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THE KERMARIO ALIGNMENTS

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In 1972 and 1973 we made two further expeditions to Carnac.[1] Much new and useful information was obtained, but the most important task which we completed was a survey of the Kermario alignments from end to end, to a scale of 1:500. In 1973 the survey was checked on the ground and carried further east into the woods where we found a number of fallen stones, and still further on we found an upright six-foot menhir *E* (see Figure 1) which probably belongs to the alignments. This is on the field boundary just before the high ground in the wood where there may have been a cromlech. In 1972 much of the ground was covered by thick gorse which made accurate surveying difficult, but the whole site is almost completely cleared now. The fact that two open traverses run from end to end agreed to within a few inches in length and azimuth, gives us complete confidence in the backbone on which our survey is based. The survey sheet is about 8 ft long and so a reproduction cannot be given here, but an accurate small scale copy with our geometrical interpretation is shown in Figure 1 and larger details of parts will be found in Figures 2, 3 and 4. A key plan is shown in Figure 5, divided into seven sections so that each section can be analysed and discussed separately.

It will be seen that the main part of the alignments consists of seven rows that run certainly as far as the pond now filling the Ravin de Kerloquet. To the south of these there are various other lines, but discussion of these will have to wait till later in the paper. At the west end it is seen that the rows are curved to a radius of about 1,000 Megalithic rods. Throughout Sections 1, 2 and 3 the rows are parallel and spaced 12 Megalithic yards (my) apart (1 rod = $2\frac{1}{2}$ my). It will be remembered[2] that at Le Menec the angle of the bend at the knee in the middle of the rows was decided by the juxtaposition of two almost exact Pythagorean triangles. In Kermario there are three such bends each based again on coupled right-angled triangles. The geometry is shown in insets (a), (b) and (c) on Figure 1. The first bend (a) is produced by two right-angled triangles, one with sides 12 and 21 and the other 10 and 22. Now $12^2 + 21^2 = 585$ and $10^2 + 22^2 = 584$, which shows how accurately these two triangles will fit together on the common hypotenuse. The emerging rows have been turned through $+5°20'$ and at the same time the spacing is reduced from 12my to 10my. The second bend (b) is effected in the same way but here the sum of the squares is 884 for the one triangle and $884\frac{1}{2}$ for the other. The row spacing is reduced from 10 to $8\frac{1}{2}$ and Rows II to VII emerge at $+2°17'$ to the original direction. The next bend (c) is effected by two triangles which are not quite so exact, the sum of the squares being $128\frac{1}{2}$ and 128. These triangles have the effect of reducing the spacing from $8\frac{1}{2}$ to 8 and bending the rows so that the final angle to the original direction is only $-(1°20')$. Due to the slight inexactitude of the various triangles, slightly different theoretical values are possible for the calculated angles, but the permissible range is small and the final direction of the rows on the ground is only a few minutes different from the theoretical value.

It will be seen at the east end that, almost certainly, there are remains of two

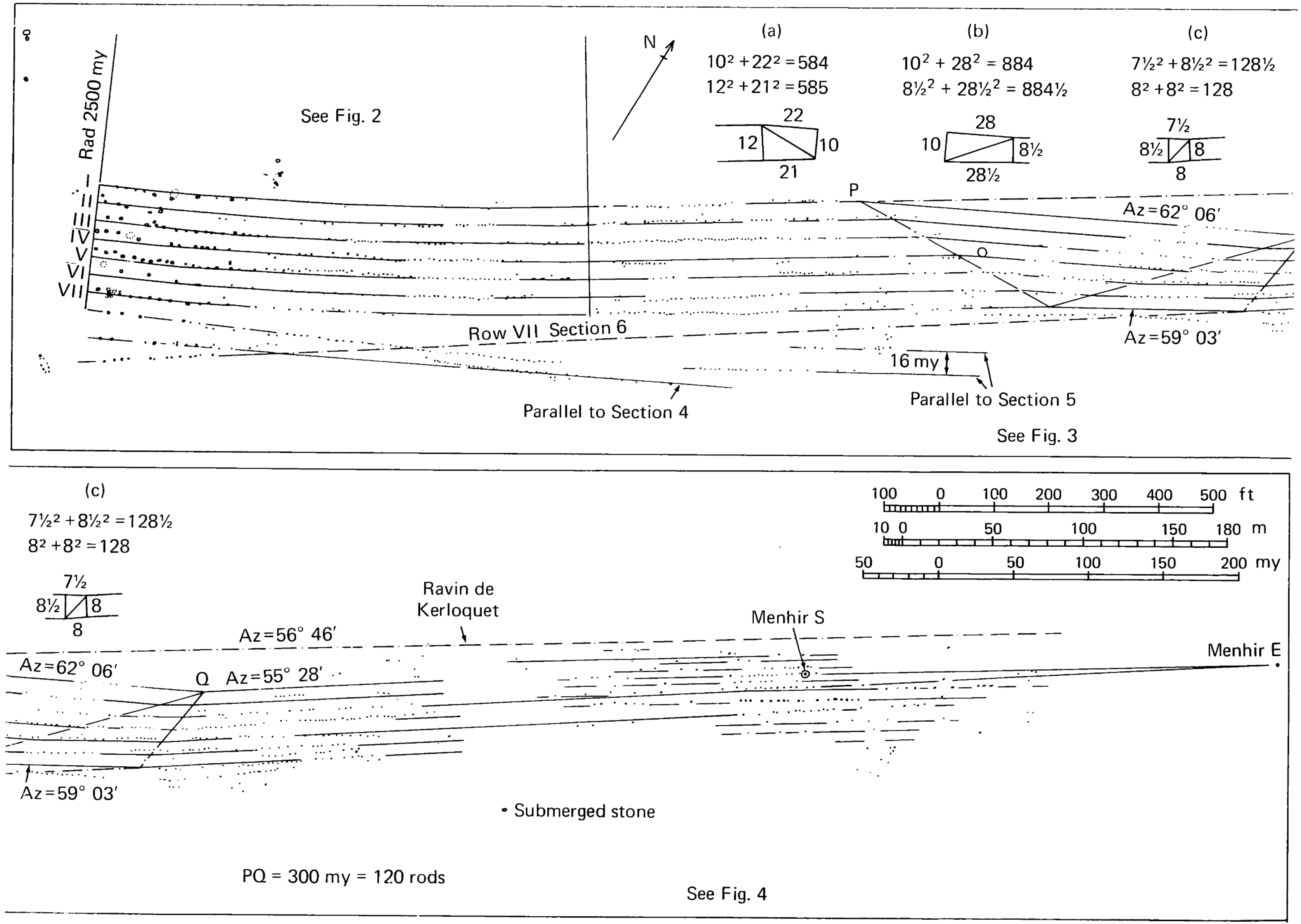

FIG. 1. The Kermario alignments.

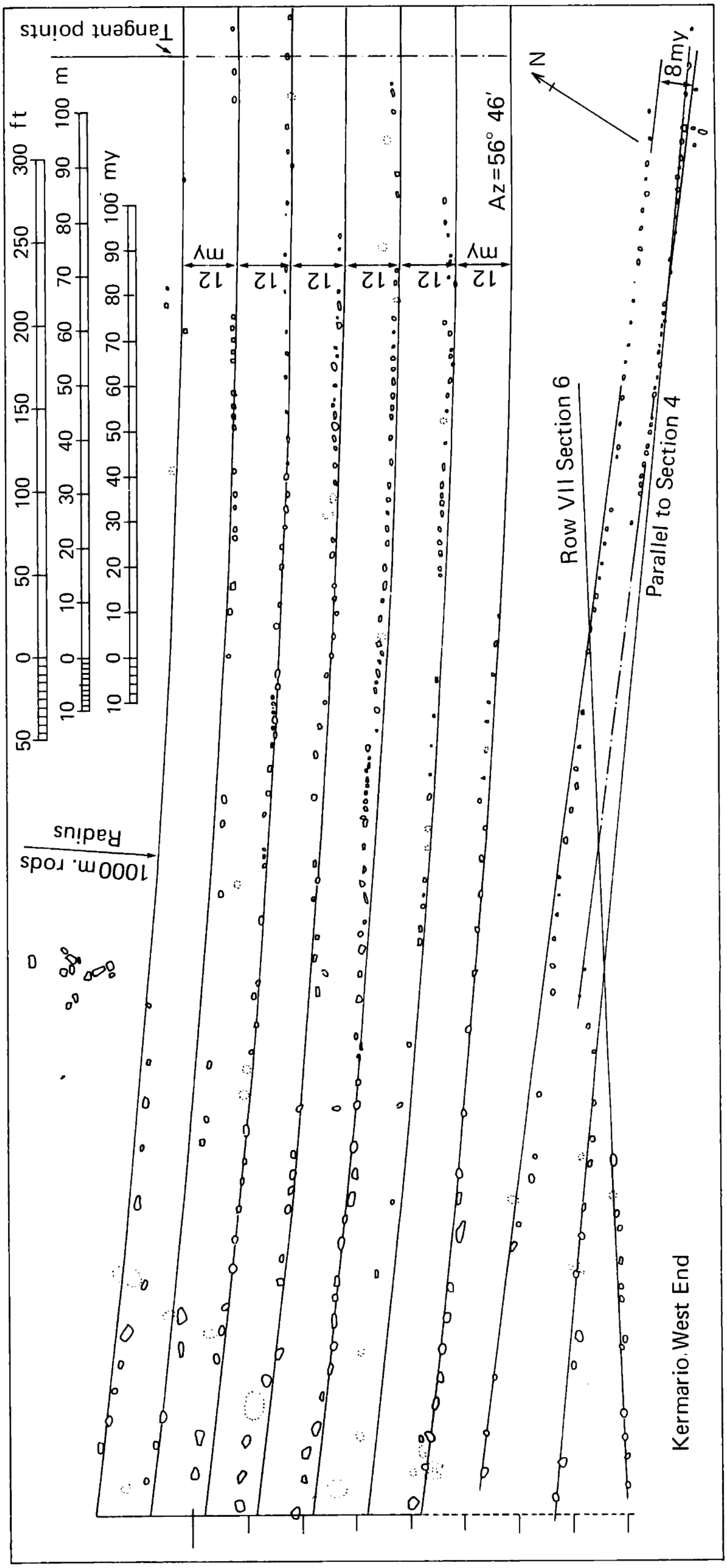

FIG. 2. Kermario, stones at west end. Superimposed are arcs, all of 1000 Megalithic rods (2500 my) radius. These arcs form extensions of the parallel rows at 12 my spacing that run from the tangent points eastwards, all at an azimuth of 56° 46′.

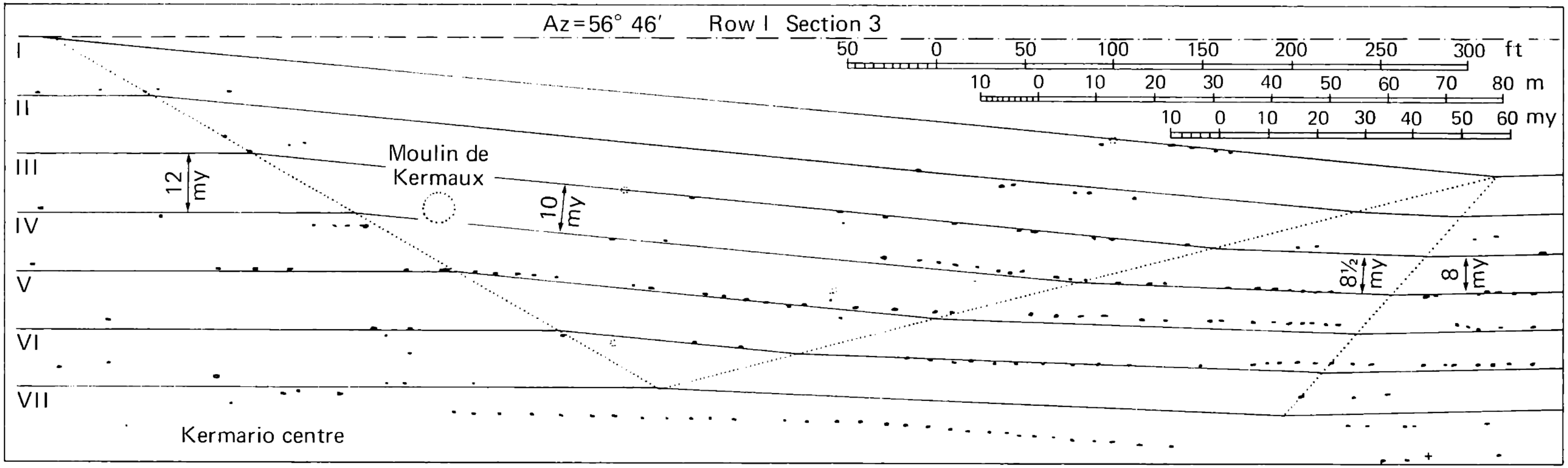

FIG. 3. Kermario, central portion of rows. Compare with the triangles shown in Figure 1 and note that in Section 4 the spacing falls from 12 my to 10, then in Section 5 to 8½, and finally in Section 6 to 8 my.

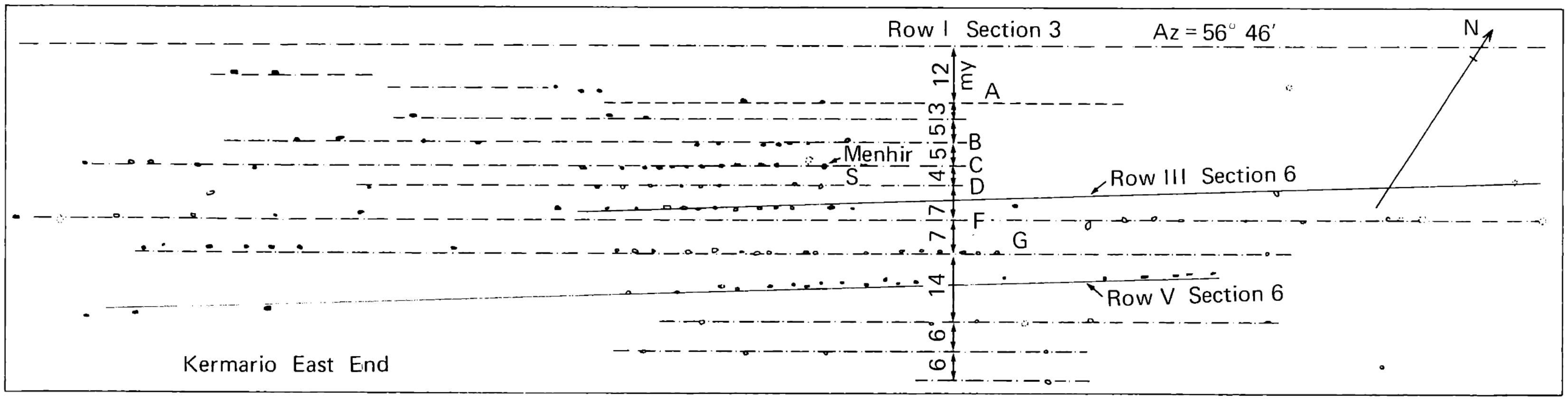

FIG. 4. Kermario, stones at east end. Note that here two systems seem to be superimposed. Two, or perhaps more, rows come through from Section 6 and the others are parallel to Section 3.

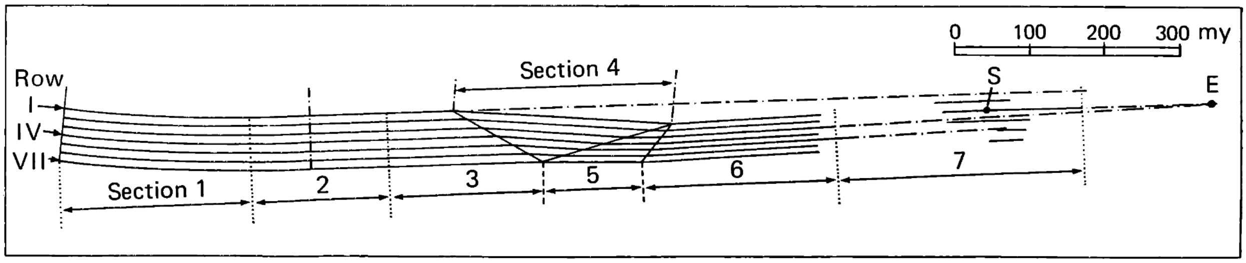

FIG. 5. Kermario: key plan showing sections for analysis.

different systems. Indeed, it seems probable that the original erectors were making some alterations here or substituting one system for another. At the end of Section 6 the alignments come to the Ravin de Kerloquet. This has now been artificially flooded and it may well be that there are stones under the water. We did in fact survey one which was below the water in 1972 but of which the dry Spring of 1973 allowed the top to show above the surface. From our point of view this steep-sided ravine is interesting because it may be possible, by analysis of the rows on the two sides, to find out if the original erectors succeeded in carrying their chainage across the ravine accurately. Unfortunately the disturbance of the rows has made this difficult but it seems likely that the error was at most about a foot (see Figure 18 on p. 43).

It must again be emphasized that disturbance in nearly all the rows has been very great. Large numbers of stones have been re-erected; many of them carry the re-erection mark. The destruction is still going on; two stones which were upright in 1972 we found pushed over in 1973. Is there any wonder that we had difficulty in fitting lines to the stones and analysing the spacing? One can picture the stones lying down at all sorts of angles before the re-erectors came along and tried to put them up in rows without any guidance as to where the original lines had been. The various slight bends in the lines probably deceived them in several places when they tried to straighten the rows.

The statistical analysis which was undertaken assumes that there are enough of the stones in their original position to allow some sort of result to be obtained. After many months of work a pattern has in fact appeared: a pattern which cannot have been apparent to the re-erectors and so can owe nothing to them. For the first six sections there can be little doubt about the suggested geometry. It is inconceivable that the three pairs of triangles shown in Figure 1 can have appeared by accident, and further proof of their reality appears in the statistical analysis of the stone spacing. There is evidence that Rows III and V continued across the ravine to appear among the stones in Section 7 which otherwise are in rows parallel to the rows in Sections 2 and 3, some 2,000 feet away. To demonstrate this, Row I from Section 3 has been produced and drawn on Figures 3 and 4.

Theory of the Statistical Analysis

Figure 6 shows three stones forming part of a long row. The distances of these, y_1, y_2 and y_3, have been measured from an arbitrary zero. Assume that

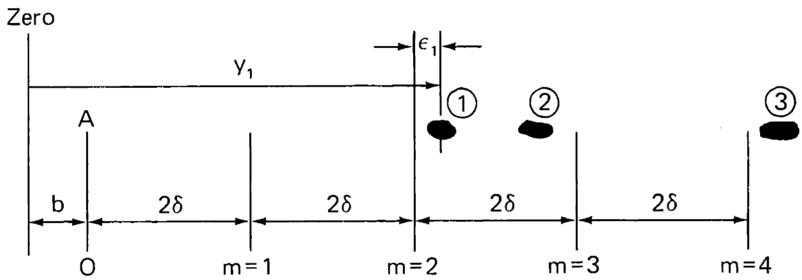

FIG. 6.

the quantum to which the stones were originally set out is 2δ and imagine marks (nodes) on the ground equally spaced at 2δ. It need not be assumed that there was a stone at every node; certainly where big stones were used there might be several quanta between each pair. We do not know how the first node (A) stands in relation to the zero; in fact we have to find the position of the nodes (given by b) which makes the average residual equal to zero. We have

$$y = b + 2m\delta + \epsilon,$$

where m is an integer, b is to be found and ϵ is the residual.

If the stones had not been much disturbed so that the residuals could be small it would be easy to assume a value for b, calculate the residuals, take the mean and adjust b to make this zero. But even when the best value has been found for b some of the residuals may still be large, and frequently during the work a small change in b will make a residual numerically greater than δ so that the stone has to be allotted to the next node. For example, if b in the figure is tentatively increased, stone 2 will become nearer to node 2 than to node 3 and the value of m will have to be decreased by unity, an adjustment which will produce a discontinuity in the value of $\Sigma\epsilon^2$. When we have found the value of b which makes the sum of the residuals zero, the sum of the squares $\Sigma\epsilon^2$ will be a minimum, and it avoids confusion if this property is used. In fact, the method adopted on all the Kermario rows was to try five or six values of b and for each to find $\Sigma\epsilon^2$. These were plotted to find the value of b giving a minimum. At every change of b values of ϵ which became greater than δ had to be subtracted numerically from 2δ. Instead of plotting $\Sigma\epsilon^2$ it is more instructive to plot s^2/δ^2, where s^2, which Broadbent[3] calls the "lumped variance", is $(1/n)\ \Sigma\epsilon^2$, n being the number of stones. If n is large and the stones are really randomly placed, s^2/δ^2 will remain close to $\frac{1}{3}$ as b is changed. If, on the other hand, the stones are not random but still show some trace of a quantum of 2δ, then, when s^2/δ^2 is plotted on b, there will appear a kind of sinusoidal curve with roughly as much above $\frac{1}{3}$ as below it. The more stones there are, the smoother and more regular will be the curve. The further the maximum and minimum values of s^2/δ^2 are above and below $\frac{1}{3}$, the more confident we can be that we are dealing with stones set out with the assumed quantum.

Broadbent's relation between the probability level (p.l.) and s^2/δ^2 and n will be found in Figure 2.1 of *Megalithic sites in Britain*.[4] We shall use this figure to determine a p.l. corresponding to the *minimum* value of s^2/δ^2. This may not be theoretically correct, but at least it gives a good criterion whereby results can be compared.

The stones in most parts of the alignments have been so much displaced that it is necessary to have a large number in a row if a reliable value of b min. (*i.e.*, the value of b making s^2/δ^2 a minimum) is to be obtained. But it is not safe to use a *very* long row because then any systematic error produced by a slight difference between the quantum actually used by the erectors and that assumed by us might begin to have an effect large enough to upset the whole process. For this reason all preliminary work has been done with lengths of under 300my.

If we could find a straight line crossing the rows and passing through a node on each, it would make the analysis much easier because all the rows in a section could then be taken together. In the Menec alignments[5] such a line was found at an angle of 1 in 2 to the normal. But in the Kermario alignments the nodes for all seven rows (in Sections 1, 2, 3, 6 and 7) seem to lie on the normal. In other words, the nodes appear opposite one another. The west end has been so much disturbed that it is not yet possible to be absolutely certain of this, but the final result goes far to justify the assumption.

An examination of the old cadastral maps shows how several of the rows were used last century as field boundaries and in some of these rows the spaces have evidently been filled by stones from the neighbouring rows. If we have identified the original nodes correctly, it might be possible to identify the intrusive stones and so to improve the analysis, but this has not yet been attempted and all the stones near the line have been retained.

To the east of the ravine the stones have suffered less but a solution here was delayed for several months because it was not realized (a) that here there were remains of two systems and (b) that the rows belonging to the second system probably had a quantum of 2my but running through it two rows, III and V, from the west system retained the $2\frac{1}{2}$my quantum.

It would be an advantage if we knew the solution to the following problem. If a row is set out with a quantum of $2\frac{1}{2}$ (or 2), will significance show up if it is

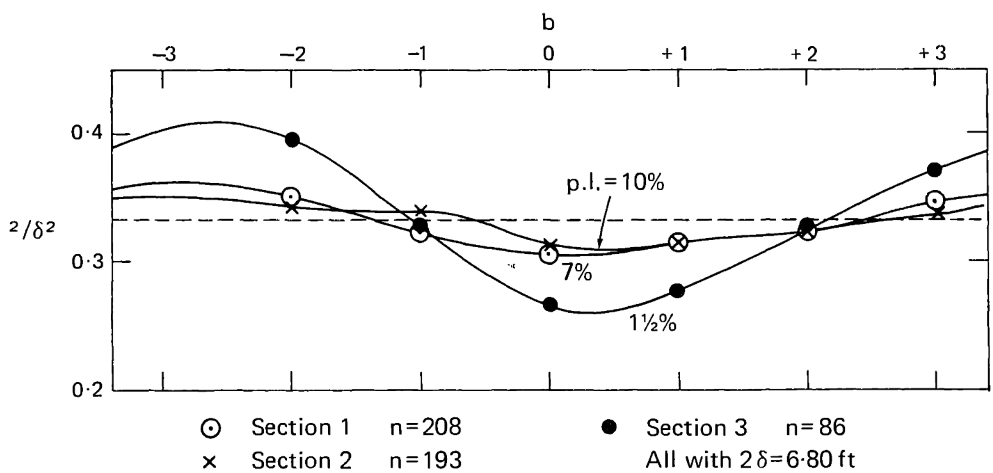

FIG. 7. Analysis of Sections 1, 2 and 3.

analysed using a quantum of 2 (or $2\frac{1}{2}$)? The question would be better put in the form: If the stones in the row have random small errors of a specified amount, what is the probability of significance when analysed with the other quantum? Neither of us is qualified to deal fully with these questions, but if the setting out is perfect with a quantum of $2\frac{1}{2}$ then on a long row s^2/δ^2 for the quantum of 2 will be 0·3125. The reverse problem shows 0·320. This means that if there is a very large number of stones, significance will appear. It seems that in some rows in Kermario, when both quanta are tested, we get values of s^2/δ^2 not greatly different from those just quoted. Examples will be found in Figures 8 and 9. But Row *G*, Section 7 shows an unexplained result, as can be seen in Figure 17. Here the $2\frac{1}{2}$my quantum shows $s^2/\delta^2 = 0{\cdot}20$, and yet the 2my quantum has s^2/δ^2 as low as 0·27. Other considerations, as we shall see, indicate that here we should expect a quantum of 2, and until a reliable solution appears to the second question above, we cannot categorically say to which quantum this line belongs.

Details of the Analysis

Marks were established accurately on the 1/500 survey in each section on Row I, by using the basic traverse, each mark being an integral number of Megalithic rods apart measured *along this row*. (Here the Megalithic rod was taken as 6·80 ft.) Fiducial lines were drawn through each of these marks at right angles to the portion of Row I in the section. The distance, *y*, of the apparent centre of each stone considered to belong to the row was scaled from the fiducial line with the easterly direction taken as positive. Stones more than 4 or 5 feet from the assumed line were neglected as being unreliable. Assuming a quantum of $2\delta = 6{\cdot}80$ ft, we formed for each row in every section the residuals

$$\epsilon = y - 6{\cdot}80m$$

for six or seven values of *b*, taking care that a value of *m* was used which would keep ϵ numerically less than δ, *i.e.* 3·40. These residuals were then squared and summed for each row, and so the values of s^2/δ^2 were found. In all about 8,000 terms were processed with a hand Curta calculating machine.

Ultimately we want answers to the following questions:

(1) Was the $2\frac{1}{2}$my quantum really used?

(2) How were the initial nodes placed?

(3) Were the nodes carried through from end to end or was a new system started at each break in direction?

(4) Did the measurements follow round the arcs at the west end? Due to the disturbances and/or the small number of stones in some rows, these questions cannot be considered independently, but a start had to be made somewhere.

Sections 1, 2 and 3

To begin with, a quantum of $2\frac{1}{2}$ was assumed and the fiducial lines in Sections 2 and 3 were taken as described. The stones in Section 1 were measured along the arcs from the fiducial line for Section 2. This allowed all the stones in each of the first three sections to be taken together. The final results are shown in Figure 7, where it is seen that Section 3 is quite satisfactory with a minimum

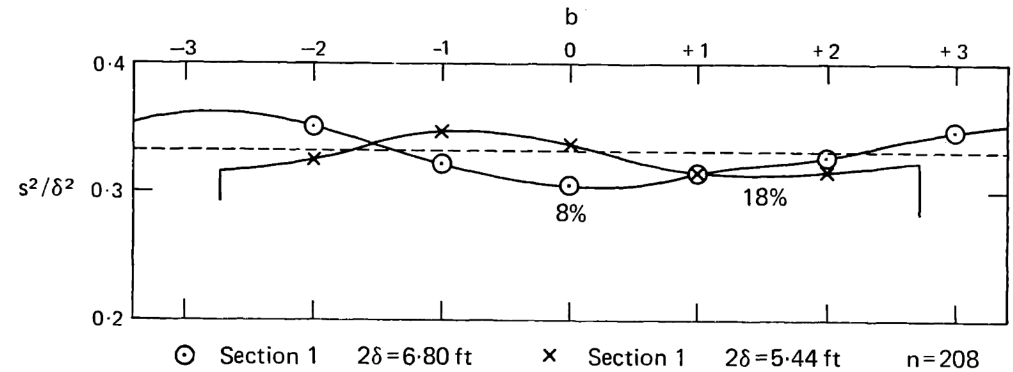

FIG. 8. Comparison of two quanta for Section 1.

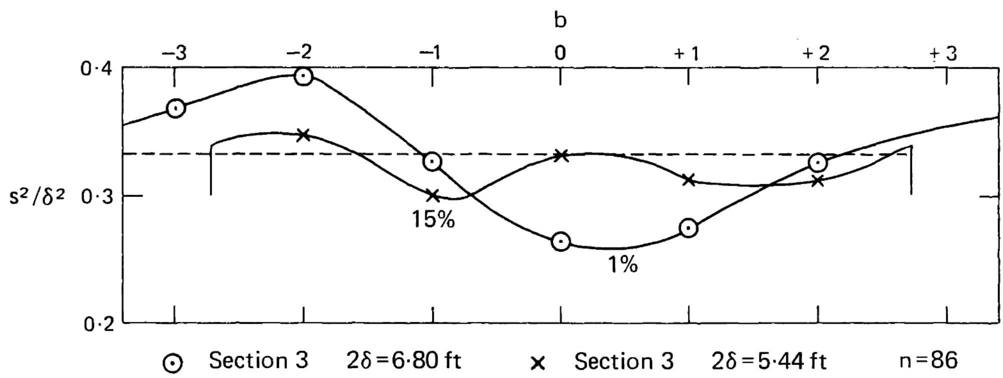

FIG. 9. Comparison of two quanta for Section 3.

s^2/δ^2 of 0·26 ($n = 86$ and so p.l. is about $1\frac{1}{2}\%$). This minimum occurs at $b = +0{\cdot}4$ which means that the indicated zero node for this section is about 0·4 ft to the east of the fiducial line. While Sections 1 and 2 both show poorer values of p.l., it will be seen that the minima are both close to that in Section 3. If this could be fully substantiated, it would indicate that the value of the Megalithic rod used in this stretch of Kermario was very close to 6·80 ft.

We then tried a quantum of 2my on Sections 1 and 3. The results are shown in Figures 8 and 9. It will be seen that in both cases the $2\frac{1}{2}$ quantum is better than the 2. This result is quite definite for Section 3. With regard to Section 1, an examination of Figure 2 shows that the ruinous condition of the rows is such that it is surprising that *any* result emerges. The position is not made any easier by the large size of the stones at the west end.

An attempt is made in Figures 10 and 11 to show that the nodes in Sections 1, 2 and 3 are on lines lying across the rows at right angles. Ideally we ought to take each row by itself, but to get more stones together neighbouring rows are combined. Thus we have combined Rows I and II, III and IV, and V and VI. This leaves VII by itself, but it will be seen that it can contribute nothing as it is quite neutral. The other three results are more definite; the minimum values fall between $b = -0{\cdot}2$ and $b = +0{\cdot}6$, and so it appears that the nodes were intended to be opposite one another.

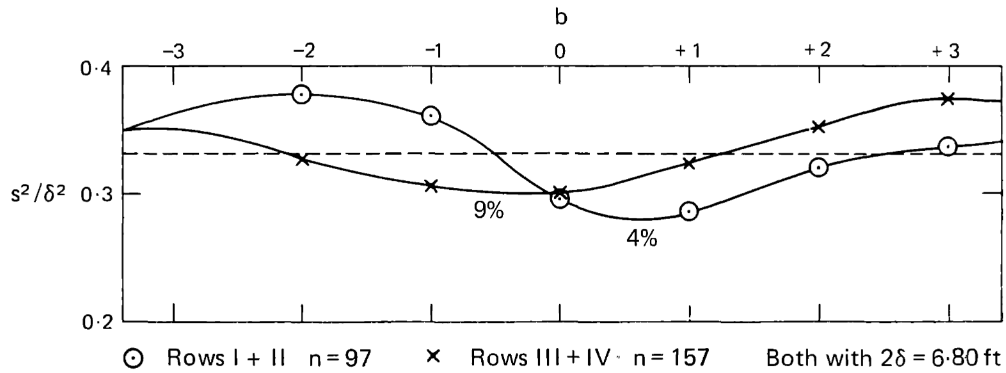

FIG. 10. Analysis to find the nodes in Sections 1, 2 and 3: Rows I–IV.

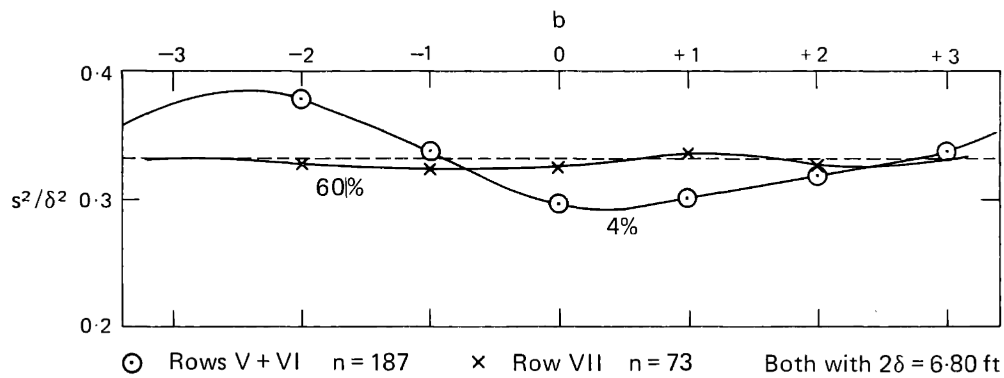

FIG. 11. Analysis to find the nodes in Sections 1, 2 and 3: Rows V–VII.

Section 4 ($n = 57$)

This is the section after the first bend (knee). We have seen that the nodes in each row approached the bend from Section 3 uniformly spaced and opposite one another. Were they carried on round the bend without a break?

It will be remembered that the assumed fiducial line *CC* was taken at right angles to the rows *in the section* (Figure 12):

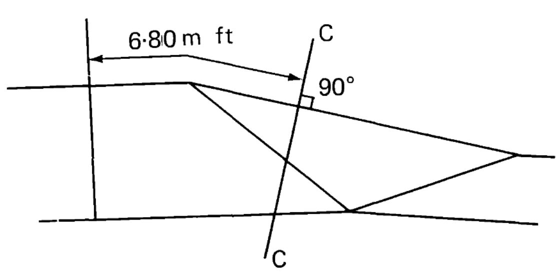

FIG. 12.

For each row $\Sigma\epsilon^2$ was calculated for a number of values of b centred on CC. These are shown in Table 1. The overall sums for each b are given and the corresponding s^2/δ^2 is plotted in Figure 13. The above assumes that the erectors

TABLE 1. Collect $\Sigma\epsilon^2$ for Section 4 to zeros on normal line. $s^2 = 1/n\ \Sigma\epsilon^2$.

r \ b	−4	−3	−2	−1	0	+1	+2	+3	n
I	8	19	32	29	24	13	6	9	5
II	39	17	6	11	32	54	61	36	8
III	34	32	39	50	47	53	42	34	11
IV	43	69	64	57	49	38	31	47	13
V	67	66	67	60	59	74	71	64	17
VI	10	11	9	9	15	14	13	10	3
Total	201	214	217	216	226	246	224	200	57
s^2/δ^2	0·305	0·325	0·330	0·328	0·343	0·374	0·340	0·304	

made a new start after the first knee, still keeping the nodes opposite one another, but we see that this is not supported by our measurements.

Accordingly we examined what would happen if the nodes were carried on through the knee. The inset (a) in Figure 1 shows what took place. The side of the triangle lying in Row r is 22my long and that of the triangle on Row $(r + 1)$ is 21my. Thus Row $(r + 1)$ is shorter than Row r by 1my, and so relative to Row r, the nodes in Row $(r + 1)$ will be pushed 1my to the east. It follows that in the r^{th} row the nodes will be $1 \times (r - 1)$my or $2{\cdot}72(r - 1)$ft further to the east than those in Row 1. New values of $\Sigma\epsilon^2$ formed for these origins are shown in Table 2. The plot of the resulting values of s^2/δ^2 in Figure 13 shows how much more likely is this hypothesis than that the nodes were on the normal. The position of the node as shown by the minimum value of s^2/δ^2 (p.l. $= 4\%$) is at $b = 1{\cdot}5$ and so has advanced slightly from that of Section 3.

Section 5 ($n = 44$)

If we assume that again the erectors' measurements continued round the second corner we see in (b) of Figure 1 that here the nodes fall *back* $\frac{1}{2}$my in each interval and so in Section 5 we should expect them to have a *total* advance of $1{\cdot}36(r - 1)$ft beyond those of Row 1. The final values of s^2/δ^2 are shown in

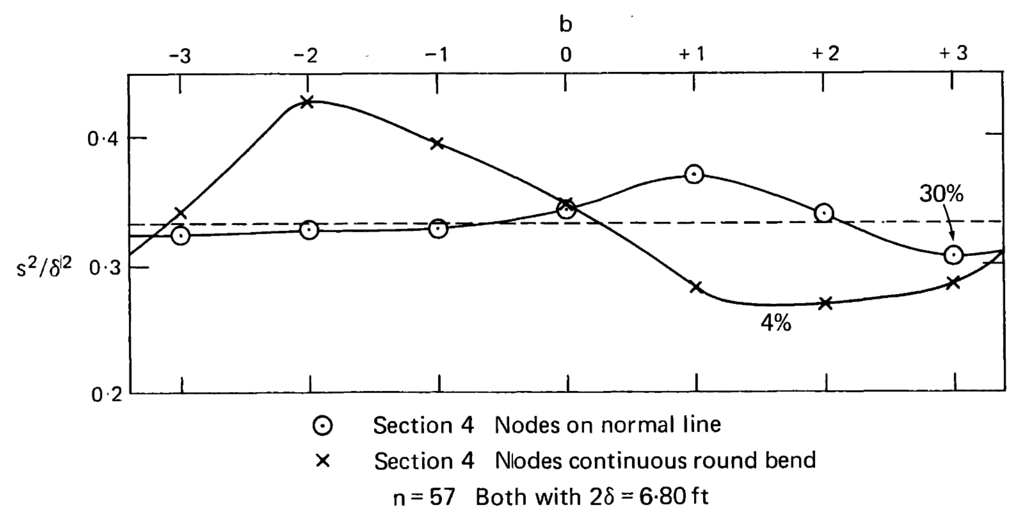

FIG. 13. Analysis to find the position of the nodes after the first bend.

TABLE 2. Collect $\Sigma\epsilon^2$ for Section 4 assuming nodes carried through bend from Section 3. These values were taken from a plot of the values in Table 1, but were read off 2·72 $(r - 1)$ ft to right, where r is the row number.

r \ b	−4	−3	−2	−1	0	+1	+2	+3	n
I	8	19	32	29	24	13	6	9	5
II	34	56	59	32	13	5	15	39	8
III	34	44	48	51	51	37	32	36	11
IV	34	36	64	66	60	49	43	32	13
V	62	58	71	72	65	65	68	61	17
VI	10	11	9	9	15	14	13	10	3
Total	182	224	283	259	228	183	177	187	57
s^2/δ^2	0·276	0·340	0·430	0·393	0·346	0·278	0·269	0·284	

Figure 14 where it is seen that a definite curve is obtained with a minimum (p.l. = $2\frac{1}{2}\%$) in nearly the same position as that in Section 4.

Section 6 ($n = 96$)

This is a difficult section. Perhaps there are one or two intrusive lines coming back through from Section 7, but no explanation fits everything and there may have been extensive re-erection. In (c) of Figure 1 it is seen that the nodes should have fallen back another 1·36$(r - 1)$ft and so the total advance is zero. That this should be so is also seen in the fact that the rows are very nearly back to the original direction. Figure 14 shows that the minimum s^2/δ^2 occurs perhaps between $b = 2·0$ ft and $b = 2·5$ ft (p.l. = 15%).

Section 7

An attempt was made to analyse the rows to the east of the ravine by continuing the lines of Section 6 right through to the end and measuring the position of the stones which were picked up. It was found, however, that only Rows III and V responded to this treatment. It will be seen in Figure 15 that these two rows were satisfactory and that the 37 stones together gave $s^2/\delta^2 = 0·23$, *i.e.* p.l.

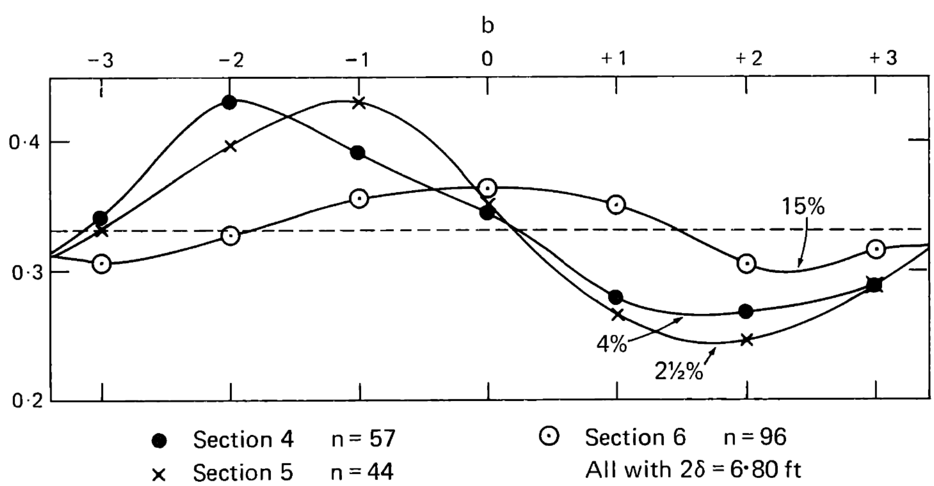

FIG. 14. Analysis of Sections 4, 5 and 6.

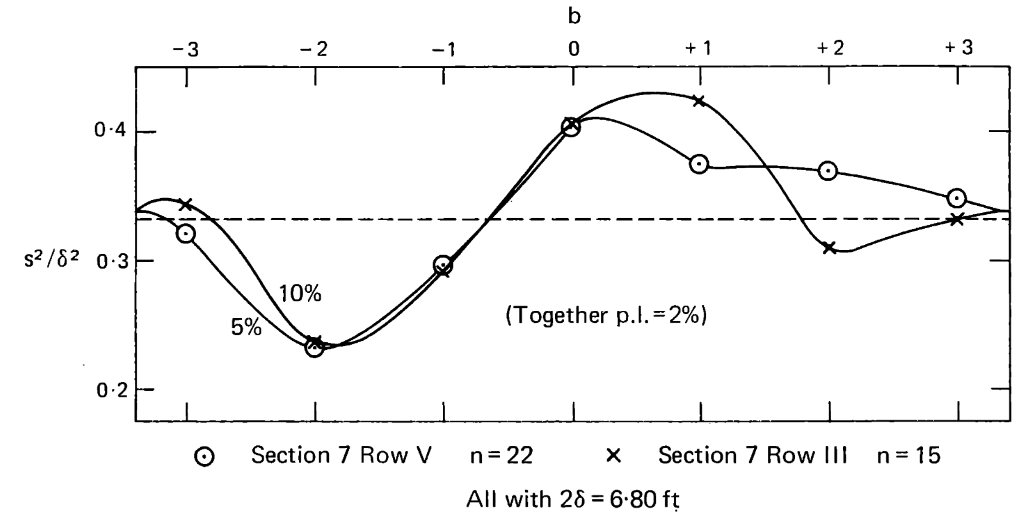

FIG. 15. Analysis of Section 7, Rows III and V.

2%. There are perhaps remnants of other lines belonging to Section 6, but the most satisfactory overall explanation of this section is to use a quantum of 2my. It seems that, with the exception of Rows III and V just described, these rows were intended to be parallel to the lines in Section 2 and 3 and to have the nodes on lines at right angles to their direction. This is brought out in Figure 16 where a comparison of quanta of 2 and $2\frac{1}{2}$my is made. With the 2my quantum, 75 stones showed the minimum $s^2/\delta^2 = 0{\cdot}22$ giving a p.l. of 0·05%. Excluding

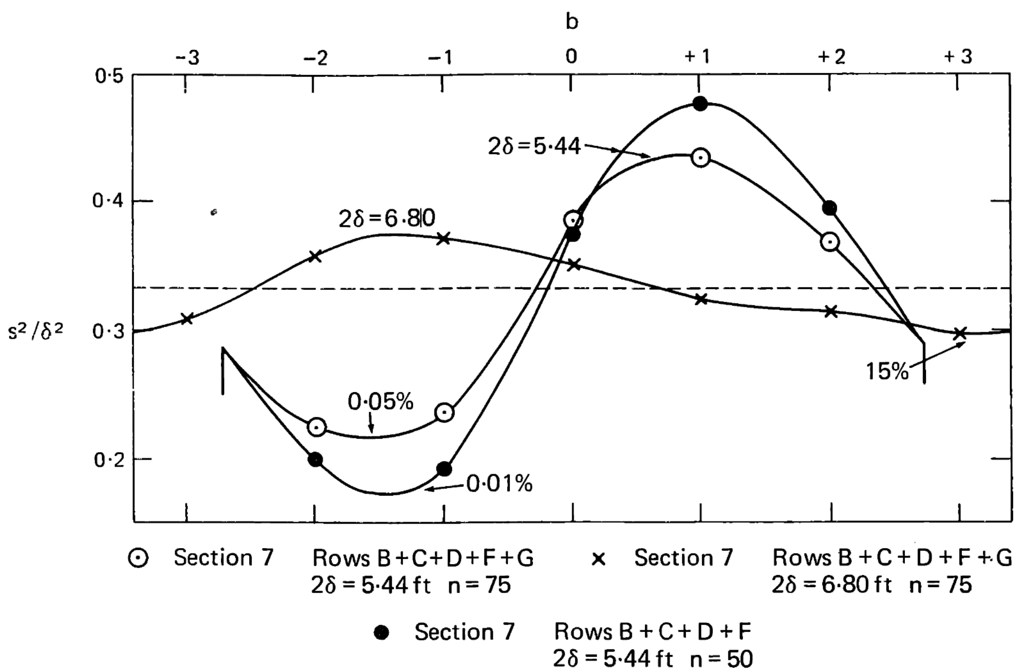

FIG. 16. Analysis showing the superiority of a quantum of 2my in Section 7.

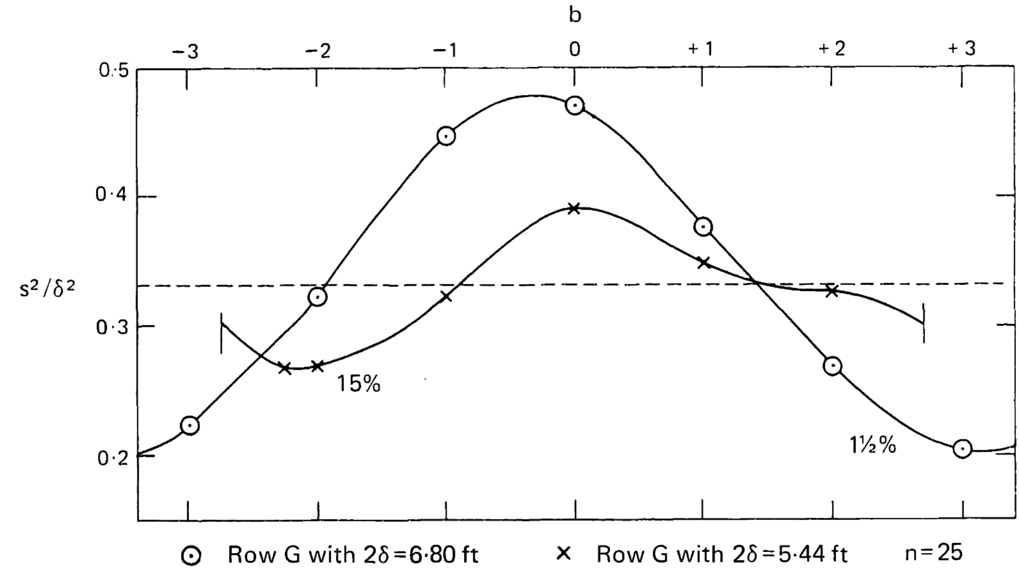

FIG. 17. Comparison of two quanta for Row G.

Row *G* we find 0·01%, much the lowest in any section. It will be seen in the same figure how badly a $2\frac{1}{2}$my quantum shows up on these rows.

It is often a matter of opinion as to which stones ought to be included in the analysis of a given row. It is possible for anyone interested to compare the number actually used (*n*) with those on the survey. Nowhere has a stone been intentionally omitted to lower (or raise) the probability level, but naturally other investigators may make a different selection, especially in Section 6.

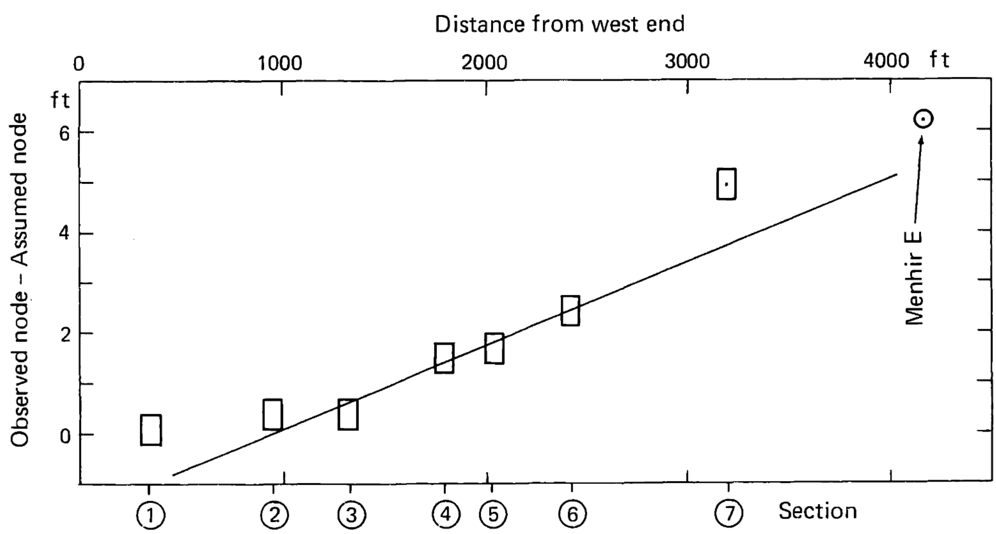

FIG. 18. The node positions along the Kermario alignments compared with nodes equally spaced at 6·800 ft.

The Indicated Value of the Quantum

Is it possible that a very slight change in the assumed quantum will partially reconcile the values of *b* min. found in the seven sections?

We may take it that each value of *b* min. pertains to the middle of the section to which it belongs. Accordingly, in Figure 18 each *b* min. is plotted on the distance from the west end of the alignments to the centre of the section. For Rows III and V in Section 7, Figure 15, *b* min. is about −1·9 ft, but if there is a node at −1·9 there is also one at 6·80 − 1·9, *i.e.* at 4·9, and this value is shown.

A point has been added at the extreme east on the assumption that the menhir *E* (Figure 1) already mentioned was on a node. There is, of course, no proof of this but we cannot exclude the possibility.

It appears that the actual nodes obtained from the stones advance relative to the assumed nodes set out with $2\delta = 6{\cdot}80$ ft.

In drawing the straight line on Figure 18, allowance has been made for the fact that Sections 1 and 2 can be given but little weight (see Figure 7), whereas Sections 3, 4 and 5 are all more reliable.

We have also to some extent ignored the point obtained for Section 7. We could say that perhaps the erectors made an error of about a foot in measuring across the ravine. They were usually meticulously careful in important lengths, but it is difficult to measure with rods on steeply sloping ground and if they used a long rope it would inevitably stretch as it hung in a catenary across the valley.

From Figure 18, an increase of about 0·17% in the quantum is indicated, which would make the Megalithic yard equal to 2·724 ft or 0·8303 metres.

The Rows on the South Side

It seems from what has gone before that the main body of the alignments consists of seven rows of stones, but external to these on the south side there are other rows which at first sight do not fit into the scheme. Most of them have, however, some connection with the main seven rows. This will be seen in Figures 1 and 2 where (for example) Row VII in Section 6, when produced westwards, picks up a line of a dozen stones at the extreme west. Also at the west there is a row exactly parallel to the rows in Section 4. In addition, there will be found in Figure 1 the remains of two rows 16my apart parallel to Section 5. Perhaps we should not be disappointed that the long row immediately south of Section 4 seems to have no relation to anything. It lies very close to the edge of the wide modern road which has been built in recent years, and so these stones may have been moved. The stones south of Section 6 seem to form part of some other system.

We do not know the position or direction of the closing line at the west. In Figure 2 this has been drawn at right angles to Sections 2 and 3 and so is parallel to lines joining the nodes on these sections. But in Figure 1 the closing line is assumed to be a radius from the centre of the arcs. It may be noticed that there is an otherwise unexplained row of stones which will be found to be exactly at right angles to this radius and so would be tangent to Row VIII had this ever been set out.

We have seen that Row III of Section 6 runs through Section 7. Continued for another 600 ft, it goes through that 6 ft menhir *E* already mentioned. Row *C* of Section 7 (Figure 4) contains the well known large menhir with the inscribed snake design, *S*, and if continued, it also picks up menhir *E* (Figure 1).

In Le Menec it is clear that the setting out began at the west end because at this end the nodes lay on straight lines. The geometry forced the nodes out of step so that at the east end they zigzagged across the rows, exactly as the theory in Thom II dictates. In Kermario, however, we cannot use this criterion to decide where erection started, because the rows are parallel and in each section are equally spaced, with the result that the nodes, though out of step in sections 4 and 5, start and end by being opposite one another.

The peculiar mix up of rows in Section 7 leaves us with the question: Were these two systems part of some scheme which used both sets of rows or, when the civilization collapsed *circa* 1500 B.C., were the builders in process of replacing one system by another?

The Arcs at the West End

On the survey we have drawn seven arcs each with a radius of 2,500my, but this is not to say that originally the rows had exactly this radius. It however seems unlikely that the original radius was outside the limits 2,500 $\pm$ 250my. It is a challenge to archaeologists to discover whether the arcs were set out to a common centre or all with the same radius.

It is with some hesitation that we put forward the following suggestion as to how this part of the alignments might have been used to obtain the extrapolation distance for the lunar backsights at Quiberon, St Pierre, Kerran and Kervilor.

It has been explained in the previous papers[6] that these stations with the huge menhir Er Grah (Le Grand Menhir Brisé) formed a huge lunar observatory, but without some method of computing the extrapolation distance on each occasion when the observatory was used, the whole scheme could not have been operated.

Reference should be made to Thom III for explanations, constants and notation. From (3) of that paper the extrapolation distance for G constant is

$$\eta_T = p^2/16\,G \qquad (1)$$

and values of $4G$ for the four backsights above will be found in Table 1 of the same paper.

With a radius of 2,500my the deviation (x) of a row from the straight tangent is with ample accuracy

$$x = y^2/5000\text{my}. \qquad (2)$$

Consider the backsight at Quiberon for which $4G = 546$my and find from (1) above the "true" value

$$\eta_T = p^2/2184. \qquad (3)$$

Suppose that p is set out from the tangent point and the distance x is measured; then x is given by (2).

But if as at Le Menec the distance x is scaled up $2\frac{1}{2}$ times when it is taken back to Quiberon (by using rods instead of Megalithic yards), then we get:

$$\eta_R = 2\tfrac{1}{2}x = p^2/2000, \qquad (4)$$

which is not very different from (3); in fact if the radius of the rows were 2700my it would be almost identical.

Let us assume that at the other stations factors (f) of 2 and 4 were used; then the rows could have served for extrapolation there also. This is shown in Table 3 which gives values for all four assuming a radius of 2700my.

	f	η_T	η_R
Kerran	4	$p^2/596$	$p^2/540$
Kervilor	4	$p^2/556$	$p^2/540$
St Pierre	2	$p^2/1100$	$p^2/1080$
Quiberon	1	$p^2/2184$	$p^2/2160$

TABLE 3

While this method is seen to give remarkably close agreement between the observed η_R values using the rows and the theoretical mean values η_T, it must be pointed out that so far no method has yet been found of obtaining anything but mean values. (It should also be mentioned that the arcs are too short to deal with *all* the values of p which might be brought in from Quiberon.) We do not know yet how the rows to the south of the seven main rows were used, nor do we know the purpose of the peculiar geometry in the middle of the rows. It may be that there was some method, such as that suggested for Menec in Thom III, whereby allowance could be made for the variations which take place in the value of G. It is most unlikely that seven rows over 3000 ft long were set out merely to demonstrate the properties of three pairs of triangles.

We have however seen in Thom III that Le Menec was capable of dealing completely with the extrapolation problem provided three clear nights occurred at one of the monthly declination maxima near the standstill. Did Kermario go further?

Conclusion

We have now made available (from the Editor, £1 post free) an accurate large-scale 8ft survey of the Kermario alignments which anyone may obtain who wishes to study the geometry of the site or to speculate about the possible reason for undertaking this enormous construction. The geometrical plan to which it was set out is fairly clear. The large triangle, comprising all that we have called Section 4, with its apex on Row VII, shows that to the west of the ravine there were only seven main rows with, of course, several ancillary rows on the south border. East of the ravine the picture becomes complicated. A possible explanation is that originally seven straight and parallel rows spaced at 12my ran through from Section 2 to the extreme end. This was then modified by the insertion of three knees with the consequent successive reduction of spacing. If this is the explanation, the modification was never completed and so, towards the east end, we are left with parts of both systems. The quantum also seems to have been different in the two schemes.

Like Le Menec, the stones at the west end are much larger than the average size. It may be that these, at an earlier date, formed a simple extrapolating sector, like that at St Pierre, Quiberon, afterwards rearranged to form part of the seven arcs that we now find. This may explain the large size, which certainly must have been an embarrassment if these arcs were really meant to represent the quadratic function necessary for even simple extrapolation.

One cannot help being impressed by the great accuracy with which the lines were laid out. After passing through three bends the azimuth of the rows is still within a few arc minutes of the theoretical direction deduced from the geometry of the six triangles involved. The positions of the stones along the rows allows us to deduce that the value of the megalithic yard used was 2·724 ft compared with 2·721 at Le Menec, 2·720 for Britain as a whole, and 2·720–2·725 in Orkney.

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