Dating the Amarna Period in Egypt:
Did a Solar Eclipse Inspire Akhenaten?

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For many years, I have been interested in the 'Heretic Pharaoh' Akhenaten of the 18th Dynasty who instituted worship of the sun (Aten) as the only god. I have speculated whether he might have been influenced by witnessing (or hearing first-hand reports of) a total eclipse of the sun, which he might have interpreted as the death and resurrection of the god, just before or soon after his accession to the throne. In Egyptian mythology, a royal succession is likened to the death of the old king Osiris to join the nightly journey of the sun through the underworld, and the rising of his son Horus to rule as king in the world of the living. The chronology of his reign has not been accurately established, but the period of interest is sometime in the 14th Century BC.

Possible circumstantial evidence.

The work of *The Akhenaten Temple Project* (1) has recovered inscriptions referring by name to a number of temples or shrines in the complex of structures built by Akhenaten at Karnak during his early years. The *Gem-pa-Aten*, translated to mean the 'rediscovery' or 'finding' of the Aten, was built to celebrate a *heb-sed* festival or 'jubilee' and was located within a very large enclosure. A typical *heb-sed* included a number of ceremonies to revitalize or rejuvenate Pharaoh, and the walls of the *Gem-pa-Aten* are decorated with scenes of Akhenaten, accompanied by Queen Nefertiti, traveling in procession from their palace to the temple and performing such ceremonies in front of various shrines. In previous reigns, each shrine would have held a different god, but here the god is always Aten.

Customarily, a king celebrated his first *heb-sed* after 30 years on the throne and others at intervals thereafter. For example, Amenhotep III, the father of Akhenaten, celebrated *heb-sed* festivals in his 30th, 34th, and 37th regnal years. However, there are enough exceptions in Egyptian history to confirm that Pharaoh could order a festival any time he wanted. Even though he was probably a young man in his twenties when he came to the throne, Akhenaten seems to have celebrated a jubilee as soon as he could build the requisite structures. Instead of being an occasion to rejuvenate Pharaoh, his *heb-sed* can likely be regarded as the *Renaissance* or *New Beginning* of the solar cult. Among the titles given to the Aten was 'Lord of Jubilees,' and a total eclipse of the sun could be regarded as celebration of a *heb-sed* in heaven. However, the Aten was praised for celebrating 'Millions of Jubilees,' so this might merely indicate the daily rising of the sun, which was the subject of thankful worship.

Egyptologists who postulate a coregency between Amenhotep III and Akhenaten argue that because Akhenaten celebrated a *heb-sed* at the very start of his reign, it must have been on behalf of his father. Some who deny a coregency suggest that Akhenaten simply finished a fourth festival for which his father was preparing at the time of his death. However, Akhenaten's *heb-sed* festival temple contained no mention of Amenhotep III, the supposed honoree and main focus of celebration! In other opinions, including mine, there was no coregency.

In 1970, the inscription on a clay tablet (KTU 1.78) found in 1948 among the ruins of Ugarit, an ancient city on the coast of Syria, was interpreted to be the earliest record of a total solar eclipse, which was then dated to May 3 1375 BC (Julian calendar) (2,3). Since Ugarit was near the border of the Egyptian empire or 'sphere of influence' at that time, and the date was close to Akhenaten's accession, according to some authorities (4), it seemed possible that this was the eclipse that might have influenced him. In 1989 other analysts redated the Ugarit eclipse to

March 5 1223 BC (5), well after the Amarna period, and they claimed that this date yielded a better fit to the conditions described on the tablet, according to their re-interpretation. However, the eclipse of 1375 BC is still listed on the NASA web page [A] as the 'Ugarit Eclipse', even though it appears that the eclipse was not total in Ugarit itself. Also, some recent authors have redated Akhenaten's accession to about 1353 BC (6). Nevertheless, it is possible that some other eclipse may have been visible in Egypt sometime during his lifetime and instigated his religious revolution.

Selecting the Site of Akhet-Aten – 'X' Marks the Spot?

I have further speculated whether the site of Akhenaten's new capital city, Akhet-Aten (today called Amarna, 27º 45' N, 30º 50' E), might implicitly preserve the record of a total solar eclipse. On the boundary stelae (7) featuring the 'Earlier Proclamation', the king emphasizes "**Now, it is the Orb, my father, who advised me concerning it, namely the Horizon of the Orb"** (Akhet-Aten) and denies that anyone else advised him. How might the sun have advised him? One suggestion is that a gap in the cliffs to the east of the site (the 'Royal Wadi') resembles the hieroglyph for 'horizon' over which the sun rises (8). Another is that Akhenaten wished to locate his capital in the true geodetic center of the country (9).

In Egypt, the location of cities is constrained to the banks of the Nile. Might the path of a total eclipse have determined the other arm of an 'X'? On the boundary stelae containing the 'Later Proclamation', the king delimits the distance between the southern and northern boundaries to be 'six *iter*, one and three-quarter rods and four cubits'. Depending upon which boundary stelae are assumed to be these limits, a distance of 12-16 km is obtained (7) pp.162-164. However, there is controversy regarding the length of the *iter*, with 20,000 cubits (10.5 km) being regarded as the 'standard', which would mean a boundary length greater than 62 km. In either case, measuring distance to the nearest cubit implies that it was of some concern to Akhenaten. Possibly, this measurement might record the width of the band of totality, as determined by questioning peasants who were working in fields along the Nile at the time. A similar strategy was used to establish that, in the eclipse of January 24, 1925, the southern edge of the path of totality crossed Broadway in New York City near 86th Street, as reported by observers who were posted on each block.

The next paragraph of the 'Earlier Proclamation' is much damaged and rather obscure, but some of the alternative word meanings suggested by the translators hint at "cover", "hide", "take away", or "cut off", perhaps referring to an eclipse. Most other writers who quote this paragraph do not mention that much is left out because it cannot be read accurately. It is uncertain how the Egyptians would have described an eclipse; their astronomical records would likely have been written on papyrus which has not survived, unlike Babylonian records written in cuneiform on clay tablets.

An Unusual Solar Scene in a Tomb at Akhet-Aten

In the tomb of Meryre I, 'The Greatest of Seers of the Aten' (high-priest), in the northern cliffs of Akhet-Aten, there is a unique depiction of the sun-disk, Figure 1, which I believe is intended to portray a total eclipse. Between the Aten disk and its rays there are several groups of multi-colored arcs, somewhat like the broad collars worn by royalty and courtiers, but with none of the typical internal details. Some have supposed this to represent the rays shining through clouds. Davies (10) notes: *"The hues and forms of the clouds are in fact the same as those employed in the hieroglyph to represent the rising sun, but in reverse position. It may be a sign that the King is performing the evening sacrifice"*.

Others have thought that this scene shows a rainbow, although upside down and below the disk instead of opposite the sun. In a recent article, Congdon (11) suggests that the arcs represent multiple solar halos, a rare phenomenon requiring ice crystals in the atmosphere. She supposes that *"the artist selected the central most important segment of the halo complex, that which would have pointed from the sun toward the zenith, and reversed it so it could be placed underneath the Aten disc in its iconographically proper location, at the apex of the scene"*.

I believe the most significant feature of the scene is the **interruption** of the sun's rays in their path towards Earth, as occurs in a total eclipse, and which does not require an iconographic reversal. I have not had the opportunity to witness a total eclipse of the sun, so I must rely on others to describe certain of their observations. In particular, McDermott (12) describes a total eclipse he witnessed in October 1995 at Angkor Wat in Cambodia:

> *"There is a strange phenomenon that occurs in the fleeting moments right before and after a total eclipse. It gradually gets darker and darker as the moon slowly passes in front of the sun, and in the seconds just before totality the light takes on an eerie quality, bathing the landscape in a monochromatic platinum tone.* ***Then the light appears to flutter as the shadow bands at the edge of the moon cause ripples of light to pass over the area.*** *The effect is surreal, psychedelic. I could actually see the movement of the moon traced on the earth, as the edge of the shadow swept toward me".* (my boldface)

The multiple arcs shown in the ancient tomb scene fit the 'ripples' in this description of shadow bands. The two main groups of arcs must correspond to the bands seen just before and just after totality. The collar-like shape of the arcs resembles the 'diamond ring' effect seen at the same times [B]. Another description of shadow bands is given by Brewer (13):

> *"While a small crescent of the sun remains in the sky, a curious eclipse phenomenon is often observed. Thin wavy lines of alternating light and dark can be seen moving and undulating in parallel on plain light-colored surfaces. These so-called shadow bands are the result of sunlight being distorted by irregularities in the Earth's atmosphere. An open floor or wall is a good place to look for them. A similar effect is seen when the Sun shines through ripples on the surface of the water in a swimming pool; the wavy lines moving on the bottom of the pool resemble the shadow bands of an eclipse."* (Figure 2)

The inscription with the scene praises the Aten as 'lord of all jubilee festivals … in the temple in Akhet-Aten'. However, this is a common phrase found in many other scenes and not unique, so it cannot be imbued with much significance. There is no inscription in the whole tomb that might explain this peculiar depiction of the Aten, which seems rather puzzling because it is unique in Amarna art. However, I believe it can be interpreted as an Egyptian method for 'time lapse' portrayal of a total eclipse.

Total Solar Eclipses Visible from Egypt in the 14th Century BC

As Brewer points out (13), [C], it seems strange that no documentary records of eclipses (of any kind) in ancient Egypt have been found, though many occurred, as seen in the map on p. 14 of his book. In particular, the map indicates that the path of totality for the eclipse of May 14 1338 BC passed through Akhet-Aten. If Akhenaten became king in 1353 BC, then 1338 BC would be his 15th year, so the city would have been built at the time of the eclipse, which could have been the one portrayed in Meryre's tomb. There may have been other eclipses that might have influenced Akhenaten, but it seems more likely that his accession date was at least 10 years later. The NASA web page [D] lists all solar eclipses worldwide, giving the dates and conditions at the point of 'Greatest Eclipse'. This location is in the Libyan Desert for the eclipse of 1338 BC (23.8°N, 23.4°E), and also for the eclipse of August 15 1352 BC (27.2°N, 25.6°E).

Following up this lead, I calculated the paths of totality for these eclipses using the computer program *EclipseMaster Plus* (14). It is relatively easy to compute the paths of recent and near future eclipses with the critical parameters that are accurately known today. However, the Earth's rotation is gradually slowing down – days are getting longer – and the rate of deceleration is not accurately known. In fact, ancient observations of total solar eclipses are of great help in measuring this rate and in determining whether it is constant. The critical factor in calculating the longitude at which an eclipse is seen is a parameter known as 'Delta T'. On his NASA Web site, Espenak gives values of Delta T and resultant calculated paths for a number of eclipses of historical interest [A]. However, the values of Delta T that are automatically estimated by *EclipseMaster Plus* differ, and the results also differ when the Delta T values in [A] are input to the program. This indicates that the algorithm employed by Espenak differs from the one used by *EclipseMaster Plus.*

To resolve the discrepancy for my purposes, I assumed that the unusual Aten scene in the tomb of Meryre I portrays an eclipse and the arcs below the disk represent shadow bands, which can appear only just before and after totality. Therefore, as input to the program, I selected an intermediate value of Delta T that places the center line of the total eclipse of 1338 BC through the site of Akhet-Aten, Figure 3. The width of the band of totality was about 256 km (159 miles) but, because the angle of the path to the parallel of latitude at Akhet-Aten was low, the width of the path was close to 15 degrees of longitude, so Delta T could vary by up to +/- 30 minutes and the eclipse would still be seen as total at Akhet-Aten (the Earth rotates at 15° per hour, 360° per day). However, it seems likely that Akhenaten would have desired to locate his new city on the center line, where the duration of the eclipse was longest (6½ minutes). At the northern and southern boundaries of the path, totality would have lasted for just an instant, but enough to attract attention from workers along the Nile, who could have reported their observation to the king's agents. By bisecting the distance between the two observational limits, the mid-point could be accurately determined.

In support of this theory, it can be noted that the value of Delta T that places the center line of the 1338 BC eclipse through Akhet-Aten, adjusted for the differences in dates, also places the center lines of the eclipses of 1375 BC and 1223 BC both very close to Ugarit, as seen in Figure 3. Of further interest, an annular eclipse would have been seen in Northern Egypt and Canaan a few years later, on March 13, 1335 BC. A second annular eclipse would have been visible in Canaan on October 17,1328 BC, its path intersecting the first near Jerusalem.

Similarly, I calculated that the path of totality for the eclipse of August 15 1352 BC intersected the Nile in Nubia, 118 km wide, near the spot where Rameses II would later build his huge rock-cut temple at Abu Simbel. Curiously, another total solar eclipse would be seen at almost the same place on December 30, 1332 BC. However, the eclipse of 1338 BC was the only total solar eclipse that could have been seen in Egypt proper during the 14th Century BC. That it would coincidentally cross the Nile at the exact spot where the sun-worshiping Pharaoh Akhenaten located his new capital city, in a previously desolate place, is difficult to believe; I am convinced there must be a connection.

If we assume that Akhenaten initiated his city-building after witnessing the eclipse of May 14 1338 BC (or, at least, hearing reports of eye witnesses), then this event must have occurred before the date of his 'Earlier Proclamation' on the boundary stelae, Regnal Year 5, Peret IV, day 13. Likely, he needed a while to consider the significance of the eclipse, but it may have triggered his decision to promulgate his new religion and start building the temples at Karnak to celebrate a *heb-sed* 'jubilee' of the Aten. This would mean that 1338 BC was within a year or two of the death of Amenhotep III and the accession of Amenhotep IV / Akhenaten, 15 years

later than the 1353 BC date estimated recently (6). The difference could be reduced to 10 years if we suppose the limiting case: Akhenaten made his founding proclamation to his assembled courtiers at the site just after the eclipse.

The ancient Egyptian calendar divided the year into three seasons of four 30-day months each, plus five extra days at the end of the year, for a total of 365 days. New Year's Day (1 Akhet I) corresponded to the heliacal rising of Sirius (in July) at the time when the calendar was introduced, but with no leap years it shifted through the seasons with a period (Sothic cycle) of 1461 Egyptian years, or 1460 Julian years having an extra day every four years. The latter is an over-correction, and the Gregorian calendar with modern adjustments keeps the seasons where they are intended. The Roman historian Censorinus recorded that the heliacal rising of Sirius recurred on the day of Egyptian New Year in 139 CE, July 20 on the Julian calendar. This date pegs the calendars together, and Holger Oertel provides a descriptive Web Page including a calendrical calculator [E] for matching dates. Table I presents the results for the selected eclipses.

Lunar Eclipses

None of the solar eclipses in Table I match any of the inscribed dates that I have been able to find, but it is possible that some events could have been scheduled to celebrate eclipses of the moon, which are visible over a much wider area and easier to predict than total eclipses of the sun. Therefore, I next tried to match certain recorded Egyptian dates to lunar eclipses visible in the region during the 14th Century BC, which are listed on the NASA web page [F]. I found only one exact match: the total lunar eclipse on December 24 in 1322 BC occurred on 8 Peret II in the Egyptian calendar, the same date as the climax of the great celebration in Year 12 of Akhenaten, featuring the presentation of foreign tribute and often called a 'durbar' by British authors. Unfortunately, there seems to be no mention of a lunar eclipse in the inscriptions or scenes on the walls of the tombs where the celebrations are depicted (Meryre II and Huya). However, in the following discussion, I will tentatively assume that this match is correct, even though it implies a chronology later than usually proposed, and explore how other lunar events might be linked to recorded historical dates.

Lunar Festivals at Full Moon or New Moon

It is known that Egyptian religious ceremonies generally followed a lunar calendar; therefore, having failed to match any other recorded dates with solar or lunar eclipses, I searched for matches with dates of ordinary full moon or new moon, as published on the NASA web page [G]. Here, there are a number of interesting matches. The tomb of Kheruef (TT192) on the West Bank at Thebes [H] contains dated scenes of ceremonies during the first and third jubilees of Amenhotep III. The recorded event during the first jubilee occurred on 27 Shemu II in Year 30. The events during the third jubilee portrayed in Kheruef's tomb included raising the *djed*-pillar on 30 Akhet IV in Year 37. The new moon on May 16 in 1341 BC fell on 27 Shemu II (Year 30?) in the Egyptian calendar, while the full moon on November 19 in 1335 BC fell on 30 Akhet IV (Year 37?). For this pair of possible jubilee date matches, the regnal years of Amenhotep III must have incremented on anniversaries of an accession date between 28 Shemu II and 29 Akhet IV.

There is no mention of the second jubilee in Kheruef's tomb. However, at the Soleb temple in Nubia, there are scenes associated with a jubilee, including 'Illuminating the Dais' rituals involving ceremonies with torches, dated for six days from 26 Peret IV to 1 Shemu I, which are connected with Amenhotep III deified as the lunar god Nebmaatra healing the lunar eye of Horus, bringing about the full moon (15, 16). This is possibly the full moon on March 19,

1337 BC (30 Peret IV) which would be during the second jubilee in Year 34.

These dates are consistent with transition from the generally accepted final Year 38 of Amenhotep III to the first Year 1 of Akhenaten in 1333 BC, which is 20 years later than the estimate of 1353 BC. The solar eclipse of 1338 BC that passed through the site of Akhet-Aten would have occurred in Year 33 of Amenhotep III, five years before the accession of Akhenaten and ten years before his founding of the city.

Earlier in the reign of Amenhotep III, he issued a so-called 'Lake Scarab' in Year 11 (17), commemorating the construction of a lake for Queen Tiyi beginning on Day 1 of Akhet III, perhaps the day after the full moon on September 26, 1360 BC. He performed an 'Opening the Lake' ceremony half a month later, on Day 16 of Akhet III, perhaps the day after new moon on October 11, 1360 BC. These possible date matches are listed in Table II.

Following our chronology pegged to Akhenaten's Year 12 durbar dated to December 24, 1322 BC, further date matches with phases of the moon are found on the boundary stelae of Akhet-Aten (7). The full moon on February 27, 1327 BC occurred the night before the Later Proclamation or 'repetition of discovery' on 13 Peret IV in Year 6, the first anniversary of the founding date. However, the Earlier Proclamation that founded the city, inscribed on three stelae and dated to 13 Peret IV in Year 5, seems to have no particular lunar connection. It may be that the actual founding date was different, but was inserted on the stelae in Year 6 or later to make it appear that the anniversary was exact.

The new moon on November 24, 1326 BC marked the occasion of a 'repetition of oath' on the following day, 8 Peret I in Year 8 (18), a short text that was appended to most of the 11 stelae bearing the later proclamation. On two of these stelae (A and B), further text records 'another oath' by Akhenaten (the 'Colophon'), dated to 30 Akhet IV in Year 8. This would seem to precede the 'repetition of oath' by eight days, but Murnane and Van Siclen (7), Ch. 5, argue that it is almost a year later and indicates that Akhenaten's accession date (and its anniversaries on which the regnal year incremented) fell between 1 Peret I and 8 Peret I.

According to this supposition, the Colophon date would be November 16 in 1325 BC, several days after new moon. However, there was a full moon on November 16 in 1324 BC, or 30 Akhet IV in Year 9. The inscribed Year 8 date can be read only on Stela B, being damaged on Stela A. Stela B may be unreliable, since it omits the Year 6 date at the start of the Later Proclamation and gives a Year 6 date for the 'repetition of oath', which all other stelae agree is Year 8. Therefore, it seems possible that the Colophon date on Stela B is in error, one of the year number strokes being omitted.

In the reign of Tutankhamen, several more inscribed dates can be matched to new or full moons if it is accepted that Ankhkheprure-Smenkhkare-Nefernefruaten had an independent reign between Akhenaten and Tutankhamen. In fact, the only complete date from the reign of Ankhkheprure, recorded in a graffito from the tomb of Pere, can be matched to a new moon. This is no official document, but the scribe may have considered it an auspicious occasion to write a secret prayer to the god Amen. These possible matches (19) are added to Table II; some regnal year dates seem to be unreadable on the inscriptions and I have indicated suggestions in parentheses. However, there appear to be no continuation of similar lunar matches to dates in the reign of King Ay. Both of the dates listed by Murnane (20) are on the first day of a civil calendar month, so Ay might have preferred such occasions over phases of the moon. Nevertheless, with so many of the relatively few ceremonial dates recorded between Year 11 of Amenhotep III and Year 8 of Tutankhamen (53 years) matched to lunar phases, it is tempting to suppose that the chronology proposed in Table II is correct.

Any conclusions must be tempered with great caution. The synodic month, from one full moon to the next, is about 29.53 days, so any given date has about a 1-in-15 chance of being either a full moon or a new moon, and occurrences will average about every 15 years. Moreover, the lunar cycles are repetitive; in particular, there are almost exactly 309 synodic months in 25 Egyptian years of 365 days each. This means that if there was a full moon on a given date of the Egyptian calendar, there would also be a full moon on the same date 25 years later, or 25 years earlier. The same can be said of new moon, or any other lunar phase; the same Egyptian lunar calendar could be reused every 25 years. The same dates in Table II would match the same phases of the moon if the entire sequence of events were advanced or retarded in multiples of 25 years. The 25-year earlier chronology is presented in Table III. The match to dates is equally good, but the total eclipse of the sun at Akhet-Aten would have occurred in Year 2 of Tutankhamen, and might have been regarded as a bad omen, leading the young king to abandon the city and the Aten religion. In this case, the unusual Aten in the tomb of Meryre I cannot be a representation of the eclipse, since the celebrants are Akhenaten and Nefertiti.

Moreover, there were close matches, just over a day in error, every 11 and 14 years before or after these 25-year intervals. Also, with an error of less than a day, every 7 and 18 years before or after, there was half-a-month difference in lunar phase; that is, there were new moons in place of full moons, and vice-versa. The 18-year interval is very close to half-a-month short of the *saros* period of 223 synodic months between similar eclipses. This means that the Egyptian date of an eclipsed full moon will have a new moon 18 years later, and another eclipse will occur upon the next full moon. This repetitive peculiarity linking lunar and solar cycles is exemplified in Table IV and may explain, in part, why the Egyptians did not introduce leap years to keep the seasons fixed. If we abandon the tentative linking of a lunar eclipse to Akhenaten's durbar, then the alternative chronologies preceding Table II by 7 or 18 years are of special interest.

The alternative 18-year earlier chronology is closer to conventional dating, and is presented for comparison in Table V. For example, the full moon on May 21 in 1359 BC also fell on 27 Shemu II in the Egyptian calendar, another possible candidate for Amenhotep III's Year 30 jubilee date. Again, the new moon on November 22 in 1353 BC fell on 29 Akhet IV, only a day earlier than what could be the Year 37 jubilee date. Also, the new moon on December 28 in 1340 BC was on 8 Peret II, perhaps the Year 12 celebration of Akhenaten. The previous full moon on December 13 was subject to a total eclipse, in the same *saros* series as the1322 BC event. Furthermore, all other inscriptional events in Table II can also be matched to lunar events, except that full moon and new moon occasions are interchanged. However, the solar eclipse of 1338 BC that passed through the site of Akhet-Aten would have occurred in Year 14 of Akhenaten, and likely regarded as a bad omen instead of inspiring him to found the city. Also, there would no longer be any reason to suppose the city would be on the central path.

The other alternative chronology is listed in Table VI, seven years before Table II, in which full moon and new moon occasions are also interchanged, but the solar eclipse of 1338 BC that passed through the site of Akhet-Aten would have occurred in Year 2 of Akhenaten. At this time, he would have been building his Karnak temples to the Aten, and likely fending off strong complaints from the Amen priests and their supporters. They may have told him that Thebes, the city of Amen, was no place to put Aten temples, urging him to go elsewhere, and the sun concurred by indicating the spot.

Note the event day and hour given in the NASA tables [G] are according to Universal Time (GMT) measured at the Prime Meridian in London. Egypt is about two hours ahead of London and the ancients began their days at sunrise, 6 a.m. modern local time at the equinoxes. Therefore, times before about 04.00 UT would have been credited to the day before by the

ancient Egyptians. Such times are indicated by asterisks in the 'Event' column of Tables II, III, V and VI.

Conclusion

The only total eclipse of the sun visible from Egypt proper during the 14th Century BC occurred on 14 May, 1338 BC and swept across the Nile at the site of Akhet-Aten. An unusual portrayal of the Aten in the tomb of Meryre I is probably a representation of this eclipse, but there is no explicit hieroglyphic inscription to settle the matter. A search of Egyptian records for evidence of other eclipses of the sun or moon in this period yields only one possibility: Akhenaten's 'durbar' on 8 Peret II in his Year 12 matches the date of a total eclipse of the moon on December 24, 1322 BC but, again, there is no explicit hieroglyphic inscription. However, assuming this dating is correct, many inscribed dates of ceremonies from the reigns of Amenhotep III to Tutankhamen can be matched to the occurrence of a full moon or a new moon on the same day, or the day after; see Table II. This chronology places the solar eclipse in Year 33 of Amenhotep III and Year 1 of Akhenaten in 1333 BC, which is 20 years later than recently suggested (1353 BC) and allows very little time between the end of the Amarna period and the accession of Ramesses II.

The repetitive nature of the Egyptian calendar allows all the inscribed dates to be matched to the same phases of the moon, but earlier or later in multiples of 25 years. The 25-year earlier chronology, Table III, dates Year 1 of Akhenaten to 1358 BC and the Akhet-Aten solar eclipse to Year 2 of Tutankhamen, when it might have been seen as a bad omen and contributed to the abandonment of the city. This chronology allows a long reign for Horemheb and the accession of Ramesses II in about 1290 BC.

There are also possible close matches, but with lunar phase reversal, at intervals of 7 and 18 years. The 18-year earlier chronology, Table V, dates Akhenaten's Year 1 to 1351 BC and the solar eclipse to his Year 14, when it might also have been taken as a negative sign. This chronology allows a short reign for Horemheb and the accession of Ramesses II in about 1290 BC.

However, the 7-year earlier chronology, Table VI, places the solar eclipse in Year 2 of Akhenaten, when he was building new temples to the Aten against probable opposition in Thebes, and taken it as a sign to move. This chronology is the best fit to a 13-year reign for Horemheb and a 1279 BC accession date for Ramesses II (21). It is consistent with my proposal that the unusual Aten in the tomb of Meryre I is a depiction of the solar eclipse, and is the scenario that I presently favor. If any one of the chronologies listed in these tables is correct, then there was essentially no coregency between Amenhotep III and Akhenaten, nor between Akhenaten and Smenkhkare.

For those who are convinced that there was a coregency between Amenhotep III and Akhenaten, the chronology in Table VII can be considered; this is a combination of Tables II and VI, allowing for a seven-year coregency. A study of whether the events described in the inscriptions are more appropriate for new moon or full moon occasions may help to decide the better chronology. In an age when artificial light was inefficient and expensive, the light of the full moon would be welcome in extending celebrations into the night. It would also facilitate the assembly of large crowds to witness the rising sun on the day after and offer morning prayers. New moon occasions would emphasize the difference between night and day at sunrise and sunset. They would also be best to stress events that signified a new beginning, such as appointment of a new office holder.

Most cities of the world were founded for economic reasons, such as strategic location. It seems that Akhenaten located his new city for some arbitrary, religiously-motivated reason, probably a total eclipse of the sun, even over the strenuous objections of his subjects. Soon after Akhenaten's death, Akhet-Aten understandably lost its status as capital city, but then was abandoned completely. Maybe it was religiously damned, but all its brand-new infrastructure and investment in homes went to waste. Likely, it was simply a poor location for a city, being too expensive to maintain; except for a few small villages, it has not been built upon before or since.

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(19) *ibid.* **94**, p. 207; **99**, p. 212; **100-B**, p. 215; **100-C**, p. 216

(20) *ibid.* **103-C**, p. 225; **103-D**, p. 226

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[A] Fred Espenak, Solar Eclipses of Historical Interest, http://sunearth.gsfc.nasa.gov/eclipse/SEhistory/SEhistory.html

[B] http://eclipse.span.ch/endof.htm

[C] http://www.earthview.com/ages/wingedsun.htm

[D] Fred Espenak, Solar Eclipses: -1399 to -1300, http://sunearth.gsfc.nasa.gov/eclipse/SEcat/SE-1399--1300.html

[E] Holger Oertel, http://www.ortelius.de/kalender/form_en2.html

[F] Fred Espenak, Lunar Eclipses: -1399 to -1300, http://sunearth.gsfc.nasa.gov/eclipse/LEcat/LE-1399--1300.html

[G] Fred Espenak, Phases of the Moon: -1399 to -1300, http://sunearth.gsfc.nasa.gov/eclipse/phase/phases. -1399--1300.html

[H] Mark Andrews, The Private Tomb of Kheruef at Asasif on the West Bank at Luxor http://www.touregypt.net/featurestories/kherueft.htm

TABLE I: Solar Eclipses Visible in Egypt During 14th Century BC (1352-1328)

Eclipse type, location	Julian date	Egyptian date
Total, Nubia	15 August, 1352 BC	20 Akhet I
Total, Akhet-Aten	14 May, 1338 BC	25 Shemu II
Annular, Egypt-Canaan	13 March, 1335 BC	24 Peret IV
Total, Nubia	30 December, 1332 BC	12 Peret II
Annular, Canaan	17 October, 1328 BC	29 Akhet III

TABLE II: Lunar Events Matching Inscriptions – Tentative Chronology

Date of inscription is in *italics* if it differs from lunar event

Event	Julian date	Egyptian date	Inscription
Full moon	26 Sep 1360 BC	30 Akhet II Year 11 *1 Akhet III*	Lake Scarab – Work begun
New moon	11 Oct 1360 BC	15 Akhet III Year 11 *16 Akhet III*	Lake Scarab – Opening the Lake
New moon	16 May 1341 BC	27 Shemu II Year 30	First Jubilee – Tomb of Kheruef
Solar eclipse, Akhet-Aten	**14 May 1338 BC**	**25 Shemu II Year 33**	**Inspired Akhenaten to found city**
Full moon	19 Mar 1337 BC	30 Peret IV (Year 34) *1 Shemu I*	Second Jubilee – Soleb Temple
Full moon	19 Nov 1335 BC	30 Akhet IV Year 37	Third Jubilee – Tomb of Kheruef
	1333 BC	Year 38 / **Year 1**	Amenhotep III / **Akhenaten**
Full moon	27 Feb 1327 BC	12 Peret IV **Year 6** *13 Peret IV*	Boundary Stelae of Akhet-Aten First anniversary
New moon	24 Nov 1326 BC	7 Peret I **Year 8** *8 Peret I*	Boundary Stelae of Akhet-Aten Repetition of Oath
Full moon	16 Nov 1324 BC	30 Akhet IV **Year 9** (***Year 8*** in error?)	Boundary Stelae of Akhet-Aten Another Oath (The Colophon)
Full moon, eclipsed	24 Dec 1322 BC	8 Peret II **Year 12**	Reception of Foreign Tribute Tombs of Meryre II and Huya
	1317 BC	**Year 17** / Year 1	**Akhenaten /** Smenkhkare
New moon *	25 Sep 1315 BC	10 Akhet III Year 3	Graffito in Tomb of Pere
	1314 BC	Year 3 / **Year 1**	Smenkhkare / **Tutankhamen**
Full moon	1 Nov 1309 BC	19 Akhet IV **(Year 6)**	Tutankhamen Restoration Stela
Full moon	26 May 1308 BC	15 Shemu III **(Year 7)** *16 Shemu III*	Stela of Merymery
New moon	1 Feb 1307 BC	21 Peret III **Year 8**	Royal charge for chancellor Maya

TABLE III: Lunar Events Matching Inscriptions – 25-Year Earlier Chronology

Date of inscription is in *italics* if it differs from lunar event

Event	Julian date	Egyptian date	Inscription
Full moon	2 Oct 1385 BC	30 Akhet II Year 11 *1 Akhet III*	Lake Scarab – Work begun
New moon *	18 Oct 1385 BC	16 Akhet III Year 11	Lake Scarab – Opening the Lake
New moon	23 May 1366 BC	27 Shemu II Year 30	First Jubilee – Tomb of Kheruef
Full moon	26 Mar 1362 BC	30 Peret IV (Year 34) *1 Shemu I*	Second Jubilee – Soleb Temple
Full moon *	25 Nov 1360 BC	30 Akhet IV Year 37	Third Jubilee – Tomb of Kheruef
	1358 BC	Year 38 / **Year 1**	Amenhotep III / **Akhenaten**
Full moon *	6 Mar 1352 BC	13 Peret IV **Year 6**	Boundary Stelae of Akhet-Aten First anniversary
New moon	30 Nov 1351 BC	7 Peret I **Year 8** *8 Peret I*	Boundary Stelae of Akhet-Aten Repetition of Oath
Full moon	22 Nov 1349 BC	30 Akhet IV **Year 9** (***Year 8*** in error?)	Boundary Stelae of Akhet-Aten Another Oath (The Colophon)
Full moon	30 Dec 1347 BC	8 Peret II **Year 12**	Reception of Foreign Tribute Tombs of Meryre II and Huya
	1342 BC	**Year 17** / Year 1	**Akhenaten /** Smenkhkare
New moon	30 Sep 1340 BC	9 Akhet III Year 3 *10 Akhet III*	Graffito in Tomb of Pere
	1339 BC	Year 3 / **Year 1**	Smenkhkare / **Tutankhamen**
Solar eclipse, Akhet-Aten	**14 May 1338 BC**	**25 Shemu II Year 2**	**Bad omen; convinced Tutankhamen to leave city**
Full moon	8 Nov 1334 BC	19 Akhet IV **(Year 6)**	Tutankhamen Restoration Stela
Full moon *	2 Jun 1333 BC	16 Shemu III **(Year 7)**	Stela of Merymery
New moon *	8 Feb 1332 BC	22 Peret III **Year 8** *21 Peret III*	Royal charge for chancellor Maya

TABLE IV: Lunar Cycles in Egyptian Years

Note: 1 day = 0.03386 month
Synodic Months of 29.53 Days in Years of 365 Days
The eclipses are in the same *saros* series, 223 months apart

Years ↓	Synodic Months	*Years* ↑	*Synodic Months*	Lunar Phase	Example Julian Date	Egyptian Date
-50	-618.00	*-75*	*-927.00*	Full	12 Jan 1396 BC	9 Peret II
-25	-309.00	*-50*	*-618.00*	Full	6 Jan 1371 BC	9 Peret II
0	0.00	*-25*	*-309.00*	Full	30 Dec 1347 BC	8 Peret II
	86.00		*-223.00*	Full Eclipsed	13 Dec 1340 BC	23 Peret I
7	86.52	*-18*	*-222.48*	New	28 Dec 1340 BC	8 Peret II
11	135.96	*-14*	*-173.04*	Full	29 Dec 1336 BC	10 Peret II
14	173.04	*-11*	*-135.96*	Full	26 Dec 1333 BC	8 Peret II
18	222.48	*-7*	*-86.52*	New	26 Dec 1329 BC	9 Peret II
25	309.00	*0*	*0.00*	Full Eclipsed	24 Dec 1322 BC	8 Peret II
50	618.00	*25*	*309.00*	Full	17 Dec 1297 BC	8 Peret II

TABLE V: Lunar Events Matching Inscriptions – 18-Year Earlier Chronology

Date of inscription is in *italics* if it differs from lunar event

Event	Julian date	Egyptian date	Inscription
New moon	1 Oct 1378 BC	30 Akhet II Year 11 *1 Akhet III*	Lake Scarab – Work begun
Full moon	15 Oct 1378 BC	14 Akhet III Year 11 *16 Akhet III*	Lake Scarab – Opening the Lake
Full moon	21 May 1359 BC	27 Shemu II Year 30	First Jubilee – Tomb of Kheruef
New moon	24 Mar 1355 BC	30 Peret IV (Year 34) *1 Shemu I*	Second Jubilee – Soleb Temple
New moon *	22 Nov 1353 BC	29 Akhet IV Year 37 *30 Akhet IV*	Third Jubilee – Tomb of Kheruef
	1351 BC	Year 38 / **Year 1**	Amenhotep III / **Akhenaten**
New moon	3 Mar 1345 BC	12 Peret IV **Year 6** *13 Peret IV*	Boundary Stelae of Akhet-Aten First anniversary
Full moon	28 Nov 1344 BC	7 Peret I **Year 8** *8 Peret I*	Boundary Stelae of Akhet-Aten Repetition of Oath
New moon	21 Nov 1342 BC	30 Akhet IV **Year 9** (***Year 8*** in error?)	Boundary Stelae of Akhet-Aten Another Oath (The Colophon)
New moon	28 Dec 1340 BC	8 Peret II **Year 12**	Reception of Foreign Tribute Tombs of Meryre II and Huya
Solar eclipse, Akhet-Aten	**14 May 1338 BC**	**25 Shemu II Year 14**	**Bad omen for Akhenaten?**
	1335 BC	**Year 17** / Year 1	**Akhenaten /** Smenkhkare
Full moon	27 Sep 1333 BC	8 Akhet III Year 3 *10 Akhet III*	Graffito in Tomb of Pere
	1332 BC	Year 3 / **Year 1**	Smenkhkare / **Tutankhamen**
New moon	5 Nov 1327 BC	18 Akhet IV **(Year 6)** *19 Akhet IV*	Tutankhamen Restoration Stela
New moon	31 May 1326 BC	15 Shemu III **(Year 7)** *16 Shemu III*	Stela of Merymery
Full moon *	7 Feb 1325 BC	22 Peret III **Year 8** *21 Peret III*	Royal charge for chancellor Maya

TABLE VI: Lunar Events Matching Inscriptions – 7-Year Earlier Chronology

Date of inscription is in *italics* if it differs from lunar event

Event	Julian date	Egyptian date	Inscription
New moon	29 Sep 1367 BC	1 Akhet III Year 11	Lake Scarab – Work begun
Full moon	13 Oct 1367 BC	15 Akhet III Year 11 *16 Akhet III*	Lake Scarab – Opening the Lake
Full moon	19 May 1348 BC	28 Shemu II Year 30 *27 Shemu II*	First Jubilee – Tomb of Kheruef
New moon	22 Mar 1344 BC	1 Shemu I (Year 34)	Second Jubilee – Soleb Temple
New moon	21 Nov 1342 BC	30 Akhet IV Year 37	Third Jubilee – Tomb of Kheruef
	1340 BC	Year 38 / **Year 1**	Amenhotep III / **Akhenaten**
Solar eclipse, Akhet-Aten	**14 May 1338 BC**	**25 Shemu II Year 2**	**Inspired Akhenaten to found city**
New moon	2 Mar 1334 BC	13 Peret IV **Year 6**	Boundary Stelae of Akhet-Aten First anniversary
Full moon	26 Nov 1333 BC	8 Peret I **Year 8**	Boundary Stelae of Akhet-Aten Repetition of Oath
New moon *	20 Nov 1331 BC	2 Peret I **Year 9** (*30 Akhet IV **Year 8***?)	Boundary Stelae of Akhet-Aten Another Oath (The Colophon)
New moon	26 Dec 1329 BC	9 Peret II **Year 12** *8 Peret II*	Reception of Foreign Tribute Tombs of Meryre II and Huya
	1335 BC	**Year 17** / Year 1	**Akhenaten /** Smenkhkare
Full moon	27 Sep 1321 BC	10 Akhet III Year 3	Graffito in Tomb of Pere
	1332 BC	Year 3 / **Year 1**	Smenkhkare / **Tutankhamen**
New moon	3 Nov 1316 BC	19 Akhet IV **(Year 6)**	Tutankhamen Restoration Stela
New moon	29 May 1315 BC	16 Shemu III **(Year 7)**	Stela of Merymery
Full moon, * eclipsed	5 Feb 1314 BC	23 Peret III **Year 8** *21 Peret III*	Royal charge for chancellor Maya

TABLE VII: Lunar Events Matching Inscriptions – 7-Year Coregency Chronology

Date of inscription is in *italics* if it differs from lunar event

Event	Julian date	Egyptian date	Inscription
Full moon	26 Sep 1360 BC	30 Akhet II Year 11 *1 Akhet III*	Lake Scarab – Work begun
New moon	11 Oct 1360 BC	15 Akhet III Year 11 *16 Akhet III*	Lake Scarab – Opening the Lake
New moon	16 May 1341 BC	27 Shemu II Year 30	First Jubilee – Tomb of Kheruef
	1340 BC	Year 31 / **Year 1**	Amenhotep III / **Akhenaten Coregency begins**
Solar eclipse, Akhet-Aten	**14 May 1338 BC**	**25 Shemu II** Year 33 / **Year 2**	**Inspired Akhenaten to found city**
Full moon	19 Mar 1337 BC	30 Peret IV (Year 34) *1 Shemu I*	Second Jubilee – Soleb Temple
Full moon	19 Nov 1335 BC	30 Akhet IV Year 37	Third Jubilee – Tomb of Kheruef
New moon	2 Mar 1334 BC	13 Peret IV **Year 6**	Boundary Stelae of Akhet-Aten First anniversary
	1333 BC	Year 38 / **Year 7**	Amenhotep III dies
Full moon	26 Nov 1333 BC	8 Peret I **Year 8**	Boundary Stelae of Akhet-Aten Repetition of Oath
New moon *	20 Nov 1331 BC	2 Peret I **Year 9** (*30 Akhet IV **Year 8***?)	Boundary Stelae of Akhet-Aten Another Oath (The Colophon)
New moon	26 Dec 1329 BC	9 Peret II **Year 12** *8 Peret II*	Reception of Foreign Tribute Tombs of Meryre II and Huya
	1335 BC	**Year 17** / Year 1	**Akhenaten /** Smenkhkare
Full moon	27 Sep 1321 BC	10 Akhet III Year 3	Graffito in Tomb of Pere
	1332 BC	Year 3 / **Year 1**	Smenkhkare / **Tutankhamen**
New moon	3 Nov 1316 BC	19 Akhet IV **(Year 6)**	Tutankhamen Restoration Stela
New moon	29 May 1315 BC	16 Shemu III **(Year 7)**	Stela of Merymery
Full moon, * eclipsed	5 Feb 1314 BC	23 Peret III **Year 8** *21 Peret III*	Royal charge for chancellor Maya

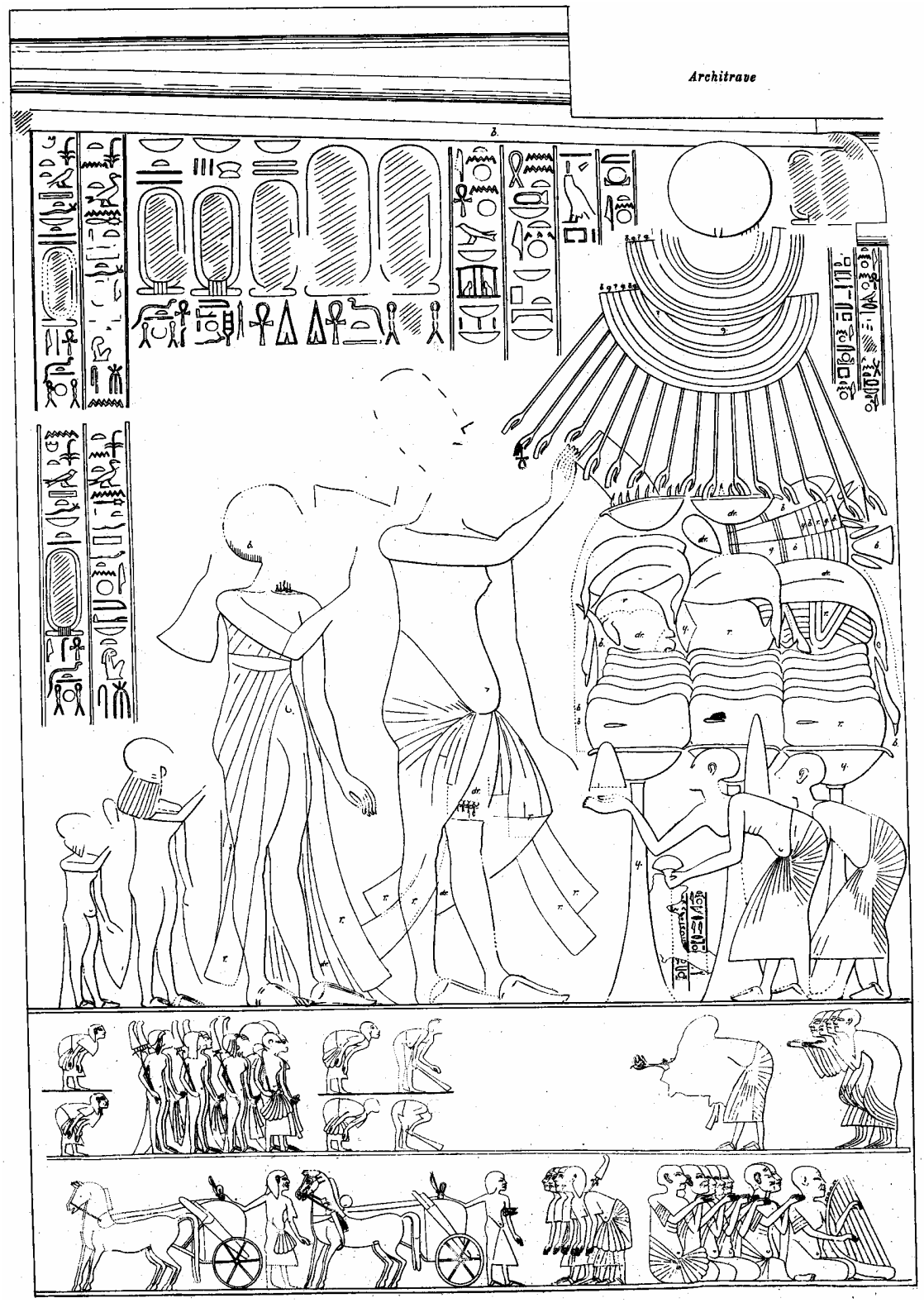

Figure 1 The Tomb of Meryre I, S. Wall, E. Side, by N. de G. Davies

The Royal Family Making Offerings to the Aten.

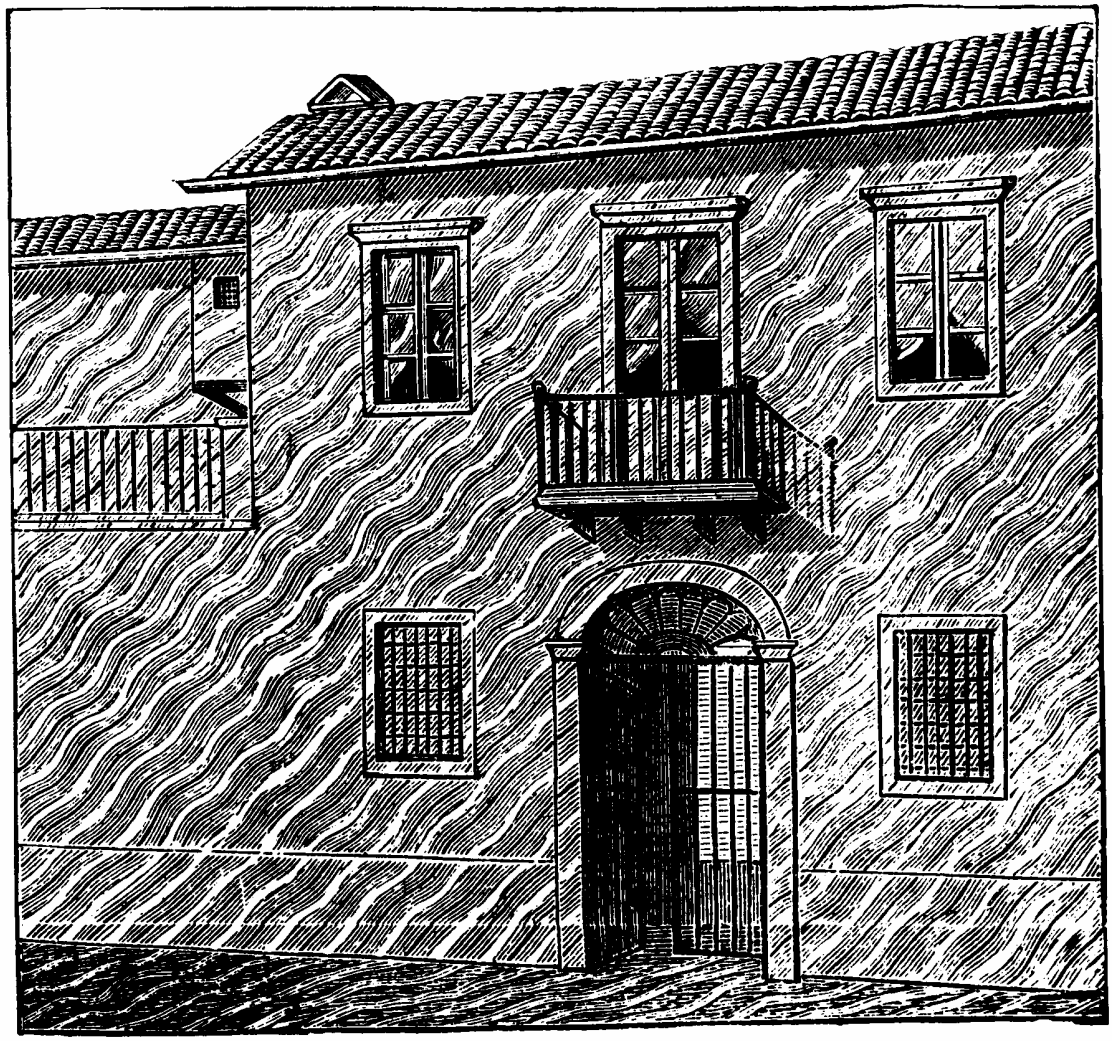

Figure 2 Brewer in *Eclipse*, p.34
Shadow bands visible just prior to totality (1900 engraving)

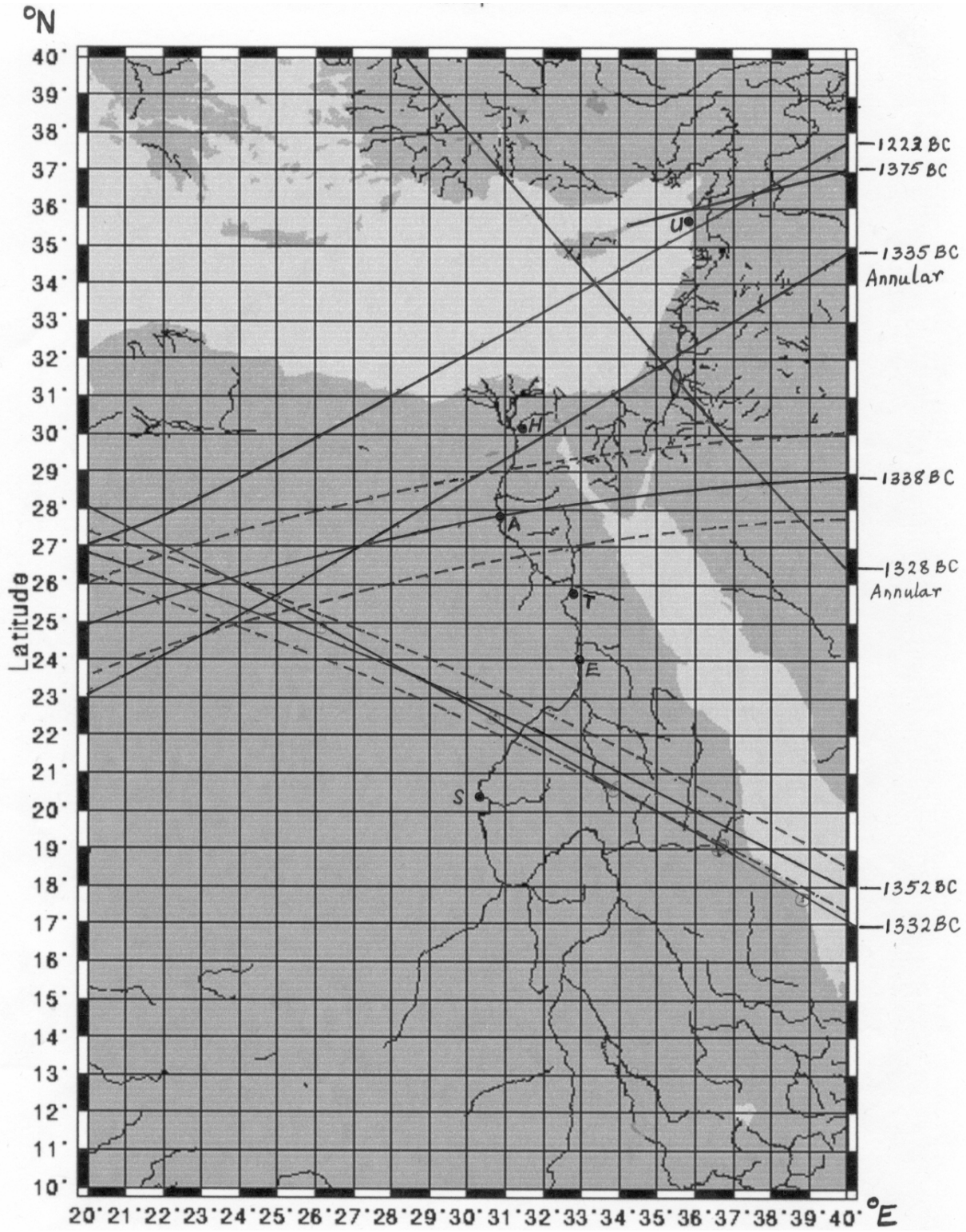

Figure 3 Selected Ancient Eclipses Visible in Egypt, Nubia, and Canaan

U=Ugarit, H=Heliopolis, A=Akhet-Aten, T=Thebes, E=Elephantine, S=Soleb