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ROMANS IN THE NEAR EAST: THE ORIENTATION OF ROMAN SETTLEMENTS IN PRESENT-DAY JORDAN

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ABSTRACT

An essential difference between the western and eastern provinces of the Roman Empire is the fact that sophisticated urban cultures had developed in Asia Minor and the Levant centuries before the Romans arrived. Underlying the Hellenized, and later Roman, veneer was a myriad of older local traditions and languages, which had an immense impact upon Roman religious tradition through elements such as the introduction of new religious practices. Following the path of previous studies, in this article we try to discern how Roman culture was inherited and adapted to the heterogeneous Eastern traditions and how it could be reflected in the architecture and urban layout, mainly in what concerns to the orientation of the urban structures. Considering ancient writings, such as those of Higynius Gromaticus (*Constitutio*, I), the orientation of these features could follow the position of certain celestial bodies, mainly the sun, which would imply a careful observation of the sky. Developing the lines of previous studies on the orientation of Roman settlements in the western part of the Empire (González-García et al., 2014 & Rodríguez-Antón et al., 2016), a number of Roman cities and military settlements in modern-day Jordan, Syria and Palestine are analysed here. Through this approach, we try to obtain a first insight into whether their orientations looked towards astronomical positions and wether there existed common patterns comparing with those sites previously measured in Hispania or Britannia. This would help us to obtain a wider vision of Roman ritual practices, cosmovisions and how Roman culture could have evolved, spread and became assimilated through lands and time.

KEYWORDS: Orientation of Roman settlements; Roman urbanism; ancient Jordan; Eastern Roman Empire; Limes Arabicus; Decapolis.

1. INTRODUCTION

By the time of the Roman arrival in the Near East in the 60s BC, the region had already hosted sophisticated urban cultures for centuries. The Hellenistic presence made Greek a common language but there were also a myriad of older local traditions that turned this region into a mosaic of different zones with different histories. From the creation of the province of Syria in 64 BC by General Pompey, to the victory of the Islamic forces in the Battle of Yarmuk in the 7th century (Kennedy, 2004), the Roman Empire in the East underwent a clear transformation. The Roman identity of the Republic and early Empire was successively merging with the local ones, creating new mentalities and religious practices.

These interactions with indigenous cultures and the non-static character of the 'Romanism' affected the urban style of the eastern Roman cities. Unlike other sites previously studied in the western Roman provinces (González-García et al., 2014), here there already existed an old urban tradition by the time of the Roman arrival. So, instead of funding new cities *ex-novo*, the Romans limited themselves to overlaying distinctive features on pre-existing settlements. These new elements might be representative public buildings such as theatres. But, most relevant for us is the introduction of one or more thoroughfares (Ball, 2000). These have been identified with processional ways in some cases, as the *cardus* of Gerasa (Ball, 2000), or regarded as a dominating feature in the cityscape, which could have reflected ancient astrological beliefs (Rabbabeh, 2014). Another significant difference is the almost complete absence of traditional *fora* in the eastern Roman provincial cities, being the heart of a Roman city in the West.

Examples of how Romans adapted their urban tradition to the eastern one can be observed in the Decapolis cities, which have been historically regarded as a sort of Graeco-Roman city-states and, more recently, as a region in northern Jordan, southern Syria and Palestine (Khouri, 1986). Although the definition of Decapolis is still vague, ancient writers such as Pliny[1], who listed the ten cities that conform the entity, mentioned it. We have introduced in our sample the eight cities that have been currently identified from that list (see Table I). We should not ignore the cohabitation of Graeco-Macedonians, Arabs (Nabateans), Jews and Romans, in order to identify whether this fact could affect the orientation patterns.

Owing to its bordering position within the Roman Empire (more concretely its south easternmost boundary), there is also a great number of military settlements in the area studied. For that reason, it needed to be protected from external pressures and a number of military infrastructures and garrisons were required. This situation arose mainly as a result of the stability policies of the 2nd century AD. This complex of military infrastructures formed the so-called *limes arabicus* (e.g. Parker, 1992 and Bowersock, 1976) and were interlinked through communication roads, such as the *Via Nova Traiana*, which spanned from Bosra to the Red Sea at Aila.

Based on all these facts, and following the line of previous archaeoastronomical studies on Roman urbanism (e.g. González-García et al., 2014) we would like to learn how the Romans adapted their traditions in this region. With this information, we seek to compare the results of the present work with those obtained in the western provinces of the Roman Empire. Our aim throughout this study is to discern how Roman practices evolved over time and discover whether a connexion between astronomical observations and urban layout existed, as can be inferred from ancient treatises[2]. All these aspects would furthermore contribute to better understand how the local customs of the indigenous peoples of all the lands of the Empire would affect the way they assimilated Roman practices, that is to say, how so-called Romanization worked in the different territories of the Empire and, particularly in this case, in frontier regions.

2. METHODOLOGY AND DATA SAMPLE

Since architecture was a key component in the consolidation of Roman power over the settled lands, we have analysed the orientation of a number of Roman cities and military settlements in modern-day Jordan, Syria, and Palestine.

The sample consists of the measurements of the azimuth and the altitude of the horizon of the main urban features of 13 Roman cities, as well as the main axes of 17 forts and fortresses built and occupied in Roman times (see Fig.1 and 2). In the case of the cities, those features are their principal streets, except for Philadelphia (present-day Amman) where we have considered the sides of the forum. Eight of these cities were originally part of the Decapolis, according to Pliny's list and were thus of Hellenistic origin. Although Roman cities in the East do not strictly fit the commonly assumed orthogonal layout (Castagnoli, 1971), they usually contain typical main streets: *cardus* and *decumanus*, running north-south

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[1] Pliny. Naturalis Historia 5.16.74. He mentioned Damascus, Philadelphia, Raphana, Scythopolis, Gadara, Hippos, Dium, Pella, Gerasa and Canatha.

[2] Frontinus De Agrimensura, 27 and Hyginus Gromaticus. Constitutio, 1.

and east-west, respectively. In those cases in which both types of streets are not clearly identified, we have considered the direction of a presumably important street, which would follow the leading orientation of the city.

In the case of the military settlements, there exist various architectonic styles in this region that differ from others found in the western provinces. Nevertheless, the playing card-shape design, common in Britain, is also present in the East to a lesser degree, as in Qasr el-Azraq surrounding the later fortification (Kennedy, 2004). There is also a lack of temporary camps, which are numerous in Britain. Additionally, there are several cases of re-occupation and re-adaptation of pre-existing settlements, sometimes without excessive modifications. This makes significantly complicated to specify which structures are properly Roman, or what was their period of construction (Parenti and Gilento, 2012). This is a problem in which archaeoastronomy could provide further information to that extracted from other archaeological works.

The data for eight cities and three military settlements were obtained in situ during a fieldwork campaign in Jordan performed in 2011 by members of our group. The instruments used were two tandems with a compass (error 0¼°) and a clinometer (error 0½°), and a GPS. The remaining site's azimuths have been measured with Google Earth, and the angular altitudes of the horizon by a digital reconstruction of the terrain, *HeyWhatsThat* (http://www.heywhatsthat.com). To determine the estimated error of these sites we have compared the data acquired in situ with the same measurements obtained by Google Earth and *HeyWhatsThat.* Based on these calculations, we have considered an average error of 1° for the azimuths and 0½° for the altitudes of the horizon. The azimuths measured with the compass have been corrected for magnetic declination with the calculator of the US National Geophysical Data Center (http://www.ngdc.noaa.gov/geomag/declination.shtml).

Assuming the existence of two axes, even in the cases in which one of them cannot be identified, we have considered four perpendicular orientations per site. We have divided the horizon into four azimuthal portions 90° wide so that, for a single site, each of its perpendicular azimuths matches one of those sectors. By this division, we consider a *decumanus* to be the streets within 45° to 135°, and 225° to 315°. The *cardus* would fall on the remaining azimuthal sectors, towards the north and south. On this basis, we classify the streets and avoid two perpendicular azimuths falling in the same division.

In addition, the '*decumanus* sectors' comprise the lunisolar range for Jordanian latitudes, that is, the azimuth of the sun at the solstices and the moon at its major standstills for an average latitude of the sample (Φ≈31°).

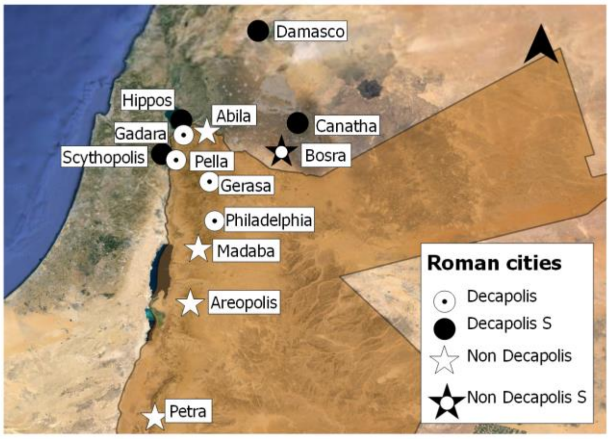

Figure 1. Roman cities of the sample.

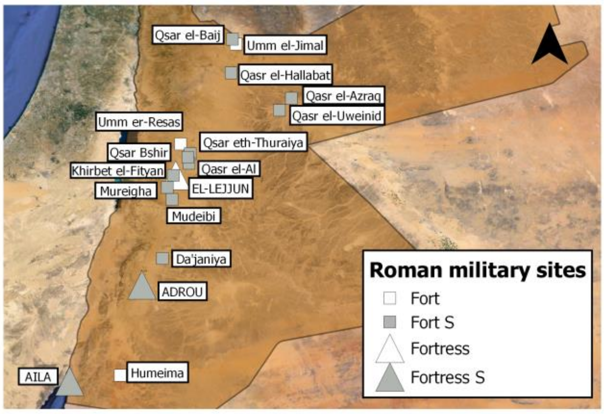

Figure 2: Roman military settlements of the sample.

In order to link properly these orientations with astronomical positions we have computed the declination for all the orientations. Knowledge of this astronomical quantity enables us to see how local topography affects the rising and setting positions of celestial bodies. Moreover, declination is independent of the geographical location. The estimated error for the declination of the data obtained in situ is 0¾°, while that for the places measured through satellite images and *HeyWhat'sThat?* is 1½°. This translates into an error of approximately 2 and 4 days, respectively.

All the data are given in Table I and Table II. Both tables provide a set of four perpendicular azimuths per site, the angular altitude of the horizon in those directions and the corresponding declination per sector. We have also introduced Petra, which is mostly Nabatean but contains Roman features, such as its colonnaded street.

2.1 Orientation of the sample

The azimuths of 13 cities are represented in an orientation diagram, where the four sectors and the solar and lunar extremes are indicated (see top of Fig. 3). It can be seen from the diagram, all the cities are within the lunisolar azimuth range. From these, all except Madaba fall within the solar range. The azimuths of this city fall on the southern and northern major lunar standstills towards the east (where the altitude of the horizon is 0º) and west, respectively. The non-Decapolis cities are concentrated around the cardinal points, and around the winter solstice towards the east, and the summer solstice towards the west. Two further azimuth groups may also be considered, one almost cardinal which comprises Damasco, Gadara, Canatha (three Decapolis cities) and Petra, and another around 114º composed of Areopolis (present-day Rabba), Hippos and Gerasa (present-day Jerash).

Regarding to the declinations (see Table I), at first sight we do not find that the cities follow any common trend but we can highlight some striking cases. Assuming declination values of ±24º for the sun at the solstices, there are three solstitially-orientated cities towards the sunset: Scythopolis, Gerasa and Pella. The first two look towards summer solstice sunset while the third one looks towards winter solstice sunset. We may also consider equinoctial orientations in the cities of the cardinal azimuth group, according to the estimated error in declination. For the second azimuth group (114º azimuth) we observe similar declinations towards the east for the three cities, and towards the west in Hippos and *Areopolis*. These last concur with sunset at the beginning of August, being the month of Augustus.

Concerning the military settlements, we count on the measurements of 17 structures, these being auxiliary forts and three legionary fortresses, but there are in total 18 sets of data due to the irregular shape of the *castellum* of Umm el-Jimal (Table II). Three of the sites were measured in situ: Umm el-Jimal, Umm er-Resas and Humeima. We estimate that our sample encompasses, at least, 40% of the measurable military sites in the region. Although we are conscious that further sites should be measured and that there are limitations on the data obtained with Google Earth, it is possible to make a first approach to the orientation patterns. In Figure 3 (bottom) the azimuthal distribution can be appreciated, with an accumulation around the meridian line. Four of the sites that share that orientation are relatively close.

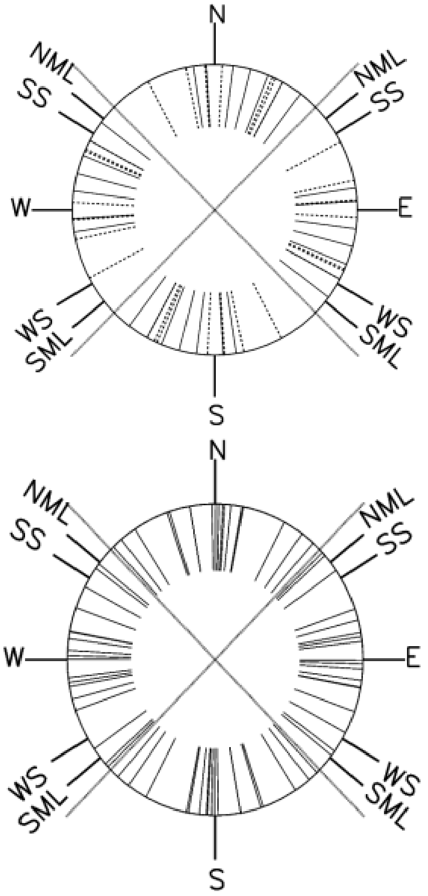

Figure 3: Orientation diagram of the Roman cities (top) and military settlements (bottom). Each short line gives the azimuth of one of their main axes. There are four directions per site, one per sector. The cities of the Decapolis are represented in dotted lines. The long dashed lines give the separation into four azimuthal sectors. SS and WS stand for sunrise and sunset at summer and winter solstice, and NML and SML stand for the northern and southern major lunar standstills, respectively, for an average latitude of the sample.

The declination has also been computed and represented in two histograms (Fig. 4) towards east and west. We chose a band pass of 2½º, considering an average between the systematic errors from the data obtained by fieldwork and satellite images. We have overwritten the declination distributions obtained from Roman military sites in *Britannia* (Rodríguez-Antón et al., 2016). The distributions obtained in the present study are broad with two main peaks that are more clearly defined in the eastern distribution. They correspond to the beginning of March and mid-October (δ≈-7º). The distribution is less defined towards the west, where such peaks blend. The maximum here would correspond to the beginning of April (δ≈4º) sunset. In both directions there are also smaller peaks beyond the solar range.

However, we should not lose sight of the fact that the sample managed in this study is not large. The histograms just show a first approach to the declination distribution, but the real data are more scattered with few sites looking towards these ‘relevant’ directions exactly.

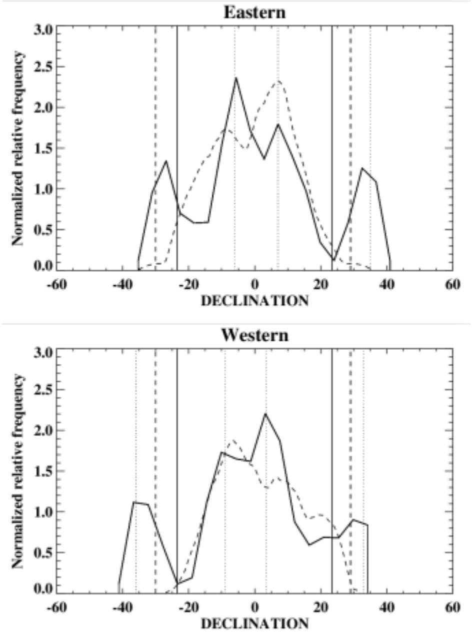

Figure 4: Declination histograms of Roman military sites in Jordan and Britain towards east (top) and west (bottom). The distributions indicated by a solid line are from Jordan and those distributions drawn with a dashed line are from Britain. Vertical solid lines indicate the extreme declinations of the sun, vertical dashed lines indicate the extreme lunar declinations, and vertical dotted lines indicate the solar declination for particular dates (see text for details).

3. DISCUSSION

3.1. Orientation of Roman cities

We have seen in the previous section that most of the orientations of the Roman cities in this area are within the solar range. But, getting into the results, we can extract some remarkable cases. Regarding the solstitial orientations, these would agree with similar results previously obtained in western regions of the Empire (Magli, 2008; González-García et al., 2014). Moreover, this pattern is also present in Nabatean monuments (Belmonte et al., 2013). According to the estimated error in declination, cities from the cardinal azimuth group mentioned in the previous section could be regarded as equinoctial. This orientation was also obtained in Greek (Boutsikas, 2009) and Nabatean temples (Belmonte et al., 2013), comprising both cultures the main cultural substratum that Romans found in this area. In fact, the orientation of the *cardus* of Petra, a city occupied by the Romans but of highly Nabatean nature, is almost equinoctial towards the east (δ=-1¼º) (Belmonte et al., 2013). This orientation could indicate that Romans did not transform the entire city plan in accordance with their precepts. Other evidence of the permanence of previous traditions would lie in the fact that some Semitic names, such as Gadara or Gerasa, were preserved. It seems likely that the local languages were the most spoken ones, remaining Latin and Greek been used as purely for administrative purposes.

Although urban development and population reached a maximum in Roman times, we should not forget that all the cities here studied had exist before the arrival of the Romans. They were simply transformed, to a greater or lesser degree, during that period. With this fact in mind, we find particularly interesting the orientation of Hippos, *Philadelphia* and *Areopolis* (present-day Amman and Rabba, respectively). These last two were the Iron Age cities of *Rabbath-Ammon* and *Rabbath-Moab,* respectively. The southern declination values of these three cities are almost orientated towards the rising point of Canopus (δ=-52¾º). This star, Arabic *Suhail*, has been a well-known celestial body for different cultures in the area since ancient times. We can appreciate its presence in previous architecture, for example, in the orientation of Nabatean buildings (Belmonte et al., 2013), as well as in the pre-islamic temple of *Ka'aba* in Mekka (Hawkings and King, 1982).

3.2. Orientation of Roman military settlements

Regarding to the azimuths of the military settlements, we found an accumulation around the meridian line. Four of those settlements in relatively close proximity. Nevertheless, rather than fully Roman structures some of them are considered by archaeologists to be previously existing sites re-occupied by the Roman army. That is the case for Qasr el-Al. There, a great deal of Iron Age and Nabatean pottery were found, and its structure is more likely to be from one of those periods (Parenti and Gilento, 2012).

The results obtained in the declination histograms seem remarkable since those orientations could be related to solar positions in March. During that month a number of festivities were traditionally celebrated in honour of Mars, a Roman god related to war. This was so at least in earlier Roman times, as mentioned in the Ovid's *Fasti* (*Fasti*, Book 3) and in the *Feriale Duranum*[3] (Espinosa et al., *at this voulme*).

The declination histograms of Jordan military sites (Fig. 4) seem to show that a March orientation is more likely to be towards the sunrise. The main peak towards the west is around the beginning of April, although there is also a secondary accumulation

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[3] Kal(endis) Ṃ[a]ṛtis ob c̣[e]r[imo]niạ[s natalicias Martis Patris Victoris (Papiry.info: Transcriptions of Feriale Duranum)

around the beginning of March. Compared to what was obtained in *Britannia*, the resulting distributions are similar but like a mirror image in each sector. That is, the peaks towards the east in Jordan match better with those towards the west in Britain, and vice versa. In the case of Britannia, we suggested that the direction of the beginning of March towards the west could be due to the high number of temporary camps in the sample (Rodríguez-Antón et al., 2016 *in press*). In that case, the hypothesis was that they were built when troops arrived at a new place at the end of the journey. So, in the case that they looked for solar orientations, they would take that of the sunset to establish the axes prior to starting the construction of the camp. This is not the case in the settlements in Jordan, where warfare activity and strategy were different, thereby resulting in the vast majority of the defensive settlements being made permanent.

3.3 *Comparing samples*

We have conducted a Kolmogorov-Smirnov test in order to broaden our understanding of the results and check whether the declination distributions for Britain and Jordan are drawn from the same parent population. This test checks whether the null hypothesis, that both samples are drawn from the same parent population, can be rejected. We obtained a probability of 0.84, thus we cannot reject that this condition is fulfilled. This does not confirm the null hypothesis either.

In addition, although orientations such as those considered equinoctial are not common in the western provinces of the Roman Empire, we obtained a number of solstitially-orientated cities in this study. These would be in line with what was extracted in Hispania (González-García et al., 2014) or Italy (Magli, 2008).

4. CONCLUSIONS

From a first overview of the results, we found that all the cities and most of the military settlements are orientated within the lunisolar azimuth range. Moreover, considering to the corresponding astronomical declinations, some of the resultant orientations are in accordance with what is observed in the western provinces of the Roman Empire as well as in some pre-existing native sites.

One remarkable distinction between this area of the Roman Empire and other provinces in the West is the different degree of urban development prior to the arrival of the Romans (Laurence et al., 2011). Whereas in some western areas urbanization really started after the Roman conquest, this was not the case in the Greek-speaking East. A perfect example are the Decapolis cities, of a presumably Hellenistic origin, as well as Petra and Bosra, both originally Nabatean cities. This fact could explain, for instance, the observation of almost equinoctial orientations in Damasco, Canatha, Gadara and Petra, which are non-Roman in origin. This orientation is practically non-existent in Hispania and Italy, and could result from Nabatean or Greek influence.

Taking all the above into account we may conclude that, in contrast to the general urbanization process in the West, here the previous cultural substratum played a major role in the cities layout. Even when Romans settled those cities and introduced their own distinctive features, they would not change the entire layout. This does not mean that they had nothing to do in the reorganization of the urban space but, in several cases, they probably limited themselves to adapting what they found to the Roman style.

In relation to the military settlements, we cannot reject the hypothesis that the declination distributions in Jordan and Britain are drawn from the same parent population. Furthermore, the vast majority of the elements of both samples are completely Roman buildings constructed with a common aim: military activity. The fact that in both cases the distributions show a tendency to cluster around dates in March is, at the very least, noteworthy. This fact constitutes added plausibility to the consideration that there could be traces of intentionality underlying the orientation of those sites, and, what is more, that the orientation could be relate to the position of the sun on those days that corresponded to the Roman army's religious feasts.

Considering the above and despite the potential role of the indigenous cultures, we cannot dismiss a possible continuity in the orientation patterns in both of these widely separated Roman territories that might have been due to the prevalence of a more ancient Roman practice still in use during the period in which all those settlements were erected.

All these considerations might have resulted from an attempt to maintain, in a greater or lesser degree, an Imperial identity in order to keep united all the distant pieces that formed the Roman puzzle.

Table I: Orientation for the 12 Roman cities in Jordan, Syria and Palestine. The places measured by Google Earth images are indicated by an asterisk. Each site is characterized by four azimuths (A1 to A4) and four altitudes of the horizon (h1 to h4), which means one per azimuthal sector. Also indicated is the latitude of the place (Φ) and the declinations computed in each azimuthal sector (δe, etc). Angular altitudes marked with asterisks were measured with a digital reconstruction of the horizon (http://www.heywhatsthat.com/), and declinations with a question mark have been calculated for a flat horizon (h=0º) because it was not possible to obtain a horizon profile in those directions.

Site	A1(º)	h1(º)	A2(º)	h2(ª)	A3(º)	h3(º)	A4(º)	h4(º)	Φ(º)	δe(º)	δw(º)	δn(º)	δs(º)
Damasco* (D)	356½	3*	86½	0*	176½	0½*	266½	2.3*	33.50	2.6	-1.8	59.1	-56.3
Canatha* (D)	3	0½*	93	3½*	183	2.6*	273	-0½*	32.70	-0.7	1.9	57.2	-54.8
Abila	351¼	--	81¼	-0.5	171¼	--	261¼	--	32.70	6.7	-7.7?	55.7?	-56.8?
Hippos* (D)	24	3¾*	114	--	204	0¼*	294	0.45*	32.70	-18.4?	20.0	53.2	-50.5
Gadara (D)	356	-0½	86	0*	176	--	266	-0½	32.60	3.1	-4.0	56.0	-57.7
Bosra*	14½	0½*	104½	--	194½	--	284½	--	32.52	-12.5?	11.8?	54.6	-55.2?
Scythopolis* (D)	28½	--	118½	--	208½	--	298½	--	32.50	-24.1?	23.4?	47.4?	-48.3?
Pella (D)	332	0.8*	62	16½	152	--	242	1	32.45	32.1	-23.0	48.4	-48.6?
Gerasa (D)	25½	2½	115½	2½	205½	2½	295½	4	32.30	-20.0	23.5	51.7	-47.8
Philadelphia (D)	348¼	13	78¼	1	168¼	5½	258¼	4.8*	31.90	10.3	-7.4	68.2	-51.1
Madaba	37	--	127	0	217	--	307	--	31.70	-31.1	30.4?	42.4?	-43.2?
Areopolis	22	0.85*	112	0*	202	0.85*	292	0*	31.20	-19.0	18.4	52.8	-52.1
Petra	7½	--	97½	10	187½	--	277½	7.5	30.32	-1.4	10.2	58.3?	-59.4?

Table II. Orientation for the 17 Roman military settlements in Jordan. The name given is the modern one. The places measured by Google Earth images are denoted with an asterisk. Each site is characterised by four azimuths (A1 to A4) and four angular altitudes of the horizon (h1 to h4), which means one per azimuth sector. Also indicated is the latitude of the place (Φ) and the declinations computed in each azimuth sector (δe, etc). Altitudes marked with asterisks were measured with a digital reconstruction of the horizon (http://www.heywhatsthat.com/), and declinations with a question mark have been calculated for a flat horizon (h=0º) because it was not possible to obtain a horizon profile in those directions.

Site	A1(º)	h1(º)	A2(º)	h2(º)	A3(º)	h3(º)	A4(º)	h4(º)	Φ(º)	δe(º)	δw(º)	δn(º)	δs(º)
Qasr el-Baij*	28	0¼*	118	0¼*	208	0*	298	0*	32.37	-23½	23.0	48.1	-48¼
Umm el-Jimal	3¾ 11	0 0½*	100¼ 109½	0.8* 0.7*	183.75 191¼	0*	280¼ 289½	0¼*	32.33	-8.6 -16.3	8.5 3.2	56.9 56.0	-58.0 -56.5
Qasr el-Hallabat*	327	0¼*	55	0½*	147	0*	235	1½*	32.09	29.0	-28.6	45	-45.7
Qasr el-Azraq*	36	0¼*	126	0*	216	0.2*	306	--	31.88	-30.3	-43.6?	42.2	29.9
Umm er-Resas	6¼	-0½	93	-0½*	186¼	-1*	273¼	-0½*	31.50	-2¼	2.6	57.0	.59.9
Qasr eth-Thuraiya*	0¼	0*	90¼	0*	180¼	0¼*	270¼	0¼*	31.50	-0.7	0½	58.0	-58.8
Qasr Bshir*	320½	0½*	47	0½*	140½	0½*	227	0½*	31.34	35.6	-35.6	41.2	-41.2
Khirbet el-Fityan*	1½	--	91½	0*	181½	0.7*	271½	1*	31.24	-1.6	1.6	58.1	-58.2
Lejjun	341	3	71	0½	161	11	251	3½	31.24	16.2	-14.6	55.9	-53.6
Mureigha*	350	0*	80	0*	170	1¼*	260	1½*	31.14	8.2	-8.1	56.8	-56.6
Mudeibi*	350	1¼*	81½	0¼*	170	0½*	261½	1½*	31.04	7.1	-6.7	58.1	-57.7
Da'janiya*	316½	1½*	46½	0*	136½	-0½*	226½	0.8*	30.50	36.0	-36.1	39.4	-39.4
Udruh*	358¾	--	83¼	-0½*	178¾	0*	263¼	1¾*	30.33	5.1	-5.1	59.1?	-60.2
Humeima	10½	-0½	100½	1	190½	0	280½	-1½	29.50	-8.8	7.9	57.8	-59.3
Qasr el-Al*	3	0*	97¾	0.1*	183	0*	277¾	--	31.50	-6.8	6.3?	57.9	-58.9
Qasr el Uweinid*	342	--	75¼	--	162	0*	255¼	0¼*	31.78	12.2?	-12.6	53.4?	-54.4
Aila*	41½	2½*	128	8*	221½	0¾*	308	2½*	29.53	-27.6	33.67	42.1	-40.5

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REFERENCES

Ball, W. (2000) *Rome in the East. The transformation of an empire*, Routledge, London

Beard, M., North, J. and Price, S. (1998) *Religions of Rome. Volume I. A History*, Cambridge University Press, Cambridge

Belmonte, J.A., González-García, A.C. and Polcaro, A. (2013) Light and Shadows over Petra: astronomy and landscape in Nabatean lands, *Nexus Network Journal*, Vol. 15, 487-501.

Boutsikas, E. (2009) Placing Greek Temples: An Archaeoastronomical Study of the Orientation of Ancient Greek Religious Structures, *Archaeoastronomy*, Vol. 21, 14-19.

Bowersock, G.W. (1983) *Roman Arabia*, Harvard University Press, US

Castagnoli, F. (1971) *Orthogonal Town planning in antiquity*. MIT Press, Cambridge, MA, U.S.A.

Espinosa Espinosa, D., González-García, A.C. and García Quintela, M.V. (2016) On the Orientation of Roman Towns in the Rhine Area. *Mediterranean Archaeology and Archaeometry,*at this volume.

Fishwick, D. (1988) Dated inscriptions and the Feriale Duranum. *Syria. Art et Histoire*, Vol. 65(3), 349-361.

Gilliver, C.M. (1999*) The Roman art of war*, TEMPUS, Stroud, UK

González-García. A.C. and Magli, G. (2014) Roman city planning and spatial organization. In C.L.N. Ruggles (ed.) *Handbook of Archaeoastronomy and Ethnoastronomy: Building bridges Between Cultures*, Cambridge University Press, Cambridge, U.K., 374-381.

González-García, A.C., Rodríguez-Antón, A. and Belmonte, J.A. (2014) The orientation of Roman towns in Hispania: preliminary results, *Mediterranean Archaeology and Archaeometry*, Vol. 14 (3), 107-119.

Hawkins, G.S. and King, D.A. (1982) On the orientation of the Ka'ba, *Journal of the History of Astronomy*, no.13, 102-109.

Kaizer, T. ed. (2008) *The variety of Local Religious Life in the Near East in the Hellenistic and Roman Periods*, BRILL, Leiden

Kennedy, D. and Riley, D. (1990) *Rome's desert frontier from the air*, B.T. Bratsford Limited, London

Kennedy, D. (ed.) (1996) The Roman Army in the East, *Journal of Roman Archaeology Supplementary Series* no.18, Ann Arbor

Kennedy, D. (2000) The Frontier of Settlement in Roman Arabia: Gerasa to Umm el-Jimal…and beyond, *Mediterraneo Antico. Economie Societá Culture*, Vol.3 (2), Instituti Editoriali e Poligrafici Internazionali, 397-453.

Kennedy, D. (2004) *The Roman Army in Jordan,* The Council for British Research in the Levant, London

Kennedy, D. and Bewley, R. (2004) *Ancient Jordan from the Air,* The Council for British Research in the Levant, London

King, D. A.(1995) The orientation of medieval Islamic religious architecture and cities, *Journal of the History of Astronomy*, no. 16, 253-274.

Khouri, R. (1986*) Jerash. A frontier city of the Roman East*, Longman group LTD, London and New York

Laurence, R., Simon Esmonde, C. and Sears, G. (2011) *The city in the Roman West c.250 BC – c. AD 250.* Cambridge University Press, Cambridge, UK

Magli, G. (2008) On the orientation of Roman towns in Italy. *Oxford Journal of Archaeology*, Vol. 26(1), 103-108.

Millar, F. (1993) *The Roman Near East 31BC-AD 337*, Harvard University Press, US

Moschek, W. (2009) The Limes: Between open Frontier and Borderline, In Fryde, N. and Reitz, D. (ed). *Walls, Ramparts, and Lines of Demarcation. Selected Studies from Antiquity to Modern Times*, LIT Verlag, Münster

Nock, A.D. (1952) The Roman Army and the Roman Religious Year, *The Harvard Theological Review*, Vol. 45(4), 187-252.

Papyri.info, The *Feriale Duranum* translations

Parenti, R. and Gilento, P. (2012) Limes Arabicus and still-standing buildings. In Vannini, G. and Nuccioti, M. (ed.) *La Transgiordania nei secoli XII-XIII e le 'frontiere' del Mediterraneo medieval*. Archaeopress, Oxford, UK, 111-124.

Parker, S.T. (1987) *The Roman frontier in Central Jordan. Final report on the Limes Arabicus Project, 1980-1989*, Vol. I-II, British Archaeological Reports. International Series340 (i), Oxford

Rababeh, S. et al. (2014) Colonnaded streets within the Roman cityscape: a "spatial" perspective. *Journal of Architecture and Urbanism*, Routledge, Vol. 38 (4), 293-305.

Raja, R. (2012) *Urban Development and Regional Identity in the Eastern Roman Provinces 50 BC-AD 250. Aprhodisias, Ephesos, Athens, Gerasa*. Museum Tusculanum Press, University of Copenhagen

Rodríguez-Antón, A., González-García, A.C. and Belmonte, J.A. (2016) Orientation of Roman camps and forts in Britannia: reconsidering Alan Richardson's work, *Sophia Centre Press*, 135-144.