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THE GEOMETRY OF MEGALITHIC MAN

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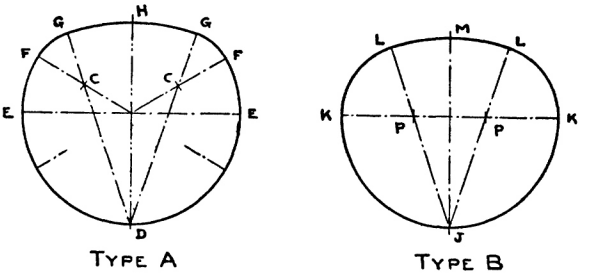
From one end of Britain to the other Megalithic Man has left us examples of geometric constructions of various designs. Originally set out on the ground by means of stakes, rope and measuring rods, the designs were rendered permanent by large stones placed along the outlines. The erection of the larger of these stones was an enormous task. It is certain that the engineers controlling the operations were working to pre-conceived plans which were set out with care and accuracy. Further, it appears that the unit of length used was the same from Land's End to John o' Groats. That this unit was 5·44 ft. I have shown in Ref. 1, and many more sites surveyed since writing that paper have amply confirmed statistically this value. Half of this, 2·72 ft., might be called the Megalithic Yard, but whether this or the Megalithic Fathom (5·44 ft.) was the length of the standard rod carried about the country it is not possible to say. The important thing is that in a statistically significant number of cases in any group of circles the major diameter is approximately an integral number of fathoms. The group can be formed according to locality, type of circle, or size; the result is the same. We also find this dimension occurring in the distances of outliers from the construction centre and the distances between circles where there are two close together. The method of analysis used was that given by Broadbent in Ref. 5.

Of the 160 circles of which I have made accurate surveys the majority are circular but 35 are definitely flattened at one side. This flattening was evidently intentional and it is proposed to show that it was always done to a geometrical pattern. Two types of pattern appear, type A and type B (Fig. 1). These were probably set out with rope and stakes. We can set a stake at the centre and


H
G
G
F
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C
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D
TYPE A
L
M
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J
TYPE B

FIG. 1

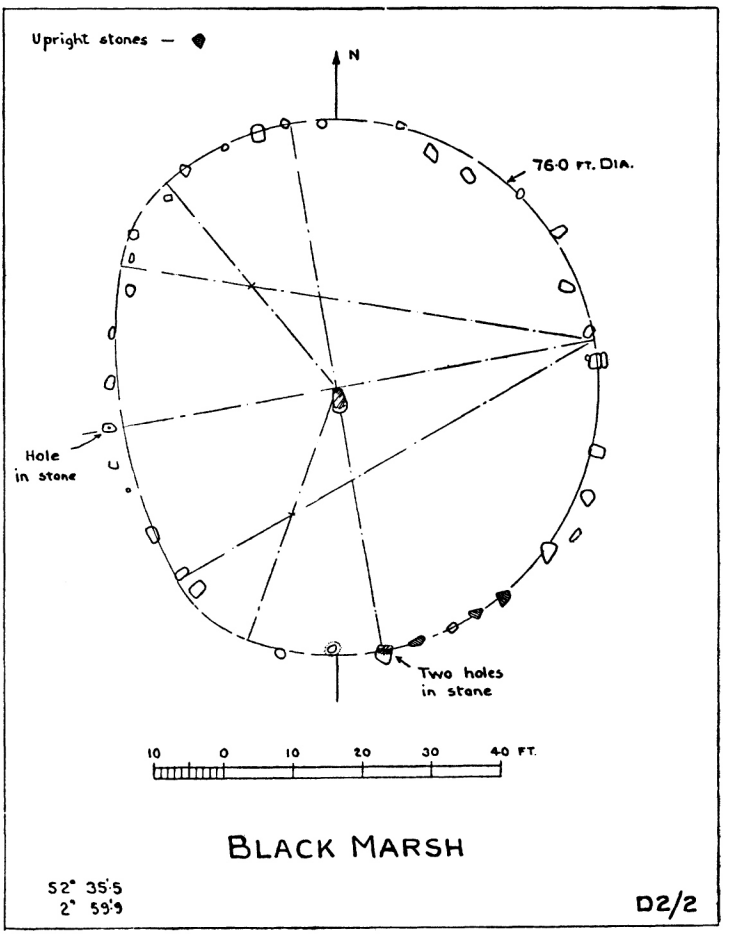
Upright stones —
N
76·0 FT. DIA.
Hole
in stone
Two holes
in stone
10 0 10 20 30 40 FT.
BLACK MARSH
52° 35·5
2° 59·9
D2/2

FIG. 3

scribe a circle round it with a length of rope and a second stake. Evidently the constructors used the property of the chord equal to the radius going round the circle six times. In both type A and type B the circular part of the construction is a multiple of 60°, in type A, 240°, and in type B, 180°. The rope used for scribing could be folded so as to bisect or trisect its length. In type A the radius was thus bisected at the point C and the short arc FG drawn in. With centre D the arc GG could now be drawn to complete the periphery. Type B is simpler: the diameter is divided into three equal parts and the points of sub-division P and P used for the minor arcs. The periphery is then closed as before with an arc centred at J on the far side.

It will be seen that both the above constructions can be carried

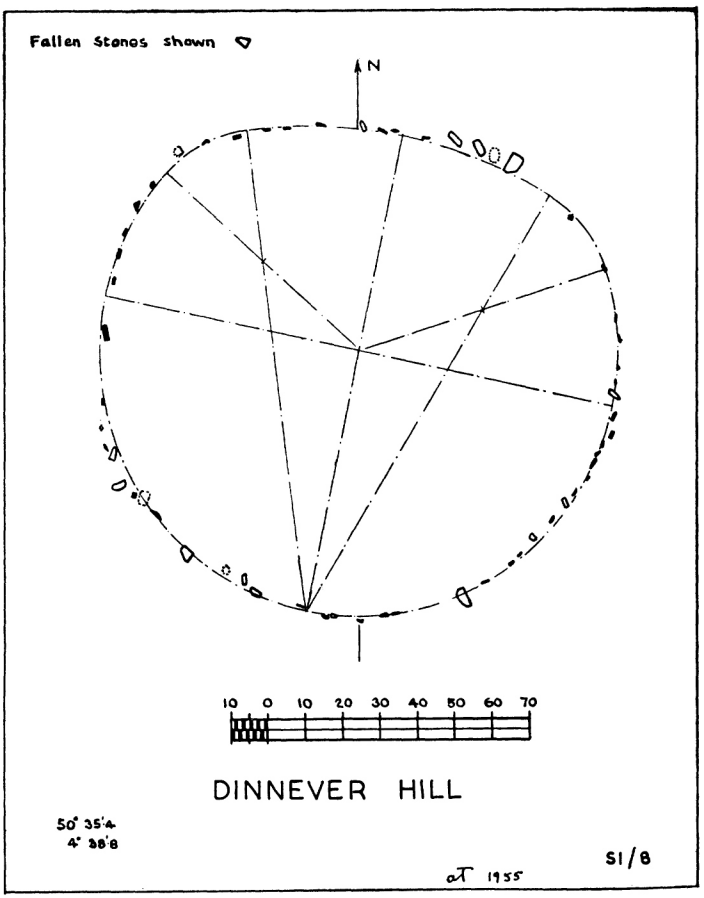

FIG. 2

out on the ground but it is interesting that the constructors realised the necessity of making the arcs of different radius meet on the line joining the centres. In Ref. 1 it is shown that in some cases the points where the radius changes are marked by stones as are the principal axes. At Castle Rigg near Keswick (Ref. 1) we find not only the 60° points marked by stones but also five of the intermediate 30° points as well as changes of radius, etc.

A good example of a type A circle is found at Dinnever Hill in Cornwall. It will be seen in Fig. 2 that the stones are mostly small which for our purpose has the obvious advantage of defining the outline more exactly than would have been the case with very large stones. Further examples of type A are shown in Figs. 3 and 6 Fig. 4 shows an example of Type B. It should be explained that in each case the surveys shown were plotted to a large scale. The geometrical construction was then plotted on tracing paper and

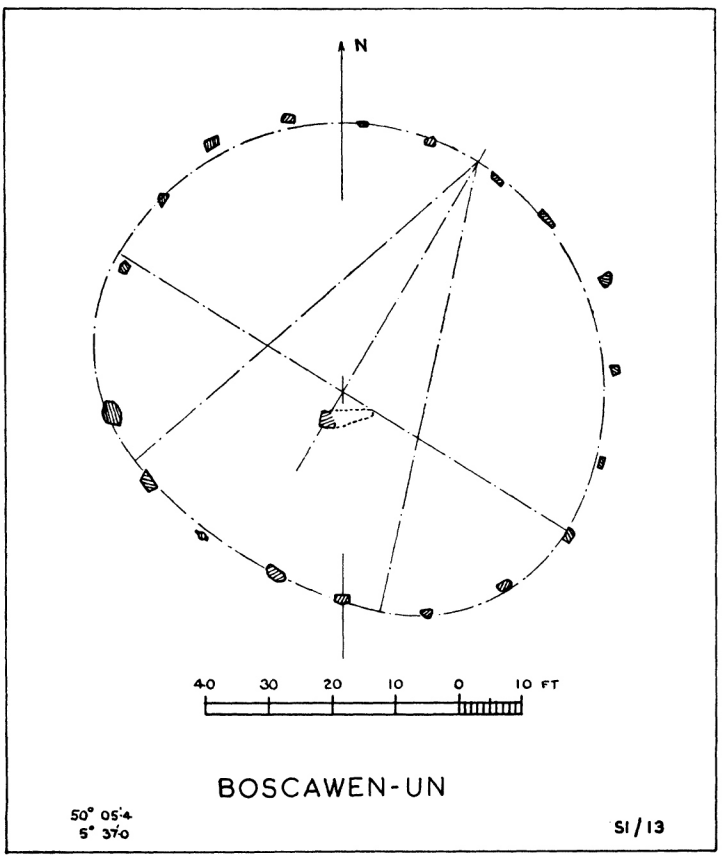

FIG. 4

moved about until the best position was found. The survey was then reduced by a precision pantograph for reproduction. Stones which are still definitely upright are shown hatched or shaded. Stones which are doubtful or fallen are shown in outline.

It is interesting to note that at Black Marsh in Shropshire (Fig. 3) the stone at one end of each axis is specially marked by having circular holes about $1\frac{1}{2}$ inches diameter and 3 to 4 inches deep. This circle also illustrates a universal characteristic of circles with a centre stone. The stone is never exactly on the geometric centre. Presumably during erection and perhaps for long after a pole stood here to which the rope used for setting out was attached. The stone was usually placed close to or touching the pole.

A very interesting circle which belongs to neither type is found at Rough Tor in Cornwall (Fig. 5). It is similar to type A but the

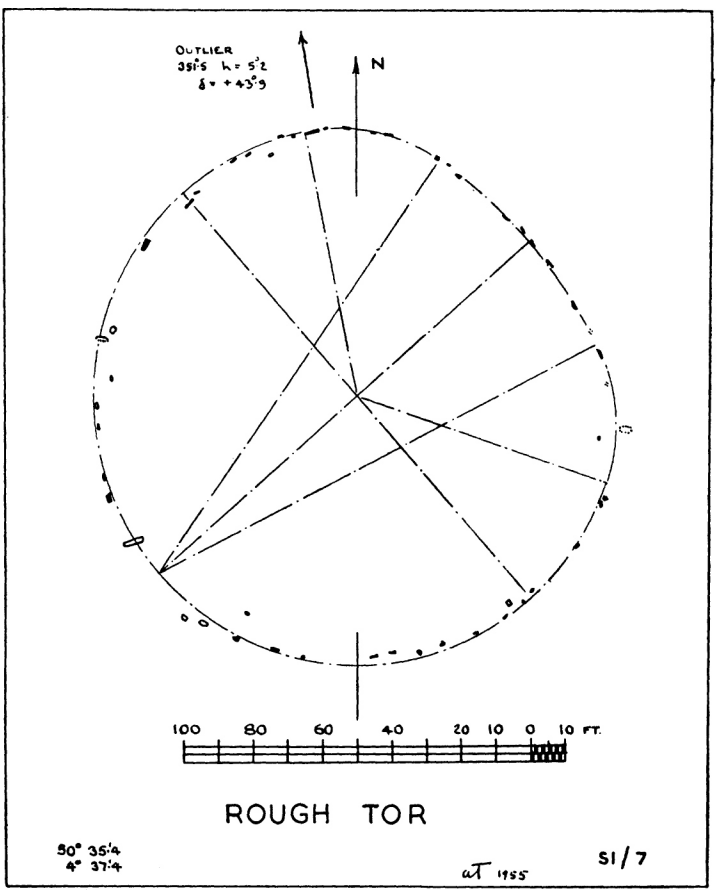

FIG. 5

radius of the small arcs is one-third of the principal diameter (as in type B) instead of one-quarter. Here again it is fortunate that the stones are small, allowing us to be quite certain as to the geometric shape. It is possible that the circle at Seascale in Cumberland belongs to this type, but no other good example is known to me.

Perhaps the most important site in Britain, and certainly the most interesting, is that at Callanish in the island of Lewis. A good survey has been twice published by Sommerville, Ref. 2 and 3, but a redetermination of the orientation shows that his azimuths should be increased by 0° 35′. Fig. 6 is taken from the inner part

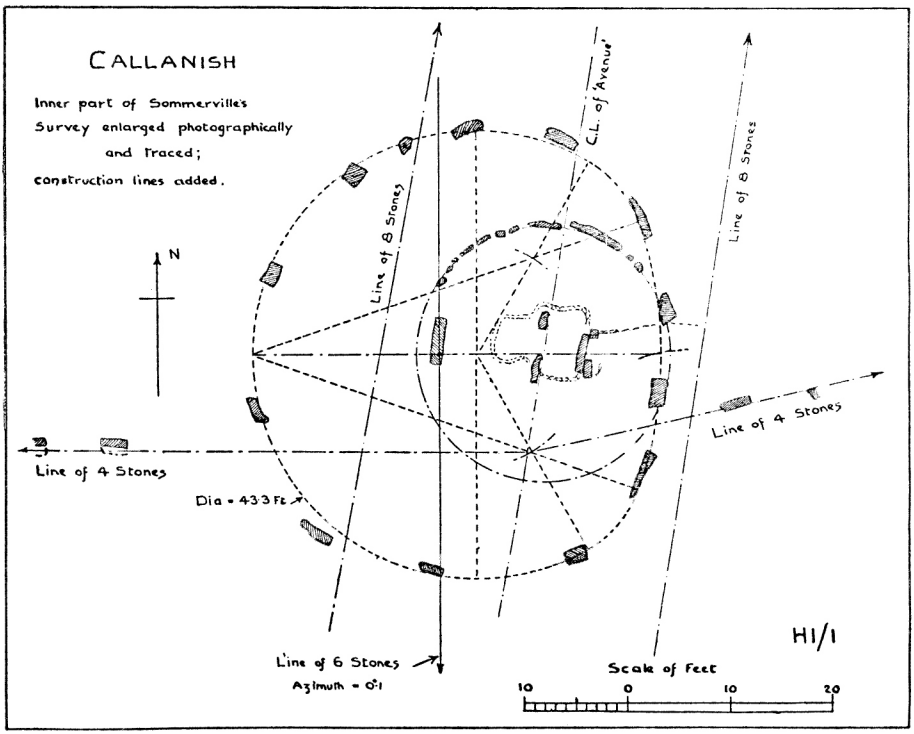

FIG. 6

of Sommerville's survey with the necessary construction lines added to show that the main circle belongs to type A with axis exactly East/West and is not just a careless attempt at setting out a true circle, as was supposed by Sommerville. It will be seen that the West line of four stones, the East line of four stones, and the centre line of the two rows of stones forming the avenue meet almost exactly at one of the auxiliary centres. It thus appears that in

some cases the constructors attached a special significance to the auxiliary centre, but in others the main centre appears to have been the important point. To give one example, at Long Meg and Her Daughters in Cumberland (type B, Ref. 1) the 12 ft. high outlier (Long Meg) *as viewed from the main construction centre* gives a declination on the horizon of 24°·2 S which was the declination of the lower limb of the mid-winter sun circ. 2000 B.C. (Ref. 4).

The megalithic fathom appears in the circle diameters, in the distance to outliers, and in the distance between circles where two are close together. Evidently it cannot also appear in the circumference and it is interesting to speculate if this was the reason for flattening the circles. Were the builders attempting to make a circle with π exactly 3? The ratio of periphery to diameter is 3·059 for type A and 2·957 for type B. The number 3 may have had a special significance; it is still considered a lucky number. In type B the diameter is divided into 3 equal parts and the interesting fact emerges that in type A the cross diameter is also divided into 3 nearly equal parts, the two outer parts being $0{\cdot}327D$ and the centre part $0{\cdot}345D$. The constructors could hardly have failed to notice this, and the consequent equality of the angle subtended

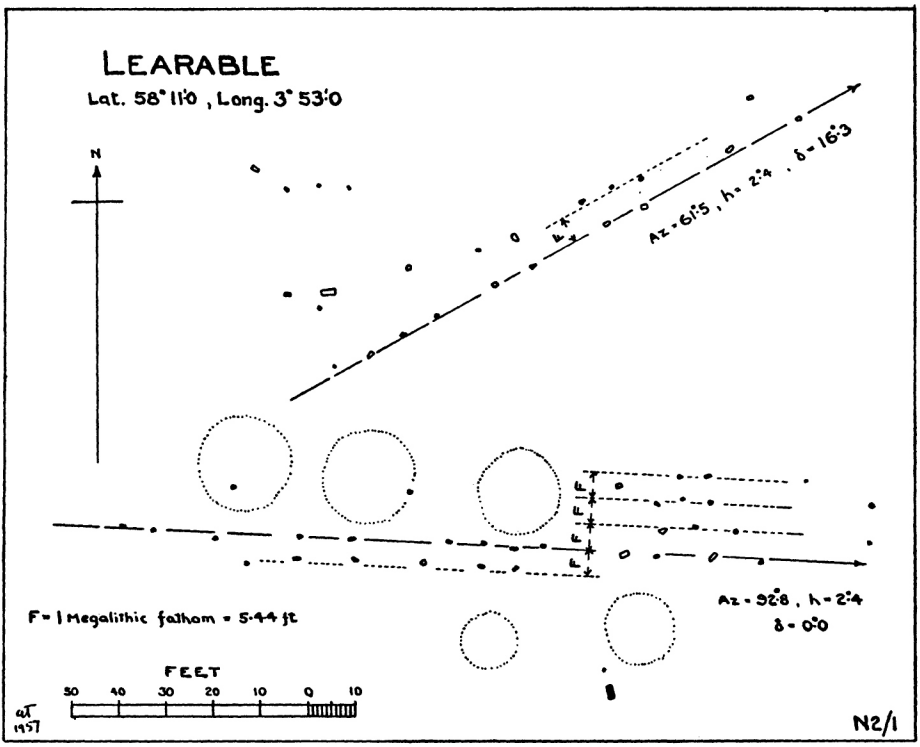

FIG. 7

by the long radius arc in the two types A and B. Thus in type A angle GDG is 38°·2 and in type B the angle LJL is 36°·9. It is not intended in this paper to describe the egg-shaped circles found in one or two localities. These again give evidence of careful setting out with circular arcs, and again the fathom appears.

Instead, it is now proposed to look at a totally different type of construction found in the Caithness and Sutherland alignments. On the high plateau on Learable Hill above Suisgill in Sutherland there are several lines of stones, some of which appear to be parallel. An accurate survey immediately reveals their purpose. In Fig. 7 we see that they fall into two groups, lines running at an azimuth of 92°·8 and lines running at 61°·5. The far off mountain horizon has at these azimuths heights of 2°·4 in both cases and this, with the azimuths, gives declinations of 0°·0 and +16°·3. The alignments thus indicate the rising points of the sun at the equinox and on a day half-way between the equinox and the solstice, sometimes called May Day. Other examples are given in Ref. 4 together with an assessment of the values of the declination (0°·6 and 16°·9) to be expected by an examination of the earth's orbit at 2000 B.C.

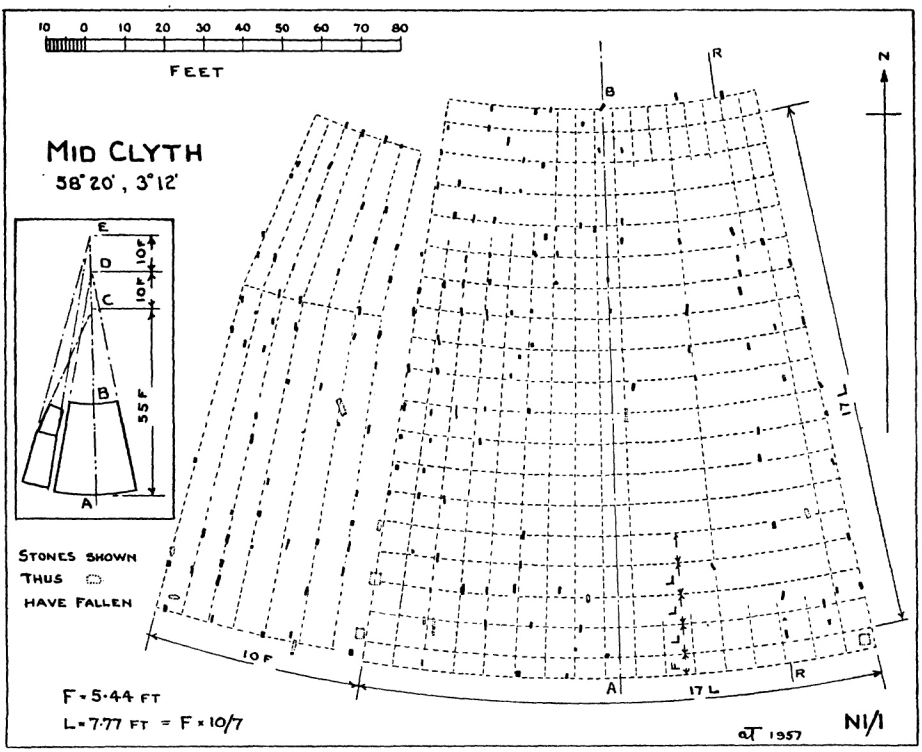

FIG. 8

At Mid Clyth there is another set of alignments of a totally different character. An accurate survey was made to a large scale and carefully studied. A reduced scale reproduction is shown in Fig. 8. This shows that the layout consists of radiating rows of stones. On a large scale plan a mean line was drawn through each row. Co-ordinates of points on these lines were then *calculated* in the neighbourhood of the intersection points so that the intersections could be plotted. It was thus found that there were three main centres, each lying on the axis of symmetry. The majority of the lines in the larger symmetrical part of the figure radiate from D (see inset diagram) but one marked RR seems to belong to the point E, which is the centre for the southerly part of the " annex " to the west. After making many assumptions regarding the arcs running across the figure, it was found that a possible construction of the main figure was as follows. Draw an arc through A with radius 65 megalithic fathoms, i.e. $65 \times 5{\cdot}44$ ft. Divide this into 17 parts ($8\frac{1}{2}$ on each side of A) each 7·77 ft. These points fix the radiating lines. The arcs themselves are at the same spacing with the exception of the top and bottom spaces which are each 1 fathom. Thus, starting from A, along the axis of symmetry set out 1 fathom followed by 17 lengths of 7·77 ft., and finish at B with 1 fathom. The arcs drawn through these points actually intersect half of the stones in the area, and have near misses for many others. No other construction I have been able to devise scores so many successes.

Setting out this construction on the ground must have been a very difficult operation, and one calling for considerable surveying skill. The inevitable elasticity of a rope several hundred feet long must have complicated an operation already made formidable by the fact that the whole site slopes up at an angle of about 4° from A to B, and thereafter the ground almost immediately begins to fall. Thus, the centres C, D and E are not visible from anywhere but the very top of the main figure, unless indeed a portable tower was used.

A later examination of the ground showed one or two stones to the east, almost certainly the remains of an " annex " like that to the west. The other stones were probably too close to the nearby road to be left undisturbed.

It is to be noted that the axis of symmetry AB lies within 1·5° of the meridian. Many other sites contain indications of a North/South line and in some cases the accuracy attained is remarkable. For example the correction to Sommerville's survey of Callanish mentioned earlier, makes the S line of megaliths lie within 0°·1 of the meridian (Fig. 6).

It is not at all clear how this orientation was obtained. On an extensive plain, bisecting the angle between observed positions of the rising and setting points of a star provides a simple method,

but in mountainous country considerable errors would arise. A shadow technique presupposes a horizontal surface and so can be ignored. At the time of the construction of these sites the pole star was nowhere near the pole, but circumpolar stars were available. To use a circumpolar star we can imagine a long plumb line from the top of a pole forming the foresight. At each elongation of the star a stake could be used to mark the backsight. We thus obtain two radiating lines at equal angles on either side of the meridian. It is possible that the figure so obtained *suggested* the construction at Mid Clyth.

It may also be noticed that the radiating lines can be used as a sundial near to apparent noon; the intervals between the lines vary from 3 minutes at midsummer to $5\frac{1}{2}$ minutes at midwinter.

Enough has been said to show the importance of obtaining really accurate large scale surveys of all the sites in Britain before the tractor and the bulldozer have reduced their number. I have come across several examples which have been recently damaged and the demand to make more use of marginal land will inevitably accelerate the disappearance of the smaller and unscheduled sites. Sometimes a site which appears to be merely a few random boulders shows up quite differently on being surveyed.

In many cases the stones are buried under several feet of peat; in others only the buried stumps remain. A potent destructive force is the growth of trees on the site. In Aberdeenshire I have seen a large standing stone which had been lifted bodily out of the ground by a tree uprooted in the 1953 gales and I have seen a standing stone almost enclosed in the trunk of a tree. Is it any wonder that slight distortions occur in outlines which have survived over three thousand years? Earth movements also take place due to creep and frost. Such movement is apparent in the slight bend which can be seen in several lines in Fig. 8.

If we are to find out more about these constructions no site can be dismissed as unimportant and all should be surveyed. Although I have made plans of some four hundred sites, this is only a beginning. Digging must also be undertaken where some of the stones are buried. High class accurate surveys must be made and published on a reasonably large scale, and these should be brought together so that they are available for detailed statistical examination.

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GLEANINGS FAR AND NEAR

1958. Next he should acquaint the youth with mathematicks; and to invite to it, he sould begin quickly to show him some of the more pleasant mechanical performances in mathematicks. That which is necessarily to be known to one that would study these sciences is Euclid's Elements, at least his first six books, arithmetick and trigonometry; and without one's understanding these, one may be a mechanist, but a mathematician shall he never be. For stereometry, algebra and conic sections, they require more subtlety and patience, than is to be expected from youth, neither are they of such use. . . . If the youth have a delight in problemes and theoremes, and be of ane active fancy, it will be good to hook him as much as can be to them; for this is by wise men judged a good advice for preserving a state quiet, to engage the young nobility who have active spirits, to mathematical sciences, which carrying their thoughts after them, will preserve them from ambition, and meddling with the state. But in this moderation is to be observed, lest their brains be too much stretched with these curiosities.—Gilbert Burnet, *Thoughts on Education* (written 1668, published 1761). [Per Mr. J. W. Ashley Smith.]

1959. On the opposite wall he could see the six-inch map of the Chaddesbourne estate, its irregular equilateral triangle outlined with a wash of red water-colour. That shape, which he had always considered as permanent and immutable as the triangular outline of England itself, no longer represented the geographical truth. The equilateral triangle had become an isosceles.—F. B. Young, *This Little World.* [Per Mr. B. J. Barnes.]

1960. They were taken to hospital and allowed home after being %-rayed and treated for cuts and bruises.—*Daily Telegraph and Morning 1 ost*, Thursday, June 26, 1958. [Per Mr. T. Knape Smith.]