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A GREAT COMET AND CEREMONIAL SITE DEVELOPMENT AT NABTA PLAYA

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ABSTRACT

Modern scientific tools and methods are playing an increasing role in illuminating key aspects of past activities of humans on Earth. Such approaches complement the more usual archaeological methods. Excavations at Nabta Playa, in the Western Desert of southern Egypt, have yielded evidence of regularly arrayed buildings in the Neolithic period, tumuli for cattle, hearths for animal sacrifices and megaliths aligned in a plurality of directions (Malville *et al.*, 1998; Malville *et al.*, 2008; Wendorf *et al.*, 1993; Kobusiewicz and Schild, 2005). The area became habitable when monsoon rains collected in a large basin 11,000-4800 years ago (Wendorf *et al.*, 1993). The structure and location of a stone circle there (Malville *et al.*, 1998; Malville *et al.*, 2008) associates the Sun (Malville et al., 1998), the celestial pole (Malville *et al.*, 1998) and the Bull's Thigh constellation (Ursa Major) (Haynie, 2014). Aligned megaliths radiate outward from a central complex, apparently having targeted the brightest heavenly bodies, based on comparisons of megalith coordinates and star positions (Malville *et al.*, 2008; Haynie, 2014). If Nabta Playa had a unified design, the megaliths were positioned c. 4300 BC, but the southernmost alignment to the northeast did not point at a notable star (Haynie, 2014). The unified design hypothesis is consistent with a combination of celestial and terrestrial targeting. Here, a consensus megalithic alignment date is shown to coincide with a computed apparition of a great comet. Ritualistic activities at Nabta Playa may have sought to align key "inhabitants" of the heavenly and earthly realms.

KEYWORDS: alignment, ceremonial center, megalith, trade center

1. INTRODUCTION

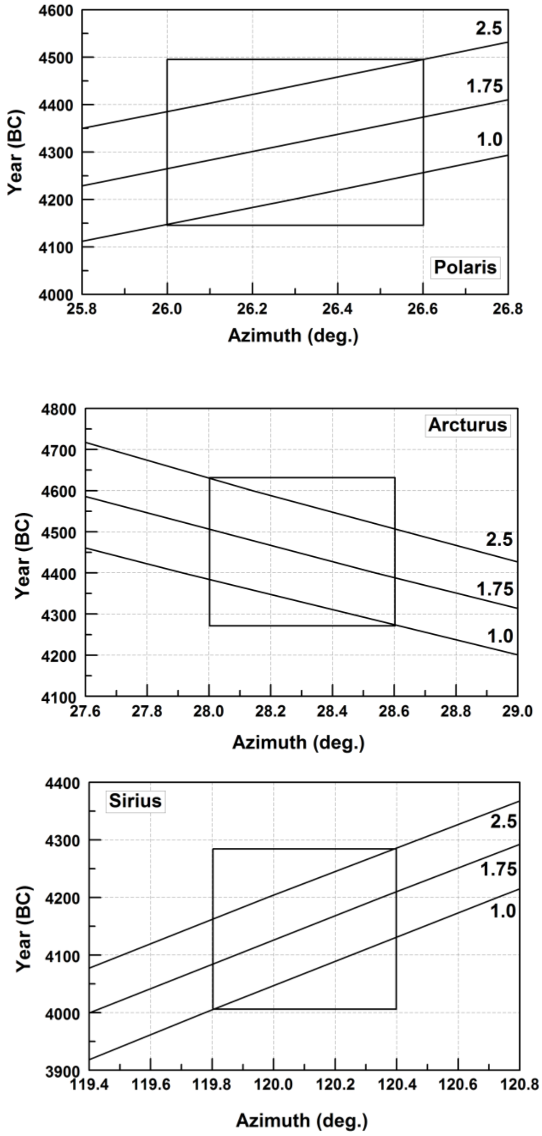
The ceremonial site at Nabta Playa comprises elaborate tumuli in which whole calves were interred in chambers of clay, wood and rock, and aligned megaliths which are oriented towards the northeast and the southeast (Malville *et al.*, 1998; Malville *et al.*, 2008). The present work concerns the alignment targets, which are suspected to have been the rising azimuths of prominent stars, and the time when the alignments were made, 4500-3600 BC (Malville et al., 1998; Brophy and Rosen, 2005; Malville *et al.*, 2008; Haynie, 2014). Arcturus (Bootes) to the north and Sirius (Canis Major) and Alnilam (Orion) to the south were among the targets (Malville et al., 2008; Haynie, 2014). All were among the brightest stars visible in Nabta Playa in 4300 BC.

Later, in Nile valley mythology, Alnilam would be associated with Sah, "father of the gods" and the personification of Orion, and Osiris. God of the afterlife, the underworld and the dead, Osiris was also associated with the swelling and retreat of the Nile and thus agriculture. Sirius was associated with Sopdet, consort of Sah, and the goddess Isis. She and Osiris were among the four children of the sky goddess, Nut, and the Sun god, Ra. The annual flooding of the Nile occurred around the time of the summer solstice and the heliacal rising of Sirius, which was widely taken as the cause of flooding. It hardly follows that these beliefs of Nile valley pastoralists evolved from beliefs of Nabta Playa nomads, but a key historical question is whether available evidence corroborates or refutes that hypothesis.

In previous work I showed that when Nabta Playa is supposed to have had an underlying organization principle, the megaliths aligned with prominent stars c. 4300 BC (Haynie, 2014). This date falls within an earlier proposed range (Malville *et al.*, 2008), and it is close to radiocarbon dates for the nearby quarry (Malville et al., 2008) and human cemetery (Kobusiewicz and Schild, 2005). On the same view, however, at least one of the alignments does not target a prominent star (Haynie, 2014). This alignment points northeast. The present study sought to identify the target. It also posits a possible spur for constructing the complex of alignments.

2. METHODS

Rising azimuth data were obtained from the astronomical software Stellarium 0.10.6.1 (USA). Data on the Great Comet of 1811 (C/1811 F1) were requested with the JPL Small-Body Database Browser at 15-day intervals for 1 January 1811-31 December 1812 and computed by Solar System Dynamics Group, Horizons On-Line Ephemeris System, Jet Propulsion Laboratory, Pasadena, California.



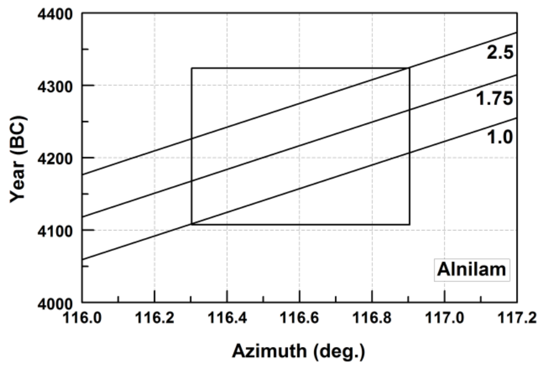


Figure 1. Determination of the year of megalithic alignments at Nabta Playa. Year is plotted against the rising azimuth of Polaris, Arcturus, Sirius and Alnilam. The width of each box represents the empirical angle ± 0.3° from archaeological study; stellar parallax was so small as to be negligible here. The height of each box represents the corresponding date range for an altitude range of 1.0-2.5°.

3. RESULTS AND DISCUSSION

Figure 1 shows computed rising azimuth data for putative stellar targets at Nabta Playa (Haynie, 2014). Alignment year, the unknown, is plotted against rising azimuth, for which values from on-site archaeological study are reported (Malville *et al.*, 2008). Alignment accuracy is generally high (R > 0.99); aligning multiple megaliths increased targeting accuracy and reduced parallax. The shape of the horizon at the time of alignment and the lowest altitude at which stars were visible must be considered somewhat uncertain (Haynie, 2014). The boxes in the figure therefore represent the Malville *et al.* (2008) rising azimuth ± 0.3° and an altitude of 1° 0'', 1° 45'' or 2° 30'' as indicated. The rationale for 1° 0'' is described elsewhere (Haynie, 2014). The data suggest that if the alignments targeted Sirius, Alnilam, Arcturus and Polaris, as argued previously (Haynie, 2014), the corresponding megaliths were positioned 4625-4010 BC, consistent with an earlier report (Malville *et al.*, 2008). The ranges for these four stars overlap in a single narrow band, 4280-4275 BC, which coincides with the mean of the four midpoints, (4280 ± 130) BC. Of course, this alone does not guarantee that the alignments were made around 4280 BC.

The plausibility of the alignment date may be tested by comparison with the Nabta Playa megalith alignment data presented by Brophy and Rosen (2005), whose azimuth values are based on satellite imagery and ground global positioning system data. For the alignment identified here with Polaris, the azimuthal angle is 25.9° rather than 26.3°, which for an altitude of 1° translates into a probable alignment date of c. 4125 rather than c. 4200 BC. Similarly, for the putative Arcturus alignment, the year is c. 4400 rather than c. 4325 BC; for Sirius, c. 4250 rather than c. 4150 BC; and for Alnilam, c. 4300 rather than c. 4150 BC. Important, all of the values fall within the noted range, (4280 ± 130) BC.

The unassigned northeastern alignment will have pointed at a celestial or a terrestrial target. Possibilities include a supernova, a comet, another ceremonial site, a necropolis or a trading partner. Unfortunately, there is no clear way of documenting a supernova c. 4300 BC, let alone its location in the sky; this possibility cannot be considered further. A great comet is an intriguing possibility. Again, however, there is no evidence of an apparition in Nabta Playa, and in any case a comet moves through the zodiac in time. The prominence of the noted stars, however, and the labor involved in quarrying and shaping the megaliths, translating them to suitable locations and aligning them, together suggest that the plausibility of a terrestrial target must turn on its probable significance to nomads at Nabta Playa.

A second alignment there, it must be noted, certainly did not target a star. Pointing virtually due east (Malville *et al.*, 1998), toward present-day Abu Simbel, this alignment may comprise one or more naturally-occurring markers (Wendorf and Schild, 2001). It will in any case have stood for the general azimuth of the rising Sun and a cardinal direction; the stone circle at Nabta Playa, which dates to the fifth millennium, points due north and toward the azimuth of the rising Sun on the summer solstice (Malville *et al.*, 1998). Still, there is nothing to rule the dual association of a certain alignment with both a terrestrial target and a celestial one. The Temple of Ramesses II at Abu Simbel, which dates to a much later era in Egyptian history (c. 1264-1244 BC), was located due east of Nabta Playa. Carved directly into rock on the side of a hill with a distinctive crest, the temple took an estimated 20 years to complete. The site will have been significant to ancient Egyptians. In fact, it represented the boundary with Nubia upriver. The temple was moved to its present site when the Aswan Dam was built. The latitude today, however, c. 22° 20', is essentially the same as before; a scale model of the respective locations is on display in the Nubian Museum, Aswan. The angular discrepancy between the temple and the central complex at Nabta Playa is c. 0.17°, which translates into a perpendicular distance of c. 300 m at a radius of c. 100 km, the distance of Abu Simbel from Nabta Playa. Perhaps no less important, Abu Simbel is located where the walk from Nabta Playa to the Nile was the shortest. If there was a due-east alignment in the ceremonial complex and it had a terrestrial target, surely it was the river or a site associated with the river, possibly the place which later became the location of the Ramesses II temple. The Red Sea possibility seems much less plausible.

The foregoing provides grounds for the hypothesis that the unassigned northeast alignment had a Nilotic target. The respective azimuth (30.6° in Malville *et al.*, 2008 and 30.0° in Brophy and Rosen, 2005), corresponds to a major geographical feature of the sacred waterway. Flowing roughly northwest for over 200 km before reaching it, the Nile veers northeast for about 40 km at the great oxbow, then north for about 40 km, then southwest for about 40 km and finally again northwest towards the delta. The vast temple complex of Karnak (present-day Luxor) is situated within the oxbow at 25° 43' N, 32° 39' E, forming an angle of 31.0° with due east at the central complex at Nabta Playa. The 0.4° discrepancy represents a perpendicular distance of c. 3 km at a c. 450 km radius (5 km for 0.6°). Archaeological evidence suggests that there was relatively limited development at Karnak before the Middle Kingdom (c. 2100 BC), when adjacent Thebes, which had been inhabited since c. 3200 BC, became the capital of Egypt (Shaw, 2002; Grimal, 1992). A more plausible target, perhaps, is Naqada, 25° 54' N, 32° 43' E, the site of an important town and necropolis in the pre-dynastic period (4400-3000 BC). The earliest era of human activity there, called Naqada I (c. 4400-3500 BC), involved trade with Nubia, Western Desert oases and the eastern Mediterranean (Shaw, 2002; Grimal, 1992). It is where the great east-west routes crossed the Nile, joining oases in the west and the seacoast in the east. Accurate reckoning of location from Nabta Playa could have been achieved by marking the rising azimuths of bright stars.

North, the direction of the celestial pole, was crucial for navigating featureless regions of the Western Desert (Malville *et al.*, 1998; Malville *et al.*, 2008; Haynie, 2014) and orienting temples in later periods (*e.g.* Spence, 2000). A northward alignment at Nabta Playa toward the celestial pole need not have excluded a terrestrial target. The Mediterranean Sea, though far off, seems possible. The most direct route there, however, lies well west of north. Another major geographical feature of the Nile is a stronger candidate. The river fans out, forming a delta, near present-day Cairo, Memphis, the Old Kingdom capital, and the pyramids of Saqqara and Giza. The exceptional fertility of the soil in the delta has been known since ancient times, possibly much earlier than 10,000 BC. Grave adornments at Gebel Ramlah, a playa c. 20 km from Nabta, provide evidence of trade as early as 4400 BC with inhabitants of the Sinai peninsula (Kobusiewicz and Schild, 2005). The longitude of Giza differs from that of Nabta Playa by 0.49°, which at a radius of c. 950 km amounts to a perpendicular distance of c. 8 km. The similarity in longitude may be entirely fortuitous. However, if one could survive a direct journey overland, when southern Egypt was considerably less arid than today, the delta could presumably have been reached from Nabta Playa by no more complicated a method than unwavering migration toward the pole. There are two traversals of the Nile on this path, but crossing will not have been difficult so far downstream. Hewing to the left bank of the river instead of crossing gives but a marginal increase in the length of the journey.

Possible targeting of the Nile to the east, the great oxbow to the northeast and the delta to the north is consistent with the relationship of the presumptive targets to the celestial pole. Abu Simbel (Ramesses II temple), Luxor (Naqada, Karnak, Thebes) and Cairo (Giza, Saqqara, Memphis) represent the only three places on the river in Egypt where the pole corresponds to an arc that is a unit fraction of the arc from the horizon in the north to the horizon in the south (Haynie, 2014). (See Figure 2.) No advanced knowledge of the shape of Earth, geography or geometry is required to reach this conclusion.

The larger arc, it may be noted, is personified in later Egyptian art as Nut (Wilkinson, 2003). Often depicted nude and covered with stars, she arches over Earth, feet on one horizon and hands on the other, her face turned toward its inhabitants. The Sun died on setting, passed through Nut at nighttime and emerged from her womb, renewed, the following dawn. Such associations are likely to be far older than the earliest known artistic depictions; it was recently demonstrated by modern experimental methods that mummification as practiced in dynastic Egypt is at least a millennium older than previously believed (Jones et al., 2014). Nut would later be identified with Hathor, a cow goddess and the personification of the Milky Way; the cult of Hathor may have evolved from rituals involving cattle sacrifice. Cow milk will have contributed to childrearing at Nabta Playa. A hearth adjacent to the pole- and solstice-oriented stone circle there has been radiodated to the Cattle Herder period, and excavations have uncovered tumuli for cattle (Malville *et al.*, 1998; Malville *et al.*, 2008; Wendorf *et al.*, 1993; Kobusiewicz and Schild, 2005).

Later, in dynastic Egypt, sacred bulls were believed to be successive incarnations of the sky bull Apis, protector of the deceased. Each was conceived by celestial rays, possibly alignments with stars (Wilkinson, 2003). Representing the courage and virility of pharaoh in life and his renewal in death, Apis was worshipped in Memphis, the political capital of the Old Kingdom, where he dwelt in an ornate palace and was provided a lavish interment. Memphis was also the main site of the cult of Ptah, the demiurge that existed before all things, the god who by thought and word created all, the preserver of both the world and pharaoh as ruler (Wilkinson, 2003). The name of his temple would represent the entire country for Greeks and Romans, as it does for us today. Ptah was also one of the three dedicatees of the Ramesside temple at Abu Simbel, along with Amun and Ra.

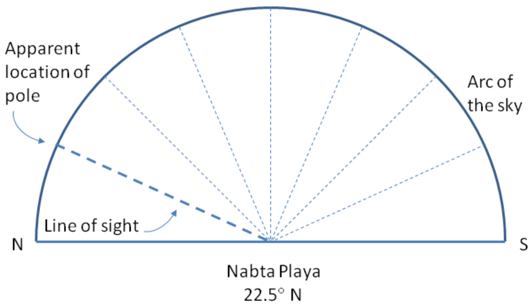


Figure 2. Schematic of the apparent position of the celestial pole at Nabta Playa. Within Egypt, integral divisions also hold for Karnak and Giza, making three in total [5]. The next smallest integer, 5, corresponds to the latitude of Rhodes and Kythira in the Mediterranean Sea and Apamea in Phrygia.

The celestial pole was vacant in 4300 BC. The pole may therefore have been associated with a forerunner of Amun, "the hidden one" (Wilkinson, 2003). The multitudinous visible denizens of the celestial realm processed around the invisible, immobile pole. The solstitial alignment in the stone circle at Nabta Playa may have included association with a forerunner of Ra. Early in the Middle Kingdom of later Egypt, when Thebes became the political capital, Amun-

Ra would be seen as "king of the gods" (Wilkinson, 2003); uniting the "invisible ruler" of the night gods (Moon, planets, stars, supernovas and great comets) and the "visible ruler" of the day gods (Sun, Moon and great comets), subordinating all to himself. The original associations are surely more ancient than the earliest evidence in extant art or text. The well-documented increase in the aridity of southern Egypt from around 4000 BC may have led nomads who watered cattle at Nabta Playa to merge with pastoralists in the Nile valley. Further evidence is needed to achieve greater clarity on this possibility.

A major puzzle of Nabta Playa has been the impetus for building at the apparent megalithic alignment date, c. 4300 BC. Summer monsoons of central Africa had arrived some 5000 y earlier and would continue for another 1500 y. The epoch was punctuated by extended periods of high aridity (Wendorf *et al.*, 1993) and a change of settlers (Malville *et al.*, 1998; Malville *et al.*, 2008). Cattle Herders, a nomadic people, arrived c. 5200 BC (Malville et al., 2008). The present megaliths would not be aligned for another 900 y, roughly 30 human generations, according the present analysis. An especially dry spell may have prompted people there to appeal to gods for precipitation. It is unclear whether that could be established by geology or archaeology.

In view of the apparent ingenuity of the Nabta Playa ceremonial site and the health and wealth of the humans interred in Gebel Ramlah c. 4400 BC (Wendorf et al., 1993; Malville et al., 2008), a singular event may have motivated the creation of the stone circle and megalithic alignments. This possibility is consistent with the hypothesized unifying rationale for the site (Haynie, 2014). A well documented great comet, one that is visible to the unaided eye, fits the time frame of the alignments to within a small margin of error.

Comets are well known to have had political and religious significance in later eras. Julius Caesar, for instance, reformer of the Roman calendar based on a far more accurate Egyptian model and father of a child by Cleopatra, ruler of Ptolemaic Egypt, was assumed apotheosized by the apparition of a comet a few days after his murder in 44 BC. Contemporaneous Roman coins show him on the obverse and the comet on the reverse. The comet depicted on the Bayeux Tapestry portends the Norman invasion of Britain in 1066.

The Great Comet of 1811 is particularly well attested. Direct observations were made for over 250 days in the northern sky of Europe (Leo Minor and Ursa Major) by noted astronomers and mathematicians, including William Herschel FRS, discoverer of the planet Uranus and infrared radiation (Kronk, 2003). The magnitude of the comet was comparable to that of Arcturus and Vega, the two brightest stars in the northern sky at Nabta Playa, and its tail reached a maximum elongation of c. 70°, roughly one-fifth of the entire azimuthal angle of the horizon (Herschel, 1812a,b). (Figure 3). The best estimate of the orbital period of the comet, based on nearly 1000 observations in 1811-12, an elliptical path, and calculations by

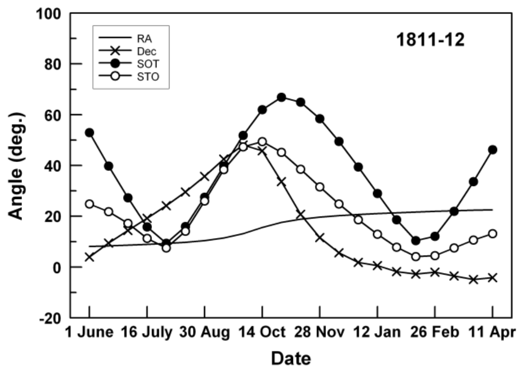


Figure 3. Astronomical data for the Great Comet of 1811. The comet was conspicuous Sept.-Dec. of that year. Right ascension (RA, solid line), or rotation angle about the pole, varied roughly from 10° to 20°. Declination (Dec, crosses), or angular distance from the pole, rose steadily from c. 0°, reached a peak of c. 50° in September 1811, fell rapidly until around 1 December and then declined gradually. SOT (filled circles) is the apparent solar elongation of the comet in degrees as seen from Earth. STO (open circles) is the interior vertex angle formed by the center of the comet and the apparent center of the Sun.

Argelander, his mentor Bessel, and Herz, is 3094 y, accounting for perturbations by planets (Humbolt, 1850; Hind, 1852; Herz, 1893; Kronk, 2003). At an accuracy of ± 1%, this value translates into earlier apparitions in (1283 ± 31) BC and (4377 ± 62) BC. The later date coincides with the reign of Ramesses II ("the Great", accession c. 1280 BC), builder of the temple at Abu Simbel. The earlier overlaps with the stellar alignment period at Nabta Playa, (4280 ± 130) BC, and it is close to the radiocarbon dates for human burials at Gebel Ramlah and for activity in the nearby quarry (Malville *et al.*, 2008; Kobusiewicz and Schild, 2005). The trajectory of the comet across the sky in the ancient past cannot be calculated reliably because the location of Earth in its orbit then is somewhat uncertain. What is important here is that the Great Comet of 1811 was visible at night most days between 1 June 1811 and 1 February 1812, an interval of over half a year. There is therefore little doubt that it will have been seen on its earlier visits to the Solar System, provided that the trajectory is periodic and the dynamics have not been especially chaotic over the last c. 10,000 y (cf. Chirikov and Vecheslavov, 1989). It hardly follows that a comet apparition caused nomads to develop the ceremonial complex at Nabta Playa, but the data noted here do make the possibility worth considering, on my view.

Finally, it is now well known that equinoctial precession results in a drift in the rising azimuth of stars. The Greek astronomer Hipparchus, who lived near present-day Istanbul, quantified the drift rate as early as c. 135 BC. As Figure 1 shows, Arcturus migrated in a qualitatively different way from the other putative stellar targets in c. 4300 BC. The declination of all members of the Bull's Thigh, Polaris, Alnilam and Sirius decreased 4800-4000 BC, excluding Alkaid, which was circumpolar and had a virtually unchanging declination in the period. The rising azimuth of Arcturus, by contrast, increased by 3° over 600 y. This difference is potentially relevant to the later inclusion of Arcturus in "the flint mooring post of the sky", the constellation to which the Bull's Thigh constellation was said to be tethered to prevent its leaving the circumpolar region, where it signified eternal life (Wilkinson, 2003). It is not certain that ancient Egyptians were aware of the stellar motion that we now ascribe to equinoctial precession. The misalignment of megaliths positioned around 4280 BC, however, will have been noticeable by c. 4000 BC to nomads well versed in astronomical lore, even if the original targets were not stars. Nabta Playa would be abandoned within c. 400 y of this time (Malville *et al.*, 1998; Malville *et al.*, 2008), and Naqada was on the verge of becoming a place of some moment in the history of human civilization in the Nile valley.

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