ORIENTATIONS OF MONUMENTAL ARCHITECTURAL REMAINS AT KERKENES DAĞ

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ABSTRACT

ORIENTATIONS OF MONUMENTAL ARCHITECTURAL REMAINS
AT KERKENES DAĞ

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This thesis aims to investigate astronomical intention of the founders of the city at Kerkenes Dağ through architectural remains and city sculptures. The excavations result suggests the idea that the whole city was planned from an ideal urban concept containing all essential elements with their specified locations. In this study, possible astronomical intentions at Kerkenes is analysed through the examination of structural orientations in relation to the direction of astronomical objects upon the horizon where rising or setting point of prominent celestial bodies take place.

Keywords: Archaeoastronomy, Kerkenes, Phrygians, Analysing Orientation

ÖZ

KERKENES DAĞ'INDA BULUNAN ANITSAL MİMARI KALINTILARININ YÖNELİMLERİ

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Yüksek Lisans, Yerleşim Arkeolojisi

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Bu tezde Kerkenes Dağ'ında bulunan mimari kalıntılar ve heykeller Arkeoastronomik bir perspektiften incelenmiştir. Kazı sonuçları tüm şehrin ideal kent kavramı düşüncesinden yola çıkılarak planlandığı sonucunu akla getirmektedir. Bu çalışmada yapı yönelimlerinin, gök cisimlerinin ufuk düzlemi üzerindeki doğma ve batma noktaları ile olan ilişkisi incelenerek, bu ideal kent kavramının göksel olaylar ile olan olası ilişkisi analiz edilmiştir

Keywords: Arkeoastronomi, Kerkenes, Frigler, Yönelim Analizi

To My Parents,

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INTRODUCTION

Analysing archaeological materials from an astronomical point of view dates back to the late 1600's. However, the methodologies which provide quantitative study were emerged around 1880's. Today, this interdisciplinary study area is widely named as archaeoastronomy, and provides suitable environment to combine different scientific methods in order to analysis the interaction of ancient people with the sky, and understand their conceptual perception of cosmos.

How the sky was perceived and conceptualised are depended on particular culture. In other words, accumulated astronomical knowledge has a strong relation with culture. Therefore, archaeoastronomy conceives the sky as a cultural resource and product that the astronomical knowledge could be encoded in figures, religious practices, myths, monuments, sites and landscape.

This study will aim to examine whether there was an astronomical intention in the direction of structures and city sculptures in the Iron Age site at Kerkenes. The examination will be performed based on analysing the orientation of the selected structures and sculptures in relation to their directions toward the celestial objects, particularly stars and the equinoxes and solstices of the Sun, upon the horizon where rising or setting point of prominent celestial bodies take places. Results will be interpreted based on the ancient astronomical knowledge of the region while as considering cross cultural relationships.

The framework stream of the study begins with the explanation of what archaeoastronomy is, and the methods and analysis which are used in this interdisciplinary study area. Chapter III will cover description of the study area and identification of the site. A brief description and explanation for each architectural remain and city sculpture will be given in order to emphasise cultural content of the site. Analysis method and data table will be given in the third Chapter. Interpretation of the result will be discussed in Chapter IV. Chapter V will be devoted to the conclusion. In the appendices, reader could find the horizon profiles for each construction in Appendix A, sky views in Appendix B, and Turkish summary of the thesis in Appendix C.

CHAPTER 2

ARCHAEOASTRONOMY METHODS AND ANALYSIS

2.1. Archaeoastronomy

Celestial phenomena have always attracted attention of the human beings. The knowledge of celestial bodies' movements and its usage in daily life were as early as hunter-gatherers. Almost all hunter-gatherers had such an astronomical system which had been derived from observing movements of the celestial bodies.[1] Even though, ancient people did not understand the physical nature of movements nor explain the physical principals of its periods, they developed methods to observe and to measure celestial events. This complex knowledge required maintenance by specialists and was transmitted from one generation to another.

The main motivation behind this interest were dependence on natural phenomena, repeating rhythm of seasonal changes which affect the temperature, volumetric flow rate of rives, and vegetation cycle; regulate systematic social activities that includes performing religious ceremonies, maintaining political power and its reliability[2]; and the requirement for navigation on land and on sea, and to create a system of homogenous intervals of time.[3] Raevsky termed these two motivative requirements as the structurization of time and space, in order to orient in both dimensions.

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[1]Hayden and Villeneuve 2011: 332 – 334

[2]Steele 2015: 93 – 101

[3]Raevsky 1998: 299 – 300

Space and time are likely considered universal and objective perceptions rather than imaginary construction. They are considered as cultural products, products of thought, and they had been used as elements of social organisation that leads the societies.[4] According to Smedt and Cruz, recognising repeating rhythm of nature had an impact on human life and so did on artefact such as calendar which helped cognitive abilities of human beings evolved by allowing accurately predicting cyclical natural events, so then, past events could have been projected into the future more accurately than it was possible with episodic memory.[5]

One of the oldest probable calendars is an antler plague from Abri Blanchard in France, dated back to about 32,000 B.P. According to Jégues-Wolkiewiez, with a set of notches at the edges, this plaque was used as a lunar calendar which reflecting both the actual position of the Moon including azimuthal and zeniths position in the sky, and depiction of the phases of the Moon with some 70 morphologically differentiated cavities. Based on the shape and direction of the ellipsoid, she argued that it may have been showing specific seasonal lunar position and the new moon occurring at the vernal equinox.[6]

Another impressive example is the bone disks from Mas D'Azil (occupation of cave ranges between 17,800 B.C. to 6500 B.C.), Ariege in Frace.[7] This bone disk with a hole in the middle indicated that prehistoric people had a concept of basic compass by building a circle starting from the center and constant radius. This tool allowed to project shadow turning on disc surface by sticking a small gnomon in the center. The pattern of marks on the periphery of the disk created an axis which allowed counting an equal number of intervals on both sides of the hole. By putting a stick in the center and fixing it in the ground, it was turned into a sun dial with which

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[4]Iwaniszewski 2015: 3 – 14

[5]De Smedt and De Cruz 2011: 63 – 76

[6]Hayden and Villeneuve 2011: 333; Jégues-Wolkiewiez 2005: 43 – 62

[7]Jègues-Wolkiewiez 2012: 1 – 3, 8 – 9

one could find the direction of north. Furthermore, for some disks it seemed possible to measure space and time in two different places with concentric circles on them. Jégues-Wolkiewiez argued that memorising the link between light movements, the horizon, and time were man's first objectives.[8]

Paleolithic cave art provides further evidence for the prehistoric celestial knowledge that could be interpreted as time-markers to track seasonal changes for ritual practices[9] as well as evidence for human cognitive awareness[10]. Rock art is considered likely a cognitive artefact rather than a technological one. Thus, it held a message and involved subjective judgments, therefore, any interpretation of it is also considered speculative. From an astronomical point of view, the idea of representation of star patterns and counting calendar seems acceptable since the visible sky we see today is almost identical to that of 15.000 years ago with only exceptions of precessional changes.[11] Moreover, cave themselves could be considered as symbols of the darkness of the night sky. Jegues-Wolkiewies argued that caves and rock shelters which had decorations and were used for rituals had entrances aligned with solstice and equinox positions of the Sun (there are also some examples that the Moon was used to track the seasonal changes). On the contrary, there was no preferential alignment for the caves without decoration.

More than two thousand paintings found in The Lascaux cave, in France, consist of mostly animal images dated back to 15,000 years ago before the present. From an astronomical point of view, one of the painted bull with the spots was interpreted as a representation of the constellation Taurus and the spot above the bull's shoulder was identified as one of the brightest star, Pleiades. This painting is

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[8]Jègues-Wolkiewiez 2012: 9

[9]Marshack 1964: 743

[10]Murray 2015: 239 – 249

[11]Precession of the Earth is the change in the orientation of the rotational axis of the Earth by moving equinoxes westward along the ecliptic. The main reason is the pull of both the Sun and Moon on the Earth's equator. Precession causes stellar coordinates to change with time by 50.2 arc-seconds/year. For further reading Kelley, Aveni and Milone 2005: 66 – 67

considered as the first planetarium.[12] Moreover, the Lascaux cave and Bernifal caves, in France, are examples to early tracking of seasonal changes as they were illuminated at the summer solstice sunset through the entrance, and the Abri Castanet and Bison caves were illuminated at the winter solstice.[13] Blanchard cave and Combarelles Cave I are other examples that were illuminated at the equinoxes. A bone artefact found at the Blanchard cave reflects not only the shape of the Moon but also the pattern of the Moon movement on the celestial sphere with azimuth and zeniths position on the sky.[14]

However, from an archaeological point of view, recognition of identifiable constellations could just be an accidental match, indeed without a cultural indicator it is almost impossible to verify relation to an astronomical intention. Thus, when symbolic representations related to the celestial events were used, making reliable interpretation becomes much more difficult. Nevertheless, rock art is culturally universal and consists some common motifs such as human hand and food, and geometrical images. This universality of motifs could be result of inherent cognitive pattern of human mind or a cultural inheritance derived from sharing common tradition.[15]

It was the 5th millennium B.C. when the Neolithic people began to build monumental structures using massive stone blocks in the coastal areas from the Mediterranean to Ireland and the North Sea. Stonehenge is one of the well-known examples for monumental structures dating back to the Neolithic period with possibly an astronomical alignment. Based on the excavation results, Stonehenge (Stonehenge I dated back to ~3000 - 2500 B.C.; Stonehenge II, 2200 - 2000 B.C.; Stonehenge III, 2000 - 1100 B.C.) was designed for solar and lunar observation.

[12]North 2008: 4 – 5

[13]Hayden and Villeneuve 2011: 332 – 333

[14]Hayden and Villeneuve 2011: 333

[15]Murray 2015: 239 – 249

Aubrey Holes found at Stonehenge, for example, were claimed to have been used as eclipses predictor.[16] According to Marshack, Hawkings' computation on the alignment of Stonehenge embracing solar-lunar knowledge was an evidence showing the existence of an earlier, basic astronomical skill and tradition evolved through some thousands of years.

Astronomical knowledge was always associated with power. The predictivity of cyclical celestial events, particularly the ones that correlated with seasonal changes brought power and respect to those who were able to track the movements in the sky, and make interpretations about it.[17] Moreover, the sky had an important influence on the territorial conceptions. The way in which terrestrial space was conceived and organised was related to the way in which celestial space was perceived.[18] The most common examples are; use of directional preference in city planning and the orientation of sacred places. The preference could be based on the movement of a chosen celestial body through the horizon such as the Sun, Moon or a specific star. Stonehenge and the majority of the Egyptian temples are well known examples which were most likely positioned according to astronomical events.[19]

Celestial knowledge was also used to link contemporary rulers with their ancestors in order to strengthen collective identity of community possessing affiliation. For example, the Mayans emerged an astronumerological system to create ties between current events and the mythic past ones in order to manipulate national history to link rulers with significant historical events or myths.[20] Most of the myths involved both the celestial and terrestrial contents including sky-based ancestral heroes and heroines which were associated with particular places on the earthly

[16] Kelley [et al.] 2005: 187

[17] Krupp 2015a: 67 – 91

[18] López 2015: 341 – 352

[19] Hawkins 1974: 157 – 167

[20] Aldana 2007 in McCluskey 2008: 264

landscape. Ethnoastronomical studies show that the sky had an important emotional and cultural significance that depends on local interpretation.[21]

Iwaniszewski approached the ancient interpretation of principles of celestial movements as they were the structures of social organisations rather than mathematical abstracts. According to him, the movements of celestial bodies were interpreted as actions similar to human agents and it was believed that they acted according to the same principles of symbolic logic, in other words, their motions interpreted as social relations. Therefore, the sky was part of the social field of the human beings as bearing references for ceremonial rituals and daily activities. Myths, songs, depicted art and symbols in rituals and beliefs which were associated with celestial events were mnemonic devices that maintained collective representations of social relationships.[22]

2.1.1. Ancient Astronomy and its Relation with the Cognitive Evolution of Human Mind

People construct conceptual models of surrounding reality inferentially.[23] What ancient people perceived in the sky and how they conceptualised it are depended on their culture. Therefore, ancient astronomical knowledge could be considered as a cultural product which developed and integrated within a particular culture.[24] Anthropologists, in generally, define culture as system of beliefs and behaviours, a system of mental constructs.[25] Culture involves social learning that information is transmitted from one individual to another via social learning

[21]Johnson 2011: 291 – 297

[22]Iwaniszewski 2011: 30 – 37

[23]Handwerker 1989: 313 – 326

[24]Iwaniszewski 2005: 11 – 16; McCluskey 1993

[25]Handwerker 1989: 313 – 326

mechanism such as imitation, emulation and stimulation.[26] Consequently, culture is inherently cumulative that all the beneficial knowledge was preserved and accumulated over generations.[27]

This shared pattern of accumulated behaviour is directly depended on the cognitive capacities of people. As people affect the culture they produce, culture also has impact on individual cognition.[28] According to Changeux, cultural tradition had an indirect neurological instantiation that the pattern of brain use was programmed based on a cultural tradition. Therefore, the use patterns of individuals' brain from different cultures were fundamentally different.[29] Culture restructures the mind not only conceptually but also in terms of neurological networks. Donald argued that culture could literally reconfigure the use patterns of the brain.[30]

Clark described the mind as "storehouse of passive internal representational structures and computational procedures while as capable of receiving and manipulating external sensory information".[31] Ancient mind, that we can only trace through material remains, could be considered more likely as encoded in that material world. Prehistoric cognition, therefore, conceptualised the human mind primarily through the symbols of representation and information-processing.[32] And as the concept of mind was more than referring to specific modes of behaviour, culture was directly related with the material world. Artefacts provide people keep

[26]Mesoudi and Jensen 2012: 419 – 433

[27]Tomasello 2009: 5 – 7

[28]Donald 1991: 9 – 14

[29]Changeux 1985 in Donald 1991: 13

[30]Donald 1991: 13; Donald 2001: 259 – 262

[31]Clark 1997

[32]Malafouris 2004: 53 – 61

information by representing the world-views, which is inherently collective, related with the social norms and organised cognitively.[33]

The needs for managing competitive feasts and governing the society caused high dependence on natural phenomena which necessitated recognising repeating rhythm of seasonal changes. [34] For instance, hunting animals with high fat required tracing cyclical pattern of nature. The fundamental reason for emerging a calendrical system was to track this seasonal changes, and making plan in order to organise and maintain social activities.[35] According to Iwaniszewski, astronomical calendars had cultural significance.[36] Ambrose argued that social factors were involved in planning, and planning was considered as a unique human form of memory for mental time travel to the future.[37] Plans are generated via constructive memories through collecting past experiences (retrospective, episodic autobiographical memory), knowledge (declarative memory), and learned skills and actions (procedural memory). According to Ambrose, long-range strategic planning may have played important role in coevolution of social cooperation.

In order to record astronomical information, a conventional symbolic sign had been used.[38] De Smedt and De Cruz argued that artefacts such as bones, shell beads, ochre plaques which were used to represent numerical information, celestial body or sky view were earliest examples for storage of symbolic information outside the human brain, thus they considered Paleolithic rock art as a device serving like an

[33]Iwaniszewski 2015: 3 – 14; López 2015: 341 – 352

[34]Changeux 1985 in Donald 1991: 13

[35]Krupp 2015a: 67 – 91

[36]Iwaniszewski 2015a: 3 – 14

[37]Ambrose 2010: 135 – 147

[38]Raevsky 1998: 299 – 305

artificial memory system.[39] The ability of representing information through artefact allowed to store more information than one can perceive immediately.[40]

Symbols and icons were intentionally produced and understood as means holding ideational representations of references within specific culture which was emerged from different domain of human experiences along interactional creativity in many forms like art, religion, science, and political life.[41] Reading symbols and signs involve different structural arrangement of cognitive modules which are influenced by culture.[42] For instance, Late Copper Age and Early Bronze age Vucedol decorative art on fine ceramics with circular signs having star-like appearance were identified as constellations, planets or astronomical events. Silver ethnic marker Tuareg Crosses were also interpreted as associated with particular star cluster.[43] Representations of such celestial bodies and constellations were required a familiarity with the culture's iconography and standards of artistic representation. Therefore, any indigenous artefact that has an association with an astronomical phenomenon should be interpreted based on cultural concept of cosmos.[44]

The concept of cosmos and the world-views were encoded in mythological and ritual structures by being represented with a symbolic system which is an operating system of meaning and culturally recognisable.[45] It was believed that the

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[39]De Smedt and De Cruz 2011: 63 – 76

[40]Iwaniszewski 2015: 3 – 14

[41]Abrantes 2009: 480 – 486; Iwaniszewski 2015: 3 – 14

[42]Donald 1991: 9 – 11

[43]Pásztor 2015: 1327 – 1335

[44]McCluskey 2015b: 325 – 339

[45]Iwaniszewski 2015: 3 – 14; McCluskey 2015b: 325 – 339

stars and planets had meaning and significant for worldly affairs.[46] Iwaniszewski argued that the sky was interpreted as reflecting social concerns in both sense as providing meaningful information about how to organise social life and as the celestial bodies themselves were often believed to act like humans. So then, the patterns perceived in the sky referred to collective representations of social relationships, and he considered this relation as mnemonic devices.[47]

According to Raevsky, the mythological thoughts concerning to the celestial events strongly related with their perceptions of both nature and society. The sky was perceived as the home of gods and ancient astronomical knowledge was the reflection of mythology, thus, it was used to predetermine the fortunes.[48] Donald argued the importance of myth was that it was the earliest attempts of symbolic modelling of the human universe, and the coherent historical reconstruction of the past that encompassing events with a place and meaning.[49] According to him, myth governed the collective mind, and the stories could have been influential that it operated daily life.[50]

The perception of cosmos also directly influenced how ancient people conceived and ordered their terrestrial space.[51] Humans have a dialectical relationship with their material environment.[52] As well as artefacts, landscapes and settlements are also part of the material culture which was conceptualised as an integral part of the social life.[53] Nassauer emphasised the strong correlation between

[46]Campion 2015: 103 – 116; Iwaniszewski 2015b: 287 – 300

[47]Iwaniszewski 2011: 30 – 37

[48]Raevsky 1998: 299 – 305

[49]Donald 1991: 201 – 269

[50]Donald 1991: 295 – 298

[51]López 2015: 341 – 352

[52]Handwerker 1989: 313 – 326

[53]Iwaniszewski 2015c: 315 – 324

culture and landscape. He considered landscape as an artefact that changed culture, while as culture structured landscape pattern in both inhabited and natural landscapes.[54] According to Iwaniszewski, architectural remains and landscapes usually reflected a specific conception of the cosmos, of space and of time. For instance, astronomically oriented monuments or any other human activity related with celestial events could provide information about ancient people understanding of the cosmos.[55]

According to Wynn any trace of ancient people's actions derived from archaeological remains provided information about their aspect of cognition.[56] Astronomical interest of ancient people may not directly but indirectly affect the cognitive evolution of human mind through influencing culture. Archaeoastronomy as a scientific field studying the diversity of interactions between people and their interest in the sky, conceives sky as a cultural resources and product. Astronomical knowledge that was encoded in monuments, sites and landscapes are regarded as valuable and important as our cultural heritages.[57]

In this study, orientation preference of the structures and city sculptures in the city will be analysed in order to understand whether the direction was intended toward a specific celestial object. Any meaningful result could support the idea that the founder of the Iron Age city at Kerkenes had an interest in sky, thus the suspected celestial object itself could be considered as a key to link their traditional religious beliefs and rituals with their accumulated astronomical knowledge or may indicate the influence of other cultures on them. Result could be helpful to understand their perception of cosmos and mythological structures.

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[54]Nassauer 1995: 229 – 237

[55]Iwaniszewski 2005: 11 – 16

[56]Wynn 2002: 389 – 402

[57]Iwaniszewski 2005: 11 – 16; Iwaniszewski 2015c: 315 – 324

2.1.2. What is Archaeoastronomy?

Archaeoastronomy derives its name from the combination of archaeology and astronomy, and the term archaeoastronomy has been used since 1969.[58] This field is an interdisciplinary study area that includes archaeology, anthropology, ethnology, and mythology together with astronomy. [59] The professional research organisation, the Center for Archaeoastronomy, describes Archaeoastronomy as "a study of the astronomical practices, celestial lore, mythologies, religious and world-views of all ancient cultures". [60] Hawkins used the term "astro-archaeology" to name studies that sought evidence for impact of astronomical events on archaeological finds[61], and later Thom preferred to use the term "Megalithic Astronomy"[62] for his studies. On the other hand, MacKie who questioned Thom's theories through traditional archaeological methods, preferred to use the term "Archaeoastronomy" which is more widely used to describe this interdisciplinary study area today. [63]

There are still debates whether Archaeoastronomy should be considered as a single discipline or a sub-discipline of Archaeology, but, it was never considered as a field of Astronomy. [64] Bostwick emphasised that the objective of the studies are archaeological remains and finds, therefore, they need to be studied within their

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[58]Ruggles 2005: 20

[59]Carlson, Dearborn, McCluskey and Ruggles 1999

[60]Official web site of The Center for Archaeoastronomy http://terpconnect.umd.edu/~tlaloc/archastro/cfaar_as.html

[61]Hawkins 1968: 45 – 88

[62]Megalithic Astronomy concerns the astronomical significance of the megalithic monuments, particularly of Britain and Ireland. However, this term is inadequate due to the fact that prehistoric communities were able to built structures in earth, timber and other materials beside the stone structures which are more higly stood still until today. For further reading Ruggles 2005: 248

[63]Baity et al. 1973: 390

[64]Polcaro and Polcaro 2009: 223 – 224

cultural context by archaeological methods. [65] Judge also agreed and added that Archaeoastronomy should be developed within Archaeology. On the other hand, some scholars agree that to prove astronomical interest of an ancient culture; archaeological, historical and anthropological data are not necessary but could be used to support the results. [66]

In any case, whether a single discipline or a sub-discipline, all scholars agree that Archaeoastronomy is an interdisciplinary study area and the main purposes of this field are to understand what ancient people experienced and how they interpreted astronomical phenomena; how they observed and measured these phenomena; how they used this knowledge in their daily life and how their culture was affected by it. Ruggles defined Archaeoastronomy as the study of beliefs and practices concerning the sky, particularly in prehistory, and the uses of astronomical knowledge.[67] Archaeoastronomical studies do not only concern with the spatial patterning and monumental constructions but also with artefacts, iconography, inscriptions, historical documentation, and written accounts that revealing evidence of ancient human perceptions and actions relating to the celestial phenomena.[68] Study results provide new perspectives for the history of human race and their interaction with the cosmos.

Since archaeology developed from ancient history in Europe and in America it is considered as a sub-discipline of anthropology. The fundamental difference between European and American ways to approach to archaeoastronomy occurs in terms of the nature of the archaeological evidences and practices.[69] Brown Archaeoastronomy is a term to describe the study that alignment is not primarily

[65]Bostwick 2006: 1 – 10

[66]Aveni 2006 in Ruggles 2015a: 353 – 372

[67]Ruggles 2005: 19

[68]Ruggles 2011: 1

[69]Salt 2015: 213 – 226

focus of it, instead, it concerns much broader range of evidences form humanities and social science disciplines such as history, cultural anthropology, ethnography, history of religions, and so on. This approach emerged in North America focusing particularly in native North America and pre-Columbian Mesoamerica, in archaeoastronomy during the 1970s.[70]

Green Archaeoastronomy, on the other hand, is a term to describe the study primarily focuses on developing procedures in order to analysis the possible astronomical alignment of monumental structures. Study also involves determining criteria for data selection and filed work methodology, and developing statistical analysis for the result in order to verify intentionality of the alignments. This approach emerged in Britain during the 1970s to analysis megalithic alignments considering the debate between archaeologist and astronomers on Thom's works.[71] The main difference between Brown and Green Archaeoastronomy, therefore, can be termed as statistical and multidisciplinary approaches. This leads to divide the approaches as formal and informed.

An astronomical perspective to analysis an archaeological concept is not limited to ancient techniques and instruments. It can also deal with concept and predictions. The standard questioning to ancient observation, and their analyses have not been emerged through a determined perspective of modern astronomy, instead, through varying perspectives of local astronomical concept that had developed in specific times and places.[72] For instance, Babylonians used a numeric system based on a scale of sixty derived from Sumerians. Babylonians divided daylight into twelve equal parts and night as well. They have a 12 double hours that each divided into 30 parts, and one of which was thus 4 minutes of our time. They observed the cycle of eclipses, of 18.03 years (more exactly $6585^{1/3}$ days). By the 8^{th} century B.C.

[70]Ruggles 2005: 52

[71]Ruggles 2005: 169 and 2015: 355

[72]McCluskey 2015a: 227 – 237

Babylonians used as 8-year-period (99 synodic months), and later they started using a 27-year period (334 months) but the most widely used period was equal to 19 years (235 months).[73] Maya used two different calendar systems called the Haab and Tzolkin calendars. The Haab was a civil calendar based on the solar year and consisting of 18 months of 20 days each together with 5 additional days at the end. The Tzolkin was a religious calendar consisting of two cycles; a 13-day count and a cycle of 20 names, and it was used for prediction of human destiny and to determine cultivation time.[74]

Archaeoastronomy is not well represented in introductory archaeology courses at the universities or study text books. The study area still continues to be underappreciated by some archaeologists. Nevertheless, following the evolution in archaeology from the culture historical approach to the processual approach, then to the postprocessual approach, the status of the archaeoastronomy has been changing.[75] The awareness of archaic astronomy began with the release of astronomical connotations of Stonehenge. Astronomical aspect of the ancient world has been considered an exotic part of the ancient periods and attracted the attentions of popular culture as well, increasingly from the beginning of the twenty-first century. Unfortunately, the variety of pseudoscientific enterprises in popular culture made archaeologists approach it unwillingly and sceptically.[76]

The objective of Archaeoastronomy is also associated with history of astronomy. Since ancient records of past astronomical events could be used to understand today's certain astronomical problems such as variations in the length of the day; fluctuations in the mean motions of the Moon, Sun and planets; and tidal

[73]North 2008: 36 – 64

[74]Dershowitz and Reingold 2008: 137 – 145

[75]Fisher 2015: 251 – 261

[76]Krupp 2015b: 263 – 285

friction.[77] Besides that, the most common interests were in the positions of equinoxes and solstices of the Sun, and the movement of the Moon. Planets, stars and constellations were also observed and monuments were built to mark certain positions of specific celestial bodies. Even observed eclipses, comets and other astronomical phenomena like supernovae were memorialised in different ways.

For an accurate monitoring of movements of the celestial bodies, trees, posts or rock alignments, caves (etc.) were used, and monumental buildings were built in regards to a specified orientation. Therefore, the studies mainly concentrated on detection of the alignment with the horizontal points where the movement starts and ends on the sky. But calculation of an alignment and statistical result do not remain the only aim of archaeoastronomy. As archaeology moves beyond processual point of view, archaeoastronomy also moves beyond the simple calculations and statistical data. So then, archaeoastronomical studies do not only concern the ancient techniques and instruments but also involve concept and prediction.[78] By analysing material artefacts, architectural remains, and written and oral sources that were shaped by common cognition, it enlightens the connection between myths, religion, philosophy, science and political organisation in ancient cultures.

Today, archaeoastronomy develops different scientific methods in order to enlighten the interaction of ancient communities with the sky and brings together various research tools from different specialisations, and allows us to make interpretation by combining archaeology with other disciplines to understand history of our past.[79] As a result, we are not only able to detect how ancient people observed and measured periodical movement of the celestial bodies, but also able to analyse their perception of cosmos and conceptual landscape.

[77]Stephenson 1997

[78]McCluskey 2015a: 227 – 237

[79]Iwaniszewski 2005: 11 – 16

Nowadays it is suggested that not only the ecological and economical aspects of human history but also cognitive state of ancient communities could be examined using scientific methods. New inventions, which were considered as reflections of enhanced creative abilities, are indicative examples to understand how mind functions. The interest of the sky could be associated with the common cognitive status of an ancient culture which had been developed by transmission of knowledge from one generation to another, and from interactions with other culture(s). And observation methods and techniques developed through time could help us to explain their underlying cognitive process.[80]

2.1.3. The history of Archaeoastronomy

Archaeoastronomy dates back to the late 1600's and early 1700's. Aubrey[81] (in 1678) and Chauncy (in 1700) both noticed that Stonehenge had specific orientations in relation to the movements of the celestial bodies. Later, in 1740, Stukeley examined Stonehenge and attempted to associate the alignment of the monuments with astronomical phenomena, and he used astronomical dating methods[82] to estimate the date when the structure was built. [83] Aubrey and Stukeley[84] proposed that it was a Druidical temple in 1743.[85] In 1771, Smith claimed

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[80]Gabora 2007

[81]The Heritage Journal web site, https://heritageaction.wordpress.com/2013/03/12/antiquarians-john-aubrey-1626-1697/

[82]Astronomical dating is a dating method using modern astronomy to calculate the best day which fit with the alignment toward an astronomical target. Ruggles 2005: 27

[83]Atkinson 1982: 112

[84]Stukeley 1740

[85]Nilsson 1866: 245

Stonehenge as an astronomical temple, and in 1796, Wansey emphasised the precession of the equinoxes through Stonehenge.[86]

In 1880s, archaeologist Petrie made the first quantitative study, which focused on the alignments toward the solstice at Stonehenge[87] and estimated the construction date of Stonehenge by considering precession.[88] Higgins also dated Stonehenge by astronomical dating method in 1827. Fourteen years later, an astrophysicist Lockyer introduced a methodology, and established the fundamental principles of archaeoastronomy to detect astronomical alignments.[89] Later, he was called the father of archaeoastronomy. In 1890, Nissen, Lockyer and Penrose measured and studied the orientation of a number of Greek temples on the Greek mainland, the islands, the Ionian coast and South Italy. Their work was the beginning of the archaeoastronomical research in Greek.[90] In 1869, Nissen brought forward the idea that the Greek and Roman temples had varying orientations due to the fact that they were built at the different days and aligned, therefore, towards different directions. He also extended his works to Mesopotamia.

In 1912, Somerville moved archaeoastronomy one step forward by directing the attention on the effect of astronomical knowledge on culture with his research on a considerable number of megalithic buildings aligned accordingly to the Moon cycle in Callanish.[91] His studies were also considered as a guide for many research projects investigating astronomical orientation of prehistoric European, Mesopotamian and pre-Columbian as well as Egyptian sites. The studies created further excitement in

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[86]Smith 1771 in Dinsmoor 1939: 97

[87]Polcaro and Polcaro 2009

[88]Dinsmoor 1939: 97

[89]Carlson et al.: 6 – 7; Dinsmoor 1939: 97

[90]Papathanassiou 1994

[91]Polcaro and Polcaro 2009

1960s when astronomer Hawkins argued that Stonehenge was used as an observatory in the Neolithic period in order to determine the movements of the Sun and Moon as well as other astronomical phenomena. However, his analysis disregarded its context.[92] Avenie worked on pre-Columbian astronomy in Mesoamerica around 1980 and concluded that some Mesoamerican monuments were built to observe Venus.[93] He discussed the social context of astronomical practices, while Hawkins and Thom tried to demonstrate the use of astronomy in culture.[94] Thom investigated almost 250 megalithic sites in England and Scotland and made statistical examinations. He discovered that there was some relation between astronomical alignments and in the plans of the megalithic structures. They were mostly arranged in circles of standing stones and oriented based on the periodic movement of the Moon[95]. Krupp, Ruggles, Bates, Dearborn, Bender, and Marshack are among contemporary scientists who have been working on archaeoastronomy.

2.2. Archaeoastronomy in Anatolia

2.2.1. Structural Analysis of Enclosures in Göbeklitepe Through Archaeoastronomical Perspective

There are very few research studies done on archaeoastronomy for ancient Anatolian cultures. Göbeklitepe is one of the earliest sites dated to 9500 – 9000 B.C. It is believed that the site was used as a sanctuary and not for habitation, since no residential buildings have been discovered yet. It consists of several megalithic enclosures in circular shape with T-shaped standing stones. There are two types of structures detected; one is a modification of the other. Discovery of the site changed

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[92]Polcaro and Polcaro 2009: 223 – 245

[93]Aveni 1982

[94]Salt 2015: 213 – 226

[95]Thom 1955: 275 – 295

todays' understanding of the ancient process of sedentism and the beginning of agriculture. According to Schmidt, the site was a regional centre where the complex rites had been performed, and it was rapidly buried after use. The T-shaped pillars with arms and hands carved on them, have drawn most attention, and they were interpreted as human-like beings. Most of the pillars were decorated with reliefs often with animals figures (like as felines, foxes, boars, vultures, spiders, snakes, and scorpions) and some symbols (mainly in the form of the letter H, crescent, discs and antithetic motifs). The ancient people, who built these megalithic enclosures, must have had a common knowledge of symbolic concepts, so they could produce, read and interpret them.[96]

The parallel alignment of the twin central monoliths leads the researches to look for possible alignment towards celestial bodies. First in 2006, Collins suggested possible alignment of the twin pillar towards Deneb, the brightest star in the Cygnuc constellation[97], in 2012, Schoch proposed the three stars of Orion's belt as a target of the alignment in his book[98], and in 2013 Magli propounded Sirius for the motivation of orientation.

Magli is an Italian astrophysicist who is interested in archaeoastronomy, particularly, the relationship between architecture and the celestial interest. He proposed that they were built to observe the brilliant star Sirius which appears in the southern sky.[99] He started his research based on the similarities with the sanctuaries of Menorca built some 8000 years later than Göbeklitepe. At Menorca, sanctuaries are oval-shaped enclosures centered on a huge T-shaped object, and they were claimed to have oriented towards the brilliant stars of the southern sky, called Crux in the Centaurus constellation. Thus, the earliest research done by Belmonte and Garcia

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[96]Schmidt 2010: 239 – 256

[97]Collins 2006

[98]Schoch 2012: 38 – 57

[99]Magli 2013

in 2010 showed that in Göbeklitepe, there is a rectangular building which was oriented to the cardinal points. In the light of these arguments, he sought possible stellar-based orientations of enclosures.

According to Magli, the structures were not proper for observations of Orion or for Cygnus constellations on the ancient sky due to the fact that the enclosures are south-east orientated. Instead, he suggested Sirius was the target of the observation, the brightest and new star on the southern sky which was come to closer to the horizon and became visible on the sky around the 15000 B.C. To prove his argument, he analysed the orientation of Structures D, C and B by regarding altitudes of the structures and azimuths of Sirius through time passed. Analysis results showed that Sirius could have been observed from Structure D at around 9100 B.C., from Structure C at around 8750 B.C., and from Structure B at around 8300 B.C. However, his result ignored the actual chronological order of these three structures. Magli concluded his paper by arguing that Structure F with an estimated azimuth of 59° could have been used to observe rising sun at the summer solstice if it had an opening to the north-east direction.

Collins and Hale also investigated the Enclosures built at the Göbeklitepe. They claimed Magi to ignore atmospheric extinction for visibility of Sirius, and its diurnal arcs when the structures had begun to be constructed, and in their later paper for ignoring atmospheric refraction.[100] Sirius' usual magnitude diminished due to atmospheric extinction since it reappeared low on the south horizon from the latitude of Göbeklitepe since c. 15.000 B.C. After using mathematical calculation for dimming affect of atmosphere on a light of star, the mean value for the altitude at which Sirius become visible is 0,6°. Thus, the daily rotation of Sirius on the sky during night was just 20 minutes around c. 9300-9000 B.C. Therefore, Collins and Hale assumed that Sirius could have been the target object for an altitude of 0,5° because of having a magnitude of 6 at an altitude of 0,5°, which meant that the star

[100]Collins and Hale 2013

could barely be observed by naked eye, due to the fact of atmospheric extinction and atmospheric refraction.

Moreover, they also remeasured the azimuths values of Structure B, C and D. Result differed from those of Magli's. Then, new visibility calculation for Sirius was done by regarding these new azimuths values. Results are for Structure D at around 9400 B.C., for Structure C at around 8950 B.C., and for Structure B at around 8275 B.C. For the date 9400 B.C., Sirius was barely visible to the naked eye during its transit on the southern horizon. Only around 8275 B.C., the star reached an altitude of 6°. Although, radiocarbon dates for Structure B ranged between 8306-8236 B.C., Schmidt and Dietrich proposed that those three structures were probably contemporaneous.[101] Collins and Hale also rejected Magli's acceptance of a southern orientation, instead they proposed northern orientations for structures, and the target for Structure C and D was Deneb, the brightest star in the Cygnus constellation.

In another paper, Collins and Hale discussed Magli's argument, and they suggested that not only atmospheric conditions but also topographical features of the Structure C must have obstructed the visibility of the star by 8950 B.C. The radiocarbon dates derived from the human bones in imported soil found in Structure B and its place on bedrock gave rise to the thought that Structures B,C and D had been all constructed at around 9000 B.C. Consequently, orientation towards Sirius seems not convincing. Instead, they defended Deneb and the Dark Rift as targeted celestial objects for the orientation direction of the monument towards to northern sky.[102]

They assumed that the orientation direction should have been adopted from cult tradition of previews cultures of the Proto-Neolithic Age. Based on this idea and Brian Hayden's inference on northern directional preference of Hallan Çemi culture, they proposed orientation direction toward North as being related to the direction of

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[101]Schmidt and Dietrich 2010: 82 – 83

[102]Collins and Hale 2013

liminal activities and supernatural agencies. Regarding the preference of northern orientation, Collins and Hale remeasured the three structures B, C and D, and concluded that the star Deneb in the Cygnus constellation was strong candidate for target object to have been observed around c. 9400 – 8900 B.C. They interpreted the choice of Deneb as marking the opening of the Milky Way's Dark Rift, also known as Cygnus Rift, an entrance to the sky-world, the place for afterlife.

The Pillar 43 in Structure D was brought forward as evidence to support their idea. The images carved on the pillar were interpreted as the bird representing the Cygnus constellation, and the scorpion representing the constellation Scorpius.[103] These constellations are found at the top and bottom of the Milky Way's Dark Rift. Moreover, another stone with a hole on it facing towards the twin central pillars was placed in a way that it could have been used to observe the setting of Deneb by anyone who stood between these two pillars around c. 9400 B.C.

The Structure F, on the other hand, was oriented towards the sunrise at the time of summer solstice. They associated the twin lion reliefs at the Lion Pillar with the constellation Leo. They were both oriented towards sunrise at the time of equinoxes, and constellation of Leo would have risen into the sky immediately prior to the Sun at the time of the spring equinox. According to Collins and Hale, it was the first time the Sun was a primary motivation for the orientation direction with the introduction of subsistence agriculture by c. 8500-8000 B.C.[104]

In 2014, De Lorenzis and Orofino confirmed Collins and Hale's argument concerning the target of the orientation by using Cartes du Ciel software which uses different calculation algorithm for measuring atmospheric extinction and for the position of the star in remote past epochs. They also analysed orientation of the Structures E, F and G in which two large T-shaped pillars had been placed in the

[103]Belmonte 2010: 2052 – 2062

[104]Collins and Hale 2013

centre.[105] They regarded the behaviour of the Earth's orbit including the affect of gravitational perturbations on it for the reconstruction of the change of the rising azimuth of the celestial objects. They found Collins and Hale's hypothesis on the orientation of Structure F towards the summer solstice unreliable, and they suggested that Structure F was aligned in the direction of the sunrise on the 41st day after the summer solstice, the day of the Harvest Festival about 8400 B.C. that may be connected with the newly starting agricultural activities of the builders.

They also analysed Structure A oriented northwest-southeast (or vice versa) with azimuths of 132° and 312°. Lorenzis and Orofino wanted to search for possible orientation towards the stopping points of the Moon, also called the lunar standstill[106] based on the consideration of similar orientations that had been intended by ancient observers. They assumed a reference date as 8500 B.C. by regarding Dietrich's carbon-14 results for the finds found in the imported soil of the Structure A[107] in order to obtain a precise date for computing the sky view of the time and the location of the Moon in the sky when the structure was built. According to their result, the azimuth of the Moon, when it was in its extreme lower standstill, was found to be equal to 130° which is close to the azimuth of Structure A. Consequently, they concluded that Structure A was oriented with respect to the minor lunar standstill.

2.2.2. Structural Analysis of Architectural Remains in Karahan Tepe Through Archaeoastronomical Perspective

Karahan Tepe, extended over an area of 60000 m^2, and it was located in the high region on Tektek Mountains plateau within the boundaries of Şanlıurfa. Karahan

[105]De Lorenzis and Orofino 2014

[106]The phenomena is termed as geocentric extreme declination of the Moon in archaeoastronomy by Ruggles (1999). Lunar standstills occur twice every nineteen years when the Moon is in middle transit between its southern and northern extreme points while it meets the horizon. Sims 2006: 157 – 163

[107]Dietrich 2011

Tepe was a single period settlement dating back to the Pre-Pottery Neolithic (ca. 9500-600 B.C.) and like at the other sites Göbeklitepe, Nevali Çori, Taşlı Tepe and Hamzan Tepe,[108] the site has similar T-shaped stone pillars erected in rows including two snake reliefs, one bird-shaped relief (other animal figures as the head and forelegs of a rabbit, the hind legs and tail of gazelle, and the hind legs of an unidentified animal), and three pieces of stele with human-shaped arms reliefs carved on them.[109]

Collins commented that, climbing toward the summit of the hill, the sunken pillars appeared as a stone avenue with an orientation towards north-northeast to south-southwest direction. He detected at least three avenues consisting of pillars aligning towards the same spot, and other pillars either lying outside of the avenues or with a different orientation's direction. The northerly-placed hill, called Keçili North Tepe, was located exactly 1,6 km way from Karahan Tepe with azimuths 338° and 339,63° was claimed to have been used as a backsight[110] by someone standing on Karahan Tepe. He suggested that Karahan's northern knoll might have been used for celestial observation in relation with Keçili North Tepe. [111]

Based on Hale's examination results on the case, the bright star Deneb in Cygnus constellation, represented as a bird, could have been the target object between ca. 8685 B.C. and ca. 8375 B.C., when it set into the hill summit's eastern edge of Keçili North Tepe with an azimuth of 345,25°, and western edge with and azimuth of 338°. The star would have set into the middle of the hill in ca. 8550 B.C. All these three dates were coherent with the occupation period of the site.[112] As

[108]Çelik, Güler and Güler 2011: 227

[109]Çelik 2011: 241 – 253

[110]By Collins, backsight is used to term a sanctuary place from where observation of rising or seting of a celestial object are made toward a foresight.

[111]Collins 2014

[112]According to Çelik, Karahan Tepe was inhabited only during the Pre-Pottery Neolithic period. Çelik 2011: 241 – 253

mentioned earlier, according to Collins, Milky Way was considered as the entrance of the afterlife, the cosmic womb of the souls, and Deneb marked the northern opening of the Milky Way's Dark Rift. Therefore, the constellation Cygnus was probably represented as bird, swan, goose eagle or vulture in regards to the transmigration of the soul in myths and legends. He concluded with proposing the idea that Karahan Tepe builders may have adapted the stellar-based belief system from Göbeklitepe.

2.2.3. Archaeoastronomical Researches on Hittites

In 2007, Erginöz studied the astronomical knowledge of the Hittites through the cuneiform tablets.[113] The existence of the Hittites in Anatolia is dated back to the 19th -18th centuries B.C., and the Hittites established a kingdom governed around 1600 B.C. with a capital in Hattuşha. According to Erginöz, Hittites' knowledge of astronomy was influenced by Mesopotamian cultures, particularly by Babylonian astronomy. Copies of Babylonian astronomical diaries were found in the Hittites' archives in Hattuşha. Hittites related celestial bodies' movements with the divinities, and interpreted them to make prediction about future as the Babylonian did by using horoscopes.[114] They translated some Babylonian omens into their language, and observed the movements of the planets to generate a horoscope. The cuneiform tablets found in the archives in Hattuşha are not directly related to astronomy but mainly to omens and associated celestial events including solar and lunar eclipses. Their mythology also consisted of interpretations of astronomical events, and some

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[113]Erginöz 2008: 199 – 213

[114]Babylonian divination have a cosmic characters and movements of the celestial bodies were considered as their behaviours. By this means it was used for determining the fate as horoscope. The oldest known horoscope was found at the Babylonian temple and dated back to 410 B.C. There were two kind of astronomical diaries: Enuma-Anu-enil tablets contains also omina from the beginning of the 1st millennium which associated with astronomical phenomenon; and MUL-Apin only contains of astronomical knowledges including constellations in the path of the Moon, the planets, and list of stars. Astrological interpretation of the eclipses had influenced especially on their political life. All the eclipses had been analysed based on the Mesopotamian astrological theories by regarding such variables like date, the eclipse area, direction of the wind, eclipse type, and the presence of the planets during the event. Neugebauer 1947: 37 – 43; North 2008: 36 – 66; Aaboe 1980:14 – 35; Sachs 1974: 43 – 50

of their festivals were related to the seasonal changes relevant to difficult environmental conditions of Anatolia during that period. Their motivations were not only derived from the need of predicting seasonal conditions such as drought, but also from the desire to be protected from natural disasters by organising festivals for their deities. Hittites had also cult ceremonies on specific days of the years, therefore, it was important for them to maintain an accurate calendar.

In 2011, another study on Hittite culture was conducted by Gonzalez-Garcia and Belmonte.[115] Their study was based on statistical analyses of orientations of Hittite monuments, and compared the results with the Phrygian monuments, especially with religious monuments in order to understand transition of orientation customs from the Late Bronze Age to the Early Iron Age. They started their research first by determining possible celestial bodies as a target object for orientation of the monuments through a consideration of Hittite religion within its Anatolian context. Besides the Sun and the Moon, Venus and Mercury were the other candidates for the possible direction of orientation, and the Pleiades was the only evidence for a stellar cult in Hittite culture. The constellations, on the other hand, were briefly mentioned in the context of rituals that were celebrated during the "purulli" festival. Gonzalez-Garcia and Belmonte interpreted the Hittite monument Eflatun Pınar as a representation of a Hittite cosmogram where the supreme gods of the pantheon, the Sun goddess of Arinna, and the storm-god of Hatti, mountain gods were figured with bull-head genii sustaining the sky above.

Gonzalez-Garcia and Belmonte also examined the cultic calendar of the Hittites in order to estimate the proper time for the special festivals dedicated to deities, and to make a list of possible important dates for the orientation. Besides the annual festivals, Hittites also had some festivals that were celebrated over longer period of cycled time. For example, the festival of the god Telepinu was celebrated every nine years. Some of the most important Hittite feasts were AN.TAH.SUM that was dedicated to the supreme gods of the land the Sun goddess of Arinna and the

[115]González-García and Belmonte 2011: 461 – 494 and 2015: 1783 – 1792

Storm god of Hatti, and some other important gods and goddess; the Nuntarriyashas feast; and Purulli believed to be related to the original Hattic new year feast.

Since the Hittites did not have funerary architecture in monumental scale, Gonzalez-Garcia and Belmonte decided to make their statistical analysis on the temples, shrines, monumental gates including the gates which had a relevant ritual and symbolic character in the border of Hattusha, Yazılıkaya, Alaca Höyük, Karatepe, and the Ain Dora in northern Syria. According to their analysis, the most significant choice was for solar orientation, followed by the winter solstice. They possibly calculated their calendar by lunar months.[116] Gonzalez-Garcia and Belmonte argued that the winter solstice orientation could be related to the winter festival of the Sun goddess of Arinna.

Accordingly, the Lion and King Gates were oriented in such a way that, sunrise could be observed in the eastern hills from outside of the Lion gate in the spring equinox, and sunset could be observed from the King Gates about 40 days later, in the epoch of Beltone. This 40 days period reminded the duration of the AN.TAH.SUM festival, which makes these two days the possible candidates for the feast. Another result showed that declination of $-17^{3/4°}$ was also preferred for the orientation. Gonzalez-Garcia and Belmonte argued that this declination was related to Sirius, and they proposed that the celestial god Pirinkir could be identified with Sirius, thus, term ISTHAR.MUL could have an association with Pirinkir.

Müller-Karpe analysed the orientations and the position of the temples found at Kuşaklı-Sarissa, about 60km south of Sivas.[117] According to him, the settlement could have had a royal foundation role during the Old Hittite Period in the early twenties or thirties of the 16^{th} century B.C. Moreover, the Kulmaçdağı, the mountain range immediately south of Sarissa could have been Mt. Sarissa which had a religious significance due to the fact of its geographical position where the watershed

[116]Belmonte and González-García 2015b: 10

[117]Müller-Karpe 2014: 83 – 92

divides Anatolia into three parts. Müller-Karpe suggested that the temple found at the Gölgediği (2.5km south of Kuşaklı) and the city Sarissa were built based on a plan which regarded the cardinal points of the compass, or diagonal orientation to the cardinal points. These principles were also applied in the outline of the city plan including the orientation of public buildings and city gates, and outside of the city (such as dams which were built based on these principles). For instance, Building C, presumably the temple of the storm god of Sarissa, was oriented in a way that its corners pointed the four cardinal points with a main axis rotated toward the North-South direction.

Some buildings in the northern district of the city were planned according to the sun's path, particularly to the summer solstice. The temple on the north terrace had a longitudinal axis toward to the North-East, the most northern rising point of the Sun on the horizon (around June 21). Thus the north eastern city gate was also oriented toward to the rising point of the summer solstice, while as the north western city gate pointed to the setting point of the summer solstice. Müller-Karper interpreted this intended tendency of the orientations of the structures as a desire to monumentalize the cosmic order and to reflect the divine structure of the world through the master plan of the city.

2.2.4. Archaeoastronomical Researches on Phrygians

To see the transition of orientation customs from the Late Bronze Age to the Early Iron Age, Gonzalez-Garcia and Belmonte also analysed Phrygian step monuments and façades. [118] They found Berndt-Ersöz's analysis[119] on Phrygian step monuments was not very useful from an astronomical research since she used general and prosaic cardinal point information which makes it difficult to distinguish specific dates, and causes confusion for interpretation of the results. Nevertheless,

[118]González-García and Belmonte 2011: 24 – 29

[119]Berndt-Ersöz 2006

they compered their results with Berndt-Ersöz's emphasising either east or south-east orientation for the majority of the step monuments and façades.

Gonzalez-Garcia and Belmonte analysed 19 step monuments and 8 façades at Gordion, and the datum of the temple of Matar at Pessinus built in the Roman period. The result indicated that there was a preferred lunisolar orientation for the Phrygian structures, and Gordion seems to have had a major alignment towards summer solstice sunrise for buildings, and cultic structures built with an axis perpendicular to this alignment. By considering Berndt-Ersöz's conclusion, they concluded that south-east orientation could be considered as the preferred orientation with an astronomical intention, and added that some Hittite practices dated to the Late Bronze Age could have continued during the Iron Age. They also proposed that there could have been relation between the Phrygian Matar and the Sun goddess (either of Arinna or of the Earth) but it was clarified that at least the intention of astronomical orientation continued during the Iron Age.

2.2.5. Archaeoastronomical Research on Mount Nemrut

In another study, Belmonte and Gonzalez-Garcia analysed the hierothesion of Antiochos I, King of Commagene, at Mount Nemrut, the temple of Gods considered the eighth wonder of the world[120], through an astronomical point of view.[121] On top of the mountain there is an artificial mound, tumulus of the King Antiochos I. This tumulus with an unfound burial chamber, and three terraces are all called the hierothesion of Antiochos I. Belmonte and Gonzalez-Garcia examined the direction of the orientation of these terraces, and a lion sculpture which was interpreted as reflecting the sky view of the year 49B.C. when the monument had started to be built.

[120]Özsoy 2010: 339 – 351

[121]Belmonte and González-García 2010: 469 – 481; 2015a: 1659 – 1668; and 2015b: 8 – 12

Commagene played an important role during the late Hellenistic and early period as a buffer kingdom between the Seleucid and Parthian Empires not only because of its geological positions but also its cultural and political aspects. Especially, Antiochos I Theos (c. 69-36 B.C.) who had both Iranian and Hellenistic ancestries, had a political and cultural strategies that balanced East and West. He unified Hellenic culture and Persian and established a new cult and his burial monument is an important example of this new cult. The mountain cult was very common in Hittites culture during the Late Bronze Age and Early Iron Age in Syrian descendents. Therefore, the choice for the burial location had historical background. In both eastern and western terraces of the Mount Nemrut there are astonishing group of five limestone cyclopean statues, nearly identical and were accompanied by a lion and an eagle on both sides. They were considered as representing the divinities of Antiochos's new cult. Moreover, the inscription *nomos* (written in Greek) which was written on the back of the seats of the statues, mentioned about the foundation of this new cult.

The lion relief with stars and the crescent on his body attracted most attention. Whole relief was interpreted as a representation of the constellation Leo, and each of the three stars presentations of celestial bodies Mars, Mercury and Jupiter. In 1959, Neugebauer and van Hoessen proposed that the scene might represent a horoscope for the date 7 (6) July 62 B.C., the beginning of the reign of Antiochos I.[122] They also considered some other dates such as 15 July 109 B.C., but, Belmonte and Gonzalez-Garcia did not agree on those suggested dates.

In their research, possible alignments of the ancient site were examined. The results showed that both the eastern and western terraces had been constructed on an axis that closely followed the solstitial line. The orientations indicated the sunrise on July 23, 49 B.C., and the sunset on December 23, 49B.C. Belmonte and Gonzalez-Garcia argued that the eastern terrace was facing sunrise on the day when Antiochos ascended to the throne, the western terrace facing sunset on the day when Antiochos

[122]Neugebauer and Van Hoesen 1959: 14 – 16; Belmonte and González-García 2010: 474

was born, and these two days were the days in the year 49 B.C. which is the beginning of the construction of the hierothesion of Antiochos I. By regarding the acceptance the year 49 B.C., the lion horoscope representing the new moon and other planetary conjunctions of Jupiter, Mercury, and Mars that had taken place in the constellation of Leo happened on the day July, 12.

2.3. Methods And Analysis

2.3.1. Categories of Evidence

The archaeological evidences which have value for an archaeoastronomical study are materialised expressions associated with celestial objects and phenomena. The main types of evidence are structural orientation, light and shadow effects, and symbols. Based on the taxonomy adopted by UNESCO's Astronomy and World Heritage Initiative[123] Ruggles divides the evidence into two main categories[124]:

- Fixed constructions or movable objects which have a significance in relation to celestial objects or events

- Representation of the sky and celestial objects or events

Beside these two categories, UNESCO also counts observatories and instruments as a third category. This category contains buildings and devices which were used for observing the sky, and some instruments which were used to regulate calendars.

A fourth category is the material artefacts such as notched bones, clay tablets, and ochre plaques which had direct relation with the celestial events. These artefacts are also considered as material evidences of storage of symbolic information outside of the human mind. De Smedt and De Cruz argued that based on the cross-cultural evidence from non-literate societies, people had been using materials to remember

[123]Cotte and Ruggles 2010: 1 – 12

[124]Ruggles 2015a: 353 – 372

specific events accurately. During late Pleistocene, people made objects and rock arts which represented numerical information indicating time intervals to keep track of time.[125]

After analysing Upper Paleolithic artefacts in 65 European collections A. Marshack concluded that tradition of notation in ubiquitous used on material artefacts shows evolution of human's cognitive-intellectual ability and the level of symbolic development in the early cultures. According to him, the purpose of these artefacts were recall, recognition and feedback on visual-kinesthetic and spatial-temporal inputs, and argued that particularly notched artefacts reflected a long term, cumulative sequential notation.[126]

Like the artefacts, Paleolithic art also served as an artificial memory system to recall and communicate as a temporal marker via storing information about temporal regularities of their environment, that supposedly were useful especially to hunters. Since humans had a cognitive adaptation skill that allowed for temporal regularities, they were able to simulate future events by regarding past experience through using material culture which served to store genealogical knowledge. Material culture, therefore, played an important role to allow projection of past event into the future more accurately than solely via episodic memory.[127]

Astronomical alignment is considered as an instrument which gives information about phenomenon observed, precision of observation, technique used, and what people could draw from such observations.[128] Hodder proposed that alignments by regarding natural phenomena were strategical actions to produce hierarchal rank.[129] Pearson and Richards showed that even the lay out of the houses

[125]De Smedt and De Cruz 2011: 63 – 76

[126]Marshack 1972: 445 – 477

[127]De Smedt and De Cruz 2011: 63 – 76

[128]McCluskey 2015a: 227 – 237

[129]Hodder 1984: 51 – 68 in McCluskey 2015a: 227 – 237

were managed as a zodiacal calendar as well as mirroring the organisation of the settlement its self. In some cases, houses were considered as modelling cosmos, and especially cardinal points were the key fact used in construction of the houses. They emphasised the significance of alignment direction for each cultures examined and its relation to traditional beliefs and internal social division.[130]

Not only alignment but also how they used their environmental features for such observations also has been important evidence for archaeoastronomy. In many cases, the celestial phenomena influenced terrestrial conception of the community, and the way in which terrestrial space was organised is closely related with the way in which celestial space was perceived. A territory was considered as a geographical space which is exclusive property of the notion-states with defined borders, that each notion was emerged based on cultural dynamics. The construction of cosmological system, techniques for observation, interpretation of celestial events had strong relations with collective interest and effort.[131] The usage of landscape, as a historical production of human, was embodied human connection with celestial phenomena, and urban layouts and architectural designs could have reflected the perception and conceptualisation of the sky[132].

Archaeoastronomers seek spatial patterning in material record, particularly the structural alignments based on the rising and setting positions of specific celestial body, or the light-shadow effects as a result of architectural configuration of the space. Detecting symbolic expressions on prehistoric artefacts and in rock art are the other cases that archaeoastronomical studies are more commonly interested in. Even though, the main aim is to reveal astronomical potentialities within evidence taking into account the full range of archaeological, historical and ethnographic evidences,

[130]Pearson and Richards 1994: 13 – 17

[131]López 2015: 341 – 352

[132]Iwaniszewski 2005

it is fair to say that the most commonly considered evidence are structural orientations, light-shadow effects and symbolic expressions[133].

The Green Archaeoastronomical approach primarily focuses on a possible astronomical alignment of monumental structure, therefore, it may cause such methodological issues since the result could accidentally occur without any relation to astronomical intention. According to Ruggles, most of these issues are results of the preferentially selection of data. Interpretive archaeologists argued that strict objectivity is not possible in terms of practice as a result of the inherence of selection process itself. Others supported the idea that any approach, regardless of which scientific study area it is derived from, will not be objective, instead, will favour a particular idea with some level of subjectivity.

Another approach is called the data-driven approach, and allows the data to speak for itself. However, this approach also poses problems; it does not provide an explanation for any significance and meaning related to astronomical intention; relatively few datasets exist and they may not show any pattern as an evidence; only concerning about orientation causes overlooking other astronomical connections; over slighting the possibility of complex sequence of change and reuse of structure by time; and lack of absolute consistency in human behaviour. This approach is more efficient when it is used as an initial step of analysis in order to better understand all aspects of the monuments concerned.

The most important argument, on the other hand, is on giving attention to methodological considerations such as the fair selection of data before concerning about social theory and the cultural context. Freemen emphasised the importance of observation without ignoring any data even those which was considered as irrelevant to the study subject. He suggest to report all observed, and make a clear statement regarding the relation between hypotheses and data.[134] Ruggles indicated that there

[133]Ruggles 2015b: 373

[134]Freeman 1982: 45 – 52

was a danger of choosing data in order to justify preconceived ideas, and suggested that it was important to make fair selection of data without prejudice. Ruggles also emphasised the importance of precision of data with a high accuracy. For instance, the measurements for a structural alignment need an appropriate level of precision with a high accuracy. A given precision does not guaranty high accuracy because of the possibility of systematic errors. This may lead a failed result in the attempt to estimate dates of construction of the architectural remains by regarding orientation.[135]

Similar concerning is also take count for evidences based on light-shadow effect. Ignorance of some sites or architectural constructions that were considered not related with any celestial events at first sight, or expecting to detected certain light-shadow configuration while ignoring other configurations that are equally important but occur at different times are some similar set of issues which lead to misleading selection of data. For the symbolic expression cases, similar set of issues should also be taken into account such as selection of some symbols and ignoring others. The most common mistake is trying to explain every number by an astronomically significant number. Since, in general there is little or no contextual evidence to help the interpretation of symbols, there is a potential both for the misleading selection of data and for misinterpretation of the data.

According to Ruggles, for the best practice of archaeoastronomy, the aim should be to document and justify the selected data through an appropriate interpretative framework instead of looking for an objective criterion for preconceived data, therefore, it is better to document all data known before making selections in order to consider and compare different explanatory hypotheses. For light-shadow case, he suggested to record the site parameters in sufficient detail in order to enable data for further reconstruction and examination by other scholars.[136]

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[135]Ruggles 2015b: 373 – 388

[136]Ruggles 2015b: 373 – 388

Using technology such as 3D modelling or any other visualisation techniques could be useful for analysing data and making proper interpretations. Especially, geo-spatial measurement technologies provide opportunities to archaeoastronomers in terms of accuracy of data and processing them.

As a result, to come to a credible interpretation of evidence it is important to support results by broader social theories while corroborating contextual evidence from history, ethnography and any others which may provide sufficient information. Aveni emphasised that the interpretations should be done with a regard to the cultural context, and especially ethnographic evidence should be taken into consideration, attention to replication in order to understand whether there is an alignment or not could help for better understanding of evidence. However, for any case it is impossible to prove the intentionality as well as disprove it.[137]

2.3.2. Field Survey

A Field survey of an archaeological site and monuments is undertaken in order to investigate archaeological remains within their context for better understanding of evidence's function and for emerging culturally relevant framework for an archaeoastronomical study. A monumental structure or any other constructions could have embodied cosmological aspects within its size and shape, material used, acoustic qualities, its location in relation to surrounding landscape, and so on. For the best practice, the theoretical starting point is to consider cultural relevance.[138] To determine any potential link or suspected function in that cultural context, the main focus subjects of a field survey are determination of structural orientation; capturing possible light and shadowconfigurations; detecting symbols that are suspected to have a meaning related with celestial phenomena; recognising patterns in locations of

[137]Aveni 2006 in Ruggles 2015a: 353 – 372

[138]Ruggles 2015c: 411 – 425

buildings and other features in occupied landscape which may have reflected or represented patterns of stars in the sky.[139]

To determine the orientation of any structure, main parameters are azimuth and horizon altitude. The declination value of a structure can be calculated by combining geological coordinates of the structure with local horizon profile in order to compare with the declination value of the prominent celestial body or an astronomical event. Measurement should be done in relation to the visible landscape and the surrounding horizon to take into consideration of prominent natural features such as a distant mountain peak or other structure that were used as foresight to mark rising or setting location of a celestial body on the horizon. The precision of any measurement is important in terms of reaching meaningful results. Therefore, the instrument which will be used for determining the azimuth and altitude of the selected structure is depended on the precision required as well as the resources available.[140]

According to Prendergast, a monument's axis often played an important role as a ceremonial entrance and pathway, therefore, if any astronomical intention had been aimed, it should have provided often through a line over the main axis.[141] Process starts with estimating the mean axis of a structure by a line through the center of the back wall and the center of the entrance or passage could be measured, or by identifying the best option that is available for the measurements. And it is followed by measuring the azimuth, the angle along the horizon eastward from the North point to the monument's axis; and the altitude, the angular distance above the horizon. The latitude of the structure is also needed to calculate the declination.

For the best lay out to archive astronomical data relating to either a single structure or complete site, the study should consist of a table showing the azimuths

[139]Ruggles 2015b: 373 – 388 and 2015c: 411 – 425; McCluskey 2015c: 427 – 444

[140]Prendergast 2015: 389 – 409; Ruggles 2015b: 373 – 388

[141]Prendergast 2015: 390

(or range of azimuths); altitudes; declinations; latitude; additional information such as the way how the measurements are derived and the important locations with their distances; a photograph or digitally generated horizon profile in which the indicated point (or range), azimuth and altitude scale are represented by lines and indication of the position from which the profile was measured. It is best to use statistical methods to identify significant accumulations of probability in case that it is not possible to recognise the result.

Since archaeological evidences are inherently limited, it is not easy to obtain the original orientation. For instance, the structure itself could have been modified in times, so then the uncovered remains may have been different from the intended. For some cases, it may not be possible to make measurement properly, so then it is more relevant to consider a sector of horizon, a wider horizon profile, in each of the directions of interest. A range of azimuths and altitudes complemented by a photographic record allows the parameters of intermediate points to be interpolated. Even more, for some case, the entire horizon could be considered as a part of statistical investigation. After measuring azimuth and altitude, the values are converted to declination directly using a standard formula. At his point, it may be necessary to take account of atmospheric refraction by applying a mean correction dependent upon the altitude.[142]

All these measurements are done based on the assumptions that the indicated direction for the structure was aligned in regards towards the point of celestial body's rising/settings on the horizon. However, it is better to keep in mind that the intended alignment might have been aimed to point out a celestial object when it was up in the sky, especially transit passage toward observer's meridian. Indeed, most of the starts because of their luminosity cannot be observed over a low horizon due to the atmospheric extinction.

[142]Ruggles 2015c: 411 – 425

Light and shadowinteraction is another phenomenon that reflects astronomical or calendrical concerns of a community. Determining an interaction is one of the challenging field survey in terms of technical difficulties. The original circumstances which provide intended effect may have changed by time naturally or by human agency, or the geometric details of the interaction could be complex to detect since the nature of the phenomenon depends on the changing daily and yearly motion of the Sun.[143]

McCluskey emphasised two different ways to document these interactions. One of the ways is to focus on the site itself, and make detailed description of the place where it occurs. The other one is to focus the phenomena itself and documenting all the details including the time of the changing interactions, positions on the receiving surface through the year. According McCluskey, to understand the entire process of the light and shadowinteraction, the documentation of a survey should include orientation of the receiving surface and all other surfaces that are relevant to the phenomena and measurement of the inclination of the surface to the horizon and the azimuth of the perpendicular to the surface; record all markings on the receiving surface; and take photographs of site and its surroundings in detail. The photographs which directly related with the interactions should be captured throughout the day and specific times in a year precisely, especially more near the equinoxes when the Sun's declination changes rapidly and less near the solstices when the declination changes slowly.[144] And all the data should be documented with their determined orientation values by relation to a fixed coordinate system.[145]

[143]Ruggles 2015b: 382; McCluskey 2015c: 427 – 428

[144]Sofaer, Price, Holmlund, Nicoli and Piscitello 2011: 76 – 77

[145]McCluskey 2015c: 427 – 428

2.3.3. Data Analysis

For an archaeoastronomical investigation, it is important to detect the null hypothesis where an alignment is a coincidence or any astronomical intention was aimed. According to Schaefer, without any independent evidence, the prior expectation should strongly favour the null hypothesis due to the fact that the astronomical content in daily activities and in rituals were not common in ancient societies, moreover, it should better be tested through probabilistic or statistical analysis in order to make a convincing conclusion.[146]

A null hypothesis is tested in general by a probabilistic or statistical analysis. Random distribution and the degree for correlation between the parameters are compared to the actual data. To investigate possible astronomical alignments, Schaefer suggested Bernoulli's equation, as an alternative to classical probability method, for testing the hypothesis where threshold levels of >3-sigma ($P<0.0027$) are required in general. Data selection bias, unknown systematic effects and inherent intention of pattern-recognition of human mind are the main reasons behind the determination of these threshold levels. He also recommended using Bayesian techniques as an alternative to the classical probability methods to test conditional probability in the case where one parameter is depended on the other ones condition in terms of propositional logic.

Freeman and Elmore suggested to use Central Limit test as a probability test for the cases where a homogenous, well defined group of sites investigated to understand if there were an intended alignments towards an astronomical events.[147] Higginbottom and Clay used cross-correlation tests in order to determine the probability of intended astronomical orientation of overall monument.[148] Gonzalez-Garcia suggested to use cluster analysis in order to find groups within a hierarchy of

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[146]Schaefer 2000b: 132 – 135

[147]Freeman and Elmore 1979: 86 – 96

[148]Higginbottom and Clay 2014

distance; and principal component analysis to display the data by a combination of a number of dimension within multidimensional space.[149] However, statistical analysis may not useful, or the results do not give a satisfied confidence to make a conclusion, but this does not disprove an intention related with astronomy. Inscriptions and written documents together with ethnohistoric account could be used as evidences to support the hypothesis.

Today's technologies support 3D analysis provide the calculation of horizon profile from topographic data; the viewshed analysis giving visibility throughout surrounding ground features; the intervisibility of archaeological site; indicated declinations of alignments in a mountain terrain; and generating light and shadow effect in digital format. Virtual reconstruction techniques are widely used in archaeoastronomical studies in order to demonstrate analysis result. Orientation of an archaeological structure toward possible celestial object, and the impact of natural or artificial illumination could be displayed with even including static sky snapshots from planetarium software. Calculated horizon profile with relevant astronomical data could be combined with specified sky view in relation to 3D modelled geographical data in order to provide better environment for an investigation of potential astronomical intention.[150] However, Schaefer suggested direct observation for analysing alignments and light and shadow effect, if there were suitable conditions.

2.3.3.1. Analysing Orientation

In 1939, Dinsmoor combined archaeological and ethnographical evidence, particularly ancient religious evidence, to estimate construction dates for the Great Pyramid of Khufu at Giza, Stonehenge in England, and temples of ancient Greece, and listed five factors for an orientation. According to him, determined orientation

[149]González-García 2015: 493 – 506

[150]Zotti and Neubauer 2012: 33 – 40

could be by chance; result of topography in relation with ground, streets or other building; intended to get best benefits of climatic conditions such as sun light or prevailing winds and so on; prescribed by cult or previous traditions related with religious concern; or aligned toward and astronomical event. Dinsmoor also emphasised the need for more precisely measurement and calculation, especially for assumed solar alignment, in order to astronomical dating of an archaeological remain in regards to precession and obliquity.[151]

In 1979, Seymour and Edberg developed simplified algebraic expressions derived from spherical trigonometry to calculate declination values for determination of possible horizontal alignment. They gave two formula which are intended to be used based on topographic condition of the surveyed field, and emphasised taking account the environmental features which can be considered as a suspected object associated with horizontal alignment of celestial object. Inability of determination of azimuth for an alignment was indicated as a major source for an error in the calculations. They also suggested a formula providing a quickly calculation to estimate the pointing direction of any possible alignment, and a table in which declination values of the selected bright stars considered as potential for an astronomical intentions was provided. However, shifting the positions of celestial bodies over a long time period was only very briefly mentioned and they did not take account these fact in their calculations.[152]

For investigation of rising and setting alignments on horizon, two phenomena caused by the Earth's atmosphere should be taken into account, especially when the interested object is closed to the horizon. They are: refraction, a slight increase of apparent altitude for all celestial bodies; and extinction which reduces the celestial object's luminosities. Refraction depends on time, season, and location, therefore the relation between azimuth and declination also changes. For a standard

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[151]Dinsmoor 1939: 96

[152]Seymour and Edberg 1979: 64 – 70

archaeoastronomical study, Shaefer standardised a formula for refraction depended on average conditions (for the U.S. Standard Atmosphere).[153]

Atmospheric extinction is one of the factors which have an effect on visibility of celestial bodies. The term extinction is used to describe the diminution of light because of the atmosphere. It depends on the thickness of atmosphere, and it is proportional to the reverse cosine of zenith distance.[154] Regarding to the results derived from different models for an atmospheric extinction, Schaefer emphasised the importance of determination of it which has a significant effect on visibility of a star, especially when it is closed to the horizon. He concluded that the extinction angle is only irrelevant for the Sun, Moon and Venus because of their magnitudes, and only the brightest starts could actually be observed at rising and settings points because of the atmospheric scattering and haze.[155] Precession and proper motion are the other facts that effect star positions over millennia, and their effect is more noticeable where the ecliptic crosses the equator.

Thom proposed the rule of thumb that a star only becomes visible at an altitude equal to its magnitude.[156] Shaltout and Belmonte emerged a generalised formula based on Thom's assumption in which possible alignments should be expected toward the point of appearance or disappearance of the star instead of rising or setting points on the horizon. As a deduction, at the higher altitudes the rising and setting have significant angle to the vertical, the appearance and disappearance points may be significantly different from the rising and setting points on the horizon.[157] Kelly and Milone made an approximation for a wide use, and suggested that the altitude in degrees at which celestial object can be first appear for the naked eye

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[153]Schaefer 2000b: 125

[154]Kelley [et al.] 2005: 50

[155]Schaefer 1986

[156]Schaefer 2000b: 123

[157]Shaltout and Belmonte 2009 in Ruggles 2015f: 519

(which is brighter than about visual magnitude 6) is equal to its magnitude (for example: a 4th magnitude star would be first seen at an altitude of about 4°).[158]

For analysing an astronomical intention in an orientation of a structure, it is very important to collect all the necessary data before examination, and document them in the study paper for further examinations in order to provide a discussion about the result. Earliest studies did not take into consideration the landscape features which surround examined structure, instead, it was assumed that the structure was located on a flat land due to the lack of proper data presenting surveyed horizon. Consequently, the study results could not be examined for further analysing in favour or against possible celestial alignments since it was not clear whether they pointed toward the mathematical horizon or take into count the local horizon.

Schaefer indicated the importance of in situ observation of study cases, and suggested an investigation process including the horizon profiles derived from topographic data; prominent mountains; the intervisibility of archaeological site; the indicated declinations of alignments in a mountainous terrain; taking account of possible light and shadowinteraction; general information about the site itself. He also recommended such computer programs to use in an archaeoastronomical study like GIS (Global Information Systems) to manage databases and combine various types of data together, and VRML to provide a three-dimensional visualisation standardised environment.[159]

Zotti suggested a method which combines the archaeological map with the celestial map that allows the identification of possible alignments. He used data set consisted of geographical position (λ, φ)[160] of the observer, the celestial object's

[158]Kelley [et al.] 2005: 53 – 55

[159]Schaefer 2000b: 130

[160]λ is positive for longitudes east of Greenwich, and φ is positive on a latitude on the northern hemisphere. Zotti 2006: 152 – 166

coordinates (α, δ)[161], and time for observation (local mean solar time). The rising and setting azimuths of a star on a horizon depend on geographical latitude of the observer, so then the object's azimuth and altitude can be calculated.

For an investigation looks for an intended alignment, it is important to have at least a narrowed construction date for the structure in order to estimate an appropriate sky view. According to Zotti, celestial map should show the diurnal arcs of the stars which allows to read the rising and setting points of celestial objects; the altitudes and combined azimuths that an object can reach; and stars passing close to the zenith (center of the map). Instead of traditional map for the hemisphere, he recommended to create a map with an open space in the center with a sky view flattened outward of its center. After placing archaeological map at the center of this map, identification of alignments could be more easily detected. The map could be enhanced by adding a horizon diagram. This histogram only works if the horizons are not highly elevated, and when the settlement area can be considered as in the same latitude. In his conclusion, Zotti suggested an interactive, navigable VR/AR (virtual reality/augmented reality) environment with an astronomically correct and high-quality sky simulation that allows virtual reconstructions of archaeological site to make an immediate investigation, and he mentioned about a system which was used at UCLA's Cultural VR Lab for archaeoastronomical studies.[162]

For a standard process, it is better to examine wider horizon for each interested directions. However, in practice it may not be possible to examine wider horizon because of the atmospheric or environmental obstacles. For such circumstances, a point nearby could be used for the survey, and then calculation would be made for an offset correction trigonometrically, or if it is possible a topographic map could be used via software to generate horizon profiles from digital terrain data.

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[161] α is right ascension eastward from the First Point of Aries γ, δ is declination positive for objects north of the celestial equator. Zotti 2006: 152 – 166

[162] Zotti 2006: 152 – 166

In any case where an in situ survey for measurement cannot be performed, an accurate data such as a site plan or a map also sufficiently works for this task. The main necessity for an investigation of possible intended orientation is to determine the azimuth and horizon altitude that provide a local horizon profile, and combine them with the geographical location of the observer's place and latitude. Then, calculate declination of the direction of the structure or any archaeological remains. The declination[163] derived from the azimuth and altitude values can be either a single value or a range of values which provides a minimum or maximum values rather than an absolute value.[164]

Patat proposed a method to compute a synthetic horizon altitude profile which was derived from digital elevation models for an orientation analysis of a site in which local Earth's curvature and atmospheric refraction were simplified in it. The results were reliable and applicable when the distance to the local horizon is larger than ~10km and rms deviation of data is of ~0º.1 degrees. Patal also compared the result which was constructed by Shuttle Radar Topographic Mission data of Maes Howe, Neolithic site, with the direct theodolite measurements in order to understand how well his computational model works.[165]

On the other hand, such computer programs also provide a horizon profile. Horizon[166] is a GIS tool which calculates accurate horizon profile particularly designed for archaeoastronomical studies examining orientation. It is a landscape

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[163]Horizontal Coordinate System uses the observer's local horizon as the fundamental plane. It is determined by two paramters; altitude (a) as the angular distance above the hoizon, and azimuth (A) the angular distance measured from the North towards the East. Equatorial Coordinate System uses the projection of the Earth's equator onto the celestial sphere as a fundamental plane. It is determined by two parameters; declination (δ) as the angular distance of an object perpendicular to the celestial equator (positive for the North and negative for the South), and Hour Angle (H) as the angular distance of the celestial object between the meridian of the observer and the hour circle passing through the object. Formula to calculate declination converted from horizontal coordinate system parameters is $\sin(\delta) = \cos(a)\cos(\phi)\cos A + \sin(a)\sin\phi$, ϕ: observer's latitude

[164]Ruggles 2015c: 411 – 425

[165]Patat 2011: 743 – 749

[166]Horizon, http://www.agksmith.net/horizon/

visualisation tool generates full 360 degree panoramic scenes using DTM/DEM mapping data. Vertical Mapper and ER Mapper are softwares that generate set of images of 360 degrees panoramic view. The generated images are composed by using Photoshop to export data into Starry Night software for investigation of any astronomical intention.[167]

The website HeyWhatsThat[168] also provides free interactive application that computes a horizon profile. Calculated profile is derived from The Shuttle Radar Tomography Mission elevation data taken in a grid of 90m increments across the Earth that is available online from CGIAR Consortium for Spatial Information. By entering the latitude, longitude and elevation of any location, website calculates horizon profile which can be downloaded in kmz format. But one keeps in mind to check the far away mountain for the region where it is surrounded with mountainous terrain.

Unlike the GIS, Spatial Data Infrastructure (SDI) is a service-oriented system that allows a spatial service provider that stores and updates spatial data, so then each layer of data can be worked by different teams, and then integrated without duplication. By integrating with other systems, SDI displays astronomical data such as heliacal rising of the bright stars and planets shown with in a map, dating historical events throughout the eclipses, calculating azimuth of the Sun and Moon over the horizon. The formation stored in database is used standard protocol WMS or WFS that supports GeoRSS and GML format. Thus, with the additional geoprocessing tools like SEXTANTE and GDAL libraries, data could be examined much more efficiently.[169]

167Khoumeri, Santucci and Thury-Bouvet 2006

168heywhatsthat, http://www.heywhatsthat.com

169Mejuto, Rodríguez-Caderot and Castaño 2012: 117 – 132

2.3.3.1.1. Solar Alignment

The Sun is the most important celestial body which has a strong impact on the Earth and its ecosystem as being the main foundation of energy for the entire living beings. The natural cycle is directly related with the sun's movement on the sky. The annual transition of the Sun on the celestial sphere is called the ecliptic and changes continuously as the Earth moves around the Sun. The Earth's rotation axis is tilted by 23°.5 with respect to the ecliptic. The Sun's most Northern declination occurs at +23°.5, called the June solstice, and its most Southern declination occurs at -23°.5, called the December solstice. So that, the Sun's declination varies by about 47° during the year and crosses the celestial equator at two points (at 0°) called equinoxes where the Sun spends half time above and half time below the horizon.

After passing at the winter solstice, each day the Sun rises further to the North while its azimuth decreasing. When it reaches its smallest value, it is a middle summer date in the northern hemisphere. Then, it starts to rise further to the south day by day while its azimuth increases until reaching summer solstice. As a result, the sun is above the horizon longer in summer which increase the delivered solar energy than in winter at all altitudes except the equator. The Sun moves about 1° along the ecliptic and it takes 24 hours to complete one cycle, called synodic day. On the other hand, a particular star completes its tour in 23h 56 min 14s, called sidereal day, which is almost 4 minutes shorter than synodic day.[170]

The most significant of points of the Sun on its annual movement on the sky are the two solstices; the winter solstice and the summer solstice. During the solstices, that the word comes from the Latin for the Sun standstill, the Sun seems to show up for a few days at the same point on the horizon. Equinox is the point when the Sun passes over the Earth's Equator twice a year. Since it moves at the equinoxes relatively faster than solstices, so then an equinoctial marker can be more precise and more efficient to track the time. On the other hand, the more commonly discussed

[170]Kelley [et al.] 2005: 20 – 26; Belmonte 2015: 483 – 492

concepts in an archaeoastronomical researches are the temporal equinox (halfway point between the two solstices) and the spatial equinox (spatial midpoint between rising or setting positions of the sun at the two solstices).[171]

The Sun had been used as an astronomical reference to determine cardinal directions to produce spatial order as well as generate solar calendar. People could have been able to construct a model of the cosmos connecting celestial and terrestrial perceptions that have been used in the arrangement of sacred places, monumental architecture, and settlement layout. Especially settlement layout were often organised around a centre, and conceptualised through a vertical axis in relation to three cosmic levels the upper world, the earth plane and the nether world with an intersection of cardinal directions.[172]

A solar alignment can be obtained through the direction of the building itself without any additional component in the landscape or through light-shadow effect. For such cases, alignments were composed of more than one structure, so then the ensemble itself was aligned in respect particular direction. This ensemble could also involve elements of the landscape (either natural or artificial) such as mountain or rock feature.[173]

Neolithic rondels (dated around 4800 B.C.) found in the extended area between the Germany and Hungary had been built by Stichbandkeramik, one of the first farmer cultures in Northern and Central Europe. Many of the Goseck rondels were oriented toward the cardinal points or the intermediate points. They consist of a circular ditch and two wooden palisade rings. It is suggested that they were used as a solar observatory and for worship area. Goseck rondel with gates oriented the southeast and southwest was built to observe midwinter sunrise and sunset.

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[171]Ruggles 2015d: 446

[172]Iwaniszewski 2015a: 3 – 14

[173]Belmonte 2015: 483 – 492

According to Ridderstad, the main motivation for the alignment was to track time in order to organise agricultural activities.[174]

In ancient Egypt, some temples were astronomically aligned. They were built by regarding the cardinal points and some were directed to the rising of the Sun especially at the winter solstice. Light and shadow effect was also used as a common feature in structures of the sacred monuments to illuminate specified chamber or a solar divinity placed in the chamber by the Sun's ray at the certain day of the year. For example, the great pyramid of Khufu in the Giza group was accurately oriented to the Sun. The temple of Ra-Hor-Akhtyis another example in which the solar chamber had a window looking toward the winter solstice sunrise. A smaller temple of Ra-Hor-Akhty and the temple of Amun-Re were also other examples which oriented toward the winter solstice sunrise.[175]

2.3.3.1.2. Lunar Alignment

The motion of the Moon is more complex than the motion of the Sun. Its declination changes in during monthly movement, and so its diurnal arc across the sky changes just as the Sun does. Moreover, since the Moon's rotation is tilted about 5° with respect to the ecliptic plane, its declination varies more than Sun's extreme values and the changing value of its azimuth has a 18.6-year cycle. The most extreme declinations reached by the Moon called the major and minor lunar standstill. The time passes for the Moon completing one revolution around the Earth is 27.322 days and it is called a sidereal month. However, since the Earth constantly moves around the Sun on its orbit, the Moon must travel more than 360° to get from one new moon phase to the next one which takes 29.531 days, called synodic month. Only after

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[174]Ridderstad 2009

[175]Kelley [et al.] 2005: 267 – 268

three sidereal months later the moon is about an hour east of the observer's meridian at the same time of the night and in the same constellation but may be at a different lunar phase.[176]

The intentionality of lunar orientation is harder to prove due to the fact that the Moon has more complex motion than the sun. Thus, the extreme values for the moon declinations do not have to occur during rising or setting time, indeed, it is a very difficult and rare event to observe. However, Thom discussed number of alignments of the monumental structures found in British Isles that were set up for astronomical intention with corrected orientation in relation to the Moon's declination band.[177] According to Thom, some monuments were built in following years respects to the Moon's cycle of 18,6 years, therefore their orientation directions showed consistent orientation distributions toward the major lunar standstill limits changed by times.

The thin crescent moon in the evening sky was important for many cultures in the matter of calendric purposes. The detection of crescent moon observation needs additional calculation because of the visibility issue. According to Schaefer, detailed review of thousands of observations showed that rules of thumb may not give a satisfying prediction. He criticised the calculation approach assuming same conditions for an average site, and claimed that assuming good conditions and fair conditions are same, and it was the main reason for misinterpretation.[178] He suggested approaching this visibility issue as a special case of the heliacal rise problem with only needed an accurate lunar ephemerides, including lunar surface brightness as a function of the lunar phase.[179]

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[176]Kelley [et al.] 2005: 29 – 36; González-García 2015: 493 – 506

[177]Thom and Thom 1983

[178]Schaefer 1988: 511 – 523

[179]Schaefer 2000b: 127

The orientation toward an eclipse is also another possible intention, however, it is difficult to detect because of the different geometries of the solar and lunar eclipses, and the difficulty of discerning from other options. For this kind of cases it is suggested to apply a statistical or probabilistic analysis for determining ecliptic orientation, and even better to support the result with cultural information. González-García suggested applying Bayesian methods to make better interpretation of the data. Multivariate analysis, cluster analysis, and principal component analysis are best suit with the cases in which a groups or cluster were examined.[180]

The Ziggurate of Ur, built by King Ur-Nammu was a step pyramidal structure with a temple on top of it. According to González-García, the main staircase and the top temple were both oriented toward moonrise at the northern lunar standstill limit, a direction that the sun was never observed. The Egyptian temple of Thoth at Seikh Abada, was another case that the temple axis, unlike the other neighbourhood temples, was not perpendicular to the Nile, but it was towards to the northernmost moonrise passing across the zenith of the temple.

2.3.3.1.3. Planetary Alignment

The five brightest planets Mercury, Venus, Mars, Jupiter and Saturn have been known since ancient times. Unlike stars, the positions of the planets change slightly night by night. They move eastward along the ecliptic (called direct motion), then reverse the direction and move to westward direction for a while (called retrograde motion). Then, they continue their direct motion again. Retrograde motion can last from weeks (for Mercury) to months (for Saturn). Since planets are among the brightest object and located very close to the Sun (especially Mercury and Venus) on the celestial sphere, they observed ether as a morning star in the east or as an evening star in the west. Because of their low arcs of the ecliptic with respect to the horizon, and the distance from the Sun, it is difficult to observe planets. The most

[180] González-García 2015: 493 – 506

possible alignments were expected toward the extreme northerly and southerly rising and setting points of interested planet, unless another option was suggested by independent evidence.[181]

Venus and Mercury as inferior planets can only be seen as morning star when rising before dawn, and as evening star when setting after the Sun. The synodic period of Mercury is 116 days and the period of invisibility and visibility last on average 38, 35, 38, 5 days. The synodic period of Venus is 584 days, since it is the brightest object in the sky apart from the Sun and Moon, Venus can be seen relatively longer, and the period of invisibility and visibility last on average 263, 50, 263, and 8 days. The synodic period of Mars is 780 days, a period while the planet is invisible last for about 120 days, and retrograde motion around opposition lasts for about 75 days. The synodic period of Jupiter is 399 days, invisible for about 32 during the conjunction period, and retrograde motion for around 120 days. For Saturn, the synodic period is 378 days, invisibility 25, and retrograde is 140 days.[182]

The maximum possible latitudes range from about 9° for Venus to about 2° for Jupiter.[183] Since it is not possible to distinguish maximum and minimum declinations of Jupiter and Saturn from the solstitial declinations of the Sun, interpreting an alignment toward Jupiter or Saturn is not convincing. As Venus is the brightest object in the sky after the Sun and Moon, it is relatively dominant both as an evening or a morning star.[184] Most of the planets are visible with naked eye, however, they are not considered as significant target to be reference for an alignment, but still had been observed by many cultures.

Especially, in Mesoamerica there are several architectural alignments toward the greatest extremes of the evening start, Venus. According to Šprajc, the main

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[181]Kelley [et al.] 2005: 36 – 47; Šprajc 2015: 507 – 516

[182]Ruggles 2015d: 470

[183]Evans 1998: 289

[184]For further reading about the declination variations of Venus see Šprajc 2015: 507 – 516

motivation behind this intention was to track beginning and end of the rainy season for cultivation. Other examples of alignment were found at different archaeological sites in the southern Iberian Peninsula. The structures were dated to the early half of the 1st millennium B.C., and they were oriented either towards the rising point of the Moon at its northern major standstill or the setting point of Venus at its maximum southerly extreme.[185]

By AD 200, Mayans had highly developed astronomical methods to observe celestial bodies for divine forecasting, predicting times of drought, fearsome storms and abundant crop. They interpreted the cosmos as repetitive machine that they could have advanced knowledge about their fate and they organised their rituals based on their celestial observations. Venus had a special importance, therefore, its movement on the sky had been highly accurately recorded including the duration and timing of its visibility over the morning and evening sky in the Mayan hierographic books, the Dresden Codex.[186]

Ancient Chinese astronomers observed planets to predict seasonal changes as well as the Sun. Thought that planets assist the Sun and Moon to manage five natural events: rain, sunshine, wind, heat, and cold. They were associated with the five elements: Mercury was called as Chhen-Hsing (Hour Star), indicating North direction and representing the element water; Venus was called Thai-Pai (Great White), indicating West direction and representing the element metal; Mars was called Ying-Huo (Glitterer), indicating South direction, and representing the element fire; Jupiter was called Sui-Hsing (Year Star), indicating East direction, and representing the element wood; Saturn was called Thien-Hsing (Filler), indicating centre, and representing the element earth.[187]

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[185] Šprajc 2015: 507 – 516

[186] Bartusiak 2004: 7 – 11

[187] Kelley [et al.] 2005: 327 – 328

In ancient Egypt a text, dated to Ramses VI, mentioned Mercury as both morning and evening star, "Seth in the evening twilight, a god in the morning twilight".[188]

2.3.3.1.4. Stellar Alignment

The main purpose of observation of stars was navigation during the night time and calculation of seasonal cycle. Structures may also have been oriented toward a single star or group of stars. It is not necessarily relate to the rising or setting of a star at night, for some cases, architecture of the structure could have been design for a direction through high up in the sky. Pyramid of Khufu at Giza is an example indicating the altitude in the sky of an asterism concerned. At this point, it is more important to support the intention with solid corroborating evidence due to the fact the flexible possibilities for more than one interpretation.[189]

Unlike the Sun and Moon, the rise and setting points of a star do not change periodically during a year. Therefore, even during the earliest periods structures had been often oriented towards the rising and settings of bright stars rather than toward the Sun or Moon. Because of the precession of the Earth, the right ascension and declination (so then rise and set azimuths) of a star changes in a very long time (approximately 26000 years or 1° every 72 years). Hipparchus is the first one who noticed this phenomenon by comparing the positions of the stars on the sky that had been recorded in the previous almanacs with their current positions in the 2nd century B.C.[190]

Even though, the visibility of stars also varies through the seasonal changes, they have a constant declination on the celestial sphere, and complete a circuit in

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[188]Neugebauer and Parker 1969: 182 in Kelley [et al.] 2005

[189]Ruggles 2015f: 517 – 530

[190]North 2008: 51

about 23h 56min. Except the circumpolar stars, whose declination $\delta > 90° - \varphi$ (latitude) in the northern hemisphere, $\delta < -90° - \varphi$ (latitude) in the southern hemisphere so then they do not rise or set, they are three distinctive daily events; rising, culmination (transit, crossing the observer's meridian at its greatest altitude), and setting.[191]

As well as the atmospheric extinction which effecting visibility of celestial bodies, heliacal rising and setting of a star should also be considered for analysing intended astronomical alignment. The altitude of which a star or asterism first becomes visible above the eastern horizon, and each day rises earlier and stay longer over the horizon until the light of the sun overwhelms it. Moreover, due to the precession of the Earth, the right ascension and declination (so then rise and set azimuths) of stars change in a very long time.[192]

Ruggles suggested data-driven approach for analysing orientation of a single structure to identify the alignment's intention, while for a set of putative stellar alignments statistical analysis will be best work to detect the coherency. However, if there is any other kind of independent evidence supporting the intention of a stellar alignment, it is mostly postulated without applying statistical analysis.[193]

According to Zotti, the rising of Pleiades star cluster and the setting of Antares in Scorpius are most commonly targets for orientation. He concluded that the Pleiades' heliacal rising occurred just after spring equinox, so then the Neolithic farmers observed this celestial event in order to track cultivation time. Deneb is another bright star which was also used as a target for the structural orientation.[194]

Hoskin examined the prehistoric tombs and temples that were found at the Taula sanctuaries in Menorca (Spain), and interpreted that they were oriented

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[191]Ruggles 2015d: 463 – 465

[192]Ruggles 2015f: 517 – 530; Schaefer 2000a: 149 – 155; North 2008: 100

[193]Ruggles 2015f: 517 – 530

[194]Zotti 2006: 152 – 166

towards the declinations of the Southern Cross and Pointers (α and β Cen) at the time of construction around 1000 B.C. He supported his interpretation with evidence, a small inscribed bronze statue from Egypt, showing a possible association with the Greek constellation of the Centaur. Another structure was claimed to be oriented toward rising of Sirius, and bronze horse hooves from a former statue which was associated with Centaur Chiron and rituals associated with the heliacal rising of Sirius were the evidences supporting Sirius as an intended target.[195]

2.3.3.2. Analysing Light-Shadow Interaction

Light and shadow effect is a phenomenon occurred based on changing light during day and year in accordance to the Sun's movement in the sky. As well as orientation, light-shadow interaction had been used for celestial concerns and it is considered one of the most difficult processes to determine because of the technical issues. McCluskey emphasised that it was difficult to understand if the interaction, either created by nature or by human agency, and it was aimed from the beginning or it was recognised and then used later. The other issue is the geometrical feature of this intention, especially if it has a complex structure.[196]

The light and shadowinteractions was categorised by regarding different mechanisms that cause the phenomena:[197]

- Change in illumination of an interior surface: this change occurs because of an obstacle causing shadow or a feature that allows light on a specific place of a surface.

[195]Hoskin 2001: 37 – 52 in Ruggles 2015f: 520 – 521

[196]McCluskey 2015c: 427 – 444

[197]Preston and Preston 2005: 112 in McCluskey 2015c: 427 – 444

– Sunlight passes through a large aperture in a simple two-dimensional structure and reach on a specific surface

– Sunlight passes through an extended gap in a multifaceted three-dimensional structure, so the change itself becomes dynamic.

The interpretation of any analysis result should be better supported by other kind of evidence, which can be associated with an astronomical intention, such as a mark on receiving surface where the phenomena occur. D'Errico interpreted artefacts with engraved marks as “artificial memory systems” (AMS) which have been used as a physical devise that could store and recover coded information.[198] Therefore, the mark drawn on a surface where the light and shadowinteraction occurs could be a symbolic representation of an astronomical intention. Nevertheless, an image on the surface may not always represent a celestial representation. Aveni emphasised the importance of referring the historical and ethnographic evidences that could inform about the conception of cosmos, so then the coded information could be properly interpreted regarding its cultural context.[199]

For any case of light and shadowinteractions the main fact is using the Sun light (for almost all cases), therefore, it can only occur when the Sun is above the horizon and the changing azimuth of the Sun is the principal factor. It is better not to make any pre-judgmental assumptions like the lights only reach one face of a structure, instead there are examples showing that sunlight may reach on all sides of faces in a structure. Even northern face of structures could be illuminated by the Sun early in the morning and late in the afternoon during summer at the northern hemisphere. Due to the nature of the interactions which depend on local circumstances, there is no universal analysing method for the phenomena. The obstacle which generates the light and shadowinteraction could be a particular geometric shape of a structure's part, or nearby natural land formation such as a rock.

[198]D’Errico 1998: 19 – 50 in Iwaniszewski 2015c: 315 – 324

[199]Aveni 2006 in Ruggles 2015a: 353 – 372

McCluskey termed as a simple edge interaction to describe light and shadowphenomenon in which the shape of the edge determines the form of the shadow on a receiving surface such as a simple straight line, a pointer, a dagger of the Sun light or more complex forms. For example, in the octagonal Tower of the Winds in Athens a simple edge interaction occurs. The surfaces of the tower had been used as a sundial on which the Sun lights were reaching different angles, and causing shadows on different surfaces of the Tower as the Sun moving above the horizon.[200] The Castillo of Chichen Itza is another example for complex interaction where a serpent descending through the staircase appears on the north side due to steps of the pyramid which cast the Sun lights[201].

Another form of light and shadowinteractions occur through an aperture which lets the Sun light get into darkened place and reach a surface. This kind of interaction can show different geometrical features from simple ones to the more complex examples. Belmonte, González–García, and Polcaro made statistical analysis for orientation of temples and sacred buildings in Nabataean Lands, particularly focusing on Petra to understand astronomical concerns related with religious practice. During the on-site observation light and shadow effects were also observed. At the winter solstice Sun set in Ad Deir monument light and shadow effects occurred in the interior where the motab for installation of the sacred baetyls is located. This sacred place is lightened by the setting Sun's light passing by through the gate, and this effect lasts for only a week. Thought that Zibb Attuf, the Pillars of Mericful, was a marker to track the time through shadow casts at sunrise. Their current research results also confirmed Belmonte's previous discovery that revealed astronomical intention for the Urn Tomb. [202] The internal structure of the monument were design regarding to winter solstice, summer solstice sunsets and equinoctial

[200]Stuart and Revett N [1762] 2008 in McCluskey 2015c: 427 – 444

[201]Carlson 1999: 136 – 252 in McCluskey 2015c: 430

[202]Belmonte 1999: 77 – 90

sunset, the sun light illuminated the specific area by passing the main gate of the tomb.[203]

For some cases the whole site itself designed regarding the light and shadow effect. According to McCluskey, the main element which indicates the possible astronomical intention is the presence of at least two collimating edges located at different distances from the receiving surface. The distance provides light and shadow effects and generates images that change dramatically, and often move transversely based on the movement of the Sun. To better analysis the mechanism, he recommended modelling the complete site in 3D. He aggregated different types of multiple edge sites into two general categories, Hovenweep-type site and Fajada Butte-type site.

Hovenweep-type of sites can be distinguished by two roughly horizontal collimating edges that generate images. As a result of non-ideal geometric lines and planes, the expanded blade of light has irregular boundaries appearing separated daggers on received surface. On the other hand, the Fajada Butte-type site is vertical oriented version of Hovenweep-type with two geometrically ideal planes parallel to the main collimating surfaces which provide a constant width beam of sunlight moving across the surface. The interaction has three phases: an eastern border where the image begin to appear; a central region where the image is constant in size; and a western border where the image begins to disappear.[204]

In order to better analysis light and shadow effect an interactive computer graphic model which provides replication of the light patterns as well as its geometry and the complete process itself could be used. The Solstice Project produced a digital model for the Sun Dagger site, of Chaco Canyon in New Mexico. This program accurately displays the physical elements of the site while providing users experience the interplay of the elements with the cyclical movements of the Sun and Moon, and

[203]Belmonte, González–García and Polcaro 2013: 487 – 501

[204]McCluskey 2015c: 427 – 444

evaluate the interaction pattern as markings. The research results showed that the three large sandstone slabs at the Sun Dagger site were used for producing light and shadow patterns on two spiral petroglyphs to mark the extremes and mid-positions of both the solar and lunar cycles, and the equinoxes.[205]

2.3.3.3. Analysis the Position of a Celestial Object

For an archaeoastronomical study, all stars could be assumed to be at the same distance from the observer on the Earth and located on an imaginary celestial sphere. For the naked eye observer, this assumption is acceptable since most of the celestial objects (except the sun, moon and planets) are far enough not to shift their positions among the other stars while observer moves from one place to other on the Earth. Celestial objects on the sky have diurnal arcs by moving across the sky, rise from east and set from west in the sky for an observer facing north, and give a sense that it turns.[206]

The pattern of the stars on the sky had not changed significantly since the early prehistory. However, because of the cyclic precession of Earth's axis of rotation[207], as the equinoxes[208], where the ecliptic and the celestial equator intersects, move along the ecliptic, the declination of any given star and its rising and setting positions shift by 50.2 arc-seconds/year (a complete round along the ecliptic in about 25800 years). Ruggles summarised the changing in declinations of the 25 brightest

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[205]Sofaer, Price, Holmlund, Nicoli and Piscitello 2011: 67 – 92

[206]Kelley [et al.] 2005: 13, 66 – 67

[207]For further reading about precession see Fukushima 2003: 494 – 534; Ruggles 2015e: 473 – 482

[208]Some astronomical coordinates (right ascension and celestial longitude) are measured by using equinox as a reference point. Kelley [et al.] 2005: 66

stars, and recommended to use Stellarium software for visualising the sky appearance of specified time for an archaeoastronomical study.[209]

Changing obliquity of ecliptic is another fact which affects the rising and setting positions of the celestial bodies over a long timescale (of about 41,000 years). Nevertheless, it must be considered and be taken into account for calculation of celestial bodies' positions. The effect of this phenomenon is the maximum on the Sun by reducing the arc of the Sun's movement on the sky. Therefore, particularly for the Paleolithic sites, the astronomical dating by using the rising and setting position of the Sun is considered less reliable than by using stellar positions as a time indicator for dating the structures. The minor and major standstill limits of the Moon's declination, and the extreme rising and setting positions of the planets are also depended on obliquity of the ecliptic and shift slightly in accordance with changing.[210]

In order to calculate the movements of the celestial objects during the specific time of the year and make analysis on its position on the 3-dimensional celestial sphere, a celestial coordinate system is used as spherical geometric matrix. For an archaeoastronomical study, the commonly used coordinate systems are the horizontal system that uses reference points on the earth and it is mostly used to determine a celestial object through a specified direction; equatorial system that uses reference points on the celestial sphere to determine the position of a celestial body; and ecliptic system that uses reference points on the Earth's orbit, and it has two variants as geocentric ecliptic coordinates (which is useful for computing the apparent motion of the Sun, Moon and planets) and heliocentric ecliptic coordinates (which is primarily used for computing the positions of planets and other solar system elements). To estimate the position of the celestial body on the celestial sphere, two

[209]Ruggles 2015e: 473 – 482

[210]Ruggles 2015e: 473 – 482

angles longitude and latitude are used.[211] Determination of the position of a celestial object depends on the observation coordinates and the daily lines of constant declination of celestial body which derived from its azimuth, altitude and latitude values. Except the circumpolar stars, the main celestial events occur on the sky are rising, culmination and setting of the celestial bodies.

2.3.4. Observational Problems

The limiting visual magnitude is one of the main issues for a naked eye observation. Sixth-magnitude star is considered as visual threshold in theory, however, this limits depend not only on the atmospheric conditions but also on the brightness of the sky, the acuity of the observer as well as the altitude of a star. The facts which effect atmospheric condition are:

- Relative humidity and air pollution
- The altitude above the sea level
- The time of the year
- The latitude
- The ground temperature

The Earth atmosphere absorbs almost of all the ɤ-rays and x-rays, ultraviolet and infrared radiation while as ionosphere reflects and scatters away much of the radio frequencies. The closer the celestial object to the horizon, the longer the path length through the atmosphere, therefore, the light of the object is scattered greater owning to Rayleigh scattering off gas molecules, Mie scattering off aerosols, selective extinction from ozone and selective extinction from water (the term

[211] Ruggles 2015d: 459 – 472

extinction refers diminution of the light caused by its passage through atmosphere).[212]

The movement of the celestial object through the sky also changes by times and effects its visibility by standing below or above the local horizon. As mentioned previous chapter, due to the movement of the Sun through the sky, during a period of time a star becomes invisible, then becomes visible again when it is far enough from the Sun on the celestial sphere. When a star visible in the dawn sky for the first time after being invisible it is called heliacal rising, and the last date of a star still visible above the horizon in the evening twilight is called heliacal setting. This mechanical fact had been observed and used for generating a calendar based on the heliacal rising and setting of a celestial object such as Sirius by Egyptians, Canopus by the Arabs, Venus by the Maya, and Pleiades by the Aztec, including even such constellations by the ancient Greeks.[213]

Atmospheric refraction and extinction are two important phenomena which have affect especially on horizon observations of rising or setting objects. Atmospheric refraction causes changes the position of celestial objects in the sky, the altitudes of the objects appear higher than their real positions. It depends on time, season, and location, therefore, the relation between the azimuth and the declination also changes. Shaefer standardised a formula for the refraction depended on average conditions (for the U.S. Standard Atmosphere) to be used in a standard archaeoastronomical study. Dip and parallax corrections are the other facts which should be considered with the refraction correction. The higher altitude observer stands, the more one see over a level horizon, therefore, differs from the depressed

[212] Schaefer 2000b: 121 – 123; Kelley [et al.] 2005: 49 – 50

[213] Schaefer 2000b: 124

horizon. The amount of parallax observed, on the other hand, depends both on the distance of the object and on the size of the observer's baseline.[214]

Atmospheric extinction causes in reducing the celestial object's luminosities so then effects visibility of celestial bodies especially when it is closed to the horizon, and it is only irrelevant for the Sun, Moon and Venus because of their magnitudes. It depends on its thickness, it is proportional to the reverse cosine of zenith distance. According to Schaefer, determination of atmospheric extinction was important in analysing horizontal alignment, and beside the Sun, Moon and Venus only the brightest starts could actually have been observed at rising and settings points because of the atmospheric scattering and haze. Precession and proper motion are the other facts that effect star positions over millennia, and their effect is more noticeable where the ecliptic crosses the equator. [215]

2.3.5. Software and Instruments used in Archaeoastronomy[216]

Today's technology such as digital measurement equipment, terrain modelling methods, mapping productions, and landscape analysis software leverage the study data with high-quality results by combining digital environment with simulated sky appearance in order to better understanding and explaining the processes.

Visualisation Programs for Sky View – Planetarium Software

- Most of the visualisation programs provide 3D simulation of virtual universe, display the sky view from any location on the Earth at any date and time from thousands of years in the past and future, and calculate the position of the solar system objects as a default feature. Desktop planetarium software

[214] Schaefer 2000b: 124 – 125; Kelley [et al.] 2005: 61 – 64

[215] Schaefer 1986; Kelley [et al.] 2005: 50

[216] For further reading about instruments used in archaeoastronomy see Prendergast 2015: 389 – 409; Schaefer 2000b: 121 – 136

provides sky view, some including a horizon panorama with resembling the landscape surrounding the observatory.

– Sky and Telescope: Astro Software, http://www.skyandtelescope.com/astronomy-equipment/software/

– Starry Night is planetarium software which provides 3D simulation of virtual universe including detailed interactive multimedia tutorials; display the sky view from any location on the Earth or any position in the solar system at a given date and time in the past or future; calculates the position of the solar system objects, and so on.http://astronomy.starrynight.com

– Go Sky Watch is an application displaying the sky view at the correct orientation where pointed to the sky. http://www.gosoftworks.com/GoSkyWatch/GoSkyWatch.html

– Stellarium is a software to visualise the sky view in 3D from a given point at a given date while as provide widely control over visualisation of additional grids, projection types and so on. The software gives realistic atmosphere, sunrise and sunset views. http://www.stellarium.org

– SkyPaint is a program for creating and editing 3D, seamless, 360° panoramic sky view images. http://www.skypaint.com

– Horizon Finder is a program which scanning a greyscale image in Adobe Photoshop format and giving digitised and calibrated horizon profile. The program calculates the azimuth, altitude and declination of sequence of the digitalised and calibrated horizon profile from one side to the other.

http://www.le.ac.uk/archaeology/rug/aa/progs/HorizonFinder.html

– Vertical Mapper is a spatial data analysis tool providing 360 degrees panoramic view by using geographic coordinates.

http://www.mapinfo.com/product/mapinfo-vertical-mapper/

– ER Mapper provides 360 degrees panoramic view

http://www.geoinfo.rs/E/ErMapper_e.asp

Calculation Programs for Positional Astronomy

– MICA (Multiyear Interactive Computer Almanac) is a software system that provides accurate information on the positions, motions, and phenomena of celestial objects with a computational date range from 1800 to 2050. http://www.willbell.com/almanacs/almanac_mica.htm

– DECPAK is a set of three DOS programs which help to calculate declination values from field survey data

- PBERRS is a program to calculate collimation error, maximum centring error, plate bearing of zero centric error, and standard deviation of one observation.

  http://www.le.ac.uk/archaeology/rug/aa/progs/pberrs.html

- STIMES calculates the correction derived projection of horizon profile (PB-Az correction), provide to ameliorate instrumental errors, give the Sun's azimuth from a given location at a given time

  http://www.le.ac.uk/archaeology/rug/aa/progs/stimes.html

- GETDEC is a program to calculate declination value of horizon point as viewed from a given point

  http://www.le.ac.uk/archaeology/rug/aa/progs/getdec.html

– DECTOAZ calculates the corresponding azimuth on the eastern and western horizon through a given declination, latitude of the site and altitude of the horizon.

http://www.le.ac.uk/archaeology/rug/aa/progs/oddsnends.html

– SUNUP.BAS, times of sunrise/set at any place on Earth
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– ALTAZ.BAS, star altitude and azimuth at a given time
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– XYZ.BAS, x y z coordinates of the Sun
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– SUNSHINE.BAS, hours of sunshine for a specific latitude
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– HELIAC.BAS, heliacal rise and set times
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– CHART.BAS, find atlas charts for any celestial coordinates
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– PRECESS.BAS, rigorous precession of a star's coordinates
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– LUNAR.BAS, compute dates of lunar eclipses
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– PERIAP.BAS, compute lunar apogee and perigee
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– MOONS.BAS, dates and times of the new and full moon
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– MOONFX.BAS, Moon phases and distance on any given date
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– MOONUP.BAS, compute moonrise-moonset times for any place
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– VISLIMIT.BAS, visual limiting magnitude from any site
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– EXTINC.BAS, compute extinction of starlight
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– OCCVIS.BAS, Compute the visibility of a star near the Moon
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– ALTAZ2.BAS, correct altitudes for refraction
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– REFR1.BAS, compute atmospheric refraction
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– SUNTAN.BAS, effects of ozone, haze, on suntanning time
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

– LIST.BAS, make index list of objects on star atlases
http://www.skyandtelescope.com/astronomy-resources/basic-programs-from-sky-telescope/

Calculation Program for Ancient Calendar Systems

– Pohualli is a computer simulation used for Mesoamerican Calendar System. The main purpose of this program is to convert quickly a date in Christian calendar into the Maya or the Aztec calendar, or vice-versa.
http://www.le.ac.uk/archaeology/rug/aa/progs/pohualli.html

Programs for Processing Geographical Information

– A GIS program is system which designed to digitalise, store, manage, analysis and display spatial and geographical data. Since location is the key index, it is widely used in archaeoastronomy as well as archaeology. The Most commonly programs used in archaeoastronomy is ArcGIS. If the digitalised survey data include digital terrain model with proper accuracy, after georeferencing the data illumination by the Sun or Moon could be simulated. Programs allow to analysis orientation in relation to important natural directions toward an astronomical event.[217]

– SDI (Spatial Data Infrastructure) as service-oriented software displays heliacal rising of the bright stars and planets and present in mapping in order to detect possible alignment by regarding proper motion of the stars, precession, correction for atmospheric refraction; dates historical events throughout the eclipses, calculated with JPL's Horizon software, depended on the local circumstances; and calculates azimuth of the Sun and Moon over the horizon.[218]

[217]Zotti 2015: 447

[218]Mejuto, Rodríguez-Caderot and Castaño 2012: 117 – 132

– Genesis can be used to generate realistic landscapes derived from topographic maps http://geomantics.software.informer.com

– GRIDLA converts a Transverse Mercator Grid easting and northing to latitude and longitude, and calculates convergence, local scale factor and bending as well. http://www.le.ac.uk/archaeology/rug/aa/progs/oddsnends.html

– LAGRID converts latitude and longitude to a Transverse Mercator Grid easting and northing, and calculates convergence, local scale factor and bending. http://www.le.ac.uk/archaeology/rug/aa/progs/oddsnends.html

Programs for Processing Archaeological data

Architectural visualisation systems allow to digitalise archaeological data and display reconstructed structural remains derived from laser scanning. Documented 3D modelling of monument or complete site allows to simulate daylight process. Virtual reconstruction of ancient architecture display plausible reconstructions of structures or even complete site itself which allowing to better understanding of spatial relationship between the structures. However, this methods has been criticised as not been scientific instead fantastic. Virtual models, on the other hand, displays data generated from digital recording techniques and provides more realistic results.[219]

– Spazz3D can be used to make simple VRML (Virtual Reality Modelling Language) models http://www.spazz3d.com

– Autodesk provides technical preview in 3D formats,

Instruments used in Field-Survey

– GNSS (Global Navigation Satellite System) is a satellite based navigation system that is used to position the user. http://searchnetworking.techtarget.com/definition/GNSS

[219]Zotti 2015: 446

- Gyro Station Techniques is combination of a theodolite and a suspended gyroscope designed for underground use. It provides rapid and high accuracy orientation surveys, particularly inside the burial chamber, a tomb or a building.
- Geodetic Techniques are used for positioning, mapping and navigation tasks.
- Hand-held compass and clinometer are sufficient to measure with and accurate to about 1°[220]
- Total Station is an electronic distance meter used in modern survey in archaeology. It is used to document the outline and topography of top and bottom surface of single trench or archaeological feature.
- 3D Optical instruments:
    - Terrestrial laser scanning (TLS) is a ground based technique to measure the position and dimension of object or structure in three dimensional spaces. It allows to produce an accurate and detailed surface model.[221]
    - Photogrammetry is a technique to make measurements from photographs, and provides reliable information about physical objects and the environment with 3D geometry and texture. Images like satellite, airborne, balloon, UAVs, terrestrial and even underwater images can be used to build a 3D model.[222]
    - Structured light scanner (SLS) measures the 3D shape of an object, rock carvings of inscriptions in a stone surface using projected light patterns and a camera system.[223]

[220]Ruggles 2015c: 411 – 425

[221]Doneus et al. 2011: 81

[222]Barsanti, Remondino and Visintini 2012

[223]Zotti 2015: 451

2.3.4. Analysing Symbolic Representation of Astronomical Events, Celestial Objects, and Artefacts Related to an Astronomical Intention

Archaeological remains are perceived as material traces of human activities that were organised in fragmented patterns structured in regard to a cultural system. Anthropologists define culture as a system of mental constructs which coded wide variety of information. This information was attained through dialectical interactions of people with their external environment, and turns into a systematic knowledge that were constructed upon the foundation of common-sense knowledge. As the collective information changed over time, people's perceptions and concepts of external environment also changed. The knowledge of cosmological system, techniques for observation, and methods for interpretation of the celestial phenomena are directly related with the groups' interest and need collective efforts. Therefore, the concepts of space and time could be considered as cultural products, products of thought which were embedded and embodied in physical objects.[224]

Artefacts are part of the material world of people. They were designed in purpose to serve for a specified task, and actively used in daily life as having meaning and significance. Therefore, they are considered as self-evidence and defined by their functions. Unless their function indicates, they are non-symbolic. Such artefacts (as notched bones, clay tablets, and ochre plaques), rock arts, and reliefs could have had direct or symbolic relation with the celestial events. They could be a graphical presentation of the celestial object that may include the place of the object on the sky; a symbolic representation which was associated with particular astronomical event; or for some case both intentions were reflected.[225]

For a processual approach symbol is considered as representing social realities, they serve to their viewers as an instrument that transmits information and meanings, therefore it has a material life created and governed by human intentions.

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[224]Iwaniszewski 2015a: 3 – 14; López 2015: 341 – 352; Handwerker 1989: 313 – 326

[225]Iwaniszewski 2015a: 3 – 14 and 2015b: 287 – 300; Murray 2015: 239 – 249; Robb 1998: 329 – 346

On the other hand, form a postprocessualist approach, symbols was considered as a theme which constitutes and structures social reality. Some scholars also argued that symbol was culturally emergent, therefore, its meaning depended on the interaction between artefact and people who used it and it was not fixed but contestable, thus it had a fragmented nature consists of qualities such as colour, shape, and size. This poststructuralist approach seeks an explanation to understand how it was experienced through their pre-fixed referent, if there were, instead of formal or economic qualities of artefact.[226]

Robb listed key aspects of symbol related with meanings such as iconic or representational, structural or rational, and phenomenological or experiential meanings; its contexts such as grammars, variations of form, technique, and decoration; and quantitative and qualitative natures of the artefact such as perceptual aspect (visual, auditory, tactile features), and economic aspects of artefact manufacture and circulation, artefact life history from manufacture through deposition. He also enlightened how different research approaches to one specific subject, particularly Upper Paleolithic art, brought different study results. According to Robb, the methodology should involve contextual analysis of artefact use, structural analysis of cultural principles, iconographical analysis of depicted figurines and art.[227]

Attempting to attribute an astronomical meaning to a symbolic representation or to an archaeological artefact is one of the difficult interpretations due to the fact that astronomical interpretations of symbols are considered approvable if the evidence can be supported by contextual evidence. Ruggles termed this form of archaeological evidence as “symbolic counts of things” that representing symbolic expression of perceived relationships with celestial objects and events in the sky.[228]

[226]Robb 1998: 329 – 346

[227]Robb 1998: 335

[228]Ruggles 2015a: 353 – 372

The most common forms of representations are calendrical symbols, maps and charts.

According to Smedt and De Cruz, the invention of calendrical systems during the Middle to Upper Paleolithic transition was a behavioural innovation as well as technological one, and could be considered as an extension of internal time presentation which enables people to project past events into the future by containing symbolic information. Artefacts such as shell beads, notched bones, and plaques are the earliest examples of artificial memory systems storing information in order to recall and predict such events accurately than is possible with episodic memory.[229]

Artefacts were productions of cultural prototypes to construct and negotiate collective concepts and social relationships, and symbols were often objective addressing a particular context of the mind by referring common ideational representations that remain stable across the individual differentiation. Accordingly, they involved subjective judgments, and long-term changes in terms of meaning became problematic.[230] So then, interpretations are often considered as speculative. As mentioned earlier, even though the idea of representation of star patterns and counting calendar seems acceptable from an astronomical point of view, it could be an accidental match. Therefore, to make a reliable interpretation, it is important to verify the association with an astronomical intention through cultural indicators.

According to Ruggles, even though the number marked on a surface or an artefact have an explanation, it does not have always a meaning related with an astronomical event, unless any other evidence supporting the assumption.[231] He emphasised that there was no need to try to explain every number, and he recommended to analysis symbol counts in pictographs or petroglyphs in regards to relevant contextual evidences. Selecting some symbols and not the others; ignoring

[229]De Smedt and De Cruz 2011: 63 – 76

[230]Abrantes 2009: 480 – 486; Handwerker 1989: 313 – 326

[231]Ruggles 2015a: 353 – 372

that symbolic usage is a system and needs to be analysed as a whole system; and making assumptions for missing part are some facts which may cause misinterpretation of data.[232]

In 1960s the first scientific methodological approaches were established in order to analysis symbolic count dated to Paleolithic Period. Research results showed some interrelation between lunar cycles and rhythmic grooves, and pits. The mammoth's tusk fragment (found at Gontsy Upper Paleolithic settlement in Ukraine) dated to 16-12 millennia B.C. is one of the early examples that were considered as an arithmetical coding system in order to mark astronomical events. This mammoth's tusk has lines with two distinct lengths (one longer and several shorter ones afterwards followed by sae patterns, in total 32 long and 78 short lines) showing a pattern. This pattern of lines was interpreted as representation of lunar phase observations during the lunar months where V-vivide line was the axis of time and lines with different lengths representing the phases of the Moon.[233]

According to Pasztor, atmospheric phenomena, giving the Sun and Moon special appearances (for this case; the incoming light was diffracted, refracted, reflected and diffused when they are low in the sky or when in the atmosphere there are ice crystals, especially during the winter, in regions at higher altitudes or in areas at higher latitudes), cause corona (colourful concentric rings encircling one in an others) or halo phenomena (various complex form as sun dogs, light pillars and light crosses, light rings and arcs and so on) were also represented on artefacts. She also proposed that the importance of the number three was derived from the sun dogs phenomenon which could be observed around both the Sun and Moon, and the prototype for disk-shaped pendants with concentric circles and a central spike may have represented the light pillar.[234]

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[232]Ruggles 2015b: 373 – 388

[233]Vavilova and Artemenko 2009

[234]Pasztor 2015

Based on study results done on Bronze Age representation found in Hungary, Pasztor suggested that there was an increase in the similar representations found through the world indicating the symbolic presentation of the Sun and Moon due to the fact that the volcanic activities increased in the 17th century B.C. resulting in extending significance of the atmospheric phenomena. According to Pasztor, the most commonly occurring symbol circle with four spokes has been misinterpreted either as a symbol of the four-spoken wheel of the Sun god's chariot or as representing the Sun with four cardinal points. Instead, it represented the Sun surrounded by a light cross and a halo occurred because of the atmospheric phenomenon. The Bratislava type bowls dated to the Late Copper Age, the Golden Cone of Ezelsdorf-Buch and the Berlin Gold Hat dated to the Late Bronze Age (14th - 8th century B.C.) are examples of artefacts that have similar symbols that were interpreted as four sun dogs observed symmetrically around the Sun because of the specific atmospheric condition.

CHAPTER 3

KERKENES

Kerkenes Dağ is located on the border of Şahmuratlı and İdrisli villages in Sorgun (coordinates is 39°45′00″N 35°03′56″E) with an altitude of 1,500m. The settlement encompasses an area of about 2.5 km^2 on a low granitic mountain and it is surrounded by 7 km long fortification with seven gates. The natural defensive properties and permanent freshwater sources provided suitable environment for the ancient city to have a control over the region.

The chosen location for the settlement has a geopolitical importance. It is found at the intersection of natural routes in north-south direction which connected the Black Sea to the Mediterranean, and the trans-European east-west highway which connected the Persian lands with the west. The strategic position of the city leads it to have control over northern Cappadocia plateau including important roads while being supported with natural defensive features of the topography of the region.[235]

3.1. Archaeology at Kerkenes

The site was first examined by J.G.C. Anderson in 1903. In his paper, "A journey of Exploration in Pontus (1903)", he identified the city as the Galatian site of Mithradation, however, no evidence had been found to support his suggestion for the identification.[236] In 1926, H.H von der Osten visited the ancient site with fellows from the Oriental Institute of the University of Chicago who had begun a campaign of research in the basin of the Halys River (today called Kızılırmak). He briefly

[235] Summers 2000

[236] Summers 2001

mentioned the site at Kerkenes Dağ in his report (1926). Forrer, the Hittitologist, was also interested in the ancient site and suggested that remains could have belonged to the Cimmerians.[237] The following year, in 1927, accompanied by Erich Schmidt and Frank H. Blackburn, von der Osten carried out a more detailed survey of the site. With the help of Blackburn, a detailed map of the walls with the towers and gates were prepared. He tried to understand the relations between the site and the surrounded region including a tumulus. Based on the location and the size of the city, von der Osten suggested that the site must have had a dominating power over its surrounding region. He resembled the fortification walls to those at Boğazköy, and he associated potsherds with Hittite examples found at nearby sites dated to the Hittite period.[238]

In 1927, in order to obtain more information about the ancient site at Kerkenes, Dr. J. Breasted, the director of the Oriental Institute, suggested to organise test excavations. Accompanied by R. Martin, F.H. Blackburn, K.V. Brand and J. Reifenmüller, who were all members of the Institute, Erich F. Schmidt conducted an on series of test excavations.[239] Their main concern at Kerkenes Dağ was to determine whether the site had been built during the Hittite Empire period or during some preceding or succeeding period. Byzantine, Roman and Greek periods of occupations had been detected during their stratigraphic studies. Schmidt argued that the ancient city on Kerkenes Dağ was built completely by the first-comers based on the results from the test excavations and surface surveys, which showed uniformities both in the arrangement of the site plan, which is even easily traceable from the surface, and the materials found in different structures. He proposed that the ancient site was post-Hittite pre-Classical, and later he dated the city to the Iron Age period. Based on the stratigraphical studies, a second occupation may seem to have taken

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[237]The Kerkenes Project Official Web site, http://www.kerkenes.metu.edu.tr/kerk1/04explo/histexpl/index.html

[238]Von der Osten 1928

[239]Schmidt 1929

place probably during the Hellenistic period and/or more strongly possibly during the Roman period. According to Schmidt, neither Romans nor other occupants could have successfully occupied the whole city. During the excavation season, Dr. Julius von Mészaros, the co-director of the Ethnological Museum in Ankara, visited he village of Şahmuratlı, and conducted some ethnological studies.

In 1993, a long-term archaeological study, the Kerkenes Project, was started by Francoise and Geoffrey D. Summers under the auspices of the British Institute at Ankara (BIAA) with a permit granted by the Turkish Ministry of Culture. During annual fieldwork remote sensing techniques and traditional excavation methods were combined to obtain deeper understanding about the Iron Age site.[240] Francoise and Geoffrey Summers conducted the Kerkenes Project supported by funds from the National Geographic Society, the BIAA, METU, The British Academy and mores, for more than two decades.[241] Today, excavations are leaded by Scott Branting from the University of Central Florida.

3.2. Identification of the Site

Anatolian Iron Age started around 1200 B.C. – 1180 B.C., around the time of the collapse of the Hittite Empire and the simultaneous destruction of the Mycenaean centers.[242] Following the collapse of the great empires that dominated the 14th and 13th centuries, the entire political and administrative structure of Anatolia dramatically changed and new Iron Age communities rapidly emerged.[243] Ancient urban centers became independent kingdoms as less centralised political and

[240]Summers and Ahmet 1995

[241]The Kerkenes Project Official Web site, http://www.kerkenes.metu.edu.tr/kerk1/14spons/prospon/index.html

[242]Thuesen 2002: 43 – 55

[243]Kealhofer, Grave, Bahar and Marsh 2015: 342 – 357

economic configurations, and Neo-Hittite culture appeared.[244] Some of these city-states were new formations but some were reformation of earlier urban centers.[245] However, within this complex political geography none of them played a dominant role in forming of a political structure over a wide region. Often the city was a large urban center, located specifically at the strategic points of the old trade routes[246], with a fortified citadel encompassing private houses and temples that were surrounded by a lower town within the city wall as a result of increasing concern for security. The Hittite traditions lasted for another five centuries, and new city-states were under the influence of the Hittite culture in architecture and cult practices.[247]

The introduction of iron was the main factor that changed the social stratification in society by providing non-elites the use of more effective tools for the first time since the Neolithic Period.[248] Thus, increase in use of iron also influenced the balance of new economic and military powers of kingdom and tribes over the region, and affected their interactions which determined their destiny.[249] By the early 8th century there was neither a great capital nor a centre for regional power[250] until the rise of Alişhar Höyük[251].

The hieroglyphic alphabet was expanded, and followed synchronously by the spread of religious believes with strong affinities to the Hittites.[252] Luwian monumental hieroglyphic inscriptions were adapted to the new traditions, and started

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[244]Thuesen 2002: 43 – 55

[245]Mazzoni 1995: 181 – 191 in Thuesen 2002: 43 – 55

[246]Çapar 1987: 43 – 75

[247]Sagona and Zimansky 2009: 291

[248]Sagona and Zimansky 2009: 291 – 299

[249]Özdemir 2007: 501 – 518

[250]Summers 2009a

[251]Summers 2009b

[252]Sagona and Zimansky 2009: 291 – 299

to be widely used as well as sculptures of lions, sphinxes or other mythological creatures located at the gates, which continued the Hittite traditions in the Neo-Hittite city-states.[253] By the end of the 8th century B.C. Phrygians in the west, Urartians in the east, Tabal in the general area of northwest Cappadocia had become dominant political powers over their territories.[254] Phrygians and Urartians gave rise to transition from bronze industry to iron technology result in expansion of iron usage all over Anatolia.[255]

The identification of the ancient site on Kerkenes Dağ has not been easy because of the short occupation period of the site and the inadequate knowledge about the Iron Age period. As mentioned above, Anderson was the first scholar who attempted to identify the site as the Galatian city of Mithradation in 1903.[256] According to Forrer, this impressive city with the fortification walls was the capital of the Cimmerians (1927).[257] Schmidt proposed that the city could be dated neither to Hittite nor pre-Hittite, but possibly to post-Hittite more closely to pre-Classical Period. A second occupation took place possibly during the Hellenistic period, but the city was definitely reoccupied during the Roman period, particularly Kiremitlik and the Kale were reinhabited.[258] According to Summers, there were no indication of specifically Hittite or Neo-Hittite tradition at Kerkenes.[259] Gurney[260] and Gorny[261] identified Kerkenes Dağ with a Hittite sacred mountain in their independent research

[253]Thuesen 2002: 43 – 55

[254]Kealhofer et al. 2015: 342 – 357; Çapar 1987: 43 – 75

[255]Özdemir 2007: 501 – 518

[256]Summers 2001

[257]Forrer 1927: 38 – 39 in von der Osten 1930: 54

[258]Schmidt 1929: 83 – 97

[259]Summers 2009a: 662

[260]Gurney 1995: 69 – 71

[261]Gorny 1997: 552

results. According to Gorny, although there was no direct evidence of a cult area, Kerkenes must have been an important cult center, Mt. Dahha.

Based on the size and the short time period of occupation, von der Osten suggested that it may have been the city of Pteria mentioned by the Greek historian Herodotus.[262] Not only the location of the site but also its physical features fit well with Herodotus' descriptions (Book I, chapter 74).[263] The foundation of the Pteria was predated to the end of the Six-year War between Medes and the Lydian, around 600 B.C. According to Herodotus, the Median-Lydian war ended in the afternoon of May 28th 585 B.C. because of the total solar eclipse.[264] History memorised this war as the Battle of the Eclipse, and peace was sustained by the exchange of marriages between the two kingdoms.[265] Pteria could have played an important role as a central place of the western extension of the Median Empire and aimed to become the strongest place in Cappadocia region. Herodotus located the city Pteria at the east of the Halys River and due south of Sinop. The Byzantine geographer Stephanos also mentioned Pteria, however, whether he referred to Herodotus as a source or not is not clear.[266] Nevertheless, they both distinguished native Cappadocians from the Pterians. On the other hand, no archaeological and epigraphic evidence had been found so far to prove this identification.

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[262]von der Osten 1930

[263]Summers 1997

[264]Two annular eclipses between 588 B.C. and 581 B.C. were calculated for the most potent in Asia Minor, but the coverage area of each eclipses was no more than 0,96 of the Sun. Therefore, Herodotus' account of the onset darkness by day which interrupted the war is doubtful. Nevertheless, the calculated date for the solar eclipse in 585 B.C. is remarkably close to that mentioned by Pliny in the 1st century A.D. But, he did not mention about the battle, in fact, he noted that foretold solar eclipse occurred in the region of Alyattes in the 170th year after the foundation of Rome. Eventually, a solar eclipse in May 28, 585 B.C. in Asia Minor is certain but the relation between the battle is debatable. Stephenson 1997: 342 – 343

[265]Summers 1999; Summers, Summers, Özcan and Stronach 2000

[266]Summers 1997

The research results derived from the archaeological studies done under the Kerkenes Project highlight that the ancient site on the Kerkenes Dağ was a new foundation, an imperial city which was culturally Phrygian and established in the second half of the 7th century B.C.,[267] Middle Phrygian Period, and there is no evidence indicating an early occupational phase. The ancient site was classified as a city based on its size and density of building complexes; multi-function of the site with administrative, military and storage areas including religious components; and differentiation between the residential urban blocks suggesting some social stratification.[268] Summers also supported the identification of Kerkenes with the historical city Pteria based on the site location; foundation period; the short period of occupation; unfinished constructions of monuments; the centralised city planning; architectural features, particularly columned hall and a type of building which reflects Iranian tradition; and lack of later occupation.[269] E. Dusinberre also agreed with this identification and argued that there was no other major urban mound around this region which confirmed Herodotus' description. She considered Kerkenes as western edge of the expansionist Median state[270], and interpreted discovery of ivory as an evidence of gift exchange between Lydia and Media around 580 -570 B.C.[271]

However, Ş. Dönmez found Summers' argument debatable due to the fact that Pteria was mentioned to be close to Sinop (Kerkenes is about 400km far from Sinop) and no information related to the Medians was given in Historia I, 76 by

[267]According to Summers, the foundation of the site is no earlier that the mid seventh B.C. and he supports his idea with pottery analysis and sculptural sytle in Summers and Summers 2012; Summers 2009a: 662

[268]Summers 2000

[269]Summers 1997; 2006a; 2009b; Summers and Summers 2000

[270]Identification with the Median state was proved wrong by excavation results, instead supported the identification with the Pteria of Herodotus, called "a city of the Medes" by the Byzentine geographer Stephanos. Summers and Summers 2000

[271]Dusinberre 2002: 17 – 54

Herodotus.[272] According to Dönmez, Summers' argument is not supported by adequate evidence. Based on the architectural remains and other ancient written sources, he suggested that the Akalan Castle (about 160km far from Sinop), located on the border of Çatmaoluk village in Samsun, was Herodotus' Pteria which was first put forward by T. Macridy in 1907.[273] According to V. Sevin, the site on Kerkenes Dağ could have been related to an Iron Age Anatolian local kingdom, possibly to Kaşkili Dadilu.[274]

Whether the Iron Age city on Kerkenes Dağ was Herodotus' Pteria or not, the site was established to be an imperial foundation having a military and administrative purpose rather than as a self-sustaining city that was economically supported by surrounding countryside.[275] The city was interpreted as a new foundation based on the whole defensive system of a single design, one building period, centralised urban plan including developed inner streets network, urban blocks, and water management systems. Thus, research results showed that the major streets and many of the urban blocks were laid out only after the construction of the city defences.[276]

Kerkenes was founded in a region where political configuration and the balance of power of the region were dynamically changing once again. By the 670 B.C. Phrygian kingdom lost its power over Lydia, and it was under the danger of collapse[277]. While as Medes became dominant in the east of the Kızılırmak[278]. In 614 B.C. Medes attacked to the Neo-Assyrian capital Nemrud, and by the 590-589 B.C.

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[272]Dönmez ?: 67 – 91; Bilgi, Atasoy, Dönmez and Summerer 2000: 279 – 296

[273]Macridy 1907: 167 – 175 in Bilgi et al. 2000: 282

[274]Sevin 1998: 60 – 61 in Bilgi et al. 2000: 284

[275]Summers and Summers 1994

[276]Summers 2006a

[277]Çapar 1987: 43 – 75

[278]Sagona and Zimansky 2009

were fighting against the Lydians who intended to extend into central Anatolia.[279] By 643 B.C. Urartu lost all its political power which it gained between the middle 9th and late 8th centuries, and never had a significant control over the southwest Asia.[280] In c.550 B.C., Persians increased the power over the Medes, and Cyrus the Great established himself as a king over the united Medes and Persians which started the Achaemenid Period.[281]

Evolution of local traditions including emergence of monumental sculptures, loss of political centralisation, spread of hieroglyphic writing as both continuity and adaptation to the newly developed traditions, and the wide spread use of iron were the main facts of the transition from the Bronze age to the Iron Age. Kerkenes as being considered the largest pre-Hellenistic city known in Anatolia[282] purveys important information in order to understand the period. The estimated time for the foundation of the city was contemporaneous with the time when the balance of political power of the region was critical. Thus, the size of the city and its location, where important routes crossed, clearly indicate the intention of controlling the region as well as the concern of security. Carefully chosen site location, elaborately designed settlement's pattern, and hierarchical architecture and its style, monumental sculptures show the influence of Phrygians, Lydians, and the Neo-Hittite kingdoms on the founders of Kerkenes.

Even though first impression of the city recalls some similarities with Neo-Hittite cities such as Carchemish and Arslantepe: defensive walls pierced by gates (lion sculpture placed at monumental gate way in Aslantepe) surrounding cities which had strategical location providing control over their territories,[283] in Kerkenes

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[279]Summers 1997: 81 – 94

[280]Smith 2000: 131 – 163

[281]Curtis and Stewart 2005: 123, 126

[282]Sagona and Zimansky 2009: 367 – 370

[283]Thuesen 2002: 43 – 55

there were no internal defences separating the citadel from the rest of the city, instead a palatial complex with a narrow enclosure wall was constructed.[284] A closer examination of architectural techniques, particularly architectural stone works, displayed similarities to the ones found in Eskişehir-Afyon region of Phrygian Highlands,[285] meanwhile, megaron type buildings found in the Palatial Complex were well known from Gordion.[286] Nevertheless, the stone defences supported by a stone glacis which reminds cyclopean style, defence system with towers with unique architectural design, hierarchical architecture used in separate city zones within the centralised city plan were unique features of Kerkenes for which no parallel example can be found in Phrygia.[287]

In order to understand the interaction between the three Iron Age sites in Yozgat province; Çadır Höyük, Kerkenes and Tilkigediği Tepe, and provide regional frame on economic and political change during the Iron Age, local and non-local ceramic productions were analysed.[288] Based on the results, it became clear that Kerkenes served as an urban centre for regional trade and administration obtaining goods from a wider region, and the founding of the city possibly had a major impact on nearby settlements. Not only the existence of non-local jar/jug sherds but also other artefacts such as ivory are evidences which support the urban role of this ancient site.

Systematic research at the entire site was done through remote sensing, and it showed that the city was a continual building site. Besides the crowded structures within the city blocks, there were some suitable areas for further buildings without a need for reconstruction or demolition of the old ones. Unfinished defences and much

[284]Summers 2013

[285]Summers 2006c

[286]Summers 2007; Sagona and Zimansky 2009: 353 – 362

[287]Summers 2013

[288]Kealhofer et al. 2010

of the city buildings indicate that the city was not completed by the time of its destruction, and it was only occupied for about a century by the final destruction in the 540s B.C. It is thought that the destruction of the city was connected with the conflict between Cyrus the Great of Persia and Croesus King of Lydia while as Phrygian kingdom begun to lose its power over north central Anatolia. Lydia and Media, on the other hand, were applying an expansive strategy during the early 6th century B.C.[289] According to Summers, the city did not seem to have been burnt when it was captured, thus, it took several days for it to burn by a catastrophic fire,[290] and the intention was to destroy the whole city so it included systematic torching of structures.[291] The final destruction and abandonment of the city took place in the 540s just before the "Battle of Pteria" by either Croesus or Cyrus the Great who conquered Anatolia. There is no evidence for Median garrisoning at Kerkenes.

The ancient site has unique architectural features incomparable to any Iron Age city.[292]The urban area was settled inside the fortification walls built according to the topographical features of the mountain. The layout of the city allows citizens to easily access anywhere inside the walls by mainly straight streets as best using the land features where out crops of rock and slopes were seen.[293]The whole city seems to have been planned based on an ideal urban concept including all the essential elements for an imperial foundation such as royal, administrative, religious, military and residential zones indicating some degree of imposed order within the city walls regarding to the land usage. The location of the seven city gates with different structural plans were considered to have been chosen strategically in relation to natural routes as well as connecting the main inter routes. The architectural forms

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[289]Summers 2009a

[290]Summers and Summers 2012

[291]Summers 2000

[292]Summers 1997

[293]Summers 2006a

and the plan of the city bring to mind traditional architecture on city planning from the East. Unlike the Greek cities there was no acropolis, no internal walls separating rural and urban zones. This arrangement indicates that the occupants were supporters of the local government.[294]

The complexes were intended to contain relatively small population, especially for an elite society, probably for colonial or imperial community.[295] Unlike the other examples of its time, Kerkenes did not have a royal citadel. Freestanding two-roomed building with a gabled thatch-covered roof was the standard building type of the city and it resembled the megarons found at Gordion. Both construction techniques of the architectural remains, and material remains displayed characteristic features of the Phrygian culture, and posit the idea that the whole population of the city migrated from the west.[296]

The wide range of archaeological finds belonged to both elite and non-elite societies. Material remains include cult images, (aniconic and semi-iconic) idols and, variety of pottery and inscriptions with graffiti in alphabetic scripts of Phrygian language. The use of Old Phrygian language in the graffiti on vessels as well as sandstone blocks at important public spots, like the one found close to the Cappadocia Gate, support the idea that the daily and administrative language of the city at Kerkenes was Phrygian.[297] If the identification of the city with Pteria is accepted, then, Pterians were of mostly Phrygians, and the founders of the city were a part of a larger group of migrants from centre or western Phrygian Highlands.[298] There is no significant evidence of any trace of assimilation of local tradition.[299]

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[294]Summers 1997

[295]Summers 1997

[296]Summers and Summers 2013

[297]Summers 2006a

[298]Summers and Summers 2012

[299]Summers 2013

Sculptures of sphinx or griffin, steles (located at the gates/entrance), the life size statue (interpreted as the Phrygian goddess Matar[300]) found in Kerkenes were typical cultic features of prehistoric of Anatolia. The earliest example of Mother Goddess figurines and reliefs found in Çatalhöyük were dated to the Neolithic Period, and interpreted as the prehistoric examples of the Greek and Roman Cybele by L. Roller.[301] Some of the figurines found at Çatalhöyük and Hacılar were depicted in sitting position on a throne supported with animal figures (felids).[302] After the rich material of Neolithic period, there were only few examples that appeared until the first millennium B.C. The Hittites occasionally used female deity, thus the concept of the sacred mountain, attention paid to underground water sources emerged in the Hittites culture from which the Phrygian were influenced. Sculptural works of Phrygians, on the other hand, displayed similarities with the Neo-Hittite' examples. Three of Kubaba reliefs from Karkamış were placed at the entrance to the main center of the city. It was the Phrygian that brought back the depiction of the Mother Goddess, and spread it to a wider region.

As a conclusion, although the similarities reflecting influence of previous and contemporaneous cultures, Kerkenes does not fit to any generalised descriptions. The city provides important information about the dynamics of the Iron Age as well as the transition from the Bronze Age in order to better understand the development in settlement pattern, interactions between different cultures and influences of one on another, economic and political development of the region.

[300]Branting 2009: 88 – 95

[301]Roller 1999: 28

[302]Dündartepe, Etiyokuşu, Tilmenhöyük, Canhasan, Horoztepe, Beycesultan, Hacılar, Kültepe, Alacahöyük, Konya Karahöyük were the archaeological sites where other prehistoric examples of Mother Goddess were found. Oral 2014: 156 – 157

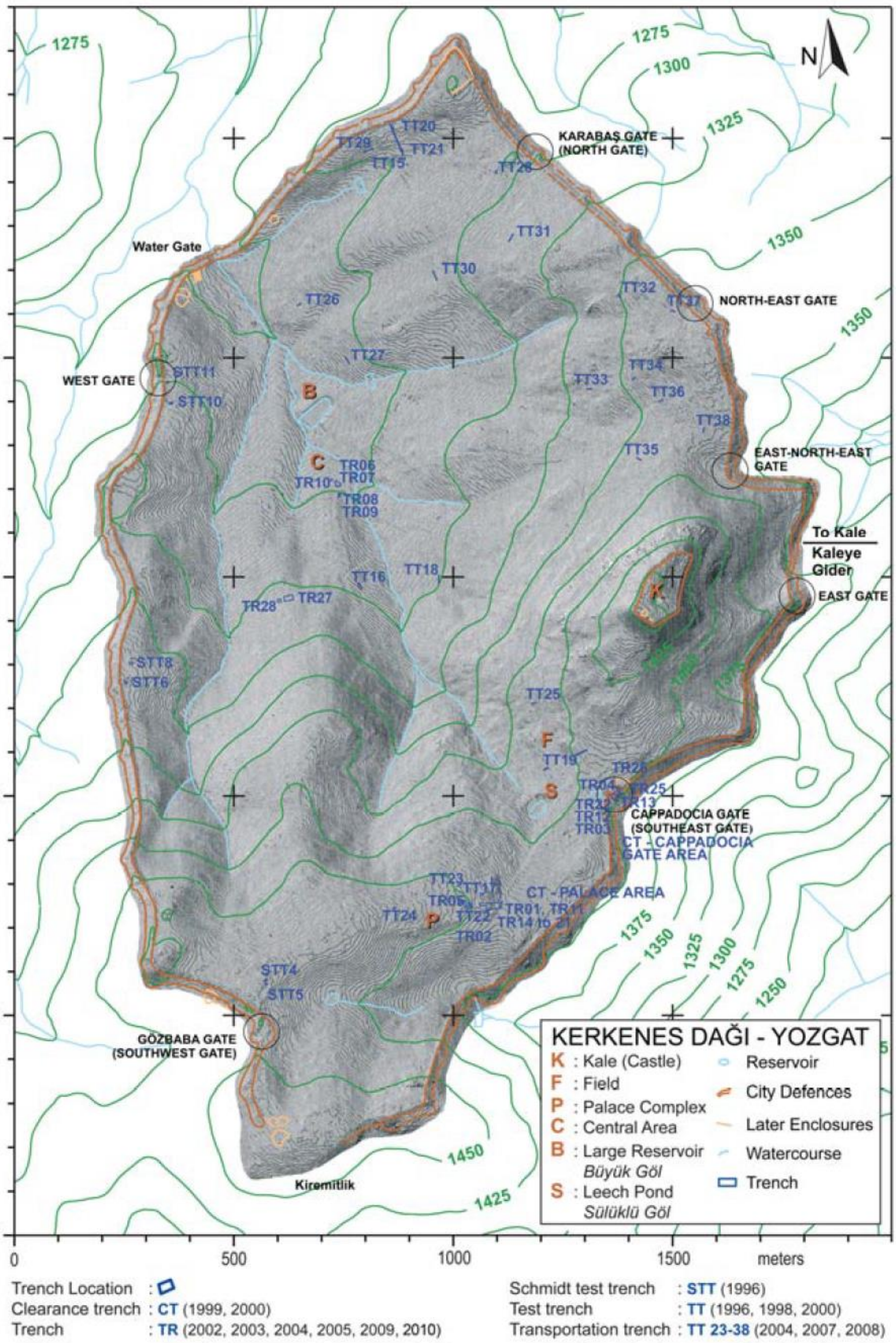

Figure 1 Digital Terrain Model (DTM) of the city, source Summers et al. 2010: 2

3.3. Analysis

In this study, astronomical intention of the founders of the city of Kerkenes will be analysed. A monumental structure or any other construction may have a potential to embody an intention related with celestial phenomena within its size, shape, construction materials, its geographical location in relation to the surrounding landscape. In this study, possible astronomical intentions at Kerkenes will be examined through the analysing of structural orientations in relation to the direction of astronomical objects upon the horizon where rising or setting point of prominent celestial bodies take place. The method which will be applied is designed to detect whether there was an intended orientation towards to a star, constellation, or solar alignment.

In order to analyse the astronomical potentials of the direction of chosen structures, geographical coordinates, the azimuth, and horizon profile, of each prominent structure will be determined. The measurements will be done in relation to the visible landscape and the surrounding horizon in order to take into consideration the prominent features, both natural and human-made that may have been used as foresight to mark rising or setting of a celestial body on the horizon. The main criteria for data selection was the significance of structures without regarding suitability for the direct observation in order to avoid data loss which may indicate cultural tradition either derived from previous generation or from other cultures. The main data is AutoCAD drawings of each constructions derived from the Kerkenes Data Project.

3.3.1. Elements of Urban Settlement

Prendergast emphasised that a construction's axis often plays a role as a ceremonial entrance and pathway.[303] In this study, the axis of each chosen construction will be determined in order to measure the main azimuth of a structure.

[303] Prendergast 2015: 390

Process starts with estimating the mean axis by a line through the center of the back wall and the center of the entrance or passage of the structure or by identifying the best option that is available for the measurements. Then, the angle along the horizon eastward from the North point to the construction's axis will be determined. After determining the azimuth, a local horizon profile will be generated regarding to geographic coordinates including elevation of the chosen construction in order to examine wider horizon for each of the concerned directions and estimate minimum altitude value based on the azimuth direction.

City sculptures, on the other hand, will be considered as symbolic objects. They will be examined in relation to their cultural context aiming to understand if astronomy in any was associated with their placement. This study particularly focuses on cultic installations which are common features for especially city gates in the Eastern Mediterranean and Ancient Near East.[304] In the Phrygian Highlands, the anthropomorphic or semi-iconic rock-cut representations had been used as a part of an architectural order.[305]

3.3.1.1. Monumental Buildings

The Palatial Complex

The Palatial Complex is located between the acropolis and western defences on the high southern ridge. The entire complex is enclosed by a substantial wall along the northern, western and southern sides. The size of the complex is 250m in length, 56m at the west and at the maximum 80m in width. The south-eastern corner is reused later for animal breeding and constructing tumulus. The interior part of the complex is divided into rectangular units. The large spaces are subdivided into

[304]Summers and Summers 2009a: 7

[305]Summers, Summers and Branting 2006: 3

smaller units square or rectilinear in shape.[306] Three phases were identified: the foundation phase dated to the second half of the 7th century B.C.; the second phase of reconstruction of some buildings; and the last phase of construction that was completed before the destruction of the city around 540s B.C.[307] The defensive nature of the Complex was modified by additional structures and Monumental Entrance.[308]

The building characterising the Palatial Complex are listed below:[309]

- Structure A dominating eastern end,
- The largest trapezoidal urban block of the city at the western sector,
- A pair of large two-roomed halls each with an entre-room in the centre of the southern part,
- The Audience Hall and the Ashlar Building which were constructed later between Structure A and the large urban blocks,
- The second megaron, Structure B,
- The third major two-roomed building (Structure E) with two rectangular rooms along each side surrounded by long narrow magazin like rooms in the center of the hall placed east of the Ashlar Building on the paved court,
- Rows of small cells (Structure C) may be used as a storage they seem to divide the entire complex into two each dominated by one of the megaron,

[306] Summers and Summers 1997: 34 – 36

[307] Smith and Branting 2014: 44 – 51

[308] Summers 2006a: 164 – 202

[309] Summers and Summers 2003: 41 – 57; Summers and Summers 2007: 5 – 6; Summers, Summers and Branting 2007: 15 – 17

– A rectangular building, Structure D, with a door on the south eastern corner; massive terraces on the south side,

– The Monumental Entrance with its towers constructed a few years before the destruction and abandonment of the city in the final phase.

All those independent monumental buildings are not paralleled elsewhere in the city. The megaron type buildings are distinct from the other two-roomed building within the city in terms of size and appearance.[310]

In this study, Structure A, the Monumental Entrance, the Ashlar Building, the Audience Hall are going to be examined. Their distinctive sizes and locations in the Palatial Complex give the impression that these constructions were demanded a fairly great effort to be built, therefore, must have had some significance for the founders of the city as well as the citizens.

[310]Summers, Summers and Branting 2004: 7 – 41

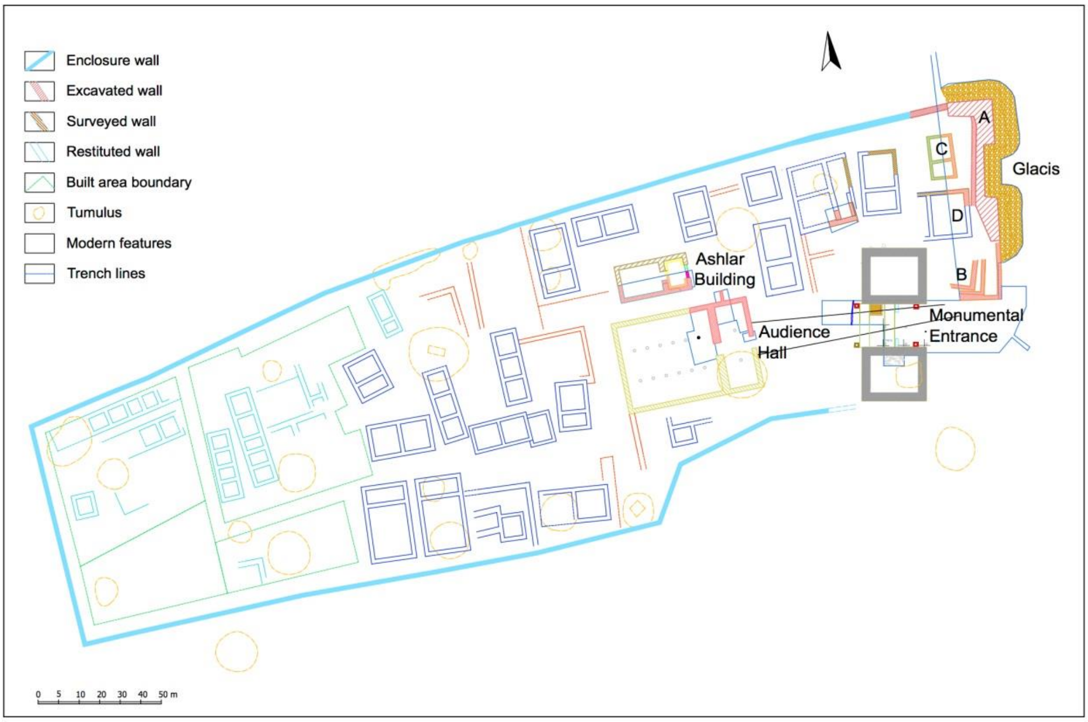

Figure 2 map of Palatial Complex shows Structure A, Audience Hall, Ashlar Building and the Monumental Entrance, source the Kerkenes Project Database

Structure A

Structure A was built on an empty area where the wall and glacis were built directly on the bedrock and possibly some parts of granite were modified during the development of the newly founded city. The area enclosed of the construction is about 30m by 30m, and dominates the eastern end of the Palatial Complex.[311] According to stratigraphic relationships between the Structures A, B, C and D, Structure A seems to have been built the first. Its location indicates careful choice that takes into a consideration of elevation and topographical features of the surrounded area on the north-east end of the Palatial Complex. Structure A has characteristics of defensive architecture with impressively tall, two L-shaped

[311]Summers, Summers, Branting and Yöney 2010: 44 – 71

projecting corner towers (the front one no less than 12 height) that were presumably stairs. There is no symmetry in the entire plan, probably because of the topographical features causing different elevations. The entrance of the monumental structure was positioned on the southern side with ramped stone pavement in front of it.[312]

There are three facts that make Structure A important: the massive wall with the tall tower-like construction similar to those found at the city walls; the amount of stone used for construction which indicates the monumentality of the structure, an unusual feature within the city; and location of the structure providing control over the high southern ridge, perhaps clear view beyond the city defence including a vista towards the eastern lands for the one standing on top of it.

[312]Summers and Summers (in press): Chapter 2

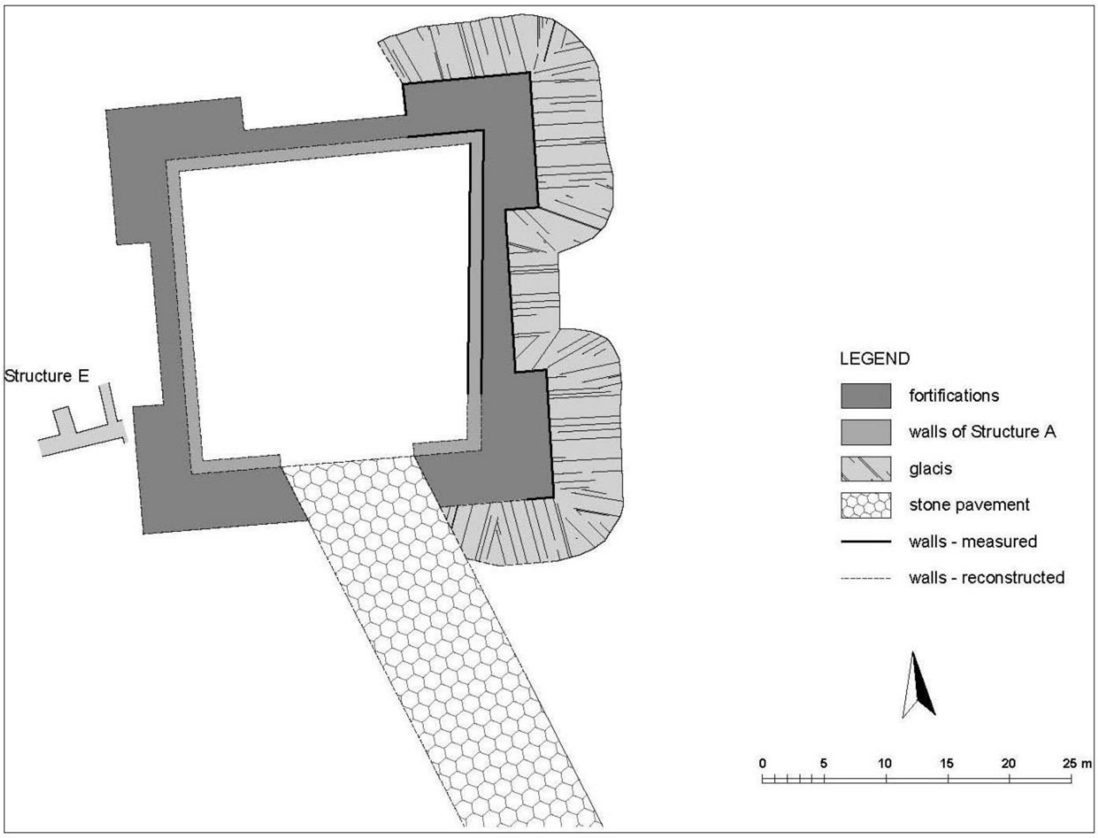

Figure 3 foundation plan of the Structure A with the probable position of the original entrance, source Summers and Summers (in press): Chapter2

Based on the construction form with two towers and an external glacis, Summers argued that the main purpose of Structure A was defensive and it functioned as a fortified castellum encompassing about 900m^2 enclosed area. The angled approaches to entrances are seen at the entrance of the Cappadocia Gate and in the pavement of the Audience Hall as well as Structure A. The building technique used for the walls suggests that a double-leafed door housed in a substantial wooden facade was used in the entrance. According to Summers, the structure was used as a monumental defensive building during the establishment of the city at a time when its defence was not completed yet, and then later it was modified as part of the entrance of the Palatial Complex. The water source found at the base of the glacis could be the main factor for constructing a defence at this specific location.[313]

The Monumental Entrance

The Monumental Entrance with the two massive towers and a passageway leading towards the Audience Hall give the impression of a public monument. It is located immediately to the south of Structure A and west of Structure B. The entrance, built on top of the pavement, is oriented in an east-west direction and displays symmetry both in plan and in elevation. The towers are separated by 10.5m, and located more or less midway between the southeast edge of the pavement and the Audience Hall. Two timber-framed façades were located across the entrance. The entrance to the front façade is through a large double doorway and the exit probably through a similar doorway in the rear facade. The width of the entrance was reduced in the inner passageway by a small square room that mirrored the southern side.[314]

The original south-eastern part of the pavement was limited by a row of large slabs, and there is an extension which is composed of relatively small stones laid with less care continuing beneath the Structure B but not reaching to the front of Structure A.[315] To achieve symmetry, a plinth standing at one side of the front facade, and an aniconic stele standing at the door of the rear facade were used.[316]

313Summers and Summers (in press): Chapter 2

314Summers and Summers 2005b: 18 – 36

315Summers, Summers and Stronach 2002a: 24 – 26

316Summers and Summers 2005b: 37

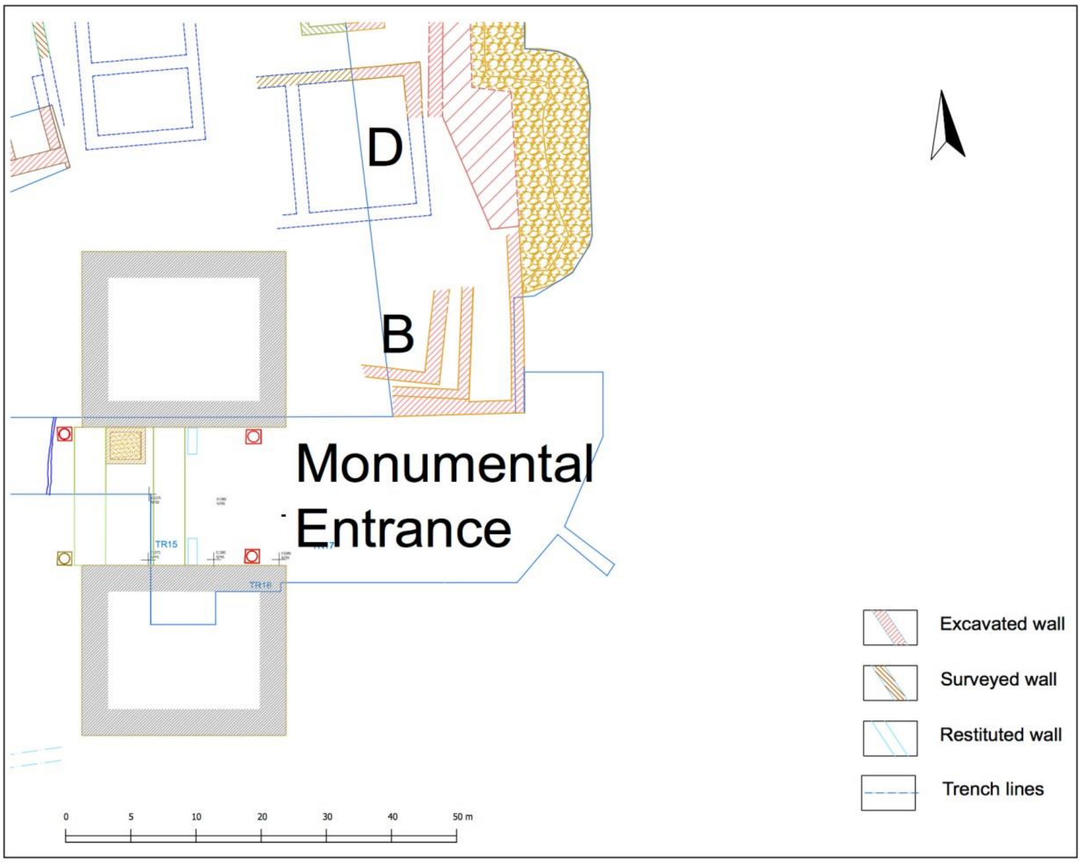

Figure 4 foundation of the Monumental Entrance with gateway columns, source the Kerkenes Project Database

It is constructed as a gate, and a passage way and control point between the interior and exterior. The stone paving in front and behind the entrance and in the passageway itself may indicate that the entrance may have served as a gate of the Palace Complex as well as a variety of other public functions. The structure does not indicate a concern for defence of the Palatial Complex.[317] According to Summers, this platform could have been designed as a terrace in order to provide an impressive architectural solution to reduce the differences in elevation. However, the setting lines preserved in the ramped pavement is not parallel to the orientation of the

[317]Summers and Summers 2005b: 18 – 36

Entrance. It seems better oriented with the doorway of the Audience Hall which may indicate that the original pavement and the Audience Hall could have been constructed before the Monumental Entrance,[318] or that there was another purpose such as orienting towards the rising sun. The Monumental Entrance shows similarities to the Cappadocia Gate with less of concern in defence.[319]

Figure 5 view of the Monumental Entrance from the east with the threshold of the front Façade, source Summers and Summers (in press): Chapter6

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[318]Summers and Summers 2005b: 27

[319]Summers and Summers (in press): Chapter 6

Ashlar Building

The Ashlar Building consists of two rooms each with a wide central doorway on the eastern side. Its overall size measures 15x8.80 m, with a square large inner room 6.80x6.80m, and rectangular outer room 4.90x6.80m.[320] The door which connects the two rooms is smaller than the one on the east wall.[321] The outer room has a sandstone paving surrounding it, and there may have an upper floor or balcony.[322] According to Summers, the building may not have had a daily usage since the floors indicate light traffic and the broad double-leaved doors seem left wide open. Thus, nothing has been found indicating any religious activity in the building.[323]

There are inscribed marks on the interior face of the building's walls. They were probably made with a chisel. The marks consist of letters as being referred to 'O' and 'I', are grouped by being on the same wall. The marks on the south wall of the outer wall called Ashlar 2 is 'O I I I I I I I'; and Ashlar 4 is 'O I I I I I I I I I'. They are the longest ones, the number 10, 12 and 14 has shortest and simpler ones. Both their lengths and their positions are unusual.[324] They are neither hieroglyphic nor resemble any other script. Not all but some of them may have been used as unit to indicate capacity or contents, which indicate that there was some kind of record keeping. Nevertheless, they were too long to be considered as masons marks.[325]

[320]Stronach and Summers 2003: 114

[321]Summers et al. 2002a: 28 – 32

[322]Summers and Summers 2003: 56

[323]Stronach and Summers 2003: 129

[324]Summers et al. 2002a: 32 – 34

[325]Stronach and Summers 2003: 111 – 129

The Audience Hall

The Audience Hall consists of a columned hall and an anteroom with a pair of columns and functioned as a public structure.[326] The whole building is 24m in width, it is rectangular in shape, within a square hall. The main room is 20m in size along each side and has two rows of wooden columns placed on carved stone bases. Each row has 6 column bases.[327] There was a wide central doorway connecting the anteroom to the main hall. No evidence for a doorway was found.[328] The Audience Hall has similarities to Iranian antecedents, which may strengthen the hypothesis that Kerkenes is Pteria of Herodotus.

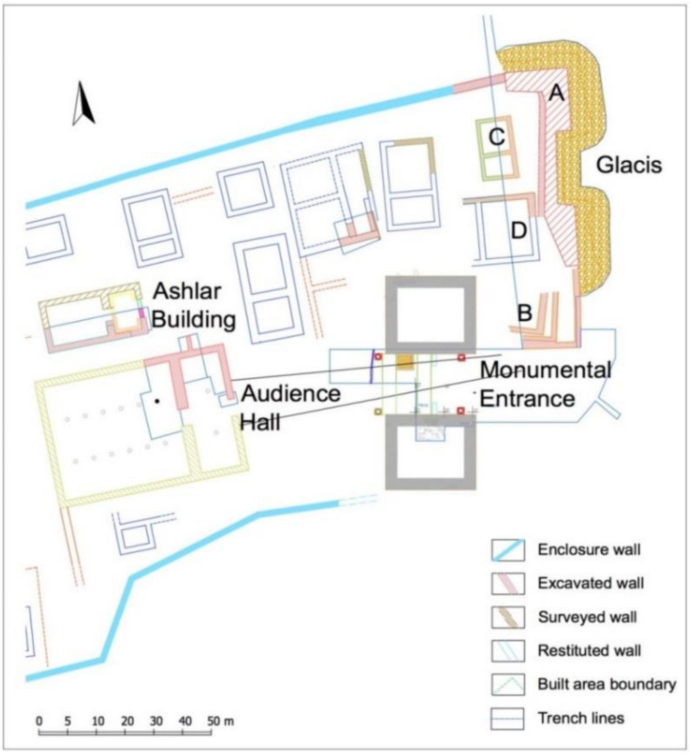

Figure 6 Ashlar Building, Audience Hall and the Monumental Entrance, source the Kerkenes Project Database

[326]Summers 2004: 16 – 20

[327]Summers et al. 2002a: 27

[328]Summers and Summers 2005b: 17

3.3.1.2. Gates

In this study, each gate is going to examined based on main entrance direction through its axis which is measured from the both ends of the gate walls.

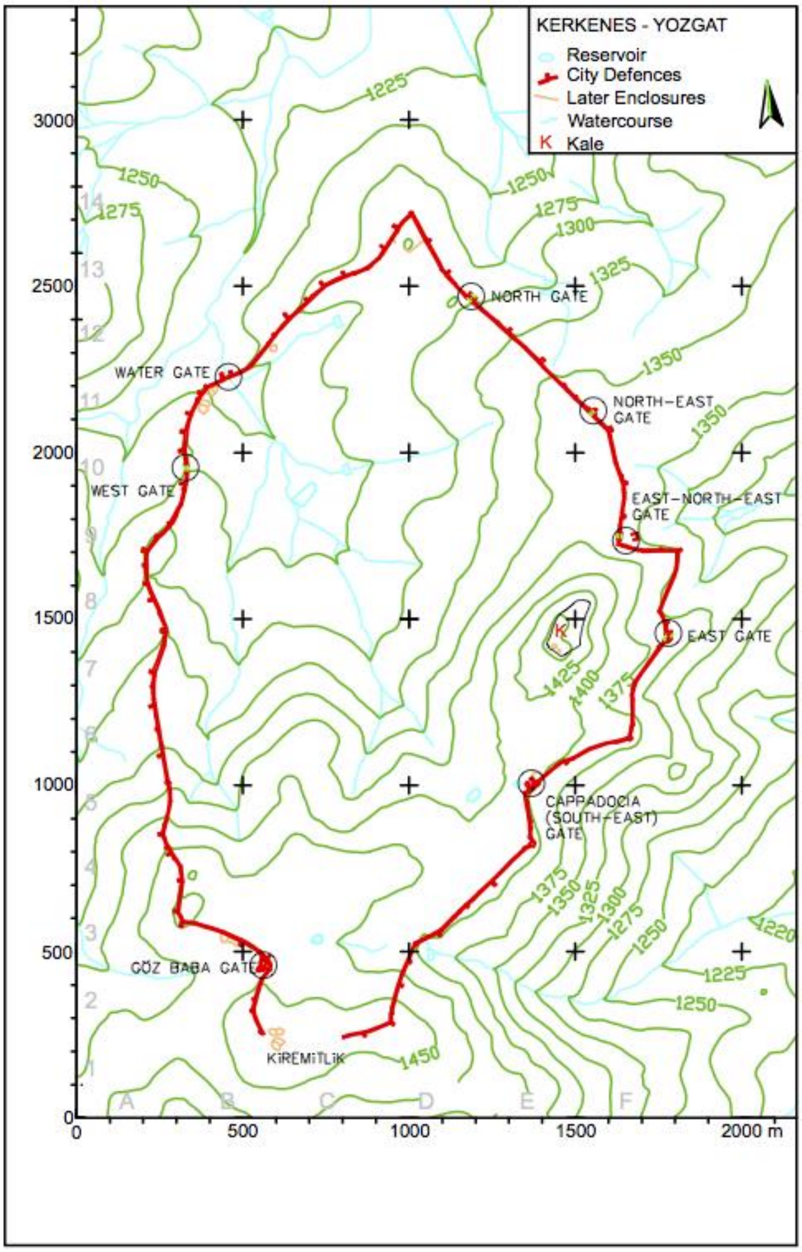

Figure 7 city map shows the defence and gates location, source the Kerkenes Project Database

Cappadocia Gate

The Cappadocia Gate is constructed at the climbs up the hillside on the prominent Iron Age road[329], and was deliberately destroyed by fire in or around 547 B.C. The Gate had 3 components an angled entrance passage, an open court, and a rear section as a central paved passage located between gated facades which permitted passage between West and North towers.[330] The Gate was designed with approximate 5 towers, 3 situated at the front, and 2 at the rear. They were not strictly aligned with one another in 90º angels.[331]

Three cultic installations were found within the Gate. An aniconic granite stele was found in the court against the northwest corner of the Middle Tower; a stepped monument supporting a semi-iconic stele located at the corner of the North tower and immediately to the right of the doors, and faces to the wooden structure; and a standstone based plint on which two crouching sphinxes were carved in relief was found in situ at the North corner of the rear section of the Gate.[332] The plinth and the statue were faced the center of the front facade at the secondary paved yard against the North-West corner, of the middle tower, but later covered with the stone and ground which were probably damaged during the destruction.[333]

The Cappadocia Gate and the Monumental Entrance of the Palatial Complex displayed similarities in conceptual design. Both structures have an aligned stone paving which displayed pre-existing gate structure as a revision that indicates increasing need of security as well as visual impact. The use of massive timber

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[329]Summers, Summers and Stronach 2002b: 11

[330]Summers and Summers 2011: 7 – 10

[331]Summers et al. 2010: 55 – 80

[332]Summers et al. 2010: 80; Summer, Summers, Branting and Langis-Barsetti 2011: 48

[333]Summers and Summers 2011: 7 – 10

structure as broad double-leaved doors in monumental wooden facades, and the association of cult practise are other features that were seen in both entrances.[334]

The Water Gate

The Water Gate is located on the north-east-east section of the city wall. The passageway permits only the foot traffic, and it is the weakest point of the defensive circuit. Therefore, this construction had been used as a gate is not certain yet. There is a reservoir and a glacis on the outer side of the wall, the internal glacis is poorly reserved. The towers are unusual in shape, and there is a stream flowing through the gate and reserved beyond the city wall.[335]

Sinop (East Valley) Gate

The Gate is at the East-North-East section of the city wall and consists of two towers with a 5m wide passageway. The Gate has a simple plan. The towers are not exactly rectangular in shape and the northern tower is longer than the southern tower which is both shaped and located in relation to the topographic features. The walls on the both side of the Gate do not line up. In front of the Gate there is a construction, most likely contemporary with the city. The size and strength of the Gate indicate an important role. The gate received passengers from the north and west via the large mount at Kuşaklı and provided a direct access to the outer road to the north of the city, and to the main residential area; to the Cappadocia Gate via the major street; and to and from the extramural temple at Karabaş.[336]

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[334]Summers and Summers 2010: 74 – 80; Summers et al. 2010: 78

[335]Summers and Summers 1997: 32

[336]Summers and Summers 1994: 13 – 14

Göz Baba Gate

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The West Gate

The Gate consists of two towers surrounded stone glacis except the passageway at both sides of the entrance. There is a large enclosed space between the east-west street to the city wall and the Gate to the corner of the Palace Complex. This enclosed area may have been used as a military headquarter, exercises yard and/or place for parade with stables, storage or barracks A long narrow corridor like building was constructed at the western limit of this enclosed area.[337] A different architectural solution was applied in order to carry the structure. Sloping façade was used as a vertical element, the passage was narrowed, and jambs may have been used for the gate.[338]

Karabaş (The North) Gate

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The NorthEast Gate

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3.3.2. City Sculptures

Semi-Iconic Idols

One of the semi-iconic idols was found, probably located, on the stepped monument at the north-eastern side of the wider rear passage on the corner of the North Tower of the Cappadocia Gate court.[339] It is in the form of a rounded fragment

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[337]Summers and Summers 1994: 13 – 14

[338]Summers and Summers 1997: 33

[339]Summers and Summers 2009a: 7; Summers and Summers 2009b: 29, 31

of white stone with curls of hair on the shoulders represented by a bolster-like element.[340] The uppermost step and idol were of different type of stone than the other two steps.[341] Although the location of stepped monument prevents the idol to be seen from outside of the city gate, it may have been used to greet who ever entered to the city or to receive the direct rays of the sun at specific time of the year. Both the stepped monument and the idol were examples of well-known Phrygian form of cult that are often associated with city gates.[342] Berndt-Ersöz interpreted this idol-steles found in Kerkenes as a built version of a rock-cut stepped monument.[343]

[340]Summers, Summers and Branting 2006: 11

[341]Summers 2006b: 647 – 658

[342]Summers, Summers and Branting 2003: 13; Summers and Summers 2003: 15, 64

[343]Berndt-Ersöz 2006: 3

Figure 8 Semi-iconic stele/idol digitally reconstructed on stepped monument which is located at the Cappadocia Gate, source Summers and Summers 2009b: 31

A pair of semi-iconic idol is found at both sides of the paved court in the Palatial Complex Entrance. They are in the form of an omega with embossed bolster-like curls on each shoulder. They are both about one meter in diameter with blank representations of faces on both sides which demonstrates that they were freestanding. The front face of each of the idols is slightly slanted in order to receive the lights of the rising sun. Based on their locations, it may be suggested that they originally formed as crenellated battlements on top of the large tower-like terraces.[344] The rectangular sunken areas may have been used for offering or libations.[345]

[344]Summers et al 2006: 11

[345]Summers and Summers 2005a: 7

According to Summers, they could be the presentation of Phrygian Mater or Mother, or were images of an unknown pantheon.[346]

Figure 9 the semi-iconic standstone idol from the Monumental Entrance of the Palatial Complex. It was placed at the Yozgat Museum in 2010, source Summers, Branting and Yöney 2010: 100

Idols are typical Phrygian images found in the Highlands of Phrygia. Berndt-Ersöz considered them as often representing Matar[347], but they were also possibly associated with other deities. Idols are simplified images of human body in

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[346]Summers et al. 2006: 11

[347]Oral indicated that Magna Mater known as Kybele especially in Phrygians (Oral 2014: 155), she also used the term Mother Goddess Kybele in order to indicate worship to a female goddess through the existence of the idols found at the Cappadocia Gate' passageway. On the other hand Roller mentioned Kybele as Hellenized name of Kubaba, one of the important The Neo-Hittite's female deity. Roller assumed that Kybebe and Kybele was the Greek name for the Phrygian Mather Goddess, and the Neo-Hittite Kubaba was the direct forerunner of the Phrygian Mather. (Roller 1999: 44 – 53)

rectangular shape with a head in circular shape, without depictions of the legs and arms, and there is no indication of gender. According to Birecikli, besides all the other deities that were worshiped by Phrygian, only Matar was represented in human form.[348] The sides of the body are usually straight and parallel. They are found either single or double-headed, however, the most common type is single-headed idols as a relief cut straight out of the rock wall or as a part of the step monument. She also suggested that the semi-circular disc represented a deity which could be considered as an idol. Pursuant to the combination of both Phrygian and Hittite iconographical images, Berndt-Ersöz suggested that the double idols were possibly representing two deities of equal status, Matar and the Phrygian Male Superior god/Weather god (*Ata* or *Tata*).[349] Bøgh agreed that they were anthropomorphic representation of Matar, and double idols represented different deities, Matar and Ata.[350]

Based on her research results, Berndt-Ersöz concluded that almost all idols found are oriented east, east-south-east, south-east, or south, and the majority of step monuments and idols face between north-east and south-east which shows that there was a general orientation preference. This preference could be based on facing the rising sun, therefore, the solar aspect in worship could have had a significance in their religion, especially the Sun's rays on the rock could have had a role in the Phrygian festival calendar.[351] Haspels also indicated the intended orientation facing east wherever possible.[352] Step monuments and idols were mostly associated with city gates, and positioned at particular places in order to protect the city. Vikela considered stelae as cultic shrines by themselves like a portable sanctuaries that

[348]Birecikli 2010: 215 – 232

[349]Berndt-Ersöz 2006: 56 – 59, 159 – 166

[350]Bøgh 2007: 328

[351]Berndt-Ersöz 2006: 16 – 19, 151 – 152, 157 – 158; Vassileva 2001: 55

[352]Haspels 1971: 73

functioned as sanctifying the place where they were placed.[353] According to Bøgh, this explained the lack of monumental temples during Phrygian period. Step monument with a semi-conic disc on top is very common primitive cultic monument. Körte and Akurgal claimed that they were thrones of the goddess.[354]

Archaeological evidence, particularly derived from Boğazköy and Delik taş, show strong correlation between Matar and city gates, and Matar is considered as a deity who had a protective role of the city.[355] In Phrygian inscriptions this female divinity was called as Matar or Mother, and associated with mountains, hollows, and wild spaces. The mountain, the water, and the predator that roamed the mountain are main three symbols related with Matar which were widely common in Anatolia, therefore, Phrygians may have imitated from the earliest and contemporary cultures, possibly from Hittites, Neo-Hittites and Urartians.[356] According to Albright, Neo-Hittite Kubaba was the ancestress of Matar.[357] On the other hand, Vassileva and Bøgh argued that Balkan affinities, particularly Thracian also had an influence on Phrygian cult and religious practices.[358] Rock-cut monuments in both solar and chthonic aspect were also related to the mountainous image of the Goddess in Thracian Orphism. Vassileva also indicated the resembles between the Phrygian rock façades and Thracian rock cut tombs.

Meter is the Greek name for the Phrygian Mater. The divinity known as Cybele is the ancient Greek name for Kubaba.[359] Brixhe argued that Kybele

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[353]Vikela 2001: 72 in Bøgh 2007: 327

[354]Akurgal 1955: 97 – 98; Körte 1898: 118 – 119 in Bøgh 2007: 328

[355]Berndt-Ersöz 2006: 151 – 152, 157 – 158; Haspels 1971: 108

[356]Roller 1999: 1 – 7, 63 – 115

[357]Albright 1928: 229 – 231

[358]According to Vassileva, Thracian monuments were part of the Aegean and eastern Medditerranean megalithic tradition. Vassileva 2001: 51 – 63; Bøgh 2007: 309 – 310

[359]Bøgh 2007: 304 – 339

(Hellenized name of Kubaba[360]) and Kubaba did not represent the same deity. Even though, there were evidences which indicate the similarities Kubaba and Matar, the differences in depictions, cultic placement of the reliefs and main attributes and main roles that they both had played were more distinctive. According to Brixhe, the iconography of Kubaba had influenced the Phrygian representation of Matar.[361] Bøgh suggested that the Greeks had interpreted Kubaba as Matar, therefore reflected such similarities while depicting Kybele. Nevertheless, the earliest evidence of the concept of Mother Goddess were dated to the early first millennium B.C., and the physical and characteristic attributes of the figure were formed during the Phrygian Period, and lasted to the final days of paganism in the Roman Empire in the 5th century C.E., and it was widely diffused through Europe, Westerns Asia and North Africa.[362]

3.4. Data Analysis

For analysing the astronomical intention of the chosen construction, the minimum altitude value of the construction, which was determined by taking consideration of the landscape features, was confronted with the altitude of potential sky object at the time of rising or setting on the horizon, that was estimated by the time when city was established. The data processing and analysing are shown through the Audience Hall drawing and figures. Reader could see the complete figures of each building at the appendix. Idols were analysed through the associated building due to the fact that each idol was oriented toward the direction of the building where they were placed.

360 Roller 1999: 44 – 53

361 Brixhe 1979: 40 – 45 in Bøgh 2007: 314

362 Roller 1999: 1 – 7, 63 – 115

The core data of this study is the AutoCAD drawings. The main steps of data processing are:

- Determining the axis of the construction
- Measuring azimuth value
- Generating horizon profile
- Determining the minimum altitude value
- Generating the sky view
- Detecting the possible sky object’s rising or setting points

In order to measure the azimuth, the main axis for each construction was estimated on its AutoCAD drawing by a line passing through the central points of the back wall and the entrances. The angle along the horizon eastward from the North point to the construction's axis was determined, and assigned as the azimuth value of the construction.

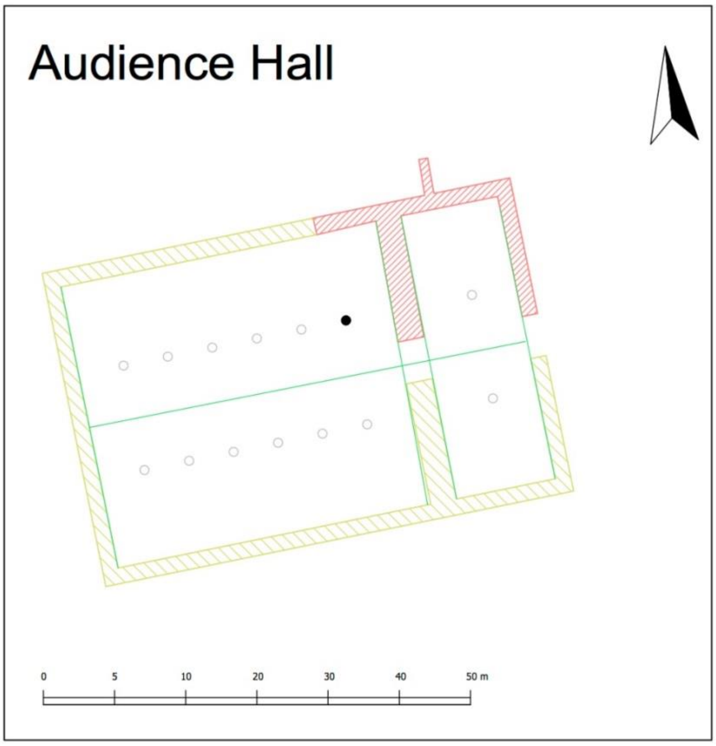

Figure 10 The axis of the Audience Hall was determined through the middle points of the back wall and the entrance. The angle, azimuth, was measured from the North point to the building's axis, source The Kerkenes Project.

Table 1 shows azimuths, geographic coordinates and evalution values for each building and city sculpture. Elevation values were derived from Google Earth.

Structure Name	Azimuth (°)	Laltitude	Longitude	Elavation (m)
Structure A	176	39°44'34.04"	35° 3'59.15"	1420
Monumental Entrance	96	39°44'32.97"	35° 3'58.11"	1423
Ashlar Building	84	39°44'33.75"	35° 3'55.78"	1427
Audience Hall	81 – 85	39°44'32.89"	35° 3'56.32"	1426
Cappadocia Gate	143	39°44'40.48"	35° 4'11.68"	1404
Göz Baba Gate	224	39°44'24.83"	35° 3'36.07"	1451
West Gate	273	39°45'13.98"	35° 3'32.28"	1278
Karabaş/North Gate	49	39°45'28.15"	35° 4'9.21"	1300
North-East Gate	57	39°45'15.94"	35° 4'22.88"	1365
East-North-East Gate	97	39°45'3.95"	35° 4'25.63"	1368
East Gate	75	39°44'52.78"	35° 4'29.46"	1366
Semi-Iconic Idols I	143	39°44'40.48"	35° 4'11.68"	1404
Semi-Iconic Idols II	96	39°44'32.97"	35° 3'58.11"	1423

Horizon profile was generated via “heywhatsthat” website.[363] The website provides a horizon profile by either given address or by latitude and longitude values, and allows to specify elevation (from the ground level). For each construction, geographical coordinates were submitted, and default elevation as 6 feet above ground level was determined. Website generated a horizon profile with two interactive vertical profiles created based on specified azimuth, and the viewshed analysis of the given point shown on the interactive Google Map. The minimum altitude value of the chosen construction was determined based on measured azimuth in order to detect in which altitude a sky object can be observed toward a specified direction.

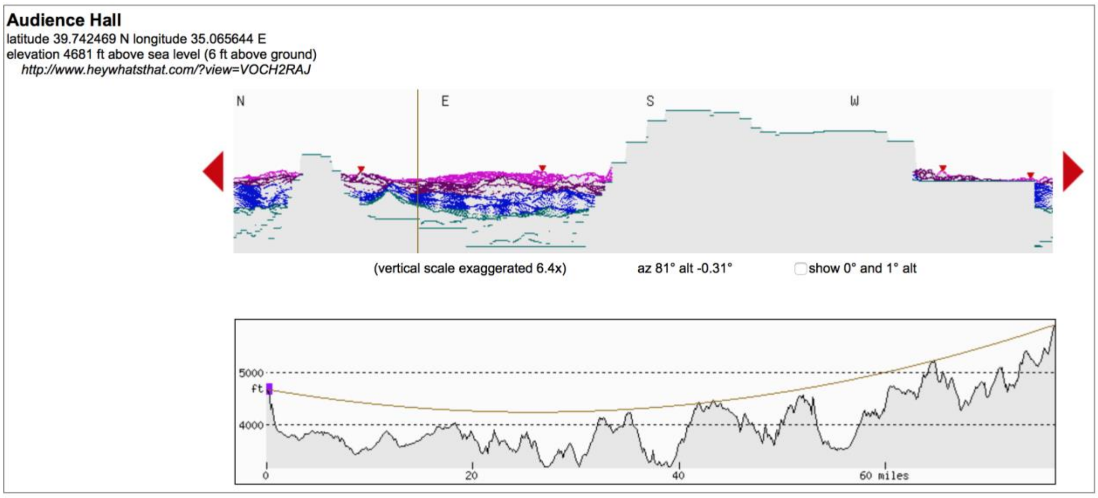

Figure 11 Horizon profile of the Audience Hall was generated via "heywhatsthat" website. The vertical profile was created for an azimuth of 81°. The minimum altitude value is determined as -0.31°

[363]http://www.heywhatsthat.com

Table 2 shows the minimum altitude value of the chosen constructions in order to detect in which altitude a sky object could be observed toward specified azimuth degree.

Structure Name	Azimuth(°)	Laltitude	Longitude	Alt. (°)
Structure A	176	39°44'34.04"	35° 3'59.15"	1,350
Monumental Entrance	96	39°44'32.97"	35° 3'58.11"	-0,050
Ashlar Building	84	39°44'33.75"	35° 3'55.78"	-0,340
Audience Hall	81 – 85	39°44'32.89"	35° 3'56.32"	-0,31 , -0.31°
Cappadocia Gate	143	39°44'40.48"	35° 4'11.68"	-0,040
Göz Baba Gate	224	39°44'24.83"	35° 3'36.07"	2,860
West Gate	273	39°45'13.98"	35° 3'32.28"	3,300
Karabaş/North Gate	49	39°45'28.15"	35° 4'9.21"	1,860
North-East Gate	57	39°45'15.94"	35° 4'22.88"	0,100
East-North-East	97	39°45'3.95"	35° 4'25.63"	-0,030
East Gate	75	39°44'52.78"	35° 4'29.46"	-0,260
Semi-Iconic Idols I	143	39°44'40.48"	35° 4'11.68"	-0,040
Semi-Iconic Idols II	96	39°44'32.97"	35° 3'58.11"	-0,050

The elevation value that was derived from Google Earth did not match with the one that website used in order to generate horizon profile. For the accuracy issue the difference between these two values for each structure was calculated. The results were considered as worthless regarding the distance of observable horizon.

Table 3 shows confrontation of the oucome elevation value for each construction with the one detemined by using a virtual global map program, Google Earth, in order to aware of precision of accuracy.

Monuments	Elevation ft	Calculated elevation (ft)	Δ(m)
Structure A	4658,736	4662	0,995
Monumental Entrance	4668,5784	4681	3,786
Ashlar Building	4681,7016	4681	-0,214
Audience Hall	4678,4208	4681	0,786
Cappadocia Gate	4606,2432	4596	-3,122
Göz Baba Gate	4760,4408	4763	0,780
West Gate	4192,8624	4192	-0,263
Karabaş/North Gate	4265,04	4278	3,950
North-East Gate	4478,292	4497	5,702
East-North-Eas (Sinop Gate)	4488,1344	4471	-5,223
East Gate	4481,5728	4491	2,873
Semi-Iconic Idols I	4606,2432	4596	-3,122
Semi-Iconic Idols II	4668,5784	4681	3,786

Stellarium, planetarium software, was used to display realistic sky view. In order to detect if the software does take consideration of the proper motion of stars, two stars α UMA (distance is 123.64 LY) and ζ UMA (distance is 78.16 LY) from Ursa Major constellation were chosen. Right ascension and declination values of each star were determined for two different dates (-580 and 2100). Then, their positions were confronted with each other. Result verifies that Stellarium does take consideration of the proper motion of the stars.

Table 4 shows the proper motion of α UMA (distance is 123.64 LY) and ζ UMA based on their RA and DE values.

Date: -580

	RA	DE°
α UMA	07:21:32	72,42194
ζ UMA	11:20:36	68,98667
Δ =	-03:59:04	3,43527

Date:2100

	RA	DE°
α UMA	11:09:48	61,21167
ζ UMA	13:27:57	54,40611
Δ =	-02:18:09	6,80556

For each construction, the sky view was generated based on its geographic coordinates and elevation value derived from Google Earth, and the date was set as 580 B.C. for each case.[364] Possible sky objects' rising or setting points were closely examined towards the measured azimuth angel of the construction. The altitude value of the suspected stars was confronted with the minimum observable altitude value for the chosen construction. Results are given in Table 5.

[364]The program also run for the time 700 B.C. in order to see whether the sky view was different fort the first-comers to this region. The result was considered worthless. 580 B.C. was used for the rest of the analysis process due to the fact that if there was an intention toward to specific celestial body, by times the construction could have been reconstructed in order to fit the alignment.

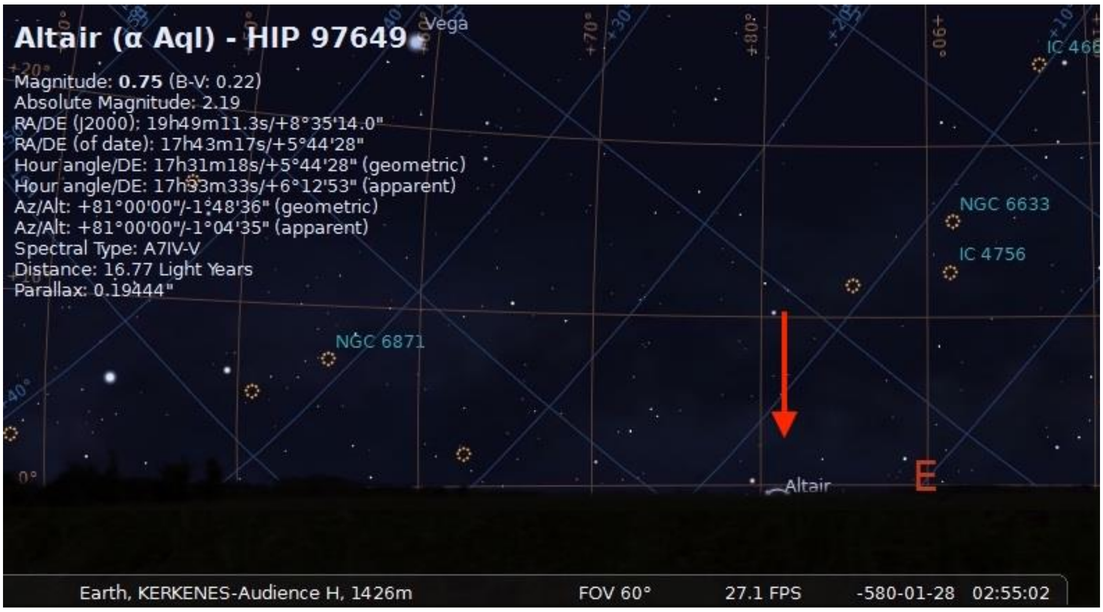

Figure 12 shows the sky view of the Audience Hall toward the azimuth angle of the building. The suspected star is indicated with red arrow.

The threshold value of the delta altitude was determined as < 2.5°. Based on the determined threshold value, only three of the results were considered fairly meaningful. Meaningful results are listed below:

For Structure A :Az / Alt: +176° / + 1° 21' 3.99

Hadar (β Cen) :Az / Alt: +176° / + 3° 44' 11" (apparent)

For the Ashlar Building :Az /Alt: +84° / - 0° 20' 24"

Altair (α Aql) :Az / Alt: +84° / + 2° 03' 40" (apparent)

For the Audience Hall :Az /Alt: +81° / - 0° 18' 36"

Altair (α Aql) :Az / Alt: +81° / - 1° 04' 35" (apparent)

Table 5 shows azimuth and altitude value of each structure, and sky object with its altitude at the specidief azimuth.

East-North-East Gate Az / Alt: +97° / -0° 1' 48"	**Monumental Entrance** Az / Alt: +96 / -0° 3' 0"
Altair (α Aql) Magnitude: 0.75 (B-V: 0.22) RA / DE (of date): 17h43m17s / +5° 44' 28" Az / Alt: +97° / +17° 17' 27" (apparent)	**Altair (α Aql)** Magnitude: 0.75 (B-V: 0.22) RA / DE (of date): 17h43m17s / +5° 44' 28" Az / Alt: +96° / + 16° 08' 55" (apparent)
Jupiter Magnitude: -2.06 RA / DE (of date): 12h32m10s / -2° 03' 43" Az / Alt: +97° / + 5° 26' 51" (apparent)	**Jupiter** Magnitude: -2.06 RA / DE (of date): 12h32m10s / -2° 03' 43" Az / Alt: +96° / + 4° 09' 13" (apparent)
Saturn Magnitude: 1.17 RA / DE (of date): 11h50m35s / + 3° 45' 38" Az / Alt: +97° / +14° 36' 11" (apparent)	**Saturn** Magnitude: 1.17 RA / DE (of date): 11h50m35s / + 3° 45' 38" Az / Alt: +96° / + 13° 04' 30" (apparent)

Audience Hall Az /Alt: +85° / -0° 18' 36"	**Ashlar Building** Az /Alt: +84° / - 0° 20' 24"
Altair (α Aql) Magnitude: 0.75 (B-V: 0.22) RA / DE (of date): 17h43m17s / +5° 44' 28" Az / Alt: +85° / +3° 11' 47" (apparent)	**Altair (α Aql)** Magnitude: 0.75 (B-V: 0.22) RA / DE (of date): 17h43m17s / +5° 44' 28" Az / Alt: +84° / + 2° 03' 40" (apparent)
Saturn Magnitude: 1.17 RA / DE (of date): 11h50m35s / + 3° 45' 38" Az / Alt: +85° / +0° 24' 22" (apparent)	**Saturn** Magnitude: 1.17 RA / DE (of date): 11h50m35s / + 3° 45' 38" Az / Alt: +84° / - 0° 35' 48" (apparent)

Karabaş (North) Gate Az / Alt: +49° / + 1° 51' 36"	**North-East Gate** Az / Alt: +57° / +0° 6' 0"
Arcturus (α Boo) Magnitude: 0.15 (B-V: 0.82) RA / DE (of date): 12h15m32s / +34° 07' 40" Az / Alt: +49° / + 5° 25' 54" (apparent)	**Arcturus (α Boo)** Magnitude: 0.15 (B-V: 0.82) RA / DE (of date): 12h15m32s / +34° 07' 40" Az / Alt: +57° / + 14° 04' 08" (apparent)
Vega (α Lyr) Magnitude: 0.00 (B-V: 0.00) RA / DE (of date): 17h09m22s / +38° 58' 28" Az / Alt: +49° / + 12° 22' 03" (apparent)	**Vega (α Lyr)** Magnitude: 0.00 (B-V: 0.00) RA / DE (of date): 17h09m22s / +38° 58' 28" Az / Alt: +57° / + 22° 11' 36" (apparent)

Structure A Az / Alt: +176° / + 1° 21' 3.99	**Audience Hall** Az /Alt: +81° / -0° 18' 36"
Hadar (β Cen) Magnitude: 0.55 (B-V: -0.03) RA / DE (of date): 11h34m46s / -46° 34' 7" Az / Alt: +176° / + 3° 44' 11" (apparent)	**Altair (α Aql)** Magnitude: 0.75 (B-V: 0.22) RA / DE (of date): 17h43m17s / +5° 44' 28" Az / Alt: +81° / - 1° 04' 35" (apparent)

West Gate Az / Alt: +273° / + 3° 17' 60"
Aldebaran (α Tau) Magnitude: 0.85 (B-V: 1.55) RA / DE (of date): 2h13m17s / +7° 45' 12" Az / Alt: +273° / + 8° 39' 21" (apparent)
Procyon (α CMi) Magnitude: 0.40 (B-V: 0.44) RA / DE (of date): 5h21m39s / +7° 55' 04" Az / Alt: +273° / + 8° 54' 45" (apparent)

In this study, possible observation of the equinoxes and solstices were also examined. In order to obtain these particular dates, Stellarium was used by monitoring the Sun's movement on ecliptic where crosses the Equator. The dates were determined for 580 B.C. as 27 of March, 29 of June, 29 of September and 27 of December. Regarding the angular diameter of the Sun (~ 0.5°)[365] and atmospheric refraction, the result for the North-East Gate could be considered as a fairly meaningful.

Table 6 Az/Alt values of the Sun for 580 B.C. at the specified azimuths

Monuments	Azimuth	Altitude	Mar 27	June 29	Sept 29	Dec 27
Structure A	176	1,350	-	-	-	-
Monumental Entrance	96	-0,050	7,332222	-	7,333056	-
Ashlar Building	84	-0,410	-7,148333	-	-7,083611	-
Audience Hall	81	-0,310	-	-	-	-
Audience Hall	85	-0,310	-5,964444	-	-5,905	-
Cappadocia Gate	143	-0,040	-	-	-	-
Göz Baba Gate	224	2,860	-	-	-	12,52306
West Gate	273	3,300	-2,838333	-	-3,608889	-
Karabaş/North Gate	49	1,860	-	-8,66444	-	-
North-East Gate	57	0,100	-	-0,7563889	-	-
East-North-East (Sinop Gate)	97	-0,030	8,490278	-	8,486389	-
East Gate	75	-0,260	-	-	-	-

365 The angular diameter of an object on the sky is the angle the object makes as seen by an observer on the Earth. http://astronomy.swin.edu.au/cosmos/A/Angular+Diameter

CHAPTER 4

DISCUSSION

Results for possible stellar alignment were evaluated by confronting the minimum altitude value of the selected building with the altitude value of the prominent celestial object at the time of rising or setting on the horizon. The threshold value of the delta altitude was determined as < 2.5°. Based on the determined threshold value, only three of the results were considered to have produced a fairly meaningful result: the star Altair for the Ashlar Building and the Audience Hall; and Hadar for Structure A. In order to understand whether these results reflect intended choices or are coincidences, a literature survey was performed to find out if the stars had ever been observed, by whom they were observed, and whether there was a link between these observers and the founders of the city at Kerkenes. Literature survey was independently performed for each star.

Altair (α Aql – Aquila)

Altair is the brightest star in the constellation Aquila. The name of the star comes from the arabic Al-Nasr Al Tair, meaning flying eagle or vulture. It is also named as Althair, Athair, Attair and Atair. Ptolemy referred to the star as Aetus (meaning eagle). According to Paul Kunitzsch, the Babylonians and Sumerians called Altair as the eagle star. The constellation was represented on a Euphratean uranographic stone dated to about 1200 B.C.[366] In Greek and Roman mythology, the eagle was the bird of Zeus who carried the thunderbolts toward the enemies. According to myth, Aquila captured and lifted up the Trojan boy Ganymede, son of

[366]Schaaf 2008: 188

King Tros, to become the cup-bearer of the gods. Ganymede himself was also represented as neighbouring constellation of Aquarius. The eagle, with connection to the story, was displayed on coins of Chalcis, Darnados, and Ilia, in a perched position with the Dolphin on coins of Sinop and other towns along the Black Sea and the Hellespont.[367]

Altair with the stars Vega and Deneb forms the Summer Triangle that can be recognised in the Northern Hemisphere as a distinctive asterism.[368] It is the second brightest star at the night sky. [369]

The earliest evidence of observation of Altair and the constellation that is associated were found in Babylonian astronomical diaries.[370] There were two different astronomical diaries, Enuma-Anu-enil and MUL-Apin tablets that had been written for different purposes.[371] Enuma-Anu-enil contained the representation of the gods and their symbols and written by a divine tradition, while MUL-Apin contained representation of rustic activities in order to generate annual calendar for farmers. Both textbooks involved different constellations as well as similar ones associated with the zodiac. The divine tradition identified most of the constellation with heraldic animals and divine figures. Altair was the royal star of the constellation Aquila, the Eagle. It was not known if the Eagle had any divine character, but the adjacent constellation was symbolised by vulture-head and represent God Zababa (the God of War).[372] The constellation Aquila was one of the parazodical constellations that had been developed in Mesopotamia from around 3200 B.C. to 500 B.C. With the other

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[367]Allen 1963: 55 – 60; Ridpath 1988: 8, 26 – 27; Rogers 1998b: 88

[368]Ridpath 1988: 27

[369]Schaaf 2008: 188 – 196

[370]Rogers 1998a: 9 – 28

[371]Neugebauer 1947: 37 – 43; North 2008: 36 – 66

[372]Rogers 1998a: 25

parazodiacal animals Hydra, Corvus, and Piscis Austrinus, Aquila were considered as signs of gods, thus several of them were represented on boundary-stones.[373]

Two texts similar to Babylonian texts were found in which 12 stars of Akkad were listed including Aquila named as A-mushen (Nashru).[374] However, van der Waerden argued that this may not show that Akkadian derived the knowledge from Babylonians, but instead they were actually local-based star list that systematised based on Old Babylonian method.[375] The classical 48 Greek constellations were derived both from Mesopotamia and from Mediterranean region, possibly from Minoans who used constellations to navigate at sea. Thus, only the divine tradition was transmitted, probably due to the importance for horoscopic calculation.[376]

In Anatolia, the known influence of Babylonian astronomical knowledge was seen in Hittite culture. Copies of Babylonian astronomical diaries were found in the Hittites' archives in Hattuşha. Like the Babylonians, Hittites also related celestial bodies' movements with the divinities, and interpreted them to make prediction about future. The cuneiform tablets found in the archives in Hattuşha contained especially omens and associated celestial events including solar and lunar eclipses.[377]

Even though the Babylonian astronomical knowledge had been transmitted to the Greeks and Romans, and there is evidence indicating Babylonian influence on Anatolian cultures, especially Hittites, thus, Roller and Albright, emphasised the influence of previous cultures of prehistoric Anatolia on Phrygians[378], none of them

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[373]Rogers 1998b: 79 – 89

[374]Rogers 1998a: 16 – 17

[375]van der Waerden 1949: 6 – 26

[376]Rogers 1998b: 79 – 89

[377]Erginöz 2008: 199 – 213

[378]Albright 1928: 229 – 231; Roller 1999: 1 – 7, 63 – 115

is a direct evidence to prove the intended orientation for both Ashlar Building and Audience Hall toward to Altair. Nevertheless, lack of evidence could be result of lack of archaeoastronomical research on Anatolian cultures. Therefore, it does not disprove the existence of intended astronomical orientation.

Hadar (β Cen)

Hadar is the Arabic name (also written as hadari, and means ground[379]) for Beta Centauri, the second brightest star in the constellation Centaurus.[380] According to G. Ottewell Hadar was derived from Arabic al-Hadar meaning the settled land.[381] The name Agena is also used for the star in modern times means the knee. Ptolemy mentioned the star as the knee of the Centaur's left front leg.[382] Hadar is the 11th brightest star of the night. Beta Centauri was used to find Southern Cross with Alpha Centauri, and together were also known as the Southern Pointers.[383]

Despite scepticism in the belief that the Phrygians origined in Europe, latest research emphasises the idea of the immigration of Phrygians from Balkans. Based on the archaeological and ancient sources, there is a strong cultural similarity between the Phrygians and the Thracians in terms of languages, religious beliefs, cult practices and architectural traditions.[384]

Vassileva and Bøgh argued that there was Thracian influence on Phrygian culture.[385] Therefore, the latest archaeoastronomical research on the Thracian region

379The star was observed very near the horizon in the south for Araps.

380Allen 1963: 152 – 155; Ridpath 1988: 48

381Ottewell 1979 in Schaaf 2008: 183

382Schaaf 2008: 183.

383Schaaf 2008: 119 – 122, 182 – 185

384Vassileva 1995: 27 – 34, 1997: 193 – 198, 1998: 300 – 305 and 2006: 224 – 239

385Bøgh 2007: 309 – 310; Vassileva 2001: 51 – 63 was also examined in order to give a meaningful explanation to my study results. Researches have been conducted mostly on Thracian dolmens, sanctuaries and menhirs.

Dolmens are funerary structures (tombs), dating back from around c. 12^{th} B.C. to about c. 6^{th} B.C. They were often composed of a rectangular chamber built by four well-cut slabs, with a fifth forming the roof with an oval or rectangular entrance in one of the short side of the vertical slabs. They were built mostly in the Stradzha, Sakar and Rodophe regions, and were often covered by a tumulus.[386] Rock-cut sanctuaries were considered as cult centers that were located at the highest places and near springs in positions which provided celestial observations.[387] Menhirs were stone blocks which were found isolated or in combination with rock pillars that were fixed into the ground. They were interpreted as sacral object.[388]

Most of the dolmens were built in the region of south-eastern Bulgaria, northern Greece and Thrace in Turkey. In 2008, 31 dolmens, found in Strandja Mountain, were examined in terms of their orientation. Research showed that most of them were oriented to the south-west direction, which supported the previous research done by Dermendshiev[389] and by Belmonte[390]. Unlike the other cases found in rest of Europe, they were obviously built either for the sunrise or sunset observation. Researchers interpreted the result as an intention of orientation toward the afternoon sun, and suggested that it could have been related to the moon or to the Great Mother Goddess.[391]

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[386]Gonzalez-Garcia, Kolev, Belmonte, Koleva and Tsonev 2009: 22; González-García, Koleva, Kolev and Belmonte 2008: 170 – 173

[387]Maglova and Stoev 2015: 1385

[388]Tsonev and Kolev 2013: 57 – 59

[389]Dermendzhiev 2005 in González-García et al. 2008: 172

[390]Belmonte 2005 in González-García et al. 2008: 172

[391]González-García et al. 2008: 170 – 173

In another research a larger number of dolmens (85 dolmens and six false-cupola tombs) were investigated in 2009. Results showed that their orientation indicated south-west direction, and once again it was challenging the sunrise sunset hypothesis. Researchers suggested another alternative explanation for the orientation toward the south-west direction. They proposed new possibilities considering the stars, the Southern Cross and the Pointers. Both clusters of stars have azimuth values which are consistent with the previous result.[392] In Greek mythology, these stars were belonged to the Centaurus constellation which was represented as half man-half horse. Thus, in the Thracian mythology a horse rider was one of the important figures. Researchers proposed that these similarities may have been indicating a link between this figure and the direction of dolmens' orientation.[393]

Later Tsonev and Kolev extended the archaeoastronomical research by including megalithic structures, menhirs as individual or as a group and stone plate circles. They found that beside the common tendency towards the South semi-horizon, the orientation tendencies in the three geographic regions (Sakar and Rhodope Mountains, South-East and South-West Bulgaria) were different. A basic principle associated with solar-chthonic character did not give a correct explanation for each situation. However, they considered two additional principles. First one was a sacral topocentric principle that dolmens were located at specific places in order to be oriented to a hill or to a peak meanwhile maintaining the common south azimuthal angle. Even though, this principle did not explain the question why a specific peak had been chosen, thus the both condition were not obtained at the same time for each cases, most of them satisfied it. Second was the neighbour principle that was used for cases which some dolmens were looking at another dolmen that may be indicating hierarchic order. But neither this explanations nor an individual preference (like totem tradition) was able to encompass all the cases. Nevertheless, they concluded that there was a common intended orientation toward the sun in its highest daily

[392]Gonzalez-Garcia et al. 2009: 19 – 31

[393]Gonzalez-Garcia et al. 2009: 29

position, and sometime its equinox positions. This tradition had continued during the later centuries.[394]

In 2015, González-García, Kolev and Koleva made detailed research on the Thracian dolmens, and concluded that the dolmens satisfy two main conditions; pointing toward mountaintops, and the prevailing orientation toward southwest, the setting of the Southern Cross and Pointers (α and β Centauri) at the time of construction (ca. 1000B.C.).[395] In the Mediterranean region, this group of stars had been known, and associated with the orientation of megalithic structures.[396] Thus, the mythological representation of the constellation Centaurus as half-man half horse was recalling the Thracian horse rider mythical character.

Maglova and Stoev investigated the orientation of the rock-cut sanctuaries which were the cult center for solar observation which devoted to the cults of the Sun and the Great Mother Goddess (Cybele), therefore situated at highest places near the settlements and spring in order to make a horizontal observation. They concluded that the Thracians had mostly observed summer solstice sun rise that it was considered as the day of the Great Mother Goddess.[397]

All of the above knowledge indicates that, there was an intention of orientation in Thracians' dolmens, sanctuaries and menhirs towards the south or south west. This direction was targeting to observe either sunrise or sunset, unlike the other examples that were found in the rest of Europe. Thus, this investigations challenged the hypothesis that Thracians had a solar-chthonic character, instead supporting the idea that the main target object could be the Southern-Cross and its Pointers, α and β Centauri.

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[394]Tsonev and Kolev 2013: 55 – 84

[395]González-García, Kolev and Koleva 2015: 1395 – 1402

[396]Aramburu-Zabala 2005 in González-García et al. 2015: 1401; García Rosselló, Fornés Bisquerra and Hoskin 2000: 58 – 64; Hoskin, Hochsieder and Knösel 1990: 37 – 48

[397]Maglova and Stoev 2015: 1385 – 1394

Vassileva indicated similarities between Thracian megalithic and Phrygian rock-cut tombs, niches and platforms including religious beliefs, worshiping the Great Mother Goddess.[398] Thracians did not have writing, therefore information about them mostly was derived from Greek and Roman sources (notably Herodotus).[399] According to these sources, the Mother Goddess was in the form of Mountain, which was considered as an intersection point between the earth and the sky situated in the center of the visible world.[400] Her son was the Sun who was born from the earth.[401] It was suggested that sanctuaries and tombstones represented the mountain and this concept became a center of the mountain symbolism. Thus, according to Marazov, observing the Sun was related with worshiping the Sun God.[402]

Like the Phrygian Cybele, Thracians had also Great Mother Goddess, called Mount Mother, associated with mountain and rocky highlands. According to Theodossiev, both of these cults of the mountain goddess are evidence indicating relation between these two cultures, and showing the origin of the Phrygians.[403] Based on these cultural similarities, I would suggest that my investigation result showing the possible orientation of the Structure A towards the β Centauri may not be just a coincidence, thus may indicate an intention which reflecting Thracian influence on Phrygian tradition.

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[398]Vassileva 1997: 193 – 198

[399]Gonzalez-Garcia et al. 2009: 20; Maglova and Stoev 2015: 1386

[400]Christov 1999 in Maglova and Stoev 2015: 1387

[401]Gonzalez-Garcia et al. 2009: 21

[402]Marazov 1994 in Maglova and Stoev 2015: 1387

[403]Theodossiev 2002: 325 – 329

Orientation Toward to the Summer Solstice

Since the natural cycle is directly related with the Sun's movement on the sky, solar observation and solar cults were widely performed all over the world, and earliest evidence were dated to the hunter-gatherers.[404] The solstices are the most significant annual movement of the Sun that the Sun seems lasting at the same point on the horizon during for a few days. Therefore, it was considered as a marker in order to track the time.[405] Some of the ancient megalithic sites, tombs, and monumental buildings were aligned to the solstices in numerous different cultures. [406]

As mentioned previously, Sumerians and later Babylonians had advanced celestial knowledge which was expanded beyond the Mesopotamia via cuneiform texts.[407] In Babylon, ziggurats[408] observation towers were built in order to observe the changing patterns of the celestial objects.[409] Sumerians had a kingship with solar association which was derived from the legendary kings of early Uruk and Kish. According to Sumerian records, the term UTU was used for the high priest and first king of Uruk. Later Neo-Sumerians stared to use the title UTU, My Sun. The usage of the term was extended in time. [410] Beckman argued that Hittites were influenced

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[404]Belmonte 2015: 483 – 492; Hayden and Villeneuve 2011: 332 – 334

[405]Ruggles 2015d: 459 – 472

[406]Bhatnager and Livingston 2005: 1 – 32; For further reading about solar observation: Stonehenge (Bhatnager and Livingston 2005: 17), The Goseck Neolithic rondel (Ridderstad 2009), The tomb at Newgrange (Bhatnager and Livingston 2005: 18), several temples and pyramids in Egypth (Shaltout and Belmonte 2005: 273 – 298; Shaltout, Belmonte and Fekri 2007: 413 – 442)

[407]Aaboe 1980:14 – 35; Neugebauer 1947: 37 – 43; North 2008: 36 – 66; Sachs 1974: 43 – 50

[408]The origin of the ziggurats were the religious architecture of the late prehistoric Ubaid and Uruk Periods around 6000 – 3000 B.C., and it was widely used in standardised form but was constructed differentlyt across all of southern Mesopotamia by Sumerinas, and Babylonians. Bille and Sorensen 2016: 323 – 324

[409]Jerome 1973: 122

[410]Michaux-Colombot (2008): 336

from Sumerographic/Akkadographic form UTU. [411] Yattusilli I, the founder of the Hittite kingdom was called as UTU. [412] During the Empire period, the solar title "eclipsing the Tabarna" was used to ascribed the king.[413] Thus, a winged solar-disk was used to indicate royal names in monumental inscriptions and royal seals.[414] There was also Old Hittite rituals which referred to the king as "UTU-summis" meaning our Sun.[415]

According to Bonatz, representation of the Hittite kings had both political and religious aspects which aimed to reflect interaction with the supernatural power. Thus, king and queen were important facts for guaranteeing agricultural production. During the great spring festival AN.TAH.SUM, they played a role which was related with the Sun-god.[416] The wife of the Hittite king was associated with the Sun-Goddess of the city Arinna,[417] and the sittar-Rosette was its symbol.[418]

The research of Gonzalez-Garcia and Belmonte provides a clear view on the astronomical interest of the Hittites. Their analysis' result indicated significant intention of orientation toward to the solstices and equinoxes. They suggested that the winter solstice orientation could have an association with the winter festival of the Sun Goddess of Arinna.[419] The positions of the Lion Gate and the King Gate in Hattuşha provide to observe spring equinox and sunset within following 40 days. This 40-day period confirms the duration of the AN.TAH:SUM festival. The axis of

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[411]Beckman 2003: 21

[412]Michaux-Colombot (2008): 329

[413]Gonnet 1979: 3 – 107 in Michaux-Colombot 329 – 330

[414]González-García and Belmonte 2011: 464

[415]Kellerman 1978: 99 – 208 in Michaux-Colombot (2008): 330

[416]Bonatz 2007: 111 – 136

[417]Beckman 2003: 18

[418]Michaux-Colombot (2008): 331

[419]Belmonte and González-García 2015b; González-García and Belmonte 2011: 461 – 494

the monumental gate of the sanctuary at the Yazılıkaya was oriented toward to the summer solstice sunset. The light and shadow effects were also detected at the Hall A. The image of Tudhaliya IV was illuminated by the Sun's rays when the sun is setting at the summer solstice.[420]

The latest researches done on the Thracian region disclaimed the previous hypothesis based on the Solar-Chthonic characters of the ancient Thracian religion, instead, emerged an alternative suggestion in order to explain the consistency of the constructions' orientation, particularly dolmens, toward to the south-southwest. [421] On the other hand, the Sun played an important role in their culture, and the solar cult was mostly represented in sacred monuments in the Thracian region, rock-cut shrines and in some artefacts which reflect such association with the Sun. [422] Maglova and Stoev summarised the archaeoastronomical research of nine Thracian mountain monuments, and they concluded that the solstices and equinoxes at the sunrise or sunset were regularly observed, especially summer solstice sunrise, the day of the Great Mother Goddess (Cybele), were most observed solar events.[423]

Gonzalez-Garcia and Belmonte also extended their analysis by including 19 step monuments and 8 façades at Gordion, and the datum of the temple of Matar at Pessinus built in the Roman period. The result indicated that there was a preferred lunisolar orientation for the Phrygian structures. Thus, the orientation of the buildings and cultic structures in Gordion were mostly toward to the summer solstice sunrise. By considering Berndt-Ersöz's conclusion,[424] they concluded that south-east orientation could be intentionally preferred for an astronomical observation.

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[420]González-García and Belmonte 2011: 482 – 483

[421]González-García et al. 2008; Gonzalez-Garcia et al. 2009; González-García et al. 2015: 1395 – 1402; Maglova and Stoev 2015: 1385 – 1394

[422]Tsonev and Kolev 2013: 55 – 84

[423]Reader could reach the whole list of the monuments Maglova and Stoev 2015: 1385 – 1394

[424]Berndt-Ersöz 2006

Gonzalez-Garcia and Belmonte interpreted this tendency as a continuation of the Hittite practices during the Iron Age. They also proposed that there could have been relation between the Phrygian Matar and the Sun goddess (either of Arinna or of the Earth). [425]

Even though, the solstices are the most significant annual movement of the Sun, and there are significant numbers of examples indicating the intended orientation toward these celestial events, it is difficult to suggest the orientation of the North-East Gate toward to summer solstice was intentional. Because, as one could see from the examples, the complex megalithic monuments have either a structural design which leaves no doubt about its propose, or for a simple monument there has been additional evidence as a symbolic representation of the Sun or an artefact associated with the Sun that could support the hypothesis.

However, the North-East Gate has a very simple structural design, and there is no additional remains found which indicates the solar observation or existence of the light-shadow effect. Without a cultural indicator it is almost impossible to verify the relation to an astronomical intention. Nevertheless, based on the examples of traditional intention for solar orientation of Hittites, Thracians, and Phrygians itself, the result propounding a possible intended orientation toward to the summer solstice sunrise could not be denied.

[425] González-García and Belmonte 2011: 461 – 494

CHAPTER 5

CONCLUSION

This study had two objectives. First one was to give brief information about what is archaeoastronomy, and methodologies which are used in order to understand how ancient people observed and measured periodical movement of the celestial bodies, and how their perceive the cosmos and conceptualised this knowledge through analysing the materialised expressions associated with celestial objects and phenomena. The second one was to analysis the archaeological remains found in the Iron Age site at Kerkenes from an archaeoastronomical point of view.

The question of the examination was that whether there had been an astronomical intention in the direction of structures and city sculptures in the Iron Age site at Kerkenes. The examination was performed based on determining the orientation of the selected structures and sculptures, and comparing the result with the prominent celestial objects upon the horizon where rising or setting point take places. The examination produced three fairly meaningful results for a stellar orientation and one for a solar orientation. The star Altair for the Ashlar Building and the Audience Hall, and the star Hadar for the Structure A were determined. Based on the Sun's rising and setting points on the horizon, the orientation direction of the North-East Gate is toward to sunrise at the summer solstice.

The earliest evidence of the observation of Altair and the constellation of Aquila were found in Babylonian astronomical diaries. The cuneiform tablets found in the archives in Hattuşha are the evidences showing the influence of Babylonians on Hittite culture. Thus, the Babylonian astronomical knowledge had been transmitted to even the Greeks and Romans. The Phrygians, which were influenced by the previous culture of the Anatolia, could have had an intended choice for the direction of the Ashlar Building and the Audience Hall in order to observe the star Altair right above the horizon where the star rose around the 580 B.C. But, there is no direct evidence support this idea.

Despite the debates about the belief that the Phrygian origined in Europe, the latest research emphasises the idea of the immigration of the Phrygians from Balkans. Moreover, there is a significant similarity between the Phrygians and The Thracians. This state strengthens that the direction of the Structure A towards the rising point of the β Centauri on the horizon may have had an intended orientation which could be considered as a reflection of the Thracian influence on the Phrygian culture.

The solstices are the most significant annual movement of the Sun, and numbers of examples indicate the intended orientation toward these celestial events, however, without a cultural indicator it is almost impossible to verify the intended orientation for the North-East Gate toward to the sunrise at the summer solstice. Nevertheless, based on the examples of traditional intention for solar orientation of Hittites, Thracians, and Phrygians itself, the result propounding a possible intended orientation toward to the summer solstice sunrise could not be denied.

As a conclusion, based on the limited study area, insufficient research on Anatolian cultures, and lack of cultural evidence, it is difficult to suggest that the founders of the city at Kerkenes considered an astronomical intention in location and orientation preferences of the buildings, city gates and city sculptures. Nevertheless, none of these facts disprove the existence of an intention, but require further analysis.

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APPENDICES

A. The Horizon Profiles

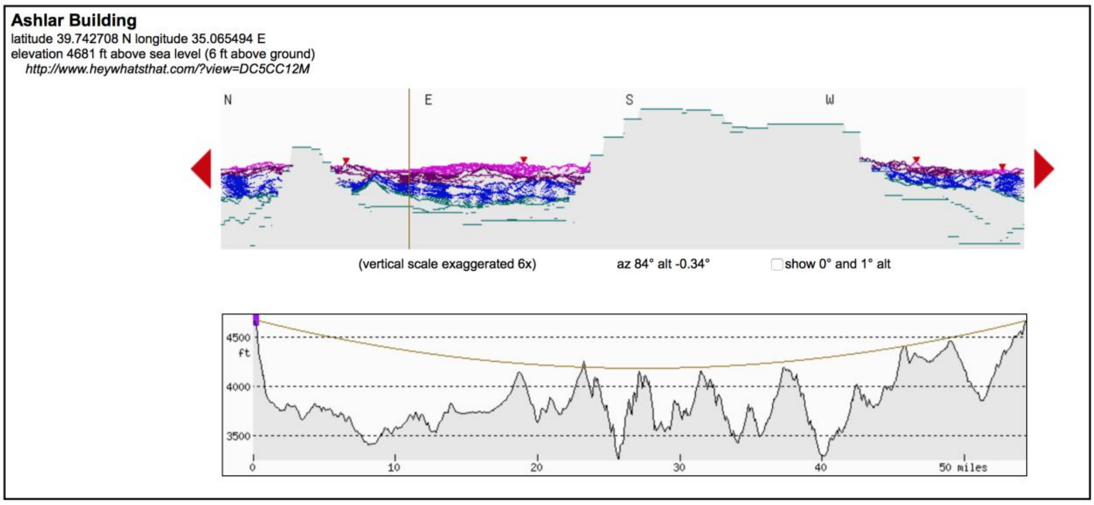

Figure 13 Horizon profile of the Ashlar Building with he vertical profile created for an azimuth of 84°. The minimum altitude value is determined as -0.34°.

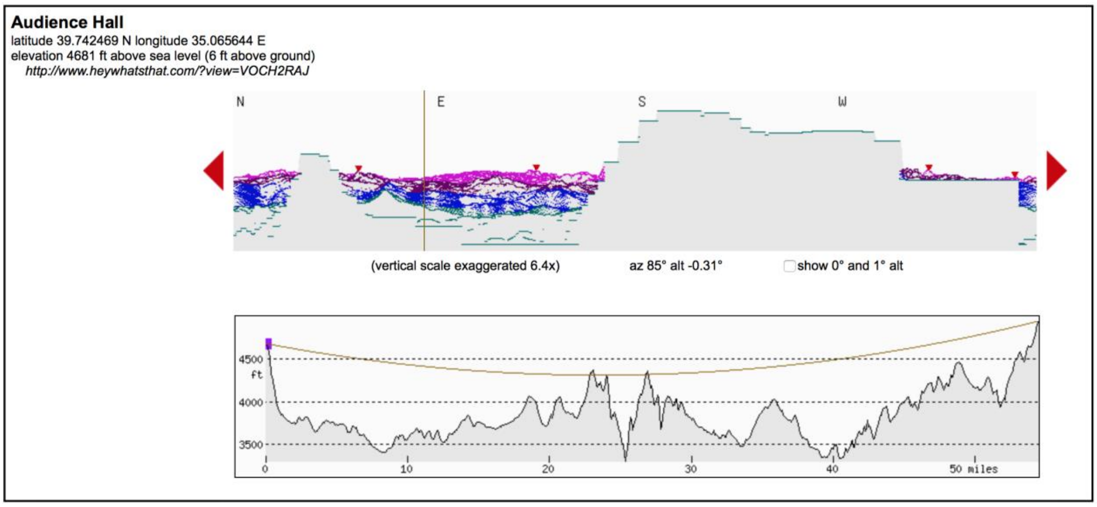

Figure 14 Horizon profile of the Audience Hall with he vertical profile created for an azimuth of 85°. The minimum altitude value is determined as -0.31°.

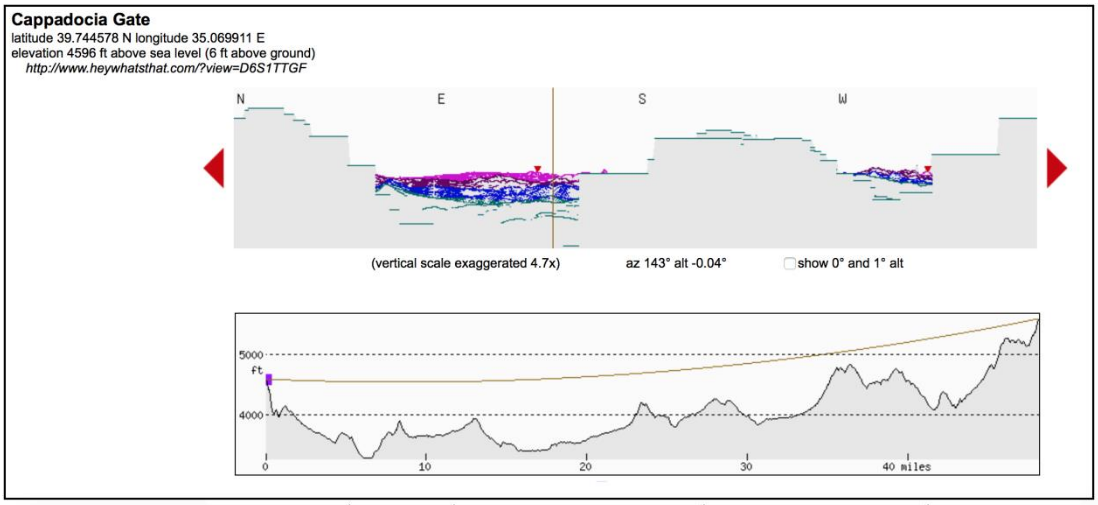

Figure 15 Horizon profile of the Cappadocia Gate with he vertical profile created for an azimuth of 143°. The minimum altitude value is determined as -0.04°.

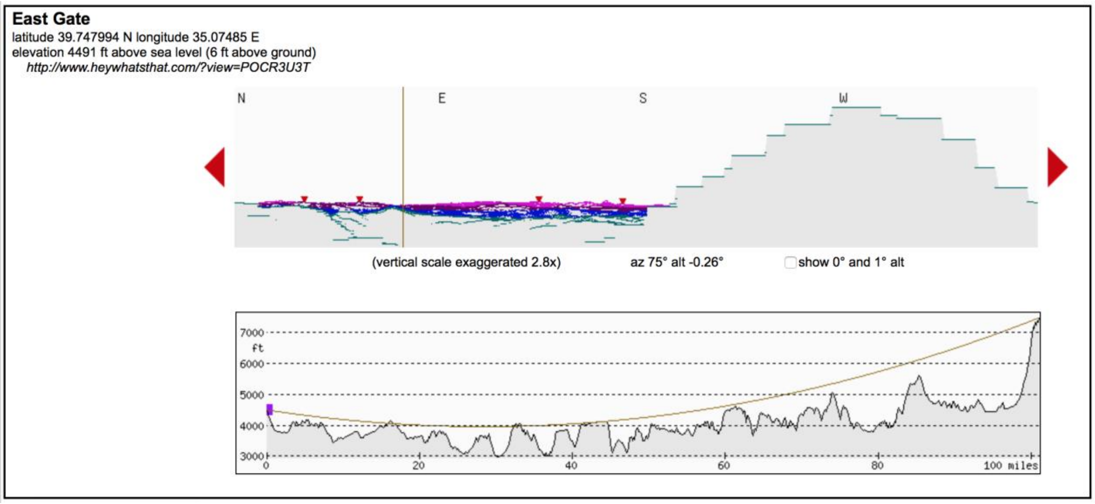

Figure 16 Horizon profile of the East Gate with he vertical profile created for an azimuth of 75°. The minimum altitude value is determined as -0.26°.

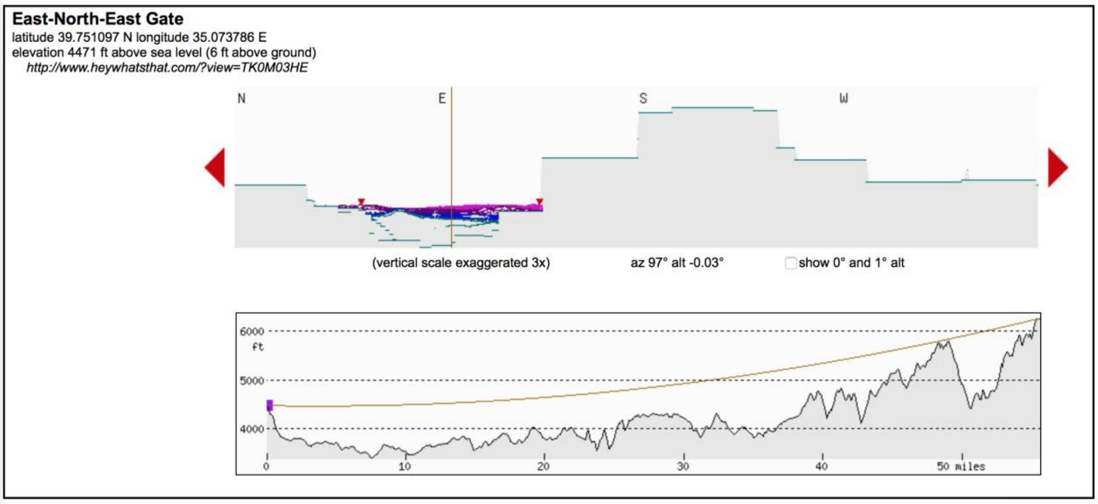

Figure 17 Horizon profile of the East-North-East Gate with he vertical profile created for an azimuth of 97°. The minimum altitude value is determined as -0.03°.

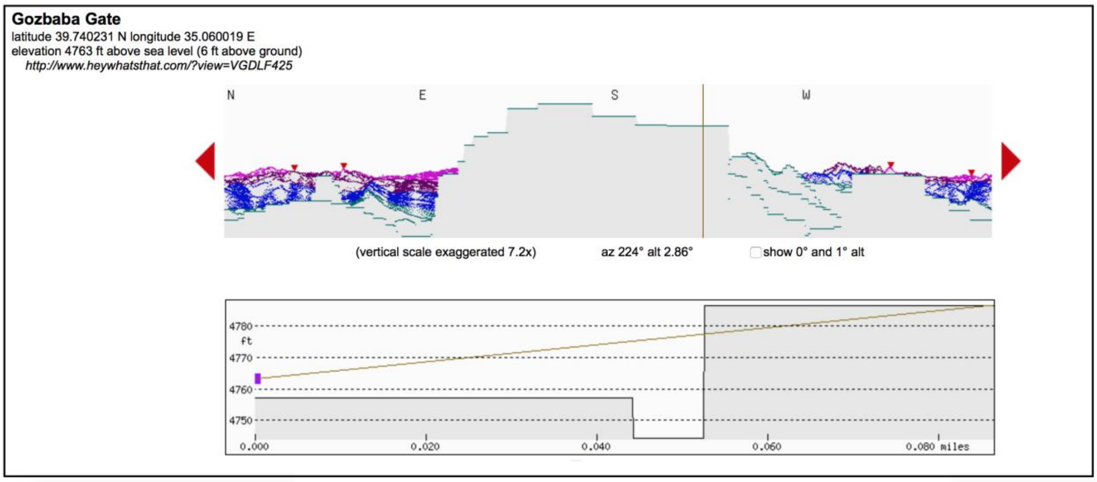

Figure 18 Horizon profile of the Gözbaba Gate with he vertical profile created for an azimuth of 224°. The minimum altitude value is determined as 2.86°.

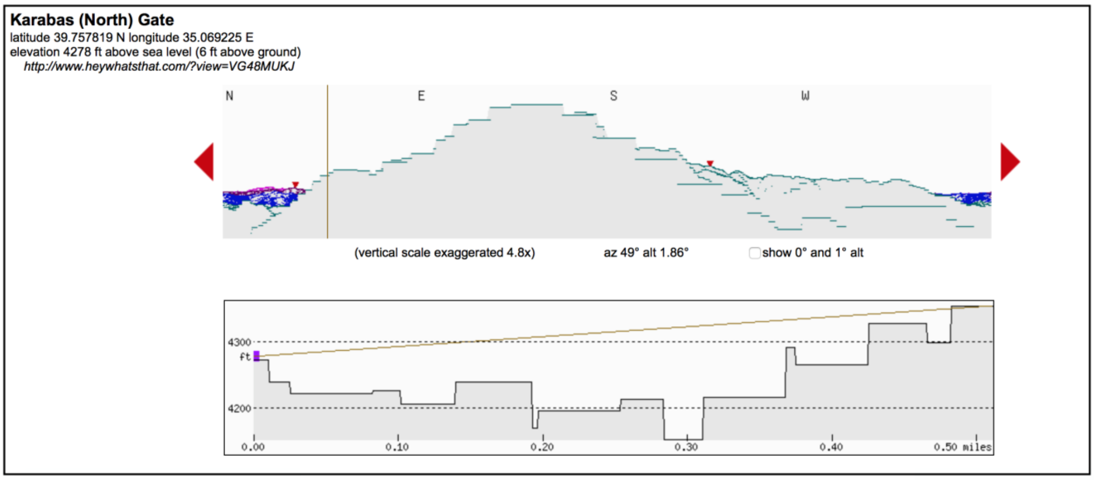

Figure 19 Horizon profile of the Karabaş (North) Gate with he vertical profile created for an azimuth of 49°. The minimum altitude value is determined as 1.86°.

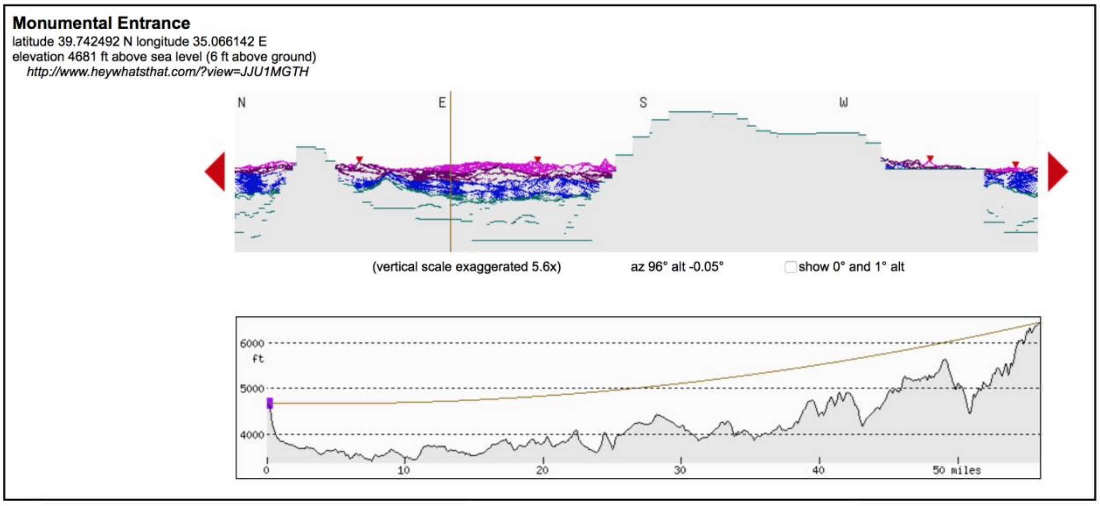

Figure 20 Horizon profile of the Monumental Entrance with he vertical profile created for an azimuth of 96°. The minimum altitude value is determined as -0.05°.

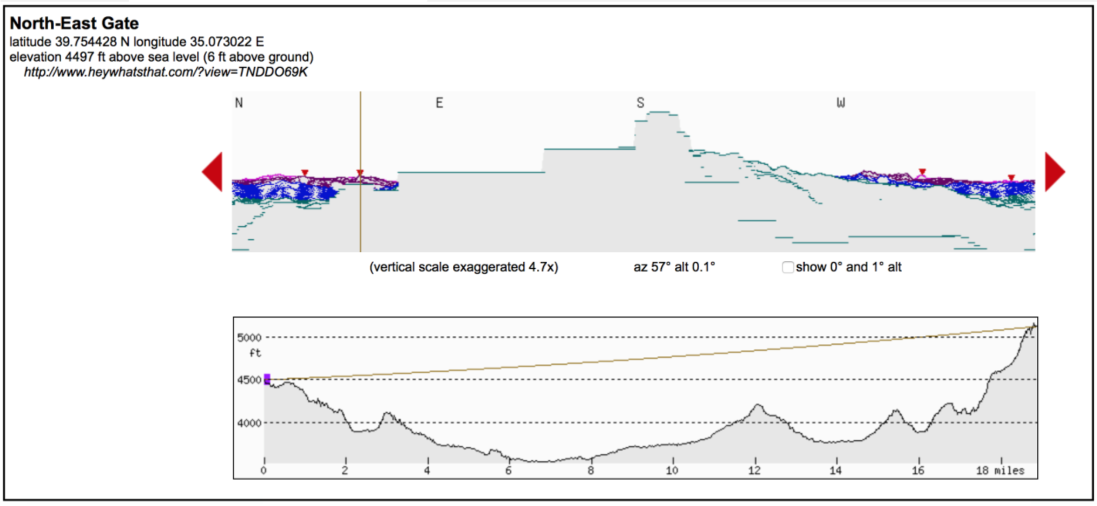

Figure 21 Horizon profile of the North-East Gate with he vertical profile created for an azimuth of 57°. The minimum altitude value is determined as 0.1°.

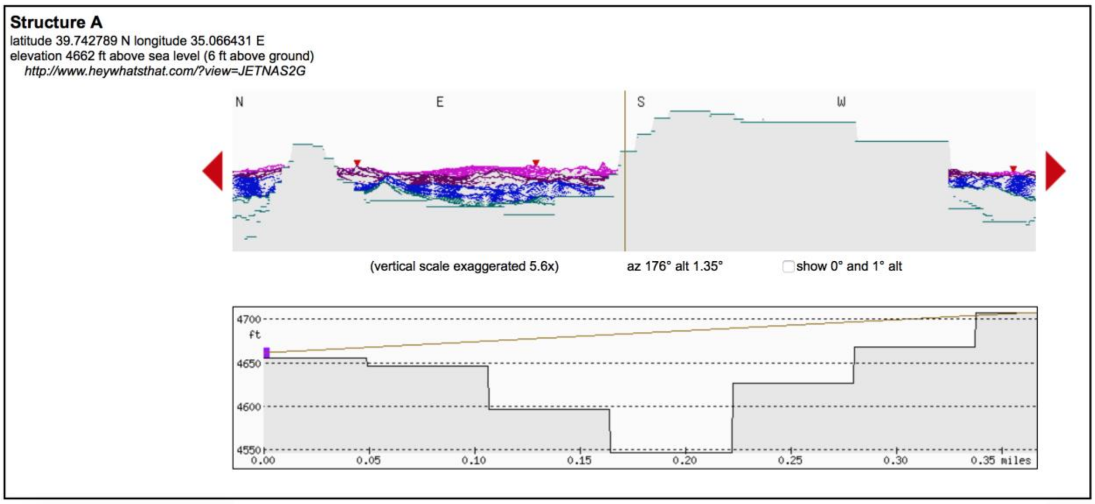

Figure 22 Horizon profile of the Structure A with he vertical profile created for an azimuth of 176°. The minimum altitude value is determined as 1.35°.

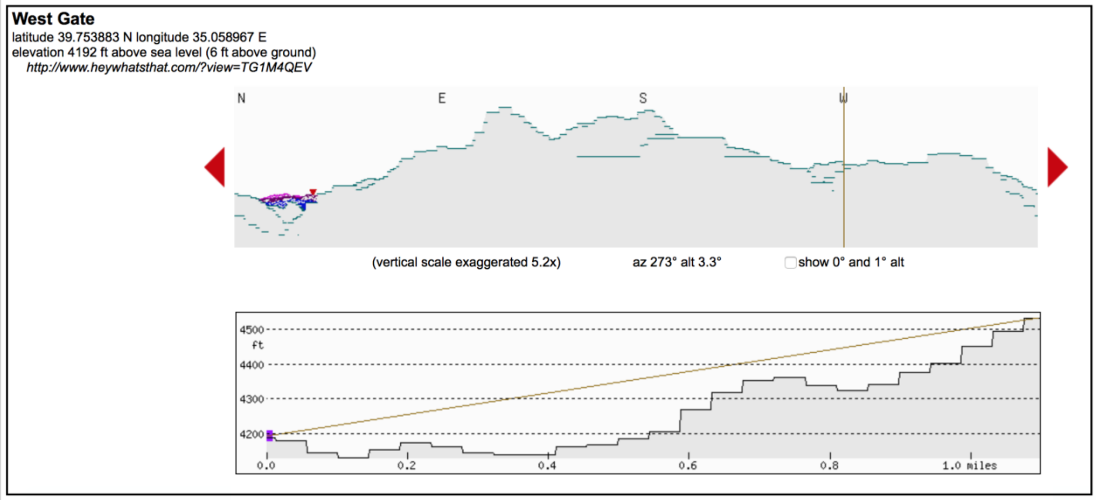

Figure 23 Horizon profile of the West Gate with he vertical profile created for an azimuth of 273°. The minimum altitude value is determined as 3.3°.

B. The Sky Views

Figure 24 the sky view of the Ashlar Building with the suspected star.

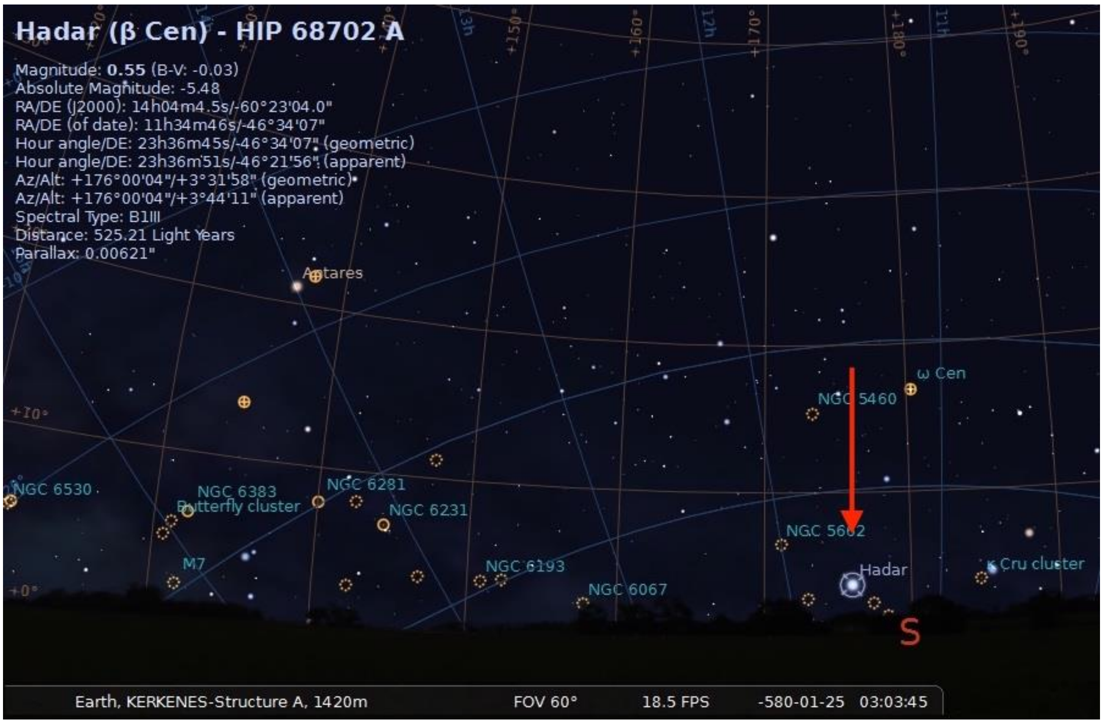

Figure 25 the sky view of the Structure A with the suspected star.

C. Turkish Summary

Göksel olgular insanların her zaman dikkatini çekmiştir. Gök cisimlerinin hareketlerinin gözlemlenmesi avcı-toplayı toplumlara kadar dayanmaktadır. Her ne kadar hareketin dayandığı fizik kanunlarını açıklayamamış olsalar da, gözlemlemek ve hareketlerin devinimini ölçmek için basit metotlar geliştirmişlerdir. Gök olaylarına duyulan bu ilgi en temelde insanoğlunun doğaya olan bağımlılığından kaynaklanmaktadır. Mevsimsel devinimin neden olduğu değişen çevre koşullarını takip etmek ve buna bağlı olarak yaşamsal ihtiyaçlarını organize etmek, kara ve denizde yön tayini yapabilmek ve sosyal etkinlikleri düzenlemek gibi birçok alanda kullanılan göksel olgulara ait bilgiler belirli kişiler tarafından muhafaza edilmiş ve nesilden nesile aktarılmıştır.

Bu tez çalışmasında Kerkenes Dağ'ındaki yerleşkede bulunan arkeolojik kalıntılar Arkeoastronomik bir perspektiften incelenmiştir. Çalışmaya öncelikle Arkeoastronomi bilim dalının çalışma alanın belirlenmesi ile başlanmıştır. Disiplinler arası bir dal olan bu alanın ilgi alanına giren farklı türden veriler derlenmiş, bu tez çalışması için en uygun metodu geliştirmek amacıyla kullanılan yazılım ve enstrümanlar da dahil olmak üzere bu zamana kadar uygulanmış metot ve analiz yöntemleri araştırılıp genel başlıklar altında incelenmiştir.

Ayrıca, göksel olayların tarih öncesi toplumlar tarafından nasıl algılandığı ve nasıl kavramlaştırıldı genel olarak tartışılmış, günümüze kadar ulaşmış buluntular üzerinden hangi yöntemlerle gözlem ve ölçüm yaptıkları incelenmiş ve genel bir başlık altında toplanmaya çalışılmıştır. Çalışmanın ikinci bölümünde ise Kerkenes Dağı'nda bulunan yerleşim yeri örnek çalışma olarak ele alınmış ve arkeolojik buluntular Arkeoastronomik bir perspektiften incelenmiştir. Elde edilen sonuçlar kültürel içerik göz önünde bulundurularak değerlendirilmiştir.

Göksel olayların gözlemlendiğine dair bulguları destekleyen bilinen en eski buluntulardan biri Fransa Abri Blanchard mağarasında bulunan M.Ö. 32.0000 yıllarına ait kemik plaktır. Plak üstünde bulunan şekil ve çiziklerin Ay'ın azimut ve zenit pozisyonlarını temsil ettiği düşünülmekte ve bilinen en eski takvim olarak değerlendirilmektedir. Bilişsel buluntu olarak değerlendirilen Paleolitik döneme ait bazı mağara resimlerinin göksel olayları temsil ettiği savı ileri sürülmekte ve zaman belirteci olarak ritüel zamanlarının belirlenmesinde kullanıldığı düşünülmektedir. Ancak bu tür buluntular sembolik anlatım içerdiğinden öznel yargı gerektirmekte bu nedenle de bilimsel değerlendirme sonuçlarının spekülatif olduğu düşünülmektedir.

İnsanoğlu etrafını saran gerçekliğin kavramsal modelini çıkarım yolu ile oluşturmaktadır. Tarih öncesi toplulukların göksel olayları nasıl algıladığı ve nasıl kavramlaştırdığı kültürel bir olgudur. Bu nedenle göksel olaylara dair bilgi, belirli bir kültürün içinde ortaya çıkmış ve yine kültür ile bütünleşmiş bir olay olarak ele alınır. Gök olayları ve gökbilimsel bilgileri kaydetmek için sembolik ifadeler kullanılmış, bilginin nesnel olarak ifade edilebilmesi sayesinde, tek seferde birden çok bilgi kodlanabilmiştir. Bu bağlamda kaya sanatı teknolojik bir buluntu yerine harici bilgi sistemi olarak yorumlanır ve bilişsel buluntu olarak değerlendirilmektedir.

Anlamsal işletim sistemi ve kültürel olarak anımsanan sembolik bir sistem ile temsil edilebilen kozmos kavramı ve dünya görüşü aynı zamanda mitolojik ve dinsel ritüellerin temellerinde de vuku bulmuştur. Dünyevi olaylar yıldızlar ve gezegenler ile ilişkilendirilmiş, sosyal hayatın düzenlenmesinde göksel olgulardan esinlenilmiştir. Gökyüzü tanrıların evi olarak algılanmış ve gök cisimlerinin hareketlerini insana özgü davranışlar atfettirilen tanrılar ile bağdaştırmışlardır. Öyle ki, göksel olaylardan faydalanılarak bir yandan gelecek öngörülmeye çalışılırken bir yanda da kralların öldükten sonra bir nevi tanrısallaştırılan ataları ile olan bağlarına ulaşılmaya çalışılarak otoritenin gücü arttırılmaya çalışılırken, milliyetçilik duygusu kuvvetlendirilmek istenmiştir.

Anadolu'da Göbeklitepe'de bulunan yapılar farklı bilim insanlarınca incelenmiştir. Yapılan çalışmaların bir kısmı oval şeklindeki yapıların bazılarının Sirius yıldızını gözlemlemek üzerine inşa edildiğini iddia etmektedir. Ancak sonraki çalışmalar, atmosferik sönümleme ve kırılma değerleri ile yapının lokasyonu göz önüne alındığında Göbeklitepenin inşa edildiği tarihlerde Sirius yıldızını gözlemlemeye uygun olmadığını vurgulamış, onun yerine yapıların bazılarının Deneb yıldızını gözlemlemek için kullanıldığı savını ortaya atmışlardır.

Tıpkı Göbeklitepe'de bulunan T-şeklindeki dikili taşlar bulunan Karahan Tepe'de, Keçili Kuzey Tepesi referans alınarak Deneb yıldızının gözlemlendiği idda edilmekte ve bu olayı Göbeklitepe'den uyarlanan yıldız-temelli inanç sisteminin yansıması olarak yorumlanmaktadır. Birçok inanışta, Samanyolu'nun karanlık bölgesinin girişinde bulunan Deneb yıldızının öte âleme geçiş kapısı olduğuna inanılmakta, öldükten sonra ruhların buradan geçtiği düşünülmektedir.

Hattuşa'da bulunan kütüphanede yapılan kazılarda Babil astronomi günlüklerinin çevirileri ele geçirilmiş, Hititlerin astronomi bilgisi ve bilgiyi kullandıkları alanlar göz önüne alındığında Babillerin etkisinin önemi oldukça açık bir şeklide görülmektedir. Tıpkı Babiller gibi yıldız ve gezegen gözlemleri yapılmış ve yıldız haritaları çıkarılarak gelecek önceden tahmin edilmeye çalışılmıştır. Ayrıca dini festivallerin tarihlerinin belirlenmesi için gözlemleri yaptıkları ortaya çıkartılmıştır. Hitit Anıtı Eflatun Pınar üzerindeki motifler Hitit kozmogramı olarak yorumlanmıştır.

Tunç Çağı'dan Demir Çağına geçiş sürecinde geleneksel yönelim doğrultusunun anlaşılması için Frigler'in tapınak ve anıtsal yapılarının yönelimlerini inceleyen çalışmalar Güneş ve Ay'ın doğma batama konumlarının gözetildiği sonucunu ortaya çıkarmıştır. Özellikle Gordion'da bazı binaların ve kültik yapıların yöneliminin Güneş'in yaz gün dönümünde ufuk çizgisinden yükseldiği nokta doğrultusunda olduğu anlaşılmıştır.

Anadolu uygarlıkları üzerine yapılan bir başka çalışmada Nemrut Dağı üzerindeki tapınağın ve heykellerin incelenmesi üzerinedir. Analiz sonuçları, tapınağın teraslarının gündönümü çizgisi göz önüne alınarak inşa edildiğini, yönelimin Güneş'in M.Ö. 49 tarihindeki 23 Temmuz'da (Antiochos 'un tahta çıktığı gün) ufuk çizgisinden yükseldiği nokta ile 23 Aralık'ta (Antiochos'un doğduğu gün) ufuk çizgisinde battığı noktalar doğrultusunda olduğunu iddia edilmektedir. Yine tapınakta bulunan aslan heykeli üzerindeki ay ve yıldız biçimindeki şekiller incelenmiş, ve şekillerin M.Ö. 12 Temmuz tarihinde inşaatına başlanan tapınağın, o tarihteki Ay ile Jupiter, Merkür ve Mars gezegenlerinin gök yüzündeki koordinatlarının betimlendiği düşünülmektedir.

Disiplinler arası bir bilim dalı olan Arkeoastronomi göksel olaylarla ilişkilendirilmiş inanç ve gözlemleri inceler. Araştırmaların genel amacı eski toplulukların gökyüzünü nasıl algıladıklarını, nasıl gözlem yaptıklarını ve gözlemler ile elde ettikleri bilgileri günlük yaşamlarına nasıl yansıttıklarını ve kültürlerinin nasıl etkilendiğine dair soruların yanıtlarını aramaktır. Yapılan çalışmalar özellikle tarih öncesi çağlar üzerine yoğunlaşmıştır. Arkeoloji, Amerika'da antropoloji dalının altında, Avrupa'da ise eski çağ tarihi olarak geliştiğinden, Arkeoastronomi her iki kıtada farklı şekilde gelişmiş ve uygulanmıştır.

"Brown Archaeoastronomy" olarak adlandırılan ve Kuzey Amerika'da 1970'lerde ortaya çıkan bu disiplin yönelim analizi dışında tarih, kültürel antropoloji, etnografya, dinler tarihi ve benzeri farklı birçok disiplinle birlikte çalışmalarını sürdürmektedir. Çalışmalar daha ziyade Kuzey Amerika ve Kolomb öncesi Mesoamerika uygarlıkları üzerine yoğunlaşmıştır. "Green Archaeoastronomy" terimi ise 1970'lerde Britanya'da ortaya çıkmıştır. Çalışma konusu, veri seçimi, arazi çalışmaları, istatistiksel analizler gibi anıtsal yapıların olası göksel bir yönelimini incelemek için geliştirilen yöntemler üzerinedir.

Arkeolojik verilerin astronomik bir perspektiften incelenmesi yalnızca eski teknikler ve materyaller ile sınırlı değildir. Kavramsal ve kuramsal olgularda bu bilim dalının alanına girmektedir. Farklı bilimsel metotlar ile tarih öncesi uygarlıkların kozmos algısı ve kavramsal mimarisine ışık tutmaya çalışan Arkeoastronomi, insanoğlunun kozmos ile olan ilişkisini açıklamaya çalışmaktadır.

Stonehenge tarih öncesi toplumların göksel olaylar ile ilgilendiğini gösteren ilk keşiflerden biri olarak bilim insanlarının dikkatlerini üstüne çekmiştir. Aubrey (1678) ve Chauncy (1700) yapmış olduğu çalışmalar sonucunda Stonehenge'deki yapıların doğrultularının gök cisimlerinin hareketleri gözetilerek belirli bir yönelime sahip olduğununu idda etmişlerdir. Stukeley, yönelimleri inceleyerek göksel olaylarla ilişkilendirilmiş, ve astronomik tarihlendirme yöntemi ile yapının inşa edildiği tarihi hesaplamıştır. Wansey Stonehenge yönelimlerini dikkate alarak ekinoks dönemlerinin presesyonunu çalışmıştır. Nicel araştırma yöntemleri ancak 1880'lerde ortaya çıkmış ve Lockyer astronomik yönelimlerin incelenmesi için gereken genel prensipleri belirleyerek araştırma metotları geliştirmiştir. Somerville 1912'de göksel olayların kültür ile olan ilişkisini inceleyerek Arkeoastronomik çalışmalara yeni bir boyut kazandırmıştır.

Oldukça geniş çeşitlilikte materyalin incelendiği bu alanda bulgular yapı yönelimi, ışık gölge etkileşimi, sembolik tasvir, buluntular, rasathaneler ve gök olayları ile ilişkilendirişmiş aletler ile yazılı ve sözel kaynaklar olarak genel başlıklar altında toplanabilir. Yapı yönelimlerinin yanı sıra kimi zaman yapının mimari tasarımı ya da tüm yerleşim yeri planı göksel olayları gözlemlemek ya da belirli yapı ve alanlara tanrısal anlamlar atfetmek üzere göksel olgularla doğrudan ya da dolaylı olarak ilişkilendirilmiş konum ve yönelimlere göre planlanmıştır. Bölgenin topografik özelliklerinin de bu plana dâhil edildiği gözlenen çoğu yerleşim ve kült alanları göksel olayların nasıl algılandığı ve dünyevi alanların kullanımında nasıl kavramsallaştığı ile ilgili önemli bilgiler içermektedir.

Bu noktada yapılacak arazi çalışması, ölçüm yöntemleri de dâhil olmak üzere uygulanacak metodun tasarlanması ve incelenecek verinin seçimi oldukça önemlidir. Keza bilimsel yayınlar göstermiştir ki aynı buluntu üzerinde çalışan farklı bilim insanları kimi zaman farklı sonuçlara ulaşmışlardır. Peşin hükmü verilmiş bir çıkarımı ispatlamak üzere seçilmiş veriyi değerlendirmekten özellikle kaçınılması gerekmekte, aksine ilgili ya da ilgisiz olduğu düşünülmeksizin hiç bir veri atlamadan buluntuların tüm detayları ile raporlanması oldukça önemlidir. Arkeoastronomik bir çalışmada nicel araştırma yaklaşımı ile olgunun ele alınması, mümkün ise arazi çalışması yapılması ve tüm verilerin belgelenmesi beklenmektedir.

Özellikle birden çok yapının yönelim analizi sonuçlarının değerlendirilmesinde istatistiksel analizlerin uygulanması yönelimin doğrultusunda herhangi bir göksel olgu gözetilip gözetilmediğinin anlaşılmasına fayda sağlamaktadır. Zira analiz sonucu rastlantısal bir olguyu da işaret ediyor olabilir. İncelenecek veriye göre dağılım analizi, korelasyon analizi, çapraz korelasyon analizi, Bernoulli dağılımı, Bayesian analizi, merkezi limit testi ve küme analizi gibi olasılık ya da istatistiksel analizler uygulanarak değerlendirme sonuçlarının güvenirliliği arttırılabilir.

Arkeoastronomik çalışmalarda kullanılan analiz yöntemleri şu ana başlıklar altında toplanabilir: yönelim analizi, ışık gölge etkileşimi, göksel olguların sembolik tasviri. Yönelim analizi ile yapıların ya da kompleks dikintilerin konumlarını ve planlarını inceleyerek göksel bir olgu ile ilişkilendirilip ilişkilendirilmediği incelenir. Yapılan araştırmalar en yaygın gözlem şeklinin gök cicimlerinin ufuk doğrultusundaki doğma ve batma noktaları olduğunu göstermektedir. Güneş, Ay, özellikle parlak yıldızlar veya yıldız kümeleri ve gezegenler gözlemlenmiştir.

Gün dönümleri, her iki gün dönümünün orta noktası ve ekinoks dönenceleri Güneş gözlemlerinde en sık tespit edilen yönelim doğrultularıdır. Ay'ın aylık hareketi ile değişen deklinasyon değeri ve sahip olduğu 5 derecelik rotasyonu nedeniyle gökyüzündeki hareketi Güneş'ten daha karmaşıktır. Bu nedenle yönelim analizlerinde geriye dönük doğma ve batma noktalarının hesaplanması ve gözlemlendiğinin ispatlanması çok daha zordur. Merkür, Venüs, Mars, Jüpiter ve Satürn sahip oldukları kadir değerleri sayesinde çıplak gözle gözlemlenebilen gezegenlerdir. Gezegenlerin gök küre üzerindeki hareketleri yıldızların aksine geceden geceye değişmekte, ekliptik düzleminde bir süre doğu yönünde devam ettikten sonra yörünge uzaklıklarına bağlı olarak bir kaç hafta ile bir kaç ay arasında değişen batı yönünde tersinir hareket yaptıktan sonra tekrar doğu yönünde hareketlerine devam ederler. İç gezegenler Güneş'e olan uzaklıkları nedeniyle ya sabah ya da akşam yıldızı olarak adlandırılır, sabah Güneş doğmadan hemen önce ya da Güneş battıktan hemen sonra gözlenirler. Ancak gezegenlerin ekliptik ile yaptıkları açı az olduğundan, bulguyu destekleyen kültürel bir başka kanıt olmadığı sürece yönelim doğrultusunun belirli bir gezegenle ilişkilendirildiği iddiasını kanıtlamak oldukça zordur.

Güneş ve Ay'ın aksine yıldızların doğma ve batma noktaları yıl içinde periyodik olarak değişmez. Ancak geriye dönük konum hesaplaması yapılırken yeryüzünün presesyon hareketinin göz önünde bulundurulması gerekmektedir. Özellikle belirli bir gün göz önüne alınarak yapılan geriye dönük hesaplamalarda mevsimsel değişim nedeni ile yıldız görünürlüğü de dikkate alınmalıdır. Ancak hangi gök cismi söz konusu olursa olsun atmosferik sönümleme ve kırılma değerleri özellikle ufuk düzlemi gözlemlerinde mutlaka gözetilmeli, bunun yanı sıra bölgenin topografik özellikleri incelenerek gözlenebilen minimum yükseklik belirlenmelidir.

Işık gölge etkileşimi Güneş'in gökyüzündeki hareketiyle ışınlarının gün içindeki geliş doğrultusunun ve açısının değişmesine bağlı bir olgudur. Ancak bu olgunun eski uygarlıklar tarafından taammüden kullanıldığının tespiti ve ispatı oldukça zordur. Zira etkileşim doğal yollarla ortaya çıkmış rastlantısal bir oluşum ya da insanlar tarafından sonradan farkında olarak ya da olmadan ortaya çıkartılmış olabilir. Bu denenle etkileşimin göksel bir olguyla olan ilişkisi farklı türde kültürel kanıtlarla desteklenmelidir.

El yapımı obje ve aletler ile sembolik tasvirler de göksel olaylarla ilişkilendirilmiştir. Gözlem için kullanılan araçlar olası bir ilişkilendirmeyi doğrudan kanıtlar niteliktedirler. Ancak objelerde ve duvar sanatında kullanılan çizim ve sembolik anlatımların tahlil ve mukayesesi yapılırken kültürel kavram ve bağlamlar göz önünde bulundurulmalıdır. Veri değerlendirmesinde ön yargıdan kaçınılması gerekmekte, özellikle sayısal bilgi izlenimi uyandıran tüm şekilleri göksel olgulara ait rakamsal verilerle açıklama çabasına girilmemelidir.

Günümüzde Arkeoastronomik verilerin işlenmesi ve değerlendirilmesinde birçok yazılım ve araç kullanılmaktadır. Genel anlamada kullanılan veriler arkeolojik kalıntılar olduğundan bilginin depolanması, işlenmesi ve görüntülenmesini sağlayan Coğrafi Bilgi Sistemleri; 3D çizim programları; özellikle arazi çalışması esnasında coğrafi bilgilerin teminini sağlayan küresel navigasyon sistemleri ve yersel konumlama, haritalama ve yön güdüm sağlayan araçlar; gök yüzü görüntüsü oluşturan planetaryum programları; ve gök cisimlerinin belirli bir tarihteki pozisyonunu hesaplayan uygulamalar bu alanda kullanılan uygulamalarından bazılarıdır.

Tezin bir diğer amacı da Kerkenes Dağ'ında bulunan arkeolojik kazıların Arkeoastronomik bir perspektiften incelenmesidir. Kerkenes Dağı Şahmuranlı ve İdris köylerinin sınırında Sorgun'da bulunmaktadır. 2.5 km^2'lik bir alanı kaplayan yerleşim yeri, yedi kapısı bulunan 7 km'lik şehir duvarı ile çevrilmiştir. Karadeniz ile Akdeniz'i ve Ege ile Pers bölgesini birbirine bağlayan doğal yolların kesim noktasında bulunan yerleşim yeri konumu itibari ile jeopolitik bir öneme sahiptir. İlk arkeolojik araştırmalar 1903 yılında yapılmıştır ve günümüze kadar halen devam etmektedir. Bu tez çalışmasında kullanılan temel veriler, Kerkenes Projesi çatısı altında yirmi yıldan fazla devam eden uzaktan algılama ve öz direnç yöntemlerinin kullanıldığı yüzey araştırmaları ve kazı sonuçlarından elde edilen verilerden derlenerek oluşturulmuştur.

Yerleşim döneminin kısa olması ve Demir Çağına ait yeterli bir bilginin olmaması yerleşim alanın tanımlanmasını zorlaştırmaktadır. Yapılan ilk arkeolojik çalışmalarda yerleşim yerinin de Hitit sonrası ve Klasik dönem öncesi olduğu düşünülen tek tabaka belirlenmiş. 1903 yılında ilk arkeolojik çalışmaları başlatan Anderson şehrin Galatlara ait Mithridates olduğunu ileri sürmüştür. 1927 yılında von der Osten'in başkanlığında devam eden çalışmalara katılan Forrer buluntuların Kimmerler'e ait olabileceği fikrini öne sürmüştür. Yirmi seneyi aşkın bir süre devam eden Kerkenes Projesi kazıları sonucunda yerleşim yerinin M.Ö. 7. yy'in ikinci yarısında inşa edilen imparatorluğa ait bir şehir olduğu düşünülmekte, kültürel olarak Frig izlerini taşıyan bu Demir Çağı başkentinin Herodotus'un bahsettiği Pteria olma ihtimalini ortaya koymaktadır.

Doğal bir savunma hattı olan şehrin yer seçiminin İç Anadolu bölgesindeki ana yollar ve kuzey Kapadokya bölgesi üzerinde egemen kuvvet olma stratejisi gözetilerek yapıldığı kuvvetle muhtemeldir. İdeal bir kent kavramından yola çıkılarak düzenlendiği gözlenen yerleşim planı, şehir kapılarını birbirine bağlayan iç yollar; konutlar, idari binalar, depo alanları gibi kullanım amacı farklı alanları birbirinden ayıran şehir blokları; ve su kanalları sistemini içeren merkezileştirilmiş şehir planına işaret eder. Kazı sonuçları şehrin henüz inşaatı tamamlanamadan yıkıldığını göstermektedir. Yıkımının Pers Kralı Büyük Kiros ile Lidya Kralı Kroisos arasındaki anlaşmazlıkla ilişkili olduğu düşünülmektedir.

Bu tez çalışmasında tüm sur kapıları; kentin Güney tarafında stratejik konumu ile çevreye hakim olan Saray Yapı Grubu'ndaki A Yapısı, Kabul Salonu, Ashlar Binası; Kapadokya Kapısı'nda ve Saray Yapı Grubu Anıtsal Girşi'nde bulunan kült taş idollerin yönelim doğrultuları incelenerek ideal kent kavramının göksel olaylar ile olan ilişkisi analiz edilmiştir. Analiz için veri seçiminde bir önceki nesilden ya da farklı kültürlerle olan etkileşimden kaynaklanan olası geleneksel yönelim eğilimini de dikkate alıcak şekilde yalnızca direk gözlem yapılabilecek yapıların yerine büyüklük ve konumları nedeniyle önem atfedilen tüm yapılar değerlendirilmeye alınmıştır. Analiz için kullanılan ana veri Kerkenes Projesi veri deposundan temin edilen ilgili yapıların AutoCAD çizimleridir.

Veri işleyiş akışı şu şekildedir: yapının jeolojik koordinatlarının ve yüksekliğinin belirlenmesi, yapının ana ekseninin belirlenmesi, azimut değerinin ölçülmesi, ufuk profilinin çıkarılması, ufuk düzlemi gözlemi için minimum yüksekliğin belirlenmesi, M.Ö. 580 tarihi için gökyüzünün oynatılması, olası gök cisminin tespiti. İdollerin yönelimleri konumlandırıldıkları yapı ile aynı doğrultuda olduğundan yeniden veri işlem süreci gerçekleştirilmemiş, onun yerine ilişkilendirilmiş yapının analizi üzerinden sonuçları değerlendirilmeye alınmıştır. Çalışma olası yıldız ve Güneş gözlemini belirlemek üzerine tasarlanmıştır.

Her bir yapının jeolojik koordinatları ve yüksekliği Google Earth ile belirlenmiştir. Ana eksen doğrultusunun kuzey ile yaptığı açı ölçülerek azimut değeri olarak atanmıştır. Her bir yapı için gereken değerler ayrı ayrı girilerek interaktif web sitesi “heywhatsthat” kullanılarak ufuk profili düzenlenmiş, ilgili yapının azimut değeri doğrultusundaki gözlenebilen minimum yükseklik ölçülmüştür. Ancak Google Earth ile elde edilen yapıya ait yükseklik değeri ile web sitesinden elde edilen yükseklik değerinin farklı olduğu gözlemlenmiş, analizin doğruluğundan emin olunması için her bir yapı için yükseklik farkı değeri hesaplanmıştır. Hesaplanan değerler insan gözünün görebileceği ufuk çizgisi mesafesi göz önüne alındığında değerlendirilmeye alınmamıştır.

İlgili tarihteki gökyüzü görünümü için kullanılan Stellarium programının yıldızların öz hareketlerini hesaplayıp hesaplamadığının anlaşılması için uzaklıkları ve öz hareketleri bilinen iki farklı yıldız için program farklı tarihler girilerek çalıştırılmıştır. Karşılaştırılan sonuçlar programın analiz için yeterli hassasiyette olduğunu destekler niteliktedir. Her bir yapı için koordinat ve yükseklik bilgisi ile ilgili tarih girilerek, o tarihe ait gökyüzü görünümü elde edilmiştir. İlk aşamada yapının yönelim doğrultusundan geçiş yapan olası gök cisimleri tespit edilmiştir. Daha sonra gözlenebilen minimum yükseklik değerleri üzerinden yola çıkılarak belirlenen eşik değeri aralığına düşen sonuçlar anlamlı bulunmuştur. Bunlar A yapısı için Hadar (β Cen) yıldızı, Ashlar Binası ve Kabul Salonu için Altair (α Aql) yıldızıdır.

Program bir kez de M.Ö. 700 tarihi ayarlanarak tüm yapılar için tekrar çalıştırılmış, bu sayede bölgeye gelen ilk yerleşimcilerin gözlemledikleri gök yüzü ile yıkım dönemi arasındaki gök cisimlerinin koordinatlarının değişimi incelenmiştir. İnceleme sonucu Kerkenes Dağ'ının kısa yerleşim dönemi ve yıldız konumlarındaki farkın göz ardı edilebilecek değerde olduğu kanaatine varılarak, analizler M.Ö. 580 tarihi göz önüne alınarak yapılmıştır. Bunun nedeni olası bir yönlendirme var ise, yıkım tarihinden önce yapının rekonstrüksiyon ile doğrultusunun güncellenmiş olması beklenir.

Gün dönümleri ve ekinoks dönemleri en çok gözlemi yapılan tarihler olduğundan planetaryum programı kullanılarak M.Ö. 580 yılı içinde Güneş'in gün dönüm ve ekinoks tarihleri ve bu tarihlerdeki doğma ve batma noktaları belirlenmiştir. Program her bir yapı için belirlenen tarihler için çalıştırılmış, Güneş'in ilgili azimut değerinde iken ki yüksekliği bulunmuştur. Elde edilen sonuçlardan Kuzey-Doğu sur kapısı yaz gün dönümü doğrultusunda anlamlı sonuç vermiştir.

Çıkan her bir anlamlı sonuç için literatür taraması yapılarak, belirlenen bu yıldızların en eski gözlem tarihleri ve kimler tarafından gözlemlendiği araştırılmış, Frigler ile aralarında kültürel bir bağ olup olmadığı tespit edilmeye çalışılmıştır. Altair yıldızı Kartal takımyıldızının en parlak, karanlık gökyüzünün ise ikinci en parlak yıldızıdır. Altair yıldızı, Vega ve Deneb yıldızları ile birlikte kuzey yarım küredeki en belirgin asterism olan yaz üçgenini oluştururlar.

Altair'e ait bilinen en eski gözlemler Sümer ve Babillere dayanmaktadır. Babil astronomi tabletlerinde adı geçen yıldıza ayrıca Akkad metinlerinde de rastlanır. Ancak Akkadlar'ın Babiller'den mi etkilendiği yoksa Babillerin sistematiğinden esinlenilerek kendi gözlemlerini mi kaydettiği tartışma konusudur. Yıldız ile ilgili gözlemlere Antik Yunan ve Roma dönemlerinde de devam edilmiştir. Hatta Antik Yunan ve Romalıların astronomi ile ilgili bilgilerinin Mezopotamya'ya dayandığı düşünülmektedir.

Hititlerin astronomi bilgisinin Babiller'den elde edildiği düşünülmekte, Babil astronomi günlüklerinin tercümesi Hattuşha'daki kütüphanede yapılan kazılarda bulunmuş olması da bu savı destekler niteliktedir. Frigler'in dini ögelerinde Hitit kültürüne ait özellikler bilinmektedir. Ancak Frigler'in Altair yıldızını gözlemlediğine dair doğrudan bir kanıt bulunamamıştır.

Hadar yıldızı Erboğa takımyıldızının ikinci, karanlık gökyüzünün ise 11. en parlak yıldızıdır. Beta Centauri olarak da adlandırılan yıldız Alpha Centauri yıldızı ile billikte Güney İşaretleyicileri olarak da bilinir ve Güneyhaçı'nı bulmak için kullanılırlar. Hadar yıldızı Trakyalılar tarafından gözlemlenmiş, yaklaşık olarak M.Ö. 1000 yılında inşa edilen gömü yapılarının yönelimlerinin Güneyhaçı ve Güney İşaretleyicileri doğrultusunda olduğu tespit edilmiştir. Her ne kadar Frigler'in kökeninin avrupaya dayandığı konusunda tartışmalar halen devam etse de, birçok çalışma Frigler ile Trakyalılar arasındaki kültürel benzerliği ortaya koymakta, bu benzerlik özellikle kültik faaliyetlerinde ve mimari yapı özelliklerinde gözlemlenmektedir. Öyle ki, Trakyalı'larda da tıpkı Frigler'deki Ana Tanrıça Cycbele'ye benzer dağ ve kayalık arazi ile özdeşleştirilen Ana Tanrıça inancı bulunmaktadır. Bu durumdan yola çıkarak, A Yapısı'nın yöneliminin Hadar yıldızının ufuk düzlemindeki batma noktası doğrultusuna yönlendirilmiş olabileceği düşünülmekte ve bu durum Antik Trakya kültürünün Frigler üzerindeki etkisinin bir yansıması olarak yorumlanmaktadır.

Sümer, Babil, Hitit ve Frigler için yapılan Arkeoastronomik çalışmalar yaz gün dönümü doğrultusunda yönelim örnekleri olduğunu göstermektedir. Ancak Kuzey-Doğu sur kapısının yöneliminin yaz gün dönümü doğrultusunda hedeflenerek inşa edildiği savını destekleyecek kültürel bir bulgu ne yazık ki yoktur.

Sonuç olarak, gerek çalışma alanının oldukça limitli bir alanı kapsıyor olması gerekse Anadolu uygarlıkları üzerinde yapılan Arkeoastronomik çalışmaların henüz çok yeni ve bu nedenle yeterli veri sağlayamaması nedeniyle bu tez çalışmasında yapılan Arkeoastronomik analizin anlamlı bulunan sonuçlarına dayanarak Kerkenes Dağı üzerine inşa edilen şehrin kurucularının, şehrin inşaatı sırasında göz önünde bulundurdukları ideal kent kavramının göksel olaylar ile ilişkilendirildiğini iddia etmek oldukça güçtür. Sonuçlar her ne kadar iddianın aksini ispatlar nitelikte olmasa da, bu konu ile ilgili yeni çalışmaların gerekliliğini vurgulamaktadır.

D. Tez Fotokopisi İzin Formu

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	
Sosyal Bilimler Enstitüsü	x
Uygulamalı Matematik Enstitüsü	
Enformatik Enstitüsü	
Deniz Bilimleri Enstitüsü	

YAZARIN

Soyadı : Alpay
Adı : Ayşe Iraz
Bölümü : Yerleşim Arkeolojisi

TEZİN ADI (İngilizce) : ORIENTATIONS OF MONUMENTAL ARCHITECTURAL REMAINS AT KERKENES DAĞ

TEZİN TÜRÜ : Yüksek Lisans [x] Doktora [ ]

1.	Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir.	
2.	Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir.	
3.	Tezimden bir (1) yıl süreyle fotokopi alınamaz.	x

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: