NEW EVIDENCE FOR THE EXISTENCE OF PRECISE LUNAR ALIGNMENTS IN THE EARLY BRONZE AGE

Dr. Thomas Gough

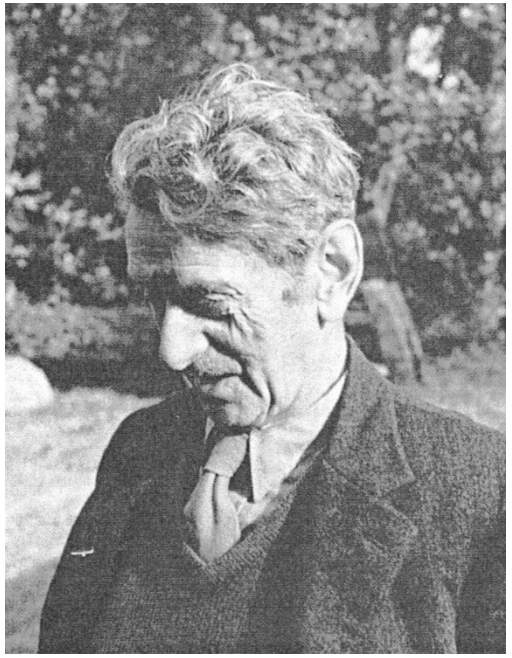
19 March 2018

ING/Mercator seminars

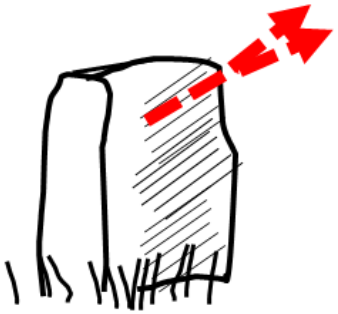
La Palma

ARCHAEOASTRONOMY

Thom was professor of Science and Engineering at Oxford from 1946 – 1961. Megalithic remains became an interest in the early ’30s; initially stone ‘circles’ but later declinations from stones and other possible backsights. He produced evidence that a 16 month solar calendar existed and that the small variation in lunar declinations at the ‘standstills’ had been observed. This last would have enabled eclipse predictions.

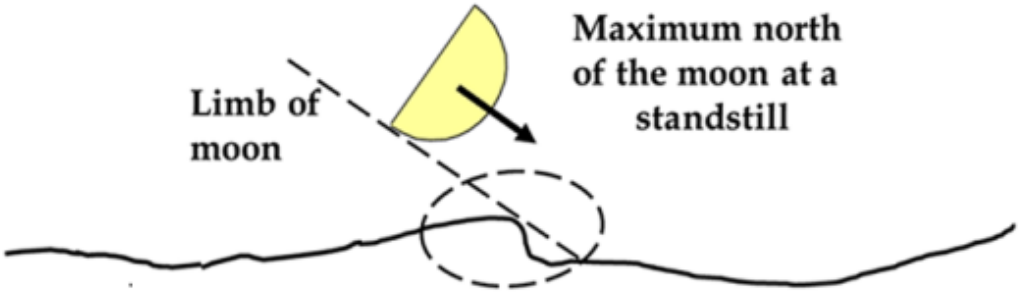


Alexander Thom
1894 -1985



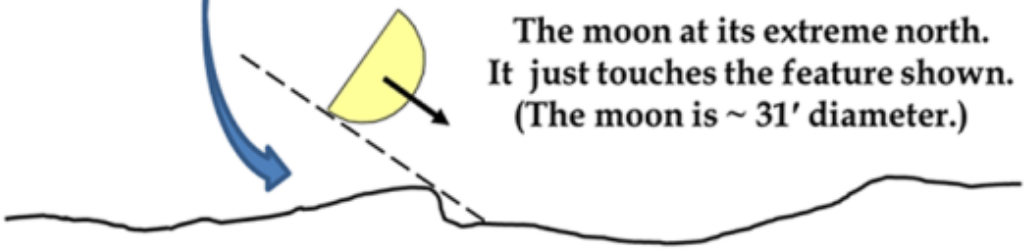
Indicated direction
about ±2°

An Alignment giving high accuracy



An orientation of about $\pm 2^0$ .....

..... can become an alignment capable of 1′ of arc precision.



Several degrees

An horizon region indicated by a backsight with a typical precision of about ± 2°. (Foresights are discussed later.)

eclipse year, and so the interval between what we shall call the danger times,

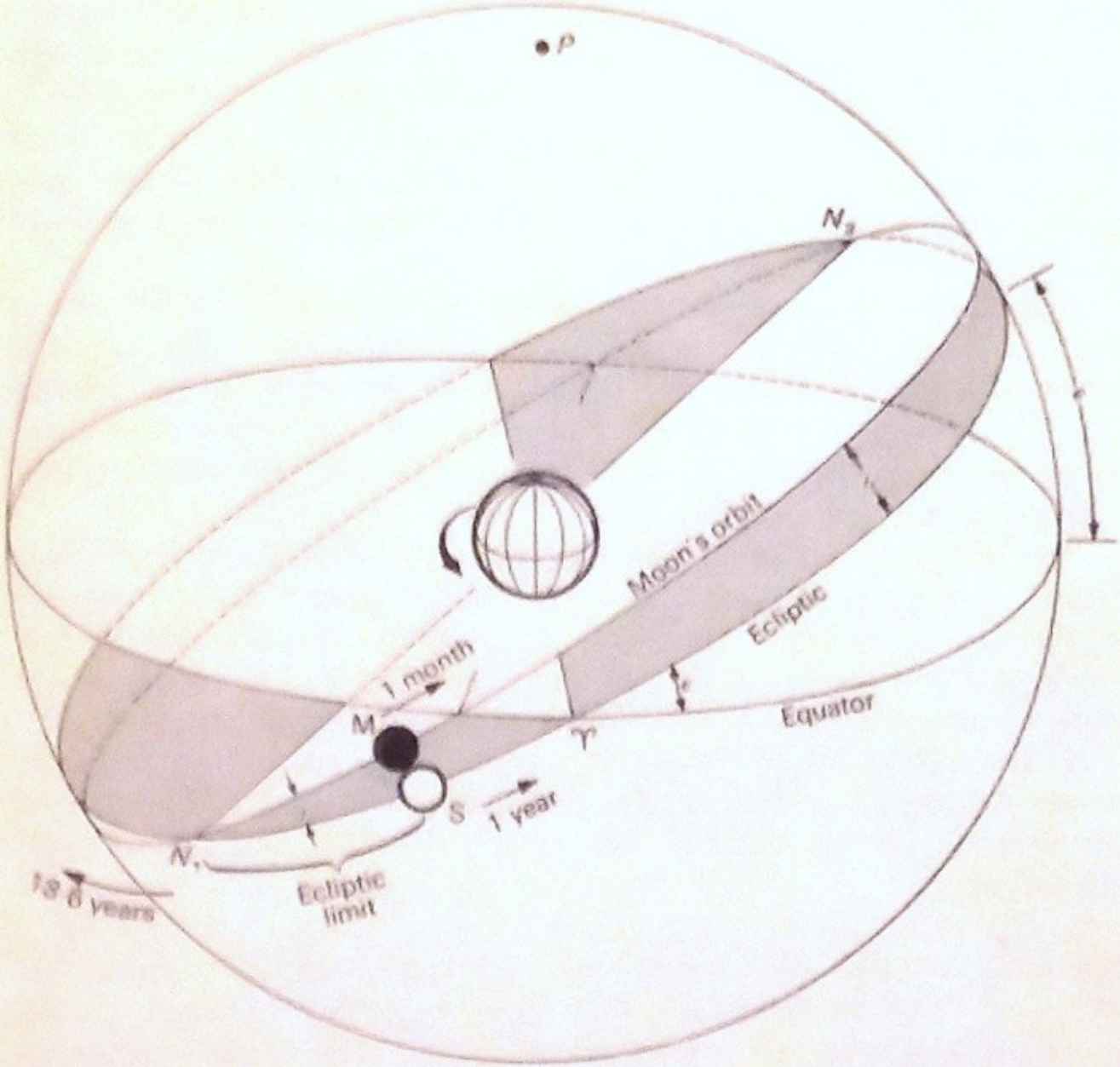
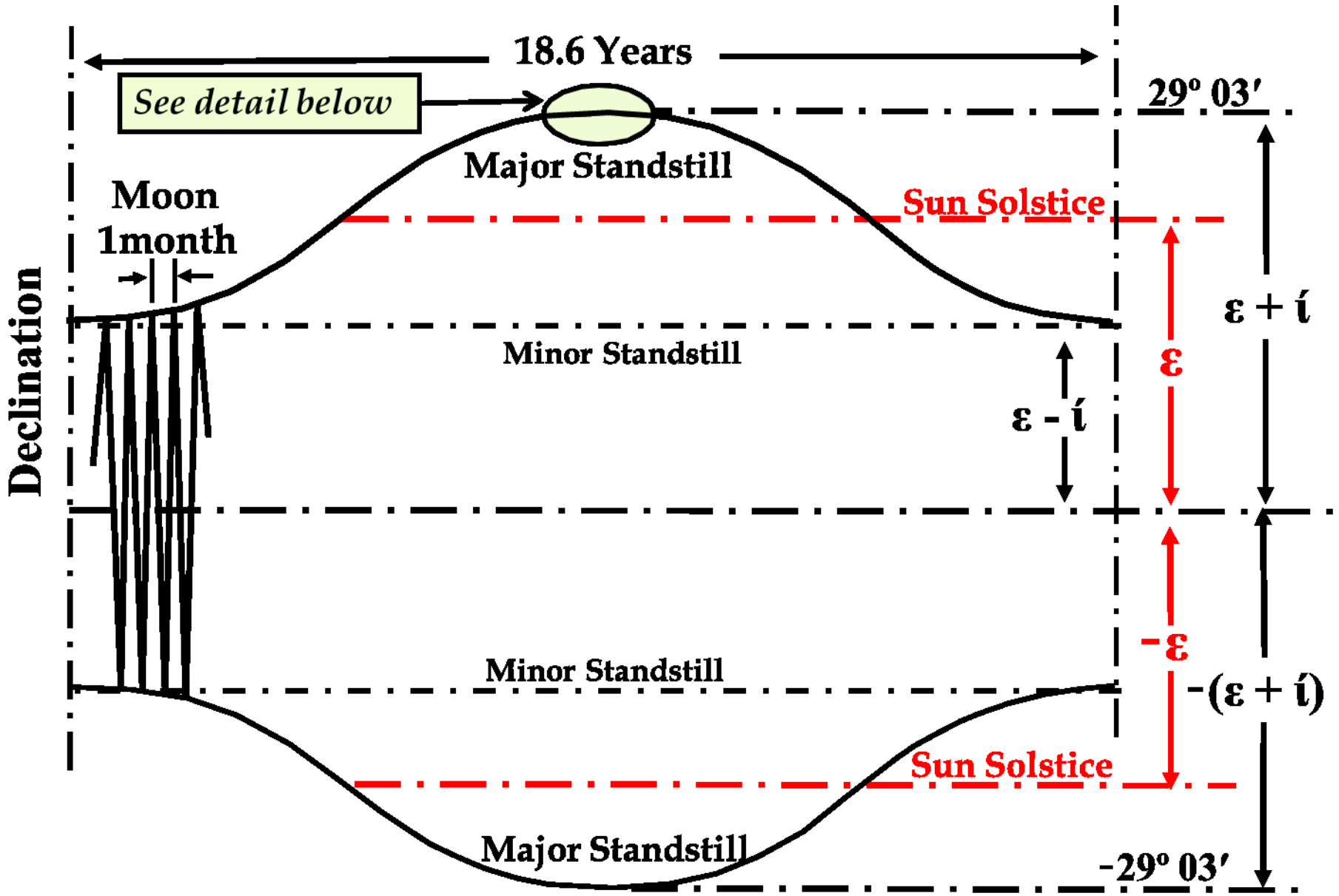
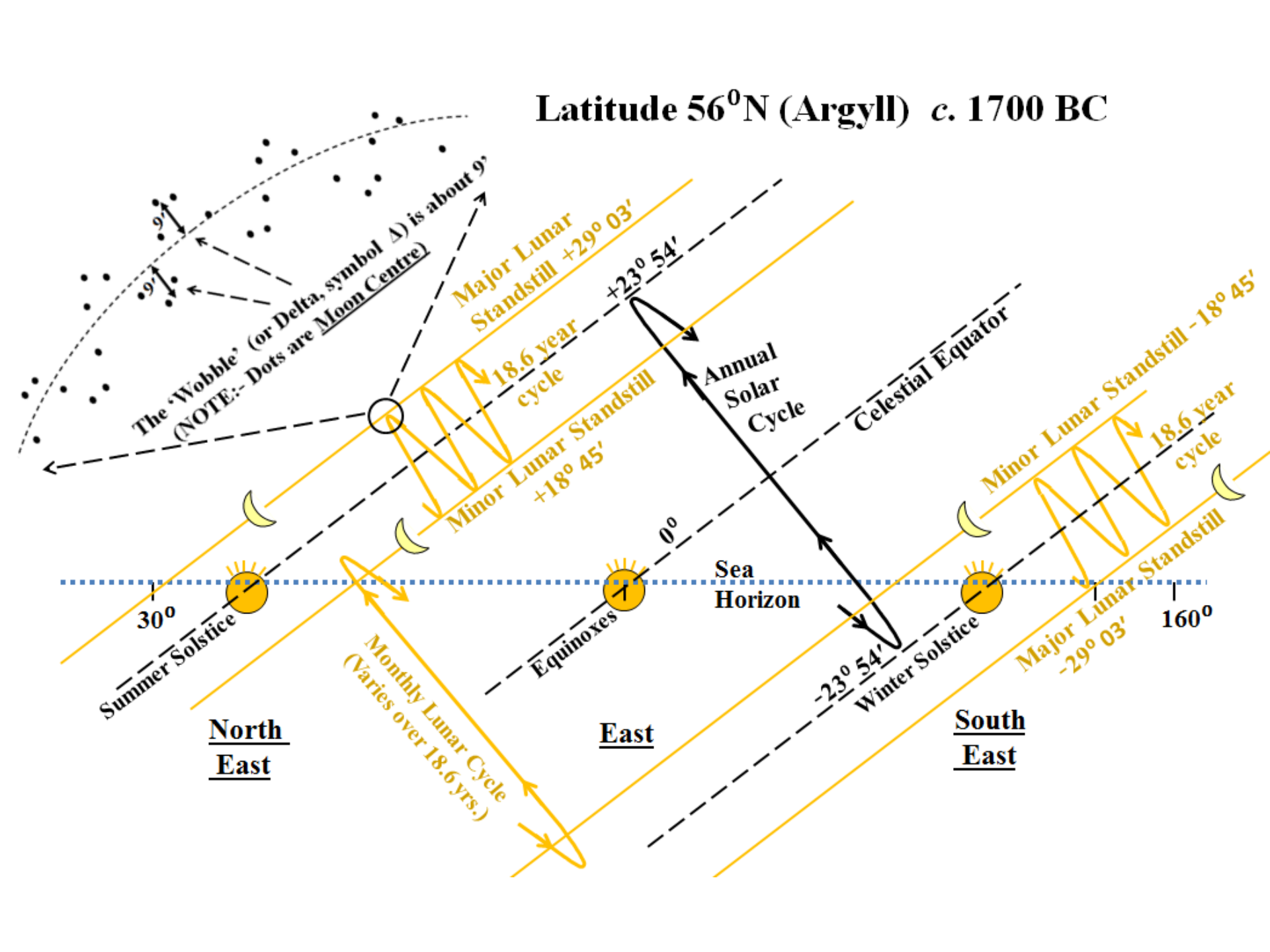
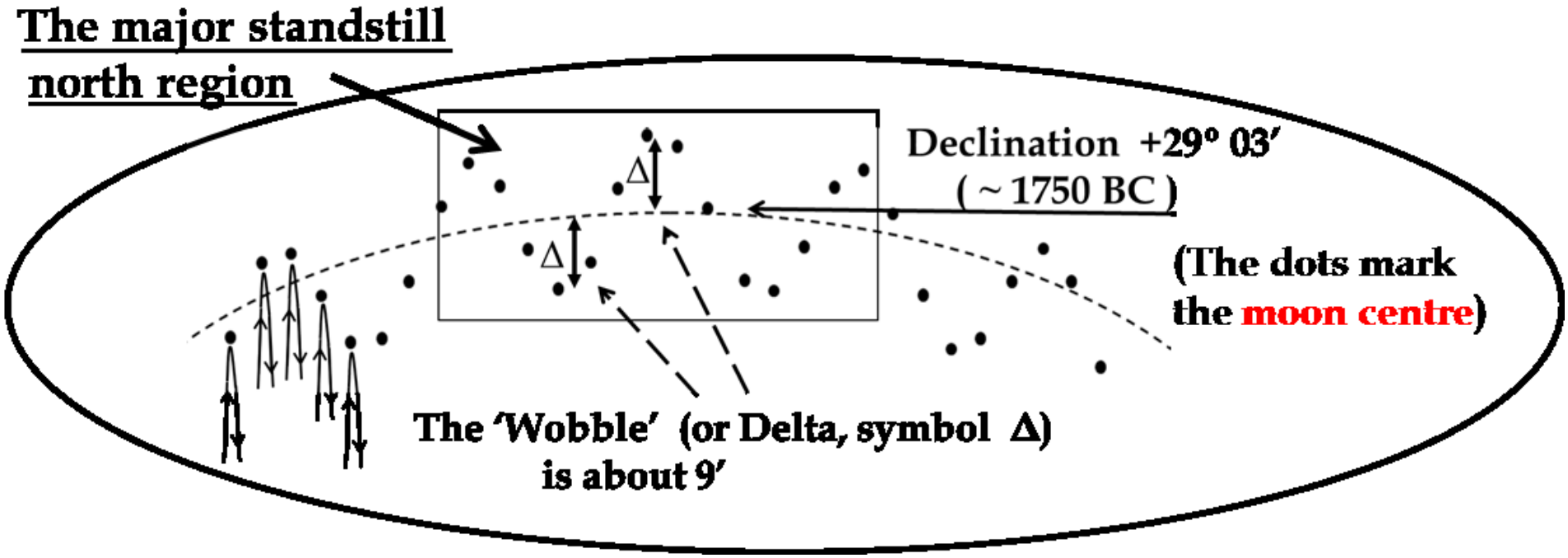
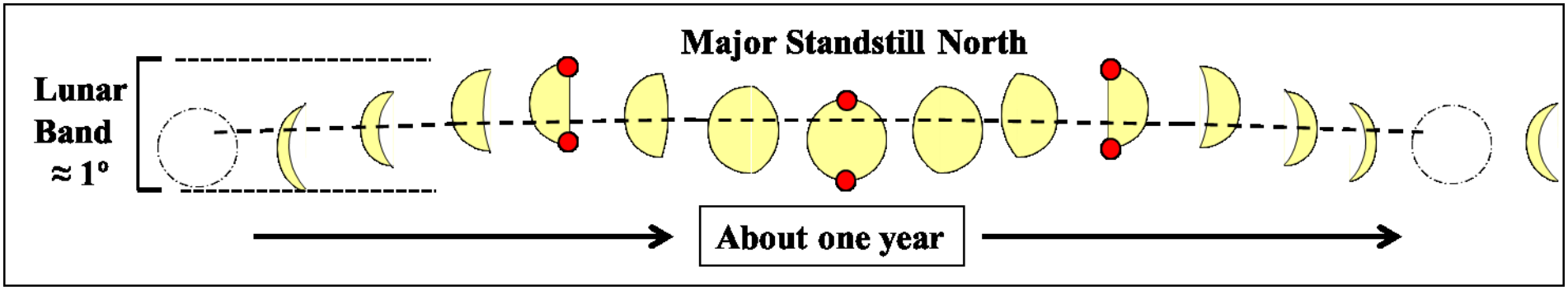


FIG. 2.1. The celestial sphere with the Earth rotating at the centre. S — Sun, M — Moon.

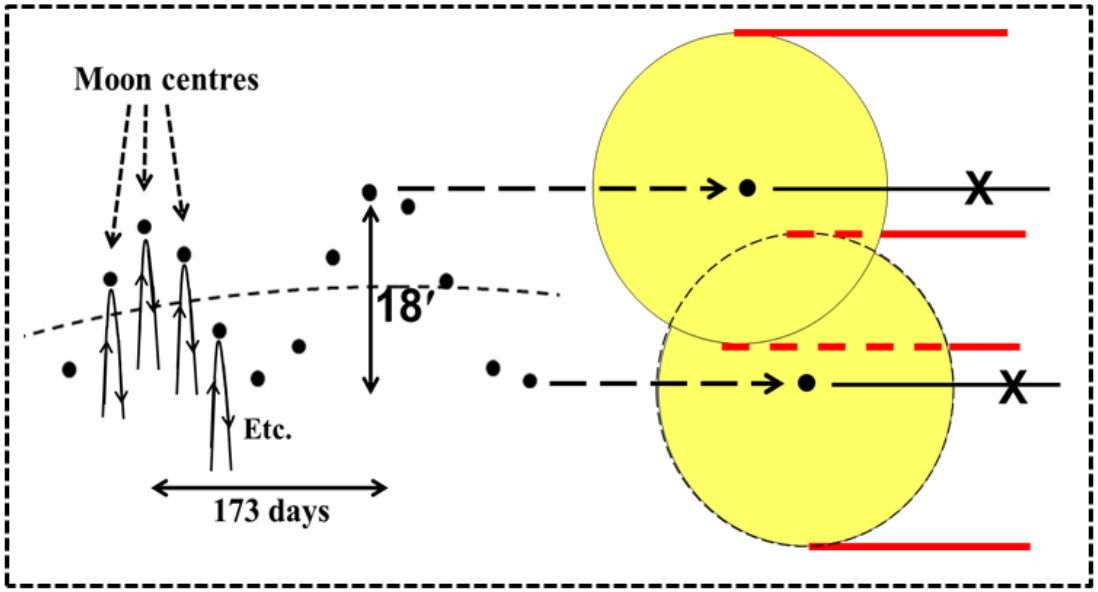

18.6 Years
See detail below
Major Standstill
29° 03′
Moon
1month
Sun Solstice
Declination
ε + í
Minor Standstill
ε
ε - í
-ε
Minor Standstill
-(ε + í)
Sun Solstice
Major Standstill
-29° 03′


Latitude 56°N (Argyll) c. 1700 BC
9′
9′
The 'Wobble' (or Delta, symbol Δ) is about 9′
(NOTE:- Dots are Moon Centre)
Major Lunar Standstill +29° 03′
18.6 year cycle
+23° 54′
Annual Solar Cycle
Celestial Equator
Minor Lunar Standstill +18° 45′
Minor Lunar Standstill -18° 45′
18.6 year cycle
0°
Sea Horizon
30°
Summer Solstice
Equinoxes
-23° 54′
Winter Solstice
Major Lunar Standstill -29° 03′
160°
Monthly Lunar Cycle (Varies over 18.6 yrs.)
North East
East
South East

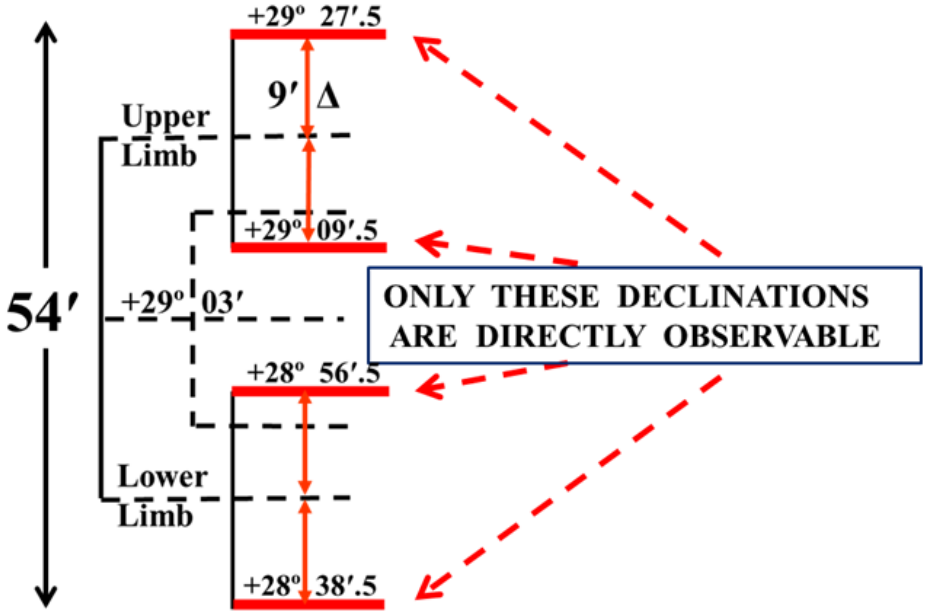

The major standstill
north region
Declination +29° 03′
(~ 1750 BC)
Δ
Δ
(The dots mark
the moon centre)
The 'Wobble' (or Delta, symbol Δ)
is about 9′


Major Standstill North
Lunar
Band
≈ 1°
About one year

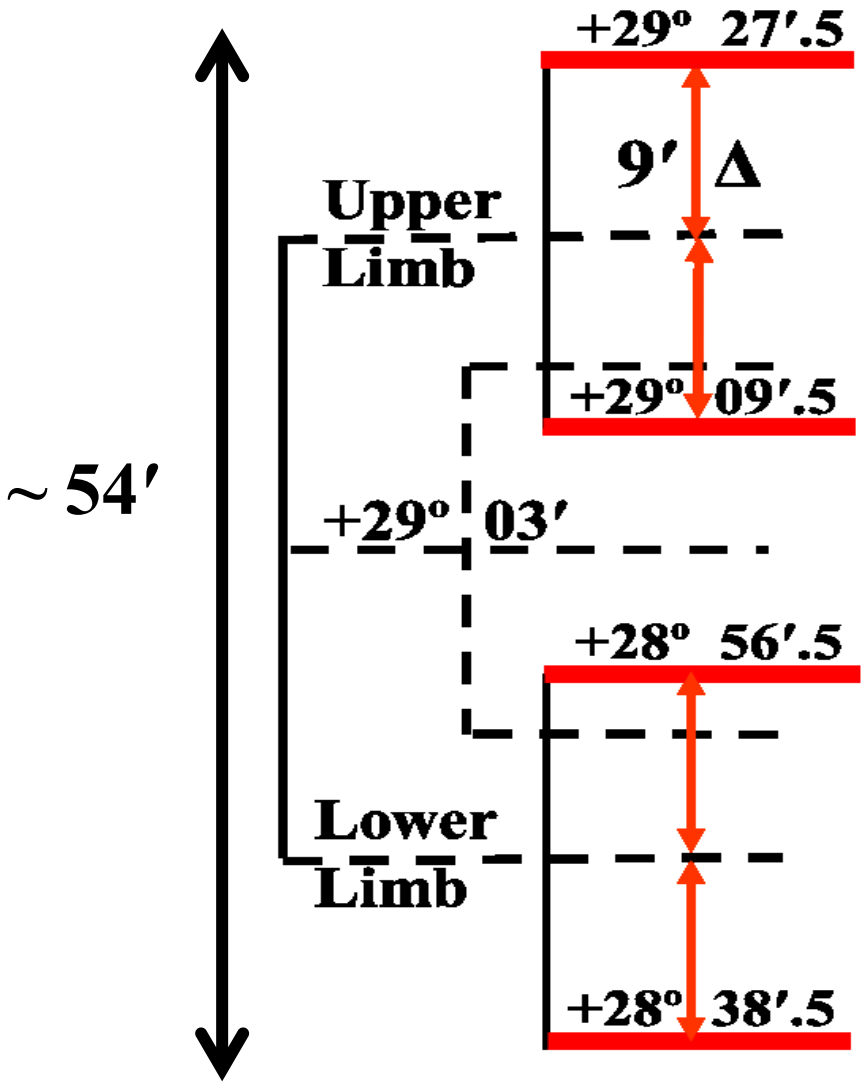
The Lunar Band – (For the Major Standstill North)



The Lunar Band

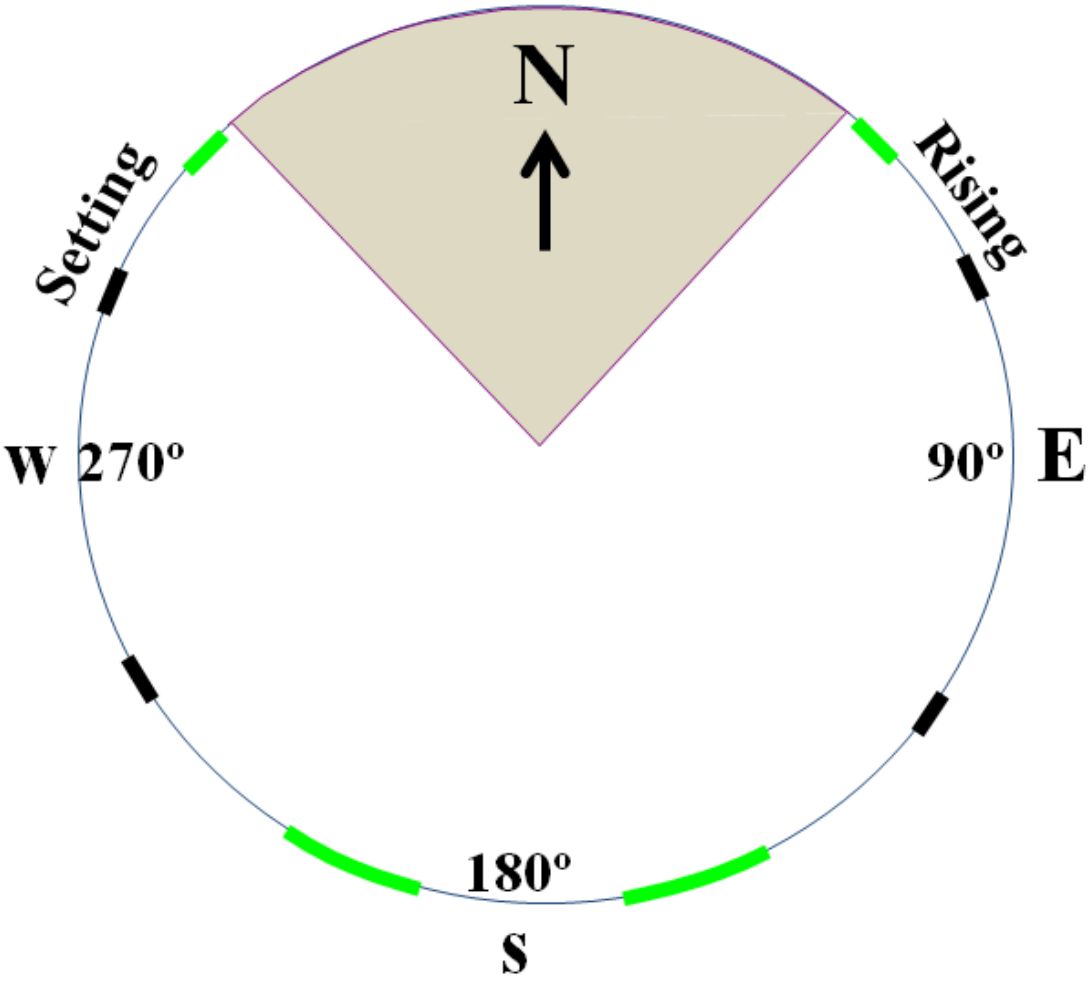


The Lunar Band



The Eight Lunar Bands

Four Major Standstill, Four Minor Standstill



Histogram of Observed Declinations

Thom, Megalithic Sites in Britain, Fig. 8.1 (with permission of O.U.P.)

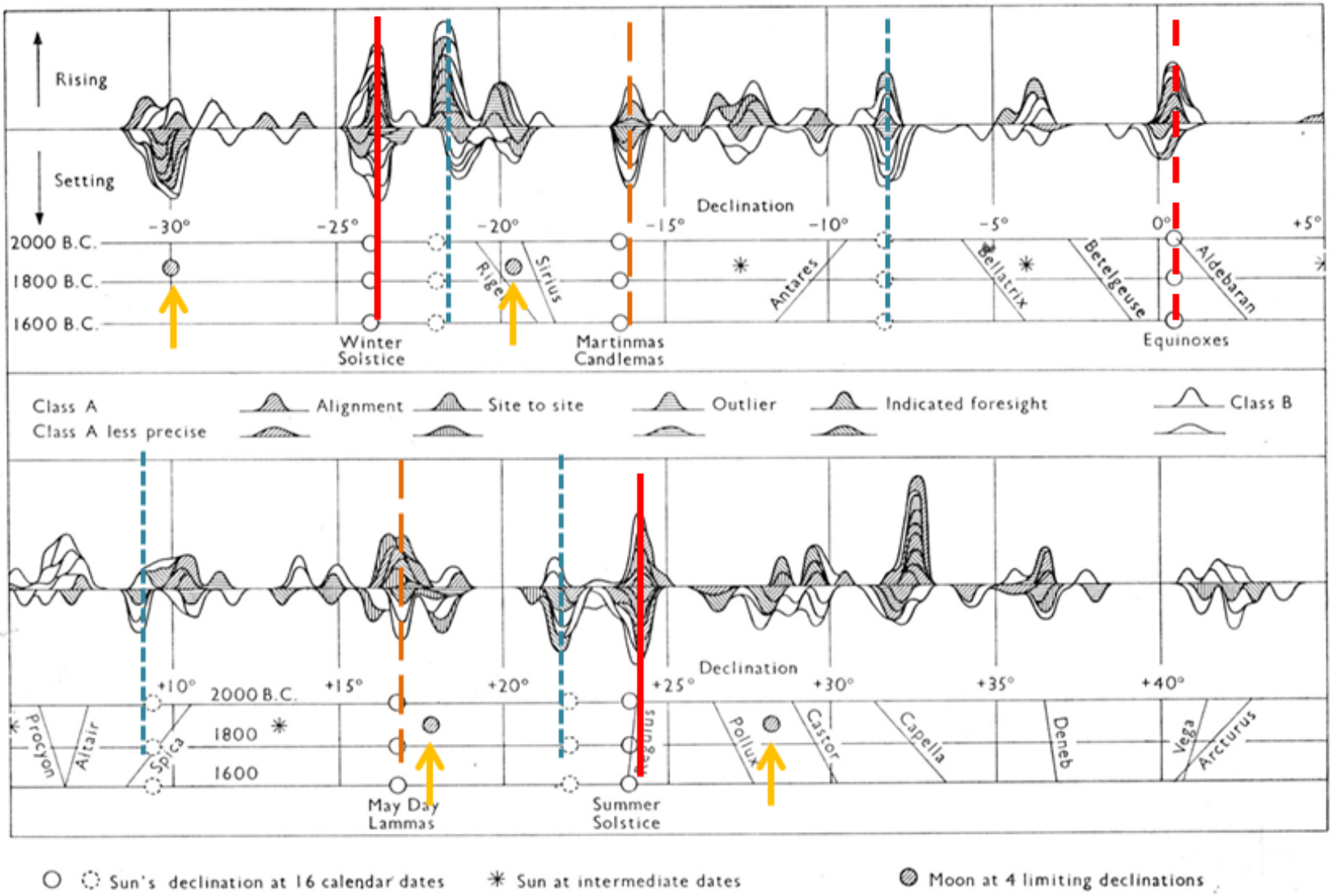
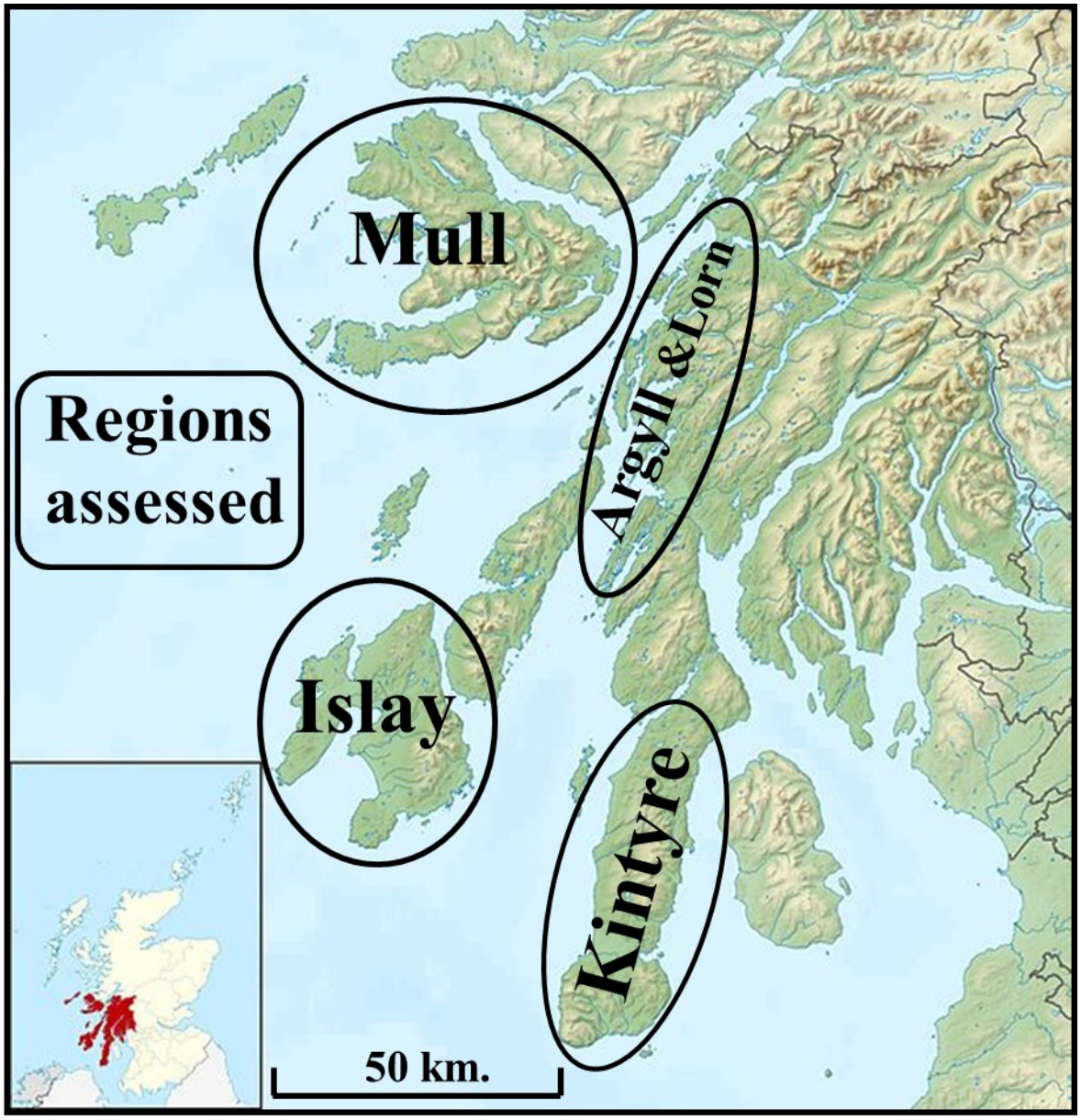
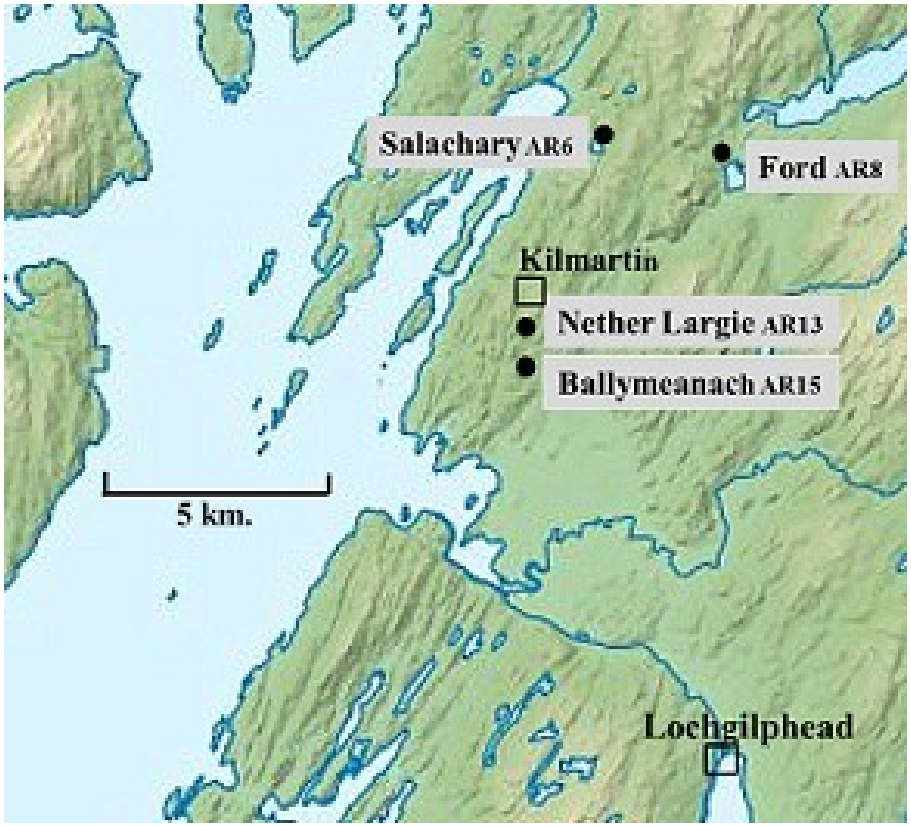
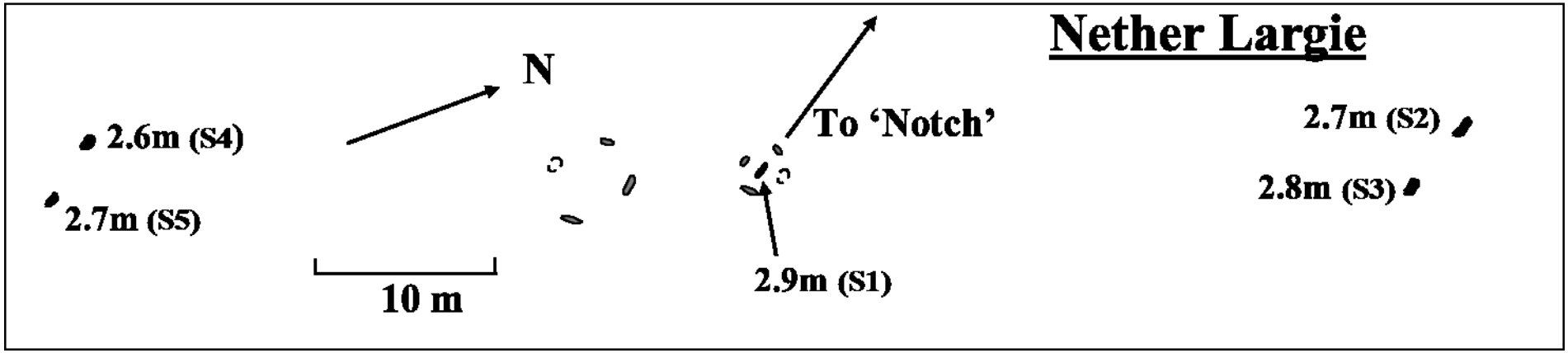
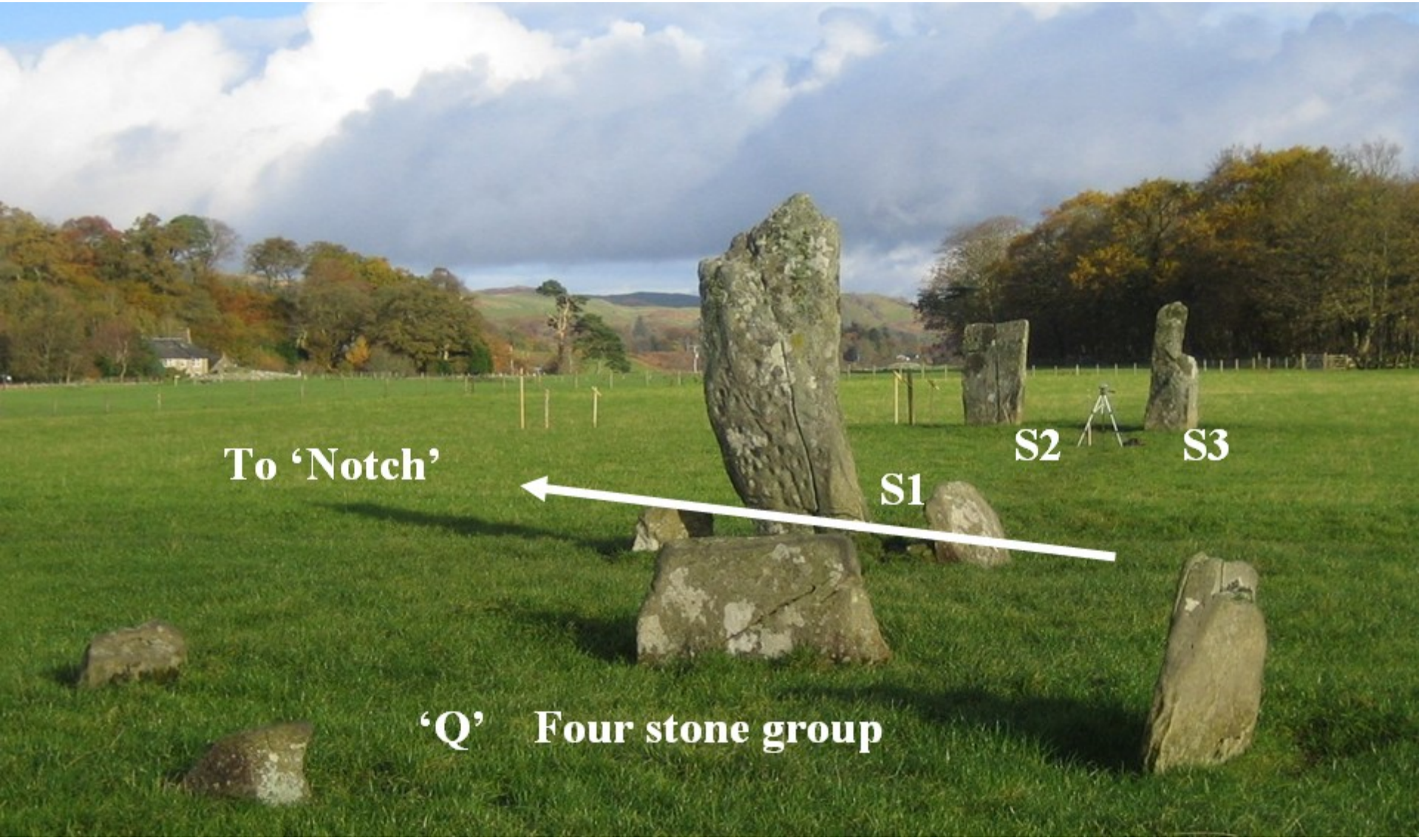


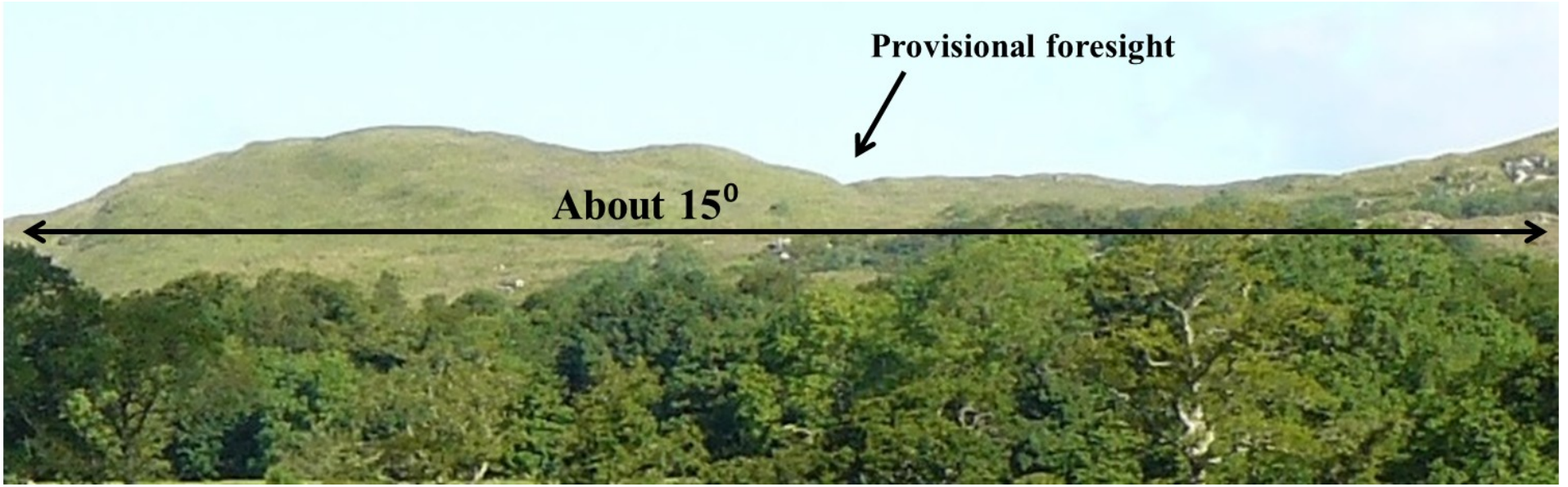
FIG. 8.1. Histogram of observed declinations.

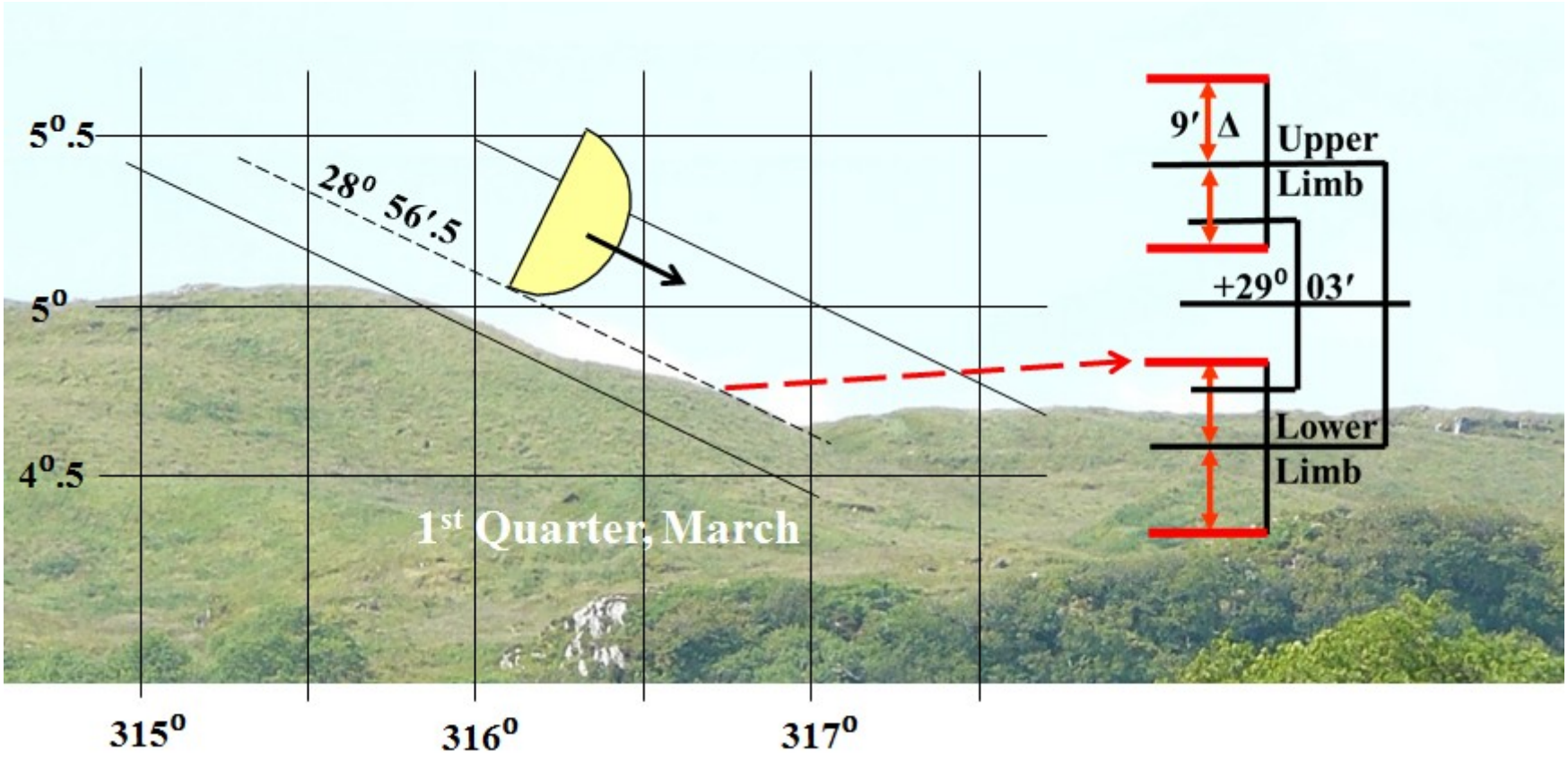

Mull
Regions assessed
Argyll &Lorn
Islay
Kintyre
50 km.

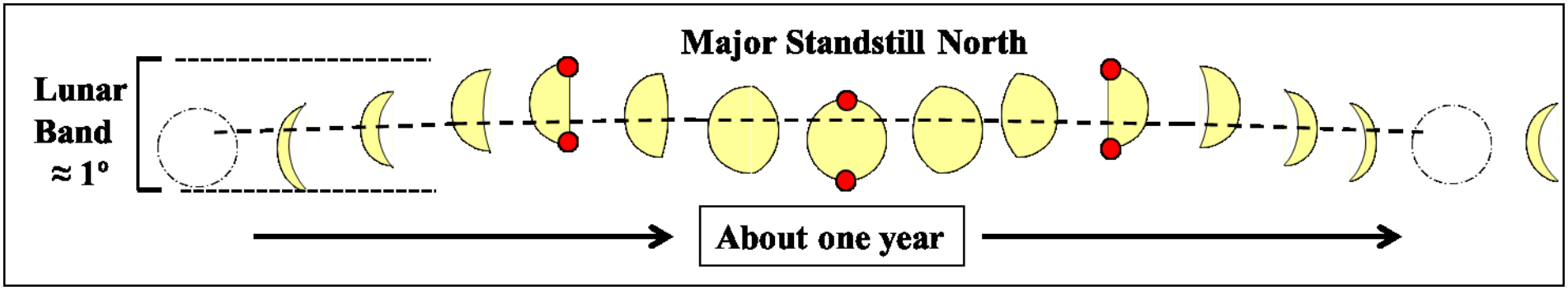

Salachary AR6
Ford AR8
Kilmartin
Nether Largie AR13
Ballymeanach AR15
5 km.
Lochgilphead


Nether Largie
N
To 'Notch'
2.6m (S4)
2.7m (S5)
2.7m (S2)
2.8m (S3)
2.9m (S1)
10 m


To 'Notch'
S1
S2
S3
'Q' Four stone group

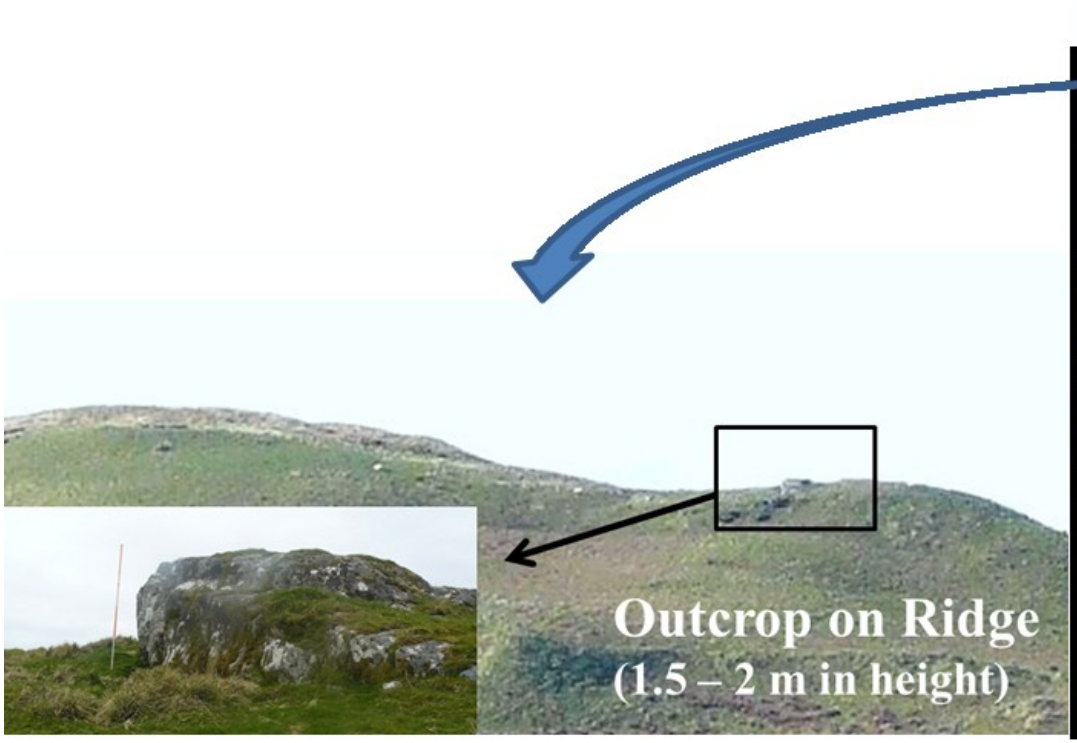

Provisional foresight
About 15^{0}

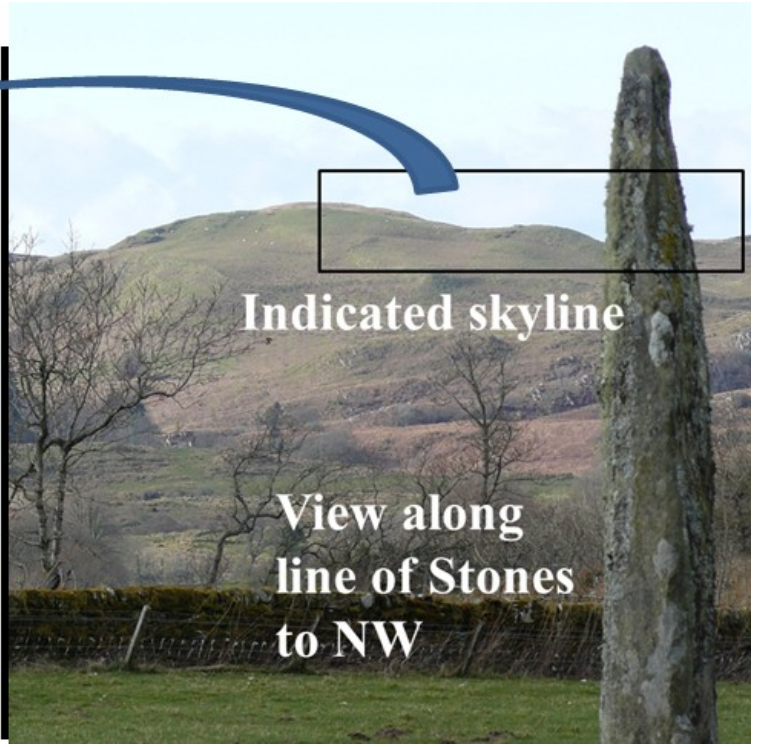

5°.5
5°
4°.5
28° 56′.5
1st Quarter, March
315°
316°
317°
9′ Δ
Upper
Limb
+29° 03′
Lower
Limb

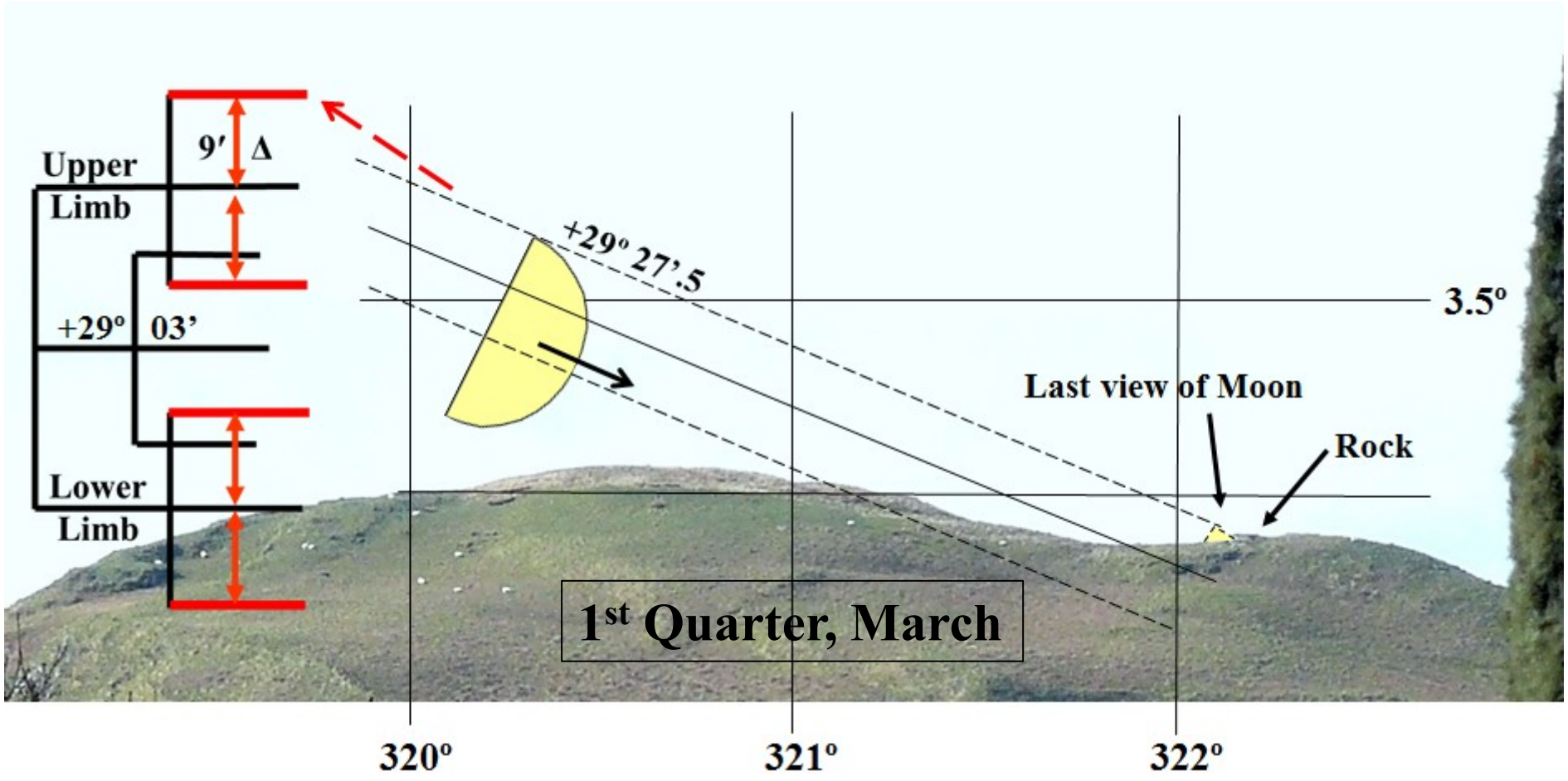

Major Standstill North
Lunar
Band
≈ 1°
About one year

Indicated Direction to NW
(Trees obscure a possible alignment for the winter solstice)

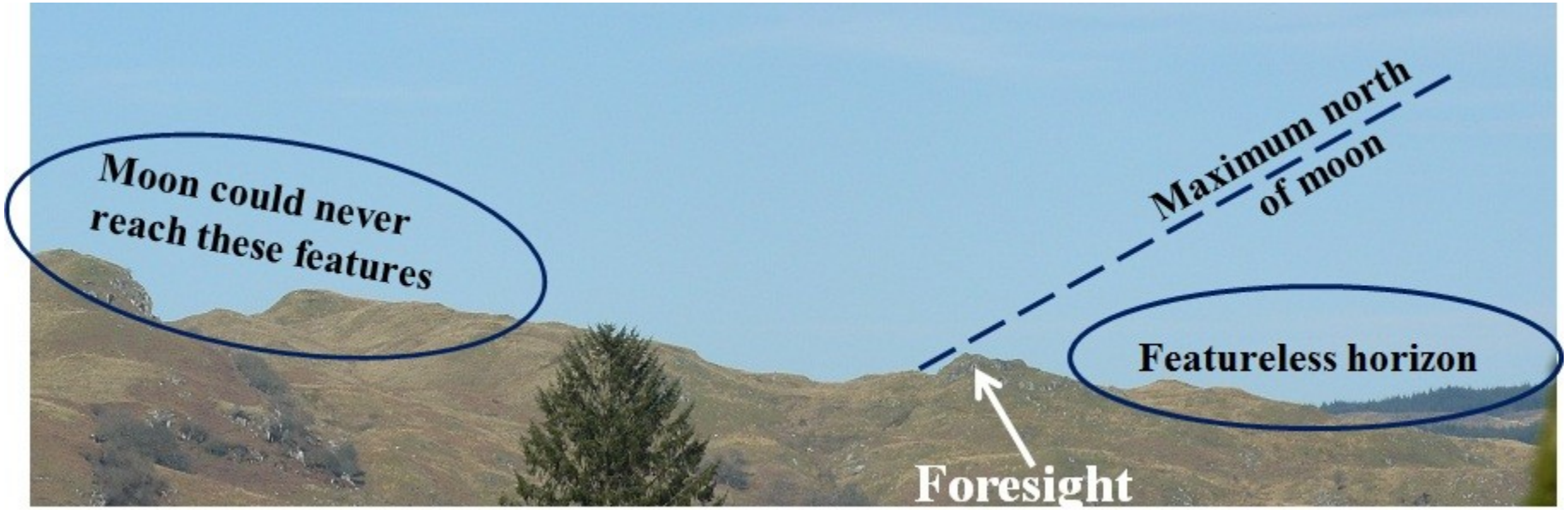
Ballymeanach Indicated foresight region

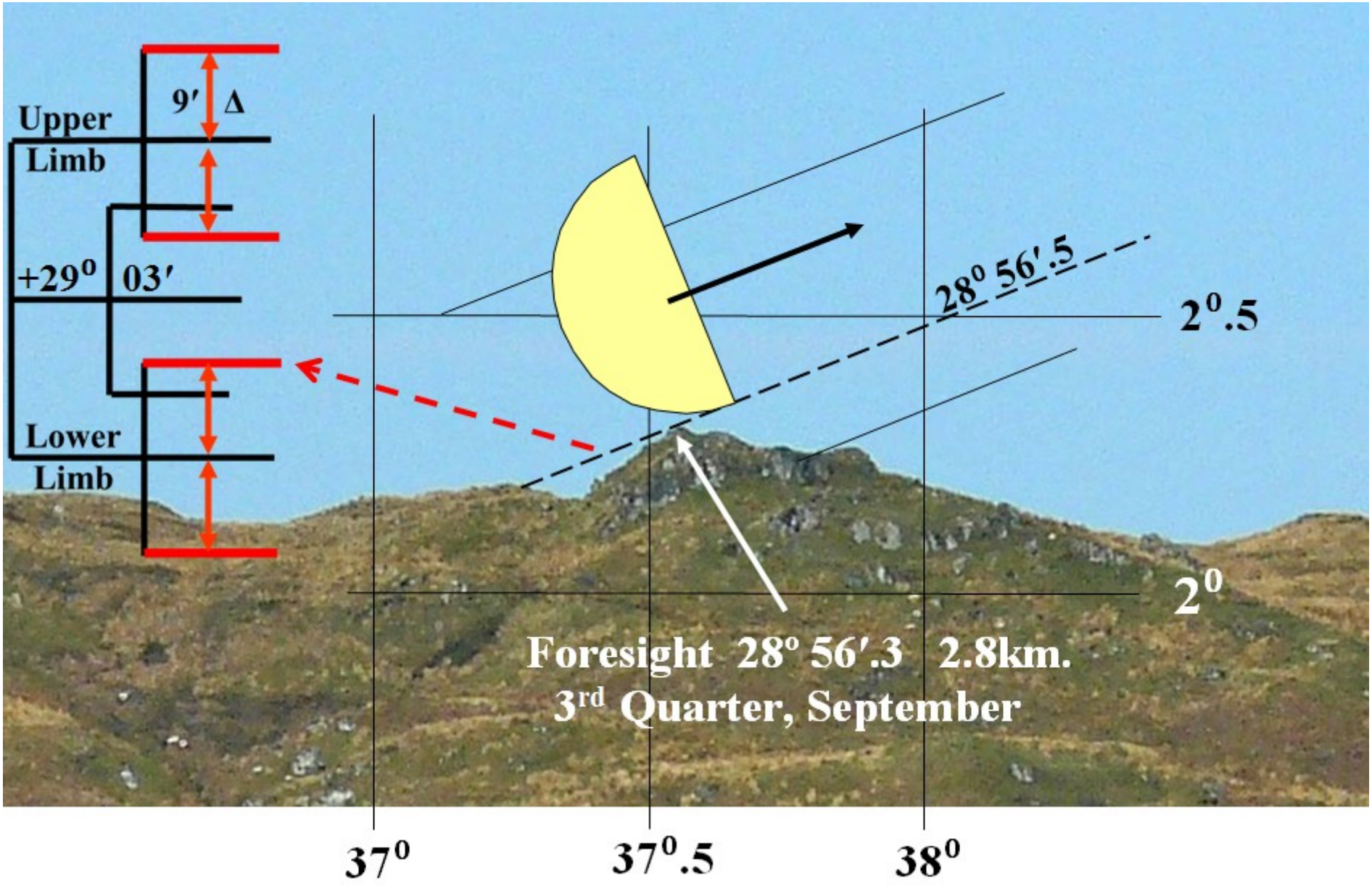


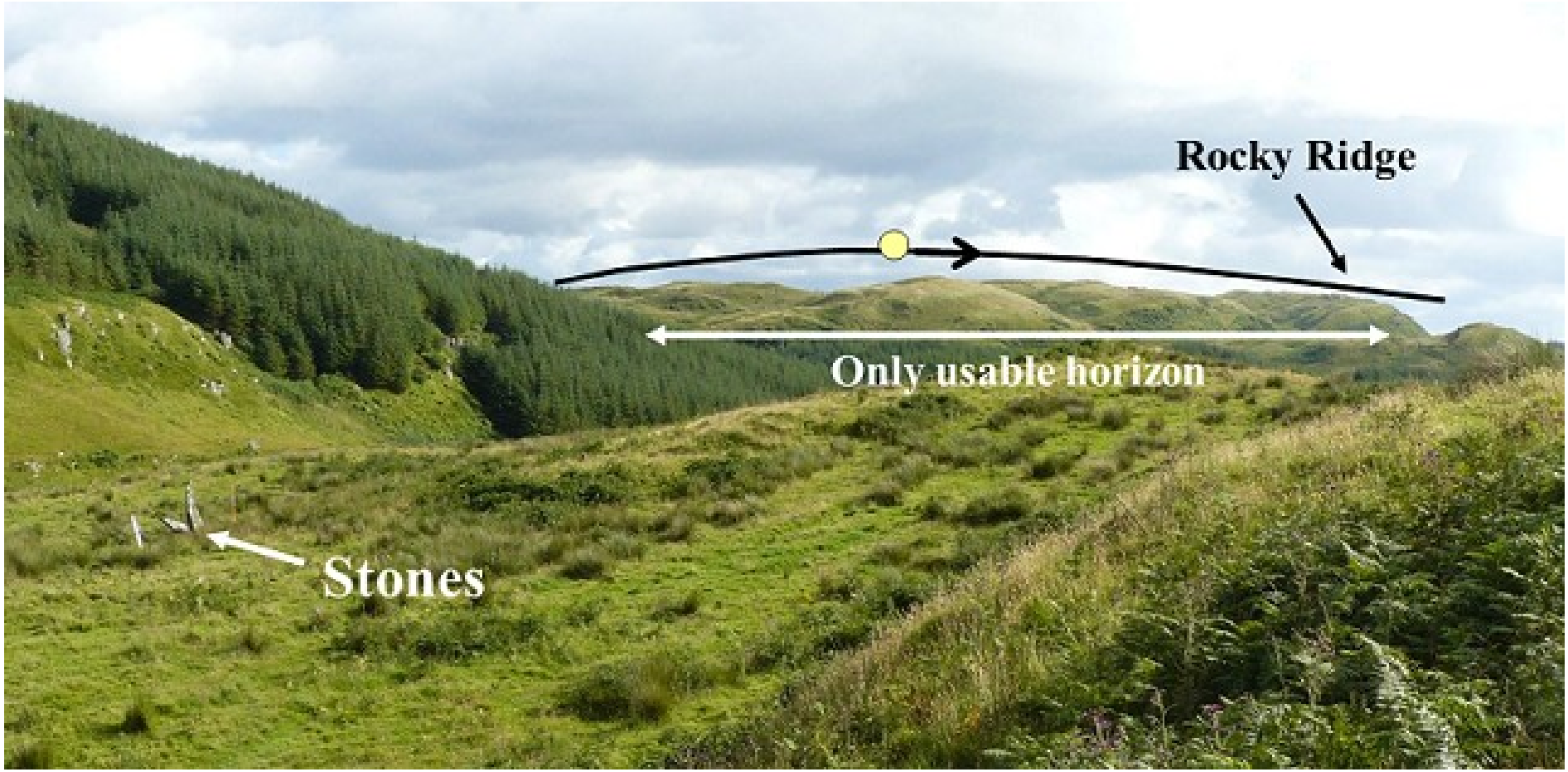


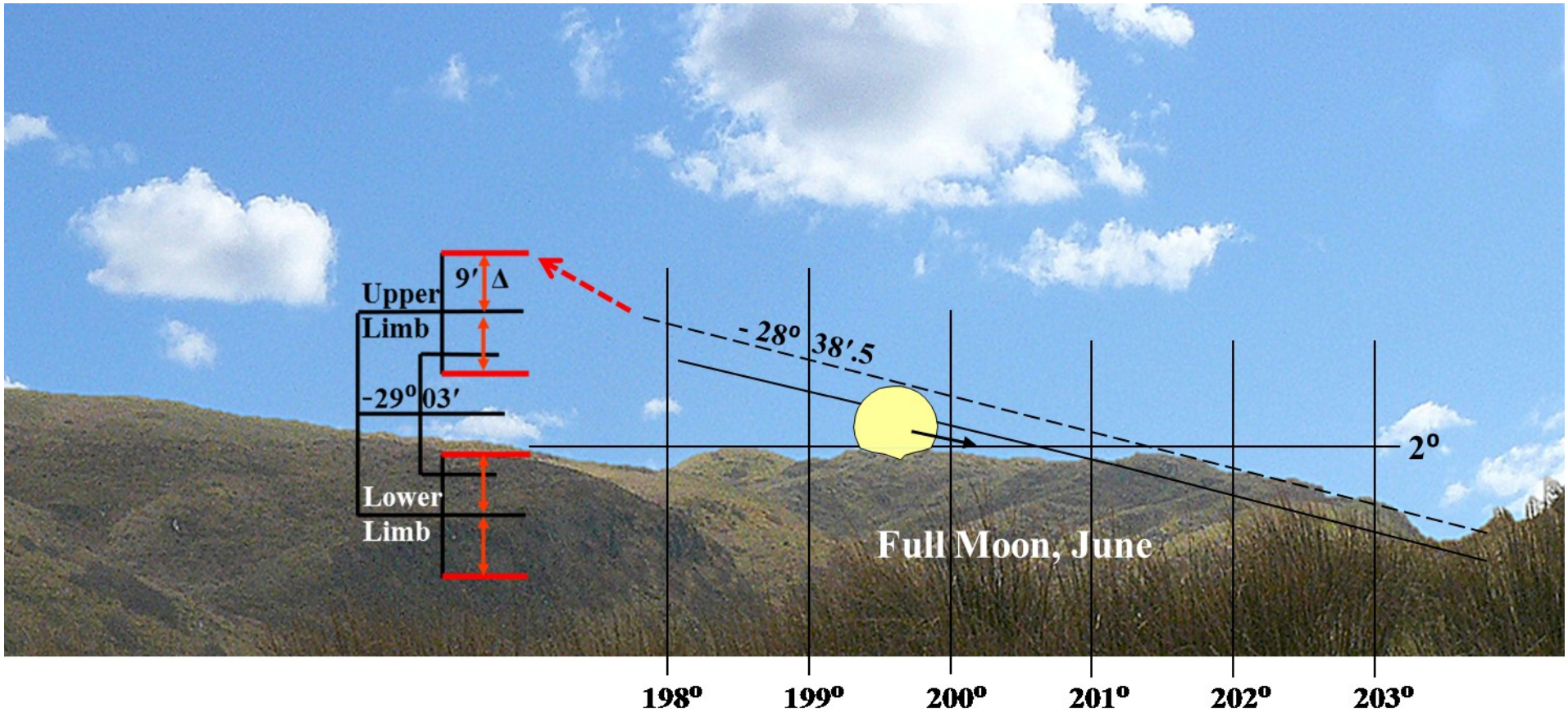

9′ Δ
Upper
Limb
+29° 03’
Lower
Limb
+29° 27’.5
3.5°
Last view of Moon
Rock
1st Quarter, March
320°
321°
322°

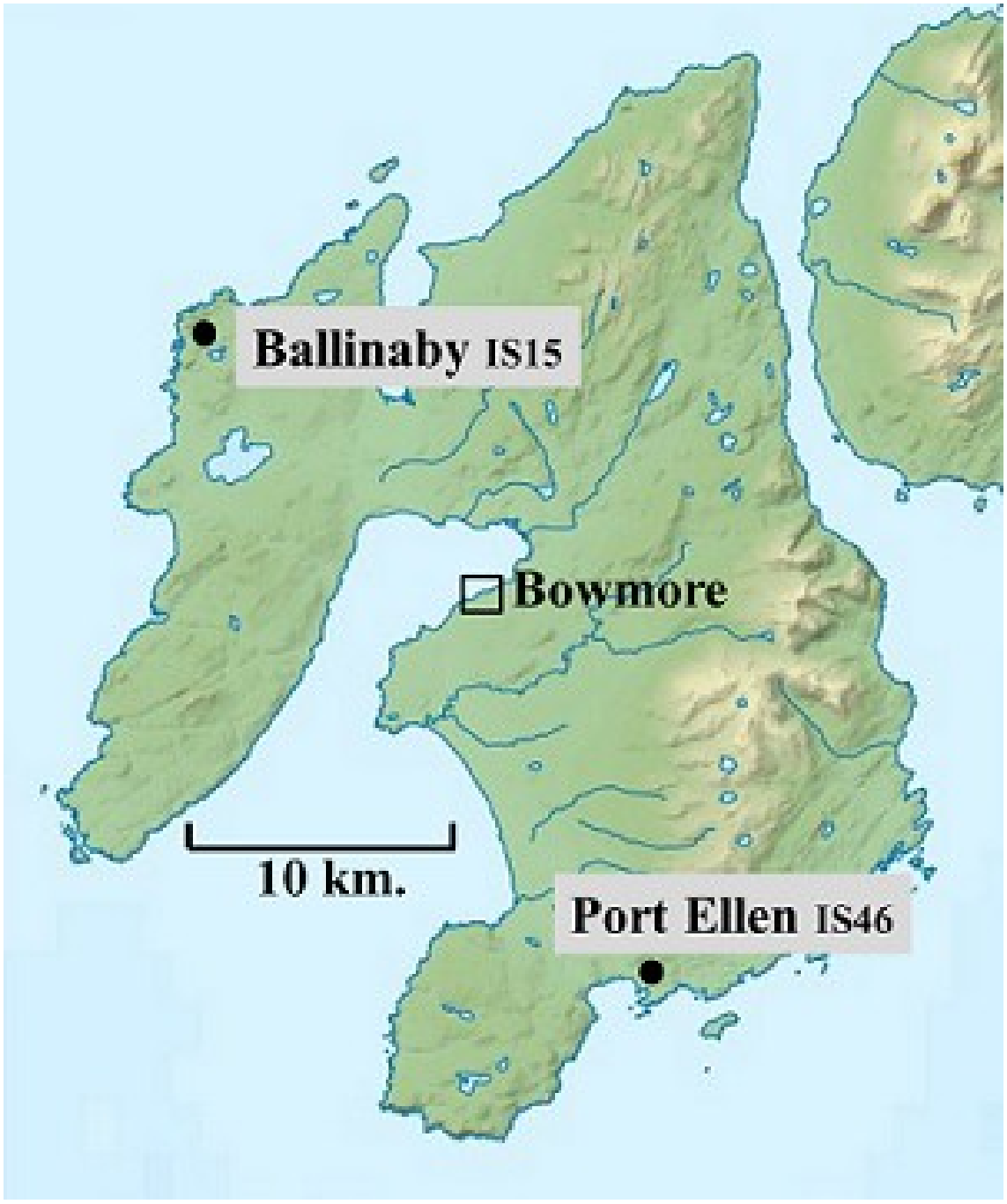
FORD


Moon could never reach these features
Maximum north of moon
Featureless horizon
Foresight

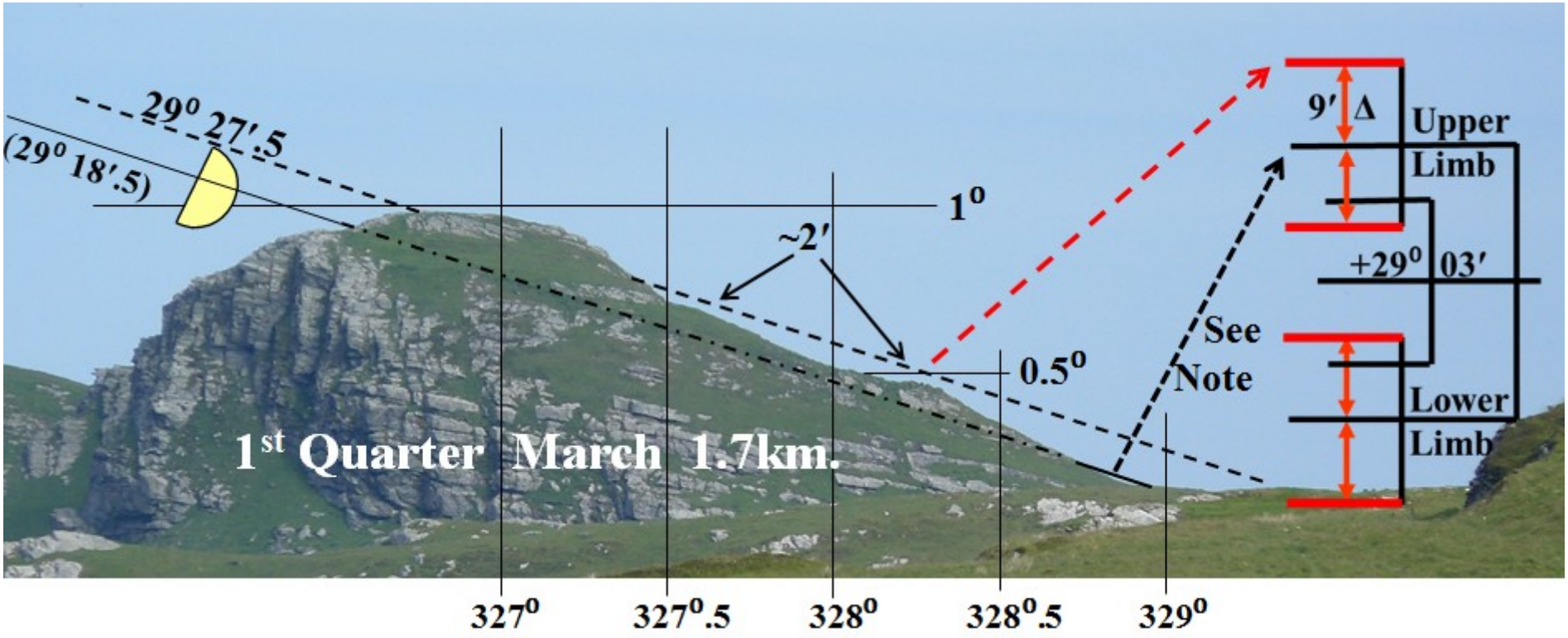

Upper
Limb
9′
Δ
+29° 03′
Lower
Limb
28° 56′.5
2°.5
2°
Foresight 28° 56′.3 2.8km.
3rd Quarter, September
37°
37°.5
38°

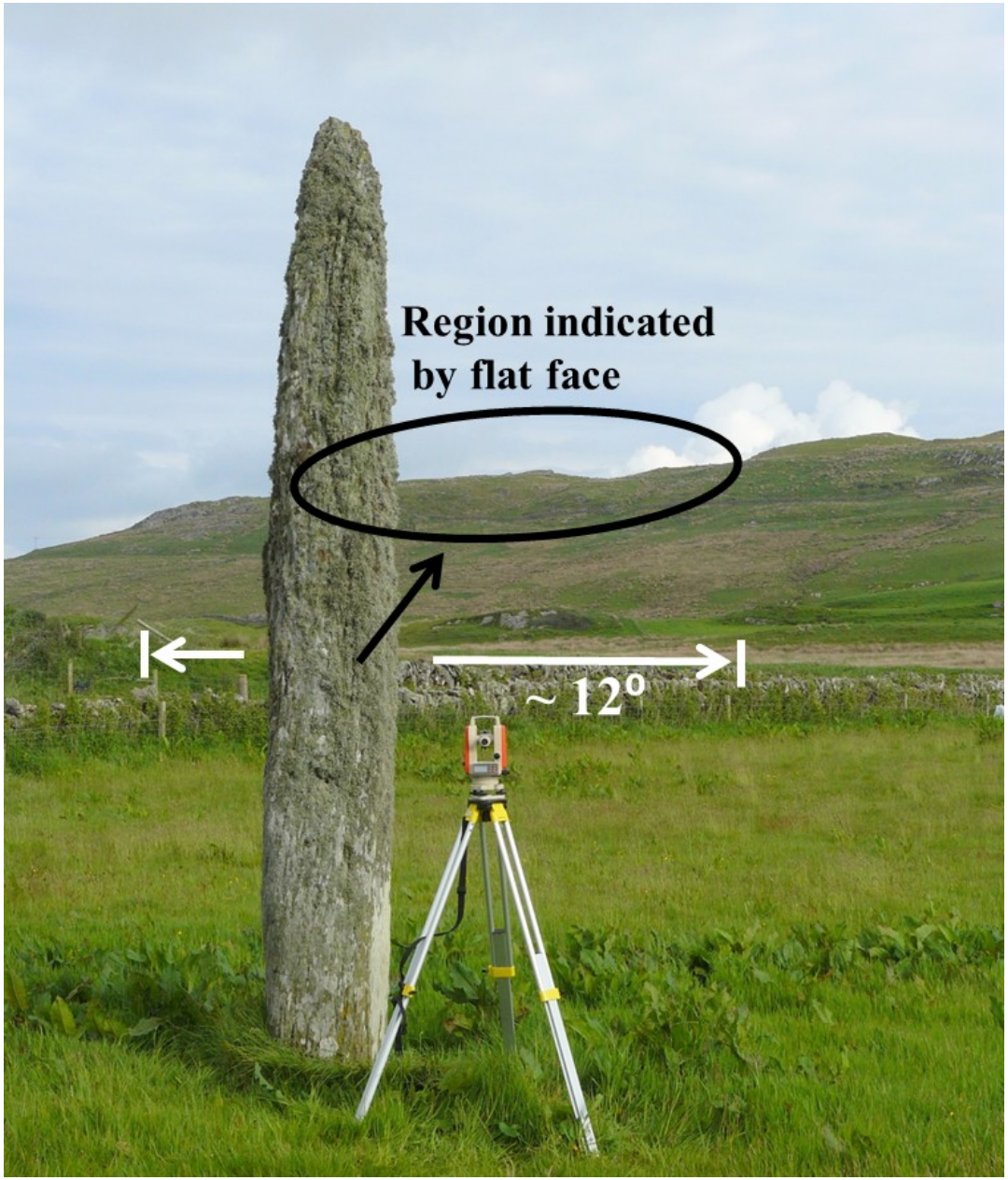

Rocky Ridge
Only usable horizon
Stones

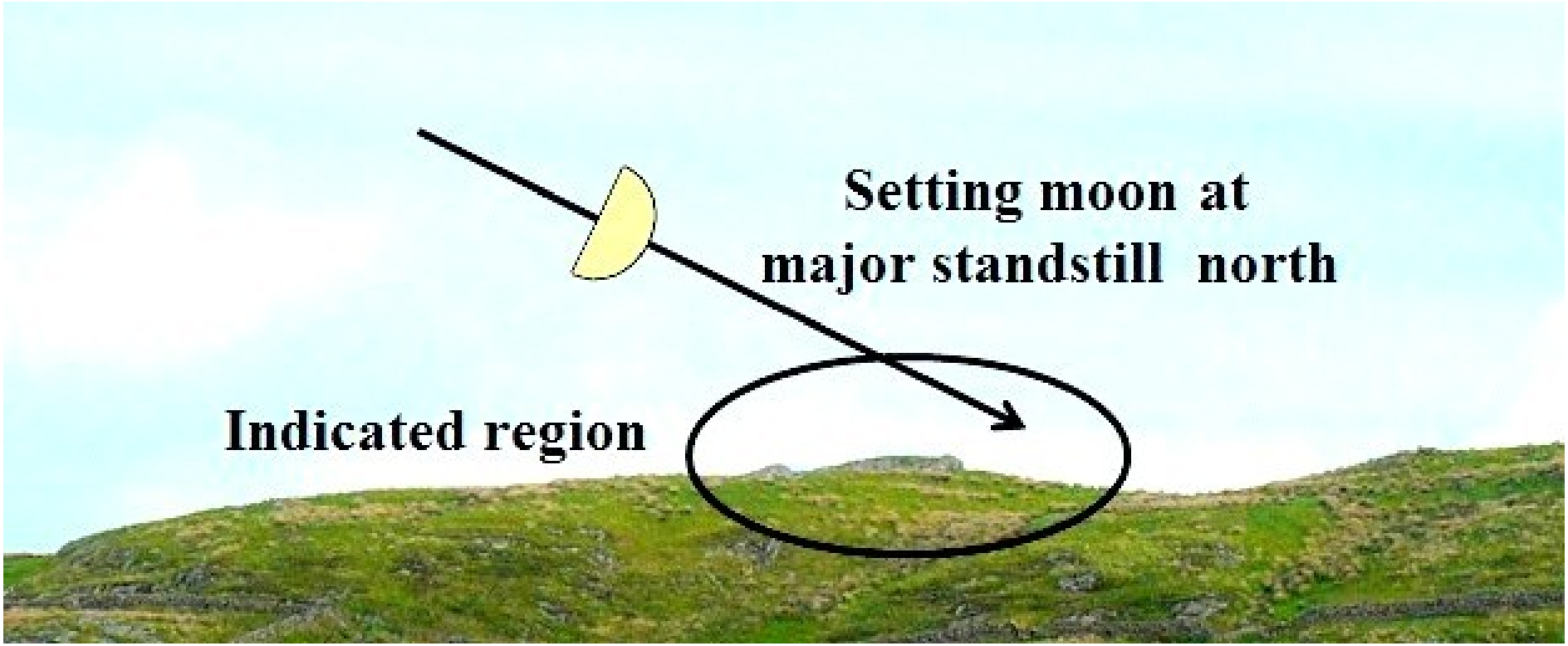

9′ Δ
Upper
Limb
-29° 03′
Lower
Limb
- 28° 38′.5
2°
Full Moon, June
198°
199°
200°
201°
202°
203°

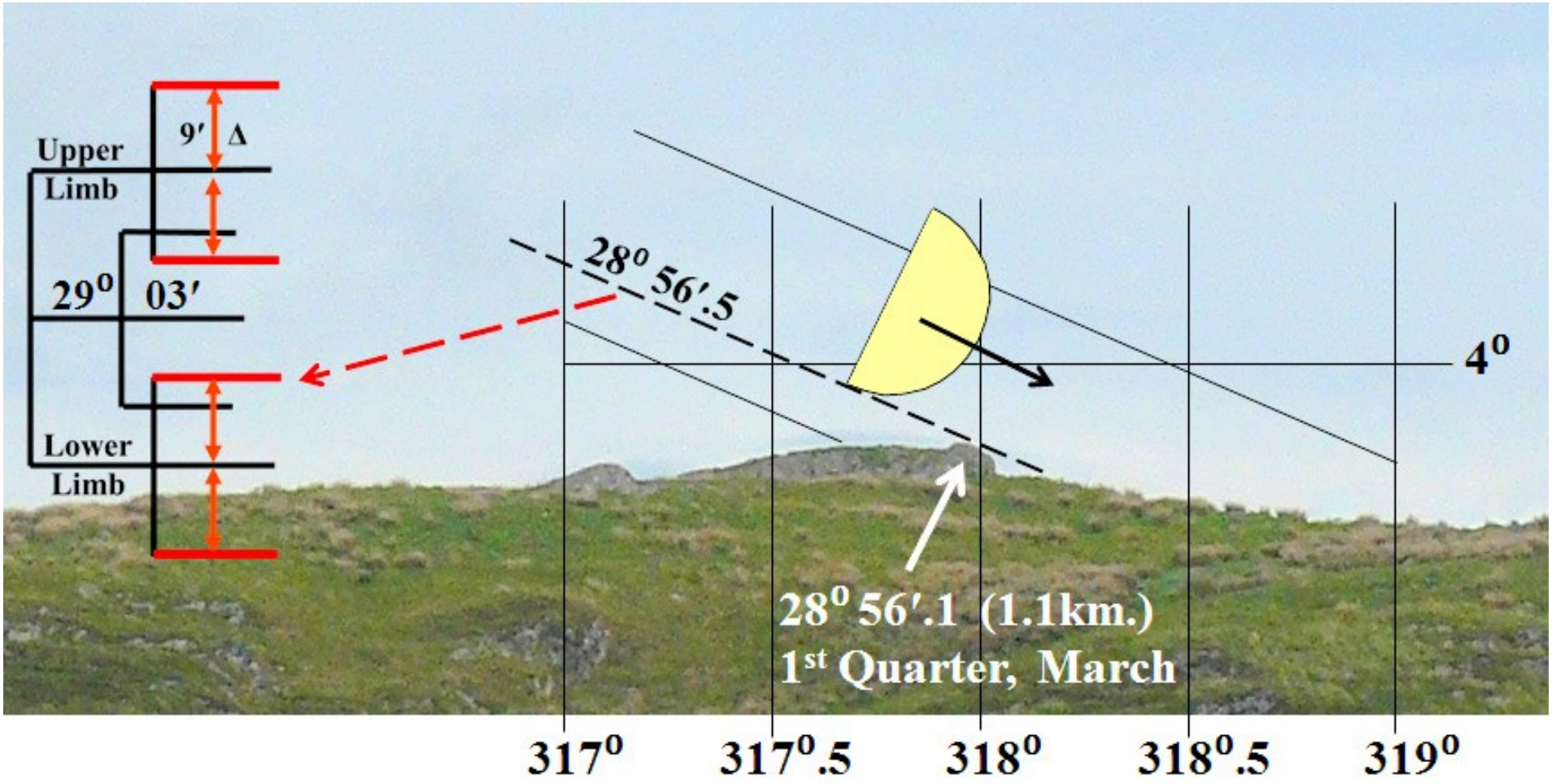

Ballinaby IS15
Bowmore
10 km.
Port Ellen IS46

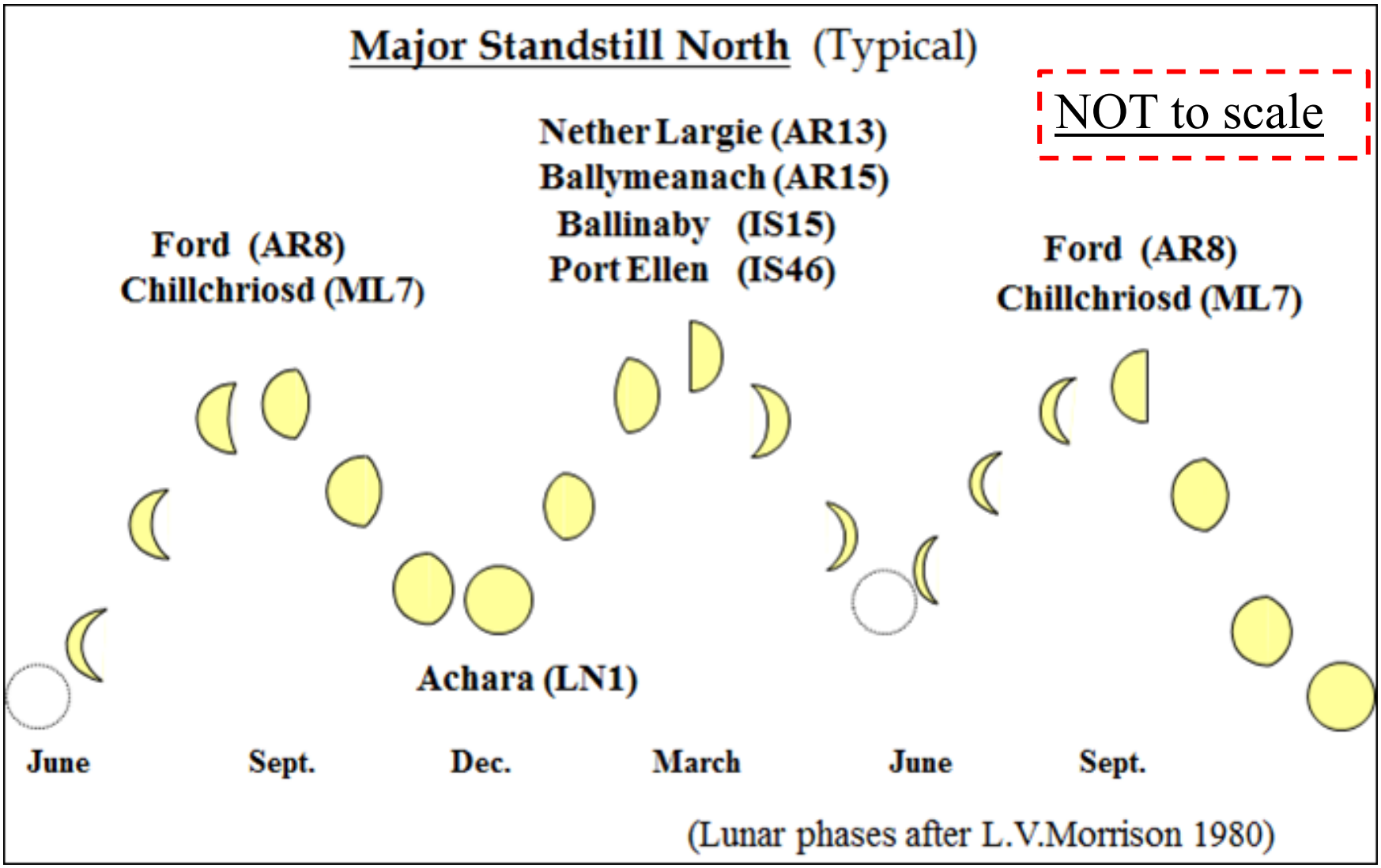
Indicated region

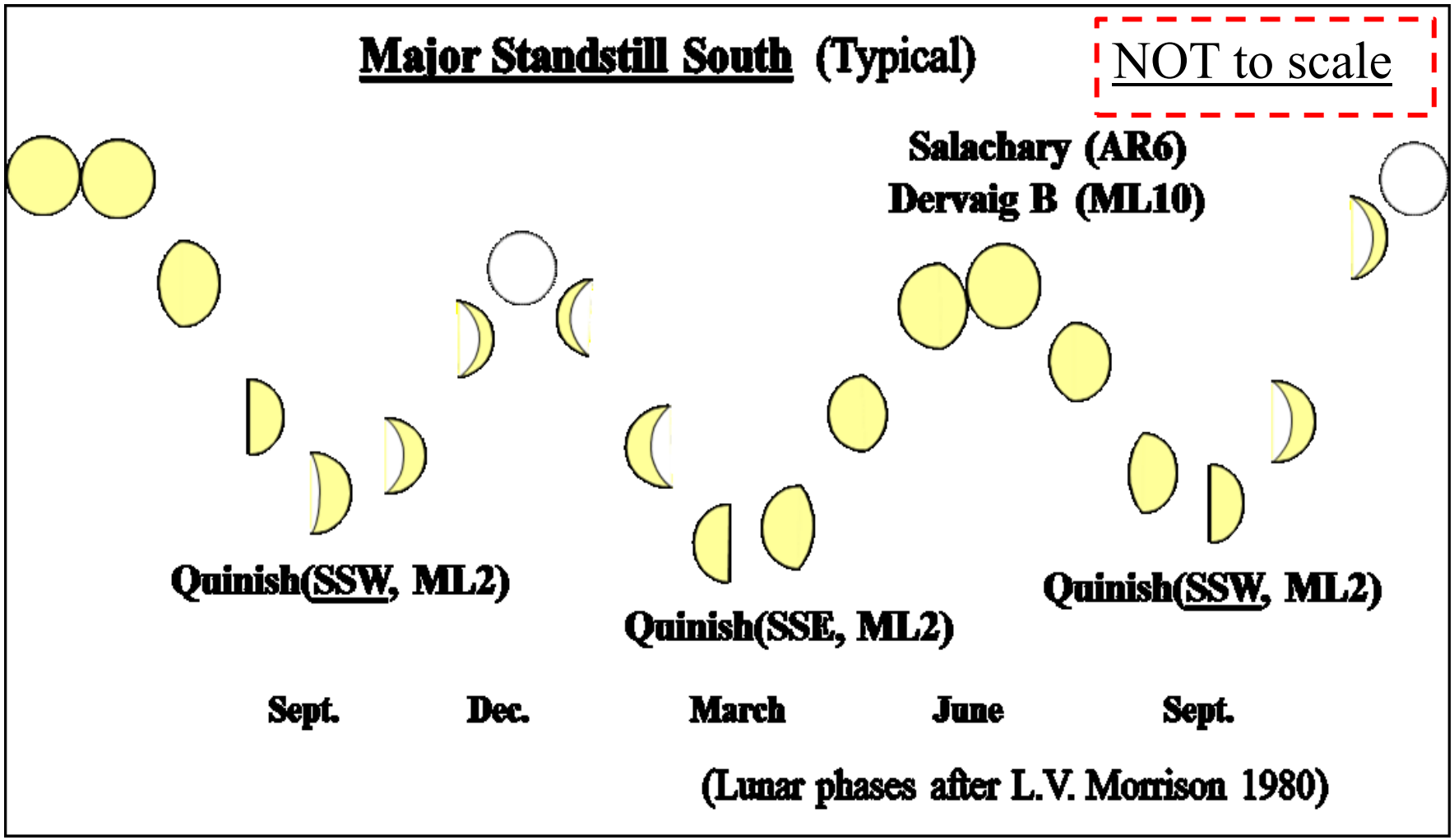

29° 27′.5
(29° 18′.5)
1°
~2′
0.5°
See Note
9′ Δ
Upper Limb
+29° 03′
Lower Limb
1st Quarter March 1.7km.
327°
327°.5
328°
328°.5
329°


Region indicated
by flat face
~ 12°


Setting moon at
major standstill north
Indicated region


9′ Δ
Upper
Limb
29° 03′
Lower
Limb
28° 56′.5
4°
28° 56′.1 (1.1km.)
1st Quarter, March
317°
317°.5
318°
318°.5
319°


Major Standstill North (Typical)
NOT to scale
Nether Largie (AR13)
Ballymeanach (AR15)
Ballinaby (IS15)
Port Ellen (IS46)
Ford (AR8)
Chillchriosd (ML7)
Ford (AR8)
Chillchriosd (ML7)
Achara (LN1)
June
Sept.
Dec.
March
June
Sept.
(Lunar phases after L.V.Morrison 1980)


Major Standstill South (Typical)
NOT to scale
Salachary (AR6)
Dervaig B (ML10)
Quinish(SSW, ML2)
Quinish(SSE, ML2)
Quinish(SSW, ML2)
Sept.
Dec.
March
June
Sept.
(Lunar phases after L.V. Morrison 1980)

Chance alignments

Ruggles has written that in hilly country from an arbitrary point:-
" …the chances are that we could find at least one or two horizon features interpretable as lunar foresights."

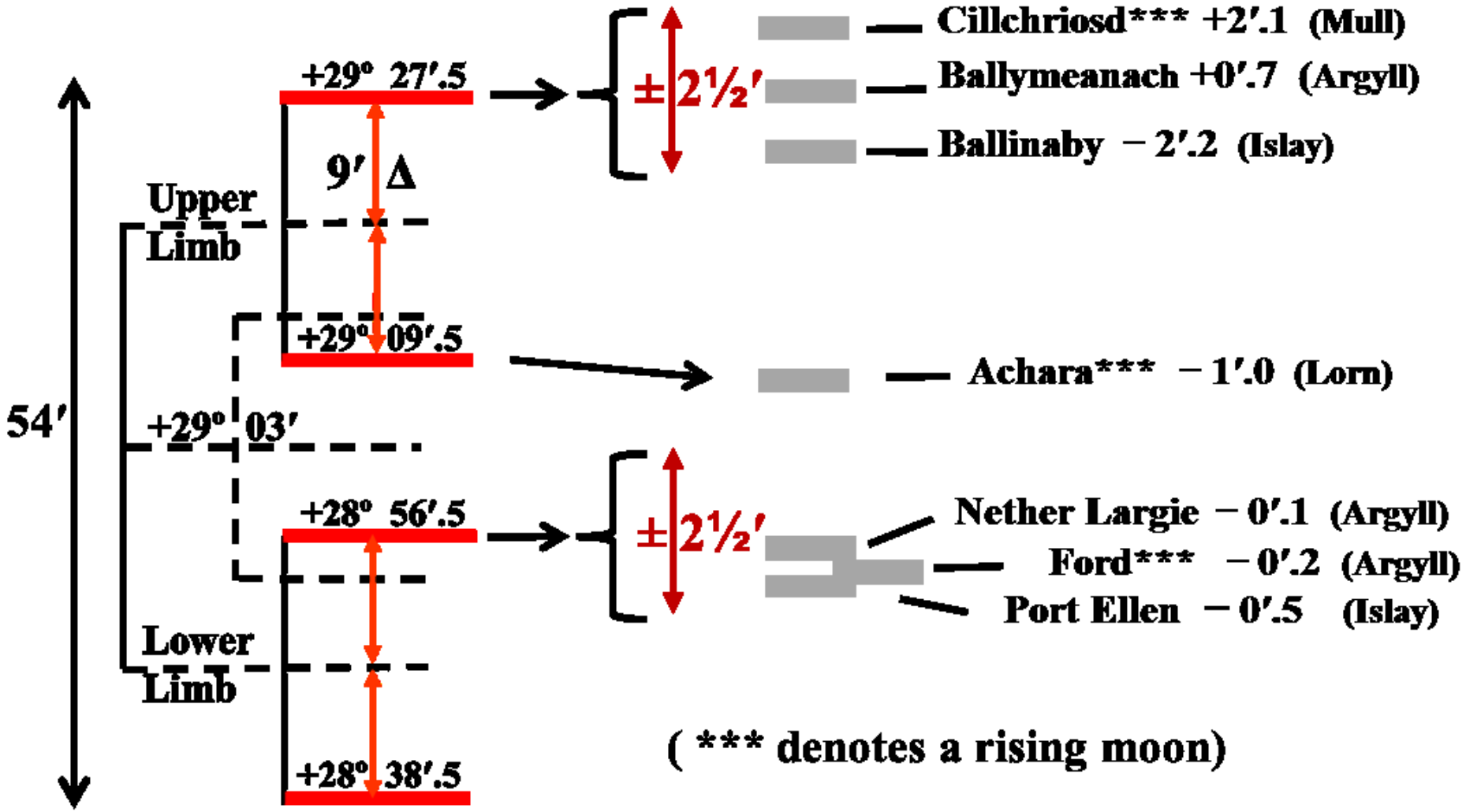
This possibility was checked in the field:-

From 10 identifiable places with suitably hilly skylines, usually at a stone, a search for chance alignments was made.

In total some 1500 degrees of hilly horizon was searched. This contained 30 lunar bands. Three chance alignments were found; two minor alignments and one major alignment.

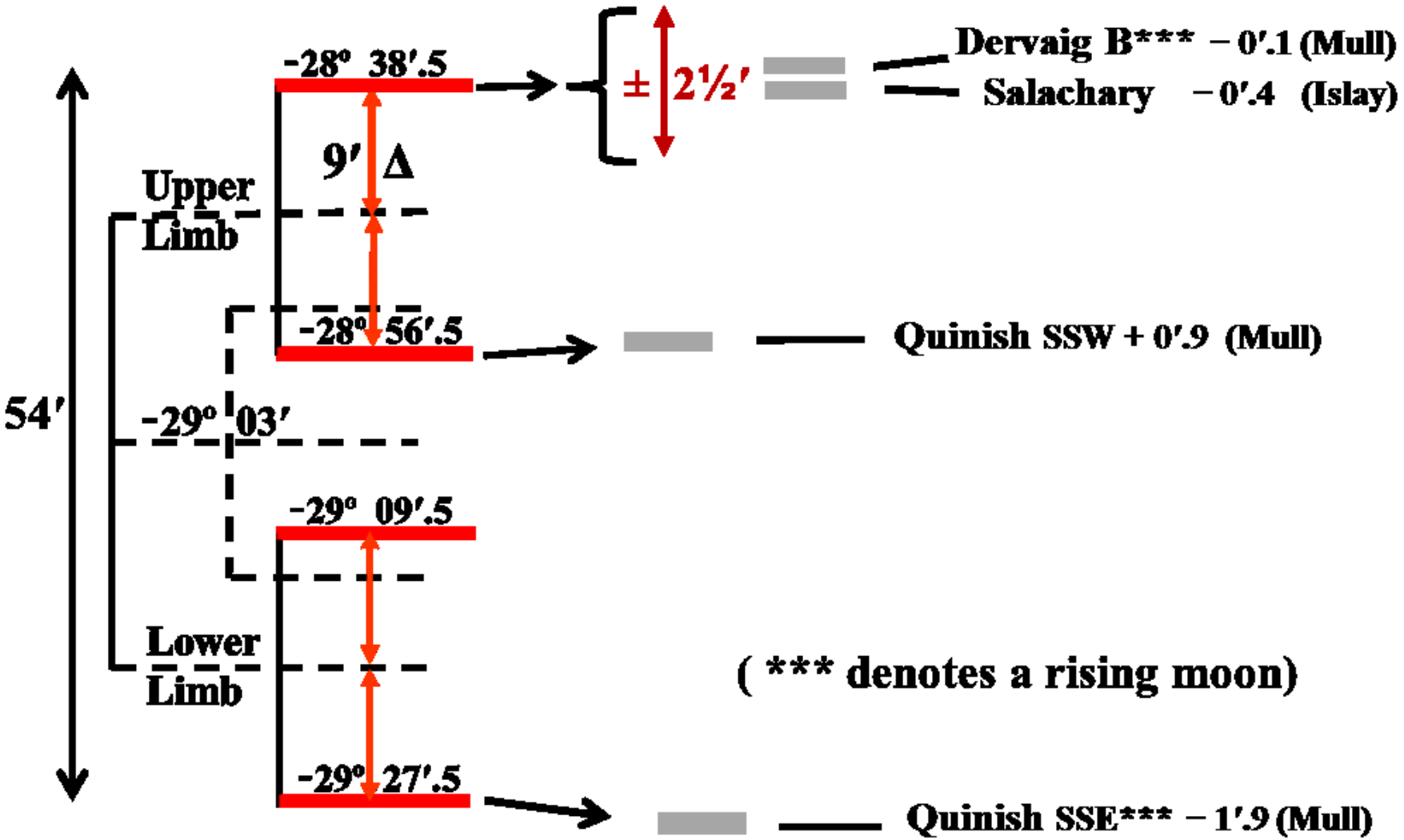
Thus in this study 1 in 10 chance alignments were found which cannot explain the results found.

The 7 precise alignments at the Lunar Standstill North



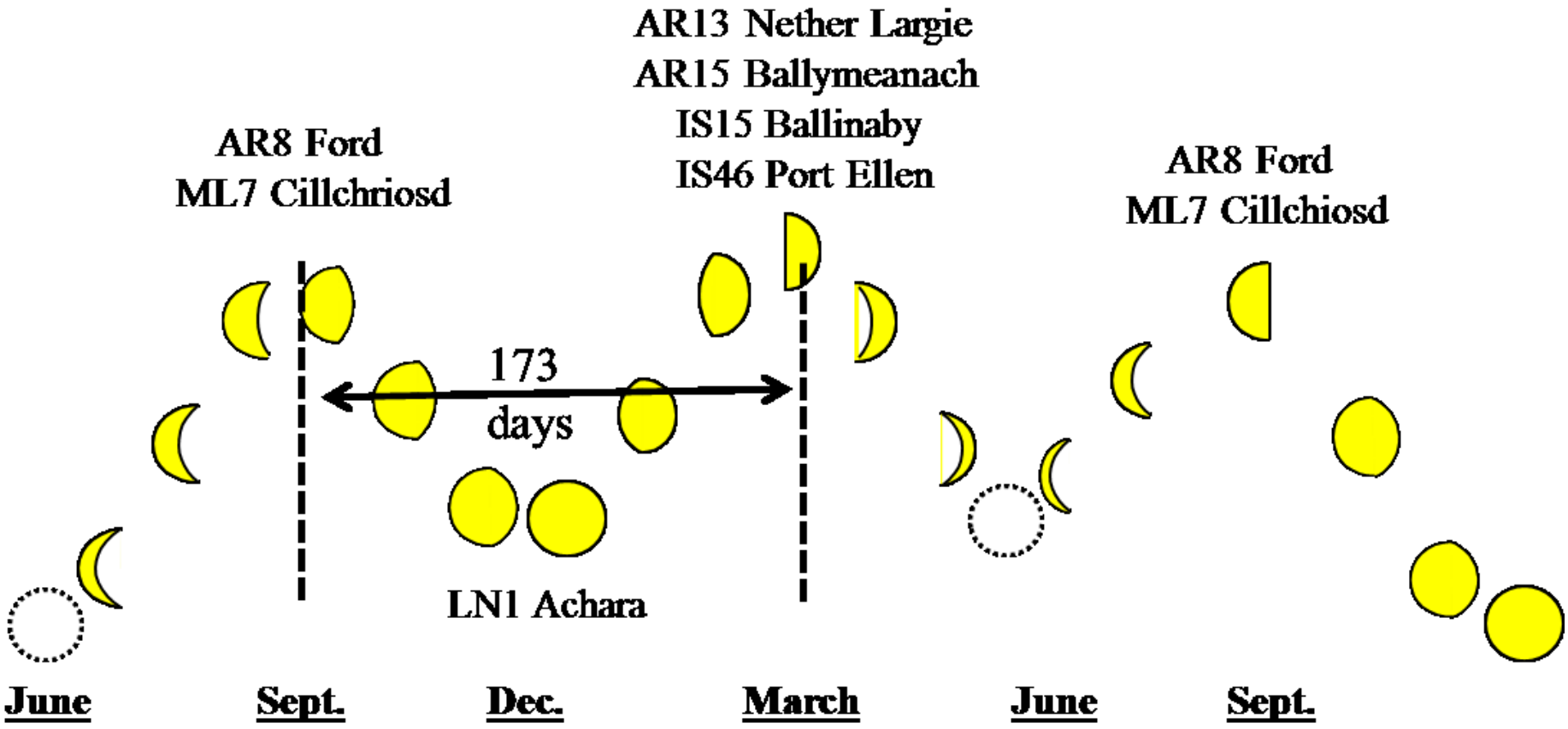
(*** denotes a rising moon)

The 4 precise alignments at the Lunar Standstill South



Maximum Standstill North (Typical)

(Note: Size of moon much reduced for clarity)



(Lunar phases after L.V. Morrison, JHA 1980)

eclipse year, and so the interval between what we shall call the danger times,

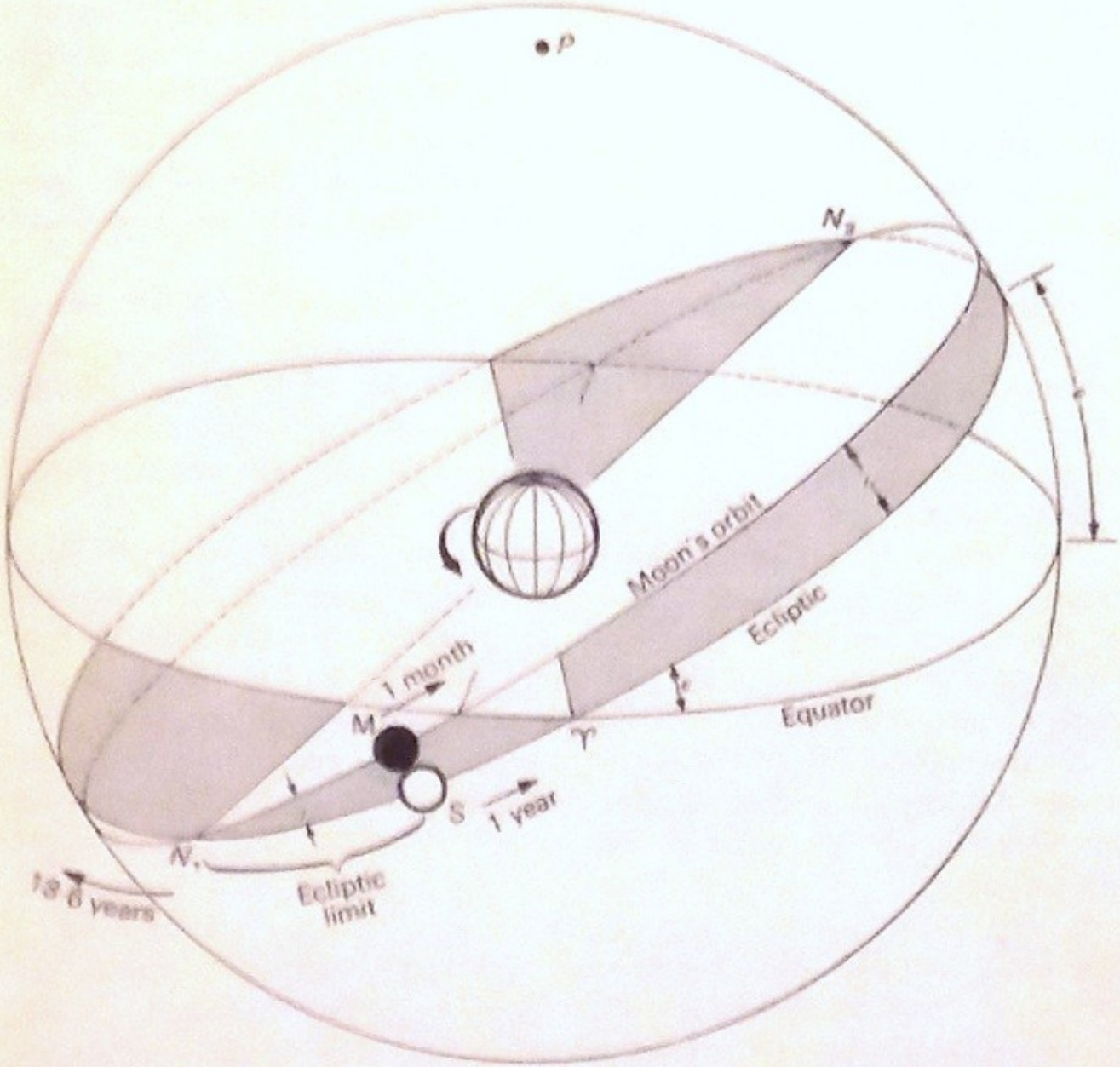
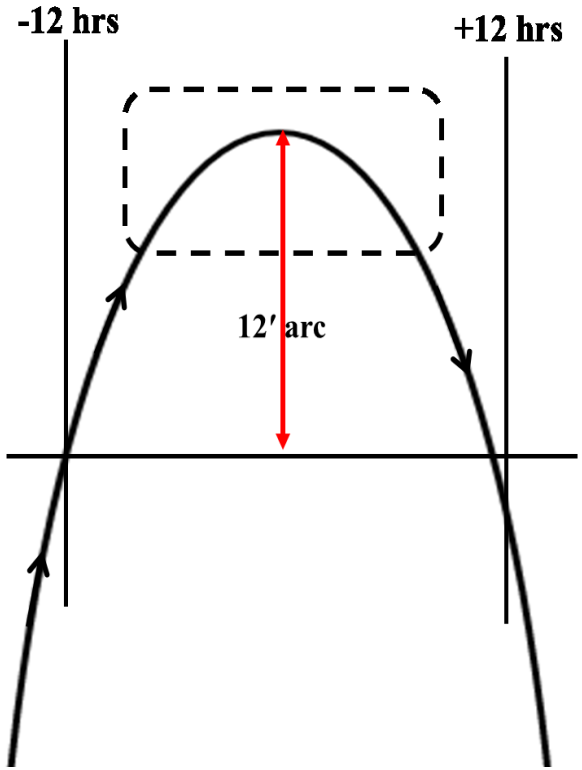
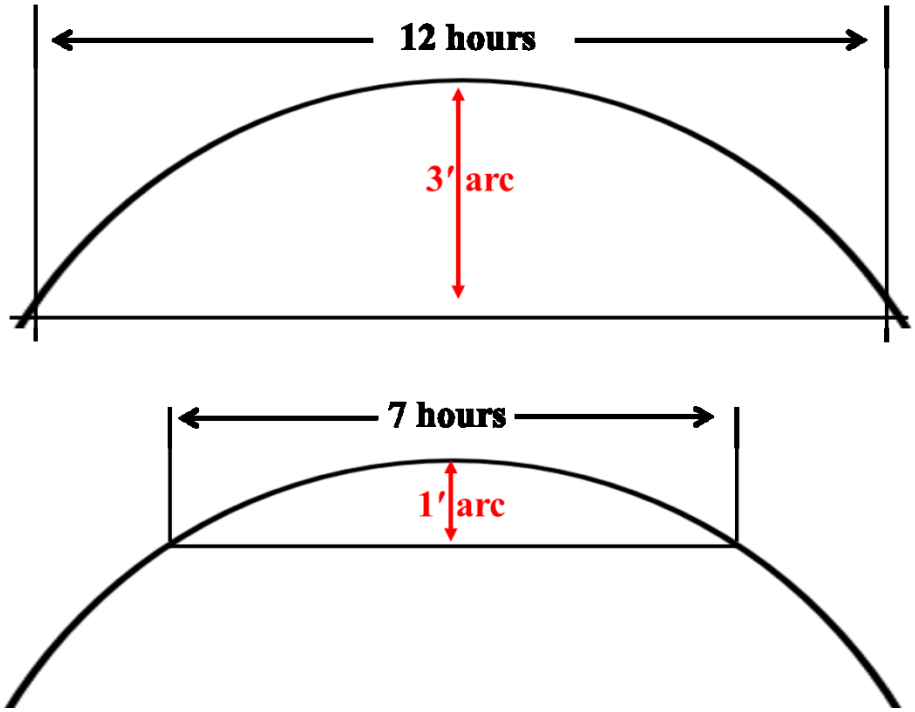


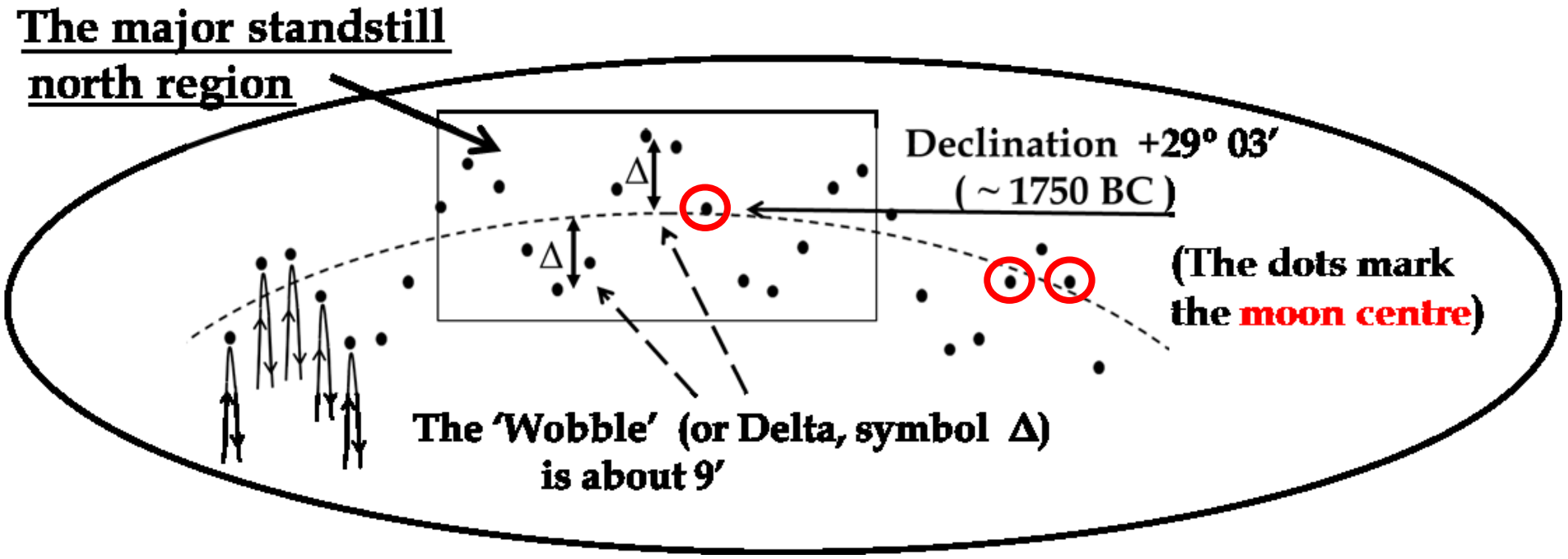
FIG. 2.1. The celestial sphere with the Earth rotating at the centre. S — Sun, M — Moon.

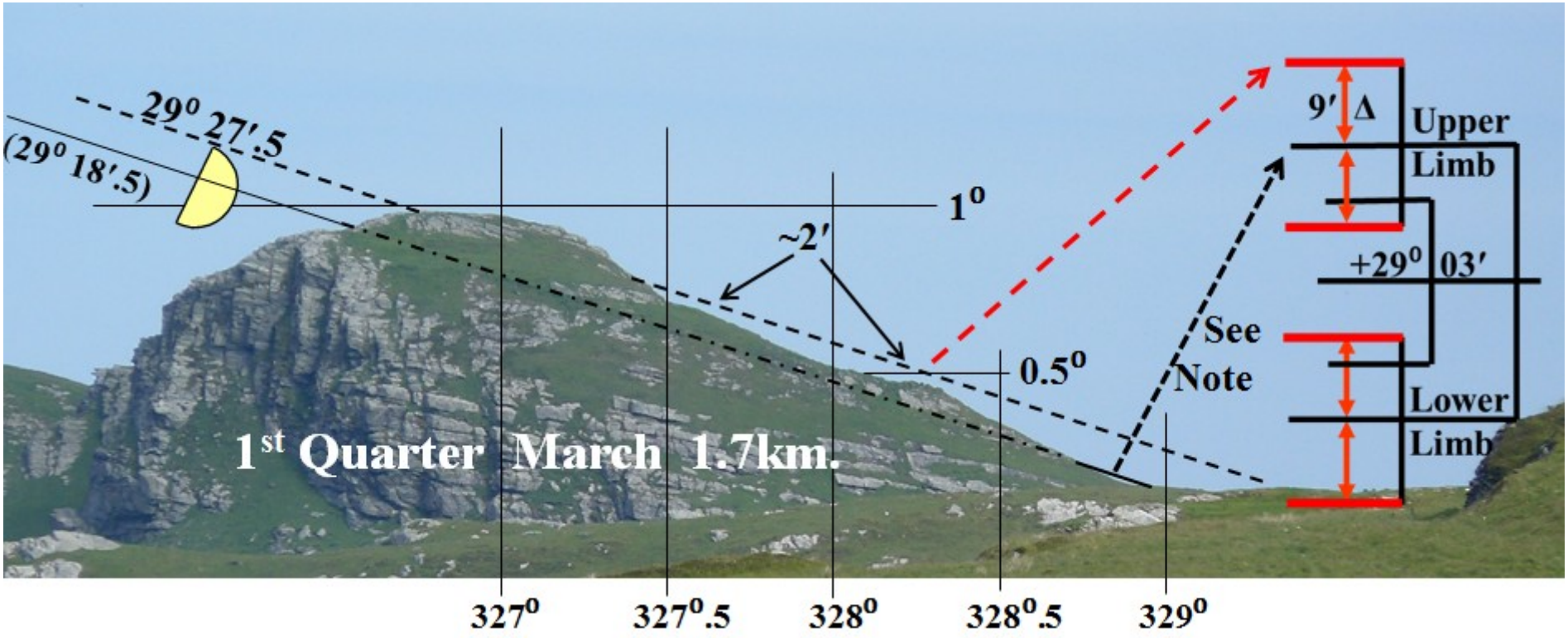
Rate of Moon movement near maximum

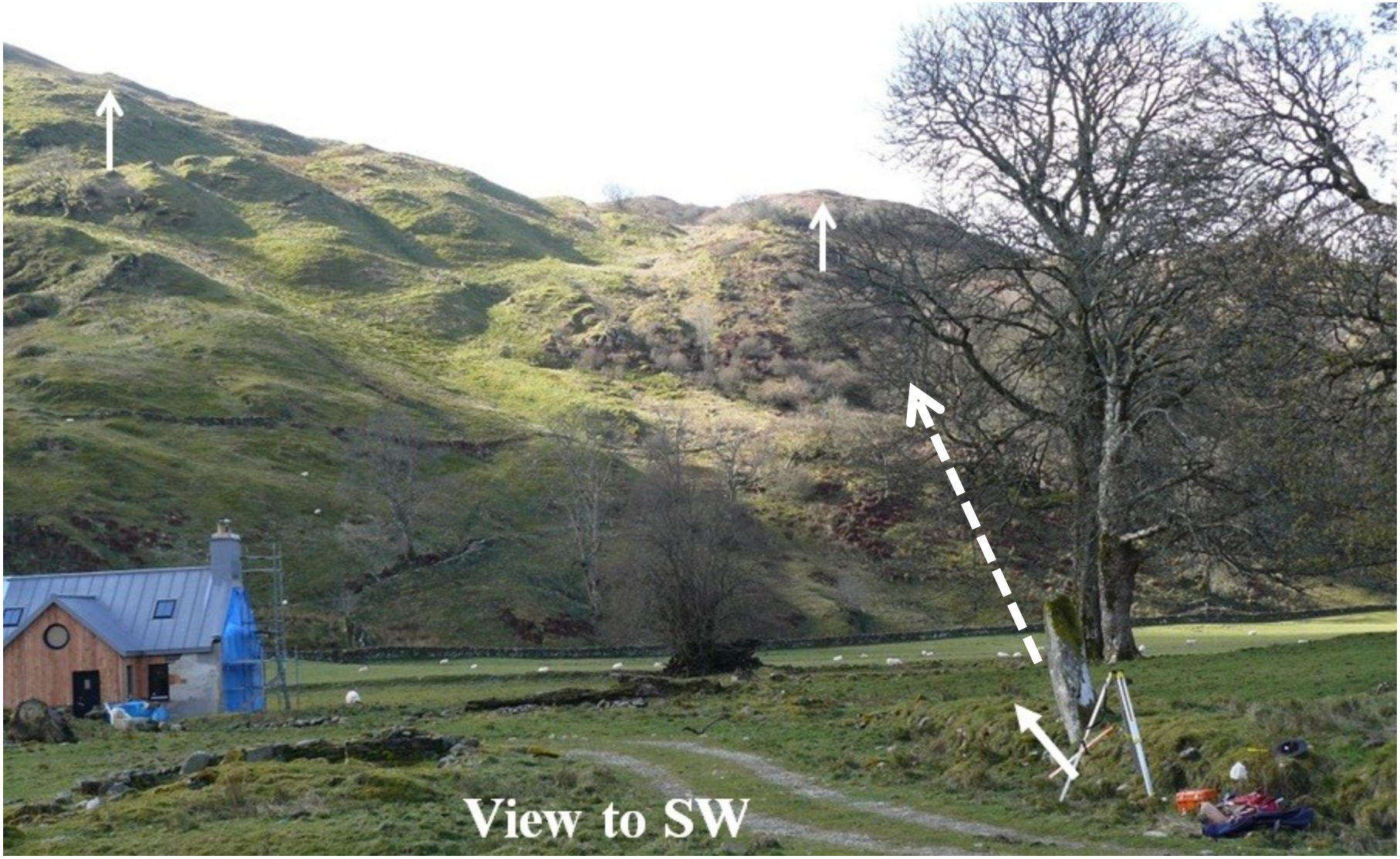


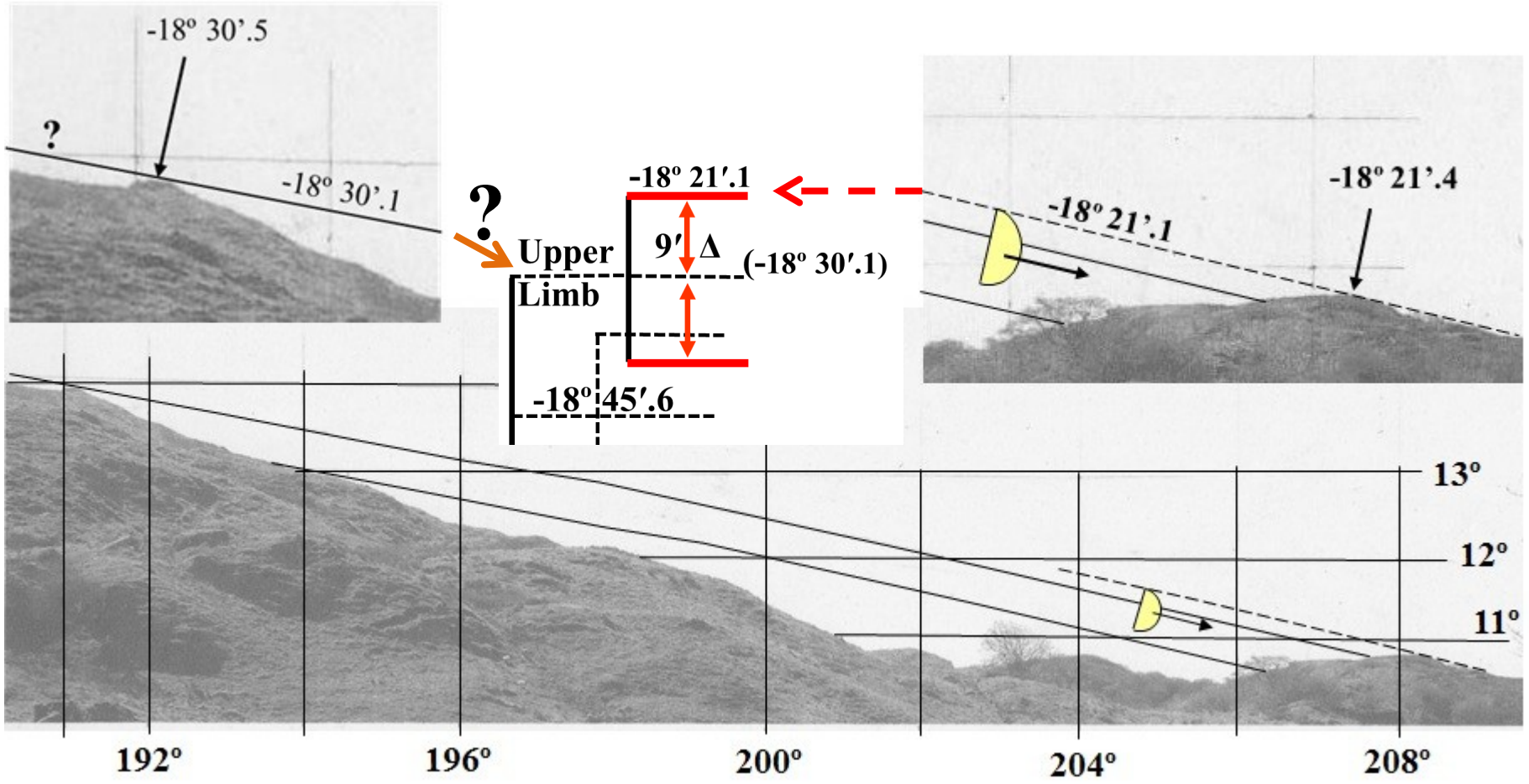


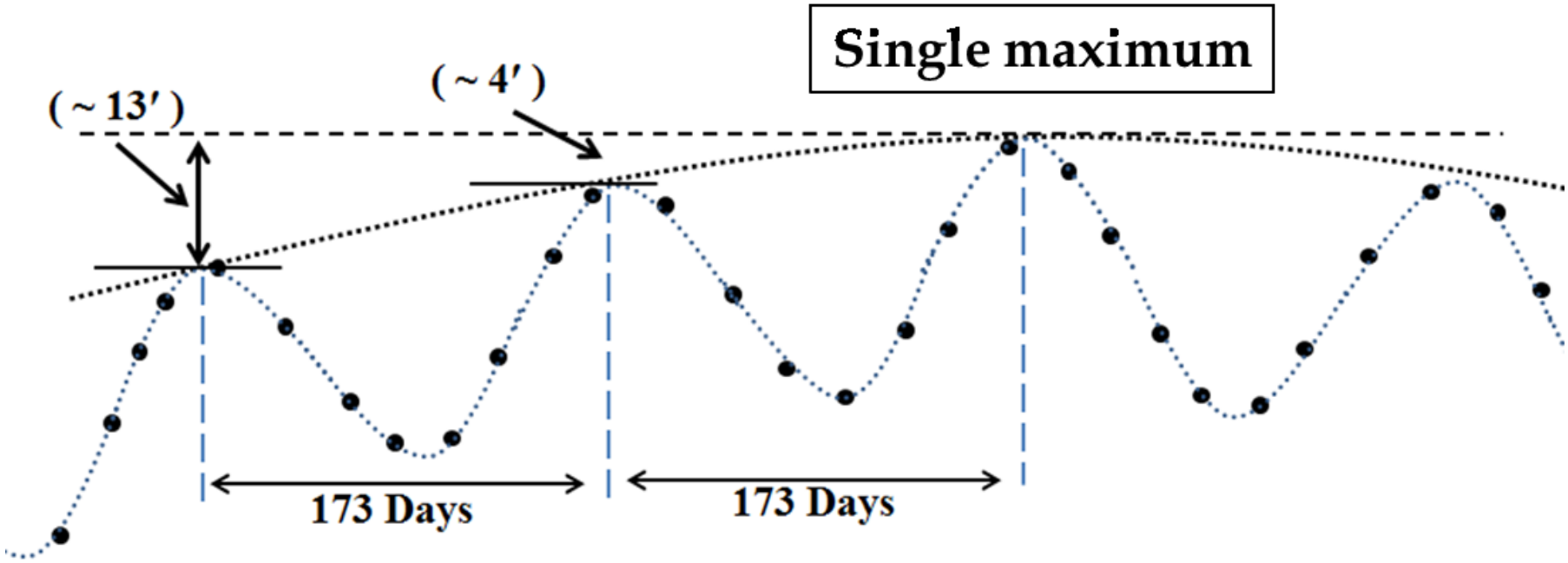
Apparent Lunar Alignments for the 'no Wobble' Moon

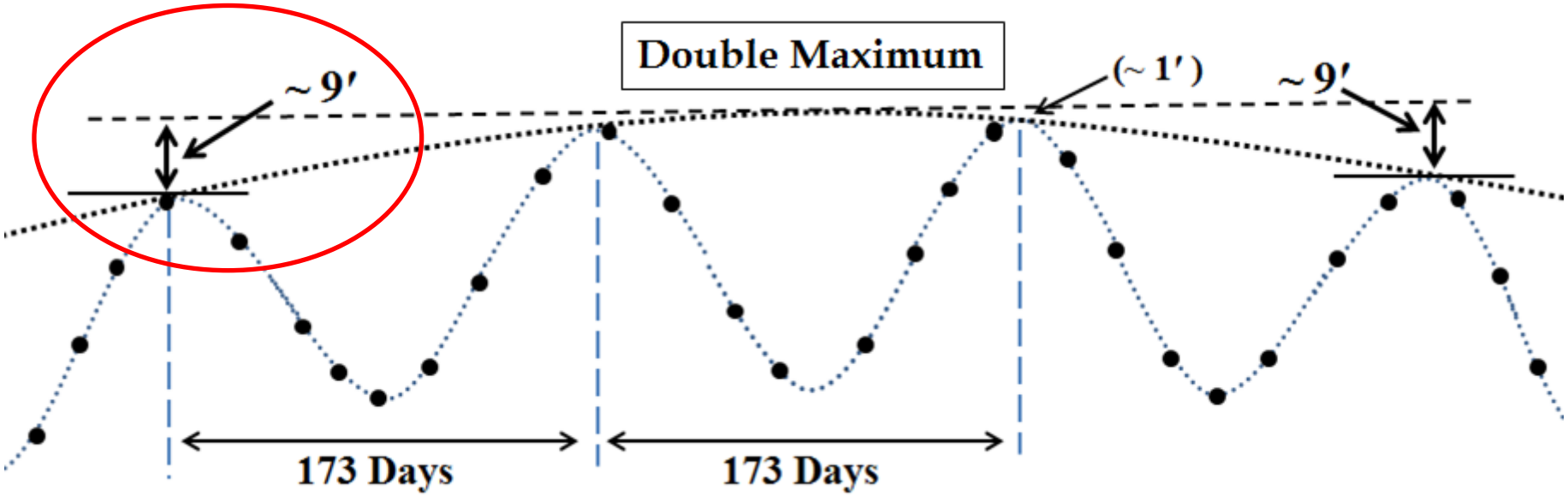



29° 27′.5
(29° 18′.5)
1°
~2′
0.5°
See Note
9′ Δ
Upper Limb
+29° 03′
Lower Limb
1st Quarter March 1.7km.
327°
327°.5
328°
328°.5
329°


View to SW

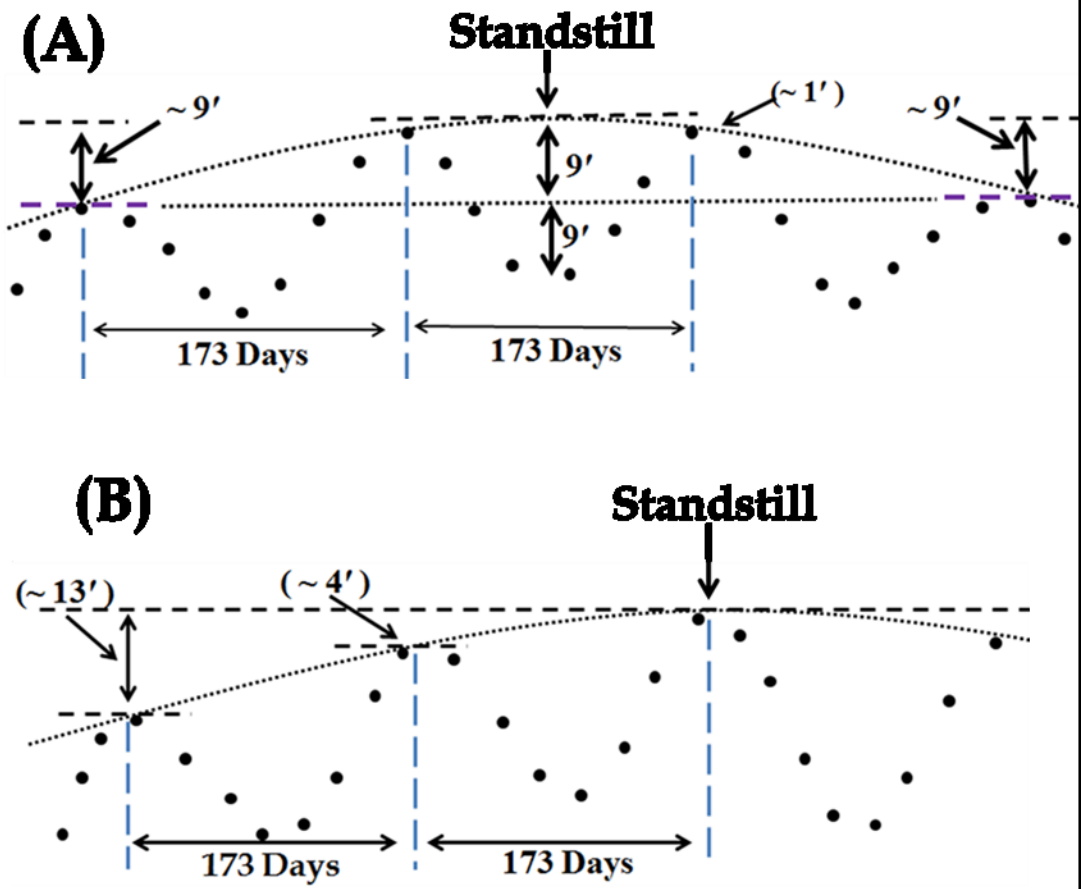

-18° 30'.5
?
-18° 30'.1
?
-18° 21'.1
Upper
Limb
9'
Δ
(-18° 30'.1)
-18° 45'.6
-18° 21'.1
-18° 21'.4
13°
12°
11°
192°
196°
200°
204°
208°

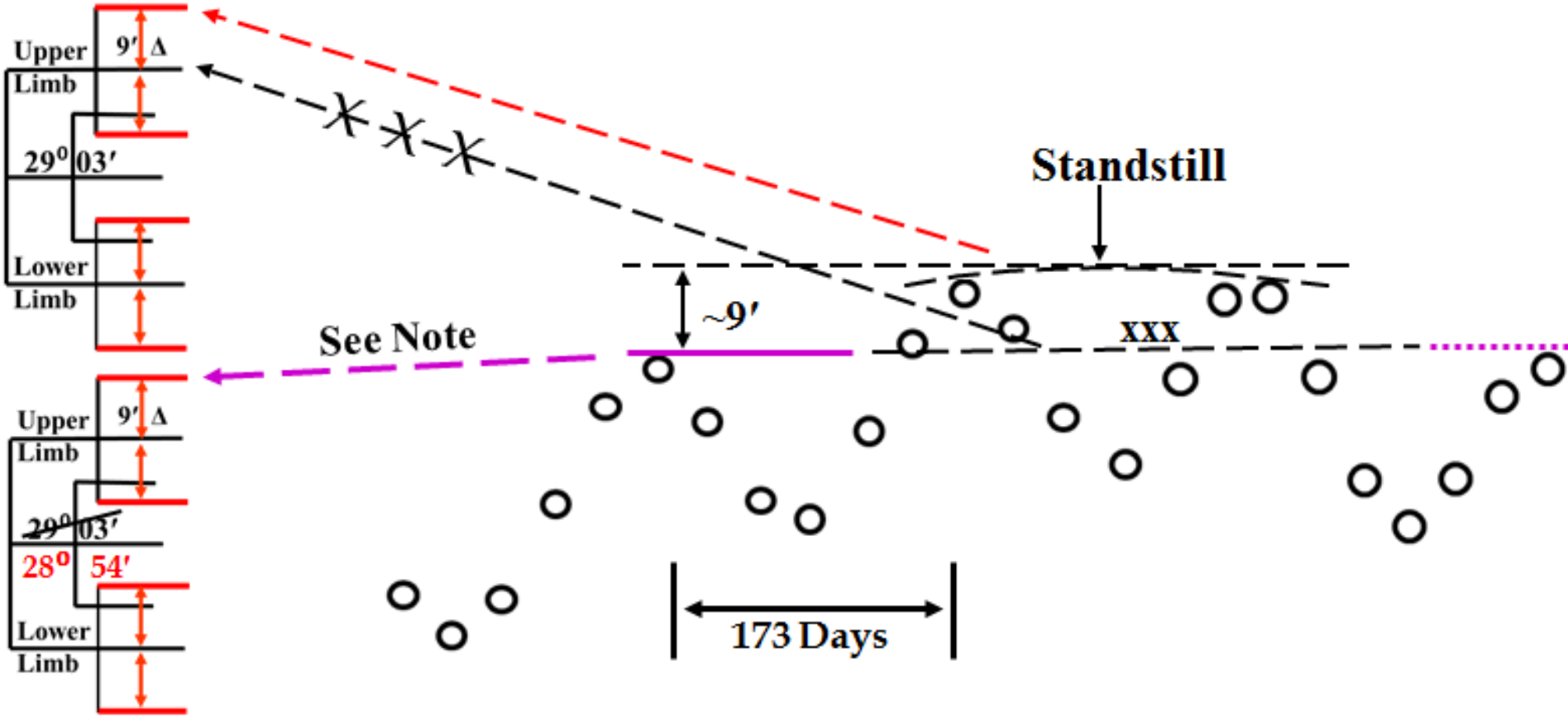

Single maximum
(~ 13′)
(~ 4′)
173 Days
173 Days

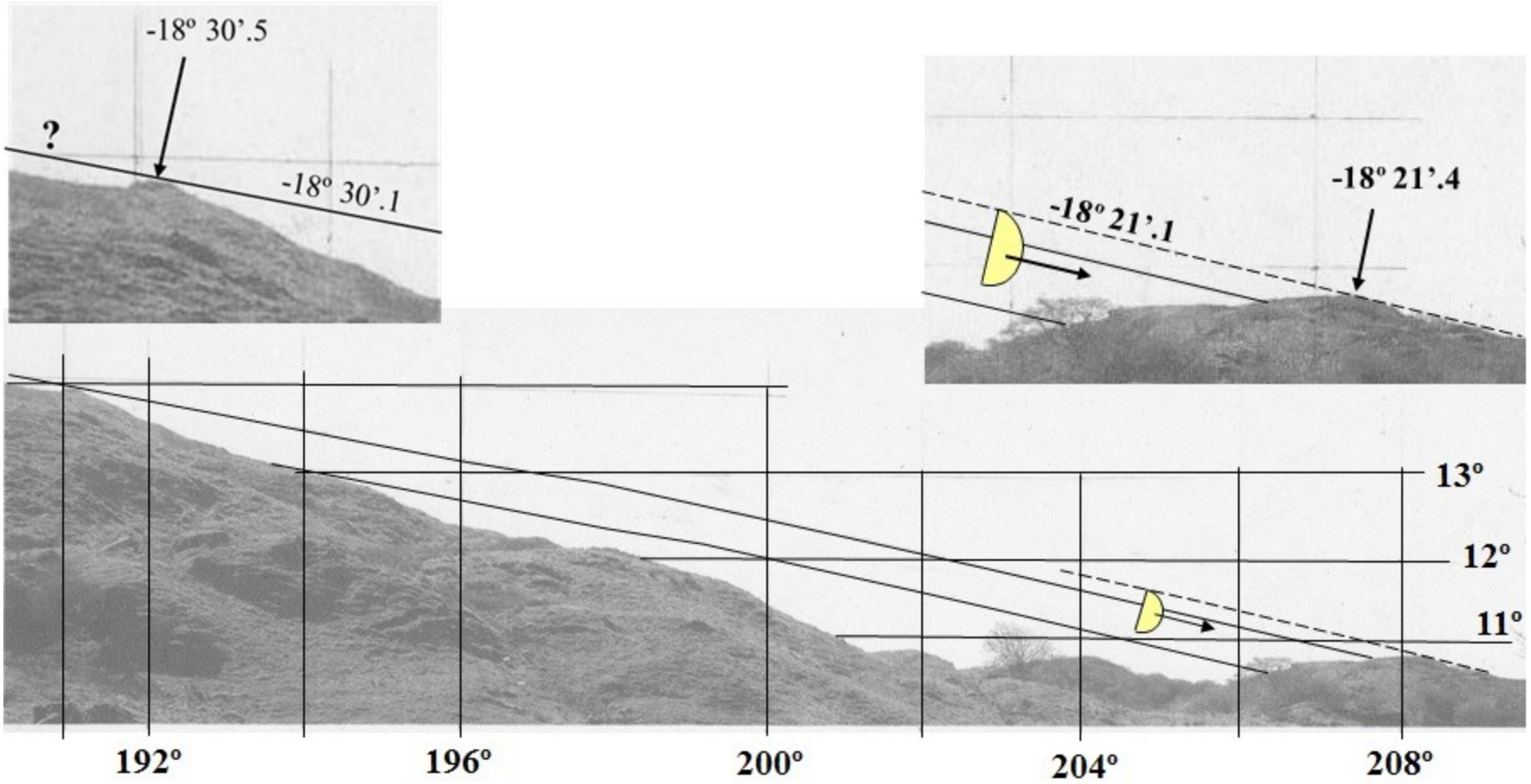

Double Maximum
~ 9′
(~ 1′)
~ 9′
173 Days
173 Days

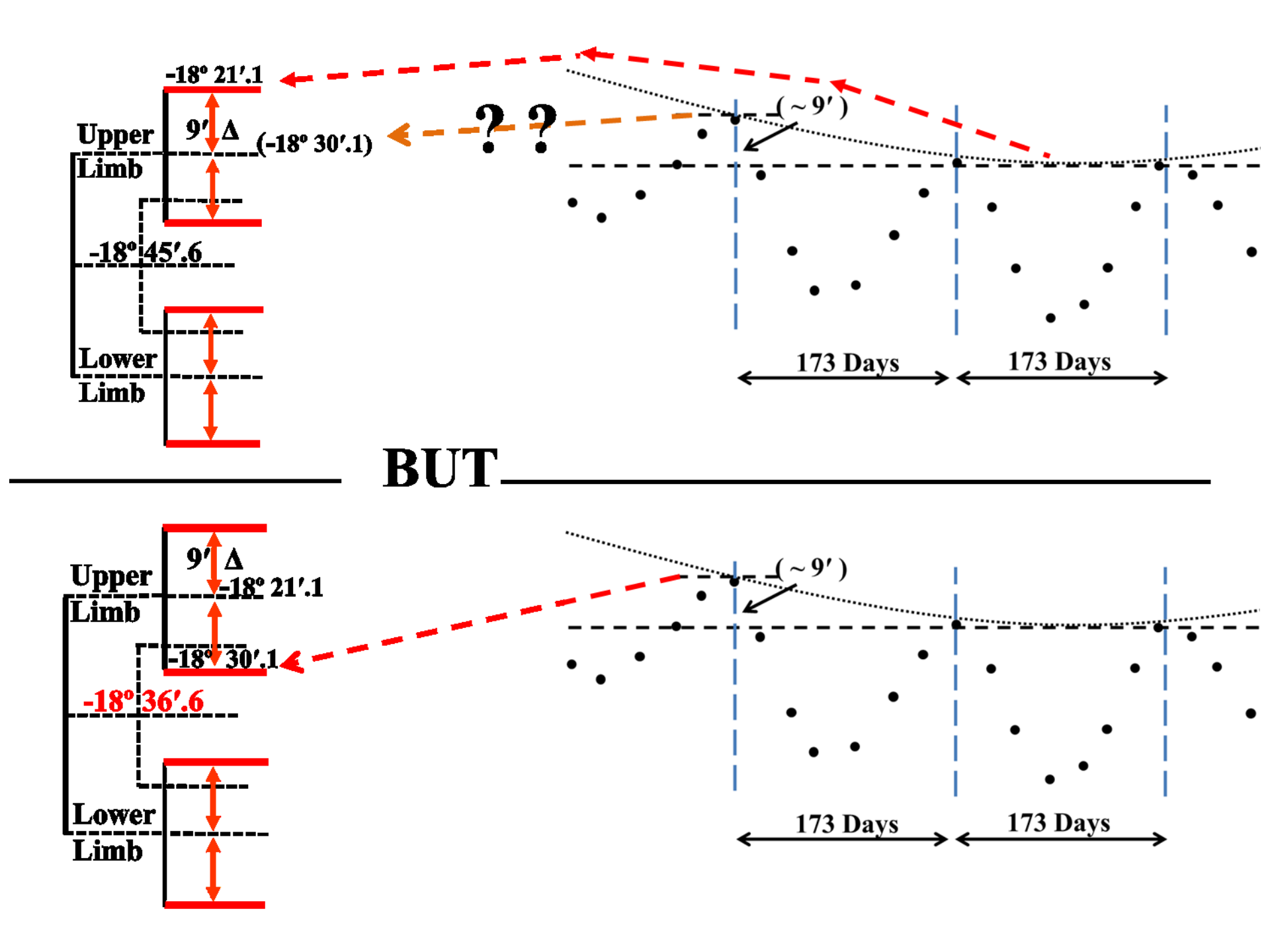
The Standstill might be as in (A) with two maxima, or (B) with a single maxima or anywhere in between. Note in (A) the deficit of 9′ of arc of the maxima 1½ ecliptic periods before the standstill maximum i.e. by chance the 'wobble' amount.
In (B) the values are as shown.

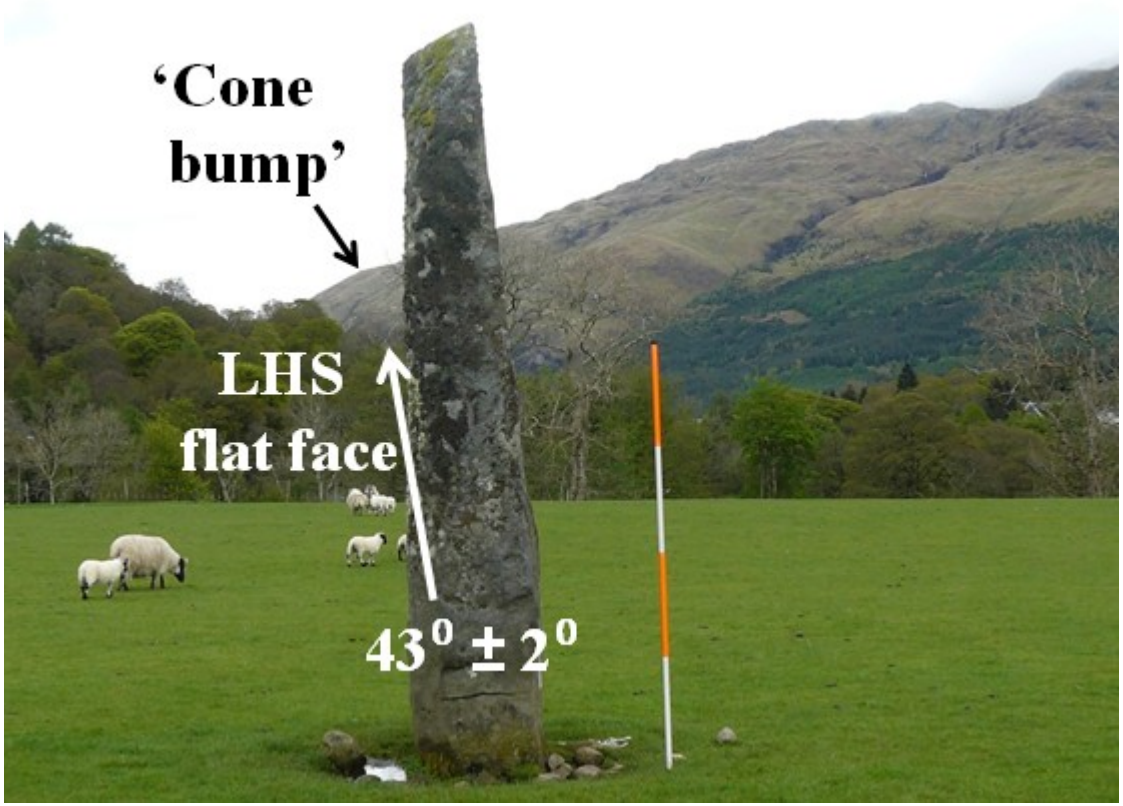
Thus a possible explanation is that the observation of what we have deemed the 'no wobble' alignment was actually for the maxima of a preceding wobble to enable prediction of the type of maxima to be expected.



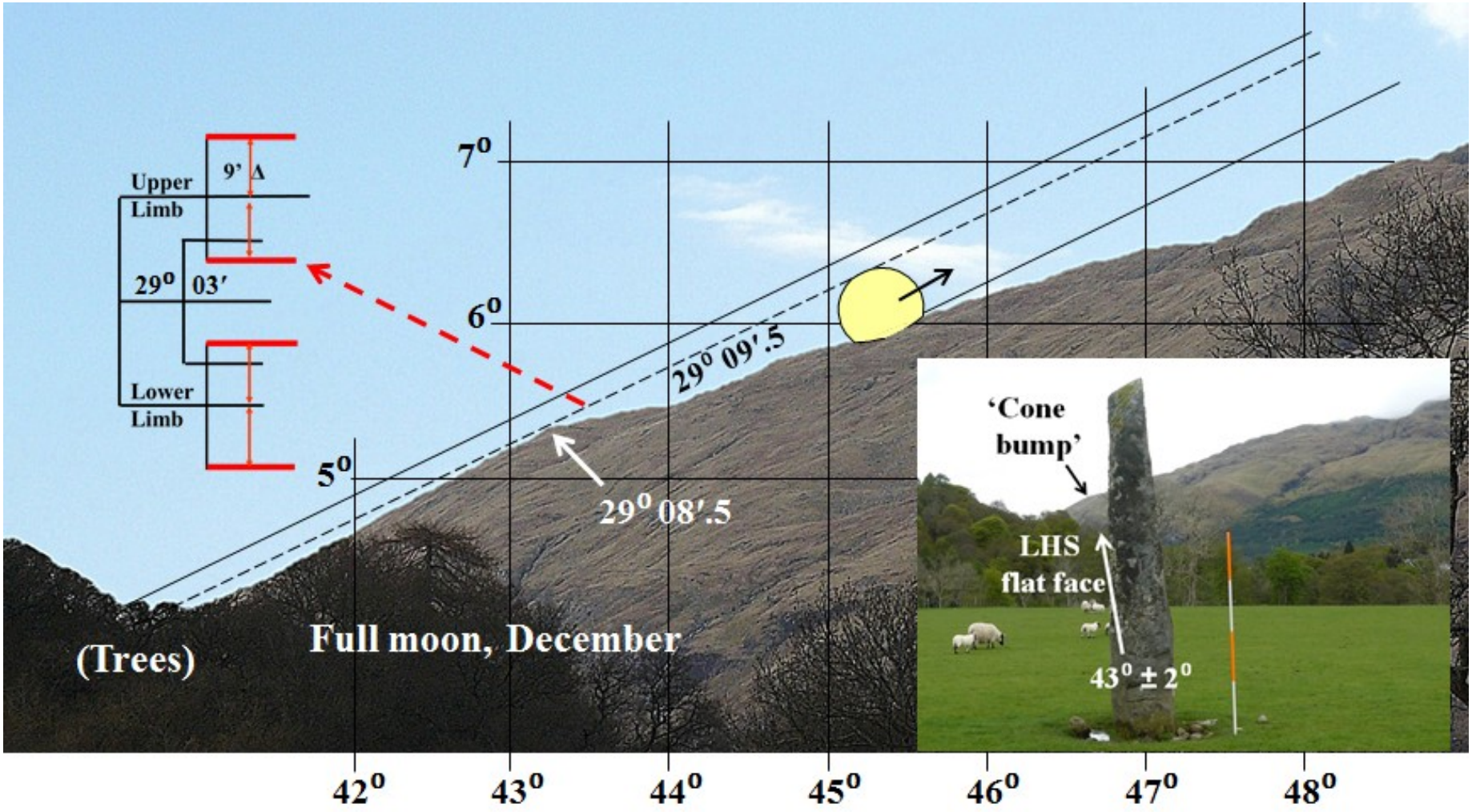

Upper
Limb
9′ Δ
29⁰ 03′
Lower
Limb
Upper
Limb
9′ Δ
29⁰ 03′
28⁰ 54′
Lower
Limb
See Note
~9′
Standstill
XXX
173 Days


-18º 30'.5
?
-18º 30'.1
-18º 21'.1
-18º 21'.4
13º
12º
11º
192º
196º
200º
204º
208º

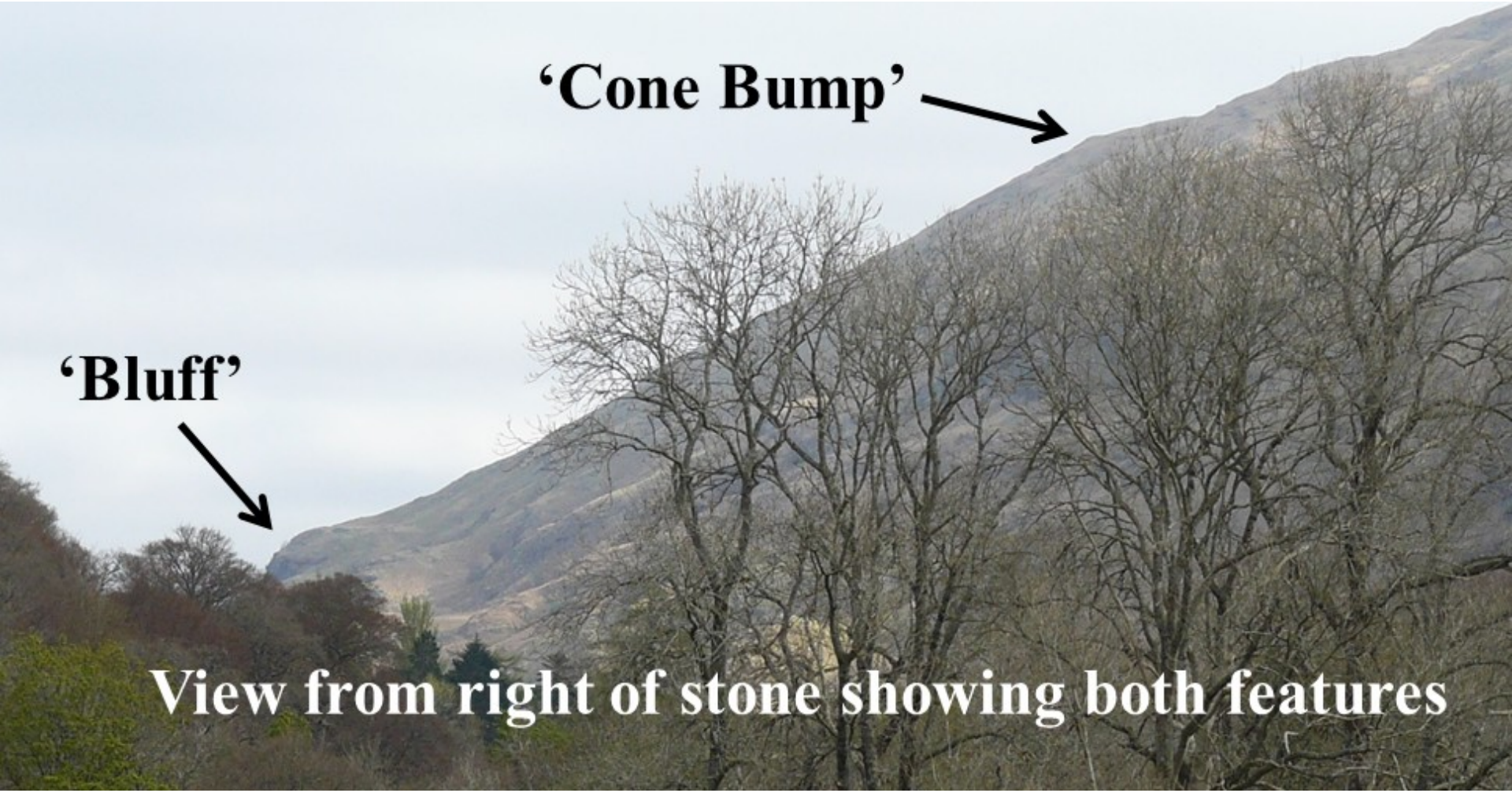

-18° 21′.1
9′ Δ
Upper Limb
(-18° 30′.1)
? ?
-18° 45′.6
Lower Limb
(~ 9′)
173 Days
173 Days
BUT
9′ Δ
Upper Limb
-18° 21′.1
-18° 30′.1
-18° 36′.6
Lower Limb
(~ 9′)
173 Days
173 Days


'Cone bump'
LHS flat face
43° ± 2°

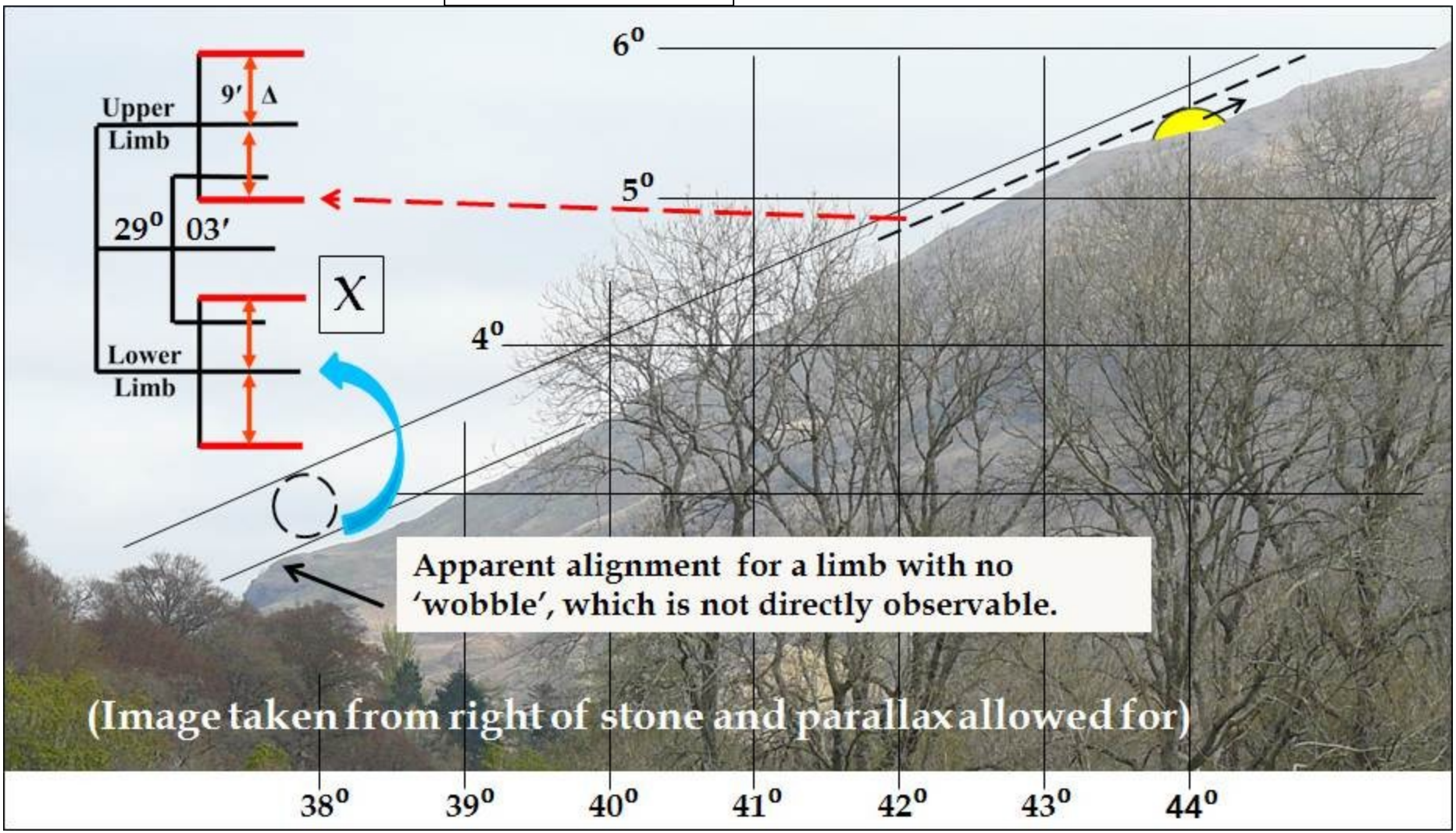
ACHARA


Upper
Limb
9′ Δ
29° 03′
Lower
Limb
7°
6°
5°
29° 09′.5
29° 08′.5
(Trees)
Full moon, December
'Cone
bump'
LHS
flat face
43° ± 2°
42°
43°
44°
45°
46°
47°
48°

RHS indicates
'Bluff' on
end of ridge

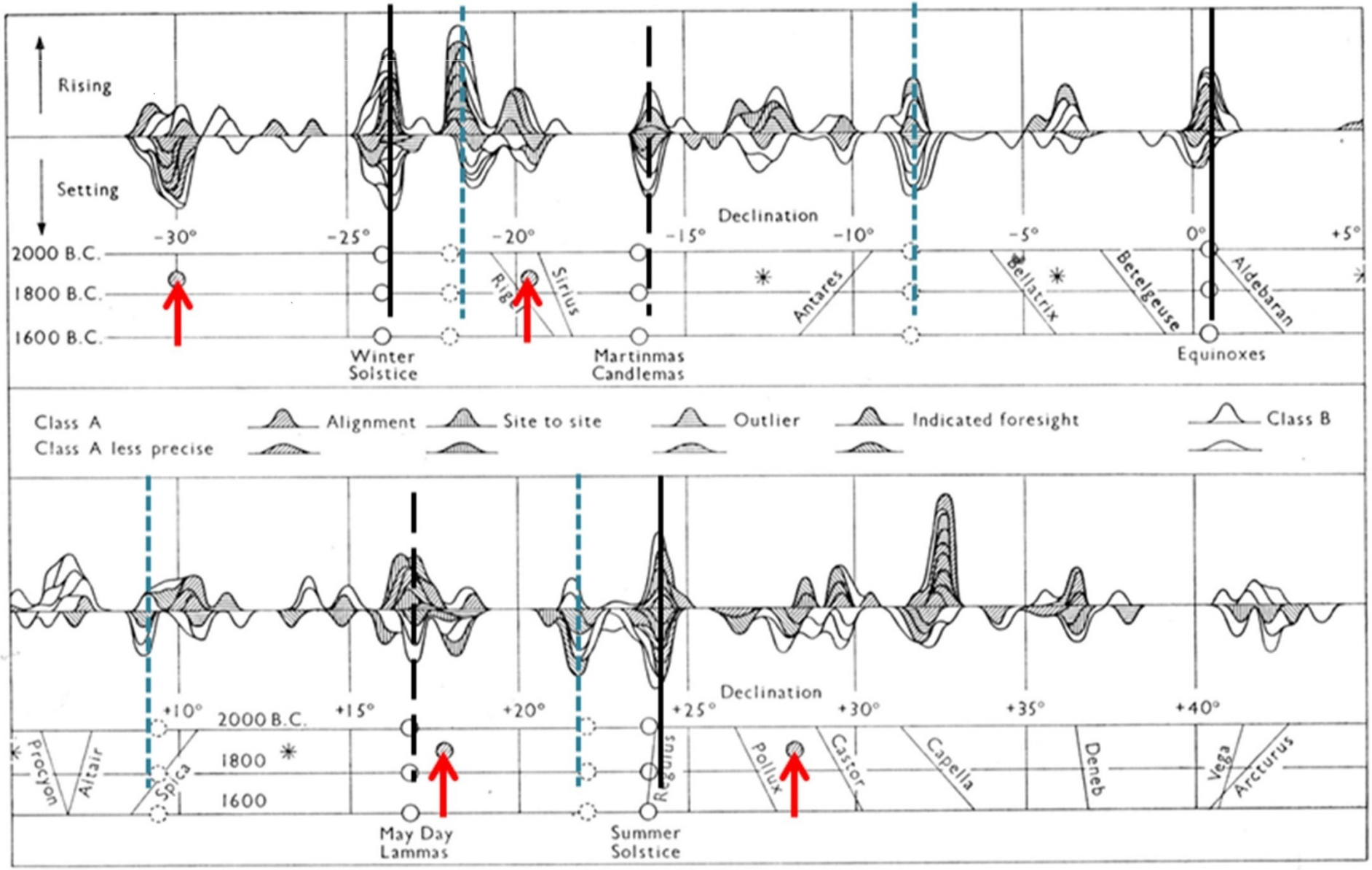

‘Cone Bump’
‘Bluff’
View from right of stone showing both features

ACHARA

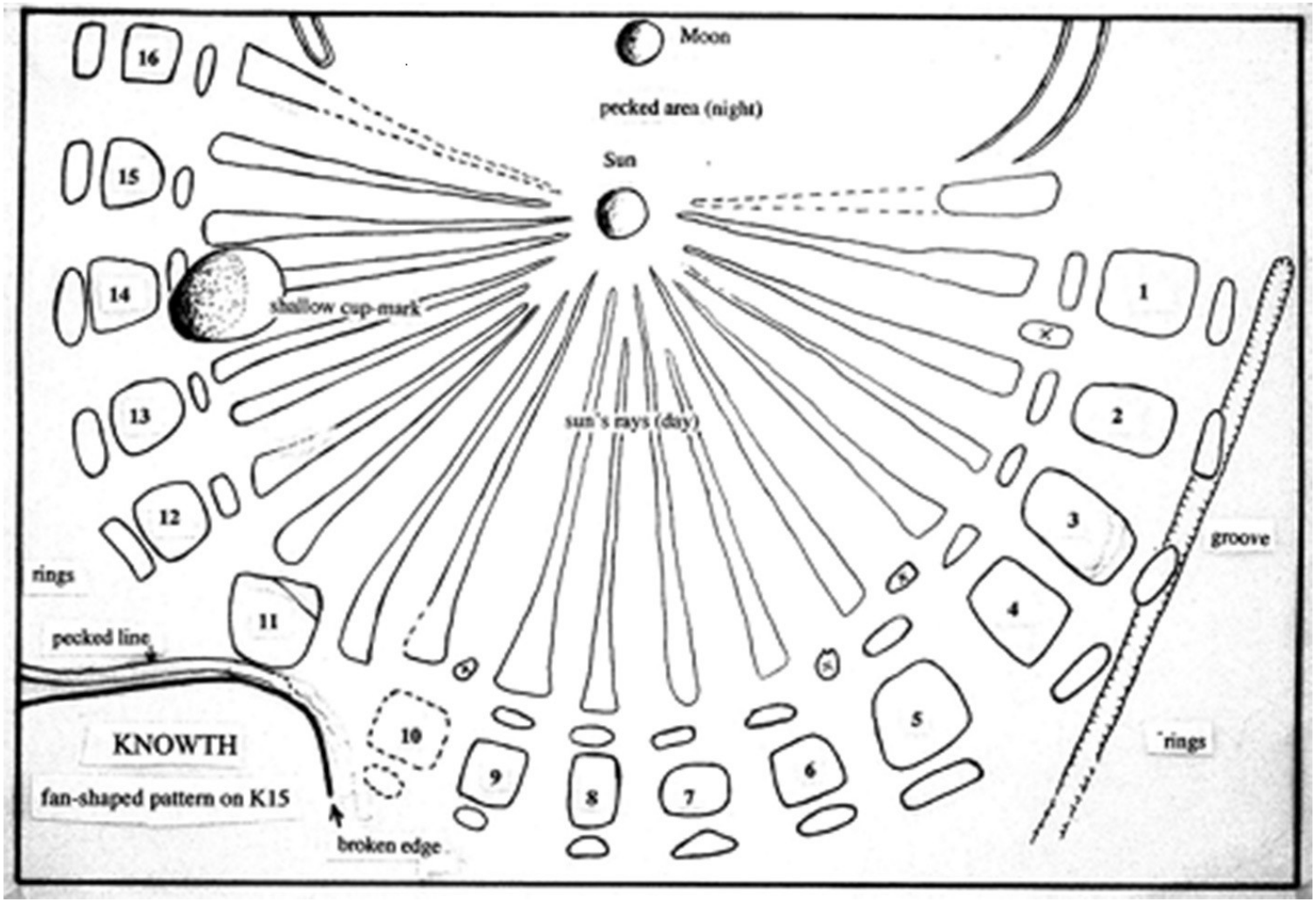

Upper
Limb
9′
Δ
29°
03′
X
Lower
Limb
6°
5°
4°
Apparent alignment for a limb with no
'wobble', which is not directly observable.
(Image taken from right of stone and parallax allowed for)
38°
39°
40°
41°
42°
43°
44°

Evidence for a prehistoric Solar Calendar

i.e. Calendrical alignments


Rising
Setting
Declination
−30°
−25°
−20°
−15°
−10°
−5°
0°
+5°
2000 B.C.
1800 B.C.
1600 B.C.
Rigel
Sirius
Antares
Bellatrix
Betelgeuse
Aldebaran
Winter Solstice
Martinmas Candlemas
Equinoxes
Class A
Class A less precise
Alignment
Site to site
Outlier
Indicated foresight
Class B
Declination
+10°
+15°
+20°
+25°
+30°
+35°
+40°
2000 B.C.
1800
1600
Procyon
Altair
Spica
Regulus
Pollux
Castor
Capella
Deneb
Vega
Arcturus
May Day Lammas
Summer Solstice

Stone K15, Knowth, Ireland


Moon
pecked area (night)
Sun
shallow cup-mark
sun's rays (day)
groove
rings
pecked line
KNOWTH
fan-shaped pattern on K15
broken edge
rings
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

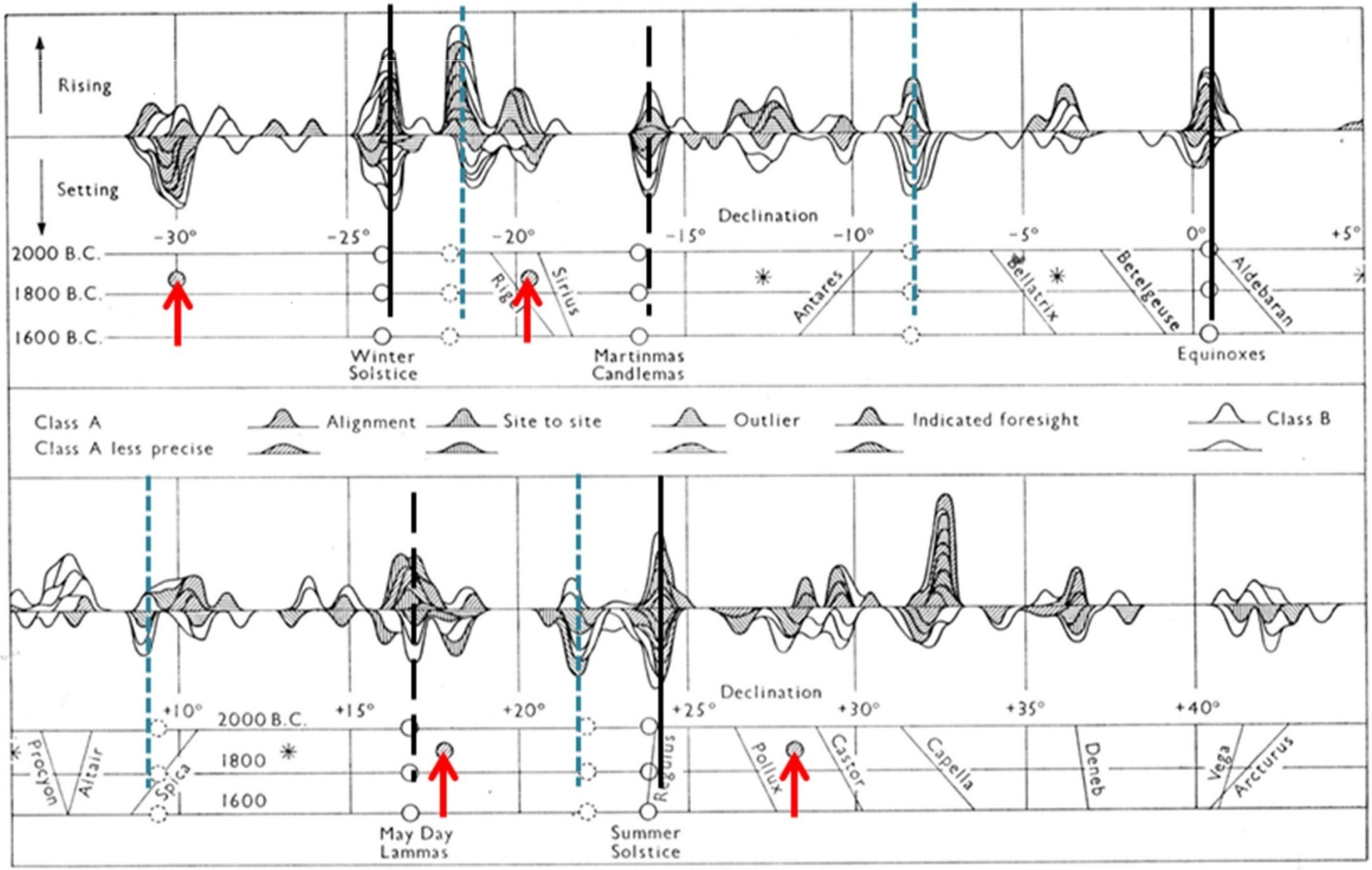

Rising
Setting
Declination
−30°
−25°
−20°
−15°
−10°
−5°
0°
+5°
2000 B.C.
1800 B.C.
1600 B.C.
Rigel
Sirius
Antares
Bellatrix
Betelgeuse
Aldebaran
Winter Solstice
Martinmas Candlemas
Equinoxes
Class A
Class A less precise
Alignment
Site to site
Outlier
Indicated foresight
Class B
Declination
+10°
+15°
+20°
+25°
+30°
+35°
+40°
2000 B.C.
1800
1600
Procyon
Altair
Spica
Regulus
Pollux
Castor
Capella
Deneb
Vega
Arcturus
May Day Lammas
Summer Solstice

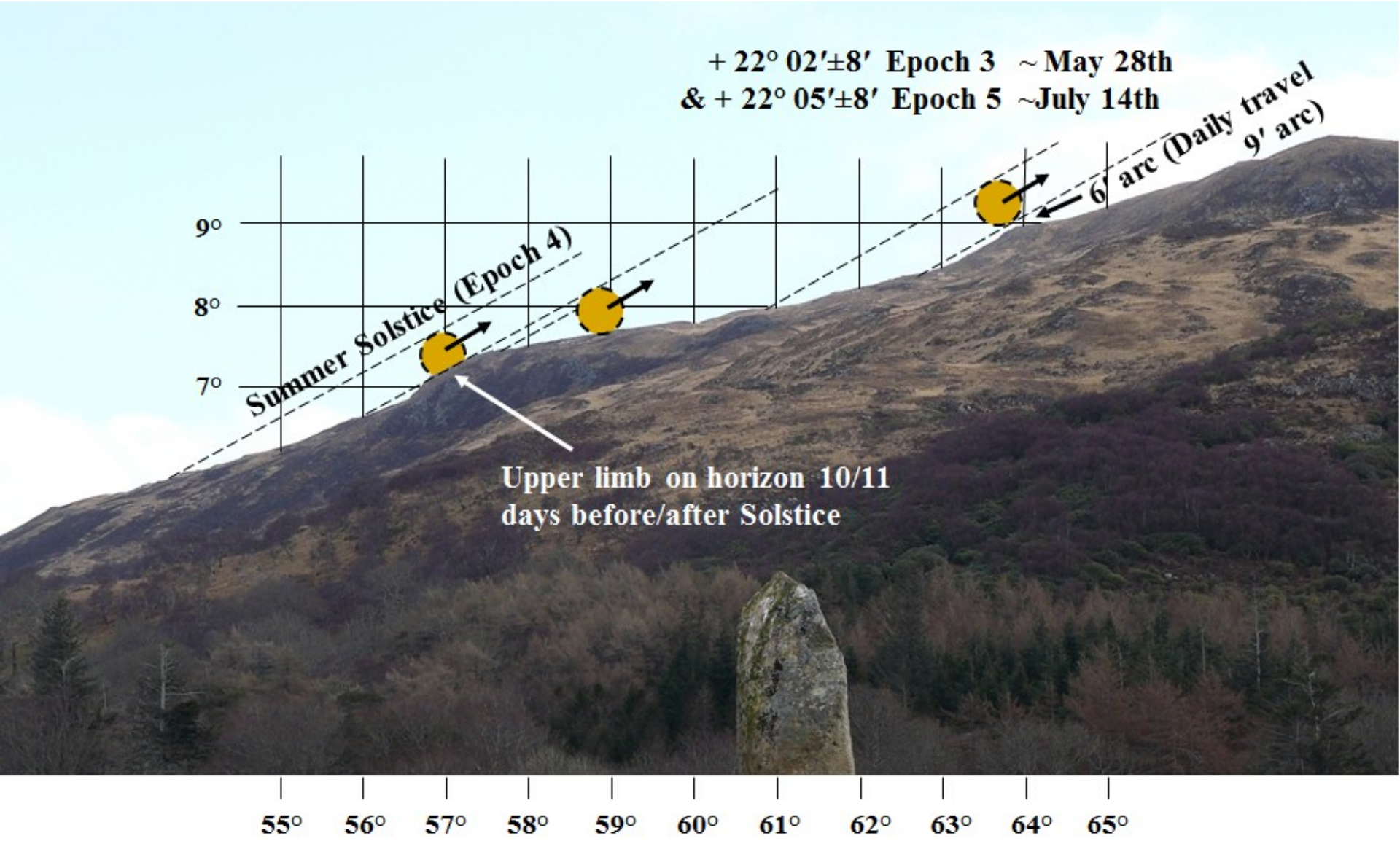
Table 9.1. *Calendar declinations*

(With Permission of O.U.P. with whom Copyright remains.)

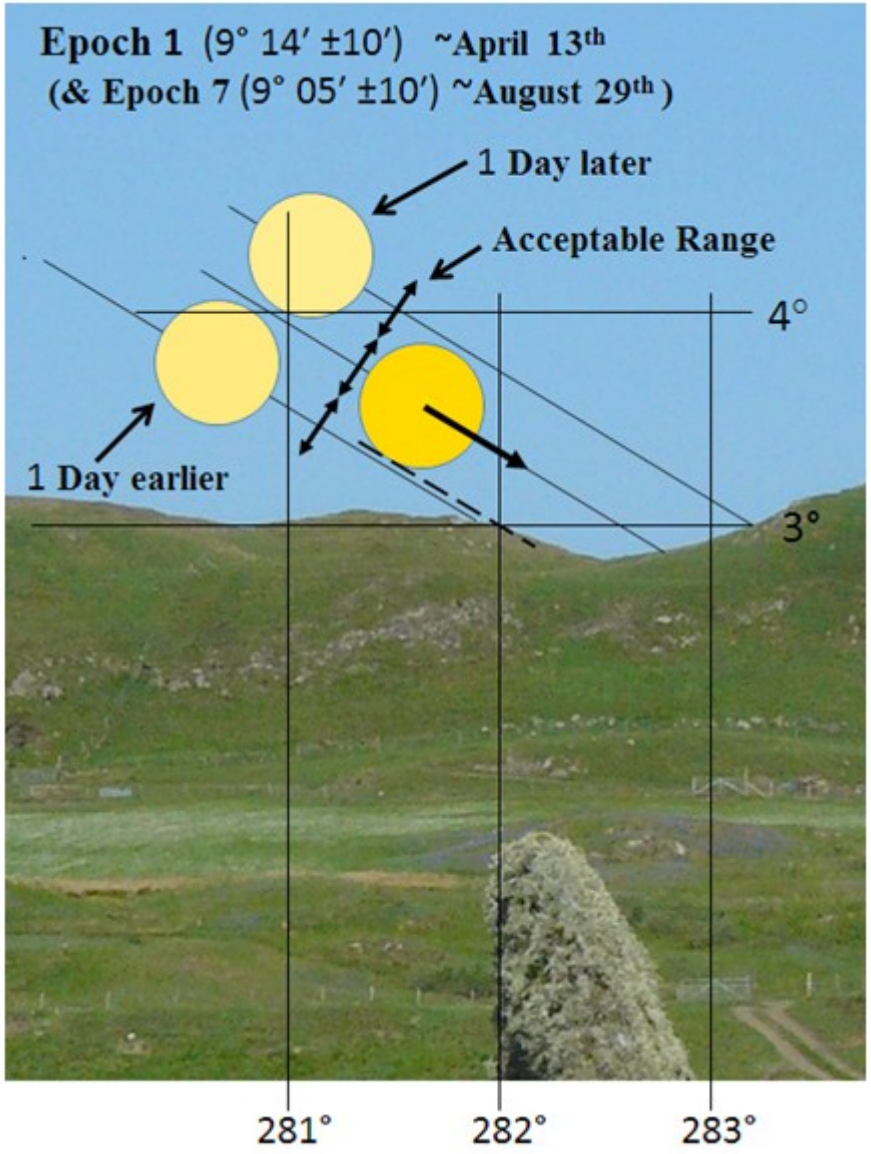
Epoch Number	Days in 'month'	Epoch		δ_R decl. at sunrise	δ_S decl. at sunset	Possible decl. range
		Nominal	Days elapsed at sunrise (t)			
0	23	0	−0·4	+ 0·37	+ 0·56	±0·19
1	23	23	22·56	+ 9·04	+ 9·24	0·17
2	24	46	45·53	+16·55	+16·72	0·14
3	23	70	69·51	+22·03	+22·13	0·07
4	23	93	92·50	+23·91	..	0·00
5	23	116	115·51	+22·09	+21·99	0·07
6	23	139	138·53	+16·80	+16·62	0·14
7	22	161	160·56	+ 9·31	+ 9·09	0·17
8	22	183	182·60	+ 0·51	+ 0·33	0·19
9	22	205	204·62	− 8·40	− 8·57	0·18
10	22	227	226·67	−16·24	−16·35	0·14
11	23	250	249·69	−21·92	−21·98	0·07
12	23	273	272·70	−23·91	..	..
13	23	296	295·70	−21·82	−21·72	0·08
14	23	319	318·68	−16·30	−16·15	0·14
15	23	342	341·64	− 8·52	− 8·37	0·19
16	..	365	364·60	+ 0·28	+ 0·47	..

Mean values at both sunrise and sunset are identical and are +0°·44, +9°·16, +16°·67 +22°·06, −8°·46, −16°·26, −21°·86.

Gruline Island of Mull

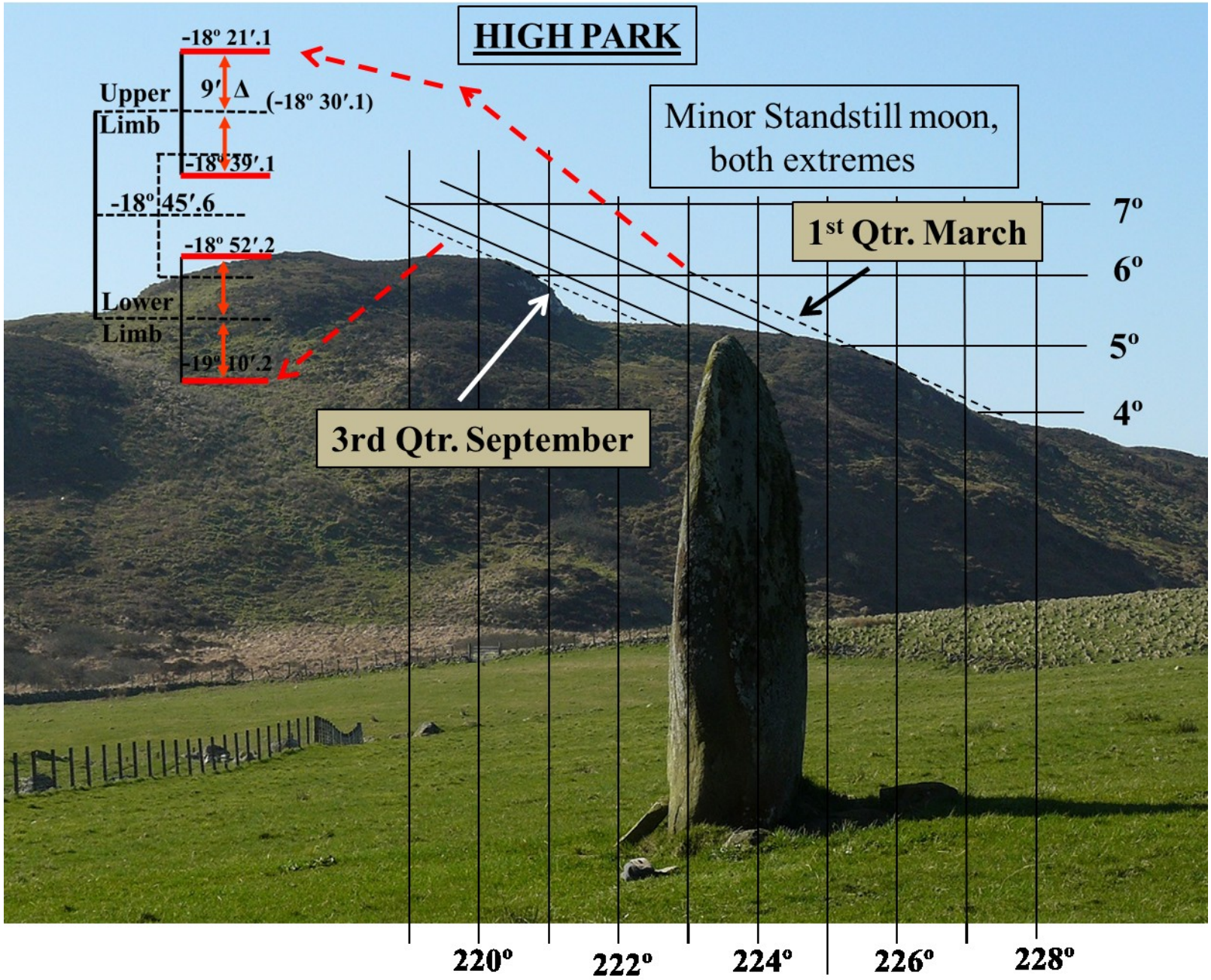


Base of
fallen stone


Epoch 1 (9° 14′ ±10′) ~April 13th
(& Epoch 7 (9° 05′ ±10′) ~August 29th)
1 Day later
Acceptable Range
4°
1 Day earlier
3°
281°
282°
283°

Thank You

Minor Standstill, High Park, Kintyre


HIGH PARK
-18° 21′.1
9′ Δ
(-18° 30′.1)
Upper Limb
-18° 39′.1
-18° 45′.6
-18° 52′.2
Lower Limb
-19° 10′.2
Minor Standstill moon, both extremes
1st Qtr. March
3rd Qtr. September
7°
6°
5°
4°
220°
222°
224°
226°
228°