

MAYA CALENDAR AND MESOAMERICAN ASTRONOMY

Gerardo Aldana – *University of California, Santa Barbara*

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A BRIEF HISTORY OF MAYA TIME

The Mayan¹ communities of present-day Mexico and Central America developed an intricate calendar with origins as early as the eighth century BCE. Though many today first encounter it through tabloid coverage of supposed predictions the calendar makes about the “end” of time, its fame in the history of science rests in part on the technological, social, and political sophistication the calendar reveals was required to reliably track historical time. Ancient Mayan cultures are best known in contemporary popular culture by representations of the archaeological sites of Tikal, Palenque, Copan and Chich’en Itza. Alongside their “pyramid temples” these sites are often recognized for the calendric records found in numerous hieroglyphic inscriptions. And while Mayan communities still thrive and struggle in southern Mexico and Central America, and while the content of the inscriptions is now understood to comprise multiple literary genres, this is likely all overshadowed in modern popular culture by the apocryphal interpretations of the “end of the Mayan calendar” in the year 2012. When we get past these straw man interpretations, however, and consider the calendar and its complexity within its historical contexts, we encounter a rich history of science, influenced by politics, religion, and social change over time.

¹ It is traditional within Maya archaeology to use “Mayan” when referring only to the languages within the family, and “Maya” for all other references. For example, we say “Maya archaeology,” “Maya region,” “Maya people.” John Justeson and David Tavarez—a linguist and a historian—have countered that in English, the latter practice is reserved for references to certain animals (fish, deer) and not for people or cultures. I accept their critique and follow their recommendation in this piece. See Justeson and Tavárez, “Colonial Northern Zapotec and Gregorian Calendars.”

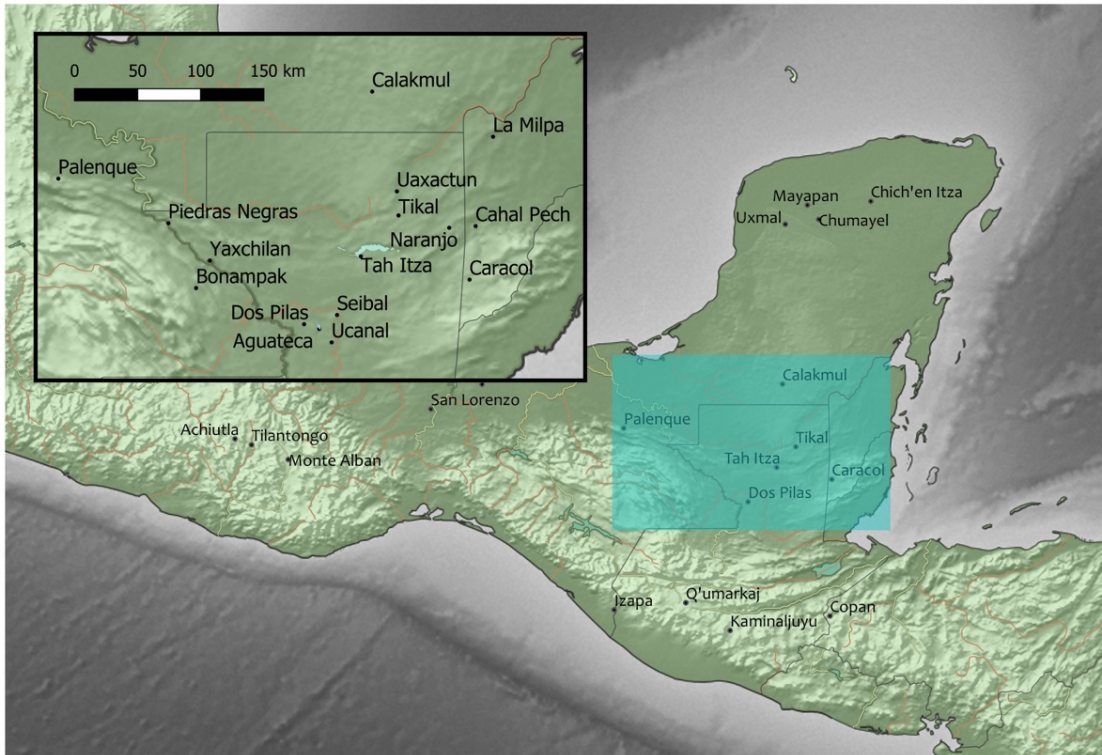


Figure 1: The Maya region, with the central Peten – focus of the Classic period – highlighted. Image courtesy of the author.

Mayan astronomy presents more than just an object of scientific curiosity. Its development offers a unique perspective through which to view Mesoamerican science and culture more broadly. For one, it evidences a Western Hemisphere indigenous science that was developed independently from Africa, Europe and Asia. Second, Mayan astronomical records were preserved in a robust hieroglyphic writing system used for centuries before cross-Atlantic contact was made. The record is unique in providing robust non-Western scientific records in architectural, artistic and textual forms. In these records, we therefore have indigenous voices addressing indigenous audiences. These are not the translations or interpretations of European colonists or evangelists, but Mayan scribes recording Mayan thoughts, philosophies, religions and sciences for Mayan audiences. This too makes them unique.



Figure 2: An example of Classic Mayan hieroglyphic writing. Here, Caracol Altar 23 depicts high-ranking captives from nearby cities, taken by the authority of the k'uhulajaw of Caracol, K'inich Joy K'awiil. The central text starts with a Calendar Round date and commemorates a k'altuun event. Image courtesy of the author.

It may be, though, that this uniqueness has left Mayan astronomy vulnerable to misinterpretation, in particular in combination with another factor. During the first centuries after cross-Atlantic contact, hieroglyphic writing was actively suppressed and replaced with writing using the Latin alphabet. Even village ritual specialists writing in their own indigenous languages for local communities began using alphabetic script, with the Books of Chilam Balam as key examples. By the late nineteenth century, literacy in the hieroglyphic writing system had been lost at least for a century, requiring modern Russian, European and American scholars to initiate a process of decipherment. Within this latter process, the number system and the components of the calendar were quickly deciphered, but the text itself remained impenetrable until the 1960s, and hasn't been considered securely deciphered until the late 1990s. This means that for nearly a century, the scholarship on Mayan astronomy was developed based on numbers and dates, without an ability to contextualize them. Its non-Western basis along with secure access only to calendric

information therefore left the interpretation of Mayan astronomy by European diasporic cultures in a precarious state.



Figure 3: Of this inscription, Teeple writes: “The wooden lintel of Temple C at Tikal (Maudslay drawing volume III, No. 78) gives a date 11 Ik 15 Chen which is usually and apparently safely considered to be 9.15.12.2.2,11 Ik 15 Chen, and in the immediately following Glyphs is a statement that “the Venus year ended in Kayab 24 days from a new moon day.”² While the Long Count date does accord with the Calendar Round, what Teeple refers to as the “Venus year” is now understood as a glyph representing war (see below), and what he takes as the calendric month K’ayab is the phonetic representation of ‘a.

In the historiography of Mayan astronomy, there have been two noteworthy peaks of activity that have strongly shaped the literature we have available today. At the end of the nineteenth century, the German librarian, Ernst Forstemann, cracked the Long Count calendric system and used it to find Venus periods in the Dresden Codex. This generated a spate of activity

² Teeple, 405.

seeking similar patterns within the vast collection of dates actively being recovered from monumental hieroglyphic inscriptions—on stelae, carved into wooden lintels, and painted on walls. Nearly all of this scholarship in the pre-decipherment early twentieth century built interpretations based on the identification of numerical patterns and their correlation to astronomical periodicities.

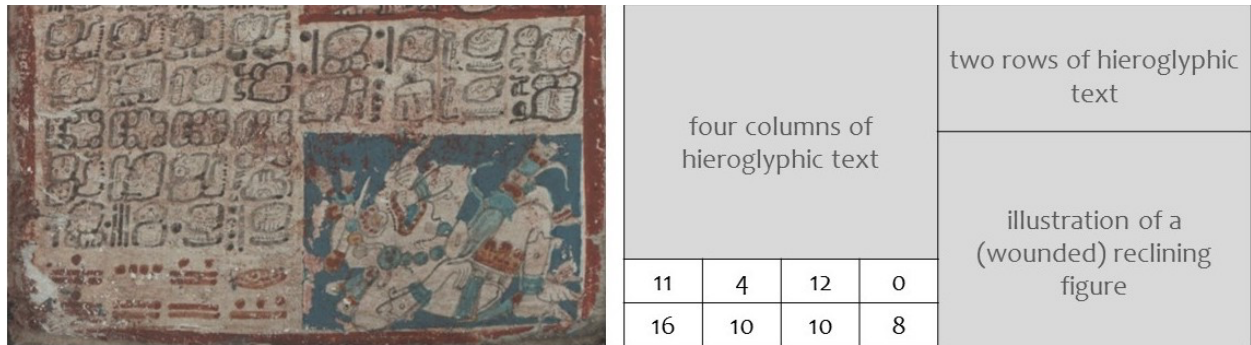


Figure 4: The lower portion of Dresden Codex Page 49. The numbers in the lower left are in positional notation, representing the numbers 236, 90, 250 and 8.

During this time, lasting until the final third of the twentieth century, the prevailing opinion was that Mayan hieroglyphic writing was ideographic and did not reflect the components of a spoken language. Scholars made use of this assumption to develop readings of inscriptions that were primarily religious or esoteric in nature, with an emphasis on astronomical content. Out of this work came the interpretation of Mayan cultures as “obsessed with time.”³ Tatiana Proskouriakoff’s demonstration that patterns in the calendric portions of hieroglyphic inscriptions better supported historical interpretations than astronomical ones probably did more than anything else to change that view.⁴ In the wake of her 1960 work, linguists and epigraphers came together to demonstrate that the writing system contained both phonetic and logographic signs, which meant that it could capture anything that could be said in the Mayan language of its day. Scholars of the 1970s and ‘80s then went on to combine hypothetical astronomical patterns with speculative new readings to produce a second peak of publication on Mayan astronomy. Most of these too, however, have fallen away with the advancing decipherment.

It is only since the late 1990s and early 2000s that we have had a reliable and well-constructed method for the decipherment of the hieroglyphic text. Epigraphers of the early twenty-first century have deciphered over 90% of the hieroglyphs attested and have reconstructed this prestige language as parallel to Latin within European Medieval and

³ Coe, *Breaking the Maya Code*; Fash, *Scribes, Warriors and Kings*.

⁴ Coe, *Breaking the Maya Code*.

Renaissance elite communities.⁵ The language of the Classic period inscriptions now has been placed within a genealogy of Mayan languages, reaching back to proto-Mayan forms. And noticeably, the number of new astronomical proposals has dropped significantly. Instead, Classic period inscriptions now are recognized to be full of historical information, genealogical and political relationships, some mythology, and even one notable first-person narrative statement (At seventh century Copan, Waxaklajun Ub'aah K'awiil had his scribes record a script on the face of a step starting with: "Ni winikhaab." Or "It is my first twenty-year period of rulership.").

While the number of deciphered texts has increased overwhelmingly since the last quarter of the twentieth century, the number of records understood to be explicit astronomical references has decreased substantially. Now that we can read inscriptions and we have a much richer archaeological record for architectural and material culture context, we encounter a subtler role of astronomy within ancient Mayan cultures. What we find is that—as in other ancient civilizations—there were substantive political applications and motivations to astronomy. In very broad outlines, this essay follows three generalized phases of astronomical application as put to political purpose: i) alliance; ii) *ajawlel*; and iii) professionalism. These three phases correspond roughly to what have been referred to as the Formative, the Classic and the Postclassic periods.

FORMATIVE PERIOD

Background

The Formative period in Mesoamerica runs roughly from 2000 BCE to 200 CE. It begins with mostly nomadic or semi-nomadic populations and some sedentary groups living sustainably throughout the region, and the period ends with large cities dotting what are now Mexico and Central America. The early settlements created a tapestry of small-population cultural forms across the landscape, in some cases within language groups and others across languages. Within such cultural tapestries, some geographic resources would be shared by communities occupying them at different times; other resources would be guarded by specific clan groups; and some would fall into open contestation periodically or persistently. Throughout the period, alliances and political accommodations would have been necessary between nomadic clans and sedentary ones.⁶

What shifts during the early Formative period is that some communities found interest in and developed the means to alter the landscape substantively. Circa 1800 BCE, sedentary communities built the first permanent, shared architectural complexes in the riverine lowlands of the Veracruz Gulf Coast and the agriculturally fertile valleys of the Oaxacan

⁵ Coe, *Breaking the Maya Code*.

⁶ Sharer, *The Ancient Maya*.

highlands. The emphasis was not on huge pyramids at this point; near the coast, most of the labor was dedicated to moving earth in order to create level, interconnected plazas, which itself was no small feat in the tropical lowlands of Veracruz and Tabasco.

Also during the early Formative period, a trade archipelago developed.⁷ Some clan or set of clans began mining jadeite in the highlands near what eventually became the city of Kaminaljuyu (and now Guatemala City), for transport to those growing permanent settlements of the lowland Gulf Coast. Since all stone resources are rare to non-existent in the Veracruz lowlands, both serpentine and jadeite were imported from some distance. At around the same time, some community botanical specialists found that the combination of rubber tree sap with an extract of a morning glory vine could create a material with new properties. In particular, this combination generated a substance that could be stretched and returned to its original shape. Eventually, this new material was made into rubber balls, which were incorporated into a game that became pervasive throughout Mesoamerica by the late Formative period, which is referred to simply as the Mesoamerican Ball Game.



Figure 5(a) The ball court at Q'umarkaj, late Postclassic city of the K'iche' Mayans. Image courtesy of the author.

⁷ Rice, *Anthropomorphizing the Cosmos*.



Figure 5(b): Nobles playing the ball game depicted on a Classic period drinking cup. This image is from Justin Kerr's "mayavase" database: www.mayavase.com and is in the public domain.

What we have, then, to contextualize the origins of astronomy in Mesoamerica is that by the middle Formative period, there was a need for long-distance alliances between communities at relatively stable locations, facilitating the movement of specialized trade goods over thousands of miles.⁸ Locally, the management of labor forces was necessary for architectural efforts serving public activities. Shared cultural activities emerged across regions.

A key mechanism for stabilizing the stations along the trade archipelago was a new and greater reliance on agriculture, which could have replaced the more nomadic lifestyle of seasonal migration to follow food productivity. While maize had been cultivated in various forms for centuries before the onset of the Formative period, it is only during the Formative period that it takes on the role of a staple within a well-diversified diet. By the Middle Formative, a dependence on maize-beans-squash agriculture, alliances facilitated by periodic play of the ball game and valuation of exotic trade goods all came together in this network across the languages and regions of Mesoamerica.⁹ It is within this context that the oldest and most enduring forms of astronomy as well as calendric technology took shape.

The 260 Day Count

Known in K'iche' as the *chol q'ij*, in Nahuatl as the *tonalpohualli* and in pseudo-Yucatec (coined by early twentieth-century Mayanists) as the *tzolkin*, the 260 Day Count shows up during the middle Formative period as the earliest calendric device in the archaeological record. An Olmec stamp from ca. 650 BCE, including a 260 Day Count date, was probably used to

⁸ Sharer, *The Ancient Maya*; Rice, *Anthropomorphizing the Cosmos*.

⁹ Sharer, *The Ancient Maya*.

decorate ceramic vessels. A 260 Day Count date on San Jose Mogote Monument 3 appears to serve as the name of an individual, dating as early as 300 BCE. Although the count has changed in graphic representation and in individual components according to language and region, in structure it has not changed since the first millennium BCE to its present use among highland Mayan communities.¹⁰

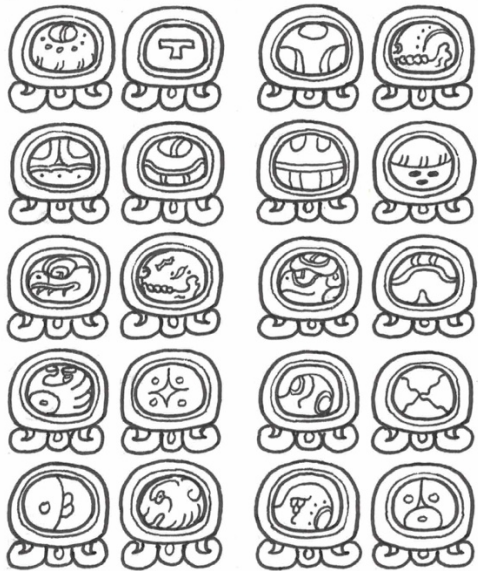


Figure 6: the 260 Day Count also known as the *ch'ol q'ij* and the *tzolk'in*. The sequence is read in paired columns from left to right; the first pair of columns reads: Imix, Ik', Ak'bal, K'an, Chikchan, Kimi, Manik, Lamat, Muluk, Ok. The second pair of columns reads: Chuwen, Eb, Ben, Ix, Men, Kib, Kaban, Etz'nab, Kawak, Ajaw.

In operation, the 260 Day Count combines thirteen numbers with twenty Day Signs. The Day Signs are symbols representing natural entities found in local environments, such as jaguars, wind and reeds. The count works by cycling through each part of the count with each passing day to generate a total of 260 different combinations. With the Day Signs in Yucatec Mayan as Imix, Ik', Ak'bal, K'an, Chikchan, Kimi, Manik, Lamat, Muluk, Ok, Chuwen, Eb, Ben, Ix, Men, Kib, Kaban, Etz'nab, Kawak, Ajaw, we could follow a daily sequence from 1 Imix to 2 Ik' to 3 Ak'bal, 4 K'an... 12 Eb to 13 Ben. After 13 Ben, the numbers "start over" at 1, having reached the largest member of the set. The Day Signs continue, however, such that 13 Ben is followed by 1 Ix, 2 Men, 3 Kib... 7 Ajaw. Here, now the Day Signs have run out, so we start that sequence over such that 7 Ajaw is followed by 8 Imix, 9 Ik', &c. Thus, 259 days after 1 Imix is the date 13 Ajaw, which is followed the next day by a return to 1 Imix.

¹⁰ Aveni, *Skywatchers*.

Early records of the 260 Day Count show iconographic similarity to later hieroglyphs, especially in the Mayan region. The artistic convention there was to embed a variable symbol within a “cartouche,” in a manner that creates a strong analogy to modern days of the week. For Mayan Day Signs, the cartouche was the graphic equivalent of the suffix “-day.” In European calendrics, the embedded image corresponds to the prefix derived from one of the seven great celestial bodies: Mon-, Tues-, Wednes-, Thurs-, Fri-, Satur-, and Sun- come from the Moon, Mars, Mercury, Jupiter, Venus, Saturn and the Sun. For the Mesoamerican case, each of the Day Signs carried symbolism, expressed either iconographically or linguistically, depending on the period and region. Where the inspiration was astronomical in the European version, Day Signs were drawn from local environmental or cosmological sources in the Mayan case. And where there are only seven European prefixes, there are twenty Mayan Day Signs. Regarding its iconography, Late Formative period representations of Day Signs at San Bartolo in central Yucatan demonstrate that the “cartouche” originated in the hieroglyph for blood, *k’iik’*. The combination of numerical coefficient and symbolic Day Sign gave each date within the count a unique character, which then could be utilized for various social and religious purposes.

The origins of the 260 Day Count are ancient, but still contested. Some scholars have proposed astronomical origins noting that along the latitude of 14.8 deg N of the Equator, the Autumnal zenith passage of the Sun occurs 260 days after the Vernal zenith passage of the Sun.¹¹ Given that the large Formative period site of Izapa sits at this latitude and appears to have served an important role in early trade routes between the Mayan highlands and the Gulf Coast, Vincent Malmstrom hypothesized that Izapa was the birthplace of the Mayan calendar. Several problems have arisen with this proposal, though, including that no 260 Day Count dates were actually recorded at Izapa even though the site is rich with iconography, and that a post-Gregorian-Reform level of accuracy for computing the solar year would have to have been attained in 1300 BCE, centuries before monuments or permanent architecture were built there, in order for his argument to hold.

On the other hand, the scholarly consensus is that the earliest attested uses of the 260 Day Count were for names. We know from written indigenous records starting in 300 BCE that individuals were named for the 260 Day Count date on which they were born. This extremely long, 2,500-year recorded tradition, has also been evidenced by modern K’iche’ Maya daykeepers, in highland Guatemala.¹² K’iche’ practitioners have suggested further that the 260 Day Count was biological in origin, which resonates with Native North American traditions that observe two “births” for an infant.¹³ A child is first “born” on the date on which its mother misses her menses, suggesting to her that she may be pregnant; and the child is

¹¹ Malmstrom, *Cycles of the Sun, Mysteries of the Moon*.

¹² Tedlock, *Time and the Highland Maya*.

¹³ Deloria, *God Is Red*.

born again on the date it “touches the earth,” as the phrase goes in Chol Mayan. On average, these births are separated by about 260 days. Under this interpretation, the count is 260 days long because it renders the same date for each of these “birth” events.

A birthdate utility to the 260 Day Count, independent of astronomical purpose, may well have been productive for Formative period community interactions. Following the same tradition for naming infants and interpreting their destinies would have facilitated alliances between nomadic or semi-nomadic groups as well as marriage proposals between members of different clans. Additionally, in the *Popol Vuh*, the authors tell us that the gods created people in order to keep their days, or even more provocatively to “dayify” the gods themselves.¹⁴ At the least, this suggests that this ritual time would have been imbued into stories and myths, providing entertainment within and between clans at festivals or gatherings. The 260 Day Count may have found numerous practical everyday uses, therefore, bringing communities together without any direct relationship to astronomical periodicities. None of this, of course, would have prohibited the 260 Day Count in the long run from being applied to keeping track of time more generally, which is unequivocally evidenced in the archaeological and historical records. In other words, the 260 Day Count may have been useful far beyond simply naming and timing ritual events, but it is not unlikely that it found its origins primarily as a social technology.

The Moon

If the 260 Day Count were primarily used as a social device both within and between clans, it’s not hard to see that the most straightforward timing mechanism for any community of the Formative period (and much earlier) would have been direct observation of the moon. Considering also the correspondence of lunar periodicity with women’s menstrual cycles and tidal fluctuations for coastal communities, the Moon was probably utilized observationally long before it was captured representationally. Visits for trade of regionally specific foodstuffs, playing the Ball Game, and providing marriage opportunities for youth could have occurred within festivals timed by lunar phases. Additionally, longer-term planning of alliances with members of village councils would have required coordination, as would meetings for specialized trade, which again would have been facilitated by lunar timing.

With increased dependence on agricultural activity, the Moon probably took on symbolic roles. Even today, Mesoamerican *milperos* commonly wait for specific phases of the Moon to begin their planting of maize or other agricultural produce.¹⁵ Anecdotal accounts from contemporary milperos can be readily found in the literature, attesting to some who wait for the first Full Moon after the first seasonal rains have started, while others wait for the first

¹⁴ Christenson, *The Popol Vuh*.

¹⁵ Bricker and Bricker, *Astronomy in the Maya Codices*.

crescent Moon after the rains. Further attesting a metaphorical relationship, one late Classic period hieroglyphic inscription describes an observed New Moon narratively using the term that is often applied to plants – *ch'ok* – when they first “sprout.”¹⁶

E-Groups

In the early twentieth century, spurred by the work of Ernst Forstemann and others who found astronomical patterns within hieroglyphic inscriptions, Sylvanus Morley and Oliver Ricketson encountered a provocative architectural complex at Uaxactun, located in the center of the Peten of what is now Guatemala. Specifically, the complex—now referred to as an “E-Group”—was useful in tracking the tropical year during the Late Formative and Early Classic periods. The name “E-Group” was incidental, reflecting that the architecture was located on a quadrant of the archaeological map labeled with an “E.” Because the same architectural features were found at other sites, they were designated as following the “E-Group” architecture at Uaxactun.¹⁷

At Uaxactun, local masons built the E-Group complex to incorporate astronomical utility based strictly on observation. The inspiration for their architecture most likely came from the Pacific Coast of Guatemala, where the earliest permanent architecture in the Mayan region was built at settlements that enjoyed astronomically useful horizons. From these towns, such as La Blanca, El Ujuxte and Paso de la Amada, the Sun rose along a variegated horizon, punctuated by volcanic peaks, themselves carrying symbolic meanings.¹⁸ Tracking the solar year would be simple, noting the geographic feature corresponding to the northernmost rise of the Sun, along with the southernmost and various points in between. Tracking the seasons, therefore, was straightforward on the Pacific Coast and increasingly useful during the mid to late Formative with the growing dependence on agriculture. To the north of these sites in the Peten, however, in the region of Uaxactun, the horizon was essentially a flat floral canopy with no prominent features available for sunrise tracking. Architects of the Late Formative period, therefore, constructed temples at heights that pierced this flat horizon to provide artificial markers facilitating a practice similar to that of observers in communities on the Pacific Coast.

¹⁶ Aldana, *Tying Headbands or Venus Appearing*.

¹⁷ Aveni, *Skywatchers*.

¹⁸ Aveni, *Skywatchers*.



Figure 7: View of the eastern horizon from Group F at Izapa. The photograph was taken on June 23, 2012, just after the summer solstice, showing sunrise behind Volcán Tajumulco. Image courtesy of the author.

At Uaxactun, three structures in the E-Group rose above the trees to mark the eastern horizon when viewed from a radially symmetric pyramid in the center of a large plaza. These three structures were evenly spaced across a long north-south platform so that the pyramid served as a viewing station for sunrise. Annually, the same pattern would repeat: the sun would rise off the southern corner of the southernmost structure on the winter solstice; it would rise from the center of the central structure on the equinoxes; and it would rise off the northern corner of the northernmost structure on the summer solstice. Over the course of the twentieth century, archaeologists found that architects at sites across the Mayan region, from Seibal and Izapa in the ninth and tenth centuries BCE constructed similar examples of this “E-Group” architecture, indicating that their construction was roughly contemporary with the first 260 Day Count records. Corroborating the architecture’s solar motivation, three stelae were planted in front of the E-Group platform at Uaxactun. The dates inscribed commemorate period ending events separated by 140 years, but transpiring at the same point in the solar year.¹⁹

¹⁹ Aldana, “Oracular Science.”



Figure 8(a): The “E-Group” architectural complex at Caracol. Image courtesy of the author.

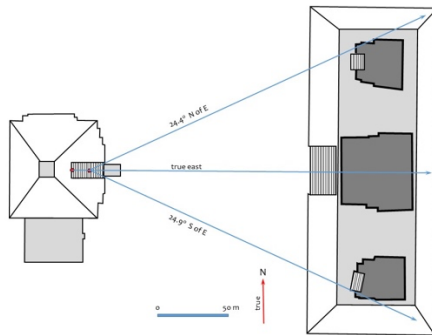


Figure 8(b): Illustration of the Uaxactun E-Group sight lines (after Ricketson, “Astronomical Observatories”).

While scholars have suggested that the alignment of architecture to sunrise stations may have reflected a religious veneration of the Sun, as with the 260 Day Count, there is also a social utility to consider. In particular, E-Group architecture provided the opportunity to support alliances amongst local communities during the middle Formative period. That is, the desire for sustained trade amidst a mosaic of independent networks of semi-nomadic and sedentary clans would render some organizational structure beneficial.

With the mosaic of lifestyles and subsistence uses of the landscape throughout Mesoamerica, a community would likely have needed more than the resources available to a single clan in order to maintain and secure a permanent location along a trade route. Alliances would certainly have facilitated the security issue, but they also would have required a system to share or distribute power given that these clans would initially have been of essentially equivalent stature.

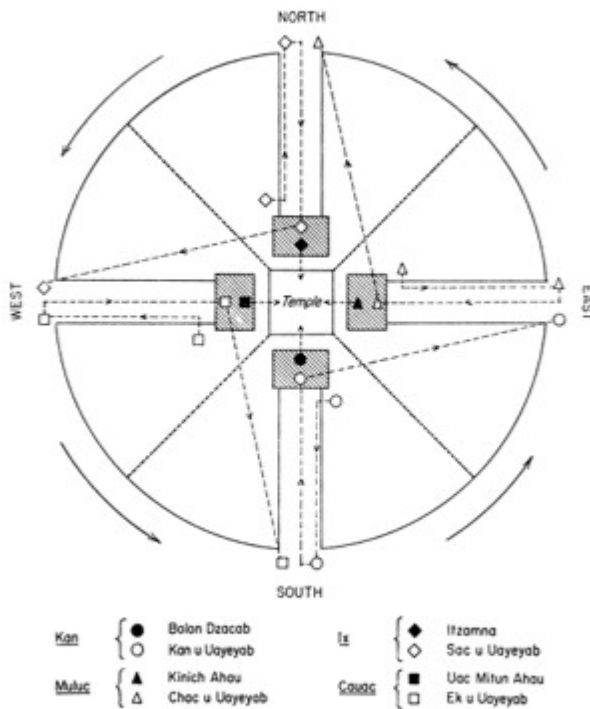


FIG. 1. Diagram of ceremonial circuits in the Uayeb Rites. The shaded oblongs represent the houses of the principales. Hollow symbols stand for the images of the Uayeb gods, and solid symbols for the images of other gods which were eventually carried into the temple.

Figure 9: Michael Coe’s model of spatio-temporally guided political organization across Mayan communities over time. Source: Coe, “Ancient Community Structure.”

Ethnohistorical documents from the northern Mayan region describe the spatio-temporal associations of indigenous political responsibilities within towns of the Postclassic period, which arguably reflect longstanding traditions and principles.²⁰ Sotuta Doc Y, for example, describes a ceremony for the governmental transition of a pueblo or small town involving a procession.²¹ In each of the cosmic regions, east, north, west and south, the principal political authority is joined by a different political subordinate as companion. Extended to the Formative period, instead of a human principal authority figure, the E-Groups would have allowed for the Sun itself to serve as the principal authority. Each of four clan leaders, then, could serve as the facilitators of a shared governance. Such a council of four “Bakabs,” would

²⁰ Coe, “Ancient Community Structure.”

²¹ Hanks, “Discourse Genres in a Theory of Practice.”

serve as a straightforward precursor to the council structures documented architecturally and hieroglyphically from the Classic period. In this sense, the Sun served as the ruler of space and time, but the four clan leaders would serve as the local regents. Perhaps as important, a village of four clans would be better positioned to withstand raids or attacks as trade route nodes than would locations populated by a single clan.

Evidence for such alliances have been found in the caches associated with Formative period E-Group architecture, for example at Cival (in present day Guatemala) from ca. sixth century BCE.²² There, local authorities commemorated an early E-Group complex with a cache of jade celts, arranged according to the cosmic directions. The cache also included jade beads, which would have served well in attested calendric devices. In addition, five large water jars, made from different clay sources, were included in the cache. Each jar was placed in line with the jade celts to commemorate the cosmic directions. Such a cache may well have represented the concerted activity of clan leaders, facilitating power-sharing amongst equal status clans within a local region. Geographically, it is worth noting that the two most straightforward routes between the highland jade sources and the Gulf Coast each included at least one established city with an E-Group complex.

²² Estrada-Belli, "Lightning Sky, Rain, and the Maize God."

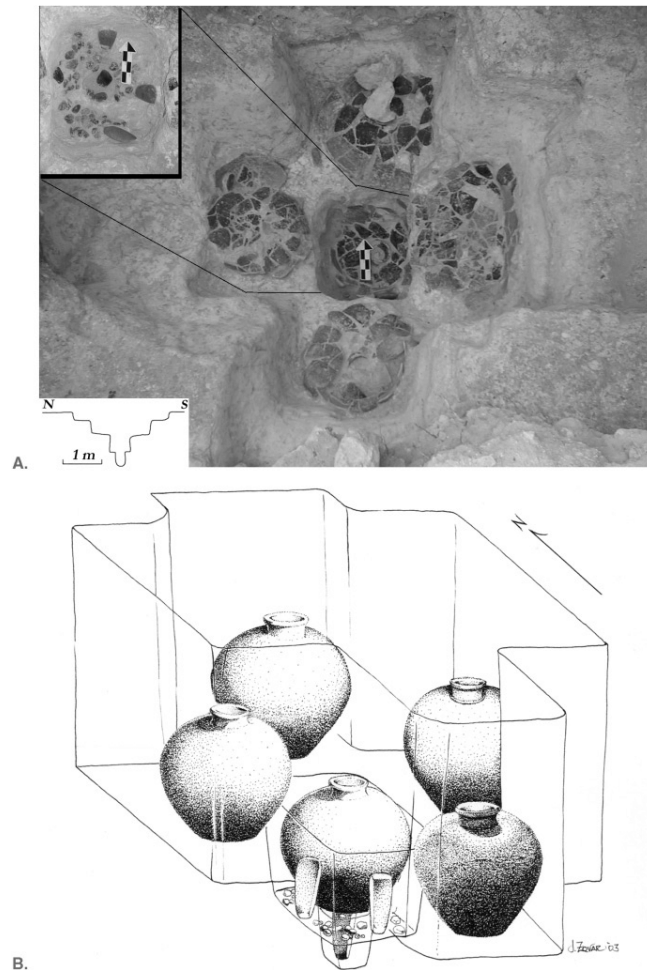


Figure 10: Quadripartite organization of a cache underneath the E-Group at Cival. Water vessels and jade celts mark the four cosmic regions.
Source: Estrada-Belli, "Lightning Sky, Rain, and the Maize God."

By the middle Formative period, then, towns serving as trade route nodes would now have had multiple devices available for coordination: a solar tracking device along the horizon; lunar phases observable to all; and a 260 Day Count for enabling day-for-day precision when necessary. These would have been more than sufficient to set the stage logistically for the burgeoning trade economies that spurred the demographic shifts of the middle and late Formative periods. Astronomically, the use of E-Group structures along with lunar observations during the middle through late Formative period would certainly have facilitated seasonal tracking, but they also would have generated ancillary astronomical products. By observing early morning skies and sunrises throughout the tropical year, patterns would have emerged, leading to the regularization of astronomical knowledge. These all come together in robust form, recorded within Long Count date inscriptions, which show up in the archaeological record during the late Formative period.

The Long Count: Politics

Between the first appearance of the E-Group structures in the middle Formative and the Late Formative periods, scribes in the Isthmus and Mayan regions created a much more elaborate calendric instrument to keep track of time. This instrument is what archaeologists refer to as the Long Count.

In terms of political utility, a new type of organization appears to have emerged alongside the Long Count. Where the E-Group would have emphasized the authority of the Sun itself and distributed political authority to a “class” of leaders, the inscriptions containing Long Count dates make clear that the paramount power is a human *k'uhulajaw* (commonly translated as “ruler”) along with his/her patron deities. Although the very earliest Long Count records were written within an Olmec writing system that hasn't yet been deciphered, Long Count records in deciphered Mayan hieroglyphic inscriptions regularly set the context for an elaboration of a *k'uhulajaw's* life history. Accordingly, they demonstrate a shift politically from the ruler as a relatively anonymous incarnation of a solar representative, to a ruler whose specific genealogy provides his/her legitimacy. It is possible that the solar representative tradition was continued elsewhere in Mesoamerica, for example, at Teotihuacan. At that Central Mexican metropolis, murals depict an anonymous figure dressed in an eagle headdress who appears to be the paramount authority. Accordingly, it would have been during the late Formative period during which Mayan views of political hegemony diverged from a more common Mesoamerican form.

The Long Count: Operation

Each Long Count date represents the number of days elapsed since a critical primordial Creation event. It is worth noting that that event itself is not a straightforward all-encompassing “Creation.” Instead, “creation” in the inscriptional record (which may have differed significantly from later documented versions, such as in the *Popol Vuh*) transpired through a protracted sequence of activities. A “zero date,” though, was recorded as the date of a specific set of ceremonial acts marking the completion of previous time periods, along with the initiation of a new set. These events were anchored to the “planting” of monuments and *k'al* (“space-time enclosing”) activities performed at each of three locations. Long after these foundational primordial events, the same ceremonies were performed by human actors—the *k'uhulajaws* themselves instead of the gods—and recorded on the public monuments. The implication (if not explicit) is that the *k'uhulajaws* served their populaces by maintaining the same practices initiated by the gods in primordial times.



Figure 11: The “end of 13 pih” creation-era event as represented on Quirigua Stela C. The inscription reads: [ISIG] 13 pih, 0 winikhaab, 0 haab, 0 winik, 0 k'in 4 Ajaw 8 Kum'ku the hearth was sighted.²³ The Jaguar and Stingray Paddlers set up the stone. It happened at the Five Sky House. It is the Jaguar Throne Stone. Ek Na Chaak ? set up the stone. It happened at the Sky-Cave. It is the Serpent Throne Stone. And then it happened, the stone enclosing at the Itzamnah House. It is the Waterlily Throne Stone. It happened at the border of the sky, the First Hearth Place. Thirteen baktuns were completed by the authority of the Six Sky Ajaw.

Operationally, the Long Count, as a count of days, functioned as a modified base 20 numerical system. The register of lowest value counted the number of days from the seating of the period – effectively “zero” – to nineteen. The scribal convention was to write the

²³ The verb here is *jel*, which some have read as “to change over; to succeed.” It also can mean “direction, or sighting,” which provides the gloss here.

coefficient of the period adjacent to the name of the period itself. The number of elapsed days was symbolized by the glyph for k'in, which would carry a coefficient of "0" to "19" within a glyph block. The next higher register tracked twenties, known as winik. The decimal number "20" accordingly would be represented hieroglyphically as "1 winik, 0 k'in." Rather than continue with a strict base 20 system, the next register augmented at the eighteenth winik. In other words, "359" was "17 winik, 19 k'in." The next date, one day later or 360 days after the zero date, would be "1 haab, 0 winik, 0 k'in." Thereafter, periods accumulated again by twenties. Twenty haab, or 7,200 days, was 1 winikhaab, 0 haab, 0 winik, 0 k'in. Then, twenty winikhaab made up one pih (144,000 days) or 1 pih, 0 winikhaab, 0 haab, 0 winik, 0 k'in. Rather than write this all out, modern scholars represent the digits of each register separated by a ".". Zero through nineteen alone, or 0 through 19 are followed by twenty, which is represented by 1.0. Adding one to this results in 1.1 or twenty-one. Next, twenty-two would be 1.2, which proceeds intuitively until we reach thirty, which is now 1.10 (or 1 twenty plus 10 ones).

Common Term	Hieroglyphic Term	Relative Value	Length of Period
K'in	K'in	--	1 day
Winal	Winik	20 k'in	20 days
Tun	Haab	18 winik	360 days
Katun	Winikhaab	20 haab	7,200 days
Baktun	Pih	20 winikhaab	144,000 days

Table 1: Long Count Components

In the Olmec region, the scribes behind Tres Zapotes Stela C recorded the earliest known Long Count date: seven pih, sixteen winikhaab, six haab, sixteen winik, eighteen k'in or 7.16.6.16.18. From the first century BCE, this Long Count date represents the date 1,125,698 days after the zero date. By this time in the beginning of the Late Formative Period, fully developed cities had emerged throughout Mesoamerica: Cuicuilco in the Basin of Mexico, Monte Alban in Oaxaca, Izapa on the Pacific Coast of Guatemala, Seibal on the Usumacinta River and El Mirador in the heart of the Peten. Only Mayan scribes, however, adopted and maintained the Long Count through the Classic period and into the Postclassic. This period corresponds to Long Count dates from roughly 8.17.0.0.0 through 10.5.0.0.0.

As with the zenith origin of the 260 Day Count, astronomical interpretations of the origins of the Long Count are implausible. Some scholars have proposed that the "zero date" of the Long Count was set to correspond to a Winter Solstice on which date the Sun was aligned

with a specific portion of the Milky Way.²⁴ These interpretations rely either on the possibility of someone having observed and recorded that event on a date from the Archaic period, two thousand years before any writing technology appears in the archaeological record, or that the date was computed in around the first century BCE and assigned the value of a zero date. For it to have been computed, though, scribes of that time would have needed a computational solar model as good as the Gregorian reform.

In any case, the Long Count date is unique and of tremendous value to modern scholarship as it provides us with relative events in the historical record to the day. This has been useful to track relative histories at different cities, patronized by independent (and many times rival) K'uhulajaws. It has also allowed for investigations into astronomical records.

The Long Count: Supplementary Series

Hieroglyphic inscriptions on monuments of the Classic period were somewhat formulaic in prose. Scribes generally initialized the inscription with a date, then recorded a significant historical event, and continued with several related events along with the dates on which they transpired. Within the initial date of a hieroglyphic inscription, the Long Count date was followed by the corresponding 260 Day Count date. That is, the “zero date” of the Long Count corresponded to the date 4 Ajaw in the 260 Day Count. The inscriptional record demonstrates that both counts progressed through the Classic period without stuttering or revision so that every Long Count date would have an associated 260 Day Count date.

Following the 260 Day Count date within a text, there is some variation across inscriptions over time and across regions. Very often, the 260 Day Count date is immediately followed by the “Supplementary Series.” This Series contains a few core elements, and then a number of variations according to time and location. Early twentieth-century Mayanists assigned letter designations to these glyphs in the most common order of: Glyph G, Glyph F, Glyph E, Glyph D, Glyph C, Glyph X, Glyph B, Glyph A.

²⁴ Freidel, Schele and Parker, *Maya Cosmos*.

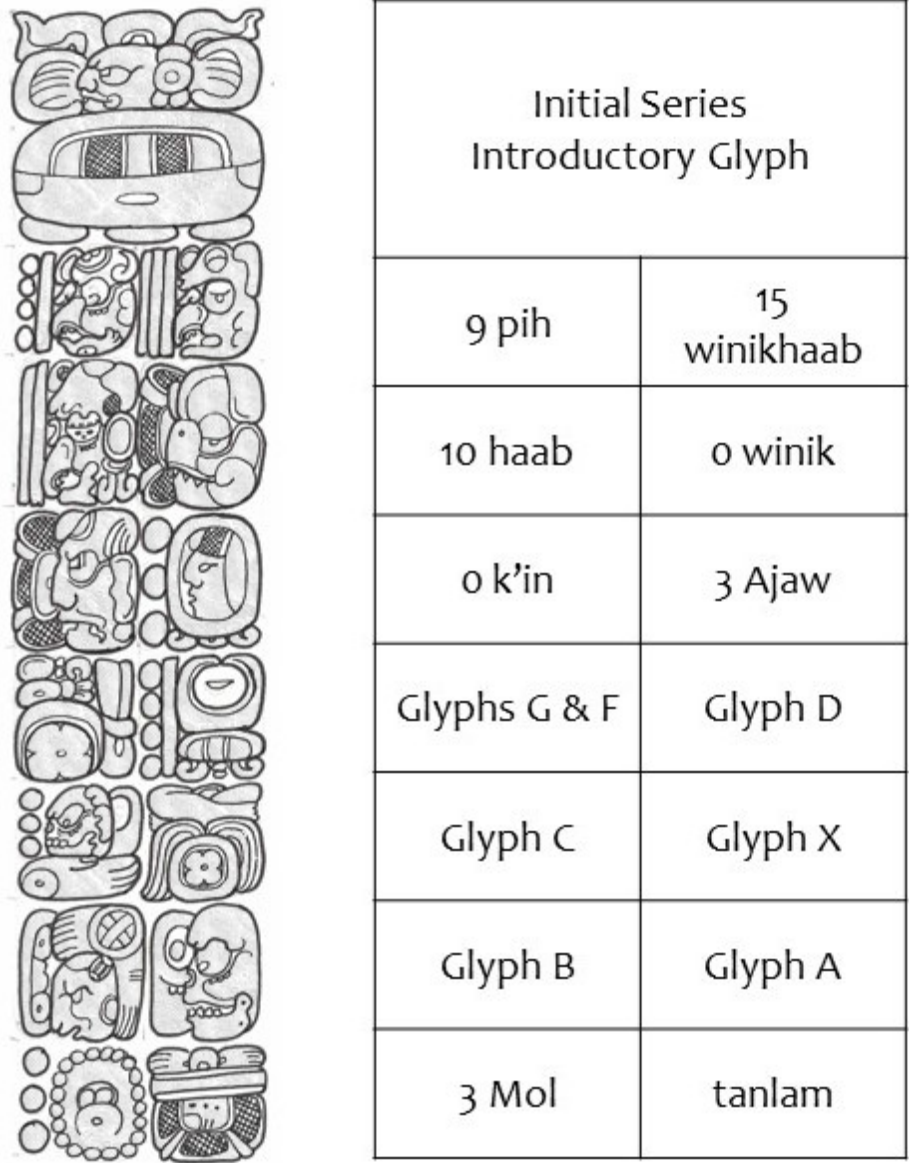


Figure 12: The Long Count date, with Supplementary Series, of Piedras Negras Stela 10.

The first elements in the Supplementary Series of a Long Count inscription go by the designation Glyph G and Glyph F, each with possible variants. Glyph F reads *ti'huun*, which literally means "mouth of the headband" and refers to a political position of "speaker for an authority figure."²⁵ Glyph G rotates daily, so this pair as text provides the name of the

²⁵ Zender, "Study on Classic Maya Priesthood."

“speaker” for any given day. Centuries after the first Mayan hieroglyphic representations, Aztec codices refer to these speakers as *yohualteuctin* in Nahuatl, or “lords of the night.” In practice, one *yohualtecutli* would hold authority from midnight of a given day to midday of the next. At midday, a separate set of deities would take over until the following midnight. Each day and each night, therefore, was “presided over” by a different speaker in a repeating cycle.

The astrological aspect of the count comes in with the initiation of the *yohualtecutli/ti’huun* each night. That is, at sunset, a “star of the night” would be identified as the first visible celestial body above the eastern horizon as the Sun dropped below the western horizon. This “star of the night” passed through “seats” of the first four yohuateuctin of that night before “meeting” the ruling *yohualtecutli* at/near zenith. At their meeting, the “speaker” would announce the omen to be in effect until midday. The pair of Glyphs G and F, then, were used for telling time at night and for daily astrological purposes.²⁶

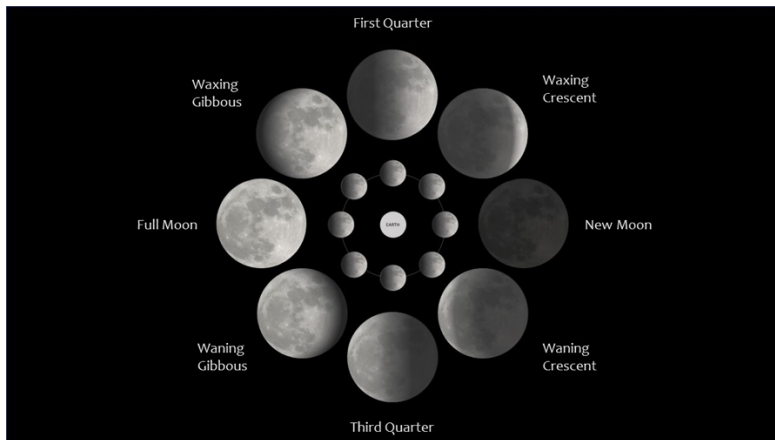


Figure 13: The Moon Age within a Lunar Series record assigns “zero” to New Moon, Full Moon at 14 or 15 days, and completion of the period at 29 or 30 days as given in Glyph A.

Following Glyphs G and F is the set of Glyphs C and D, sometimes accompanied by Glyph E, and Glyphs X, B and A. These together are recognized as the “Lunar Series” and all revolve around an observationally based record of the Moon Age. In its Classic form, Glyphs D and E combine a number with a verb. Here, the verb is *jul*, “to arrive.” This verb refers to the most recent New Moon, so that the number provides the tally of days that have elapsed since New Moon. *Bolon juliyy*, for example, would be translated as “9 days ago, it [New Moon] arrived.” Skipping Glyph C for the moment, Glyphs X, B and A form a parallel statement. Glyph A is always a “20” logogram carrying a suffix of either the number “9” or “10.” Together, these tell us whether the scribes were counting the lunar period as one of 29 days or of 30 days, since they would have to alternate periods in order to match the observational synodic period of

²⁶ Aldana, “Glyph G and the Yohualteuctin.”

29.5306 days. Glyph X takes on a number of different variants, each as a name. Glyph B reads *uch'ok k'aaba*, or “it is the youthful name of.” These then tell us that Glyph X “is the youthful name of the 30 days.” In sum, each lunar month possessed a name; periods were adjusted in length to accommodate observation; and the Moon Age on the Long Count date was preserved.

Glyph C, on the other hand, moves away from strict observational basis. This glyph block is made up of four parts:

- the verb *k'al*, taking the form of a “flat-hand” located in the bottom position;
- a coefficient ranging from one to six, vertically aligned at the left edge;
- one of three different deity heads (Ixim, Yax B'ahlam Ajaw, Kimi) known as the “lunar patron”;
- and the logogram for the Moon, *uj*, at the upper right.

The “flat-hand glyph” *k'al*, reads “to enclose” or “to encircle” and is related to the completion of space-time ritual activity, as we saw above.²⁷ This verb is associated with astronomical records of several forms: *k'alk'in*, related to the Sun; *k'ahlaj* in the Venus Table; *k'al* in the Lunar Series. In the Lunar Series, *k'al* refers to the “closing off” of periods of the moon. Overall, the variables in this glyph block follow the pattern of 1 Ixim Uj, 2 Ixim Uj, 3 Ixim Uj, ... 6 Ixim Uj, 1 Yax B'ahlam Ajaw Uj, 2 Yax B'ahlam Ajaw Uj, ... 6 Yax B'ahlam Ajaw Uj, 1 Kimi Uj, 2 Kimi Uj, ... 6 Kimi Uj, 1 Ixim Uj, ... and so on. Each completed month constitutes a lunar *k'al* event, so each named lunar month of 29 or 30 days is assigned to an element of this sequence. A full sequence for one lunar patron collects 6 moons for a 177-day period.

As a whole, the Lunar Series provides a couplet description of the Moon. “Twenty-nine days ago, the New Moon of the 3 Kimi Moon enclosing arrived. Glyph X is the name of the 30 days.” (See Figure 12.) While the Moon Age in Glyphs D and E is based on observation, the components of Glyph C are arbitrary with respect to observational phenomena. That is, each of the numbered periods of a given patron moon begins and ends with a synodic period, but the numbers and patrons assigned to any given moon is arbitrary. The result is that scribes of different cities might assign the same observed lunar period to lunar patrons in different sequences.

The archaeological record provides interesting hints about the development of the complex Classic period version of the Lunar Series from an earlier version. The earliest secure lunar record was inscribed onto the Hauberg Stela, an unprovenanced stone monument from the Late Formative period. There are four hieroglyphic elements within the Hauberg Stela lunar record glyph block, all of which show up in the Classic period Lunar Series. In the top right is the Moon glyph itself, **UJ**. The scribe attached this moon glyph to a deity head, in this case, the generic “God C,” or **K'UH**. A third element is what looks like the back of a human hand,

²⁷ Aldana, *Tying Headbands or Venus Appearing*; Aldana, *Calculating Brilliance*.

stretched out below the Moon glyph and deity head. Finally, there is a bar-and-dot number at the far left. The first three elements here are the ones that straightforwardly map onto the main elements of the Classic period Glyph C. The moon glyph remains the same across periods in form and location within the glyph block. The deity head also remains the same in form and location, although it changes in identity. The hand glyph, too, remains consistent.

There is a departure in the Hauberg Stela representation from later Lunar Series records in the numerical coefficient at the far left of the glyph block. This number here is made up of three bars and two dots representing the number 17; if we take the number in the Hauberg glyph block as a representation of the Moon Age, then it tells us the Moon was just past full on the date of the event recorded—17 days after New Moon.²⁸ Conventionally, however, the coefficient should refer to the hand glyph, in which case it would be read as referring to the seventeenth completed Moon, within a larger period of 18 synodic lunar periods. Keeping track of eighteen-moon sets would be interesting as it corresponds to an eclipse season of sorts. When a lunar or solar eclipse occurs, a solar or lunar eclipse may follow six and/or twelve moons later. An eighteen-moon count would make it straightforward to establish “eclipse warning” dates. If we recognize that by the time the Hauberg Stela was being carved, some E-Groups would have been in operation for over 500 years, it is not hard to presume this level of familiarity with eclipse cycles.

While the Hauberg Stela records a precursor to the Classic practice for counting moons, investigation continued over the next few centuries. By the Late Classic, scribes at Xultun painted a full sequence of 162 moons on a wall within an “astronomer’s workshop.” This sequence—painted adjacent to other astronomerological tables—tracked the incorporation of “extra” 30-day periods into a larger period of 4,784 days to generate an approximate synodic lunar month of 29.5309 days, which is extremely close to the modern version of 29.5306 days.²⁹

The 365 Day Count

In a typical inscription, the 365 Day Count date follows the Supplementary Series and itself is followed by the verb recording the event taking place on the Long Count date. The 365 Day Count itself was made up of eighteen periods of twenty days each, followed by a single period of five days. Unlike the 260 Day Count, a single month glyph tracked 20 days of coefficients before passing to the next month glyph. That is, the sequence of months in Yucatec Mayan are: Pohp, Wo, Sip, Sots’, Tsek, Xul, Yaxk’in, Mol, Ch’en, Yax, Sak, Keh, Mak, K’ank’in, Muwan, Pax, K’ayab, Kumk’u, Wayeb. The New Year occurred on the seating of Pohp, followed by 1

²⁸ This is the “conventional” interpretation, though there are alternatives in the literature: Milbrath, “The Legacy of Preclassic Calendars and Solar Observation in Mesoamerica’s Magic Latitude,” 124 – 125.

²⁹ Saturno et al, “Ancient Maya Astronomical Tables.”

Pohp, 2 Pohp, ... 19 Pohp, which was followed by the seating of Wo. Then, 1 Wo was followed by 2 Wo, 3 Wo, ... 19 Wo, leading to the seating of Sip. These ran through the full set until reaching the end of Kumk'u. Nineteen Kumk'u was followed by the seating of Wayeb, and then only 1 through 4 Wayeb, before the next day of the seating of Pohp of the following year.



Figure 14: The 365 Day Count. The sequence here, read in paired columns, is: Pohp, Wo, Sip, Sots', Tsek, Xul, Yaxk'in, Mol, Ch'en and Yax in the first pair. The second pair of columns is: Sak, Keh, Mak, K'ank'in, Muwan, Pax, K'ayab and Kumk'u, all of 20 days each. The final glyph represents the Wayeb, which is the final period of five days to close out the year.

Because of the abovementioned observed moon ages, the Lunar Series has been useful in demonstrating that no leap year was included in Classic period records of the 365 Day Count. The Long Count was a strict tally, and the 365 Day Count was unbreakably linked to it. The lunar records across hundreds of years make clear that adjustments were not made to incorporate slippage of the observable tropical year to the 365 Day Count.

The absence of tropical year accommodations does not require an interpretation devoid of reference to tropical years. We saw the early suggestion as to the relationship between observational astronomy and the inscriptional records in the Uaxactun E-Groups. The events commemorated there align with records at numerous other sites of k'alk'in events.³⁰ In addition, there appear to be Classic period versions of New Year's Events, which are timed by the solar calendar.³¹ In sum, such records attest to a functional astronomy by the end of the Formative period and the Early Classic, one that was put to use for both religious and political ends in the Classic period.

CLASSIC PERIOD

In the transition to the Classic period, eagle/sun representations drop off and the hieroglyphic inscriptions focus on the genealogy of the k'uhulajaw. This "ruler" now appears to hold authority based more on human genealogical relationships than to the sun. Another transition worthy of note is the emergence of "symbolic" E-Group architecture, with little obvious astronomical purpose. That is, architectural complexes were constructed to follow the layout of a functional E-Group, but the architecture's alignment did not allow for its use to mark equinoxes and solstices. Such incorporation of non-functional E-Groups architecture into civic-ceremonial plazas suggests that their socio-political role may have been maintained, but the strict connection to observational solar periods faded away.

More broadly in the Classic period, astronomical records are scarce in the inscriptional record, aside from the Lunar Series. It appears that the celestial realm and its occupants take on greater symbolism and less direct functionality. Accordingly, the most consistent representation of the celestial realm during the Classic period can be found in artwork and shows up as the iconographic construct known in the Mayanist literature as the "skyband." This construct borrows from imagery going back to the Olmec Horizon. A typical element in the skyband, for example, is a simple "crossed bands" symbol, which marked the eyes of Olmec creatures and in each case served as a marker of the sky. In function, scribes used the skyband to depict the body of the Celestial Dragon, which was a representation of a section of the Milky Way, and considered to be the repository of royal blood.³² Various representations depict a liquid pouring from the Celestial Dragon's mouth, with the liquid covered with markers of "preciousness." In many cases, in place of this liquid, artists included depictions of historical k'uhulajaws. It may well be because of this connection between the Milky Way and royal blood that the imagery of the sky shows up frequently in Classic period art with far more elaborate representations as the period progresses.

³⁰ Aldana, "Solar Stelae and a Venus Window."

³¹ Stuart, "New Year Records."

³² Stuart, "Blood Symbolism in Maya Iconography."

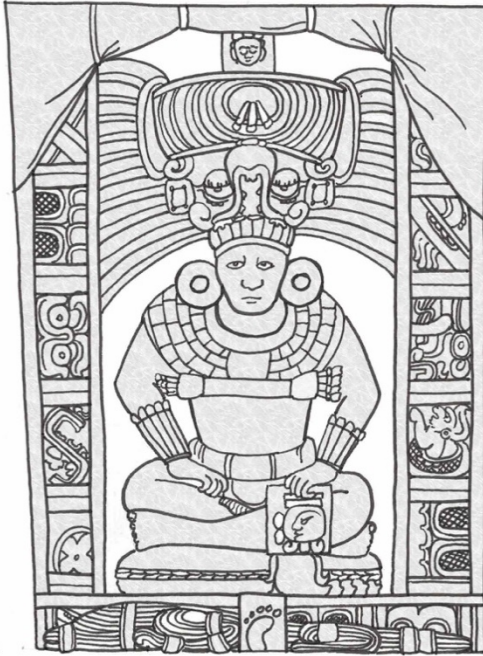


Figure 15: An example of Tatiana Proskouriakoff's "cosmic motif" on Piedras Negras Stela 11. The K'uhulajaw here is framed on either side of his throne by a "skyband."

A clear indication that the celestial realm was becoming more symbolically resonant in the middle to late Classic arises in its metaphorical use. During the middle Classic period, for instance, astronomical iconography was incorporated into a phrase used to describe military defeat. A good example comes from Dos Pilas, which may well have read *Ux lx waklajun Muwan ek'miiy ... Nuun Ujol Chaak*. The verb here, *ek'm* (possibly *ek'em*), takes on the meaning of "falling, or descending" with the glyph for "star" or "celestial body" (EK') as part of the verb.³³ This iconography fits well thematically with other Mesoamerican metaphors that referred to meteors as "arrows of the gods." Next to the more prosaic *jubuy u took u pakal* phrase recording military defeat, though, the *ek'm* version would have invoked grandeur and cosmic importance, if only rhetorically.

³³ Aldana, "Agency and the 'Star War' Glyph"; Zender, "Raccoon Glyph."



Figure 16: The "Star War verb" used twice by the scribe of Dos Pilas Hieroglyphic Stairway 2, West Section, Step 4: 11 *k'in*, 1 *winik*, 5 *haab* after [unknown] was defeated. 3 *ix* 16 *Muwan Nuun Ujol Chaak* was defeated, burned, and driven out . . . by *B'ahlaj Chan K'awiil*, captor of *Tajal Mo'*, *Mutul Kujulajaw*. The verb translated here as "was defeated" is the Star War verb, found in the glyph blocks of the second and third columns of the first row.

The use of this verb generated several proposals in the scholarly literature of the 1980s that the celestial reference revealed an intentional timing of warfare by astronomical influence. Often referred to as "Star Wars" in the Mayanist literature, the most popular of these suggested that battles were timed by the appearance of Venus.³⁴ Such interpretations, however, have not held up to more rigorous testing against the inscriptional record.³⁵ It appears that the use of EK' had more to do with an increasing popularity of celestial imagery (visual and literary) in the representation of authority than in the practical motivations for military activity.

In part, Late Classic period interest in astronomy may also have found motivation in a calendric and numerological coincidence. It appears that numerological interests themselves were spurred by the end of the thirteenth *winikhaab*, or the Long Count date 9.13.0.0.0. Since a major "Creation event" was understood to have taken place at the end of thirteen *pih* (or 13.0.0.0.0), numerologically, *k'uhulajaws* may have seen the end of 13 *winikhaab* as a resonant momentous event.³⁶ The *k'uhulajaw* of *Coba*, for one, took the opportunity to include a new character to the Long Count – he included periods that had only been used once before in the public record. Whereas the convention across the Mayan region for hundreds of inscriptions was to include only the five Long Count periods from *k'in* through *pih*, the *Coba k'uhulajaw* had his scribes include even larger periods. Twenty higher periods now marked the "Creation" event of the end of the thirteenth *pih*; now it was 13.13.13.13.13... 13.0.0.0.0 4 *Ajaw* 8 *Kumk'u*, numerologically suggesting a huge expanse of time. The specific numerology, of course, is quite clear: twenty periods, each with a coefficient of thirteen connotes the 260 Day Count "Sacred Round." In other words, this

³⁴ Closs, "Glyph for Venus as Evening Star"; Nahm, "Maya Warfare and the Venus Year."

³⁵ Aldana, "Agency and the 'Star War' Glyph"; cf. Aveni, "Monumental Inscriptions."

³⁶ Robertson, *Sculpture of Palenque*.

wasn't meant to refer to an enormous calendric count; instead, it was numerological hyperbole, commemorating a very important event.

At Palenque, a form of "astronumerology" developed out of what mathematician and linguist Floyd Lounsbury referred to as "contrived numbers."³⁷ These included the periods of the planets, translated into canonical periods that could be used for setting up relationships between events over huge expanses of time. The "presence" of Venus was implied by two events separated in time by even multiples of 584 days; Mars by 780; Jupiter by 399 and Saturn by 378. Such numerology was applied to events separated by very large time intervals, such as those used to reconstruct the placement of mythological events in Long Count time. In the process, scribes at Palenque invented a new calendric tool—what Eric Thompson called the 819 Day Count. This selectively adopted Count was developed at Palenque in the lead up to their commemoration under K'inich Kan B'ahlam of the 9.13.0.0 period end. It served both as a computational tool and a calendric tool to guide a ceremonial circuit.³⁸

By the end of the Classic period, innovation did not occur solely in computational forms, as buildings were designed and oriented to incorporate light and shadow displays based on the Sun's position along its annual path. The extensive cave systems of Belize evidence the Classic period modification of walls and outcroppings to create light and shadow displays within the Underworld. At Aktun Tunich Muknal in Belize, for example, torchlight illuminated rock formations, casting shadows that took the shape of deity profiles. Architects may have combined this experience with that underlying the E-Group alignments to create new plays of sunlight, strategically illuminating the interior of structures.³⁹

Finally, just at the close of the Late Classic period, the k'uhulajaw of Copan, Yax Pahsaj Chan Yopaat, included an explicit record of Venus – the only such textual record from the Classic period. As with so many interpretations of the Formative period, this record was not simply astronomical "data"; the Venus event in the inscription transpired during the period when a ruling k'uhulajaw lost a decisive battle against a political rival. The record thus appears to have been politically motivated to invoke the celestial realm into repairing the reputation of the genealogy.⁴⁰ Actions that appear to be astronomically motivated were clearly used during the Classic period for political purposes tied to royal genealogy and its legitimation.

³⁷ Lounsbury, "Maya Numeration."

³⁸ Aldana, *Apotheosis of Janaab' Pakal*.

³⁹ Mendez et al, "Astronomical observations."

⁴⁰ Schele and Mathews, *Code of Kings*.

POSTCLASSIC

A number of transitions come together to move what we refer to as the Classic period into the Postclassic period, between 900 and 1000 CE. For one, the k'uhulajawlel appears to break down as the predominant institution of government. This shift accords with the lack of inscriptional monuments from the Postclassic period, since, as we have seen, the Classic period content was dedicated to extolling the genealogies and ceremonies of the k'uhulajaw. Another major shift is in the trade route connecting the Mayan region to northern and southern Mesoamerica. The Usumacinta ceased its service as the superhighway of goods and information in and out of the region; now the population centers shifted to the north and west, away from the heart of the Classic period florescence.

An “international style” also became prominent throughout Mesoamerica during the Postclassic period, maintaining some of the character of the Classic Mayan period, but now very influenced by Mixtec, Zapotec, Toltec and Aztec artistic styles. This too appears to fit with a shift in governance that includes a larger role of independent priestly sodalities. Feathered Serpent priesthoods emerge in Toltec Central Mexico along with *Qchi* or “9 Wind” figures in Oaxaca. In each case, these feathered serpent figures are tied to a legendary individual and to the planet Venus, which appear to transform into the bases of priesthoods invested with ruling independent cities within a region.⁴¹ The historical ruler Iya Nacuaa (“Lord 8 Deer”) in several Mixtec codices explicitly details this process in his own accession to power. Later ethnohistorical records suggest that a resonant process occurred at Cholula for Toltec and early Aztec cities.

It is from the Postclassic period, though, that we encounter the most robust representation of Mayan astronomy and its most public display in architectural form since the E-Groups of the Formative period. Two examples help illustrate this point: first, at Chich'en Itza, we find both a structure dedicated to Venus observation and a radially symmetric pyramid structure capturing key events in the solar year. Second, the Dresden Codex features 72 pages of ritual activity, timed by the 260 Day Count, perhaps reflecting the greater roles of the priesthood in governance. Astronomical knowledge, artistic form, and political power remained intricately connected.

Architecture at Chich'en Itza

Chich'en Itza in present-day Yucatán, Mexico, is known around the world for its equinox commemorations. During the Terminal Classic period, a structure to the north of the early settlement was expanded from a traditional pyramidal structure topped by a north-facing temple to the much larger radially symmetric structure known today as “El Castillo” or the Temple of K'uk'ulkan. The latter name, K'uk'ulkan is a linguistic construct made up of two

⁴¹ Pohl and Byland, “Mixtec Landscape Perception”; Ringle, “Art of War.”

primary parts. K'uk' is the Yucatec Mayan word for the bird known as the quetzal (*Pharomachrus mocinno*), and kan is the word for serpent. A k'uk'-ul kan, then, is a bird-like serpent, or in more common translation, a "feathered serpent."



Figure 17(a): Feathered Serpents in Postclassic imagery, pt. 1: the Temple of the Feathered Serpent façade at Xochicalco.



Figure 17(b): Feathered Serpents in Postclassic imagery, pt. 2: Qchi (9 Wind) of the Borgia Codex.

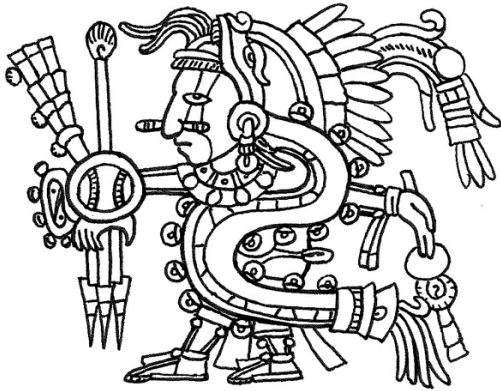


Figure 17(c): Feathered Serpents in Postclassic imagery, pt. 3: a feathered serpent headdress in the Codex Nuttall.

The feathered serpent concept had likely arisen in the region around modern Mexico City, and had spread in this period throughout all of Mesoamerica. In Nahuatl, the feathered serpent is known as Quetzalcoatl, in Yucatec Mayan K'uk'ulkan and in K'iche Mayan Guk'umatz. In each case, the construct functions both iconographically and conceptually as a powerful figure. That is, as a bird-serpent, such a creature has the ability to enter into and through all three cosmological communities: that of the Underworld, the middle world and the celestial realm. Accordingly, it is fitting that the highest priesthood order in Aztec society was that of Quetzalcoatl. Moreover, in legends recorded in the language of the Aztecs, Quetzalcoatl is intimately tied to the planet Venus, and so a Venusian astronomy also grew in significance during the Postclassic period.



Figure 18: The Temple of K'uk'ulkan (also known as El Castillo) at Chich'en Itza. Courtesy the author.

As for the "Temple of K'uk'ulkan" at Chich'en Itza, in its final state it was built with 91 steps on each side, leading to a platform with a temple structure placed on it. The four cases of 91 steps plus the platform have been understood to represent the 365 days of the year, thus referencing the sun and continuing the tradition of combining numerology and astronomy. More commonly recognized is that the orientation of the structure was rotated so that on

the equinoxes, the setting sun would cast its rays along the northwestern edge of the structure, in turn casting shadows on the balustrades of the northern staircase. These shadows produced a pattern of triangles imitating the pattern on a rattlesnake's back. The bottom of the balustrades were capped by large stone heads of feathered serpents.⁴² The overall effect was to give the impression of a feathered rattlesnake directed toward the Great Cenote at Chich'en Itza—or symbolically to depict the Feathered Serpent descending from the celestial realm, passing through the middle world and heading toward the Underworld. While unique in the Mayan region, such a construction may have been inspired on a technical level by the subtler architectural light plays of the Classic period, or the shadow plays within caves. Within a religious context, the metaphor may well have been similar to a description of Gukumatz' in the *Popol Vuh*, legendary figure of the K'iche' Mayans. He too was described as being able to move across all levels of the cosmos, from the celestial realm through the middle world and into the Underworld.⁴³



Figure 19: The Caracol (also known as the Observatory) at Chich'en Itza.

Built earlier than the Temple of K'uk'ulkan, the Caracol or “the Observatory” at Chich'en Itza has been understood as linked to Venus for several reasons. For one, it took on a circular form—somewhat rare in the Mayan region—and it has been associated with wind deities, which were in turn associated with Venus deities. More directly, there are observation windows at the second-story level of the structure, pointed at the cardinal directions.

⁴² Aveni, *Skywatchers*.

⁴³ Christenson, *The Popol Vuh*.

Scholars have shown that relevant points of Venus observations along the horizon were aligned with viewing features of these windows.⁴⁴ There are also features in the façade with links to the positions of Venus. Additionally, epigraphers have shown that a stone tenoned disc built into the Caracol included a textual reference to “K’uk’ Ek’” – “quetzal star” and a representation of a human figure wearing a feathered serpent headdress.⁴⁵ These all come together to suggest that observations of Venus from Chich’en Itza were important to the political arrival of K’uk’ulkan into the Mayan region.⁴⁶

The role of Venus in state-sponsored architecture and the explicit reference to K’uk’ulkan have led some to see Chich’en Itza as a center for religious power like those in Central Mexico. This would suggest that in the Postclassic period, astronomy was pulled away from legitimizing the k’uhulajaw, and instead informed the knowledge base of a priestly sodality that brought together an assemblage of activities and education for those aspiring to positions of leadership in their own communities. Such material is what we find in the surviving hieroglyphic codices from the period.

Astronomy in the Dresden Codex

The Dresden Codex may be the best known of Mayan books, but it is important to situate it as representative primarily of the astronomical knowledge of the Late Postclassic (post-1000 CE) period, along with the broader concerns of the time. Ironically, although it provided the first secure decipherment of Mayan hieroglyphic material, the popular literature has treated it without this context. Discovered before any k’uhulajaws or dynasties had been identified or political structures deciphered, the Codex (as interpreted by Ernst Forstemann in 1906) has led to an over emphasis, for example, on the importance of Venus for Mayan astronomy during the Classic or even Preclassic periods. When we consider the full development of Mayan astronomy over time, however, we find that Venus is largely ignored within public representations until the Terminal Classic. What this means is that some of the earliest material interpreted within modern scholarship may have most closely resembled the latest forms of Mayan interest in the celestial realm.

While the Dresden Codex is the most extensive and explicit of the four surviving Mayan codices with respect to astronomical knowledge, it also contains much more. The content of the Dresden Codex is broken up into what we might consider chapters. Most of them describe ritual activities timed by progressions through the 260 Day Count. These are often referred to as “almanacs” in that they have no historical anchors and simply cycle through

⁴⁴ Aveni, *Skywatchers*; Ricketson, “Astronomical Observatories.”

⁴⁵ Bíró and Pérez, “Caracol Disk.”

⁴⁶ Aldana, *Calculating Brilliance*.

the 260 Day Count indefinitely.⁴⁷ Among the most notable chapters are the New Year Pages, the Venus Pages and the Eclipse Table—which provide an overview of the Dresden Codex's function and meaning.



⁴⁷ Bricker and Bricker, *Astronomy in the Maya Codices*.

Figure 20: Dresden Codex pages 29b – 30b. This Chaak almanac runs across the full length of the middle of Page 29, but then takes up only the first register of Page 30b. The first register of the almanac along with the column of Day Signs, anchors the progression. Chaak is depicted seated on a throne; the text tells us that he is “stood up” in the East with the title Bakab. The food offered to him is bread, and the event occurs on 3 Ix. b) the Day Signs through the sequence are suppressed through each run, but confirmed by each anchor of 52 days (or 4 x 13). A narrative read through the text would be: “On 3 Ix, Chaak as Bakab is enthroned in the East. His offering is bread. After 13 days, on 3 [Manik], Chaak as Bakab is enthroned in the North. His offering is fish. After 13 days, on 3 [Ajaw], Chaak as Bakab is enthroned in the West. His offering is iguana bread. After 13 days, on 3 [Ben], Chaak as Bakab is enthroned in the South. After 13 days, on 3 [Kimi].” By ending on the suppressed Day Sign Kimi, we are directed to the next row of the Day Sign list in the first column to find that Kimi is just below Ix. The red coefficient of 3 thus corresponds to Kimi for this row of 52 days, and all remains the same with the exception of the four suppressed Day Signs, which now are Kawak, Eb, Chikchan, finishing with Etz’nab, which initiates the next row. It takes a total of 260 days (5 rows of 52 days each) to return to the initial date of 3 Ix. Courtesy Sächsische Landesbibliothek-Staats-und Universitätsbibliothek (SLUB).

The New Year Pages in the Dresden Codex result from the structure of Mesoamerican calendrics. With 20 Day Signs in the 260 Day Count, a pattern emerges as it progresses alongside the 365 Day Count. The five “extra” days in the 365 Day Count mathematically highlight four different Day Signs. Only these four can start any given year, so they are referred to as “yearbearers.” The New Year Pages describe the ceremonies that should be performed for each of the different yearbearers, along with the authority figures who are responsible for them. Four yearbearers tied to the progress of the solar year is reminiscent of E-Group organizations.



Figure 21: Dresden Codex Page 74 depicting the Celestial Dragon with a female deity and God L. Courtesy SLUB.

In the Dresden Codex, the New Year pages are introduced by an image that received much attention during the 2012 popular interest in Mayan calendrics.⁴⁸ The page depicts the

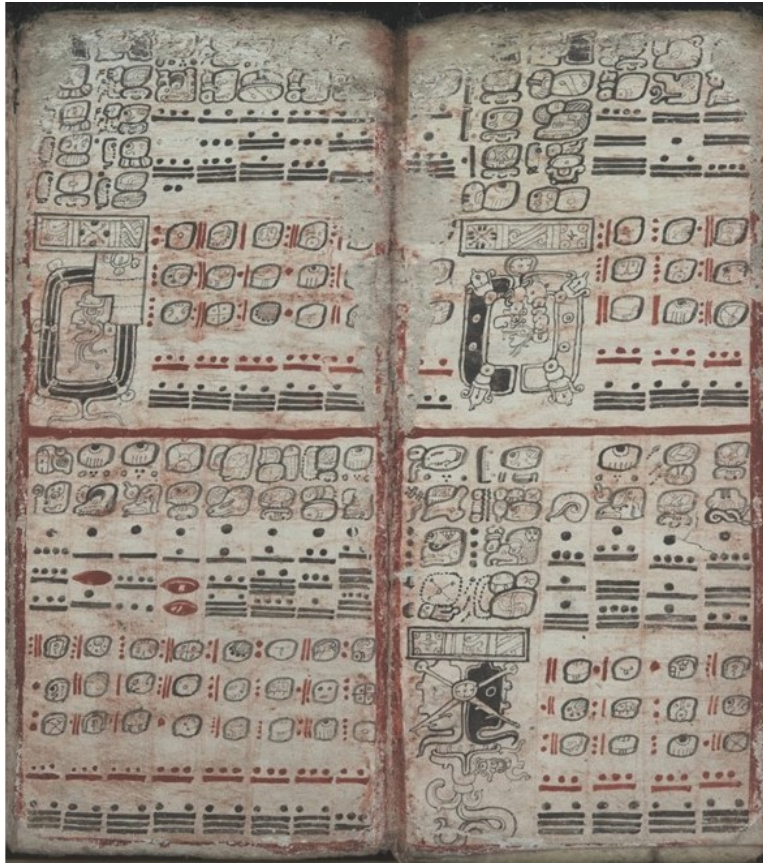
⁴⁸ Hoopes, "Critical History."

Celestial Dragon, with skyband body, at the top, and the aforementioned precious liquid falling from its mouth. Below it, a female deity pours a similar liquid from a jar, and below her, a male deity takes a warrior pose. One of the glyphs in the text above the Celestial Dragon had been interpreted as relating to a “famine.” Overall, then, some scholars have suggested that the image represents the end of the world as narrated in later Mayan and Aztec mythological accounts.⁴⁹ It is as likely, however, if not more, that the image is consistent with the rest of the document and so represents an omen that must be prepared for or mitigated by the appropriate rituals—which are given on the following New Year Pages.

Perhaps better known than the New Year Pages in the Dresden Codex is the chapter referred to as the Eclipse Table. The table begins with columns of 260 Day Count dates, each column containing three consecutive Day Signs. An interval of days is written at the top of the page, and that interval takes any 260 Day Count date in one column to its neighbor in the column to its right. The intervals on the first page are all of 177 days, which corresponds to 6 lunar synodic periods—the same period as the basis of Classic period lunar accounting practices as described above. Interrupting these sequences through time and 260 Day Count dates are images that have lunar iconography within them. These images follow breaks in the sequences represented by shifts from 177 to 148 day periods. Periods of 6 moons interrupted by periods of 5 moons have been used within other cultures to track eclipse cycles, which appears to have been the purpose here. Although they have looked, scholars have yet to find a historical sequence that matches the record of the Dresden Codex.⁵⁰

⁴⁹ Sharer, *The Ancient Maya*.

⁵⁰ Aveni, *Skywatchers*.



two columns of text		hieroglyphic text					two columns of text		hieroglyphic text			
		2422	2599	2776	2953	3130			3278	3455	3632	3809
Eclipse Image		2 Muluk 3 Ok 4 Chuwen	10 Kimi 11 Manik 12 Lamat	5 Ak'bal 6 K'an 7 Chikchan	13 Ajaw 1 Imix 2 Ik'	8 Kaban 9 Kawak 10 Etz'nab	13 Chikchan 1 Kimi 2 Manik	Eclipse Image	8 Ik' 9 Ak'bal 10 K'an	3 Kawak 4 Ajaw 5 Imix	11 Kib 12 Kaban 13 Etz'nab	
		177	177	177	177	177	148		177	177	177	
hieroglyphic text								hieroglyphic text				
8829	9007	9184	9361	9538	9715	9892	10040	two columns of text	10217	10395	10572	10749
13 Kib 1 Kaban 2 Etz'nab	9 Ix 10 Men 11 Kib	4 Chuwen 5 Eb 6 Ben	12 Lamat 13 Muluk 1 Ok	7 Chikchan 8 Kim 9 Manik	2 Ik' 3 Ak'bal 4 K'an	10 Kawak 11 Ajaw 12 Imix	2 Manik 3 Lamat 4 Muluk	Eclipse Image	10 K'an 11 Chikchan 12 Kimi	6 Ik' 7 Ak'bal 8 K'an	1 Kawak 2 Ajaw 3 Imix	9 Kib 10 Kaban 11 Etz'nab
177	177	177	177	177	177	177	148		177	177	177	177

Figure 22: Two pages of the Dresden Codex Eclipse Table, pages 55 and 56, courtesy SLUB, followed by translation into Long Count notation of dates and time intervals.

The preface to the Eclipse Table includes three Long Count dates, which appear to be historical. There is a provocative structure underlying them, though, as three of the four dates are relatively close in time. These three are 9.16.4.10.8, 9.16.4.11.3 and 9.16.4.11.18, separated by 15 days each. If either the earliest or the latest of these were an attested lunar eclipse, then the date in between might have been an inferred solar eclipse. One would expect that they might serve as historical records of eclipses, but with the most popular calendar correlation in use, none of these dates corresponds to a historical eclipse. There remains, not surprisingly, a lack of consensus around the interpretation of these dates.

The Late Classic period Long Count dates in the Eclipse Table have led several scholars to propose that parts of the Dresden Codex were developed at Chich'en Itza. The suggestion is particularly compelling for the Venus Pages as a sequence of historical Long Count dates during the Terminal Classic appear to have been intimately linked to the Venus Table's structure.⁵¹

The portion of the Venus Table that Förstemann deciphered in the late nineteenth century is that which tracks the four visibilities of Venus in a given synodic period. In the Dresden Codex, these track a morning visibility for 236 days, followed by a period of invisibility (at superior conjunction) for 90 days, an evening visibility period of 250 days, and a final period of invisibility of 8 days. The last period leads to the event highlighted by the Table and its Preface as the first morning of Venus's visibility. The Table was constructed to track Venus's synodic period through its canonic approximation of 584 days, as in the astronomerology of Palenque and Copan (the modern average is 583.92 days). There are five pages of the Venus Table, corresponding to the five different observable patterns of Venus movement against the background of the fixed stars, constituting a complete sequence of 2,920 days. On each page, the intervals are associated with the cosmic regions and described with the hieroglyphic verb *k'al*, which is the same verb we saw above used in the Lunar Series, for Long Count periods and for solar periods. In the Venus Table, it provides a narrative analog to the imagery of a contemporary Aztec codex calendric representation – that of the frontispiece of the Codex Fejervary-Mayer.⁵²

⁵¹ Aldana, "Discovering Discovery."

⁵² Aldana, "Discovering Discovery."

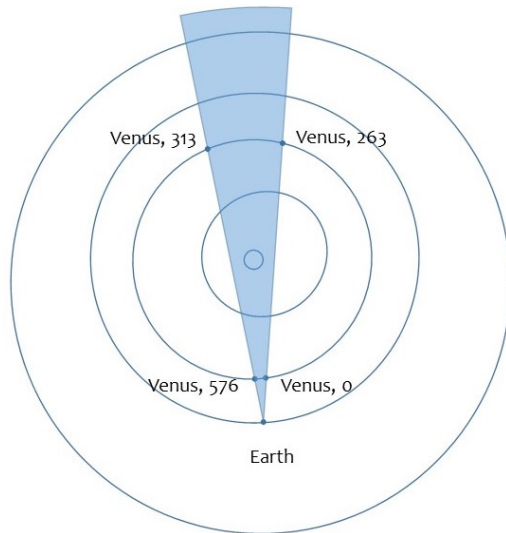


Figure 23: Fixing Earth in its orbit, four distinguishable visibilities of Venus result from its position relative to the Sun: “0” corresponds to first morning visibility, where it can be seen just above the Eastern horizon as the sun rises; 0 to 263 corresponds to Venus’s Morningstar visibility in the East; 263 to 313 represents Venus’s invisibility at superior conjunction, where it is lost in the brightness of the Sun; 313 to 576 corresponds to Venus’s visibility as eveningstar over the western horizon; 576 to 0 represents invisibility at inferior conjunction.



Figure 24: Dresden Codex page 46 – 50, the Venus pages.

On the right hand sides of the Venus Pages, three sets of images illustrate the Venus Round. In the upper register, a deity named in the text as a companion of Venus in the East, sits on a skyband throne. In the middle register, a different deity also named as a companion of Venus in the East strikes a warrior pose, wielding an Aztec weapon, the atlatl. The third image, at the bottom, depicts the victim of the warrior figure, with the text noting that it has been “speared.” The spearing is described in the hieroglyphic text surrounding the illustrations, and the text goes on to record the omens that result from the violence. It would have been the priest’s duty to interpret the omen as healthy or dangerous for the community s/he

served, and so consulted the rest of the manuscript for the appropriate rituals in response. Given the context, the most likely home of this priest would have been the late Postclassic city of Mayapan in northern Yucatan.

One of the notable features of the Venus Table is that it provides a set of intervals useful for the real-time correction of Venus observations. The Preface of the Venus Table (Page 24) includes information useful for accommodating progressions through the Long Count to compensate for the difference between the 584-day canonical period and the 583.92-day synodic period. The specific protocol for implementing these corrections has been a matter of debate for the last century, but it now appears that their implementation was relatively straightforward, and it points to a specific date of its discovery. This implementation suggests that the Venus Table was fully elaborated during the time that the Feathered Serpent was spreading across Mesoamerica, and at the time that Chich'en Itza was being transformed architecturally to be centered on the Temple of K'uk'ulkan.⁵³

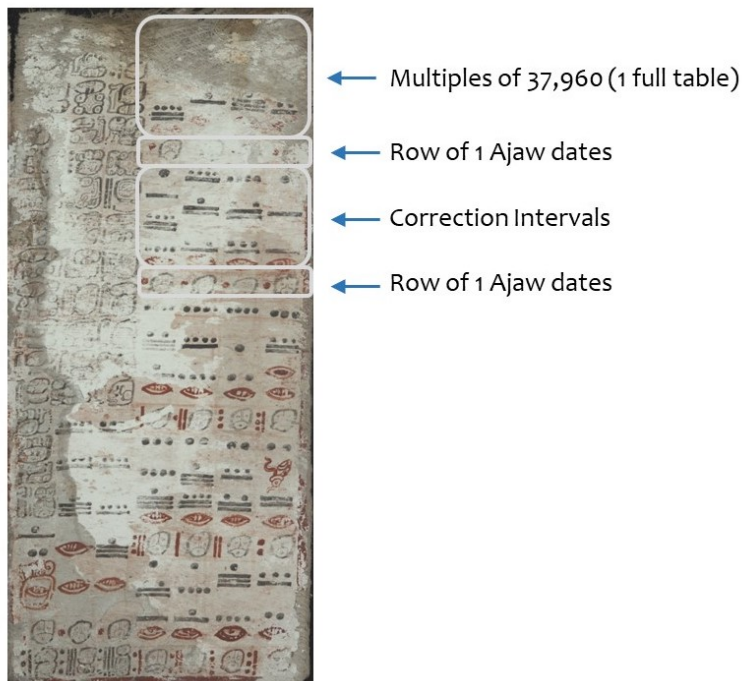


Figure 25: Dresden Codex page 24 showing preface of Venus Table.

In line with the “International” artistic style that emerged in the Postclassic period, it appears that astronomical knowledge was also increasingly shared. There is a set of New Year Pages in the Madrid Codex, which appears to be a bit later than the Dresden Codex. Perhaps more intriguing is the Venus almanac in the Mixtec manuscript known as the Borgia Codex. It was

⁵³ Aldana, “Discovering Discovery.”

instrumental in Eduard Seler's early nineteenth-century work on the Dresden Codex, although the two manuscripts do not follow the same structure.⁵⁴

MAYAN ASTRONOMY AFTER THE POSTCLASSIC

A key shift occurs during the Colonial period (post 1519 CE) or perhaps shortly before in the Late Postclassic (1300 to 1519 CE). The Long Count was dropped from calendric records, even though some of the same periodization was still used. In particular, 360-day periods, or "haab" in the Classic period, are now referred to as "tuns." These tuns were also accumulated into groups of 20, which were given the name "katun," in place of winikhaab. In turn, these katuns were run in a great cycle—no longer in linear fashion through the Long Count. This is often referred to as the Katun Count in the literature.⁵⁵

This new practice simplified record keeping, but also introduced significant ambiguity. Since each tun and each katun is a multiple of 20 days, each will start on the same Day Sign: Ajaw. The coefficient shifts however, from one katun to the next since 7,200 is not evenly divisible by 13. This structure is represented as a Katun Wheel in the *Book of Chilam Balam of Chumayel*.

The greatest complication for interpreting calendric records here is that the katun dates in the Books of Chilam Balam do not fit into a neat chronology. Many are contradictory across contemporary records, and several are inconsistent within the same book. This has led some scholars to artfully select specific dates that align with other records to argue that these are the "correct" ones and the others are in error.⁵⁶ It is more likely, however, that without the Long Count and without lunar records to tie calendric progressions to observable events, different communities introduced modifications into their local counts. We find such practices documented in Colonial period Zapotec records, and the twentieth-century Highland Maya communities, which show variation in calendric records from one community to the next.⁵⁷

These Colonial period records have influenced interpretations of Mayan astronomy to the extent that they have been used in efforts to construct a correlation that would tie Classic period Long Count dates to the European Julian calendar. Without a clear connection between the Katun Count and the Long Count, however, and with evidence for substantial variation, most attempts have resorted to arguing for selective continuity by assumption. It is important to recognize, though, that interests in finding continuity show up in the work of

⁵⁴ Aveni, *Skywatchers*; Seler, "Venus Period."

⁵⁵ Morley, *Study of the Maya Hieroglyphs*.

⁵⁶ Morley, *Study of the Maya Hieroglyphs*; Thompson, *Maya Hieroglyphic Writing*; cf Aldana, "Correlation Problem."

⁵⁷ Justeson and Tavárez, "Colonial Northern Zapotec and Gregorian Calendars."

modern scholarship—not in the indigenous documents themselves. While it may have been useful in efforts to substantiate the excessive emphasis on astronomy in Mayan culture, they may also be more valuable when we focus on their endemic purposes.

Overall, the modern decipherment of the Mayan hieroglyphic writing system was spurred by an interest in astronomy and calendrics, although such scholarship was unanchored to the actual histories recorded. As of the early twenty-first century, the hieroglyphic script has reached an advanced stage of decipherment, which has impacted our understanding of Mayan astronomy. While it is now understood as being not as prominent as previously thought, there is still much to explore at a more nuanced level in the inscriptions of the Classic period, the codices of the Postclassic and the architecture of both periods.

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