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# LUNAR STANDSTILLS AT CHIMNEY ROCK

J. McKIM MALVILLE and FRANK W. EDDY, University of Colorado, and CAROL AMBRUSTER, Villanova University

## *Introduction*

Whereas prehistoric populations in North America paid attention to the horizon sun at winter or summer solstice, evidence for observations of comparable phenomena involving the moon remains elusive and controversial. The amplitude of the monthly movement of the moon varies from a minimum at minor standstill to a maximum at major standstill with an 18.6-year period. Studies of megalithic sites in Britain dating between 3500 and 1500 B.C. provide evidence of deliberate orientation to lunar rising and setting points, especially those of maximum southern standstill.[1]

In North America the most thoroughly studied standstill marker is the three-slab site of Fajada Butte in Chaco Canyon.[2] The central slab has recently shifted, causing a change in the shadow patterns of solar apparitions, but the lunar standstill effects may have remained unaltered.[3] In addition, there are indications of standstill observations at Casa Grande[4] and Zodiac Ridge.[5]

Although the lunar aspects of the three-slab site were confirmed during the recent major standstill,[6] questions remain as to the intentionality and significance of the proposed lunar markings. It is puzzling that there is no ethnographic evidence that the historic Pueblo Indians observed or had knowledge of the 18.6-year cycle.[7] The astronomy of the Anasazi may indeed have been more elaborate than that of the historic Pueblo.[8] For cultures relying upon lunar-based calendars, systematic observations of the moon could have readily revealed the monthly standstill and probably also the systematic shift of standstill positions.

We present evidence for observation of lunar standstill within the Chimney Rock Archaeological Area (CRAA) in Southwestern Colorado (Figure 1). The CRAA contains evidence of eight semi-independent, integrated communities of late Pueblo I and Pueblo II age (A.D. 925–1125).[9] This collection of sites is dominated by the double natural pinnacles of Chimney Rock and by the Chimney Rock Pueblo, 5AA83, which has been identified as a Chaco outlier.[10] The chimneys and the associated high mesa have been recognized by the Taos Pueblo of northern New Mexico to be a shrine dedicated to the Twin War Gods of Pueblo mythology.[11]

Dramatically set on the high mesa, 1200 feet above the water and agricultural lands of the valley floor, the Chimney Rock Pueblo contains two kivas and thirty-five ground floor rooms. A second story may have contained an additional twenty rooms. The core-and-veneer masonry is similar in style to the

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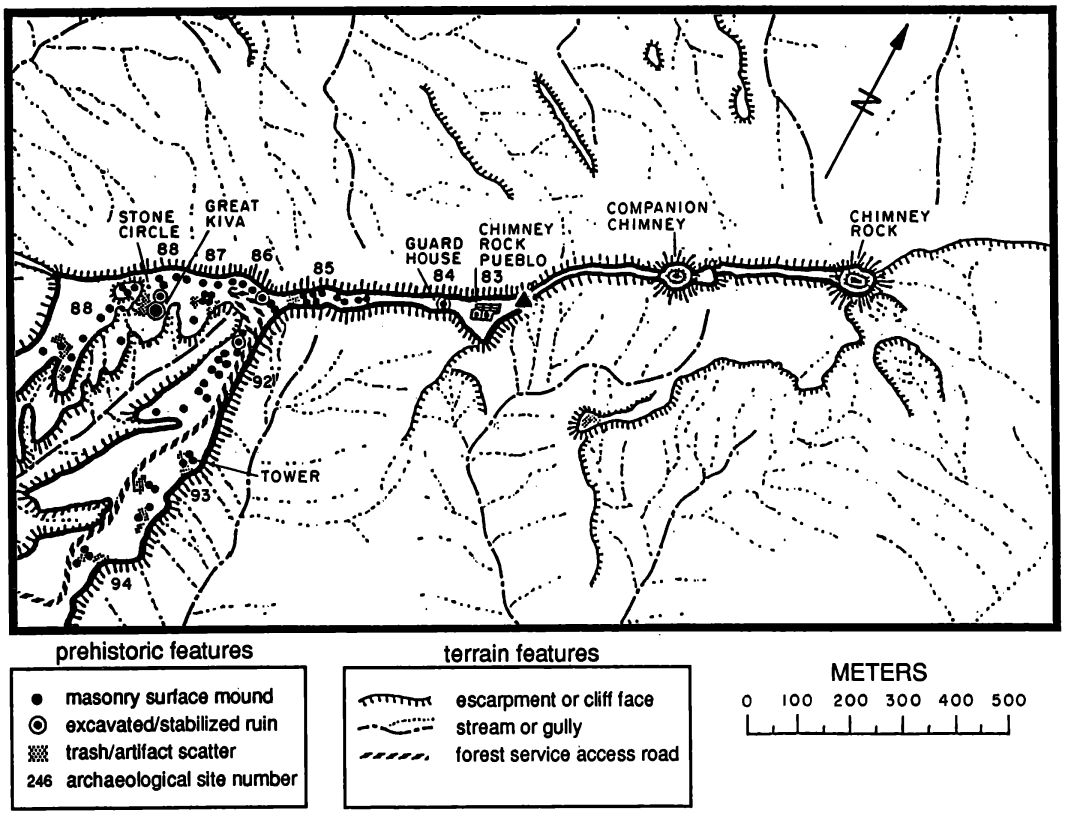


FIG. 1. Map of the high mesa of Chimney Rock; the location from which the lunar standstill was observed in 1988 is marked by a triangle. Map prepared by Dale Lightfoot based on aerial photography.

Great Houses of Chaco Canyon located some 150 straight-line kilometres to the south.[12] Among the proposed outliers of Chaco Canyon, the Chimney Rock Pueblo, 5AA83, is distinguished by being the most isolated (72.5 km to Aztec), the highest (2316 m), the most remote from arable land (2 km), and one of the first to be constructed (A.D. 1076).[13]

The Chaco-style East Kiva of 5AA83 contains two sub-floor ventilator tunnels, one on top of the other, a southern vertical ventilator shaft and a 5-ft-high banquette upon which were built eight beam rests. Other features characteristic of Chaco-style kivas are a western subfloor vault and no evidence of a sipapu. The East and West Kivas were set within a quadrangle of walls, which had been filled by the prehistoric inhabitants to the level of the kiva roofs, forming courts within the building. The East Kiva, in particular, is enclosed in a rectangular dead space which is further enclosed on the south and east by small rooms which were probably filled during the occupancy of the Pueblo. The general layout is similar to tri-wall structures which may have been built to provide ceremonial platforms.[14] In the case of the East Kiva we propose it provided an observing platform for viewing the double chimneys. The L-shaped building encloses the East Court. A bench has been built along the east-facing exterior wall in the East Court, providing another place from which to view the double chimneys.

*Observations*

Following his excavation in the Chimney Rock area, one of the authors (FWE) postulated that 5AA83 was built by Chacoan priests not from practical considerations but from a religious motivation to view and live near the double chimneys. In the spring of 1988 we advanced the hypothesis that the Pueblo was constructed, at least in part, in order to use the double chimneys as a foresight for astronomical phenomena. It appeared possible that as viewed from 5AA83, the sun, Venus and/or the moon could rise between the chimneys; Venus was particularly implicated because of its association with the Twin War gods in some Pueblo traditions.

Our survey of the Chimney Rock area during May 1988 established that neither the sun nor Venus reaches sufficiently high northern declination to rise in the gap between the chimneys as viewed from 5AA83. However, we found that the moon should rise in the gap at times of major northern standstill when viewed from the vicinity of 5AA83, as indicated in Figure 1.

A watchtower has been constructed within recent years on the high mesa between 5AA83 and the chimneys, thereby blocking the view of the gap between the double chimneys from the Pueblo. Our measurements were made on a prominent rock platform at the northeast corner of the high mesa, which is along a line connecting the Pueblo with the gap. During the summer of 1988 sufficient time remained to observe moonrise at high declinations, and on 8 August 1988, we were able to confirm our prediction, as shown in Figures 2 and 3.

*Lunar Standstills During Occupation of Chimney Rock*

Dates of lunar standstills were determined by calculating the longitude of the ascending node of the lunar orbit using the equation:

$$\Omega = 259.183° - 0.05295°d + 0.002078°T^2 + 0.000002°T^3,$$

where $d$ and $T$ are respectively the days and Julian centuries from J.D. 2415020. The declination of the moon was estimated by the function: $23.56° + 5.14° \cos(2\pi t/18.613)$, where $t$ is the time from the date of zero longitude of the ascending lunar node; the inclination perturbation is not included. The minimum lunar declination visible between the chimneys is 27.9° as seen from ground level near 5AA83, taking into account lunar parallax and refraction. We estimate that within 1.2 years from the date of zero longitude of the ascending node, every lunar month should have had at least one moonrise that cleared the gap between the spires as viewed from 5AA83. During the period from 1050 to 1120, the predicted dates of consecutive moonrises between the chimneys are 1056.0–1058.4, 1074.6–1077.0, 1093.2–1095.6, and 1112.8–1114.2.

The availability of tree ring dates from beams excavated by Eddy from the East Kiva and Room 8 of 5AA83 provides us with the opportunity for testing whether observability of lunar standstills may have had an influence upon construction of the Chimney Rock Pueblo. Specimens from 74 original trees

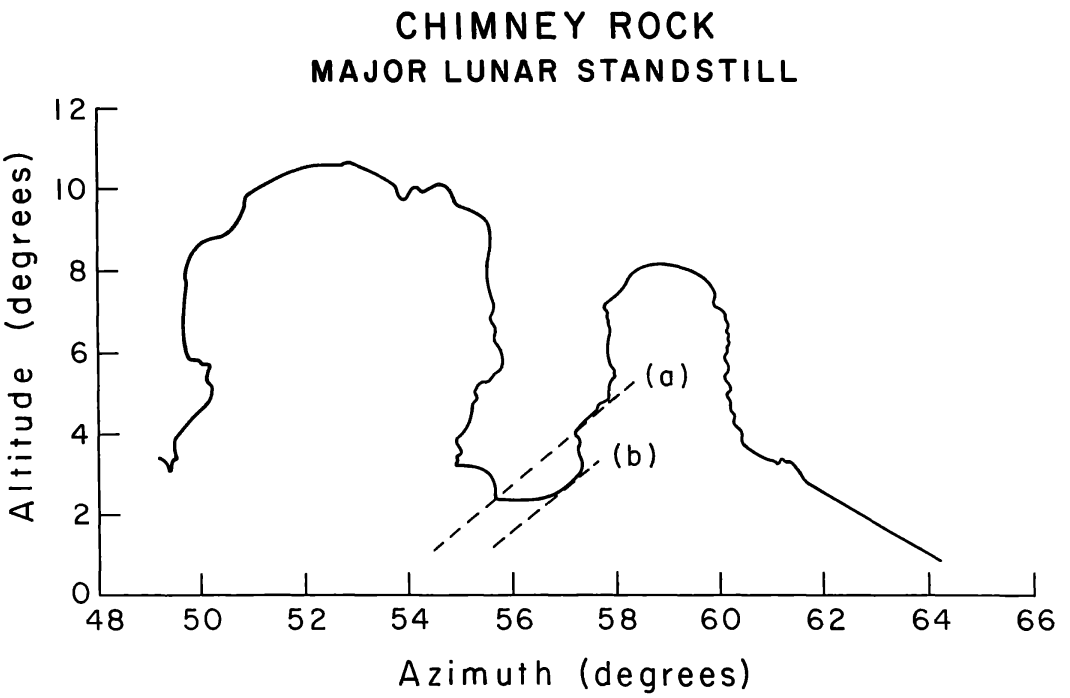


FIG. 2. Chimney Rock as viewed from the high mesa, northeast of 5AA83. The path of the centre of the moon at two declinations is indicated: (a) 28.7°, (b) 27.9°.

were collected from the East Kiva and from the remains of the roof of Room 8 of 5AA83. Of the 47 datable specimens, 41 came from Room 8, and of those 26 were dated at A.D. 1093. All of the remaining 15 dates, which fall between 1066 and 1092, are questionable because they were obtained from logs in which an unknown number of outer rings had been lost. A majority of the logs (17) that date to 1093 contained continuous outermost rings, which indicate cutting dates; two specimens contained bark and therefore give definite cutting dates. No logs were dated after 1093, indicating that it was not necessary to repair or renovate the roofing for the remainder of the life of the building which was destroyed by fire around 1125.

The six datable logs from the East Kiva yield two dates. One pole taken from the lower (and therefore the earlier) of the two horizontal ventilator tunnels contained a continuous outer ring and dates to A.D. 1076. A second log from the roof fall with a continuous outer ring dates to 1093.

Eddy[15] has concluded that the initial construction of the Pueblo was associated with the dendro-date of A.D. 1076. Some seventeen years later, about 1093, the floor of the East Kiva was raised and a second horizontal ventilator tunnel was constructed. The renovated kiva, Room 8, and by implication other portions of the Pueblo, were re-roofed with logs cut in 1093.

Comparing these dendro-dates with those of lunar standstills, we find that both of the two sets of cutting dates coincide with major lunar standstills. No trees with datable outer rings were discovered from the Pueblo with cutting dates other than 1076 and 1093.

FIG. 3. Moonrise on the morning of 8 August 1988. The moon's declination was 28.5°. The bright stars rising ahead of the moon were θ Aur and ß Tau.

*Lunar Standstill at Winter Solstice*

The most important astronomical event visible from 5AA83 may have been the rising of the full moon between the chimneys at the time of winter solstice. Among the historic Pueblo, observations of the sun and moon established ceremonial calendars. The Zunis attempted the difficult task of organizing their calendar such that winter solstice occurred at or near full moon. Within certain Pueblo traditions, White Shell Woman (the moon) helps to persuade the sun to return north at winter solstice.[16] At Hopi, the sun chief watched the setting sun to establish the date of Soyal, the winter solstice ceremony.

In the case of these two historic Pueblos, the rising moon was carefully watched near winter solstice. The inhabitants of the Chimney Rock Pueblo may have been similarly watchful of the rising moon. Near the winter solstice of A.D. 1055, or perhaps earlier, residents of the Chimney Rock area may have noted the full moon rising between the chimneys. Using Goldstine[17] and Bretagnon and Simon[18] we find that the full moon of 14 December 1057 occurred at a time when the sun had a declination less than 1′ from its value at solstice. A pre-telescopic observer could not have distinguished the date from that of solstice. On such an event a solar calendar and a lunar calendar could have been brought into agreement.

*Lunar Standstill Preceding Winter Solstice*

We suggest that the apparitions of the moon during the autumn prior to full moon standstill at winter solstice constituted a major astronomical event for the

TABLE 1. Chronology of Chimney Rock.

| | |
|---|---|
| 1056.0–1058.4 | |
| Full moon rising between the chimneys: | 25 Dec. 1056 |
| Full moon rising between the chimneys: | 14 Dec. 1057 |
| Winter solstice: | 15.6 Dec. 1057 |
| 1074.6–1077.0 | |
| Full moon rising between the chimneys: | 6 Dec. 1074 |
| Full moon rising between the chimneys: | 25 Dec. 1075 |
| Solar eclipse: | 7 March 1076 |
| Cutting of trees for 5AA83: | July–Aug. 1076 |
| Full moon rising between the chimneys: | 13 Dec. 1076 |
| Winter solstice: | 14.2 Dec. 1076 |
| 1093.2–1095.6 | |
| Cutting of trees for 5AA83: | July–Aug. 1093 |
| Full moon rising between the chimneys: | 5 Dec. 1093 |
| Full moon rising between the chimneys: | 24 Dec. 1094 |
| Full moon rising between the chimneys: | 14 Dec. 1095 |
| Winter solstice: | 15.8 Dec. 1095 |

Chimney Rock population. During that autumn season the percentage of illumination of the moon rising between the chimneys systematically increased each month, culminating in the rising of the full moon at dusk at winter solstice. These six successive moonrises should have provided an unmistakable opportunity for anticipation and may have provided confirmation of the predictive power of the priests as well as the order of the heavens. Of the other proposed instances of lunar standstills observed in either the American Southwest or megalithic Britain, none appears to have the arresting quality of the event at Chimney Rock: the moon, growing in size each month, appears in the gap in a darkened sky during the autumn; soon after rising it is eclipsed by the high pinnacle. In the east court, in the courts above the kivas, and on roof tops people could have gathered to observe moonrise through the foresight of the double spires.

It was not necessary for those responsible for planning and construction to have knowledge of the 18.6-year lunar cycle. Anticipatory observations of moonrise at the start of each northern major standstill were clearly possible, and an accurate year count would have been unnecessary.

As indicated in Table 1, during the latter half of the eleventh century the rise of the full moon between the chimneys recurred at winter solstice at intervals of the Metonic cycle of 19 years while the 'window of opportunity' for moonrise between the chimneys recurred at intervals of 18.6 years. Construction of the Pueblo or portions thereof may have been completed before the full moon of 13 December 1076. It is worthy of note that one of the two total solar eclipses in the Southwest during the latter half of the eleventh century occurred on 7 March 1076.[19] Although the eclipse was partial at Chimney Rock, the conjoining of an eclipse with the lunar apparitions between the chimneys may have further intensified interest in astronomical observation. Tree cutting commenced some four months after the eclipse.

Trees for the second episode of construction, perhaps an occasion of ceremonial reconstruction, were cut in the summer of 1093 and the first moonrise that cleared the chimneys occurred in the spring of that year. The full moon could have been seen rising between the chimneys near three winter solstices.

### *Relationship to the Three-slab Site of Fajada Butte*

Knowledge of lunar cycles may have been shared between the outlier at Chimney Rock and the centre at Chaco Canyon. As we have noted, there has been scepticism that the Anasazi actually paid attention to lunar standstills at Fajada Butte.[20] Beside the lack of appropriate ethnographic evidence, such scepticism has been prompted by the difficulty of dating the three-slab site, the absence of any obvious ceremonial or practical relevance of standstill, and the difficulty of anticipation of the event.

At Chimney Rock we encounter a well-dated site at which the major standstill is unmistakable and fully predictable. Since the relationship between the lunar and solar calendars could be re-established on such an occasion, both the Metonic cycle and the standstill cycle may have been ceremonially important and calendrically relevant. (During the 19 years between 1076 and 1095 there were only two full moons, in addition to that at standstill, when the sun was within 1′ of winter solstice declination: in 1084 and 1092.) The sight of the major lunar standstill at the Chimney Rock outlier may have been an astronomical phenomenon of such acknowledged magnitude and relevance that it inspired the lunar aspects of the three-slab site at Fajada Butte. The tree cutting dates clearly indicate that people were working near the Chimney Rock Pueblo during the two lunar standstills that occurred during the florescence of Chacoan culture.

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