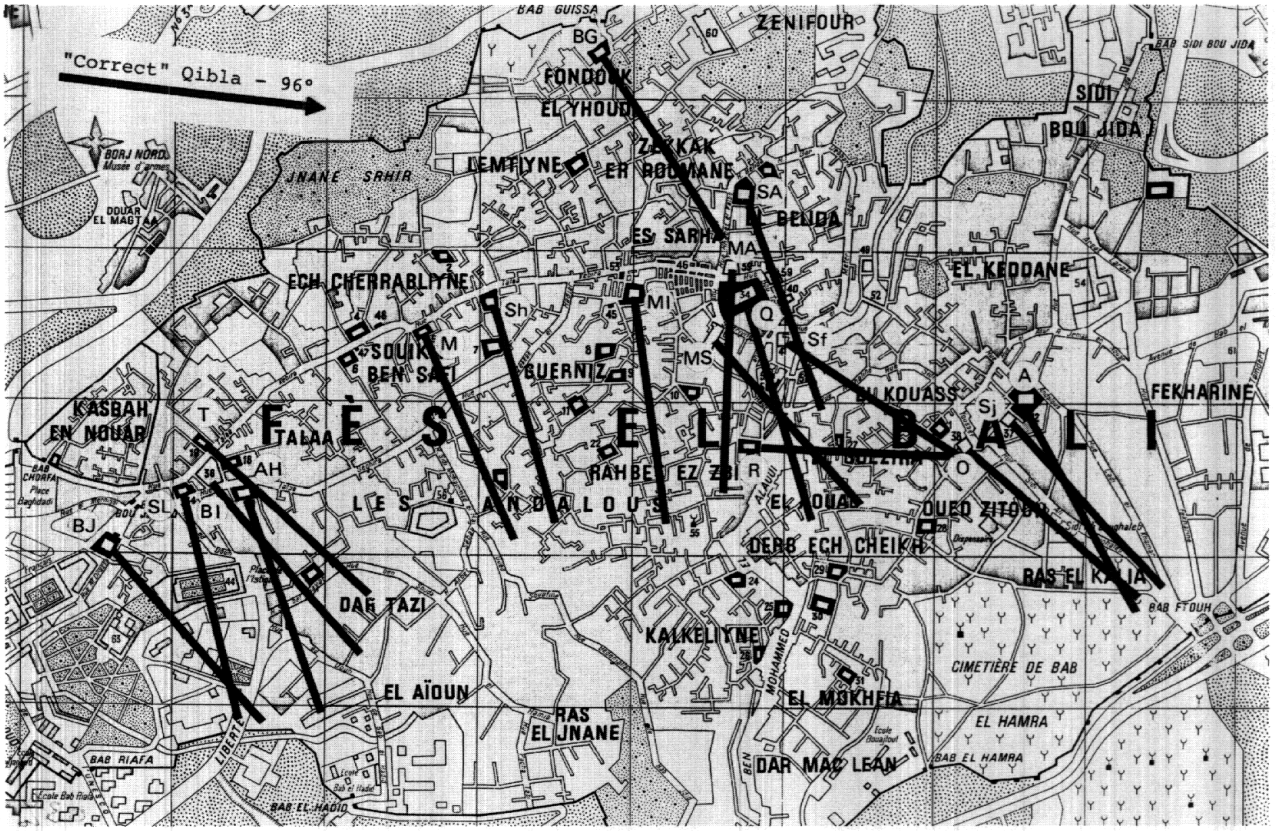
Identity Code	Building	Date	Period	Qibla (Azimuth*)	Comments
	("correct" qibla)			95° 47′	Great Circle route
Q	Qarawiyyin Mosque	9th c. (859)	Idrisid	163°	Exact reading on mihrab (through door), verified in air photo
A	Andalousian Mosque	9th c.	Idrisid	151°	Reading on side of inner courtyard, verified in air photo
sf	Madrasa Saffarin	1271	Merinid	120°	Exact reading on mihrab
GM (Fez Jadid)	Great Mosque	1289	Merinid	157°	Reading to inner courtyard, verified on air photo
Sj	Madrasa Sahrij	1321–23	Merinid	137°	Reading on sides
MA	Madrasa ʿAttarin	1325	Merinid	182°	Exact reading on mihrab
AH	Abu al-Hasan Mosque	1341	Merinid	160°	Reading on inner courtyard. Cannot locate on air photo
BI	Madrasa Bu ʿInaniya	1350–55	Merinid	136°	Exact reading on mihrab, ID on air photo not positive
H (Fez Jadid)	El Hamra Mosque	14th c.	Merinid	150°	Reading on inner courtyard, verified on air photo
Sh	Sherabliyyin Mosque	14th c.	Merinid	164°	Reading on sides
BG	Bab Guissa Mosque	14th c.	Merinid	146°	Reading on sides, verified on air photo
MI	Zawiya Mulay Idris	early 15th c.	Merinid	172°	Reading on sides, verified on air photo
MS	Madrasa Sharratin	1670	Alawite	138°	Exact reading on mihrab
R	Er-Rsif Mosque	18th c.	Alawite	94°	Reading on sides, verified on air photo
SA	Sidi Ahmed Tijani Mosque	?	?	159°	Reading on sides
O	Madrasa al-Oued	?	?	128°	Reading on sides
SL	Sidi Lezzaz Mosque	?	?	166°	Reading on sides. Cannot locate on air photo
T	Tijania Mosque	?	?	130°	Reading on sides. Cannot locate on air photo
M	El Menia Mosque	?	?	157°	Reading on sides
Ab	Mulay Abdallah Mosque (Fez Jadid)	?	?	90°	Reading on inside courtyard, verified on air photo
BJ	(Bab Bu Jelud Mosque)	?	?	139°	Reading on sides. Name not known

* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from true north.

also emphasized by the buildings along Rue Talaa Kebira, the qibla being generally at a right angle of this major street, even as it arcs through much of the city. But in a number of instances the building orientation appears to have little correspondence with the street or housing pattern. Even in Fez Jadid with its more regular street pattern (and less steep and less irregular topography), the Great Mosque has only a minimal area of similarly oriented streets and houses, the Hamra Mosque is slightly out of kilter with the street pattern, and the Mulay Abdallah Mosque is at an oblique angle to the street orientation (cf. figs. 4 and 5).

The way in which some of the religious structures are oriented differently, but have fit into the street pattern nevertheless, can be seen in the plans of the Qarawiyyin and Andalusian mosques and the Madrasa Bu ʿInaniya (fig. 6). The buildings themselves are very often irregular, filling out the space between streets, or truncating areas which normally would be built for symmetry. Similar examples of irregular mosque shapes and different orientations of the qibla to the street pattern have been noted by Kessler for Cairo.[15]

It appears, at least in the case of Fez, that the qibla, and hence the orientation of mosques and madrasas, has little influence on the street pattern or the morphology of the settlement. Topography is the overriding determinant of the orientation of streets and housing. In fact, in Fez it appears that the great variation in direction of the qibla and the orientation of religious structures is also a response to variation in slope, although this relationship does not always hold. Even though mosques and madrasas are often oriented in the same direction as immediate, adjacent streets, the variation in qibla orientations, the changing orientation, and the great irregularity of the streets all seem to confirm that the orientation of the streets and the morphology of Fez



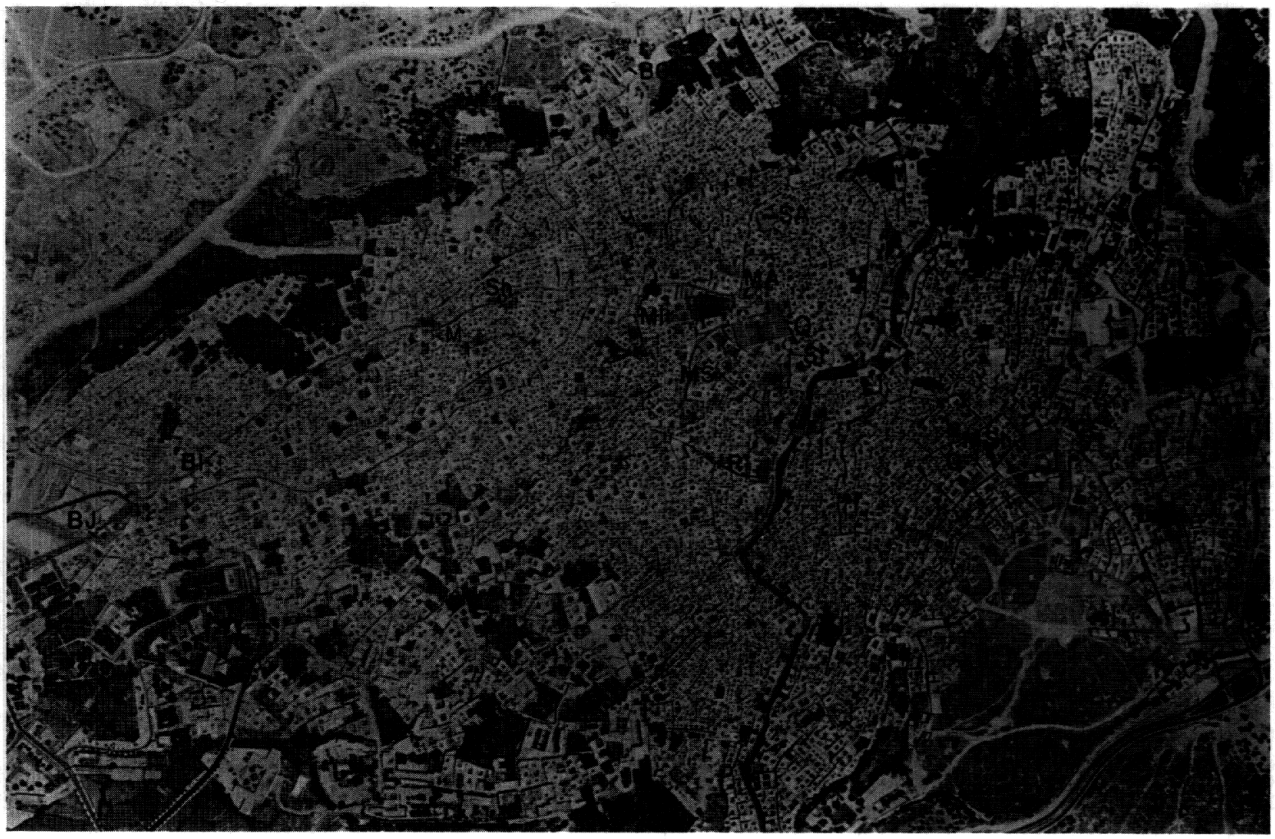
2. Qiblas in Fez el-Bali. From field data as tabulated in table 3. Base map from Plan-Guide de Fès, 1:10,000. (See table 3 for building identifications.)

evolved independently of the direction of the qibla.

Meknes. Meknes, founded in the tenth century by a Zenata Berber tribe, was fortified by the Almoravids and provided with numerous mosques and madrasas by the Almohads and Merinids. Yet it remained a rather insignificant town until becoming the Alawite capital in the seventeenth century. As one of the four imperial cities, its glory is confined particularly to Sultan Mulay Isma'il (1672–1727), a rather cruel, capricious ruler, but one who wanted to make Meknes one of the most glamorous cities of the world. Toward that end, the royal gardens and royal palace south of the old city were established by the ambitious sultan.

Religious monuments in the southern part of the medina were surveyed (table 4, figs. 7 and 8). The orientation of the qibla is generally in a similar direction, ranging from 136° for the Najarine Mosque (reputed to be the oldest surviving building in the city) to 154° for the Lalla Fidila Mosque. A major exception, however, is the mausoleum of Mulay Isma'il (d. 1727), where the qiblas of two separate mihrabs were measured, one at 112° (Magnetic N) and another at 110° (Magnetic N) and the true north direction of 105° was taken as an adjusted average of the two.

Meknes, like Fez, is built on rather hilly land. The streets and housing orientation have a most irregular pattern (fig. 8). Residential districts of the medina curve consistently and even swirl about; the religious structures often incise and interrupt this pattern. An exception to this irregularity are the newer housing districts immediately south of the old medina. For instance, the eighteenth-century Berrima Mosque has a qibla of 130°, and the streets are exactly orthogonal to this direction. This axis of 220° is at a right angle to the contours of a rather gentle slope. The old Jewish Mellah (quarter) south of Berrima changes orientation, and in fact the slope has changed, and the Mellah streets are at



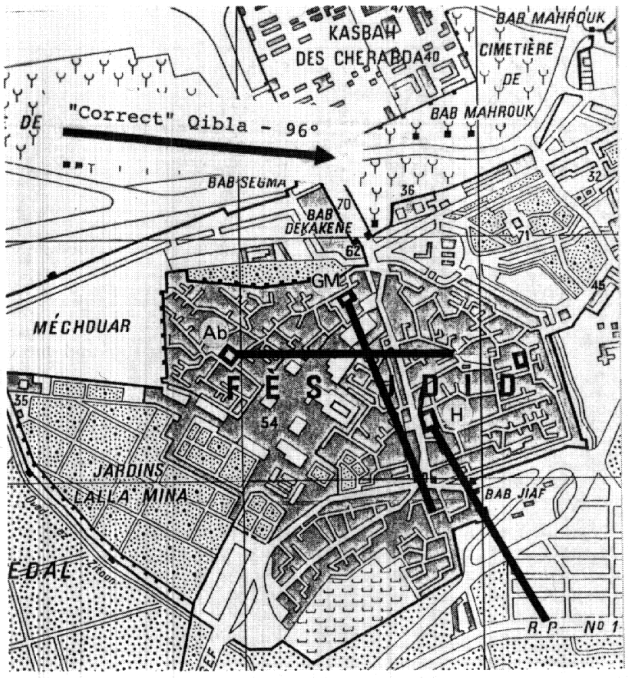
3. Aerial photograph of Fez el-Bali. From Service Géographique et Topographique, Rabat. (See table 3 for building identifications.)

right angles to that slope. This slope continues to the southeast, becoming even more gentle. It is this area where the royal gardens (now a golf course) and the royal palace were built by Mulay Isma'il, on an axis of approximately 115° and at a right angle to the slope. The mausoleum of Mulay Isma'il at the edge of the royal developments is oriented at 105°, approximately the same direction.

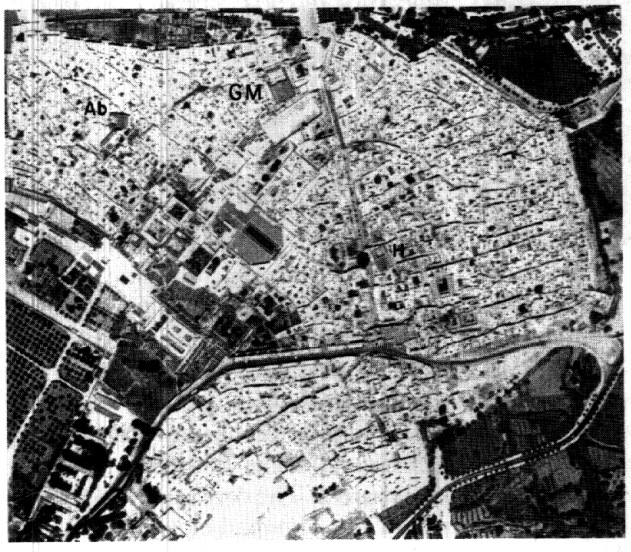
Conclusions concerning the main medina of Meknes are similar to those of Fez; the orientation of the qibla does not affect the streets and housing orientation; slope is the determining factor. Yet, in the less steep areas south of the medina, streets and housing are the same direction, and the orientation is at right angles to the main slope. In general, it is true that the main axis of the medina is in the same basic direction as the qiblas within the medina. The significance of these patterns will be dealt with later.

Marrakesh. Marrakesh was founded in 1062 by Yusuf ben Tashfin as the imperial capital of the Almoravids. Conquering Muslim Spain toward the end of the eleventh-century, this Berber dynasty was also responsible for bringing Andalusian culture to embellish the capital (and other cities). The son of the founder, 'Ali b. Yusuf, built the huge walls to enclose the city that still stand today; however, these walls did not prevent the Almohads from capturing the city in 1147. Destroying most of the Almoravid monuments, these Berber tribesmen soon built their own mosques and palaces (including the Kutubiya and Qasba mosques). The Almohads by the end of the twelfth century transferred their capital to Rabat, and Marrakesh was not a royal capital again until the Sa'dians came to the city in 1521.

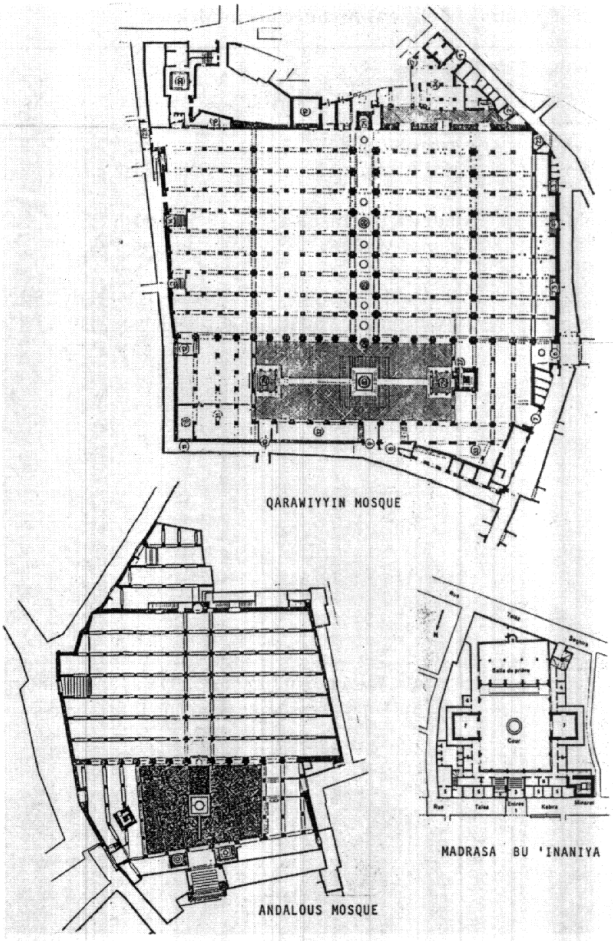
The qibla orientations of Marrakesh present a now familiar pattern — a wide variety of directions, ranging from 88° for the Ben Yusuf Mosque to the 160°'s for a number of mosques, and even 171° (table 5, fig. 9). The Ben Yusef Mosque, in fact, presents a most interesting case. At this site the Great Mosque of the Almoravids



4. Qiblas in Fez Jadid. From field data as tabulated in table 3. Base map from Plan-Guide de Fès, 1:10,000. (See table 3 for building identifications.)



5. Aerial photograph of Fez Jadid. From Service Géographique et Topographique, Rabat. (See table 3 for building identifications.)



6. Irregular building shapes and street patterns: examples from Fez. From Gaudio, 1982; Michelin, *Maroc*, 1975.

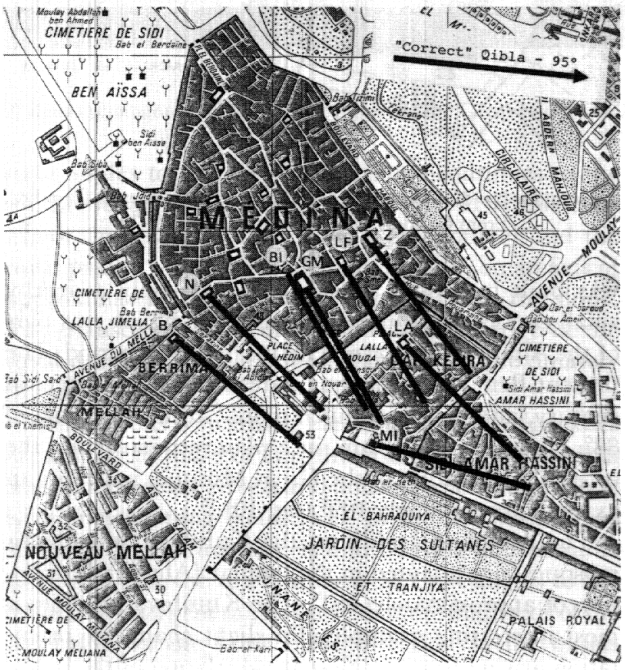
was built by ʿAli b. Yusuf. However, only a nearby small cupola, the Qubba Barrudiyyin, which was part of the Almoravid palace, remains from this period. The present Ben Yusuf Mosque dates from the nineteenth century, and hence its much more "accurate" qibla of 88°. However, Deverdun, in a plan reconstructing the original orientation of the Great Mosque, indicates an axis of approximately 109° (fig. 10).[16]

The Almohad buildings, the Kutubiya and Qasba mosques, are oriented in the familar (Almohad) direction of approximately 150°. The Kutubiya provides a most interesting example of a slight change in orientation arising from a different calculation of the qibla. The first Kutubiya was built in 1147 and the qibla orientation is 155°. It evidently was destroyed after only a few years, and at least by 1162 a second Kutubiya was

Table 4. Qiblas of Religious Architecture in Meknes

Identity Code	Building	Date	Period	Qibla (Azimuth*)	Comments
	("correct" qibla)			95° 16′	Great Circle route
GM	Great Mosque	mid-14th c.?	Merinid	151°	Reading on sides, verified on air photo
BI	Madrasa Bu ʿInaniya	mid-14th c.	Merinid	150°	Exact reading on mihrab
Z	Zaituna Mosque	14th c.	Merinid	145°	Reading on sides, verified on air photo
LA	Lalla Auda Mosque	late 17th–early 18th c.	Alawite	136°	Measured only on air photo
MI	Mausoleum of Mulay Ismaʿil	18th c. (c. 1727)	Alawite	105°	Exact readings on two mihrabs, one at 106° and one at 104°
B	Berrima Mosque	18th c.	Alawite	130°	measured only on air photo
N	Najarine Mosque	?	?	136°	Reading on sides, verified on air photo. Reputed by populace to be the oldest mosque
LF	Lalla Fidila Mosque	?	?	154°	Reading on sides, not positive ID on air photo
–	(Mosque of the Suq)	?	?	142°	Exact reading on mihrab, located at the entrance of the suq, name unknown

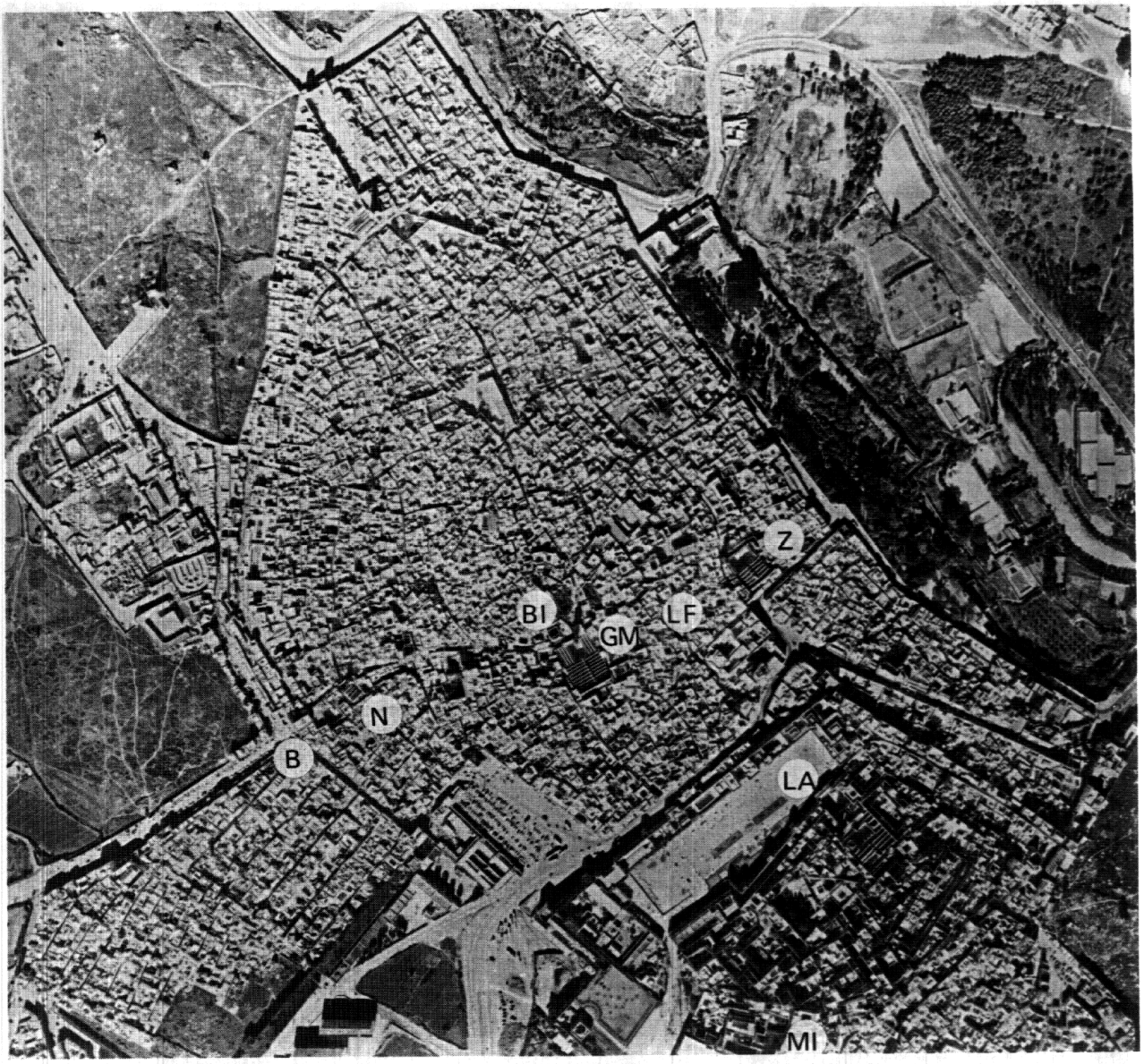
* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from the true north.



7. Qiblas in Meknes. From field data as tabulated in table 4. Base map from Plan-Guide de Meknes, 1:10,000. (See table 4 for building identifications.)

constructed adjacent to part of the older building. Yet, it has a qibla of 160°, and the axis of the building was changed accordingly, which is evident in the plan of the building as well (fig. 11). Obviously, in this case the qibla was deemed incorrect, and a change was instituted to fit a different calculation (which, of course, actually is even farther from the "correct" qibla of 91° for Marrakesh).

The orientation and location of the Almohad mosques, both Kutubiyas and the Qasba Mosque, may be significant in terms of the morphology of Marrakesh. In the south, the axis of the city is approximately 166°, which is exactly at a right angle to the main, actual upslope (fig. 12). The Qasba area, the Saʿdian Badi Palace, the nineteenth-century Bahia Palace, the nineteenth-century Agdal Gardens, and the sixteenth-century Jewish Mellah (quarter) are all oriented in this same basic direction. The slope in this case has determined the orientation of most of the street pattern and the morphology of Marrakesh in the south — a very regular, orthogonal pattern. The correspondence of the slope with the qibla of the Almohad mosques and their location considerably south of the main Almohad medina could mean that the specific sites of these mosques may have been selected for their slope characteristics.



8. Aerial Photograph of Meknes. From Service Geógraphique et Topographique, Rabat. (See table 4 for building identifications.)

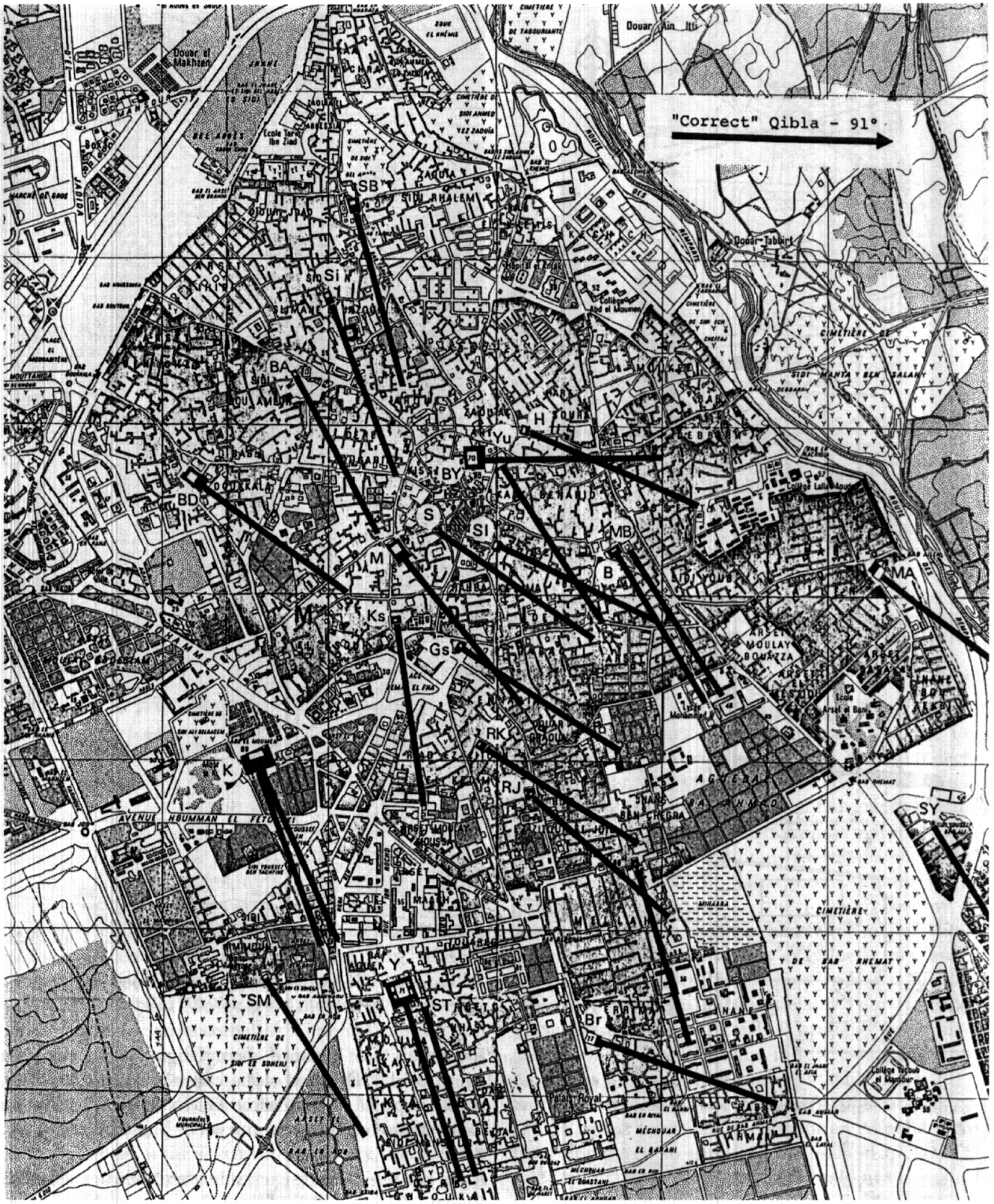
The differently oriented Berrima Mosque (109°) is Alawite, a much later period, when the calculation of the qibla had obviously changed considerably.

The core of the medina, however, is as perplexing as ever. Irrespective of the orientation of the original Ben Yusuf Mosque, the houses and streets around the area are oriented in all sorts of directions. Throughout most of the city the mosques and madrasas often do not correspond to the flow of the housing (cf. figs. 9 and 13). Even though the variety of qibla directions cannot be explained without more information on the dates of origin for the buildings, the religious structures have not influenced the basic street patterns or housing orientations in most of the medina. Although certainly less steep than Fez or Meknes, slight variations in slope probably are accounting for these patterns as well. In the northeastern part of the city the slope down to the Oued Issid is slightly irregular, with the area near Bab

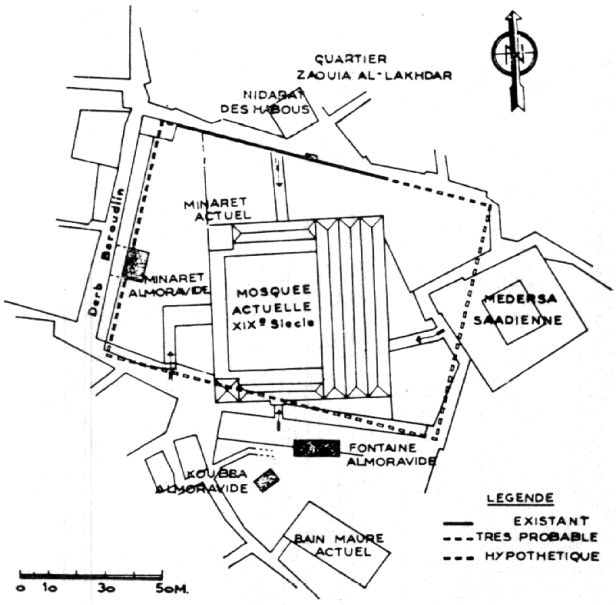
Table 5. Qiblas of Religious Architecture in Marrakesh

Identity Code	Building	Date	Period	Qibla (Azimuth*)	Comments
	("correct" qibla)			91°21′	Great Circle route
K	Kutubiya 1	1147	Almohad	154°	Reading on old mihrab
K	Kutubiya 2	1162	Almohad	159°	Reading on sides, verified on Marrakesh, 1:6,500
Y	Yaʿqub al-Mansur (Qasba) Mosque	late 12th c.	Almohad	159°	Reading on sides, verified on Marrakesh 1:6,500
M	Muʿassin Mosque	?	Merinid	140°	Reading on sides, verified on air photo
B	Ben Salih Mosque	?	Merinid	147°	Measured only on air photo and Marrakesh 1:6,500
BD	Bab Dukkala Mosque	1557	Saʿdian	125°	Reading on sides, verified on Marrakesh 1:6,500
MBY	Madrasa Ben Yusuf	1562	Saʿdian	146°	Exact reading on mihrab
SB	Zawiya Sidi Bel-ʿAbbas	16th c.	Saʿdian	165°	Measured only on Marrakesh 1:6,500
BP	(Badiʿ Palace)	end of 16th c.	Saʿdian	165°	Reading on wall (axis of palace), verified in Marrakesh 1:6,500
ST	Saʿdian Tombs	late 16th–early 17th c.	Saʿdian	160°	Exact reading on mihrab in the tomb complex
MB	Madrasa Ben Salah	18th c.	Alawite	148°	Measured only on air photo and Marrakesh 1:6,500
BY	Ben Yusuf Mosque	19th c.	Alawite	88°	Reading on inner courtyard, verified on air photo. A reconstruction and reorientation on site of older mosque
Br	Berrima Mosque	?	Alawite	109°	Reading on sides, verified in Marrakesh 1:6,500
SM	Sidi Mimun Mosque	?	?	147°	Measured only on Marrakesh 1:6,500
BP	[Bahia Palace Mosque]	?	?	162°	Measured only on Marrakesh 1:6,500. Exact name unknown
RJ	Riad ez-Zaitun Mosque (El Jadid)	?	?	135°	Measured only on Marrakesh 1:6,500. No positive ID on air photo
RK	Riad ez-Zaitun Mosque (El Kadim)	?	?	120°	Measured only on air photo and Marrakesh 1:6,500
Gs	Guessabin Mosque	?	?	121°	Measured only on air photo and Marrakesh 1:6,500
SY	Zawiya Sidi Yusuf Ben Ali	?	?	141°	Measured only on Marrakesh 1:6,500
SI	Sidi Ishak Mosque	?	?	112°	Measured only on air photo and Marrakesh 1:6,500
H	Hart Hart es Sura Mosque	?	?	108°	Measured only on air photo and Marrakesh 1:6,500
Ks	[El Ksour]? Mosque	?	?	171°	Measured only on air photo and Marrakesh 1:6,500. No positive ID on air photo
S	[Mosque of the Suq]	?	?	122°	Measured only on Marrakesh 1:6,500. Exact name unknown. Cannot locate on air photo
BA	Sidi Bu Amur Mosque	?	?	152°	Measured only on Marrakesh 1:6,500
MA	Mulay al-Sharif Mosque?		?	127°	Measured only on Marrakesh 1:6,500
Si	Sidi Ben Sliman	?	?	160°	Measured only on Marrakesh 1:6,500

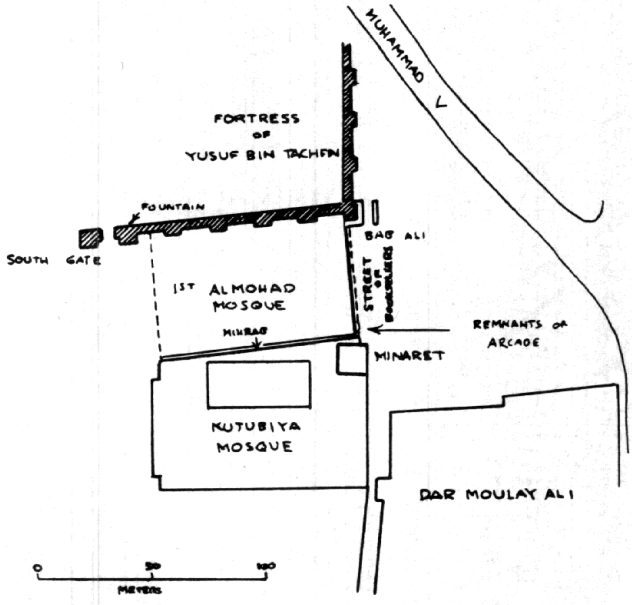
* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from true north.



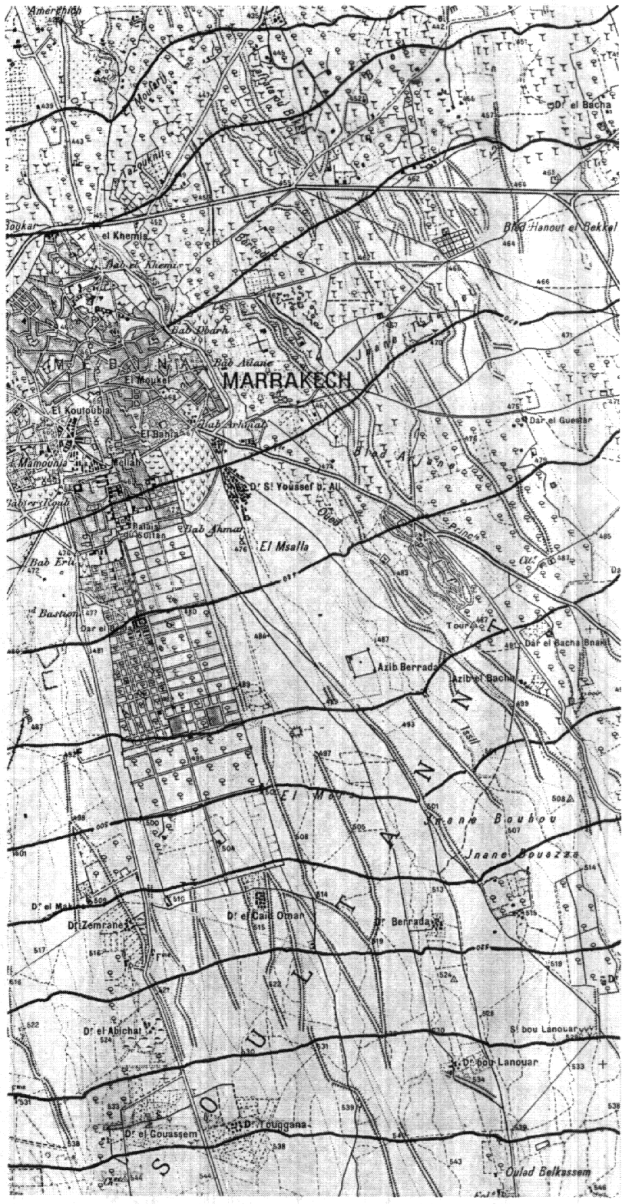
9. Qiblas in Marrakesh. From field data as tabulated in table 5. Base map from Plan-Guide de Marrakech, 1:6,500. (See table 5 for building identifications.)



10. Ben Yusuf Mosque in Marrakesh. From Deverdun, 1966.



11. Kutubiya Mosque in Marrakesh. From Parker, 1981.



12. Marrakesh axis and main slope. Contour interval = 10 meters. Base map from Carte du Maroc, 1:50,000 (Marrakech, Medina).

Debbarah, for instance, being higher than the area south of it.[17] Detailed slope characteristics, however, would require an extensive field survey, and so the exact slope conditions cannot yet be properly evaluated.

Rabat and Salé. Astride each side of the mouth of the Bou Regreg, Rabat and Salé have been competing settlements for almost a millennium. In the tenth century a

13. Aerial photograph of central Marrakesh. From Service Géographique et Topographique, Rabat. (See table 5 for building identifications.)

14. Qiblas in Rabat and Salé. Contour Interval = 5 meters (taken from Rabat-Salé, 1:10,000). From field data as tabulated in table 6. Base map from Plan-Guide de Rabat-Salé, 1:12,500 (See table 6 for building identifications.)

small fortified monastery or ribat (= rabat) was established on the left bank of the Bou Regreg. A new (or rebuilt) ribat was founded in the first half of the twelfth century by the Almoravid Sultan Tashfin ʿAli, although the real foundation of Rabat proper came in the mid-twelfth century when the Almohad ruler ʿAbd al-Muʾmin rebuilt the ribat and constructed huge walls, a palace, and a Great Mosque. By the end of the twelfth century, Rabat had become the Almohad capital, and the ruler, Abu Yusuf Yaqub, began a most ambitious building program which, however, ended with his death in 1199 and left the great Hasan Mosque (Tour Hasan) unfinished. The town declined considerably after that until, in the seventeenth century, Andalusian refugees and then piracy helped revive it.

Salé (Sala) was founded in the early eleventh century on the right bank of the Bou Regreg by the Banu ʿAshara. The present Great Mosque was founded in the mid-twelfth century by the Almohads, but the town never became as prominent as Rabat, nor did it decline as drastically. The Merinids continued to show interest in the town in the thirteenth and fourteenth centuries (and they built mosques and madrasas in Rabat as well, such as at the Chellah, about two kilometers south of the medina), and as in Rabat, both Andalusians and piracy were important for the town's economy and culture. These two medinas had fewer major religious structures than the previously examined cities, and are somewhat less difficult to analyze. In Rabat the qiblas of the Almohad Qasba Mosque and Tour Hasan (the uncompleted mosque) are 153° and 156° respectively, the Merinid Great Mosque is 139°, and a few other directions are represented as well (table 6, fig. 14). In Salé the Almohad Great Mosque's qibla and axis are 124°, a rather unusual direction for an Almohad structure (compared to the known Almohad qiblas). The orientation of the other religious buildings is basically the same direction (table 6, fig. 14).

What is significant, however, is the relatively regular

Table 6. Qiblas of Religious Architecture in Rabat and Salé

Identity Code	Building	Date	Period	Qibla (Azimuth*)	Comments
Rabat					
	("correct" qibla)			95° 36′	Great Circle route
Q	Qasba Mosque	12th c.	Almohad	153°	Reading on northwest wall, verified on air photo
H	Hasan Mosque (Tour Hasan)	end of 12th c.	Almohad	155°	Exact reading down center where mihrab would be
GM	Great Mosque	?	Merinid	139°	Reading through door, verified on air photo (but difficult to align exactly)
(Chelleh)	Abu Yusuf Mosque	early 14th c.	Merinid	127°	Exact reading on mihrab. Located c. 2 km s. of the medina
(Chelleh)	Zawiya Abu'l-Hasan	early 14th c.	Merinid	127°	Exact reading on mihrab. Located c. 2 km s. of the medina
–	Ahl al-Fahs Mosque	18th c.	Alawite	107°/110°	Reading on sides, but not square: one side 107, another 110. South of medina
M	Mulay al-Mekki Mosque	18th c.	Alawite	158°	Measured only on air photo
S	Mulay Sliman Mosque	early 19th c.	Alawite	127°	Measured only on air photo
Salé					
	("correct" qibla)			95° 39′	Great Circle route
GM	Great Mosque	late 12th c.	Almohad	124°	Reading on front door, verified on air photo
A	Madrasa Abu'l-Hasan	1335/1342	Merinid	129°	Exact reading on mihrab
SB	Sidi Ben Ashir	14th c.	Merinid	127°	Reading on sides, verified on air photo

* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from true north.

orthogonal axis of the streets and housing in both medinas. But it should also be noted that the direction of the two networks is slightly different, Rabat's being more southward than Salé's. The streets through the western part of Rabat's medina (Avenue Mohammed V and Rue Sidi Fatah) are oriented at 158°, but the main part of the medina, as shown by many of the small streets as well as the lower part of the Rue des Consuls and the Rue Oukassa, is oriented at 140°–143°. The Almohad mosques are oriented at 153° and 156° and the Great Mosque at 139°, which corresponds to the two principal directions. The eighteenth-century Mulay al-Mekki Mosque's axis is aligned exactly with the street, although the nineteenth-century Mulay Sliman Mosque at 127° does not correspond with the pattern, and other mosques outside the medina are also oriented differently (cf. table 6).

In Salé the streets are not as straight as in Rabat, but the main axis of the network is approximately 125°–130° (with a few irregularities). As noted earlier, the qibla directions taken in Salé were 124° and 129°, basically

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15. Aerial photograph of Salé. From Service Géographique et Topographique, Rabat. (See table 6 for building identifications.)

16. Aerial photograph of Rabat. From Service Géographique et Topographique, Rabat. (See table 6 for building identifications.)

the same orientation as the city axis and somewhat different than the direction of either the qiblas or the axis of Rabat (except for the nineteenth-century mosque).

The housing patterns correspond rather closely to the streets of both medinas (figs. 15 and 16). Hence the morphology of Rabat is very regular, and the courtyards of the houses are in the same direction, along the axis. In Salé the courtyards change direction slightly as the streets curve, creating a wavy effect in the direction of the main axis.

Both the direction and degree of regularity of the morphology of Rabat and Salé are due to the slope characteristics. Each of the medinas is situated on a promontory, with rather steep drops to the Atlantic and the Bou Regreg. But the medinas themselves slope downward more gently to the southeast. The main slopes are in fact in the same directions as the main axes of the street networks, that is, at a right angle to the main contours (cf. fig. 14). For both cities, the slope, the street network, and most of the qiblas are in the same direction.

Taza. The Taza valley is strategically located in the corridor between the Rif Mountains and the Middle Atlas and has been the location of various fortresses since early times. The town of Taza proper dates from the 1130's when the Almohad ruler, ʿAbd al-Muʾmin, built a Great Mosque and a wall around the city. Taza served briefly as a capital before the Almohads took Marrakesh from the Almoravids. In the mid-thirteenth century the Merinids took the town, and it again served as the capital for a short period at the end of the thirteenth century. Many mosques, madrasas, and other public buildings were built or repaired by the various dynasties, and the town continued its strategic importance even up to the twentieth century. The region of Taza is quite hilly and irregular in topography, and the medina is located on a high steep hill, about a hundred meters above the twentieth-century city to the north-

Table 7. Qiblas of Religious Architecture in Taza

Identity Code	Building	Date	Period	Qibla (Azimuth*)	Comments
	("correct" qibla)			95° 38′	Great Circle route
GM	Great Mosque	1142–1146	Almohad	154°	Reading on sides and on inner courtyard, verified on air photo. Enlarged by Merinids, end of the 13th c. & by Alawites in the late 17th c.
SA	Sidi Azouz Mosque	12th c.	Almohad	149°	Reading on sides, but may not be square
AH	Madrasa Abu'l Hasan	1323?	Merinid	154°	Reading on sides, cannot locate exactly on map or air photo
S	[Mosque of the Suq]	?	?	151°	Reading on inner courtyard, verified by air photo
A	Andalusian Mosque	?	?	148°	Reading on inner courtyard, verified on air photo. 12th c. minaret (Parker, 1981, 155)
P	[Mosque of Place Mulay el-Hasan]	?	?	155°	Reading on sides, verified on air photo

* Magnetic declination in Morocco in summer 1985 was approximately 6° west of true north, and the true north readings have been adjusted by subtracting 6° from the compass reading. Directions are expressed in azimuths from true north.

east (although the top of the hill itself is quite flat). The Almohad Great Mosque, the Jamaʿ Lakbir, is located at the lower, northern end of the medina. Its qibla direction is 154°, a more common direction for Almohad buildings. The other mosques' qiblas are also in the 150°'s range, except for the Andalusian Mosque which has a qibla of 148° (table 7, fig. 17).

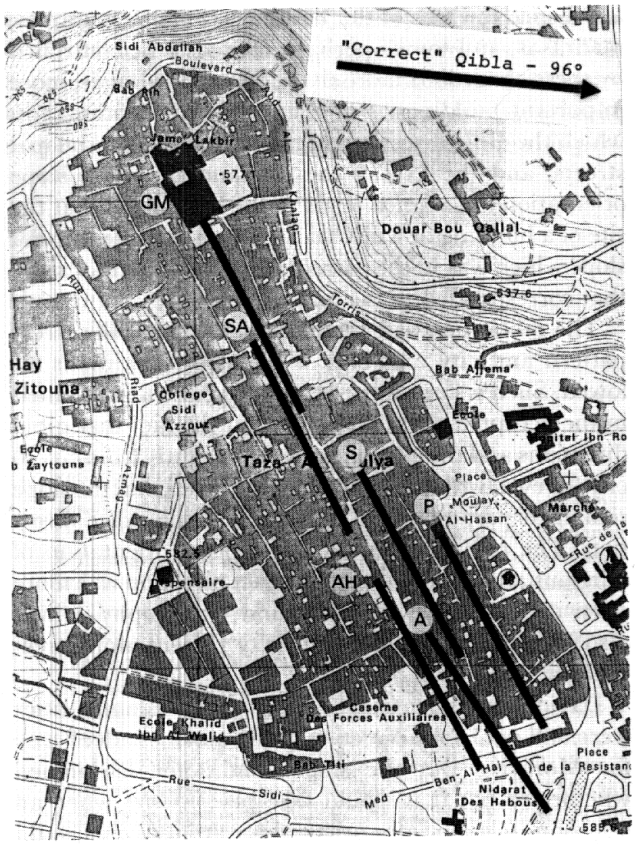
The street pattern and morphology of the city are most regular as well (fig. 18). The orthogonal pattern is oriented at an axis of 154°, the exact direction of the Great Mosque's qibla and axis. The city slopes down at a gentle 2 percent grade to the northeast, i.e., toward the Great Mosque. In the case of Taza, then, we have a rather striking example of extremely close correspondence between the qiblas, the axis of the city, and the direction of the main slope.

SOME PRELIMINARY CONCLUSIONS

This analysis of Moroccan medinas has provided data to evaluate the relationship between the qibla direction and the axis of the city and its streets and morphology. It has shown that qibla directions varied greatly, although some patterns are discernable in particular dynastic periods. The Almohad period (mid-twelfth–thirteenth century) is particularly uniform, with almost all of the qibla orientations in the 150°'s range. It is only in the Alawite period (mid-seventeenth century to the present) that the religious structures are oriented fairly closely to the contemporary "correct" calculations of the qibla based upon the shortest distance Great Circle route (from 97° in northern Morocco to 91° in Marrakesh).

Correspondence between the qibla and the street patterns show interesting, contrasting patterns. In Fez and Marrakesh, for instance, there are many different qibla orientations, and the streets are quite irregular. In hilly Fez (el-Bali) there is an accord of qiblas and immediately surrounding streets in many instances. As the main street, the Rue Talaa Kabira, curves through the medina, the qiblas and adjacent streets are at right angles to each part of the main thoroughfare. Topography appears to control the basic street pattern in Fez, and the orientation of mosques and madrasas is influenced by both slope and street pattern. The qibla direction in this instance appears to have little effect in determining street patterns.

Marrakesh has many different qibla directions and street directions, even though the city is not very hilly. In the central part of the medina, however, there is even less agreement between building orientations and the immediate surrounding streets. The pattern of streets appears to have been formed quite independently of the qibla and vice versa. Although it is probable that slight variations in slope produced the irregular city morphology, a more detailed study of the topography needs to be conducted to confirm this speculation. Only in the southern part of the city is there a predominant correspondence of the qiblas of the Almohad buildings with the street patterns and the axis of the city, which also



17. Qiblas in Taza. From field data as tabulated in table 7. Base map from Taza: Plan Urbain, 1:5,000. (See table 7 for building identifications.)

18. Aerial photograph of Taza. From Service Géographique et Topographique, Rabat. (See table 7 for building identifications.)

corresponds with the direction of a gentle slope.

In Meknes, another rather hilly town, the qiblas and street pattern also do not agree closely, except in the newer sections south of the older medina. The main axis of the medina and its major streets are, however, in the same basic direction as the qiblas. In the western part of the city where the streets begin to curve, the qiblas reflect this orientation as well. The topography also appears to predominate in Meknes.

Rabat and Salé indicate, once again, the preeminence of slope for the street direction, showing different orientations across the Bou Regreg. The axis of both cities corresponds to their predominant qibla orientations. The axis of Salé and its qibla direction are quite striking, and this is the only case where an Almohad building's qibla is not in the vicinity of the 150°'s. (Since the Great Mosque's qibla is 124°, one wonders if it was indeed Almohad, or reoriented later.) It appears in the case of Salé that the slope not only has determined the street pattern, but the qibla orientation as well.

Finally, a similar and almost exact correspondence of streets and qiblas occurs in Taza, where the gentle slope is also in the direction of the city axis. In this case, however, the Almohad Great Mosque has a familiar Almohad direction of 154°. Did the slope and therefore the streets determine the qibla, or did the qibla determine the streets? We are back to the original question posed at the beginning of the paper.

When the evidence for all the cities is considered, however, it appears that the topography is the major determinant of both the street pattern and the city structure. Streets and housing follow the slope, and if there is even a slight change in the gradient the morphology of the city is altered as well. Yet exactly how changes in slope affect the street and housing pattern requires much more detailed analyses of the slope characteristics than we have, which would in turn require more extensive field studies. There is also always the

problem of centuries of soil accumulation from dissolving, crumbling mud-brick structures which might distort the original slope conditions.

There is, however, a very significant observation about city axes and street orientations. With the exception of the extremely hilly Fez el-Bali, all the main axes of the medinas are in a roughly southwest-northeast orientation, instead of being roughly in cardinal directions. When the predominant qibla directions of the specific cities are examined, the close correspondence of the qiblas with the street patterns (and hence the main axes) exists in most cases. Then when the slope characteristics are examined, they are often in the same direction. The examples of the southern part of Marrakesh (as well as the general axis of the entire city), of Rabat, Salé, and particularly Taza confirm this correlation. Perhaps slopes in the appropriate qibla direction were selected for the location of many of these medieval Islamic Moroccan cities.

In sum, the qibla directions used for the religious architecture of Morocco range from almost due east (90°) to due south (180°), but are concentrated in degree ranges in the 120's, 140's, and 150's. Although the calculation of the qibla changed over time, it is apparent that consistency in any one direction (based on whatever calculation) was never present, or at least was not carried out in the actual orientation and construction of buildings, for even with a predominant direction, the qibla and building axes can vary by a number of degrees.

The qibla direction and hence the orientation of religious architecture correspond to the adjacent street pattern and direction when the local topography and slope are also oriented in that direction. When the street pattern and the axis of a religious building are different, the qibla determines the building orientation and the slope determines the street pattern.

The need to channel and direct water, both for distribution and for proper drainage of the city, may well have been the principal reason why the streets and houses follow the topography. Surrounding irrigated fields would also have been determined by the slope conditions, and these field patterns would have influenced the morphology of the city as it expanded into the surrounding land.[18]

The slight variations in qibla directions within a single city and the correspondence of those directions with a slightly changing street pattern indicate that local topography influenced the direction of the qibla and hence the axis of the buildings. Smaller mosques, madrasas, and tombs perhaps tended to be controlled by these conditions more than some of the larger, more important buildings. But the number of instances in which the qibla directions of major buildings, principal streets, and the axis of the city and the main slope orientation are aligned leads to the conclusion that the site of a building or a city was selected because it had a slope which was in the correct direction, that is, a slope that corresponded to the qibla.

The qibla direction therefore determined the street pattern and city axis only if the slope conditions allowed. Such a slope must be rather gentle and oriented in the accepted qibla direction, but the fact that qibla directions and the city axis can vary slightly from city to city (or even within one medina) indicates that the slope remained paramount in determining the exact direction. The qibla influenced the general orientation of religious architecture, but the exact direction was more often controlled by the slope and topography, which also was the determinant of the city's orientation, street pattern, and morphology.

David King's statement[19] that some Islamic cities were laid out in the direction of the qibla is indeed true for Morocco. But the slope conditions determined whether or not that would take place. Only when an appropriate main slope oriented toward the qibla could be found would the streets and the religious architecture also be aligned with the sacred direction. It may turn out that the various procedures outlined by King as paramount for the qibla and the orientation of religious buildings were in fact no more important, and perhaps in a great number of cases even less important, than the slope conditions.

These conclusions must of necessity remain tentative and preliminary. More detailed information on exact slope conditions, more qibla readings (and in some cases confirmed readings), and more complete information on the age and history of buildings are all needed before definite conclusions can be made. In addition, any study of Morocco must be considered in the context of the entire Maghreb as well as Andalusia and Libya. The subject deserves further research, for there are indeed intriguing patterns which indicate that the orientation of mosques, madrasas, and shrines did in many cases influence the orientation of a city — or the selection of a site for a city — or, significantly for architectural historians, that the slope and street patterns determined the qiblas and the orientation of the buildings. How extensive these various patterns were remains to

be worked out, not only for Morocco, but for other areas of the Middle East and the Islamic world as well. We hope others will begin to conduct some of the important, primary field work which will enable us to begin properly to assess Islamic city planning from this perspective.

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NOTES

1. Michael E. Bonine, "The Morphogenesis of Iranian Cities," *Annals of the Association of American Geographers* 69 (1979): 208–24.
2. David A. King, "Astronomical Alignments in Medieval Islamic Religious Architecture," *Annals of the New York Academy of Sciences* 385 (1982): 303–12; Gerald S. Hawkins and David A. King, "On the Orientation of the Kaʿba," *Journal for the History of Astronomy* 13 (1982): 101–9; David A. King, "Architecture and Astronomy: The Ventilators of Medieval Cairo and Their Secrets," *Journal of the American Oriental Society* 104 (1984): 97–133; idem, "The Astronomy of the Mamluks: A Brief Overview," *Muqarnas* 2 (1984): 73–84; idem, "The Sacred Direction in Islam: A Study of the Interaction of Religion and Science in the Middle Ages," *Interdisciplinary Science Reviews* 10 (1985): 315–28; idem, "Makka: 4. As the Centre of the World," *Encyclopaedia of Islam,* 2d ed. (Leiden, 1960–), vol. 6, pp. 180–87.
3. Idem, "Astronomical Alignments."
4. Ibid., p. 304.
5. Ibid.
6. Ibid.
7. Idem, "Architecture and Astronomy."
8. Janet Abu-Lughod, "The Legitimacy of Comparisons in Comparative Urban Studies: A Theoretical Position and an Application to North African Cities," *Urban Affairs Quarterly* 11 (1975): 13–35; idem, *Rabat: Urban Apartheid in Morocco* (Princeton, 1980), chaps. 1 and 2.
9. Idem, "Moroccan Cities: Apartheid and the Serendipity of Conservation," in *African Themes, Northwestern University Studies in Honor of Gwendolen M. Carter,* ed. Ibrahim Abu-Lughod (Evanston, Ill., 1975), pp. 77–111.
10. Field research in Morocco and Tunisia in summer 1985 was partially funded by grants from the American Institute of Maghribi Studies and the University of Arizona, Social and Behavioral Sciences Research Institute. Thanks are extended to both these institutes for their support. A preliminary version of this paper was given at the international symposium, "Traditional Dwellings and Settlements in a Comparative Perspective," held at the University of California, Berkeley, April 1988.
11. Slope was measured with a Suunto PM-5 clinometer. Unless the slopes were gentle the topographic conditions were usually too complex to measure and record effectively in the pilot survey. Compass readings were made with a Suunto optical reading compass. The qibla was determined by taking a reading to the mihrab if it was accessible. Except for the madrasas, some mausoleums, and a few mosques, however, entry into these Maliki religious structures is forbidden for non-Muslims, and lack of time prevented me from attempting to go through the red tape necessary to gain access to all the buildings. In most cases, I discovered, the qibla could still be determined quite accurately. Often the mihrab could be seen through a doorway or window, and in some cases it could be detected clearly on the outside back wall behind the building. Otherwise readings on outside walls, inner-courtyard walls, and roof alignments had to be used. If it were not obvious which wall the qibla wall was, the information was obtained from the local people. Double and triple checks by several readings and verification of the building alignments on maps, aerial photographs, and, if available, architectural plans confirmed both the readings themselves and that the seemingly haphazard method did indeed provide reliable and accurate data. The margin of error is therefore quite small, although there is always the possibility that a few of the readings are inaccurate.

    Aerial photographs of Fez, Meknes, Marrakesh, Rabat, Salé, and Taza from the 1960's and 1970's were available from the Moroccan Service Géographique et Topographique in Rabat; the photos are on such a small scale that their usefulness is limited, however. Large-scale planning maps were not available, although fairly accurate smaller-scale maps, ranging from 1:5,000 to 1:50,000, were usable. These include: Éditions Gauthey, "Plan-Guide de Fès," scale 1:10,000 (with inset "Fès el-Bali–Fès Jādid," scale 1:5,000) (Casablanca, 1979); idem, "Plan-Guide de Marrakech," scale 1:6,500 (Casablanca, 1979); idem, "Plan-Guide de Meknes," scale 1:10,000 (with inset "Médina," scale 1:5,000) (Casablanca, 1979); idem, "Plan-Guide de Rabat-Salé," scale 1:12,500 (Casablanca, 1979); Kingdom of Morocco, Division de la Cartographie, "Fès: Plan Urbain," scale 1:10,000 (Rabat, 1980); idem, "Meknes: Plan Urbain," scale 1:10,000 (Rabat, 1982); idem, "Taza: Plan Urbain," scale 1:5,000 (Rabat, 1983); Kingdom of Morocco, Division du Cadastre et de la Cartographie, "Rabat-Salé," scale 1:10,000, 2 sheets (with inset of Rabat Médina, scale 1:5,000) (Rabat, 1972); Kingdom of Morocco, Ministère de l'Agriculture et de la Reforme Agraire, "Marrakech: Médina," scale 1:50,000, Carte du Maroc au 50,000, Feville NH-29-XXIII-3a (Rabat, 1951); idem, "Fès-est," scale 1:50,000, Feville NI-30-XIV-1a (Rabat, 1973); idem, "Marrakech," scale 1:10,000, 2 sheets (Rabat, 1973); idem, "Rabat-Salé," scale 1:20,000 (Rabat, 1974).
12. All of the compass readings (magnetic north) have been adjusted to true north for the analysis in this paper. Magnetic declination in 1985 in Morocco was approximately 6° west of true north. Hence 6° has been subtracted from all the compass readings. True north and grid north are less than 1° difference on any of the maps used, and this slight difference was ignored. Considering the problems of obtaining exact (perfect) readings using a hand-held compass (as well as the problem of access to the building), the difficulty of getting the exact magnetic declination for summer 1985 for each of the Moroccan cities, and the slight differences in grid north and true north, it is estimated that the margin of error probably does not exceed 2°–3° for the qibla directions used in the analysis, and such "errors" may be canceling one another out in any case. All readings are given in azimuths from true north, where east is 90° and south is 180°.
13. David King (personal communication) has noted that the medieval "exact" or mathematically calculated qiblas also differ slightly from the modern (correct) azimuths to Mecca because longitude differences from Mecca were based on inaccurate

distance values. For instance, in fourteenth-century Marrakesh the qibla was calculated mathematically as 103° (instead of the now known, correct value of 91°). Yet, as the values in table 1 and fig. 1 indicate, the majority of the Moroccan qiblas would not be close to the medieval mathematically calculated qiblas either.

14. Data on the origins of buildings have relied not only on individual histories, but also on standard guidebooks of Morocco, including Der Grosse Polyglott, *Marokko* (Munich, 1987); Editions Marcus, *Morocco: Pocket Travel Guide* (Paris, 1984); Hachette, *Morocco* (Paris, 1966); and Michelin, *Maroc* (Paris, 1975). General surveys of Islamic/North African architecture consulted include Lucien Golvin, *Essai sur l'architecture religieuse musulmane,* Archéologie Mediterranéenne, vol. 5, pt. 4: *L'art hispano-musulman* (Paris, 1979); Derek Hill and Lucien Golvin, *Islamic Architecture: North Africa* (Hamden, Conn., 1976), with an excellent introduction by Robert Hillenbrand; Antony Hutt, *Islamic Architecture: North Africa* (London, 1977); George Marçais, *L'architecture musulmane d'Occident: Tunisie, Algerie, Maroc, Espagne et Sicile* (Paris, 1954); George Michell, ed., *Architecture of the Islamic World: Its History and Social Meaning* (New York, 1978); Richard Parker, *A Practical Guide to Islamic Monuments in Morocco* (Charlottesville, Va., 1981); and Charles Terrasse, *Méderas du Maroc* (Paris, 1927).

    Urban histories include Attilio Gaudio, *Fès: Joyau de la civilisation islamique* (Paris, 1982); Roger Tourneau, *Fès avant le Protectorat: Étude économique et sociale d'une ville de l'Occident musulman* (Casablanca, 1949); Gaston Deverdun, *Marrakech: Des origines à 1912,* 2 vols. (Rabat, 1959, 1966); Janet Abu-Lughod, *Rabat;* Kenneth L. Brown, *People of Salé: Tradition and Change in a Moroccan City, 1830–1930* (Manchester, 1976); and Mohamed Naciri, "Salé: Étude de géographie urbaine," *Revue de géographie du Maroc* 3–4 (1963): 11–82. Information on specific cities as well as general discussions of Moroccan history can be found in, for instance, Jamil M. Abun-Nasr, *A History of the Maghrib* (London, 1971); Jean Brignon et al., *Histoire du Maroc* (Casablanca, 1982); Charles-André Julien, *History of North Africa: From the Arab Conquest to 1830* (New York, 1970); and Abdallah Laroui, *The History of the Maghrib: An Interpretative Essay* (Princeton, 1977).

15. Christel Kessler, "Mecca-oriented Architecture within an Urban Context: On a Largely Unexplored Building Practice of Mediaeval Cairo," in *Arab Architecture: Past and Present,* ed. Antony Hutt (Durham, 1984), pp. 13–20.
16. Deverdun, *Marrakech,* vol. 2, pl. 9. However, an orientation of 109° is very unusual for an early Islamic building, as this research shows. I would question the validity of that reconstruction for an early Moroccan mosque (the Almoravid cupola's axis is approximately 138°, for instance).
17. See, for instance, Kingdom of Morocco, Ministère de l'Agriculture, "Marrakech," 1:10,000.
18. Cf. Bonine, "Morphogenesis of Iranian Cities," for the case of Iran.
19. King, "Astronomical Alignments," p. 304.