READING, WRITING, AND RECORDING THE ARCHITECTURE: HOW ASTRONOMICAL CYCLES MAY BE REFLECTED IN THE ARCHITECTURAL CONSTRUCTION AT MESA VERDE NATIONAL PARK, COLORADO, USA

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Abstract

When tree ring dates at Mesa Verde National Park were plotted as a function of time along the lunar standstill cycle, a correlation was evident, leading to the hypothesis that architectural features and construction phases were timed according to the lunar 18.6 year cycle. A detailed architectural analysis at Sun Temple and tree ring analysis support the sub-hypothesis that lunar maximums were observed over Sun Temple from the Painted Tower area of Cliff Palace. Tree ring dates at Balcony House and Square Tower House suggest a similar relationship between construction of specialized architecture such as kivas and the lunar maximum cycle.

Key words: archaeology, lunar maximum, architectural documentation, science, archaeoastronomy.

Introduction

While research of Ancestral Puebloan solar observations abound, studies related to lunar observation by the Ancestral Puebloans are relatively few. At Chaco Canyon Sofaer and Sinclair (1987) documented the northern lunar maximum and minumum on the "Sun Dagger" of Fajada Butte. Their results were challenged by Carlson (1987) and others, and later confirmed by Bates and Odell (1987). In the 1990's Malville, Sutcliff, and others documented Great Kiva alignments with the Northern Lunar maximum at Chimney Rock Archaeological Area, more than 100 km North of Chaco Canyon. Again in the early 1990's, research at Mesa Verde National Park, suggested ancestral observations of lunar alignment between Cliff Palace and Sun Temple (Malville 1993). Cliff Palace and Sun Temple, two sites about 0.35 kilometers apart but with a clear line of sight, allowed for Theodolite measurements and mathematical modeling, both supporting observation of the lunar maximum. Tree ring studies suggested an unknown socially driven reason for distinct discreet architectural construction cycles (Fairchild-Parks and Dean 1993; Windes 1995). Research related to the periodicity of construction may give us insight as to social/cultural phenomena as well as the development of science (particularly astronomy) by the Ancestral Puebloan people. Our objective is to assess whether or not the lunar standstill cycle influenced the placement of architectural features, structural form, construction cycles, and the location of ceremonial sites at Mesa Verde National Park between AD 1200 and 1300.

Architectural Documentation and Site Description

If the correlation of architectural construction and astronomical cycles are to be assessed, a rigorous and systematic documentation of the architecture is essential. The Architectural Documentation Program developed by Larry Nordby at Mesa Verde National Park had been used to look at households, residential units, and identify social and architectural units that were other than residential, as well as examine construction techniques through a series of models. Data collection involves a detailed system of intrasite proveniencing, data forms, scale drawings, and historical data such as photographs and reports. Altogether, this approach provides the framework for making conclusions about the construction of architecture (Nordby 2002). A major objective is to separate residential from non-residential or public architecture. It can be equally and universally applied to historic or pre-historic cultural sites throughout the world. In the summer of 2006, we applied the Architectural Documentation system to one of the most visited and least understood structures in Mesa Verde National Park, Sun Temple, which lacks evidence of traditionally defined household spaces and seems related to public or specialized architecture.

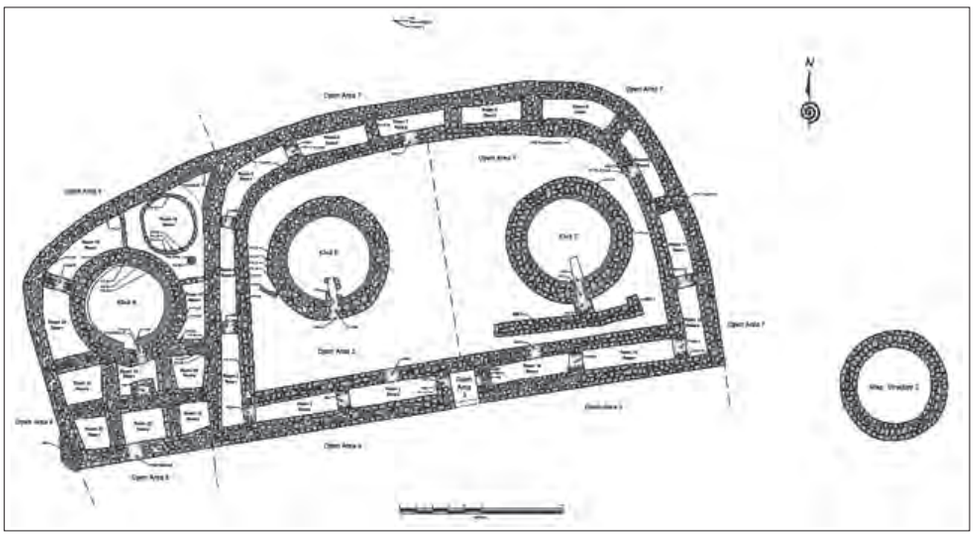

Fig. 1. Sun Temple plan map.

The overall layout of Sun Temple has a D-shaped configuration positioned around two central circular structures that appear to be towers, but are actually kivas (Fig. 1). Typical kivas are circular subterranean structures with features like banquettes, ventilator complexes, and crib roofing. Kivas are most commonly associated with ceremonial or ritual activities. An Annex was also constructed on the western portion of the site enclosing an additional circular kiva like structure.

The walls of Sun Temple are core and veneer construction built in three stages. First, build the outer veneer; secondly, build the inner veneer, and then fill the core. We evaluated each veneer abutment pattern **independently** in order to identify patterns that are not apparent if one only considers wall end abutments as a single entity. This approach provided us the room construction sequence for the D-shaped structure. Doorway placement was also helpful in this process and for evaluating the relationships between structures. The overall sequence is described in Figure 2.

In addition, there is a pecked basin that may have served as a construction datum, located to the north of the perimeter wall. This small basin seems related to the D-shaped and central towers or kivas at Sun Temple, although more work is needed to verify the actual function of the pecked basin.

Although a massive formal building, Sun Temple shows less complexity than smaller cliff dwelling rooms that have shapes and sizes that must be fitted into naturally occurring alcove spaces. Studying modal measurement values at this site would be a little less complicated, and then could be compared with other cliff dwellings and open sites. Comparisons could include Sand Canyon and Goodman Point Pueblos, as well as cliff dwellings, with the objective of studying geometry, mathematics, and building measurement systems. This applies to the characteristics of the buildings themselves as well as the overall layout. Development of a highly accurate plan map of Sun Temple is in progress and necessary before these studies can be performed.

Research Questions and Preliminary Results

Our brief investigation revealed a great deal about the architectural construction of Sun Temple. We had several general questions:

- Was Sun Temple completed by the Ancestral Puebloans, a follow-up to interpretations of Fewkes' work.
- Did the towers or Kivas B and C extend above the perimeter wall as Malville (1993) suggested?
- If the structure was completed and Kivas B and C could not be viewed above the perimeter wall from the Painted Tower area of Cliff Palace, what other data supports that Sun Temple was an astronomical observation marker or center?
- Finally, what was the role of the other buildings at Sun Temple, namely the other free-standing towers and the Annex?

Astronomy of Sun Temple

In 1991, J. McKim Malville proposed that Kivas B and C would form a marker for observation of winter solstice sunset and the southern maximum moonset from two separately marked observation points in Cliff Palace. The winter solstice sunset could be observed from a pecked basin on the Cliff Palace exit trail and the

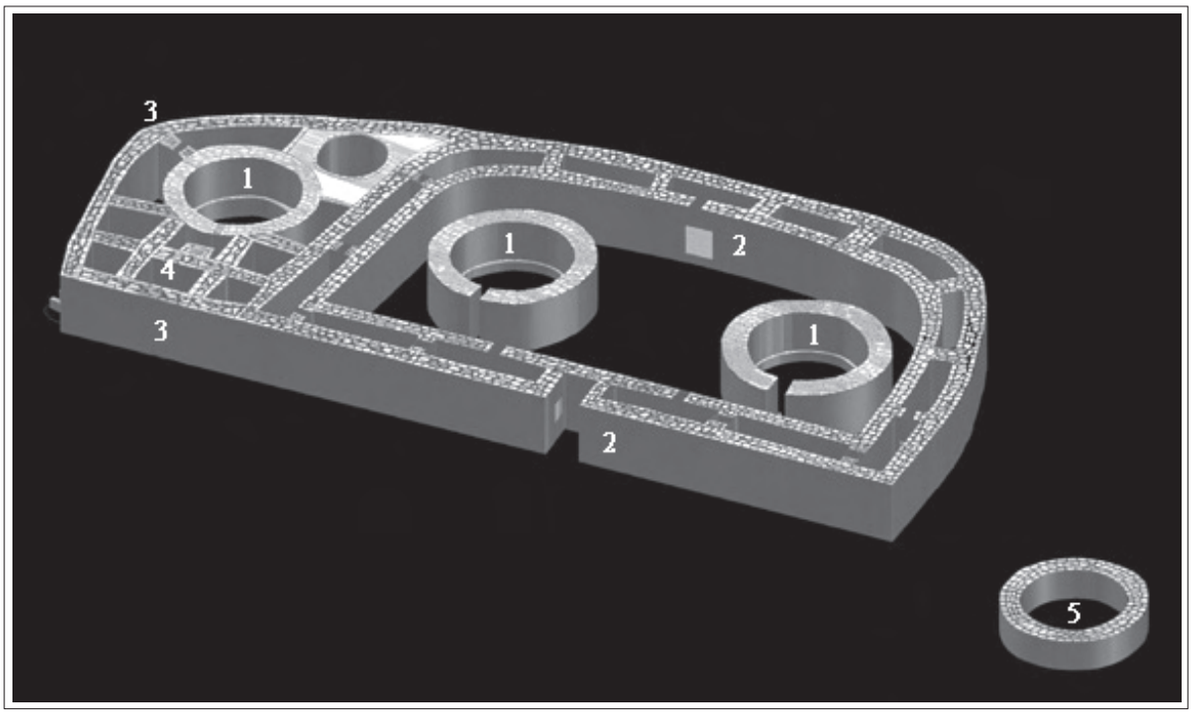

Fig. 2. Sun Temple architectural construction sequence.
1 – Kivas A, B, and C. Initially constructed as towers; 2 – Principal D perimeter wall, begining at north center and ending on the south wall; 3 – Annex perimeter wall; 4 – Annex subdivisions; 5 – Miscellaneous Structure 2, detached from main structure, sequencing indeterminate.

southern maximum moonset was best observed from an opening in the third story of the Painted Tower within Cliff Palace (Malville and Munson 1998).

These alignments would function if Kivas B and C in Sun Temple were towers that projected above the outside perimeter wall. In December of 1997, Munson observed the winter solstice sun setting over the center of Sun Temple from the pecked basin confirming Malville's first hypothesis. (Fig. 3). In June 2006, Bates and Munson observed the southern maximum full moon setting over the center of Sun Temple from the Painted Tower of Cliff Palace. Munson reconfirmed this alignment on June 2, 2007 (Fig. 4).

Fig. 3. Winter solstice sunset.

Architectural Conclusions

Using a grid construct and triangulation, we calculated an estimate of stone fall volume to determine if the current wall height was the same as the original wall height. Based on an 1891 photograph taken by Gustav Nordenskiold (Fig. 5), we believe that current wall top stones match those in the photo. Further, our calculation correlates with Fewkes' estimate of the volume of rock he removed from Sun Temple, which was then used to build administrative buildings on Chapin Mesa. With the presence of the stump, plus roots that extend through the walls, we believe that the current location of the stump is at the historic top of the origi-

Fig. 4. Southern maximum moonset.

Fig. 5. Sun Temple in 1891.

nal mound and wall tops, estimated at 3.0 meters. The amount of rubble surrounding the walls of Kivas B and C indicate they were no higher than approximately 2.5 meters. This analysis supports the conclusion that the towers or kivas did *not* extend above the D-shaped perimeter wall and thus were not visible from Cliff Palace once the surrounding wall was in place.

At this time we believe that construction at Sun Temple was completed by the Ancestral Puebloans based on openings that have been remodeled. Fewkes stabilized the structure in 1915 by adding a cap of reset building stone (Fewkes 1916). Although this cap was 40-60 cm thick, he did not significantly alter the overall layout or details. We currently believe that no portion of Sun Temple was roofed or was ever designed to be roofed. This is based on wall heights, the absence of roof beam sockets, and the need for light to penetrate rear rooms of the structure.

Cliff Palace/Painted Tower Architecture

Before we make any conclusions as to the astronomical uses of Sun Temple, we must address the architectural history of the Painted Tower area in Cliff Palace. Previously recorded features of the Painted Tower that support astronomical usage are the vent in the third story west wall and a well preserved pictograph also located in the third story that is reported to depict lunar cycles (Malville and Munson 1998) although there are alternative interpretations of this decoration. Historic photographs show the pictograph to be largely intact in 1896 while about 3/4 of the vent was reconstructed in 1934. It should be noted that through repeated Theodolite measurements, this opening is in the proper orientation to observe the southern maximum moonset over the central portion of Sun Temple.

In June of 2006, we located what appeared to be a small sealed opening in the southwest exterior corner of the Painted Tower near the base of the third story.

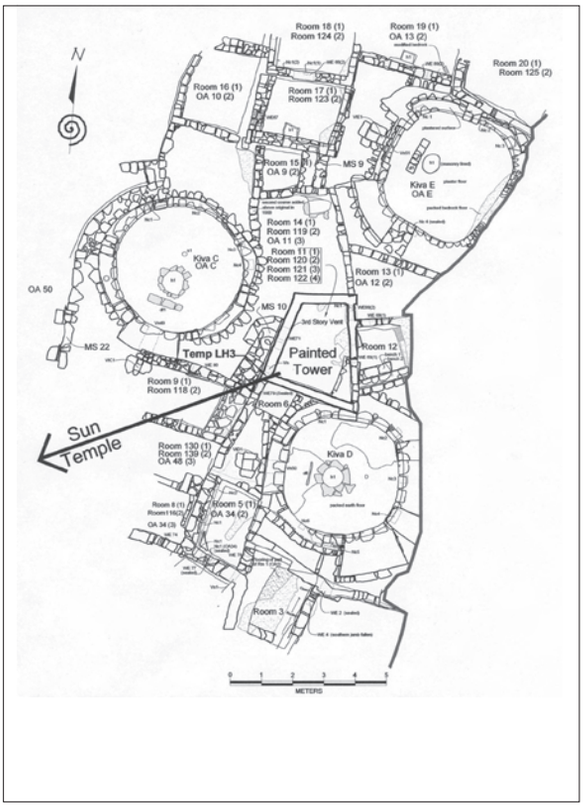

Fig. 6. Cliff Palace Painted Tower area.

The opening is circular with a diameter of 8 cm and angled through the wall. The opening was sealed by the Ancestral Puebloans with adobe from the interior, plastered over, and then decorated with the pictograph. When it was open, the angle and position of the opening may have provided an observer with a well framed and easy to use view of Sun Temple (Fig. 6). The exact alignment is difficult to assess as the feature is sealed.

Immediately to the south of the Painted Tower is Kiva D. In June of 2006 we noted that the southern maxima moon could be seen setting over the top of Sun Temple from the roof elevation of Kiva D.

These investigations suggest that Sun Temple could have been used as an astronomical marker for both winter solstice and southern maximum moonset as viewed from separate locations in Cliff Palace. Original features show orientation and views of Sun Temple applicable to the southern maximum moonset. Modifications to these features over time indicate a possible change in how this event was viewed and recorded. The southern lunar standstill events of 1279 AD to 1281AD could be observed setting over some portion of Sun Temple by a large population located at ground level from Kiva A to Kiva F and south of the Painted Tower in Cliff Palace. Persons with specialized or sacred knowledge may have been located in an elevated position, either on the roof top of Kiva D or in the third story of the Painted Tower. This may have provided

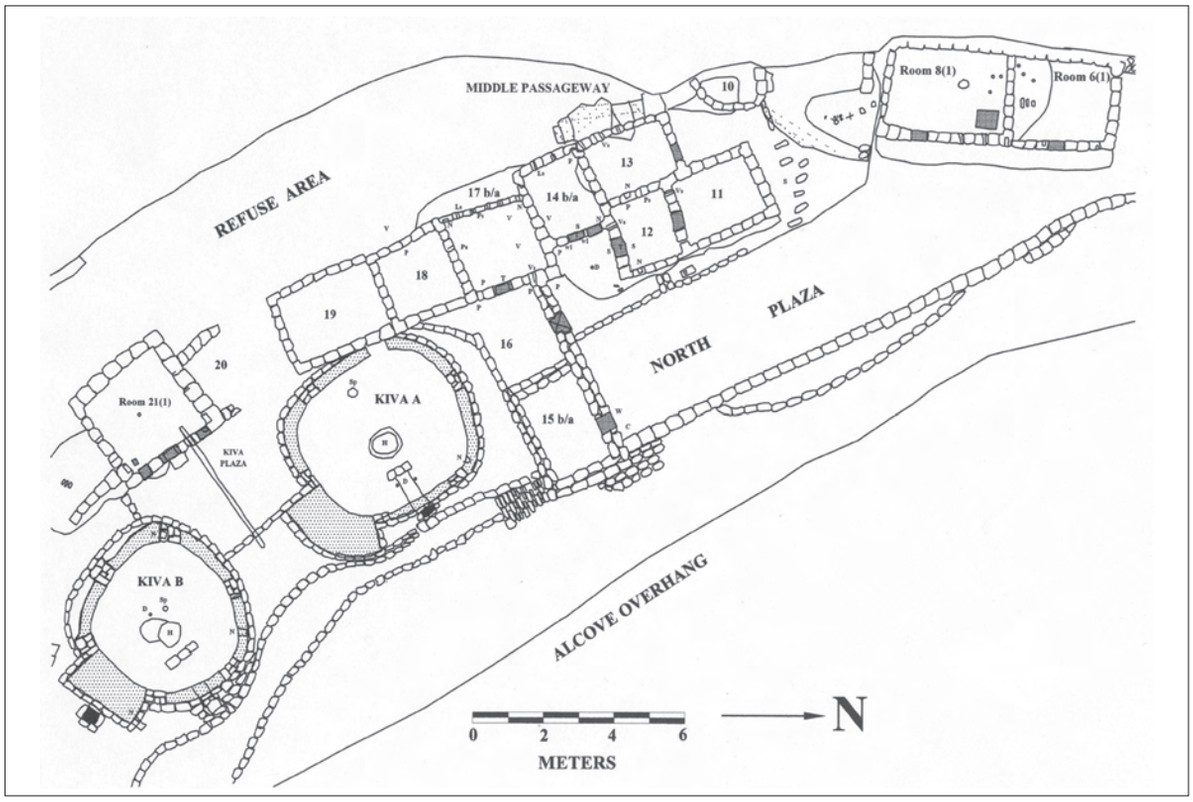

Fig. 7. Balcony House, plan map, central area.

timing for the 18.6 year lunar maximum cycle, a figure perhaps not too unlike a human generational reproductive cycle in the AD 1200's. This may have been used for the purpose of timing large public gatherings. References to this type of information are not currently found in puebloan ethnography as it may be secret or such practices were discontinued at the time of the Ancestral Puebloan migration around 1300 AD.

Dendrochronology Studies

The other major component to our research is analyzing the relationship of the lunar standstill cycle and architectural construction phases. Dendrochronology studies have shown an association of the lunar standstill cycle with architectural construction at the Chimney Rock Great House Pueblo (Malville 1999). Dendrochronology or tree ring dating is a process where structural wood samples are cross dated through time to provide room construction dates. Enough samples show periods or cycles of construction. Our use of dendrochronology is consistent with research protocol proposed by Bates and Bostwick at the Oxford 6 symposium (Bates and Bostwick 1999).

Although Cliff Palace does not contain enough wood to produce aggregates of construction dates, Balcony House (Fig. 7) provides an architectural example at Mesa Verde National Park. A chart of sample dates shows clusters in the early to mid 1200's, in the 1240's, and the mid to late 1270's AD. When a graph of the southern lunar maximum declinations is added, an **approximate** correlation with the maximums of 1204-1206, 1242-1244, and 1279-1281 AD can be observed (Fig 8). To make any conclusions, we must examine the type and location of the architecture represented by the samples. The early dates are associated with Room 4, Room 8, and the woodpile that is believed to be the roof timbers for Kivas A and B. The 1240's dates are primarily associated with Room 8 and the wood pile. The mid to late 1270's dates are associated with Room 6, Room 21, construction of the "Big Wall", and the east and south passageways.

Room 8 was constructed in the 1240's. Studies in 1997 showed the viewshed of this room to include equinox sunrise and possible links to the southern maximum moonrise (Malville and Munson 1998). Observations in 2006 and 2007 found the southern maximum moon rising at the intersection of the northeast corner of the "Big Wall" and the horizon from a basin pecked into the floor of Room 8 (Figs. 9-11). Based on Brunton compass measurements, no other culturally significant astronomical alignment were visually confirmed; however, we did not observe all potetnially significant cultural dates when an astronomical alignment would be expected or anticipated.

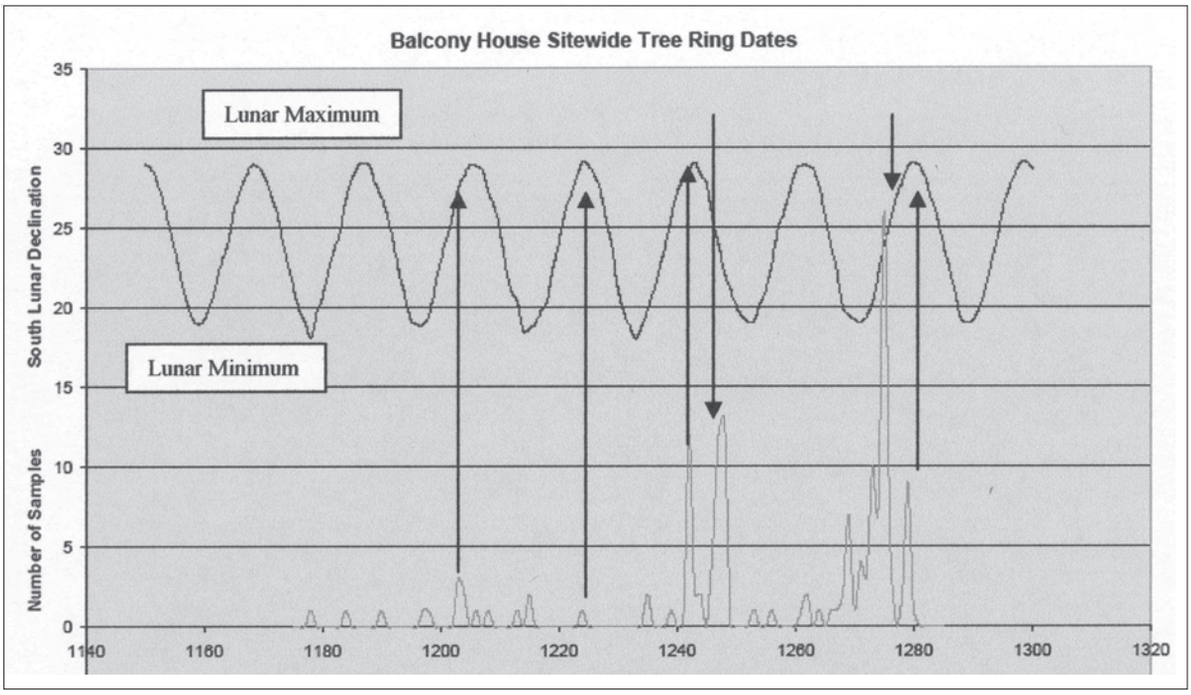

Fig. 8. Tree ring dates at Balcony House.

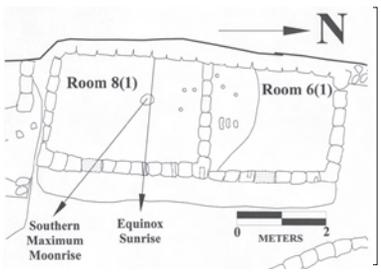

Fig. 9. Balcony House Room 8.

Fig. 10. Equinox sunrise.

Fig. 11. Southern lunar maximum.

Room 21 (Fig. 12) is part of the late phase construction with wood cutting dates between 1273 and 1276 AD. Room 21's architecture includes a T-Shaped door, two upper vents, and a lower vent in the east wall. A mudline on the exterior of this wall suggests additional architecture adjoined this room to the east. There is also heavy smoke staining inside this room even though no archaeologist has yet located the fire pit. Munson observed on December 5, 2006 that the northern maximum moonrise was framed by the upper portion of the T-Shaped door of Room 21 and on a line between Kivas A and B (Fig. 13). Complete architectural documentation is needed for this unit to further assess this association and the potential impact of the adjoining architecture.

The construction, dating, and orientation of some openings toward astronomical observations suggests that some rooms in Balcony House were associated with observation of the lunar maximum cycle. This conclusion cannot be made until a full set of architectural documentation data has been developed. It is through the documentation process that a solid architectural foundation will be formed for further studies at Balcony House.

Square Tower House

Because Balcony House lacks the dendrochronology needed to fully evaluate kiva construction cycles, we turn to Square Tower House, specifically Kivas F and G. (Fig 14). These two kivas represent the most intact kiva roofing available in Mesa Verde National Park. The roof of Kiva F (Fig. 15) shows a strong date cluster at 1203 - 1205 AD (23 samples) with additional small sample numbers through 1245 AD. The samples after 1205 AD probably represent periodic maintenance (Figs. 16). Kiva F was built between 1203 and 1206 AD corresponding to the lunar maxima of 1204-1206 AD.

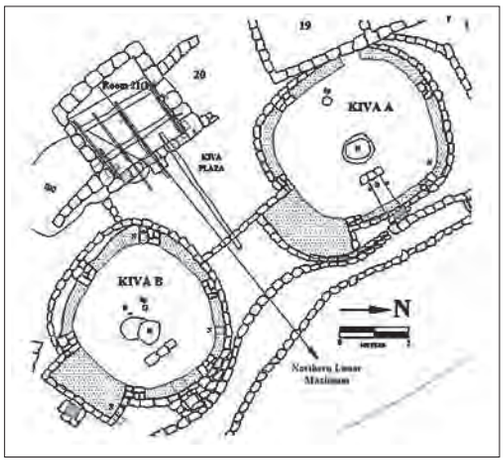

Fig. 12. Room 21, Kivas A&B plan map.

Fig. 13. Room 21 northern maximum moonrise.

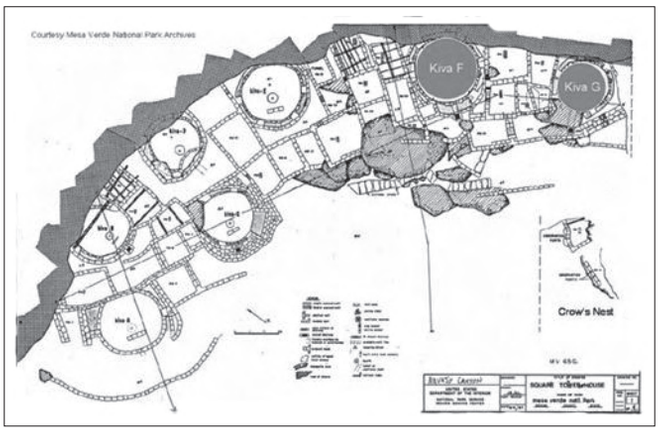

Fig. 14. Square Tower House plan map.

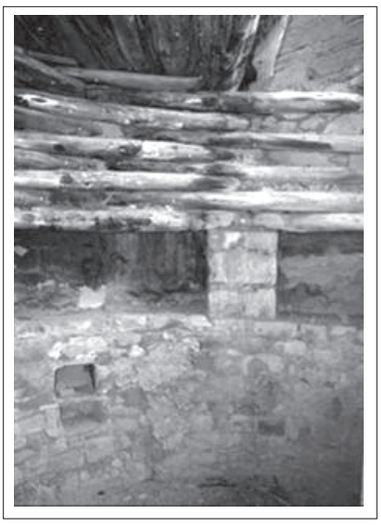

Fig. 15. Kiva F roof.

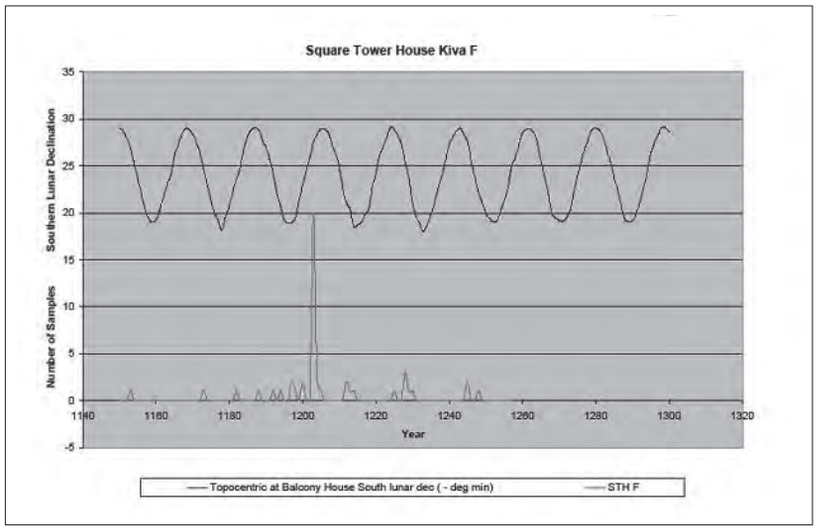

Fig. 16. Kiva F tree ring dates.

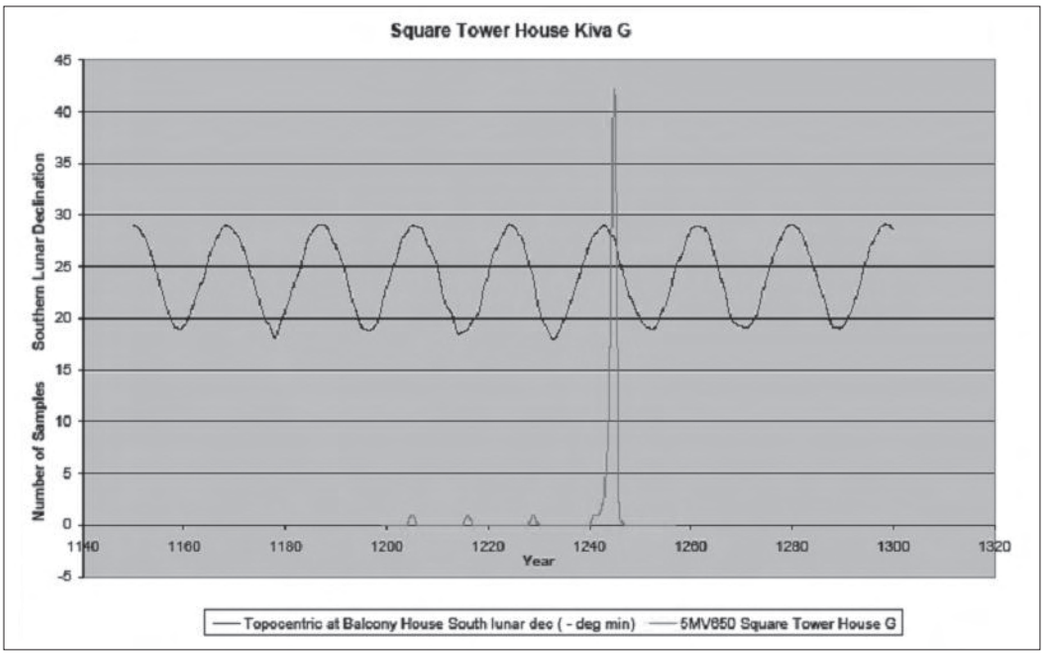

Fig. 17. Kiva G tree ring dates.

The construction of Kiva G is precisely dated to 1243-1245 AD (58 samples) corresponding with the lunar maxima of 1242-1244 AD (Fig. 17). Kiva G is the eastern most kiva in Square Tower House and is most closely associated with the access up to the Crow's Nest.

Following the Oxford VIII Conference, we noted a descrepency in the tree-ring data set for Square Tower House. We obtained corrected data from the Laboratory for Tree-Ring Research (University of Arizona, Tucson, AZ.) and updated our database and graphics as presented above.

As with Balcony House, a full architectural documentation package is needed for Square Tower House before any solidly based conclusions can be made.We are currernty conducting a Mesa Verde wide analysis of all tree ring cutting dates as well as at our control sites in an atttempt to better test our hypothesis.

Summary & Conclusions

In this project we used the principles of architectural documentation to examine form, feature placement, and phases of construction in relation to the Lunar Standstill Cycle. The Sun Temple documentation project confirmed Fewkes' belief that Sun Temple was a special building, but refined many of his observations regarding construction sequencing and potential usage. Sun Temple could have been used as a marker by observers in Cliff Palace for winter solstice sunset and southern lunar maxima moonset. The pictograph and newly recognized features in the Painted Tower of Cliff Palace, as well as direct observations, support our assertion that the area could have been used by sky-watchers and religious leaders for the observation of the 18.6 year lunar cycle. In the case of Sun Temple, a flat tree-covered horizon necessitated the construtction of a human created horizon (i.e Sun Temple) in order to accurately observe the southern maxima lunar standstill. The documented observation of lunar maximum cycles at the Chimney Rock Great House Pueblo provides indirect support for this process occuring at Mesa Verde.

Our examination of the tree ring dating record has revealed a correlation with the lunar maximum cycle. We see the closest associations in the well preserved kivas of Square Tower House and the specialized architecture of Balcony House, although both data sets are incomplete. Date clusters that preceed lunar maximums may be related to the construction of anticipatory architecture and features. Date clusters that follow lunar maximums are probably related to repair/replacement of roofs and not to observed astronomic cycles. In addition, consideration must be given to the influence of climatic cycles such as drought and localized environmental factors such as resource depletion. Our data set currently contains over 3000 dendrochronology samples from nine surface archaeological sites and 14 major cliff dwellings. Additional data is being incorporated so that a more thorough statistical analysis can be performed with additional construction units.

Our reseach clearly reveals that there is a correlation between the building of specialized architecture and

the lunar standstill cycle at Mesa Verde National Park. The question remains whether the construction of these buildings was driven by (a) astronomy or (b) enviornmental/cultural concerns. To answer this in part, we need to continue to evaluate construction dates of special function architecture (as documented by tree-ring analysis, palynology and other datable methodologies). But further, we need to assess what information the ancestral cultures derived from this astronomy. Per David Whitley, "it is necessary to identify why (not how) [astronomy] was done and how this knowledge and practice was used." (Whitley 2006, p.91). Such information could have been used to construct architecture for prediction, observation, and celebration for the purpose of maintaining agricultural or ceremonial calendars that time public gatherings which establish kinship groups and reaffirm cultural identity.

We now hypothesize that this correlation is intentional and we will continue to assess the physical data (astronomical/ tree ring) at regional and contemporary sites in the Mesa Verde region while also probing the "why" or what information the lunar min-max cycle may have provided the ancestral cultures and how they used that information. To assess the latter, we will analyze the records of J.W. Fewkes and others via their archived records at the National Anthropological Archives as well as continuing to interview living and knowledgable Puebloans about the extent of the astronomical knowledge within their culture.

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SKAITANT ARCHITEKTŪRINIUS ĮRAŠUS: KAIP ASTRONOMINIAI CIKLAI GALI ATSISPINDĖTI ARCHITEKTŪRINĖSE KONSTRUKCIJOSE MESA VERDE NACIONALINIAME PARKE, KOLORADO VALSTIJOJE, JAV

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Santrauka

Dendrochronologinio datavimo būdu ištyrus architektūrinių konstrukcijų iš Mesa Verde nacionalinio parko amžių ir statinių orientacijų ryšį su pagrindiniais Mėnulio azimutais, buvo nustatyta koreliacija, leidusi iškelti hipotezę, kad šie statiniai ir jų konstrukcijos galėjo būti orientuojami atsižvelgiant į 18,6 m. trukmės Mėnulio ciklą apie 1150–1300 m. Detali architektūrinė ir dendrochronologinė Saulės šventovės (Sun Temple) analizės patvirtino pradinę hipotezę, kad pietinis „aukšto“ Mėnulio azimutas buvo stebimas virš Saulės šventovės iš Dažyto bokšto (Painted Tower) Uoliniuose rūmuose (Cliff Palace). Analogiški statinių konstrukcijų ir reikšmingų Mėnulio azimutų sąryšiai buvo aptikti ir kituose statiniuose.

Anksčiau atlikti Čakų kanjono (apie 800–1100 m.) ir Kamino uolos (Chimney Rock) archeologinės vietovės (1000–1100 m.) archeologinių tyrimų duomenys taip pat parodė, jog senieji krašto gyventojai pueblai stebėjo architektūriškai pažymėtą 18,6 m. trukmės Mėnulio ciklą. Kita vertus, šios hipotezės pagrįstumą sustiprina ir XIX a. etnografinė medžiaga, XX a. pradžios fotonuotraukos bei dokumentuoti pokalbiai su Pueblo genties vyresniaisiais.

Tolesni tyrimai turėtų atsakyti į klausimą, kokiems konkretiems tikslams buvo naudojamos šios astronomiškai reikšmingos konstrukcijos.

Vertė Jonas Vaiškūnas