

Environmental and societal determinates of ancient astronomies

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Abstract. A goal of cultural astronomy is an understanding of the meaning and value of astronomy in ancient cultures and, as a consequence, new insights into the nature of the culture itself. In many cultures there appear to be unique connections between astronomy, cultural traditions and the environment, which include both landscape and skyline. In some cases, with sufficient knowledge of a culture, one can anticipate its astronomy. Three cases are presented where astronomy appears to be a natural consequence of the culture and its environment.

Key words: Nabta Playa–Surya Puja–Chaco Canyon

1. Introduction

The field of archaeoastronomy has undergone a transformation from its earliest roots when goals were largely limited to searches for astronomical alignments. Today, a major concern is the cultural context of the astronomy that is suggested by those alignments. A goal of this paper is to go beyond context and search for meaning. What were people thinking when they designed and built massive construction projects aligned to the heavens? I believe the reason is that certain members of the culture had engaged in what we might identify as mythic thinking, attempting to develop a holistic interpretation of the wider world in which they found themselves. Cassirer (1955) describes mythic thinking as the intuitive understanding of wholeness. Without some sort of narrative involving the interconnectedness between people and the larger world, experiences would remain chaotic and fragmentary, a collection of seemingly unrelated events (Malville 1975). Although myths may often be products of pure imagination and often not falsifiable (the *sina qua non* of modern science), Popper (1961) has suggested that many notable scientific theories have had their origins in mythic thinking. We search for those early myths that might be examples of nascent scientific thinking.

Nabta Playa in southern Egypt contains the oldest known collection of megalithic astronomical alignments, predating by more than a millennium the well-known sites of Stonehenge, New Grange, and the temple culture of Malta. We have no knowledge of the mythmaking of the nomadic pastoralists who built a ceremonial center at Nabta Playa, but we do know something about their stone monuments and can speculate about their mythmaking. In the Late and Terminal Neolithic (7500-5400 BP) nomadic pastoralists built a ceremonial center on the western

shore of the seasonally flood lake known as Nabta Playa. The center consists of complex megalithic structures, stone circles, and lines of megaliths crossing the playa. The astronomy of the site appears to be a natural outgrowth of two aspects of the cultures of the nomadic pastoralists: the need to use the brightest stars as navigational aids for annual journeys to the playa for water and forage, and the appearance of monsoon rains around June solstice that brought water to the playa. These nomads were members of a cattle worshiping culture and this combination of June solstice, water, cow worship, and star worship may have been carried by them into the Nile valley and perhaps beyond, continuing for millennia as worship of the cow goddess, Hathor, heliacal rising of Sirius, and the flooding of the Nile.

The second case involves the ceremony of Surya Puja, which is practiced in a number of temples in Tamil Nadu, India. The appearance of naked-eye sunspots at the onset of the Medieval Maximum of solar activity, at the time these were being constructed, apparently produced cogitative dissonance among the Hindu culture, which considered the sun god, Surya, as pure and unblemished.

Finally, in the American Southwest in Chaco Canyon, the appearance of the rising of the December solstice sun over Fajada Butte as viewed from a Great Kiva is the earliest known case of astronomy in Chaco Canyon. It may be the consequence of a horizon calendar and the concern to maintain the cyclic regularity of the seasons.

2. Nabta Playa

Nabta Playa is an internally drained basin located about 100 km due west of Abu Simbel. It is one of the two such basins in the southern Western Desert of Egypt, and was fed by runoff from an enormous area some 1500 square km in size. (Malville et al 1998, 2008) The earliest excavated sites at Nabta have calibrated radiocarbon dates of 10,300- 9800 BP. The area began to function as a regional center for nomadic pastoralists during Middle Neolithic (8100-7600 BP), based upon the numerous hearths and the highest frequency of cattle bones of any locality in the Nubian Desert. The Middle Neolithic ended with a short but deep drought, which began around 7600 BP, lasting about 100 years. In the Late Neolithic (7400 to 6600 BP), a new group of nomads began frequenting the playa when it had water. These people, the Ruat El Baquar people (Cattle Herders) were responsible for cattle burials in clay-lined and roofed chambers. The diminished rainfall in the Late Neolithic meant that only a few watered refuges such as Gilf Kebir and Nabta Playa remained (Kuiper and Kropelin 2006). Increasingly skillful navigational techniques, using the stars, would have been required for the nomadic pastoralists to locate these isolated sources of water. Finally, some 30 complex megalithic structures together with lines of megaliths were built during the Terminal Neolithic by Bunat El Ansalm people (Megalith Builders). The Terminal Neolithic at Nabta Playa extended from 6600 BP to total abandonment of the area in approximately 5500 BP. These nomads skipped sedentism with its associated agriculture and permanent villages, entering the Late Neolithic with

their own repertory of concepts involving astronomy, design of sacred structures, and ritual. Another place where monumental ceremonialism by-passed sedentism appears to have been Göbekli Tepe in southern Turkey.

The Valley of Sacrifices and the Calendar Circle

Along the western rocky bank of a wadi that entered the playa from the north there are at least ten mounds or tumuli. Built of broken sandstone blocks, the tumuli contained offerings of parts of butchered cattle, goats, and sheep. The largest and perhaps the oldest tumulus contained an entire young cow, the most precious offering that a pastoralist can make. A piece of tamarisk from its roof yielded a calibrated radio carbon date of 7270 years BCE. The animal was lying on its left side, oriented approximately north-south, with its head to the south. This wadi, which is now called the Valley of Sacrifices, brought water to the playa and would have been an appropriate place to ask the gods for rain by performing cattle sacrifices and other rituals.

The wadi ends with a small sandy knoll containing a circle of stones at its top. A radiocarbon date from a hearth adjacent to the circle yielded a date of 6800 years BP. The circle, approximately four meters in diameter, is composed of individual slabs, ranging in length from 20 to 70 cm set in the sand. Four sets of prominent upright slabs appear to be gates for viewing. When one is lying in the sand, these portals provide sightlines towards the north and toward the position of the rising sun on June solstice. These two alignments may reveal two major astronomical elements in the lives of the nomads. North was important when navigating across the oceans of sand of the Sahara. Even though there was no star at the north celestial pole during this period, the point in the sky around which stars circle would have been a useful navigation tool. June solstice would have been significant for marking a date near the onset of monsoon rains and the flooding of the playa. The association of the of the stone circle with cattle sacrifices in the Valley of Sacrifices suggests rituals connections between the flooding of the playa, cattle worship, and the solstice sun.

The Complex Structures

South of the Valley of Sacrifices there are about 30 complex megalithic structures built during the Terminal Neolithic. The largest of the structures is the focus of five radiating megalithic alignments. The builders dug a pit through playa sediments to expose a table rock at a depth of 2.6 m. The rock is a thick lens of hard, quartzitic sandstone that remained after the surrounding softer sediments had been removed by erosion. The northern and western sides of the table rock were shaped and its top was probably worked and smoothed. The oval rock (Figure 1: 1) measures 3.3 m by 2.3 m with its long axis aligned slightly west of north. The pit was partially refilled with sand, and a large secondary stone, weighing 2-3 tons, was placed over the center of the table rock (Figure 1:5). This stone was carefully shaped with a large head-like projection giving it the appearance of a cow. It was oriented approximately north-south and held upright by two large slabs set against the structure at its north end.

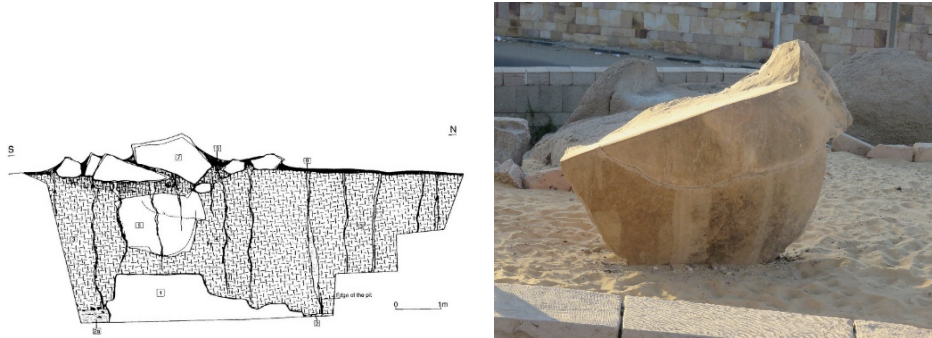


Figure 1. The Central Complex Structure

The Alignments

Megaliths are organized along five lines that radiate outward from the largest complex structure (Figure 2). The average weight of the 19 megaliths in the alignments for which we have good measurements, is 2.6 metric tons, ranging upward to the largest megalith, which has a weight of approximately 12 metric tons. The flat sides of the standing megaliths face north. Charcoal from fires in the nearby quarry have given us five radiocarbon dates associated with the quarrying of the megaliths ranging from 6600 BP to 6200 BP.

The brightest star in the region of the sky north of the celestial equator, Arcturus, is a reasonable candidate for the three northern alignments. Each of these three alignments may have been built to account for the changing location of that star due to precession over the period 6600-5700 BP. The two southern alignments may have been associated with stars in the belt of Orion between approximately 6400-6200 BP and toward Sirius and α Centauri, approximately 6600-6300 BP. A dramatic sight would have greeted those who stood at the edge of the flooded playa watching the reflections of stars as they above the eastern horizon coming into alignment with the monoliths rising above the dark waters.

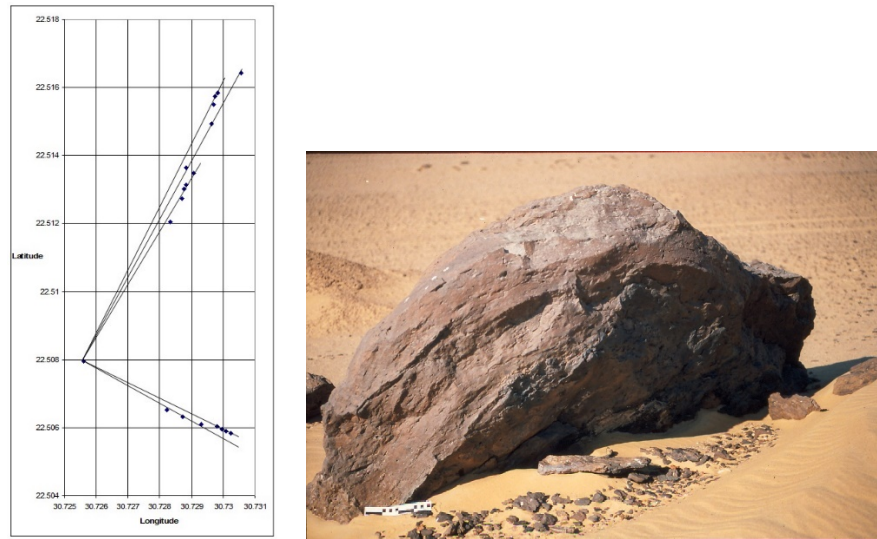


Figure 2. The Five Alignments

The placing these megaliths into the playa would have been a significant investment in time and resources in an activity, which transcended survival. It also displays management skills and control over a group of people for extended periods of time, unexpected for Late Neolithic people in the Sahara. That these five alignments converge on the large complex structure, which contains a buried sculpture with the appearance of a cow suggests again the dominance of this animal in the society and, in a fascinating way, the entanglement cow, nomads, landscape, and skyscape.

Summary

The evidence for attention to the heavens by these nomads comes in three forms. The repetitive orientation of the faces of the megaliths along a north-south direction, and the cardinal orientations of cattle burials reveals an early symbolic connection to the north, which is what one expects for nomads who need to navigate using the stars. The second bit of evidence for astronomy is found in the stone circle with its two sightlines toward the north and the direction of rising sun near June solstice; the latter associated with monsoon rains and the flooding of the playa. Finally, the alignments of megaliths, which, if intentionally oriented to the brightest stars of Nabta Playa suggest an even more careful attention to the heavens. Honoring those stars is understandable if the nomads relied upon them for navigation across the Sahara.

Some of the cognitive features of early Dynastic Egypt, such as cattle worship June solstice, rising stars, and rising of the Nile may have been carried into pre-dynastic cultures in the Nile valley. As the desert dried up, there was perhaps a

cyclical movement of nomads between the two ecosystems of the desert and Nile valley in Lower Nubia. Eventually after around 3500 BCE after the desert became hyper-arid, there was a major migration to the middle Nile Valley, lower Nubia. (Gatto 2011). For the pastoralists, cattle may have served as walking larders, providing milk and blood. In contrast, the Predynastic and Old Kingdom residents of the Nile valley had an economy that was based primarily on agriculture and small livestock, such as sheep and goats. The growth of the cult of Hathor is remarkable, especially because it seems to incorporate many of the themes expressed at Nabta Playa such as the onset of flooding, the sun at summer solstice, and the heliacal rising of Sirius, which became a marker for summer solstice and flood. The explicit connection between Hathor, flooding of the Nile, and the heliacal rising of the Nile expressed in the Temple of Hathor at Dendera, built during the Ptolemaic period in the second century BCE, appears as a testament to the persistent power of a tradition, which may have had its roots in the nomadic pastoralists of the Western desert.

3. The Surya Puja Temples of South India

There are more than 70 temples in Tamil Nadu in which light of the rising or setting sun, near equinox, enters the sanctuary, and illuminates the image of the god contained therein (Malville and Swaminathan 2005). In many of these temples the event, known as a surya puja, is an elaborate ceremony, organized by the priest of the temple and witnessed by a throng of celebrants. The name of the events suggests the worship (puja) and honoring of the sun god, Surya. The reality is quite different. Since most of these temples are in worship today, it is possible to participate in the ceremony and discuss its meaning with the head priest. The majority of these temples are Shaivite, and the intent of the worshippers is to honor lord Shiva not the sun. For many of the participants, the sun is seen as a horizontal beam of light, prostrating himself before Shiva.

The best known surya puja in the Tanjor District of Tamil Nadu is held in Nageswarar Temple in Kumbakonam. During the three days of the ceremony some 500 people line up on either side of the horizontal beam of sunlight to watch the illumination of the polished Shiva linga. The priest of the temple has explained that the sun is suffering from leprosy and only by worshipping Shiva could he be cured. That the sun should have leprosy is, indeed, a puzzle. Traditionally light of the sun purifies all that it touches, cleanses laundry, and, indeed, cures one of leprosy. Surya is described as unblemished, pure and white, like a water lily rising out of a muddy pond. Naked-eye sunspots began to appear on the sun in the late eleventh century when the sun entered the period known as the Medieval Maximum of solar activity (1100-1250 BCE). When the sun is dimmed by smoke or fog, large sun spots can be seen, especially at dawn. In the Hindu culture, these sunspots must have produced cognitive dissonance: how could the sun be so afflicted? According to temple traditions at Nageswarar the sun acquired leprosy due to the curse of a rishi, a Hindu holy man, who was suffering from that disease. When he asked Surya to cure the disease, the sun replied that he was powerless

to help. Leprosy was the result of past negative karma, due to misdeeds in a previous life, and the role of the sun was to bestow on human beings both the positive and negative consequence of karmic forces. Upon receiving this response, the rishi cursed the sun for his lack of compassion for the suffering of humans and caused Surya to acquire the disease. Other stories of the leprous sun are found at the temple of Suryanarkoil one of the few living temples in which Surya is the primary deity. Elsewhere in India, the ruined sun temple of Khakola Aditya in Varanasi had a ceremony in which dark seeds were thrown into a fire to cleanse spots from the face of the sun (Malville and Singh 1996), which were described as coiled dark snakes. During the same period, Samba, the sun of Krishna, also suffered from leprosy and was cured in the vicinity of the great sun temple of Konarak (Malville 1989).

4. Fajada Butte in Chaco Canyon, Southwestern United States

Fajada Butte is the single most dramatic topographic feature of Chaco Canyon, the center of a regional system, some 30,000 square miles in size, which flourished from 1000 CE to about 1150 CE in what is now northern New Mexico (Figure 3). At its height it was associated with some 200 outlying communities, the members of which may have travelled to Chaco Canyon around winter solstice for ceremonies and trade (Malville 2008). Before the establishment of the regional system, Fajada Butte may have been the spiritual magnet for early emigrants to the Canyon. They established the Fajada Gap community, a group of 54 small house sites which flourished in the 900s and early 1000s CE. The community contains one of the earliest Great Kivas to be constructed in the canyon. Great Kivas are semi-subterranean structures some 15 to 20 meters in diameter, which may have functioned as community gathering places.



Figure 3. Location of Chaco Canyon

A recent discovery is that the December solstice sun rises over the center of Fajada Butte as viewed from the unexcavated, isolated Great Kiva in Marcia's Rincon (Malville 2014a). This appears to be the earliest example of direct observational astronomy in Chaco Canyon. With a diameter of twenty meters, this Great Kiva is the second largest of twenty-one Great Kivas to have been built in

Chaco Canyon. Its location places it within the shadow cast by Fajada Butte at sunrise on December solstice. Celebrants emerging from the Great Kiva at dawn would have observed the sun rising over the summit of Fajada Butte. A ramp combined with ladders and steps cut into the rock gave access to the summit. Fire pits were constructed at the base of the ramp and at the summit. A fire may have been lit in the two fireboxes at sunrise. Considering the visual power of Fajada Butte combined with winter solstice sunrise, it seems likely that the Great Kiva was intentionally located in order to achieve this astronomical alignment. The surface ceramics of the site as well as the ramp contain pottery, which date from the 900s to early 1000s CE. The ramp is evidence that the small house community was capable of engaging in a cooperative project of substantial proportions. More recent ceramic scatter on the ramp establishes that it was in use up to the late 1200s when the area was abandoned. Even though the residential and ceremonial center of Chaco Canyon was moved further to the west to the vicinity of Pueblo Bonito, winter solstice ceremonies may have taken place at this great kiva and on Fajada Butte until abandonment of the canyon.

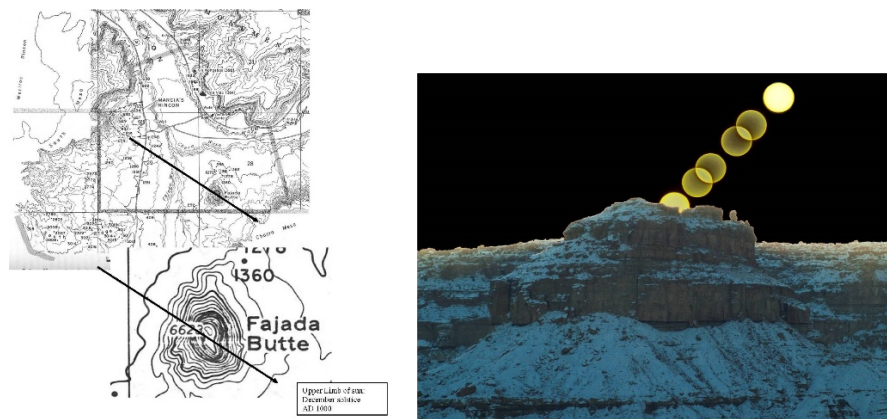


Figure 4. Winter solstice sight-line from the Great Kiva to the summit of Fajada Butte

Unlike other locations in the Americas where the horizon is smooth or is established by jungle, the horizons of many of the Ancestral Pueblos are irregular, such that a horizon calendar could be established by the changing location of the sun between summer and winter. One tradition among the historic Pueblo is that the Sun has two homes, a northern house in which he stays for a few days around summer and a southern house for winter. There has been some concern that the sun would remain in his southern house too long, when the land was becoming cold. In the Rio Grande pueblos today, near Santa Fe, dances and trade fairs continue to take place near winter solstice, reminding the sun of his responsibility to return to the north again, assuring the continuing cycle of the seasons.

5. Final Remarks

It is possible that the astronomy born out of the harsh conditions of the Western Desert has influenced the long enduring tradition involving Hathor, the rising of the Nile near summer solstice, and the heliacal rising of Sirius. The appearance of naked-eye sunspots on the sun, which, according to Hindu tradition, should be pure and absolutely unblemished, appears to have initiated stories about the leprous sun and ritual celebrations of surya puja. Festivals in Chaco Canyon may have been designed to keep the sun moving between his summer and winter houses, maintaining the cycle of the seasons.

Among the heritage of the Ancestral Pueblos there are other examples of societal and environmental determinants that have been used successfully to predict new astronomical alignments. These include solstice events at nearly all of the Late Bonito Great Houses in Chaco Canyon (Malville 2008, Munro et al 2017). In India the outgrowth of these determinates appears as zenith sun alignments at Vijayanagara and orientations of temples at Khajurao to major Hindu festivals (Malville 2014b). There have, of course, been other many discoveries in archaeoastronomy that were totally unexpected, and from those we can learn something. These surprises reveal aspects of the cultures that have not been fully understood by modern scholars and suggest exciting new lines of research.

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