The Astronomical Significance of Stonehenge

by
C A Newham

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The author taking solar observation July, 1958
Orientation of the Heelstone to centre.

Mr. Newham's interest in Stonehenge was first aroused after talking to the wardens, whilst he was on holiday in 1957. After his retirement from the North Eastern Gas Board shortly afterwards, Mr. Newham devoted the rest of his life to the study of Stonehenge. Without the help and encouragement from the site staff, both past and present, this book might never have been written. *(Photo: Y. Moon, daughter of author)*

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The many contacts I have made with site officials during my frequent visits to Stonehenge, have been both pleasurable and informative. To all concerned, including my friend, Mr. Charles Carr, I wish to express my sincere thanks and appreciation.

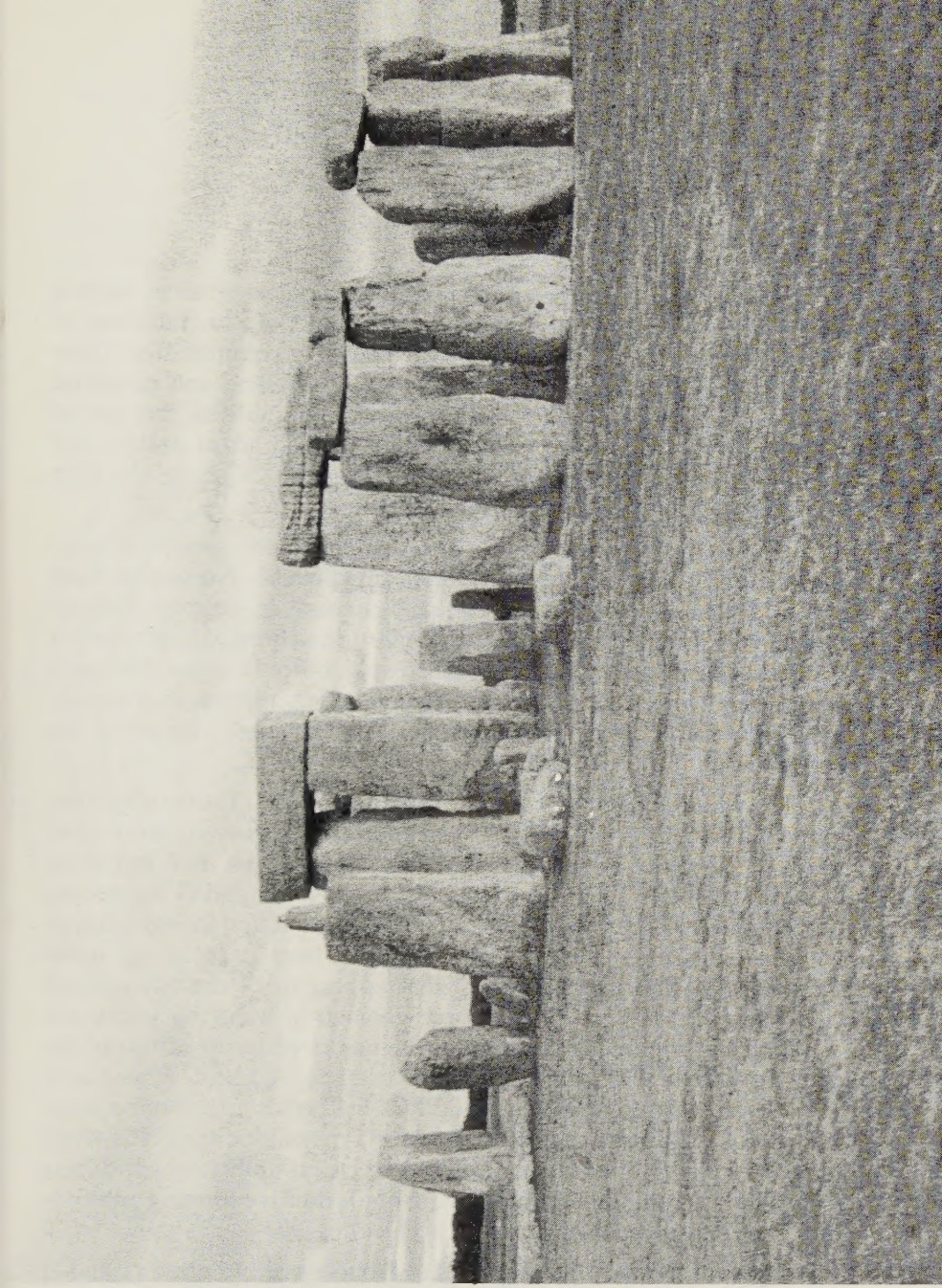
C. A. N.

Preface

The purpose of this publication is to provide lay readers, in broad and simplified terms, with basic astronomical information deemed necessary to understand the astronomical implications of Stonehenge. Even so, 'Stonehenge astronomy' has little meaning unless considered along with site information provided by archaeologists, especially with regard to the positions and dating of below ground features. The importance of the three post holes situated in the Stonehenge car park cannot be over emphasised. In my opinion they provide confirmatory evidence of the kind of activities in which Stonehenge people were engaged during the earlier stages of site development. By their advent it is now possible to deduce answers to many outstanding questions and open up an entirely new field for investigation as exemplified herein.

The 'astronomical' interpretations given to various archaeological discoveries should be regarded as provisional. Doubtless new archaeological evidence will necessitate reassessment. However, I am of the opinion that there is every jusification for believing that the general impressions given are substantially in accordance with the evidence so far available.

C. A. N.



From position of Station Stone 92 on the south mound

Introduction

The Builders

Judging from the large number of archaeological remains, there is no reason to doubt that Britain, at the time of the building of Stonehenge, was inhabited by primative farming communities. There is evidence of trade and cultural contacts with Ireland and mainland Europe. The artifacts which have been found indicate the use of pottery, of stone for axes, hammers and drills, and of antlers and shoulder bones for digging and clearing the land. Nothing has been found to indicate a more sophisticated culture.

Among the remains attributed to this period are groups of large stones, often appearing to be crudely formed circles. No two of these appear to be exactly alike and their purpose is unkown though believed to have had religious or ritualistic meaning. Hundreds are scattered throughout the British Isles, and it would seem that each community created its own form of stone groupings, as, in a similar way, a church in some form is to be found in most villages at the present time.

The very remarkable work done by Professor A. Thom (*Megalithic Sites in Britain*, OUP 1967), who has undertaken surveys of over three hundred of these megalithic sites found in Britain not including Stonehenge shows that at the time of Stonehenge I and II the people concerned were far more sophisticated than was at first thought. Many of these sites are regarded by Professor Thom as solar or lunar observatories, and he states that what appear to be crudely formed circles are actually based on simple geometry, involving important astronomical alignments. He finds evidence of widespread use of the principal properties of right-angled triangles and of a standard measure, the length of which he derives mathematically from a mass of data to be 2.72 feet and which he calls a megalithic yard. His work implies a degree of mathematical and technical ability which differs considerably from the original picture of a primitive farming community based on archaeological evidence.

My own independent findings at Stonehenge of Periods I and II confirm some of the suggestions made by Professor Thom. The laying

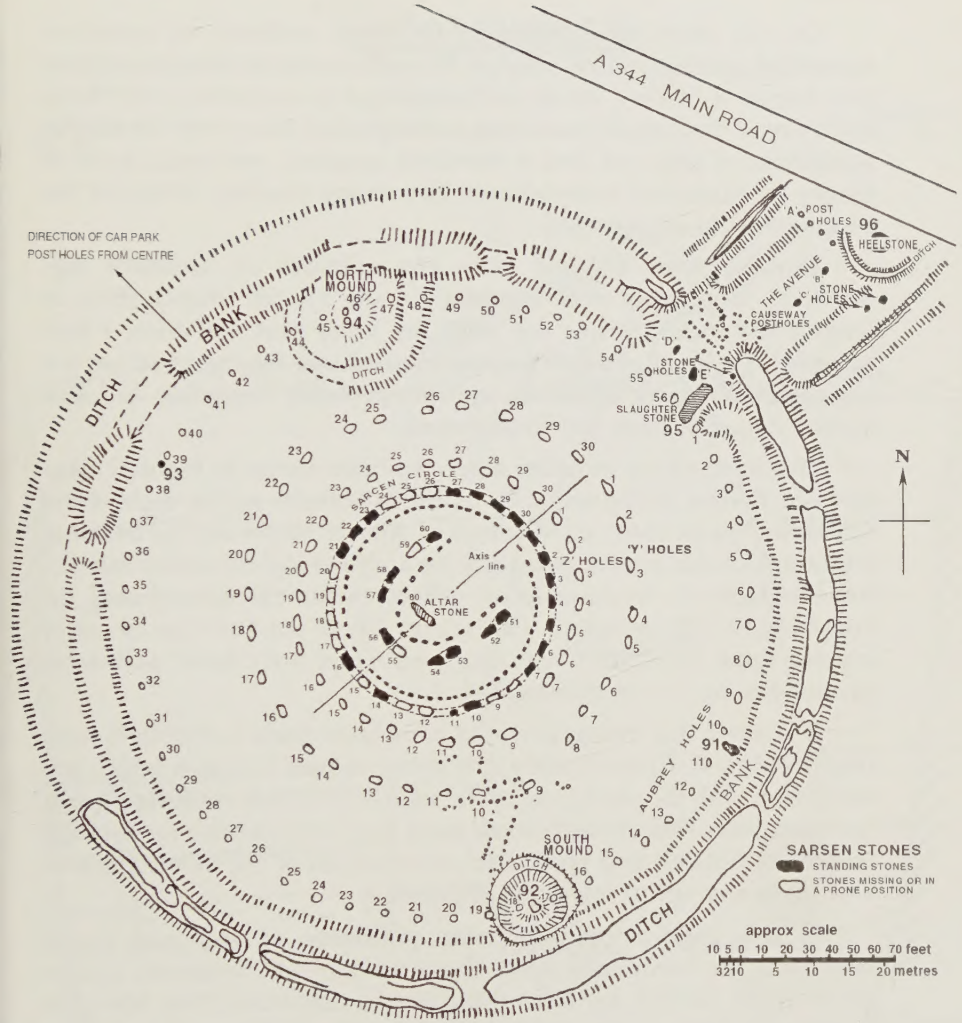


Fig. 1—Descriptive Plan of Stonehenge Main Features

Based on the Ministry Guide Book plan but with several modifications for special descriptive purposes

out of the site during the periods has strong geometrical bases, and the astonishing accuracy of solar and lunar alignment support his theory.

On the other hand, there is no direct evidence of extensive theoretical geometrical knowledge. No archaeological remains suggest any degree of literacy. As far as Stonehenge is concerned, everything so far found there could have been accomplished using only the simple equipment of peg and line, a standard measure, and some form of tokens for numerical comparisons. The strong practical ability of the people must be emphasised.

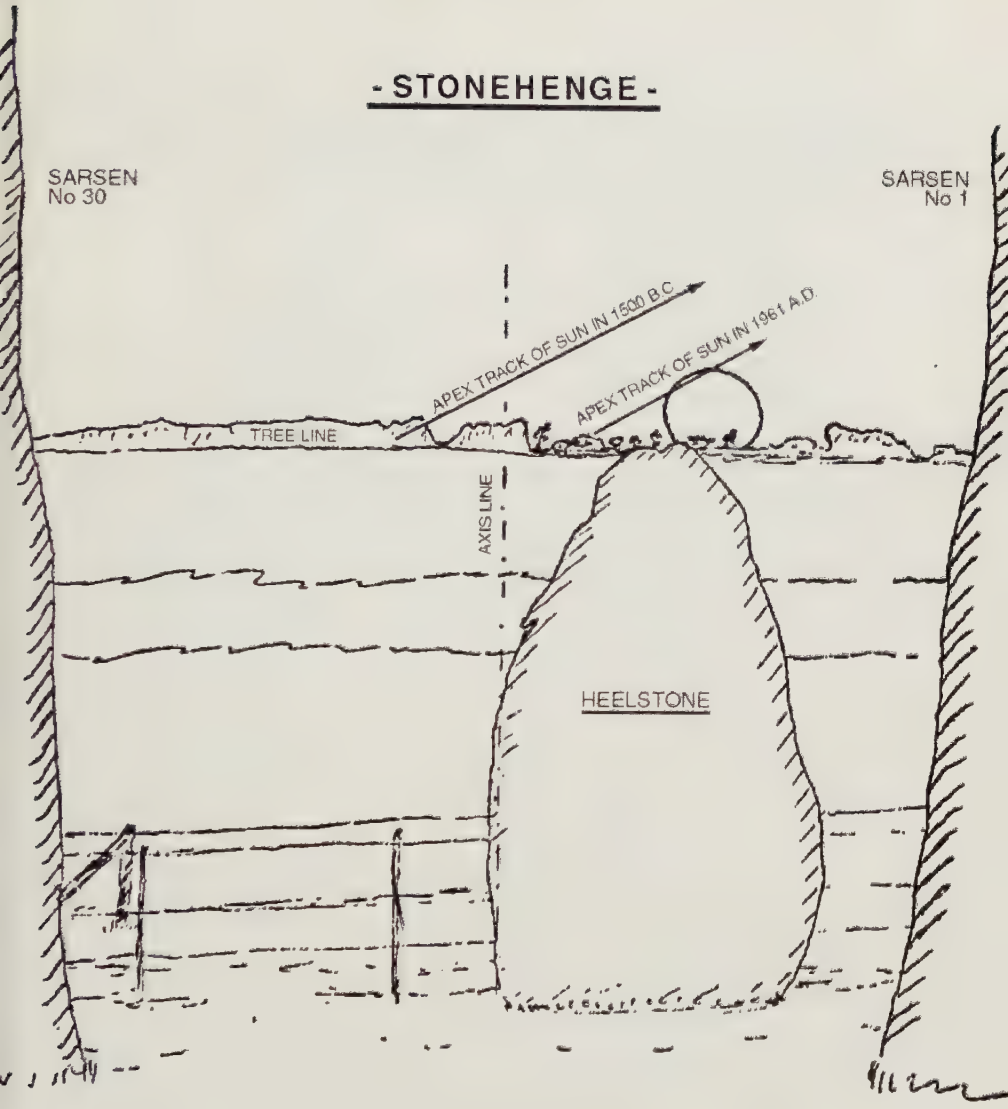
During Period I, apart from any religious or ritualistic significance, Stonehenge was essentially a site for the investigation of lunar phenomena. It was not until the latter part of Period I that purposeful solar alignments became evident and the use of stones for alignment purposes began to appear, probably replacing the less durable wooden posts previously used.

The moon phase provides a very suitable means to regulate day-to-day activities, by the use of such time indications as 'the night of the full moon,' or so many days before or after it. However, for defining important annual events, necessary for a settled agricultural community, the moon is inadequate. A reliable solar calendar, based on knowledge of the points of the horizon where the sun rose or set at regular times each year, was required. Thus both lunar and solar phenomena had to be investigated.

It is likely that attempts would have been made to correlate their two 'calendars'. Unfortunately, the moon moves in cycles which are not in step with the yearly sun cycle, and considerable confusion could have resulted. This in itself would have been an incentive for them to undertake difficult and protracted observations of the moon's behaviour in an attempt to solve this problem.

In this publication, the basic principles of sun and moon behaviour are introduced. Once these fundamental ideas are understood there should be little difficulty in understanding how the Stonehenge astronomers tackled their severe problem and in appreciating their remarkable ingenuity. It will then be possible to discuss in chronological order the development of the site from the earliest known works to the erection of the final grand central structures, the remains of which are seen today.

Stonehenge should not be regarded as a single identity, as was



View of North Eastern Horizon as seen from the centre of the Sarsen Circle, showing the Sun's position about four minutes after 'First Light' 20th June, 1961

perhaps the case at the beginning of this century, but rather as a place recording the activities of many generations of intelligent though illiterate people, with continually changing ideas about the methods employed in their search for knowledge and the manner in which it was used.

It is in respect of the latter that Stonehenge became unique when the grand Sarsen stone structure finally appeared many hundreds of years after lunar investigation began.

Description and Dating of Stonehenge

A general description of the main features and an approximate dating sequence. This is divided into three periods based primarily upon those set out by Professor R. J. C. Atkinson in 1956 but updated to take into account more recent thinking.

Period

Stonehenge (8500–7600 B.C.)

Three large postholes situated in the car park and probably others not yet discovered situated away out in the surrounding fields.

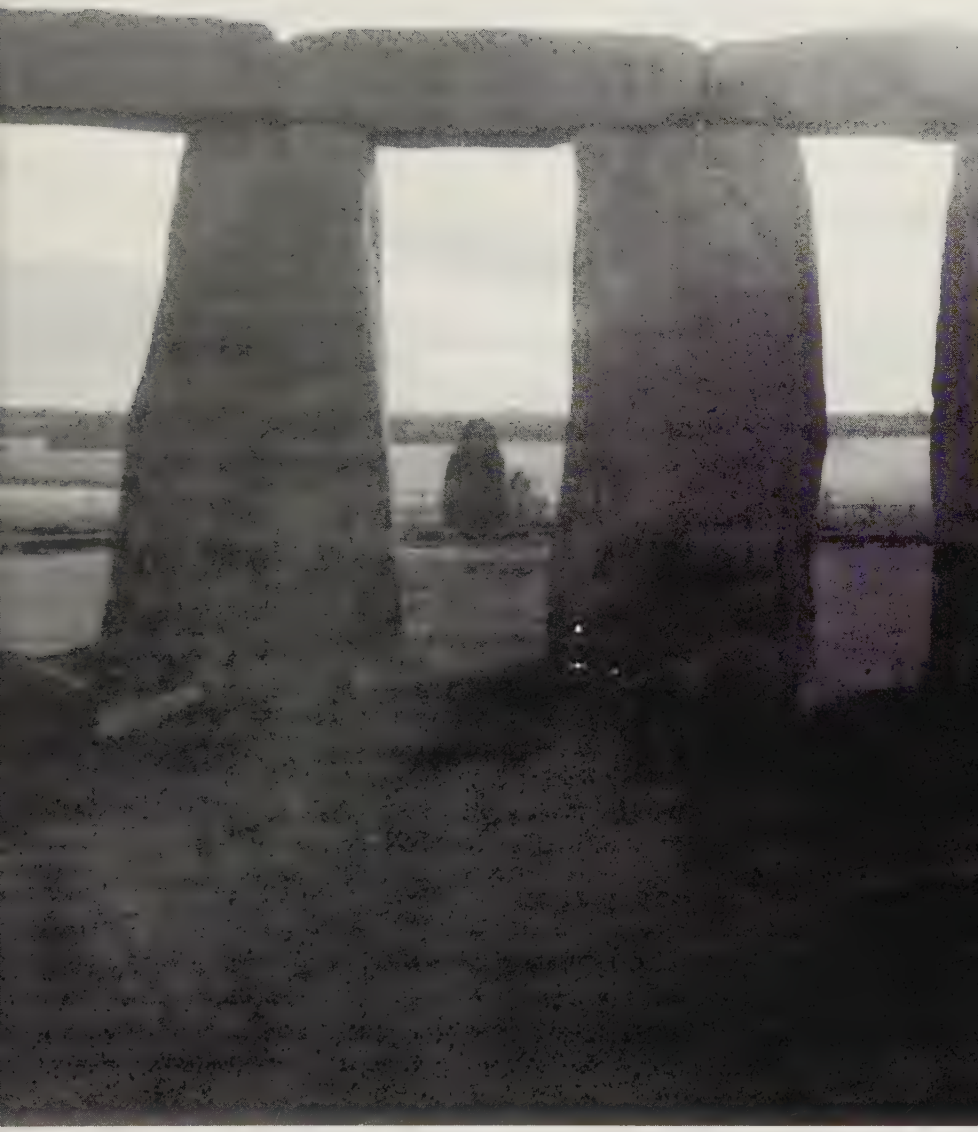
Stonehenge I (2350–1900 B.C.)

(a) Construction of the circular bank from the earth material immediately outside, thus forming the surrounding ditch. The bank was about 6ft. high and some 320ft. in diameter. Access to the enclosed space was provided by a 35ft. gap in the bank facing towards the northeast.

(b) Digging out the 56 Aubrey holes that were refilled shortly after. Stoneholes 'B' 'D' and 'E'.

(c) The formation of the causeway postholes situated immediately outside the entrance gap. Other odd groups of postholes.

(e) The four 'A' postholes. The small circular ditches and probable erection of posts at Stations 92, 94, and Heelstone 96 and later the erection of stones at these positions and at Stations 91 and 93. Removal of stone 'D' to 'C' position and taking down stone 'E', which was buried alongside the hole.



Line of summer solstice sunrise, 21st June, looking between stones 30 and 1

Stonehenge II (2550–2200 B.C.)

Filling in of Heelstone ditch. Possible transporting from South Wales of the 'Blue' stones and their erection in the form of a double circle at the centre of the enclosure. (This project was never completed. Only about two-thirds of the stones were erected. These were later removed and the holes filled with tightly rammed chalk in preparation for the erection of the Sarsen stones).

Stonehenge III (2200–1550 B.C.)

(a) Transporting the large Sarsen stones from the Marlborough Downs and their erection at Stonehenge as five Trilithons (two upright stones capped with a lintel) in horseshoe formation inside a circle of thirty upright stones capped with lintels joined together to form a complete ring.

(b) Making of The Avenue

(c) Re-erection of the bluestones, which were subject to modification and finally took the form of 59 or 60 arranged in a circle 8 to 9 feet inside the Sarson circle, and 19 stones in a horseshoe formation inside the five Trilithons, as shown in Fig. 1.

(d) Digging and abandoning of the 59 Y and Z holes.

Stones Outside the Sarsen Circle

Only four of about twelve stones remain to be seen today. Probably at one time or another they all served as alignment markers. Of these four remaining stones, only 96 (Heelstone) and 93 (Station stone) are standing in their original positions. 91 (Station stone) has fallen and now lies almost prone. The last of the four visible stones probably once stood in stonehole 'E' and was then later removed and buried nearby. It is known as the Slaughter Stone but the term has no valid significance. Station stones 92 and 94 are missing, but with the Station stones 91 and 93, the Heelstone 96 and the missing stone at stonehole 'C', present a remarkable combination of alignments directed towards sun and moon rising and setting positions.

Line of summer solstice sunset, 21st June, looking between stones 22 and 23

Other Features

None of the remaining features marked on the plan can now be seen except the general outline of the surrounding bank and ditch, the Avenue and traces which remain of the two small circular ditches at Stations 92 and 94, and a number of white patches bare of grass marking the positions of excavated Aubrey holes 1 to 30. All the other Aubrey holes are not marked but their positions have been found mostly by probing or other above-ground techniques.

The Sun: Simple Explanation of its Movements

Particulars of important sunrising and settings at the latitude of Stonehenge (approximate).

	General Direction		*Hours above and below Horizon*	
Date	*Rising*	*Setting*	*Above*	*Below*
21st June (summer solstice)	N.E.	N.W.	16	8
21st September (autumn equinox)	E.	W.	12	12
21st December (winter solstice)	S.E.	S.W.	8	16
21st March (spring equinox)	E.	W.	12	12

Thus it takes six months for the point of sunrise (setting) to move from one extreme to the other or twelve months to complete the full cycle. Notice that the direction of summer solstice sunrise is opposite to the winter solstice sunset and the winter solstice sunrise is opposite to the summer solstice sunset. The same principle applies throughout the year. Risings (settings) that occure either six months before or after a particular day, are opposite to the settings (risings).

Rising and Setting Phenomena etc.

North of the equator all heavenly bodies appear to move from left to right (clockwise). Given clear conditions, the apex of the rising sun suddenly appears on the horizon, almost like a car headlight coming into view over a hill-top. Slowly the full orb comes into view, which takes about four minutes. Meanwhile the sun will have moved nearly

one degree to the right. When exact alignments are required, they are usually taken either on the point of first flash (or gleam) or at the point were the full orb appears tangent to the horizon.

Setting phenomena of sun are in reverse order. The full orb first descends to the horizon and the point where it finally disappears is referred to as 'last light' (or gleam). Examples in picture form are given in Fig. 5 on page 40.

Day and night hours at the time of the equinoxes are equally divided. The further north of Stonehenge one goes between March and September, the longer the daylight hours become until daylight endures continuously for six months on reaching the North Pole. Between September and March all is in reverse.

The word solstice denotes the time when the sunrise reaches its extreme positions, when it appears to remain static or stand still for several days. This made it difficult to know the exact day of the solstice, so the ancients marked the point of sunrise well before the solstice day, and then counted the number of days before it returned to the marked position. Half this number would define the Solstice day. The Heelstone could have been used for this purpose. For example if it took 20 days for the point of sunrise marked by the Heelstone to return to the same position, so 10 days after the first reaching of the Heelstone alignment would be the actual solstice day.

Azimuth: The horizon 'circle' is usually divided into 360 degrees taken in a clockwise direction starting from true north.

Thus east, south and west in azimuthal terms will be 90°, 180° and 270° respectively. For very refined alignments each degree is divided into 60 minutes of arc and each minute into 60 seconds. One second of arc is therefore 1/3600 of a degree.

Details of Sun Rising Phenomenon

In order to ascertain exactly the position of sun rise or setting as actually observed at the time when Stonehenge was erected, various factors have to be taken into consideration. These principally include (a) the angle of the earth's axis to the ecliptic at the time in question, (b) the difference in elevation of the critical portion of the horizon from that of the observer, and (c) the corresponding effect of refraction.

(a) *The progressive change of the Earth's axis to the eclipitic.* (Obliquity of the Ecliptic).

The change in the angle of the Polar axis to the ecliptic affects the observed point of sunrise or setting. Although the rate of change is exceedingly small and hardly noticeable during a man's lifetime, it becomes of consequence when considering the period elapsed since the erection of Stonehenge some 4,000 years ago when the sun would appear to rise and set almost one degree further north or south at the time of the summer or winter solstices than it does today.

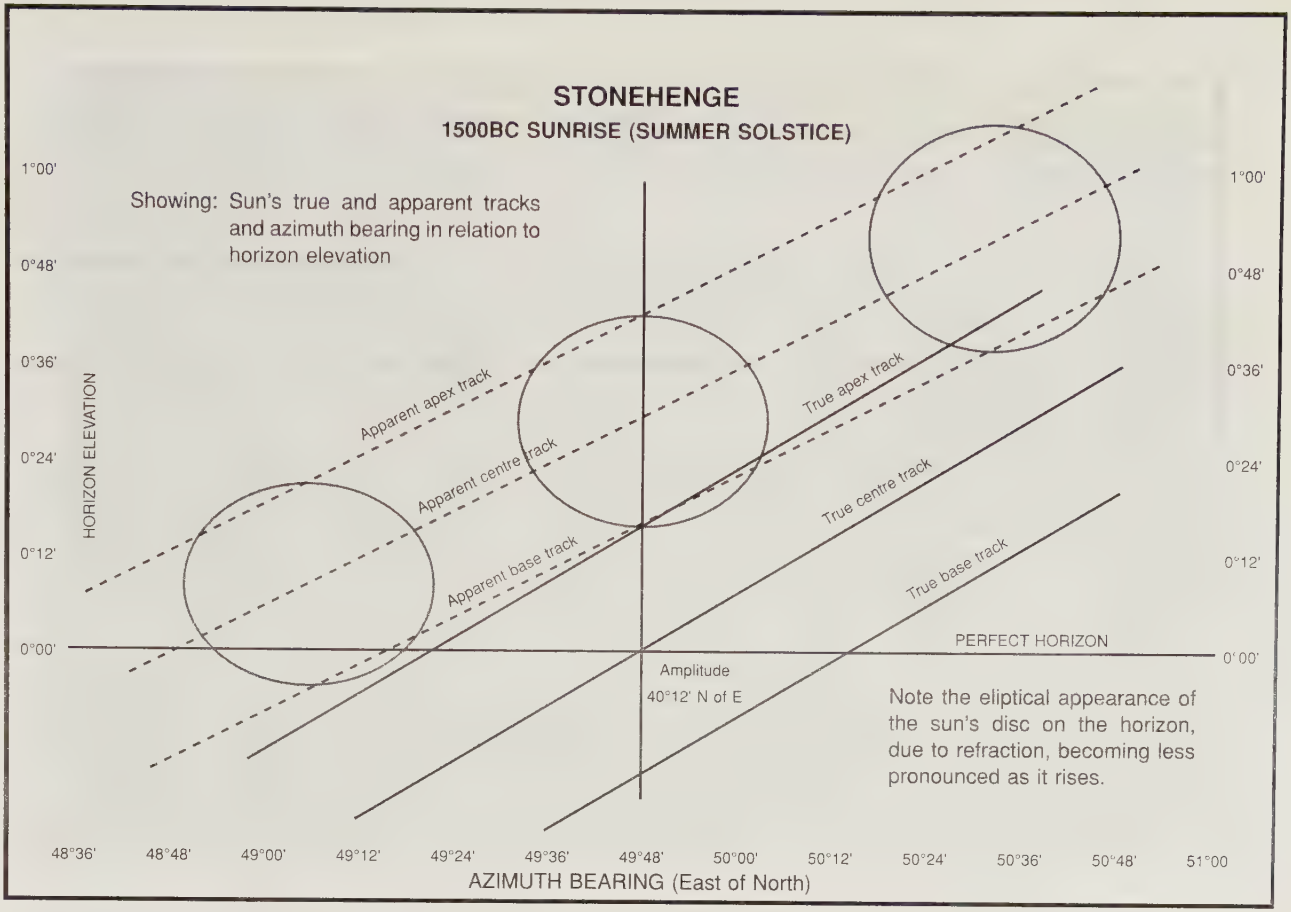
(b) *Difference in horizon elevation.*

Obviously, the higher the critical horizon is above the observer, the later the sun will appear on rising and the sooner disappear on setting, and the bearings on such will also change accordingly.

(c) *Refraction of light.*

Refraction is a term used to denote the bending of light rays when passing from one medium, such as air, glass or water, to another or through different degrees of density in the same medium. The effect of light passing through air is to cause the 'elevation' of a celestial body to appear higher in the sky than it really is. This effect is greatest when on the level horizon, when it amounts to a little more than the apparent diameter of the sun, so that when the full disk appears to rest on the horizon, the true apex of the sun is slightly below the horizon. Without entering into rather involved calculation, the graph opposite shows the combined effect on the sun rising phenomenon for the year 1500 B.C.

The full diagonal lines show the true path of the rising sun as would be seen, if the atmosphere were entirely absent, at the summer


STONEHENGE
1500BC SUNRISE (SUMMER SOLSTICE)
Showing: Sun's true and apparent tracks and azimuth bearing in relation to horizon elevation
HORIZON ELEVATION
1°00'
0°48'
0°36'
0°24'
0°12'
0°00'
Apparent apex track
Apparent centre track
Apparent base track
True apex track
True centre track
True base track
PERFECT HORIZON
Amplitude
40°12' N of E
Note the eliptical appearance of the sun's disc on the horizon, due to refraction, becoming less pronounced as it rises.
48°36'
48°48'
49°00'
49°12'
49°24'
49°36'
49°48'
50°00'
50°12'
50°24'
50°36'
50°48'
51°00
AZIMUTH BEARING (East of North)

solstice. Its *amplitude* is that point when the sun's true centre on rising or setting, is in line with a "level" horizon, and for any day of the year is the angle north or south of east or west. In this case it is 40° 12' north of east or 49° 48' east of north (azimuth bearing). These bearings are marked along the base line of the graph. The vertical co-ordinate gives the horizon elevation and when used in conjunction with the broken diagonal lines which mark the apparent track of the sun, after allowing for the effect due to refraction, it is possible to ascertain the actual bearing of any stage of sun rising according to the horizon elevation.

For example, if the critical horizon elevation were 00°36' then first light would be in an azimuth bearing of 49°36' east of north.

It should be understood that some slight distortion occurs in presenting a spherical movement on a flat surface. However, since the angular distance depicted is small, the error is also small and may be correct to within less than one minute of arc (1/60 of a degree).

NOTE: The graph can be used for sun rising and setting of both winter and summer solstices but adjustment should be made to the direction of azimuth bearings either side of the amplitude point—also reverse direction for setting.

View from Aubrey Hole 29 looking north-east

The Moon: What it appears to do at the Stonehenge Latitude

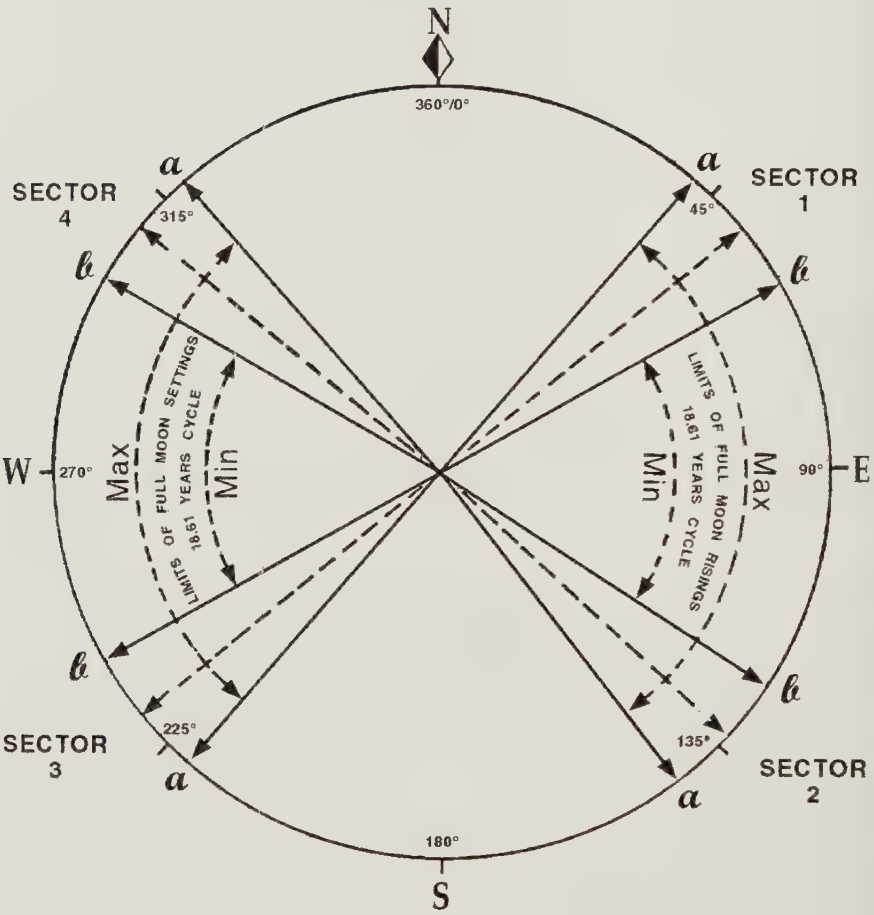


Fig. 2 What the moon appears to do at Stonehenge

Fig. 2 refers to important moon rising and setting phenomena. If the moon were self-illuminated it would be seen to rise and set each day like the sun, but instead of taking twelve months to move from one extreme rising position to the other and back again as does the sun, only about 27 days would be required. As it is, we see all visible phases by reflected sunlight and the full orb once every month, on average 29.53 days when opposite to the sun.

For simplicity of explanation, subsequent mention of moon will imply the time when it is full moon, nearest to the summer or winter solstices, and the sun will be in the opposite direction. Thus at about the time the **midwinter** sun is setting in the southwest, the moon will appear over the northeasterly horizon, covered by Sector 1. Likewise Sector 4 indicates the direction where it will set. In a similar way summer moonrise will be in the southeasterly direction marked by Sector 2 at about the time the sun sets away to the northwest. About six hours later the moon will set towards the southwest in Sector 3 as the summer sun rises towards the northeast. In general moon phenomena will be in reverse to that of the sun in regard to the season and time it is above or below the horizon. We will now consider another important 'anomaly'.

Let us assume the moon is seen to rise in the direction of 'a' (Sector 1) by an observer standing at the centre of Stonehenge one midwinter day in late afternoon as the sun is about to set in the opposite direction. The point of moonrise will be about 10° left of the Heelstone. The moon will then travel southwards and reach its highest point in the sky when it is due south and then slowly descend until it has set in the direction of 'a' (Sector No. 4). Six months later, the point of summer moonrise would be about in line with 'a' (Sector 2). If the same observations were taken each subsequent year, the *point of winter moonrise* would gradually move towards the right and after 9 years it would be about 10° right of the Heelstone in line with 'b' (Sector 1) and the corresponding summer moonrise would have moved from 'a' to 'b' (Sector 2). Thereafter the points of moon risings slowly return towards the 'a' positions, completing the whole cycle in 18.61 years. Similar conditions apply to the setting moons marked by Sectors 3 and 4. The broken lines mark midpoint of the Sectors which very closely coincide with sun setting and rising alignments at the time of the solstices.

When the moon is at the 'a' or 'b' positions, similar 'standstill'

conditions apply to that of the solstice sun. Professor Thom refers to them as Major or Minor standstill respectively.

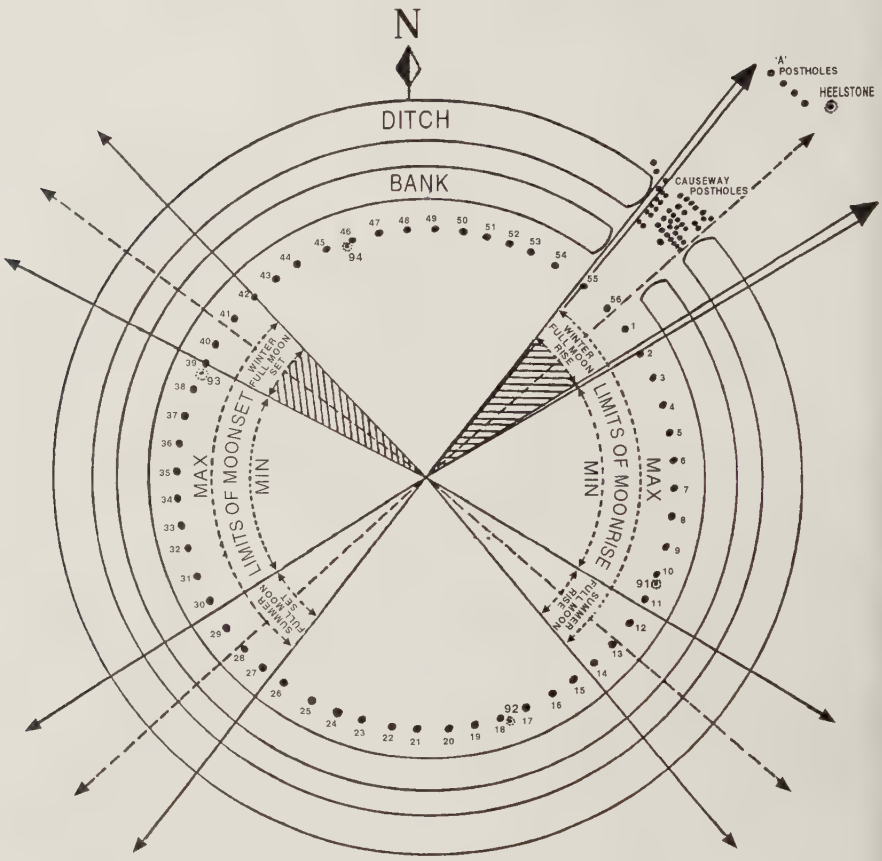


Fig. 3 Moon alignments - Aubrey Holes

The four Sectors of Fig. 2 are superimposed on Fig. 3 above. Notice how the four sectors relate to some of the Stonehenge features, and that the northeastern sector 1 has double lines corresponding to the 'a' and 'b' alignments which exemplifies conditions applicable to the other three sectors. The double lines take into account the difference between the first gleam and full orb as the critical sighting alignment, and also minor perturbations to which the moon is subject.

Central horseshoe trilithons formed from stones 51, 52 and 152, and 53, 54 and 154

General view of stones from arou

Z holes 10 and 11 looking north

Early Indications of Lunar Investigation

Fig. 3 shows a cluster of about forty postholes situated in the Causeway, immediately outside the entrance gap. They appear to be arranged in six rows, concentrically with the bank, and to radiate from the centre of the enclosure.

Superimposed on Fig. 3. is Sector 1, denoting the direction in which the winter full moon rising took place. As explained in Fig. 2, this sector marks the limits of the winter full moon 'swing' within the major and minor limits marked 'a' and 'b' respectively. It will be noticed that all the postholes appear to occupy the northern half of the Sector.

Their arrangements are similar to what could be expected if the 'Stonehenge Astronomers' planted poles aligned on succesive mid-winter full moon risings when observed from the enclosure centre. The number of such moon risings appearing in a cycle of 18.61 years in this half of the Sector would usually be nine. Apparently some are missing, probably due to occasions when the rising moon could not be seen because of cloud or mist.

Since six rows are involved, it indicates that observation covered six cycles, a period of over a hundred years, being 6 x 18.61 years. The actual point of rising varies slightly in each cycle from year to year. An example of this is shown in Fig. 4 on page 28, which also shows the postholes in detail as group A. Group B, below that, gives an example of the bearings based on known moon risings over the past hundred years. It will be noticed that whilst there are certain differences there is a resemblance between the patterns as a whole.

What could have been learned from this? By such a series of observations it would have been possible to detect the 19 years Metonic cycle, in which the same phases of the moon are repeated on the same date of the year to within an hour or so after a period of nineteen years, a fact which was supposedly discovered by Meton around 430 B.C. but is believed to have been known earlier.

The 18.61 years retrograde nodal cycle governs eclipse cycles, so that there is a possibility that this was another reason for the recording of these observations, although there is no evidence of such an

Direction of winter solstice sunset, 22nd December,
looking S.W. on Axis line

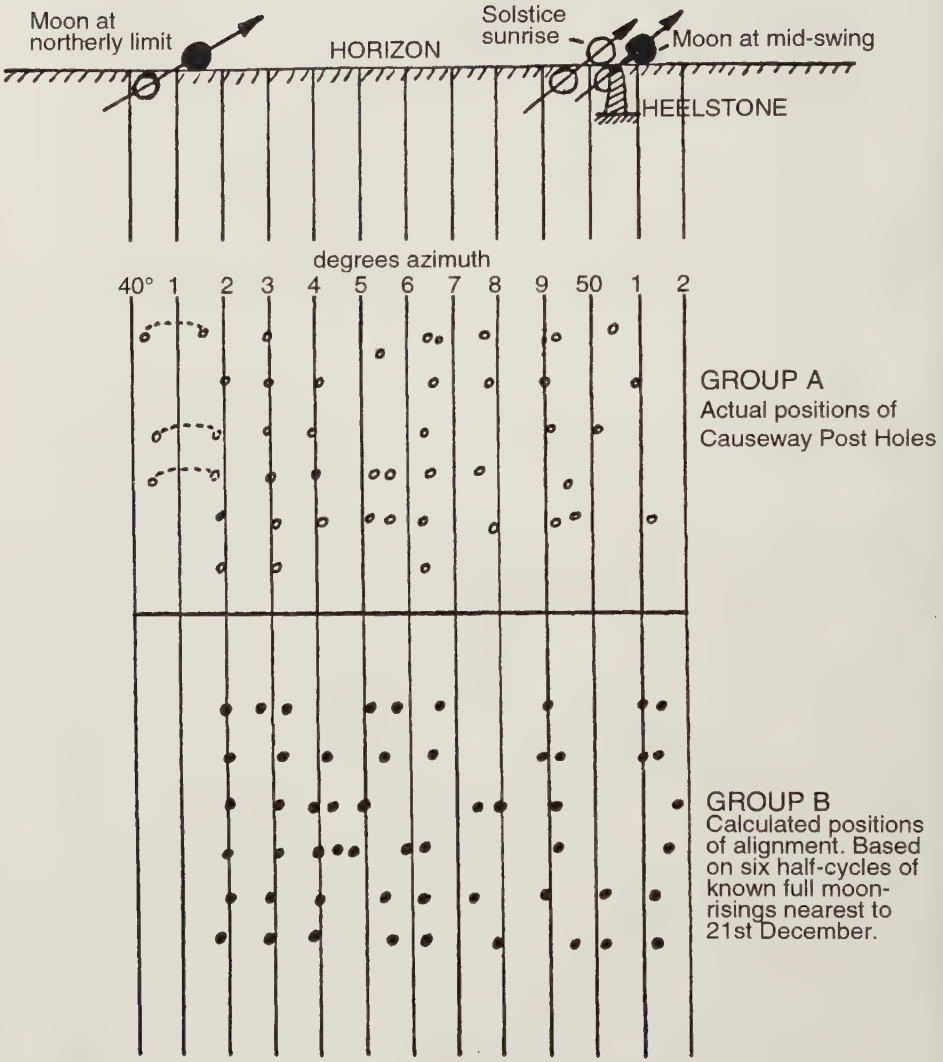


Fig.4. Causeway Post Holes in relation to mid-winter full moonrisings

intention. It would certainly have been more difficult to define eclipse cycles by this crude method.

It is possible that similar observations were made in the north western direction on the setting of the winter moon, but the critical part of the site has not been uncovered.

Group A

The holes are shown in plan and the vertical lines correspond to their bearings in degrees azimuth as seen from the centre of the enclosure. The limits of moonrisings (max. northerly to midswing) are depicted on the horizon as is the corresponding summer solstice sunrise in relation to the Heelstone.

Group B

The hypothetical holes are all calculated on full orb of about 1700 B.C. The indication are that the postholes are earlier than 1700 B.C., and that in some instances the point of 'first gleam' was the critical sighting line.

The 56 Aubrey Holes

This section is devoted to a discussion about the enigmatic circle of 56 Aubrey Holes, and to show the remarkable relationship that appears to exist between the number 56 and observable moon phenomena. By so doing it reveals a possible reason for the setting out of a circle of 56 holes based entirely on the elementary method of alignment as practised by the people of Stonehenge. Before doing so, however, it may be helpful to readers if mention is made of some major items concerning this enigmatical feature:

1. Their general arrangement is shown in Fig. 3, and the holes are numbered in accordance with the old Ministry of Works plans.
2. Only about half of the holes have been excavated and their contents examined, the remainder have been found by probing. The major part of the operation was carried out during the nineteen-twenties.
3. The official guide book describes the 56 holes as being placed on the circumference of a circle about 284ft. 6in. in diameter,

concentric to the bank. The holes are slightly less than 16ft. apart. The centre of none of them is more than 1ft. 7in. from the circle and the greatest spacing error, centre to centre, does not exceed 1ft. 9in. They vary somewhat in size, their average diameter and depth being 3ft. 6in. and 2ft. 6in. respectively.

4. The majority were found to contain, amongst other material, the remains of cremated humans.

5. The holes were probably dug after the erection of the bank.

6. They were filled up again shortly after their digging and most were opened out at a later date, some several times, for burial purposes. They may also have served for purposes of a religious nature.

7. Neither stones nor posts were erected in them.

Such then was the general impression held regarding their history and function since their discovery. At that time, controversy arose as to whether or not the holes were intended for posts, which after all was only a difference of opinion on assumption. It seems to me the idea that posts were intended would have carried the day if the wider astronomical implications relating to the monument and other megalithic remains had been known at the time.

However, several outstanding questions remain to be answered, *e.g.*

(a) What was the purpose for which the holes were originally intended?

(b) If the holes were intended to hold posts, why was the project abandoned before completion?

(c) Why the necessity for 56 holes? Why go to the trouble of dividing a circle into a relatively complex number?

The assumption that the holes were intended to hold posts is based on the following considerations:

The setting out of the Aubrey circle probably took place after the inception of the ditch and bank, at a time when the people made use of wooden posts for alignment purposes. They continued to do so, with one or two exceptions, until the latter part of Period 1 or the beginning of Period 2. It was also about the time when geometrical

From the north mound, or approximately the position of Station stone 94

implications first began to appear, including the probable use of a Lunar Measure and triangulation based on winter 'moonswing'. The approximate date of 3000–2800 B.C. seems earlier than the earliest Megalithic 'observatories' suggested by Professor Thom with their estimated dates based on their astronomical alignments.

The question arises: How can a circle of 56 posts serve to meet both astronomical and geometrical alignment purposes?

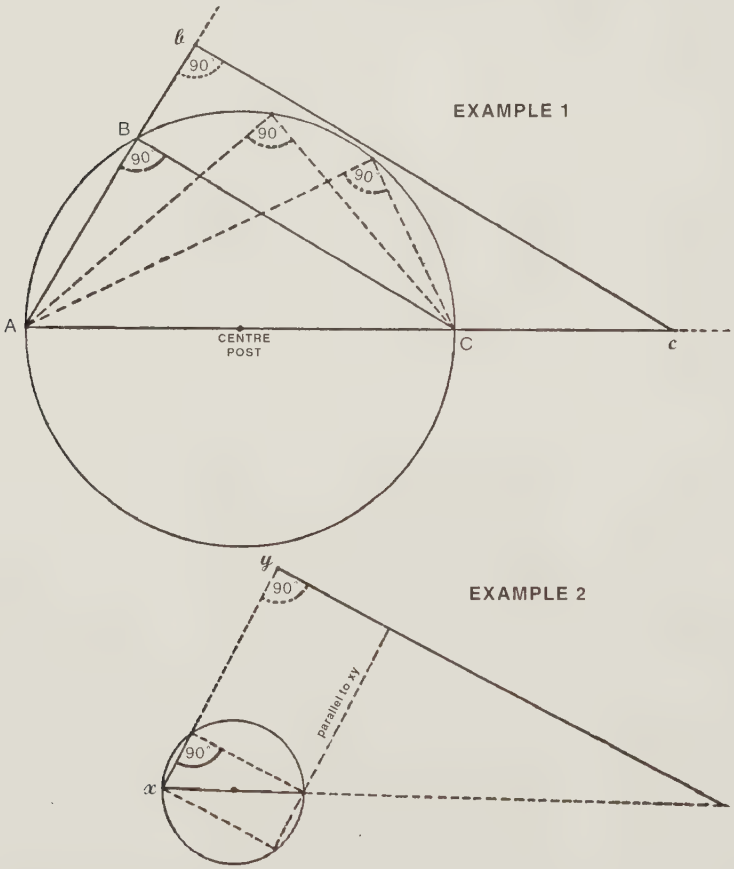


Fig. 4a, above, shows how a circle can be used to define 90° triangles, not only in the circle itself but to distances well beyond its circumference. Lines connecting any three points on its circumference form a 90° triangle provided one line passes through the circle centre.

This elementary property of a circle was known to people of ancient times. Thus an even number of equally spaced posts will always have two posts diamentrically opposite and will provide means by sighting to find (or project) alignment angles between observed astronomical phenomena or other inter-related geometrical positions. It is not suggested that the Aubrey circle was based on this principle; indeed it could be the reverse. However, the potentiality of the principle is considerable. This opinion is based on personal practical experience in setting out purposeful 90° triangles of large dimensions correctly to within 0.5° or 3 inches over a distance of 619ft., my equipment was a few straight rods and pegs, part of an old tape measure cut to a standard length, the simple integrals of which were obtained by folding the measure the requisite number of times.

Example 1

Say line A-b is one and a half times the length of A-B. Place a marker at 'c', one and a half diameters of the circle from A in line with the circle centre. Line b-c will have the same ratio as line B-C.

Example 2

Demonstrates how parallel alignments can be projected in relation to any desired angle etc.

The possible significance of the number 56 is now discussed.

The number 56

One interesting example of how sun and moon phenomena appears to be related to number 56. 56 is almost three times the years taken to complete the retrograde nodal cycle of the moon. (3 x 18.61 = **55.83**).

There are other examples; the difference in days between three solar years of 365.242 days and three lunar years of thirteen lunations each (3 x 29.53 x 13) – (3 x 365.242) = **55.95.**

Or in five years, each of 12 lunations, taken to the nearest first decimal 5 x 29.5 x 12 = (5 x 365.2) – **56.0**.

The properties of 56 in relation to circular measure.

The following examples will show the remarkable relationship between a circle of 56 units, and the observable and calculated angles between the major and minor extremes of the setting or rising of the winter moon.

1. Average spacing between the 56 Aubrey holes = 6.428°
2. Average angular distance of three spaces = 19.286°
3. Average yearly angular change of the moon's nodal cycle 360/18.61 = 19.344°
4. The angular differences as recorded by the 'Builders' between winter moon settings at major and minor extremes (see Fig. 5 examples 1 and 3 on page 40) = 19.26° 318.8°—299.54°
5. Calculated mean of 2 to 4 above = 19.3°±0.1°
6. The chord of 19.26° applied to the Aubrey circle is 47.56 feet. For convenience, this will later be referred to as the Lunar Measure, or 1 L.M. of 47.6 feet.

It is also interesting to note that the chord of 19.26° is almost one-third of a circle radius. Thus six times their observed angular measure taken along any circle sets the diameter. The reverse procedure could also apply. If they chose for convenience to keep the circumference of the circle a few feet within the bank, then by using their "Yardstick" to mark equal intervals, one round would position 18 holes and the 19th mark would overlap by one-third of their marker. Thus after 3 rounds all the 56 positions could be recorded. There are other methods, but at least this suggestion serves to demonstrate the principle. No knowledge of astronomy is required other than direct observation of two moon alignments.

Neither is there call for relatively involved mathematics. All could be accomplished by the use of a 'peg and line', a few stakes or poles for alignment purposes, and one cut to 'yardstick' length (or a knotted line), all backed by persons possessed of inquiring minds with the

practical gumption and the tenacity of purpose to undertake protracted observations.

However, the foregoing leaves several questions to be answered. What was the incentive? What was the reason for the abandonment of the project?

Before further examination of the site evidence, one further point: In arriving at the forementioned suggestion, reference was made to two car park moon alignments implicating the Heelstone and Station positions. This implies that these alignment markers were set up at a later date, probably long after the inception of the Aubrey circle. The assumption that these two alignments were approximately known at the time was based also on the orientation of Aubrey holes Nos. 42 and 39, especially in conjunction with the causeway post holes.

Further Evidence

Detailed study of all known and accepted Stonehenge moon alignments draws attention to one particular feature. Whilst there are many post and stone holes that can be attributed to winter moon investigation, there is none that seem to be concerned with summer moonset. Also, up to the present time only one appears to be directly connected with summer moonrise.

Reference to the Causeway post holes has been made, which in my opinion provide sufficient reason to believe that the line of the most northerly moonrise had been established. There are also alignments of winter moonrise near the minor extreme, but they are not so well defined. The method of setting out the Aubrey holes on winter moonset as previously described could equally well apply to the conditions of winter moonrise, but in my opinion a combination of the two is preferable.

The Method

Fig. 3 shows the Aubrey circle correctly orientated in relation to true north and other Stonehenge features. My suggested method by which the holes were positioned is as follows:

Assuming they were well familiar with the winter moon alignments as already stated, but less so with summer moon alignments, and desired to erect a more efficient and permanent device to assist

them to further their lunar investigations, then a circle of sighting posts would be one of the simplest means of doing so.

First mark out a suitable size circle radiating from the centre of the enclosure. Then place temporary markers at the positions of holes Nos. 39, 42, 55 and 2, thus marking the four important moon alignments of winter moon setting and rising. These are clearly marked in Fig. 3. The sector to the N.W. marks the limits of the full winter moon settings and will be about 19.3°. Similar conditions apply to the sector to the N.E. in respect of the rising moons.

In all probability, judging by their apparent flair for incorporating in their designs regular angles and division of them, a marker could be placed at 90° to one another of the moon lines. Suppose their next marker was placed at 56 hole position *i.e.* 90° to the 42 to centre line; extending these lines across the circle diameter they would give a position of holes 14 and 28 and possibly stone hole 'B', which is twice the distance of their 'moonswing' measure from hole 56 or five times from the centre of the Aubrey circle.

If they had not been fully aware of exact summer moon alignments it would be excusable for them to believe that similar uniform conditions of winter moon would also apply to summer moon.

Unless human nature has greatly changed since that time, their enthusiasm would provide the desire to complete the project as far as possible pending the opportunity to confirm summer moon alignments. Meanwhile the holes would be dug in preparation and since at least nine years would elapse before they found that the summer moon lines failed to conform with the regular pattern of holes, it could be indicative of the time the holes remained open and the abandoment of the project. They had not realised their failure was due to the relatively short distance between the earth and moon as compared with the sun. How could they?

Objection to the 'alignment posts' theory may be raised on account of inexactitude of the holes themselves; the holes had vertical sides and were flat at the base. Speaking as a practical engineer given the task of erecting 56 equally spaced posts along a circle some 285ft. in diameter with crude equipment, I am sure that the man in charge of the operation would regard the original layout of the Aubrey holes with complete satisfaction as the necessary prelude for the purpose. Their size and shape would allow for posts to be manoeuvred into the

From seven feet beyond Slaughter Stone tip, along Axis line towards Heelstone

correct positions before securing. Obviously slight inroad to one of two holes would be necessary, but the extra work involved would be very small indeed. We cannot be certain if the size of the holes was indicative of post dimensions. Presumably they were large enough to accommodate the person whilst digging the hole.

Trilithon formed of stones 53 and 54 looking NNE

The Three Car Park Post Holes

In 1966 extensions to the Stonehenge car park took place. During these operations three disturbances were found in the chalk rock immediately below ground surface. These proved to be large post holes and their positions are now indicated by three concrete circles set in the return carriageway at the lower end of the car park.

The holes are 30 to 40ft. apart almost on a line running east to west. They are indentified on the Ministry plan No. S.249-67, as No. 1, Centre, and No. 2. No. 1 is to the west and No. 2 to the east of the middle or centre hole. Their distances and bearings from the Sarsen centre datum peg are also recorded. From this position none of the alignments first appeared to be of significance, but having in mind the possibility that they might have served as distance alignment markers when observed from other important positions, further investigation to this end proved amply justified. It appeared that all three holes were in line with important setting phenomena of sun and moon when observed from the four Stations and Heelstone positions. Site survey showed that had the holes contained the posts to align on the distant horizon, their height above ground level must have been in the region of 30ft. Obviously, posts of such dimensions at once implied the use of tall straight tree trunks. Confirmation of such was forthcoming when the contents of the holes were carefully examined by archaeologists Major H. F. W. L. and Mrs. Vatcher. They found signs of decayed bark rings of tree trunks some 2ft. 6in. in diameter and signs of wedges used as supports.

These post holes are unique for several important reasons. In my opinion they can be regarded as the most positive 'astronomical' discovery yet made at Stonehenge. Not only do they align on sun and moon setting positions with an extreme accuracy made possible by their considerable distance from the observation positions, but also the direction of alignments is positive and cannot be regarded as reversible. These two properties alone liquidate the main arguments concerning the Station alignments and open up an entirely new field for investigation. Here we have positive evidence that 'distant markers' were employed and also indications of the critical sighting points that were intended by the people concerned, which in turn demonstrate their remarkable ability.

Seen from:

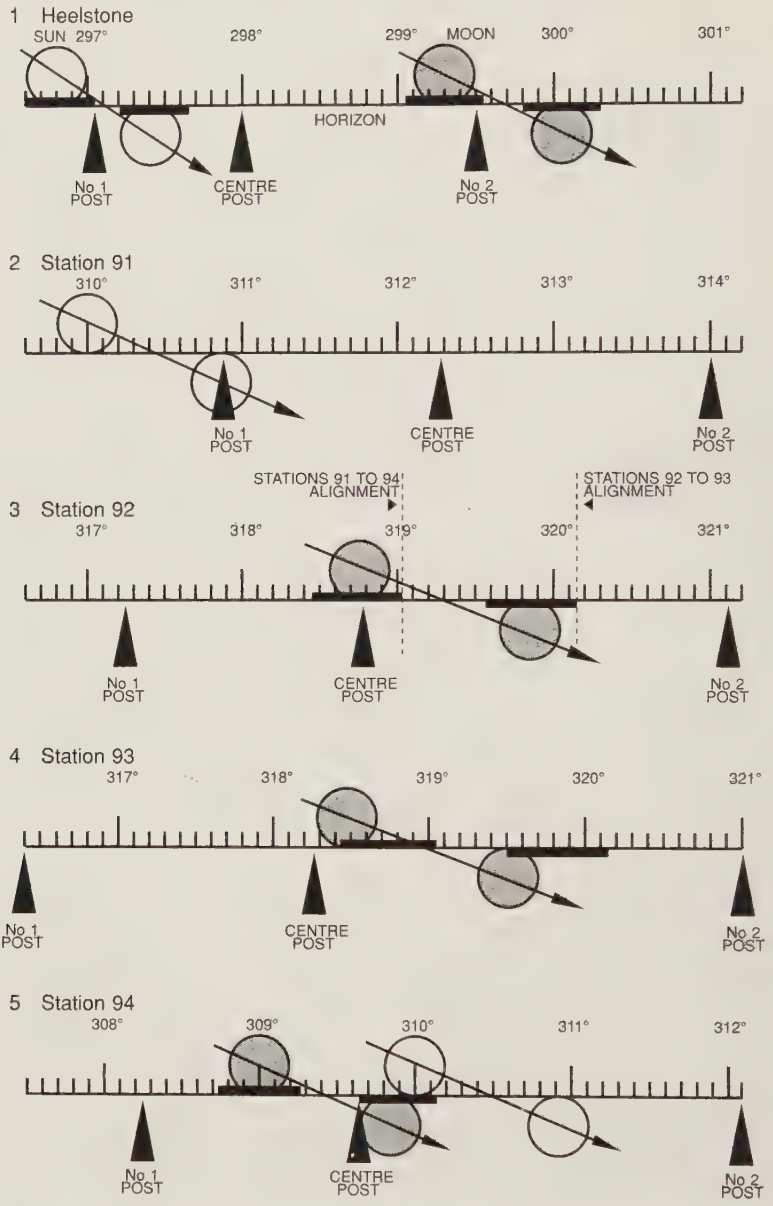


Fig 5. The three car park post hole alignments

The Car Park Post Holes Alignments Fig. 5

Showing five separate views of the north westerly horizon looking over the three car park post holes from the Heelstone and the four Station positions in relation to sun and moon setting alignments. The appropriate bearings of sun/moon phenomena and posts (holes) are given in degrees azimuth. The short broad lines on the horizon lines mark the limits in which setting phenomena could take place on occasions, due to oscillations of the moon and leap year considerations in respect of mid quarters sun alignments.

Description of Phenomena:

(1) Mid quarters sunset. decl. +16°;
Winter moonset decl. +18.76° (Minor position)

(2) Summer sunset decl. +23.92°

(3) Midwinter moonset decl. +29.03° (Major position)

(4) Midwinter moonset (Major position)

(5) Midwinter moonset at observed mean of extremes of (1) and (3).
Summer sunset.
Note: The centre post bears the same relation to sun and moon settings as does the Heelstone to the mean winter moonrise and summer solstice sunrise when seen from the centre of the Sarsen circle.

The full effect can be seen when observed by mirror reflection.

The Heelstone replaces the Post and the arrow direction should be regarded in reverse as depicted in Fig. 4 (top right).

Other Details of Alignments

Generally the use made of individual posts is as follows:

(a) Post hole No. 1 serves only as a solar alignment, *i.e.* last light of summer solstice sunset seen from Station (91), and mid-quarter sunsets seen from the Heelstone, which also happens to be the same as 91 to 93 alignment.

(b) Post hole No. 2 serves only as the marker for the moonset when

at the minor extreme of moon swing, seen from the Heelstone. The poles in both No.1 and No.2 holes would have to be shorter than the centre one to align on the horizon, owing to the distances and ground elevations of these two observation positions.

(c) The centre hole aligns on the extreme northerly or major moonset position when seen from 92 Station.

(d) Seen from '93' none of the holes appears to align exactly on sun or moon phenomena. However, the centre hole is less than a fifth of a degree short of the extreme major moon alignment at full orb.

(e) The centre hole seen from '94' also aligns on moonset when midway between the other two extremes. Its position is just short of the summer solstice sunset line, so that a pole so placed bears a similar relation to sun and moon settings as the Heelstone does to their risings when seen from the centre of the Sarsen circle.

It is possible that some of the Station positions were also used in connection with summer moonrise or winter sunrise as they would appear in the opposite direction or south easterly. More final assessment will be possible if and when post or stone holes are found in that direction. The possibility of such can be gathered from examination of the remarkable geometrical lay-out of the post holes in relation to other main features of Stonehenge. See Fig. 6, opposite.

NOTE: A fourth posthole has subsequently been discovered. At present it is hidden under the pay desk.

Geometrical Properties

Like so many other Megalithic sites in Britain, Stonehenge gives evidence of its builders' flair for incorporating geometrical designs into astronomical alignments. See figure 6. Here we find a remarkable combination of astronomical alignments, right angle triangles and measurements based on a standard unit of length. The unit of length applied in this particular case is the one referred to on page 30 as a 'Lunar Measure' or LM, where one LM is equivalent to 47.6ft. It is interesting to note the relationship between the LM and Professor Thom's Megalitic Yard, one MY being equivalent to 2.72ft. It may be nothing more than a coincidence that 1 LM = 17½ MY. However, attention is now drawn to Fig. 6.

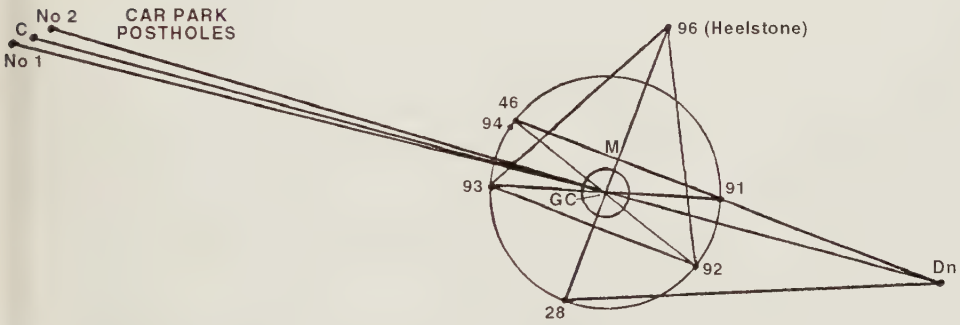


Fig. 6. The geometery of the 'Stations' in relation to the car park postholes

Symbols used:

'Dn' for 5ft. diameter depression (probable stone hole)

'GC' for geometrical centre 1.2ft. east of datum peg

'M' for mid point

'C' for centre hole in car park

Distances between main features:

1. Car park hole 'C' — 'GC' — 'Dn' are all in line.
   Total distance = 30½ LM

2.	C to GC	17½ LM
3.	GC to Dn	13 LM
4.	GC to No. 1 posthole	18 LM
5.	GC to No. 2 posthole	17 LM
6.	96 to Aubrey Hole 28	8½ LM
7.	M to 96 or 28	4¼ LM
8.	91 to 93	6 LM
9.	92 to 93	5½ LM
10.	91 to Aubrey Hole 46	5½ LM

11. Line 'Dn' to 46 is parallel to line 92-93 on 320.15° or Last Gleam of moonset (see Fig. 5 ex.3). This line also passes through 91 and intersects line 96-28 at 90° at 'M' (mid point) Angle 92-96-93 = 45°.

If temporary pegs had been placed at terminal positions in accordance with Fig. 6 design, then they would all fall within the circumference of the stone markers actually used with one exception, stone 94. Had the stone been positioned at Aubrey hole 46, then when seen from 91 there would be two alignments exactly on the last gleam of moonset, the other one being the 92-93 alignment. By placing 94 about 5ft. nearer towards 93, then the 91-94 aligned on the full orb of moonset.

Almost in all cases their marker stones were involved with more than one alignment that inevitably require some minor adjustment, *e.g.* 92 to 91 marks the first gleam of summer solstice sunrise or about full orb of winter solstice sunset taken in reverse direction. This requires placing 92 about 1ft. further away from 93 in order to establish the sun alignments without disturbing the forementioned 92 to 93 moon alignment.

Several other meaningful features with respect to their geometrical and astronomical properties are not shown in Fig. 6 in order to avoid possible confusion. If all be taken into consideration many other design patterns would be required, also an extended list of LM distances etc. As one studies this extraordinary alignment combination, one cannot help but notice the ingenuity of the people concerned, the progressive improvement of their alignment techniques, made

From the position of Station Stone No. 92 looking over the fallen No. 91, with the Heelstone in the left background

possible by the practical experience of former generations, much of which was gained by 'trial and error' expedient.

It may be argued that the symmetrical arrangement of the Station etc., was the natural outcome of astronomical alignments themselves or inherent in principle due to the latitude of Stonehenge. However, the evidence indicates a gradual 'build up' of knowledge throughout many generations, rather than conformity to a preconceived idea of early date. This does not entirely invalidate the idea that the choice of the site with its 90° implication was intentional. As each scrap of new evidence comes to light its implications can be far-reaching in solving problems which at the moment have possible alternatives.

Before concluding this account related to the car park postholes attention is again drawn to Fig. 6 which concerns the 'Dn' position situated in the outfield to the southeast, which deserves special mention.

Archaeologist R. S. Newall, F.S.A., has devoted many years to the study of Stonehenge, and has contributed a great deal towards that which is known today. It was at his suggestion the re-discovery of the Aubrey Holes came about, to quote only one example. He has the remarkable, indeed uncanny, knack of pointing to the direction in which valuable information may be found. I am most grateful to Mr. Newall for his guidance in this respect and also for his kindly encouragement and advice that has made my own research possible.

Shortly after the discovery of the car park postholes, Mr. Newall showed me an artist's engraving of Stonehenge of about 1700 A.D. or earlier. The drawing depicted two upright stones (similar to the Heelstone) situated in field towards the southeast. Whether or not these stones ever existed is open to question. They certainly were not there some 50 years later. A rough estimate of their position was made which coincided with a shallow depression clearly outlined on a photograph taken from the air.

This feature is shown in Fig. 6 (as 'Dn') because of its remarkable geometrical significance. Details are listed below fig. 6. It may be nothing more than a 'red herring' and the six 'geometrical pointers' to its apparent significance merely coincidental. Such a state of affairs would be remarkable without taking into account the existence of two astronomical alignments that are also involved.

A marker at the 'Dn' position seen from 93 marks the mid point

between the full orbs of winter sunrise and summer full moonrise, similar to the two examples already mentioned. The line from Aubrey 28 to 'Dn' is also directed to the point of summer moonrise when at Minor extreme. Doubtless, archaeological investigation of the 'depression' will provide the answer. This again emphasises the great importance of the work and skill carried out by archaeologists.

The Astronomical Implications of the Sarsen Structure

Apart from its axial direction that seems purposeful, there does not appear to be any other crucial alignment of astronomical significance that is acceptable. Any part of the horizon can be seen through one opening or another between the stones provided the observer moves position. Lacking any evidence to denote the exact stance position from which observations could be made, is reasonable grounds to disregard the idea of alignment technique. One guess is as good as another. There are reasons to believe that the positions of the stones, their height and numbers had some meaning. Many regarded the structure as being architectural and not mechanical and mainly used for ritualistic purposes not intellectual, also it was orientated on the sun with symbolic intent.

However, it seems the strong lunar influence with which Stonehenge must now be associated necessitates revision of hitherto accepted explanations of some salient features. Until new evidence is found pointing to the contrary, it may be more logical to conclude:

(a) That the small stone (No. 11) in the Sarsen circle was intentional, and that the circle represented the 29.5 days of the lunar month.

(b) The double circle or spiral of the 'Y' and 'Z' holes represented the 59 days of two lunar months. The strong possibility that there were fifty-nine blue stones inside the Sarsen circle would provide a more suitable means of representing the same thing.

(c) Either the 19 year phase cycle or the 18.61 year nodal cycle

was represented by the 19 blue stones inside the trilithon 'horeshoe'.

Such an arrangement would serve as an enduring calendar. By moving a staff or indicator one stone each day along the outer circle, (counting No. 11 as half a day) the person in charge could keep tally with the lunar months. He would always know the number of days since the last full moon or the days before the next one was due. The same principle would apply to the other units of 59 holes or stones. The 19 stone 'horseshoe' would serve as a yearly device, indicating the direction of the mid winter full moonrise and the year it would appear over or near the Heelstone. Such a position could be indicative of possible eclipses and whilst there is no positive evidence of their success in this connection, there are indications that they attempted to define eclipse periods. This suggestion is prompted by considering the position of three or four postholes in the Causeway in conjunction with others situated near Station stone 92. The principle of using movable indicators as outlined above would require resetting of their indicators on occasions. Their solar alignments would serve as a suitable datum of this purpose.

Possibly their astronomical activities would be inter-woven with their religious ritual, whatever it may have been (perhaps some form of fertility cult involving the Sun (male) and Moon (female)). However, it has been shown that throughout the three periods of the Monument's development lunar consideration played a major part.

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