Robert Hannah

Faculty of Arts & Social Sciences
The University of Waikato
Private Bag 3105
Hamilton 3240
NEW ZEALAND
roberth@waikato.ac.nz

Keywords: orientation, alignment, temple, Older Parthenon, Greece, landscape and architecture, landscape archaeology, Dinsmoor, Scully, archaeoastronomy, calendar, myth, religion, sun, Athena, Panathenaia

Presented at Nexus 2012: Relationships Between Architecture and Mathematics, Milan, 11-14 June 2012

Research

Greek Temple Orientation: The Case of the Older Parthenon in Athens

Abstract. The study of the orientation of ancient structures has recently experienced a renaissance in scientific interest after languishing for much of the twentieth century. Under the umbrella of the new multi-discipline of archaeoastronomy, the analyses of orientations have become more sophisticated, with a wider range of celestial phenomena now included, along with information derived from cult myths and rituals, so that celestial phenomena are identified through being relevant on a local, cultural and cultic level. Ironically, this revival of interest in temple orientations largely matches in its methodology that of Dinsmoor [1931], yet his work has lost favour because of his insistence on the priority of solar phenomena. In this paper, I revisit Dinsmoor's analysis of one temple, the Older Parthenon in Athens, to assess his methodology and conclusions.

Introduction

In recent years the study of the orientation of ancient structures has experienced a renaissance in serious scientific interest. The astronomical analyses have become more sophisticated, without, however, seeking the extreme precision of earlier studies, as such precision went beyond what people could naturally perceive. Solar phenomena are no longer prioritized, but instead the net is kept deliberately wide so as to include also the moon and stars (see generally [Belmonte et al. 2006, 2008; Magli 2009, 2011, 2012; Ruggles 1999; Ruggles and Urton 2007; Shaltout et al. 2005, 2007]). The researcher now uses information derived from cult myths and rituals, where these are known, so that celestial bodies and their associated phenomena (rising, culmination, setting) are identified not arbitrarily but as being relevant on a local, cultural and indeed cultic level (for example, within the ancient Greek world: [Boutsikas 2007, 2008a, 2008b, 2009, 2011; Boutsikas and Ruggles 2011; Boutsikas and Hannah 2012]).

While this revival of interest in temple orientations largely matches in its research questions those of Dinsmoor, his own work has lost favour because of his insistence on the priority of solar phenomena in interpreting orientations and, in some cases, the decontextualized nature of his approach. Yet Dinsmoor was at times well aware of cultural and religious context, and also made use of his intimate knowledge of the Athenian lunisolar festival calendar and the workings of the 19-year Metonic cycle [Dinsmoor 1931]. Nowadays his opinion in this regard demands renewed respect [Hannah 2009: 37]. In this paper, I revisit Dinsmoor's analysis of one temple, the Older Parthenon in Athens, where he made use of his extensive knowledge of the broader cultural context, in order to examine his conclusion that the temple's orientation signals a foundation date of 31 August 488 BCE.

Early in the twentieth century any potential for understanding what relationship may have existed between Greek sacred areas, particularly temple sites, and the wider celestial 'landscape' seemed doomed to failure, in the wake of misdirected studies in the late nineteenth and early twentieth centuries. Almost simultaneously, Lockyer [1964] studied

DOI 10.1007/s00004-013-0169-1; *published online* 21 November 2013

Egyptian temple orientations, while Nissen [1869, 1906-1910] investigated Greek and Roman examples. It is important to acknowledge the method. Lockyer, and Penrose after him, took it that the Egyptian temples were oriented towards certain stars:

> As respects Egypt, there is the strongest possible evidence that, when a temple was built, the direction of the axis was pointed to the place on the horizon where some conspicuous star would rise or set. There is distinct hieroglyphical evidence that such was the case [Penrose 1893b: 806].

The method was not haphazard, nor wilful, but based on textual evidence. As examples Penrose quotes a couple of texts used by Lockyer [1892], such as:

> a translation from an hieroglyphical relation of the rebuilding of a temple in the time of Seti I., about 1445 B.C.: 'The living God, the magnificent son of Asti [a name of Thoth], nourished by the sublime goddess in the temple, the sovereign of the country, stretches the rope in joy. With his glance towards the *āk* (the middle?) of the Bull's Thigh constellation, he establishes the temple-house of the mistress of Denderah, as took place there before.'[1]

Lockyer himself repeated this soon afterwards in his book, *The Dawn of Astronomy* [Lockyer 1964: 175-76], but there adjusted the date for Seti I to ca. 1380 BCE. This is still about a century too early for this Pharaoh, just one of the problems which undermine Lockyer's work. Another is the date of the temple itself attributed to Seti I: nowadays it is regarded as belonging to the re-foundation of the temple under Ptolemy Auletes in 54 BCE [Cauville et al. 1992, Shaltout and Belmonte 2005].[2]

Penrose, in a long series of articles [1893, 1894, 1897a, 1897b, 1900, 1901], was influenced by both Lockyer and Nissen, examining temples in mainland and colonial Greece, and had directed analyses of temple orientations along the lines of solar, or at best stellar-solar alignments, with priority given to the sun, and where the star's role was simply to serve as a forewarning of the impending solar phenomenon of sunrise. Penrose had certainly engaged initially in a proper scientific analysis, by establishing a body of data relating to the horizon alignments of various temples in the Greek world, not only on the Greek mainland but also in the western (Sicilian and South Italian) and eastern (Ionian) Greek worlds. His theodolite measurements remain unsurpassed in their precision (although this is not to say that they were accurate; see [Boutsikas and Ruggles 2011: 58]). He sought to use such data to derive very specific dates for the foundations of the temples, and he based his work on the assumption that the alignments were towards only a solar phenomenon, i.e., the typically eastward-facing entrance of a Greek temple was aligned towards sunrise on a particular day of the year. The extreme detail of his measurements gave him the freedom to allow for the very slight shifts in the obliquity of ecliptic over centuries, but he took his data to the point where he came to postulate impossibly distant prehistoric dates of foundation for temples which were known to have been founded in later historical times. He sought to explain the vast difference in time between his proposed prehistoric dates of foundation and the historical dates by reference to hypothetical Bronze Age temples lying under and parallel to the later historical foundations.

The temple with which Penrose [1893b] chose to demonstrate his method, the Temple of Zeus at Olympia, provided a foundation date of 790 BCE: still too early in comparison with the historically dated, fifth-century temple, but implicitly associated by Penrose with the supposed first Olympic Games of 776 BCE. His method seems straightforward, although it lacks precision at times and the figures published are occasionally, and frustratingly, wrong.

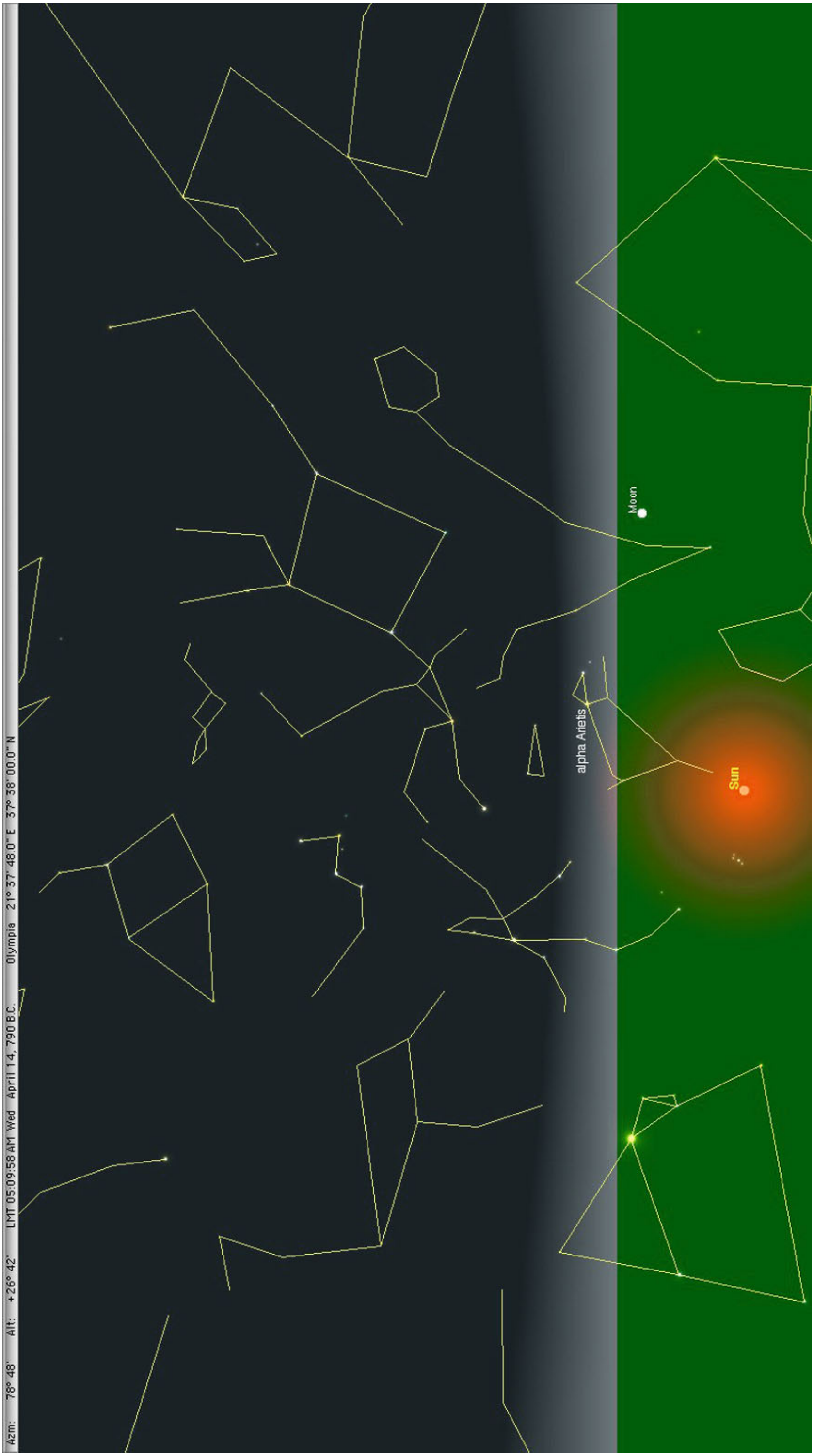

Fig. 1. Heliacal rise of α Arietis at Olympia, 14 April 790 BCE

Fig. 1 provides a modern computerised illustration of the resulting pre-dawn sky, with the sun 12° and α Arietis 3° respectively below horizon, as Penrose assumed:

> On the other hand, the Older Parthenon in Athens (which Penrose called the 'Hekatompedon') illustrates the more extreme results that Penrose's studies are notorious for. This temple is generally taken now to have been begun in 490 BCE soon after the Battle of Marathon but to have been destroyed in the sack of Athens by the Persians in 480 [Hurwit 1999: 132-35; 2004: 68-71].

Penrose, however, arrives at a date of 26 April, 1150 BCE. An earlier temple, his 'Archaic Temple of Minerva', is assigned to an even earlier foundation date of 20/21 April 1530 BCE – indeed, in a later publication, he corrected this date (apparently a typographical error) to an even earlier one, 1830 BCE, and then changed it on astronomical grounds to 2020 BCE. In the same article he shifted the foundation date of the Older Parthenon from 1150 BCE to 1495 BCE [Penrose 1897a: 45]. Yet none of these dates for either temple – which we now call the Older Parthenon and the Hekatompedon respectively – makes sense in terms of the astronomical context that Penrose was seeking to recreate, nor in terms of the archaeology of the sites. Astronomically the star group, the Pleiades, was too close to the sun to be visible heliacally. This could be resolved by opting for a date a few days later to allow a greater distance between the stars and the rising sun. But the prehistoric years produced by Penrose's method cannot be resolved unless we accept that on the sites of both buildings on the Akropolis there originally stood Early Bronze Age structures which were revered millennia later. Connections between the Late Bronze Age, or Mycenaean period, may be thought possible, but nothing known goes back beyond this period. In neither case did Penrose adduce testimony to explain his choice of prehistoric dates, and since his astronomical data are contradicted by modern calculations and reconstructions, his results remain difficult to comprehend. To be fair, he was writing just a generation after the excavations by Heinrich Schliemann, who uncovered both Troy in Turkey and Mycenae in Greece, both of which sites belong to what we now call the Late Bronze Age or Myceaean Period. Knowledge of the Bronze Age as a whole was therefore extremely limited in Penrose's time.

It was into this muddled world that Dinsmoor walked in 1939. At that time he was a member of the American School of Classical Studies in Athens, and best known for his extensive work on the chronology and calendar of ancient Athens as reflected in the lists of the annual civil magistrates, the archons, in the post-Classical period [Dinsmoor 1931]. He recognized the futility of the earlier studies, which set hypothetical, astronomically-based data in tension with archaeological information. Instead, by foregrounding the archaeological data Dinsmoor sought and gained for a number of Greek temples more realistic dates of foundation, within the generally recognised historical timeframe. In broad terms, his method was to combine information from a much wider variety of scientific and cultural sources than his predecessors had done. He expressed this method in pseudo-algebraic form through the equation:

$$X = Ar + R + C + As$$

where X is the usually unknown date of foundation, Ar the archaeological evidence with regard to the date, R the religious evidence concerning the temple's cult, C the artificial astronomy underpinning the local festival calendar, and As the natural astronomical observations. If only one of these elements was unknown, Dinsmoor proposed that the others might provide it; but if more than one or two were unknown, a solution would probably not be found [Dinsmoor 1939: 119].

Thus astronomy was only one component of the whole investigation. Just as important were the archaeological data, to temper the astronomically derived information, now allied crucially with the local cultural evidence provided by the temple's cult and the festival calendar. Still fundamental to Dinsmoor's approach, however, was the assumption that Greek temples were predominantly oriented towards the eastern horizon and hence towards the rising sun.

He adopted the Parthenon as a case study to test this formula, because many of the elements of the formula could be more easily determined there than on other buildings. It was not, however, the well-known and surviving Parthenon that he investigated. This, he knew, dated from 447 BCE, but rests on an earlier platform, which had different dimensions but governed the orientation of the later building. This earlier building we call the Older Parthenon. Fortunately for both Dinsmoor and for us, there is still consensus that this building is to be dated between the Battle of Marathon in 490 BCE and the sack of the Akropolis by the Persians in 480, with its foundations laid near the start of that decade [Hurwit 1999: 132-35; 2004: 68-71; Stewart 2008: 401, 407]. This responds to element *Ar*, the archaeological evidence, in Dinsmoor's methodological equation.

As for the next element, *R*, the religious evidence, Dinsmoor took it that

> The religious evidence suggests that the lines of the foundation were laid out on Athena's birthday, Hekatombaion 27 (28), at sunrise, the moment when the Panathenaic procession began to move from the lower city [Dinsmoor 1939: 120-121].[3]

This provided Dinsmoor with a lunar date for the foundation, and sends us to the third element of the equation, *C*, the artificial astronomy underpinning the local festival calendar. How to fix that in our solar calendar? Dinsmoor [1939: 134] used as a calendar marker the solar eclipse of 2 October 480 BCE (mentioned by Herodotus 9.10 in association with events a few days after the Greek naval victory over the Persians at the Battle of Salamis).[4] This eclipse provides a datable new moon, by which the Athenian month could have been fixed. The date of the Battle of Salamis is given by Plutarch, *Camillus* 19.6, as 'about the 20th' of the month of Boedromion. Boedromion was the third month of the Athenian lunar calendar. As Dinsmoor [1939: 134] argued:

> … it is evident that the eclipse must have been at the very end of Boedromion, just before the visible new moon locating Pyanopsion 1 [the fourth month] = October 3/4. Hence the preceding new year day, 59 days before the beginning of Boedromion, was within a day of 7 July 480 B.C.

In other words:

- a new moon was necessary for a solar eclipse;
- each new Athenian month began with the visible new moon crescent;
- one would expect an eclipse therefore at the very end of an Athenian month, in the late twenties of a month – Plutarch's phrase ('about the 20th') may have some leeway and be able to be translated as 'around (or in) the 20s'.[5]

Dinsmoor used this astronomical 'fix' of a solar eclipse to calculate back through the first three months of the Athenian year, i.e., through the months of Boedromion, Metageitnion and Hekatombaion, to arrive at about 7 July as New Year's Day (Hekatombaion 1) in 480 BCE. We should probably be cautious and assume that with some slippage between moon and calendar, New Year's Day might have begun in fact several days after the actual new moon. And since New Year's Day was not celebrated as a festival in Athens [Parker 2011: 196], we have no cause to expect a strict adherence to the observation of the moon as a trigger for New Year or new month.[6]

On the basis of his reconstruction of the beginning of the Athenian year on 7 July 480 BCE, Dinsmoor [1939: 121] built a sequence of lunisolar years back in time to 490, in order to ascertain when the Older Parthenon's foundations may have been laid in that decade. Rather than focus on New Year's Day, Hekatombaion 1, he concentrated on days late in the month, Hekatombaion 27/28, when the Panathenaia festival was held to celebrate the birthday of Athena. This reconstructed decade is a mixture of twelve- and thirteen-month years, as we do not know what form of intercalation took place at this time in the Athenian calendar:

481, July 15/16 or August 14/15

482, July 27/28 or August 26/27

483, July 8/9, August 7/8, or September 6/7

484, July 18/19 or August 17/18

485, July 30/31 or August 28/29

486, July 11/12 or August 10/11

487, July 22/23 or August 21/22

488, August 2/3 or August 31/September 1

489, July 14/15 or August 13/14

490, July 26/27 or August 25/26.

Before resolving the question of which year is the likeliest one for the temple's foundation, Dinsmoor addressed the final element of his equation, As, the natural astronomical observations. At this point we need to remember that Dinsmoor assumed without question that the foundation of the temple would have been oriented towards sunrise on a particular day, an assumption for which he has been taken to task in recent years [Boutsikas 2007, 2008a, 2009].[7] Using Penrose's measured orientation of the Older Parthenon of 12° 53′ north of east, Dinsmoor extended this line out to Mount Hymettos, 9075 m. distant and at a height of 610 m. above sea level, or about 450 m. above the Parthenon basement, which gives the visible horizon an altitude of 2° 50′ [Dinsmoor 1939: 121].[8] Assuming that only 2′ of the sun's diameter needed to be visible above the top of Mount Hymettos for sunrise to be visible, he then calculated that sunrise on this alignment would have occurred on either 20 April or 23 August in his own day, or on 28 April or 31 August (Julian) around 500 BCE.[9] Now, 31 August alone suits the posited dates of Hekatombaion 27/28 in the decade between 490 and 480 BCE, and that is in the year 488 BCE [Dinsmoor 1939: 122]. This accordingly became his preferred date for the foundation of the Older Parthenon.

Confirmation for Dinsmoor comes from the calendar [Dinsmoor 1939: 134-136]. If 31 August 488 BCE = Hekatombaion 27, then Hekatombaion 1, New Year's Day, in 488 BCE would have fallen on 5 August. Let us combine this date with the other New Year's date provided by the solar eclipse evidence in 480 BCE, which gave us Hekatombaion 1 = 7 July in that year. The interval between the two dates is 98 months, or one month short of a full *octaeteris*, the eight-year cycle which was used in Greece to coordinate the lunar year with the solar year in the Archaic and Classical periods before the development of the nineteen-year Metonic cycle from 432 BCE. To explain the loss of one month in such a cycle, Dinsmoor suggests that the period 488–480 BCE represents not one proper eight-year cycle but rather the latter part of one such cycle and the earlier part of another. He digresses then into a reconstruction of a sequence of eight-year cycles all the way back to 566 BCE and the first celebration of the Panathenaia. This is beyond our scope, and indeed relies on much hypothesising about the early formation of Greek calendars, which needs re-investigation.

The final step was to test the idea of the date and orientation in the field. This happened on 22/23 August 1937, after Dinsmoor was reminded of the due date by a colleague and hurriedly went up to the Akropolis that night – as one could in those days – and waited for dawn. His first reaction was that he had got the date wrong, as the sun's glow before its appearance was too far to the left. But as the sun rises at that time of the year more or less in line with the slope of Mount Hymettos, he was relieved to see the sun's orb finally poke out further to the right and indeed appear between the middle columns of the Parthenon [Dinsmoor 1939: 122–123 with fig. 4, with Dinsmoor assuming that 'visibility' of the sun was achieved when 'one-eighth of its radius or 0° 2′ of its diameter rose above the mountain crest'; allowing also for refraction, this gives 'the true altitude of the sun's centre 2° 21′'] (fig. 2).

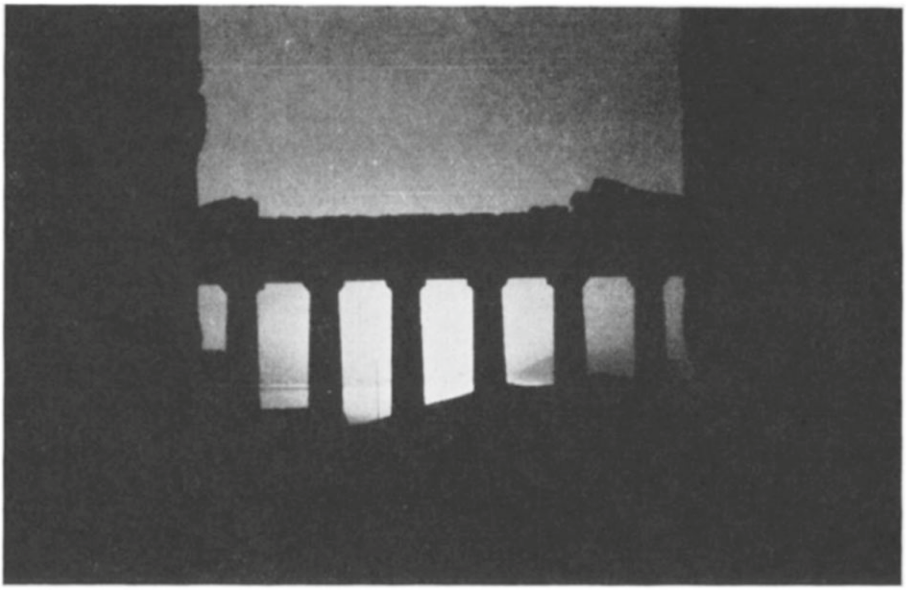

Fig. 2. Sunrise on the Parthenon axis, August 23 [Dinsmoor 1939: 123, fig. 4].
Photo: American Philosophical Society, reproduced by permission

We may recreate the moment virtually for the ancient equivalent on 31 August 488 BCE, with the modern horizon of Athens in the foreground. Taking the view from outside the Parthenon but looking along its axis, fig. 3 illustrates the first glow (with the natural sky dimmed for clarity's sake, and the sun at alt. 0°13′, azm. 75°11′); fig. 4 presents the actual moment of sunrise (again with the natural sky dimmed for clarity's sake, with the sun at alt. 2°37′, azm. 77°44′).

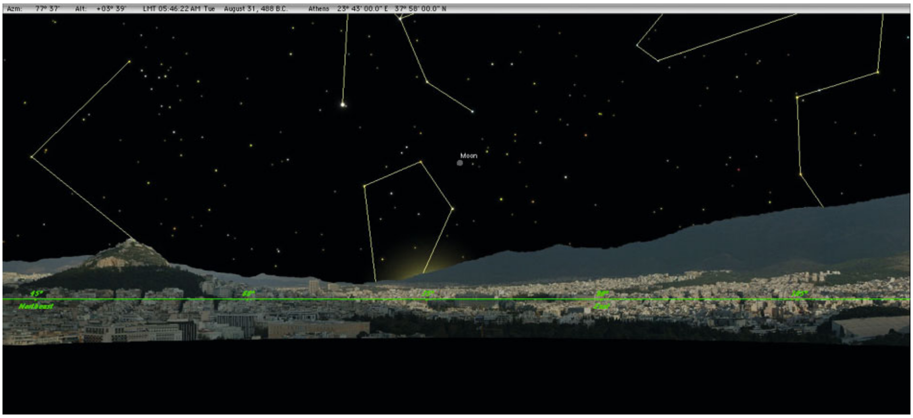

Fig. 3. First glow of sunrise as seen from the Parthenon, 31 August 488 BCE

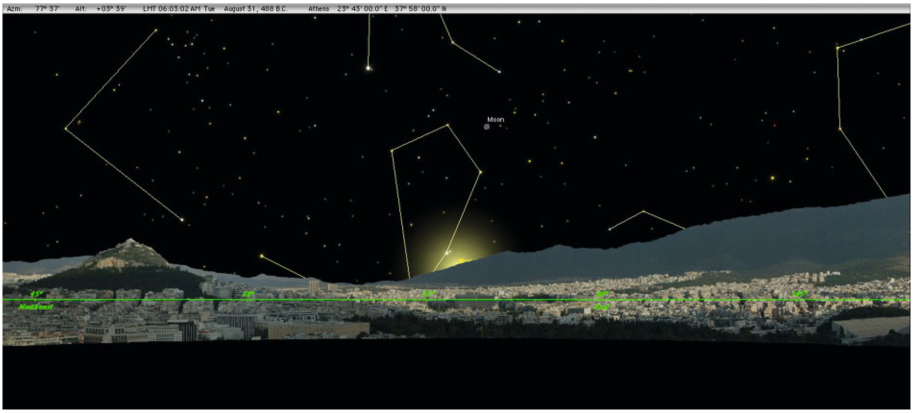

Fig. 4. Sunrise as seen from the Parthenon, 31 August 488 BCE

The rest of Dinsmoor's lengthy paper is devoted to analyses of the four elements of his formula in relation to other temples. We need not examine this, as the Older Parthenon demonstrates the method adequately. Since his time, the advances that have been made have occurred in two principal areas: those of landscape archaeology and archaeoastronomy. The former may be represented by Vincent Scully, in his now more-or-less accepted study of Greek sanctuaries in the context of their surrounding terrestrial landscape [Scully 1979].[10] Scully argued that the sanctuary and its surrounding landscape were originally regarded as embodiments of the god; that although sanctuaries may share similar topographical features, each sanctuary expressed the god's local manifestation; that certain topographical forms (conical and horned mountains, and the cleft) were natural features representing the earth-mother, by which sacred buildings were surrounded and towards which they were oriented, and which were later augmented by the addition of sky, sea and plain; that the development of this conception of sacred landscape stretches back to Minoan Crete, reaches a peak in early historical Greece, when religious and aesthetic sensitivity toward the sacred landscape is synthesised, and ends in Roman times, when there is an alienation from nature. As Seymour Howard concluded,

> What emerges, then, is not the usual conclusion that the Greeks were essentially indifferent to the site but the assumption that a complex reciprocity exists between architecture and landscape, an organization of sites as intricately determined as the legion niceties of the Greek temple itself during the best eras [Howard 1964: 90].

Objections to Scully's theses were raised most forthrightly and influentially by Homer Thompson, a member of the American School of Classical Studies at Athens. He felt that the significant topographical features, which Scully believed Greek sacred architecture was predominantly focussed on, could be found almost anywhere in Greece and were therefore not in themselves significant and diagnostic; and that the absence of ancient literary testimonia, especially from Pausanias and Vitruvius, suggested that the topographical orientations seen by Scully were figments of his own imagination, unsupported by ancient evidence. Neither criticism is valid. Regardless of whether conical or horned hills may be found almost throughout the Greek landscape, the point is whether a temple faces these, and then whether there are other features, particularly cultural ones, which would draw the Greeks' attention to these features in sacred contexts. The absence of evidence from Pausanias, on the other hand, is not evidence of absence. Pausanias in particular, as we have been discovering just in our own generation, had his own intentions when writing his guide to Greece. He fails, in our eyes, to mention many things that we now find important – the Parthenon Frieze being one well-known example. This does not mean that the Frieze, or any other aspect absent in the pilgrim travel-writer, was unimportant in his time or earlier.

To give an example of a temple whose terrestrial orientation demands explanation, we may note Temple E (Temple of Hera) at Selinus (figs. 5-7). Ironically, Scully himself saw no significance here, and instead, for meaning, turned inward to the interior of the temple rather than outward. The temple seems focussed on a very prominent hill on the distant horizon, Monte San Calógero, which rises almost 400 m. above the seaside town of Sciacca. Scully was, of course, not blind to this axis and the hill, but he saw no significance in it.

He may have been right, but the fact is that the hill is the site of hot springs which have been used since at least the Neolithic period, a feature missed by Scully, and hot springs were venerated in Sicily and elsewhere in the ancient Mediterranean as openings to the underworld. Thus there seems scope here to investigate further the associations between the Selinuntine temple(s) and the horizon landscape. In addition, in the case of Monte San Calógero, Croon has suggested that the patron of the site, a Christian monk, took over the role probably held by Herakles in antiquity, as happened in Himera in northern Sicily, where a mountain and hot springs were similarly renamed [Croon 1952: 44-45; cfr. Croon 1956: 201; 1967: 240-41]. And intriguingly at Himera itself, the temples on the acropolis there are aligned with their rear, west ends facing the other Monte San Calógero (fig. 8).

Fig. 5. Temple E at Selinunte (ancient Selinus), looking east along axis. Photo: author

Fig. 6. Temple E at Selinunte (ancient Selinus), looking east along axis, with Monte San Calogero in the distance. Photo: author

Fig. 7. Monte San Calógero, near Selinunte. Photo: author

Fig. 8. Monte San Calógero, Himera, viewed from Temples A and B. Photo: author

Another example is at the other end of the Mediterranean in Cyprus. At inland Tamassos a couple of sanctuaries have been excavated. One, identified from finds as a temple of the Great Mother, aligns along its main axis with the distant hill of Pano Vouno (fig. 9). Whether the hill had any cultural meaning, I do not yet know; the alignment may be coincidental. However, when we turn daylight to nighttime, we find perhaps another story (fig. 10).

At both dawn and dusk we find the sky over the hill of Pano Vouno dominated by the large constellation of Draco, the celestial snake. As a circumpolar constellation, Draco never rises nor sets. But at certain moments in its circuit it reaches its uppermost limit and its lowest limits, i.e. its upper and lower culminations, when γ Draconis, the brightest star situated at the tip of the snake's head, is at its highest point or lowest point above the hosrizon [Boutsikas 2011: 307].

Fig. 9. View to the hill of Pano Vouno, along the alignment of the Temple of the Great Mother, Tamassos, Cyprus. Photo: author

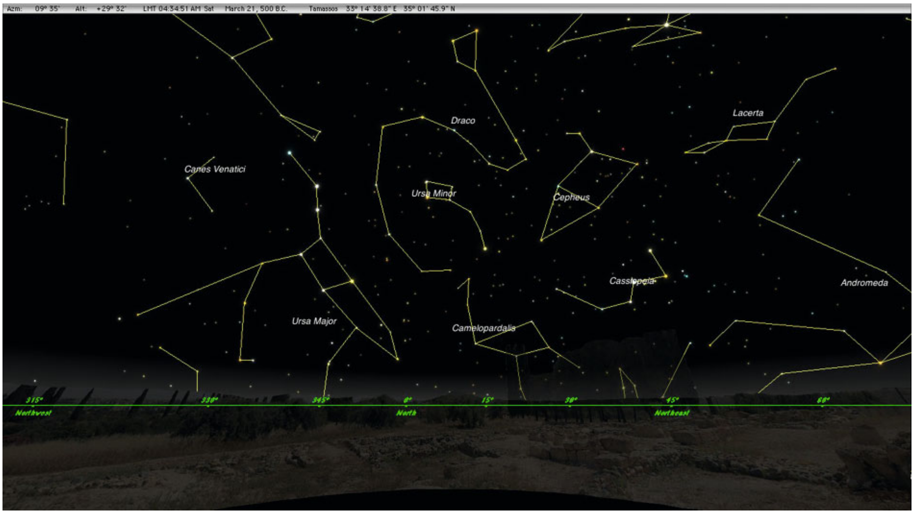

Fig. 10. Panorama of the pre-dawn sky in March 500 BC from the Temple of the Great Mother, Tamassos, Cyprus

At dawn and dusk at Tamassos in antiquity, Draco reached either its upper or its lower culmination in springtime. Terracotta snakes occur in the cultic paraphernalia of some Cypriot sanctuaries and are a well-attested symbol of death and rebirth. Spring seems to have been a crucial period for sacrifice in parts of Cyprus, to judge from excavated material. That there may be a link between the temple of the fertility gooddess, the Great Mother, and the constellation later identified as Draco cannot yet be proven, but it seems to me to be an avenue worth investigating further.

This last example illustrates the second advance since Dinsmoor: the 'multi-discipline' of archaeoastronomy. But here, ironically, modern scholarship has tended to distance itself from Dinsmoor's work, finding it too limited in its assumption of solar alignments (for example, [Boutsikas and Ruggles 2011: 58]). Instead, our gaze is now drawn to the stars, but not in the way Penrose used them, as handmaidens of the sun as they rose heliacally as advance warnings of the approach of sunrise, but rather in terms of their aetiological myths, insofar as these correlate with cultic activity on the ground. Here the best example of how we can better appreciate the 'total landscape' – both celestial and terrestrial – surrounding a sacred area is Boutsikas's study of the Akropolis and the Panathenaia [Boutsikas 2011]. Boutsikas and I have collaborated in a study of cult on the Akropolis [Boutsikas and Hannah 2012], in which we sought to establish that a series of festivals involving young women – the Kallynteria, Plynteria, and Arrhephoria – was celebrated on the Akropolis at the specific time of year when the Hyades rose heliacally over Mount Hymettos in the east. The significance here is that the Hyades in Athenian myth were catasterisms of three daughters of a mythical king of Athens, who sacrificed themselves to save the city from siege. As a reward, they were placed by the gods in the night sky as the Hyades. They were themselves henceforth to be considered goddesses and the Athenians were required to offer them annual sacrifices and choral dances performed by young girls. So cult and astronomy were intimately bound through time.

It is important to realise that Boutsikas avoids any major discussion of temple alignment in her study of the Panathenaia. Instead, her interest is in discovering whether there are any associations between the stars and the cults on the Akropolis. She finds an association in time and cult again, in relation to the appearance of the constellation Draco, which, as at Cypriot Tamassos, dominates the night sky. As she points out,

> The timing of the most significant upper culmination of the constellation coincides with the celebration of the Panathenaia, and the namesake of the constellation belongs to a catasterism myth associated with Athena, the goddess of the Panathenaia [Boutsikas 2011b: 307].

I would, however, not dismiss Dinsmoor's work out of hand in the face of even this convincing scenario. That the Older Parthenon was aligned towards a sunrise date which also lay within the period of a celebration of the Panathenaia in 488 BCE still seems worthy of consideration. Admittedly, the temple, like its successor, was not the focus of the Panthenaia and its procession to the Akropolis. Instead the shrines later caught within the ambit of the Erechtheion next to the Parthenon were the end-point for the procession, which brought a new robe to be placed on the small statue of Athena housed there. Nonetheless, both sacred spaces are bound together by their honouring the same deity, Athena, and if we look up again at the dawn/dusk sky from the Parthenon, we can see that there may be further associations with this goddess which have been missed up until now.

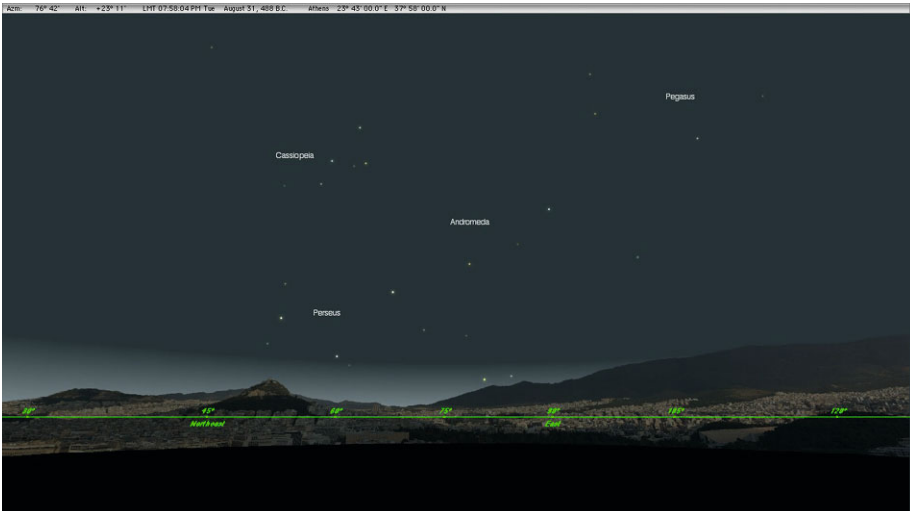

Fig. 11. Rise of Pegasus from the Parthenon, 31 August 488 BCE

Rather than go back to the moment of sunrise (see fig. 4), however, I want to go back to the the evening before, just after sunset (with the natural sky restored) (fig. 11).

Boutsikas has already noted in her paper [2011] the appearance of Pegasus in the evening sky, but not seen any significance in it. The constellation was known at least by the late fifth century BCE and was called the Horse, but which stars comprised the Horse we can only guess from its later formation as the mythical winged horse, Pegasus. A winged horse appears with the crescent moon and stars on an Athenian hydria of ca. 425 BCE.[11] It is reasonable to suppose, as all have done, that this is the constellation Pegasus, but what the image means is unclear.

The Horse as a constellation also appears in the late fifth-century parapegma of the Athenian Euktemon, the contemporary and colleague of Meton, where we find two observations:[12]

Pisces, Day 14 (March 8). Horse <rises> at dawn; cold north wind blows.

and

Leo, Day 17 (August 14). Lyre sets; and it still rains; and Etesian winds stop; and Horse rises.

The first entry, which may be placed in March, does not concern us here, but the second one, which may be set in mid-August, certainly does. The two observations probably signal the cosmical setting at dawn of the bright star Vega in Lyra, and then the achronychal rise in the evening of the Horse.[13]

Horses and Athena are combined in ancient Greek religion and art. Athena was worshipped at a site near the Academy in Athens as Athena Hippias – 'horsey Athena' – as well as at Olympia, and in a similar form at Tegea (Pausanias 1.30.4, 5.15.6, 8.47.1). As the patron of arts and crafts, Athena is depicted on a well-known red-figure oinochoe made in Athens, and now in Berlin, on which she is shown manufacturing a statue of a horse (fig. 12).[14]

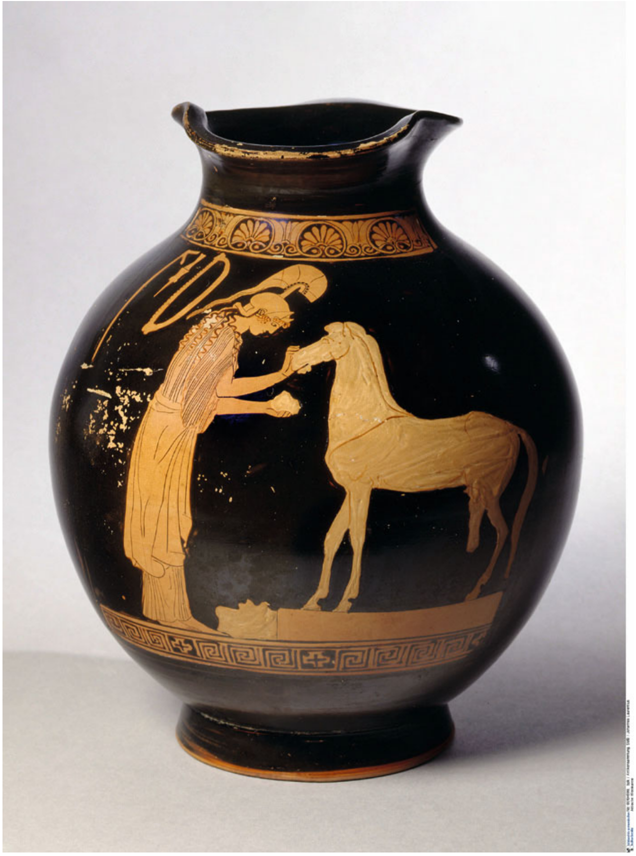

Fig. 12. Berlin, Altes Museum F2415: from Capua, ca. 460 BCE.
Photo by permission: BPK Bildagentur für Kunst, Kultur und Geschichte

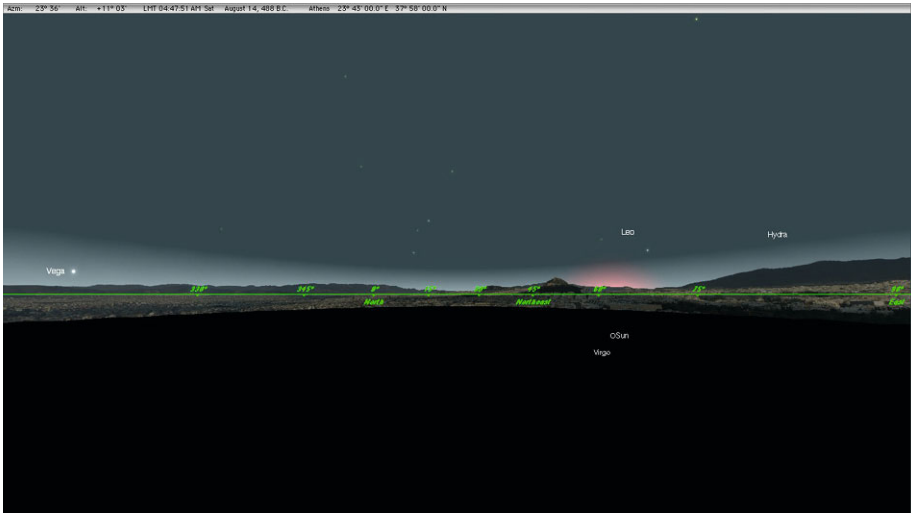

Fig. 13. Cosmical setting of Vega from the Parthenon, 14 August 488 BCE

But more than the Horse / Pegasus appeared in the evening sky at the time of the Panathenaia (fig. 12). Looking further north to the dip on the horizon between Mount Hymettos on the right and Mount Lykabettos on the left, by the time the whole of Pegasus had risen in the equivalent of late August, we find an array of constellations which represent catasterisms from the myth of Perseus, a hero patronised by Athena, from whom she gained the head of Medusa as a trophy. Perseus himself is accompanied by Andromeda and Cassiopeia. These particular constellations relating to the myth of Perseus seem to have been placed in the sky in what looks like a conscious project at the end of the fifth century BCE. We find this reflected in the plays of Sophokles and Euripides (pseudo-Eratosthenes, *Catasterismoi* 15, 16, 17, 36, and Hyginus, *de Astronomia* 2.9–11), who between them place as constellations in the sky the princess Andromeda, her mother and father Cassiopeia and Cepheus, and the sea monster Cetus. Perseus must have been sent up there too then or earlier, but the record does not survive to tell us so [Hannah 2002b].

If we briefly turn our attention to the morning sky on the same day, we may also note that coinciding with the cosmical setting at dawn of Vega is the rise of the constellation Leo, the Lion (fig. 13).

Lions and the Akropolis go together at least in the art of the Archaic period, when we find the old Near Eastern symplegma of the lion, or lions, attacking a bull in the remains of the sculptures of the 'Hekatompedon' from ca. 560 BCE [Hurwit 1999: 106–116; 2004: 66–67].

Rising with the Lion is Hydra, the water snake. Snakes and the Akropolis, and indeed Athena, go together, even snakes in the sky, as Boutsikas [2011] has pointed out in her discussion of the other snake, Draco.[15] They also coincide in art, as images of Athena regularly show her wearing the aegis, the snake-fringed cloak often adorned with the head of the Gorgon Medusa, and she is also depicted with a snake as her shield emblem, as on the Panatheanic amphora in Berlin (fig. 14).

Fig. 14. Berlin, Altes Museum F1833, Athenian black-figure Panathenaic amphora, ca. 490 BCE: Athena Promachos. Photo by permission: BPK Bildagentur für Kunst, Kultur und Geschichte

Further, she was depicted with a snake rearing up beside her, particularly in the colossal chryselephantine statue of her which was made by Pheidias to stand inside the new Parthenon in the fifth century BCE, as Pausanias (1.24.5–7) tells us:

> The statue itself is made of ivory and gold. On the middle of her helmet is placed a likeness of the Sphinx—the tale of the Sphinx I will give when I come to my description of Boeotia—and on either side of the helmet are griffins in relief. . . . The statue of Athena is upright, with a tunic reaching to the feet, and on her breast the head of Medusa is worked in ivory. She holds a statue of Victory about four cubits high, and in the other hand a spear; at her feet lies a shield and near the spear is a serpent. This serpent would be Erichthonius.

This image survives only in later Roman miniature copies [Hurwit 1999: 25-27; Hurwit 2004: 146-54].

What is not immediately obvious, because it is below the horizon, is that the sun was in the constellation Virgo at this time. The identification of Virgo with the virgin goddess Athena is recorded only by the Neoplatonic philosopher Proklos in the fifth century AD. Whether this is too late to be helpful to us is hard to judge. We do not know how far back this identification went, and there were many others in competition with it [Boll and Gundel 1924-1937: 961-63]. Furthermore, the adoption of the Babylonian zodiac by the Greeks is not attested until the fourth century BCE, although it may be pushed back to the late fifth century BCE [Hannah 2002a]. So, while Proklos's late testimony is attractive, it is hard to judge its value for earlier periods.

Overall, there remains one problem with the observation of the constellations enumerated here. There is no evidence for the Greek identification of the constellations as Snake (Draco or Hydra), Lion (Leo), Horse (Pegasus), Perseus, Andromeda and Cassiopeia before the late fifth century BCE at the earliest [Kidd 1997: 192, 248; Hannah 2002b]. Apart from the Lion and Hydra, which the Babylonians also saw as a Lion and Snake respectively, these constellations' names differ markedly from those of Babylonia; for example, Pegasus was a Field for the Babylonians, and Draco may have been divided between the Hitched Yoke (α Draconis) and the Pig (head and first coil of Draco) [Hunger and Pingree 1989: 137–38].[16] So we cannot posit an influence via that route into Greece at some indeterminate point before the late fifth century. Myth, as expressed in the plays of Sophokles and Euripides, may suggest that these catasterisms had been made by their time, but how long before then, we cannot yet tell. We may wonder whether the orientation of the Older Parthenon was aligned to the sunrise, but with a need to know when that particular sun would rise in the summer, observers noted the stars which preceded it and chose to provide them with identities which were associated in myth with the goddess Athena, to whom the temple was dedicated.

Acknowledgment

The charts reproduced in figs. 1, 4, 5, 11, 12 and 14 are from Voyager 4.1.7 (Carina Software, 865 Ackerman Drive, Danville, CA 94526, USA) and are reproduced by permission.

Notes

1. Penrose quoted this from [Lockyer 1892], but he misquoted Lockyer slightly and gave the wrong date for the original article. I have corrected the quotation to Lockyer's original translation. Lockyer himself repeated it in his book, *The Dawn of Astronomy* [1894: 175-6],

but there adjusted the date for Seti I to ca. 1380 BCE, which is still about a century too early for this Pharaoh.

2. I am grateful to Professor Giulio Magli for drawing this issue of dating to my attention.
3. Dinsmoor refers at this point only to *Inscriptiones Graecae* 2^2, 334 and Himerius, III, 16, which provide testimony to the start of the procession at sunrise. Athenaeus 3.98b associates the Panathenaia with Athena's birthday. Dinsmoor's reason for assuming that 'The religious evidence suggests that the lines of the foundation were laid out on Athena's birthday' must go back to his belief that a pre-Christian tradition is reflected in Sir Henry Chauncy's comment in 1700 that 'one end of every Church doth point to such Place, where the Sun did rise at the time the Foundation thereof was laid, . . .' [Dinsmoor 1939: 101).
4. Dinsmoor does not say so, but all his calendar dates BCE follow the Julian calendar, as is standard practice among historians for dates prior to 1582 CE, when the Gregorian calendar was initially introduced in Italy.
5. We may also suspect some slippage between actual moon and a calculated moon for the calendar months. Dinsmoor's expectation that the next month, Pyanopsion, would begin with the first visible lunar crescent after the eclipse is optimistic, as it means we would have to interpret Plutarch's 'about the 20th' as meaning 'in the late 20s' and hence 'about October 2/3', a day or two after the invisible new moon. This might be stretching the translation too far.
6. This situation arguably changes towards the end of the fifth century BCE, when the nineteen-year Metonic cycle is developed in Athens, although there is again no evidence that it was used to control the Athenian calendar until much later in the Hellenistic period; see [Dinsmoor 1931] and [Osborne 2003].
7. But see also [Boutsikas and Ruggles 2011: 58]: 'We can still accept that the sun might have played a role in the orientation of Greek temples, but we need to account for the 42% of the Greek temples that are oriented outside the range of the rising sun on the horizon.'
8. Penrose [1893b: 809] had published the figure correctly as 257° 7′ clockwise from south, but then had erroneously converted it to a solar amplitude of +15° 52′ 41″; the figures in his tables have to be checked every time.
9. The Gregorian equivalents for Dinsmoor's dates in 500 BCE are 23 April and 26 August.
10. It is worth comparing reviews of Scully's first (1963) and revised (1979) editions, to see how opinion changed over time or, perhaps, between the professions of archaeology and architecture; see [Thompson 1963] and [Plesums 1981].
11. Paris, Cabinet des Medailles 449: Beazley Archive Vase Number 5576; [Yalouris 1980: 317; Cohen 2006: 78, figs. 6-7].
12. The surviving texts of the parapegma of Euktemon is included along with others at the end of Geminus, *Introduction to the Phenomena*; see [Aujac 1975: 98-108]. On parapegmata in general and in detail, see most recently [Lehoux 2007].
13. I have argued elsewhere that the increase in stellar observations which is evident in Euktemon's parapegma, as compared with earlier 'star calendars' such as that of Hesiod in his *Works and Days*, may have been a result of a desire to correlate the festival calendar better with the solar year; see [Hannah 2002a].
14. [Hurwit 2004: 31] notes that Athena here 'is both Athena Ergane because she makes and Athena Hippia because of what she makes'.
15. The scholia to Aratos, *Phainomena* 45, indicate that Draco was identified with the snake killed either by Kadmos or by Apollo [Kidd 1997: 192]. Kadmos was assisted by Athena in his combat with the snake/dragon, so we find yet another possible link between the constellations and the goddess.
16. [Kidd 1997: 236] also notes a possible Egyptian origin for the Lion.

References

AUJAC, G. (ed.). 1975. *Géminos, Introduction aux Phénomènes*. Paris: Société d'Édition 'Les Belles Lettres'.

BELMONTE, J. A. and M. SHALTOUT. 2006. On the orientation of ancient Egyptian temples: (2) New experiments at the Oases of the Western Desert. *Journal of the History of Astronomy* **37**: 173-92.

BELMONTE, J. A., M. SHALTOUT and M. FEKRI. 2008. On the orientation of ancient Egyptian temples: (4) Epilogue in Serabit el Khadim and Overview. *Journal of the History of Astronomy* **39**: 181-211.

BOLL, F. and W. GUNDEL. 1924-1937. Sternbilder, Sternglaube und Sternsymbolik bei Griechen und Römern. Vol. 6, columns 867-1071 in *Ausführliches Lexikon der griechischen und römischen Mythologie*, W. H. Roscher, ed. Leipzig and Dresden: Teubner.

BOUTSIKAS, E. 2007. Astronomy and Ancient Greek Cult: an application of archaeoastronomy to Greek religious architecture, cosmologies and landscapes. Ph.D. thesis, University of Leicester.

———. 2008a. The orientation of Greek temples: a statistical analysis. Pp. 19-23 in *Archaeoastronomy in Archaeology and Ethnography. Papers from the annual meeting of SEAC (European Society for Astronomy in Culture) held in Kecskemet in Hungary in 2004*, E. Pasztor, ed. BAR International Series 1647. Oxford: Archaeopress.

———. 2008b. The cult of Artemis Orthia in Greece: a case of Astronomical Observations? Pp. 197-205 in *Lights and Shadows in Cultural Astronomy. Proceedings of the SEAC 2005, Isili, Sardinia, 28 June to 3 July*, M. P. Zedda and J. A. Belmonte, eds. Isili: Associazione Archeofila Sarda,.

———. 2009. Placing Greek Temples: An archaeoastronomical study of the orientation of ancient Greek religious structures. *Archaeoastronomy* **21**: 4-19.

———. 2011. Astronomical Evidence for the Timing of the Panathenaia. *American Journal of Archaeology* **115**: 303-309.

BOUTSIKAS, E. and C. RUGGLES. 2011. Temples, Stars, and Ritual Landscapes: the Potential for Archaeoastronomy in Ancient Greece. *American Journal of Archaeology* **115**: 55-68.

BOUTSIKAS, E. and R. HANNAH. 2012. Aitia, Astronomy and the Timing of the Arrhēphoria. *The Annual of the British School at Athens* **107**: 1-13.

CAUVILLE, S., E. AUBOURG, P. DELEUZE and A. LECLER. 1992. Le temple d'Isis à Dendera. *Bulletin de la Société française d'Égyptologie* **123**: 31-48.

COHEN, B. 2006. *The Colors of Clay, Special Techniques in Athenian Vases*. Los Angeles: J. Paul Getty Museum.

CROON, J. H. 1952. *The Herdsman of the Dead: Studies on Some Cults, Myths and Legends of the Ancient Greek Colonization-Area*. Utrecht: Drukkerij S. Budde.

———. 1956. Artemis Thermia and Apollo Thermios (With an Excursus on the Oetean Heracles-Cult). *Mnemosyne* **9**: 193-220.

DINSMOOR, W. B. 1931. *The Archons of Athens in the Hellenistic Age*. Cambridge, Mass.

———. 1939. Archaeology and Astronomy. *Proceedings of the American Philosophical Society* **80**: 95-173.

HANNAH, R. 2002a. Euctemon's parapegma. in C. J. Tuplin and T. E. Rihll (eds.), *Science and Mathematics in Ancient Greek Culture*. Oxford: Oxford University Press, 112-32.

———. 2002b. Imaging the Cosmos: Astronomical Ekphraseis in Euripides. in J. Elsner (ed.), *The Verbal and the Visual: Cultures of Ekphrasis in Antiquity. Ramus: Critical Studies in Greek and Roman Literature* **31**:1-2: 19-32.

———. 2009. *Time in Antiquity*. London: Routledge.

HOWARD, S. 1964. Review of V. Scully, *The Earth, the Temple, and the Gods* (1963), *Art Journal* **24**, 1: 90-92.

HUNGER, H. and D. E. Pingree. 1989. *Mul.apin: An Astronomical Compendium in Cuneiform*. Horn: F. Berge.

HURWIT, J. M. 1999. *The Athenian Acropolis: History, Mythology, and Archaeology from the Neolithic Era to the Present*. Cambridge: Cambridge University Press.

———. 2004. *The Acropolis in the Age of Pericles*. Cambridge: Cambridge University Press.

KIDD, D., ed. 1997. *Aratus, Phaenomena*. Cambridge: Cambridge University Press.

LEHOUX, D. R. 2007. *Astronomy, Weather, and Calendars in the Ancient World: Parapegmata and Related Texts in Classical and Near-Eastern Societies*. Cambridge: Cambridge University Press.

LOCKYER, J. N. 1892. On Some Points in Ancient Egyptian Astronomy. *Nature* **28**: 296-99.
———. 1964. *The Dawn of Astronomy* (1894). Cambridge, MA: MIT Press.
MAGLI, G. 2009. *Mysteries and Discoveries of Archaeoastronomy, from Giza to Easter Island.* New York: Praxis (Springer).
———. 2011. From Abydos to the Valley of the Kings and Amarna: the Conception of Royal Funerary Landscapes in the New Kingdom. *Mediterranean Archaeology and Archaeometry* **11**, 2: 22-36.
———. 2012. The Snefru Projects and the Topography of Funerary Landscapes during the Twelfth Egyptian Dynasty. *Time and Mind* **5**: 53-72.
NISSEN, H. 1869. *Das Templum, Antiquarische Untersuchungen*. Berlin: Weidmann.
———. 1906-1910. *Orientation, Studien zur Geschichte der Religion*. Berlin: Weidmann.
OSBORNE M. J. 2003. The Athenian archon Diomedon and his successors. *Zeitschrift für Papyrologie und Epigraphik* **143**:95-100.
PARKER, R. 2011. *On Greek Religion*. Ithaca: Cornell University Press.
PENROSE, F. C. 1893. On the results of an examination of the orientation of a number of Greek temples, with a view to connect these angles with the amplitudes of certain stars at the time these temples were founded, and an endeavour to derive therefrom the dates of their foundation by consideration of the changes produced upon the Right Ascension and Declination of the stars arising from the precession of the equinoxes. *Proceedings of the Royal Society of London* **53**: 288, 379-384.
———. 1894. On the results of an examination of the orientations of a number of Greek temples with a view to connect these angles with the amplitudes of certain stars at the time the temples were founded, and an endeavour to derive therefrom the dates of their foundation by consideration of the changes produced upon the Right Ascension and Declination of the stars arising from the precession of the equinoxes. *Philosophical Transactions of the Royal Society of London, Series A* **184**: 805-834.
———. 1897a. On the orientation of Greek temples and the dates of their foundation derived from astronomical considerations, being a supplement to a paper on the same subject published in the Transactions of the Royal Society in 1893. *Philosophical Transactions of the Royal Society of London, Series A* **189**: 43-65.
———. 1897b. On the orientation of Greek temples and the dates of their foundation derived from astronomical considerations, being a supplement to a paper on the same subject published in the Transactions of the Royal Society in 1893. *Proceedings of the Royal Society of London* **61**: 288, 76-78.
———. 1900. On the orientation of Greek temples, being the results of some observations taken in Greece and Sicily, in May, 1898. *Proceedings of the Royal Society of London* **65**: 288, 370-375.
———. 1901. Some additional notes on the orientation of Greek temples, being the result of a journey to Greece and Sicily in April and May, 1900. *Proceedings of the Royal Society of London* **68**: 112-114, 389-395.
PLESUMS, G. 1981. Review of V. Scully, *The Earth, the Temple, and the Gods: Greek Sacred Architecture* (1963), *Leonardo* **14**, 4: 344-45.
RUGGLES, C. L. N. 1999. *Astronomy in Prehistoric Britain and Ireland.* New Haven and London: Yale University Press.
RUGGLES, C. and G. Urton, eds. 2007. *Skywatching in the Ancient World: New Perspectives in Cultural Astronomy.* Boulder, CO: University Press of Colorado.
SCULLY, V. 1979. *The Earth, the Temple, and the Gods: Greek Sacred Architecture*, rev. ed. New Haven: Yale University Press. (1st ed. 1963).
SHALTOUT, M. and J. A. BELMONTE. 2005. On the orientation of ancient Egyptian temples: (1) Upper Egypt and Lower Nubia. *Journal of the History of Astronomy* **36**: 273-98.
SHALTOUT, M., J. A. BELMONTE and M. FEKRI. 2007. On the orientation of ancient Egyptian temples: (3) Key points at Lower Egypt and Siwa Oasis, Parts I and II. *Journal of the History of Astronomy* **38**: 141-60, 413-42.

STEWART, A. F. 2008. The Persian and Carthaginian Invasions of 480 B.C.E. and the Beginning of the Classical Style: Part 1, the Stratigraphy, Chronology, and Significance of the Acropolis Deposits. *American Journal of Archaeology* **112**: 377-412.
THOMPSON, H. A. 1963. Review of Scully (1963), *Art Bulletin* 45, 3: 277-80.
YALOURIS. N. 1980. Astral Representations in the Archaic and Classical Periods and their Connection to Literary Sources. *American Journal of Archaeology* **84**: 313-318.

About the author

Robert Hannah is Dean of the Faculty of Arts & Social Sciences at the University of Waikato, New Zealand. He was previously Professor of Classics at the University of Otago, New Zealand. He has written extensively on the use of astronomy in Greek and Roman culture. His most recent publications include the books *Greek and Roman Calendars: Constructions of Time in the Classical World* (Duckworth: London 2005), and *Time in Antiquity* (Routledge: London 2009). His current interests are in calendars, the everyday measurement and perception of time, and the metaphysics of time in antiquity.