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A LUNAR SITE IN SUTHERLAND

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In Glen Loth, Sutherland, there is a menhir, Clach Mhic Mhios, about 11ft high by 5ft wide and just over 1ft thick. On our survey we chose for a referring object the clearly defined point *B* (see Figure 1), and using the Sun and an electronic watch we made three determinations of the azimuth.[1] These were 199°02′·0, 199°01′·7 and 199°01′·7.

Using the referring object we then measured the azimuth and altitude of the other points shown in Figure 1. On the profile we represent the Moon setting at the major standstill with negative declination $-(\epsilon+i)$. For ϵ we use the value 23°53′·1 found in our recent paper.[2]

The details of the reduction for the point A_1 (Figure 1) are given in Table 1. We start by taking the four possible times of year, namely March, June, September and December.[3] Since we require the hour angle of A_1 only roughly we can get it from a celestial sphere, or we can calculate it from

$$\cos \text{H.A.} \sin \text{Az} = \cos \phi \tan h - \sin \phi \cos \text{Az},$$

where ϕ is the latitude and h the geocentric altitude.

It will be seen that only the March and December moons were on the foresight in darkness. We estimated from the modern records at Kirkwall the temperature at the appropriate times and so from the tables in the *Nautical almanac* we found the refraction. We assumed the graze angle[4] to be −0′·5 and the mean parallax to be 56′·9. Thus we found the geocentric altitude. Using this with the latitude (58°06′·7) and azimuth (197°45′), we found the declination to be −28°47′·1.

A_2 gives the same declination as A_1 and so A_1A_2 form a very good Type II foresight.[5] Since this notch must be for the upper limb, the declination of the

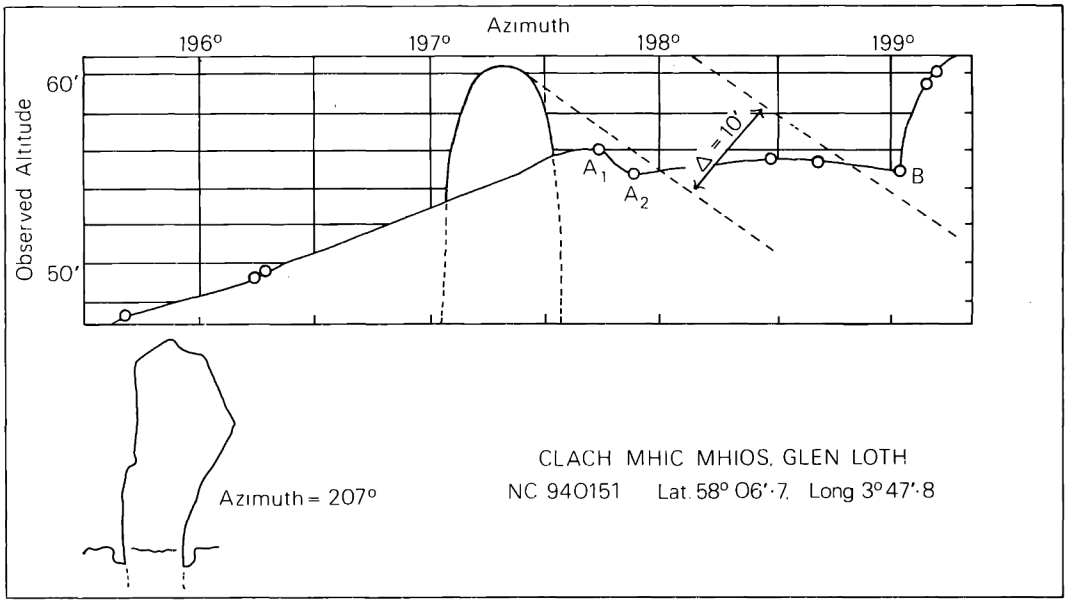

FIG. 1. The menhir Clach Mhic Mhios, showing the Moon setting with declination $-(\epsilon+i)$, where $\epsilon = 23°53'·1$.

TABLE 1. Reduction of measurements for point A_1.

	March	June	September	December
Longitude of Moon	90°	90°	90°	90°
Hour angle	19°	19°	19°	19°
Sum	109°	109°	109°	109°
Longitude of Sun	0°	90°	180°	270°
Time (degrees)	109°	19°	289°	199°
Time (hours; old astronomical)	7·3	1·3	19·3	13·3
Time (UT)	19·3	13·3	7·3	1·3
	(dark)	(day)	(day)	(dark)
Temperature	40°F			39°F
Refraction	−25′·5			−25′·5
Graze	− 0′·5			− 0′·5
Parallax	56′·4			57′·4
Mean parallax		56′·9		
Observed altitude		55′·9		
Geocentric altitude		1°26′·8		
Azimuth		197°45′		
Latitude		58°06′·7		
Hence: Declination δ_0		28°47′·1		

centre is −29°02′·6 and as this is $-(\epsilon+i)$ it follows that with $s = 15'{\cdot}5$ and $i = 5°08'{\cdot}7$ the obliquity of the ecliptic is 23°53′·9.

Thus in this site we have another of these places where the megalith erectors recorded on the ground the position midway between the point found at the equinox and that found at the solstice. It seems likely that they knew that by doing this they got a more precise position than they would have obtained by depending on a single observation. Our results certainly show that these values with no Δ in the nominal value have a smaller root mean square residual than the others.[6]

We might ask if the erectors intended to use also the point *B*, which has azimuth 199°01′ and observed altitude 54′·6. The measured declination of this point (using 57′·4 for December parallax) is about −28°33′·4. The nominal value nearest is that at $-(\epsilon+i-\Delta-s)$. It will be seen from our previous paper[7] that the appropriate value of the perturbation Δ is −10′·0, and so with $\epsilon = 23°53'{\cdot}1$ and $s = 15'{\cdot}6$ the expected value of the declination of *B* is −28°36′·2. The discrepancy of this from the above measured value is 2′·8. This is almost within the scatter of the residuals found in our previous paper and so it may be that the erectors intended the point *B* to be used. This reminds us of the second point on the profile at Ballinaby.[8] Bear in mind that the erectors could not adjust these but had to take them as they found them on the horizon.

Unfortunately the menhir Clach Mhic Mhios is orientated some 8° to the right of the foresights, but it must be remembered that the function of the back-sight is to mark a position, not a direction. In this case there is no chance of its poor orientation misleading anyone because there are no possible foresights to the immediate right of *B*.

In this connection it should be remembered that megalithic observers had probably been watching for several lunations, and certainly for several days, the gradual advancement of the setting position on the horizon at the standstill; and so they would have had no difficulty in knowing which was the notch. This is where J. Patrick was wrong when he criticized us because we claimed that the