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Recovering the Lost World, A Saturnian Cosmology -- Jno Cook Appendix D: Change of the Axis.



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An inclination of 25 Degrees

And here we shall take up the demonstration, revelation, and account of how the axis changed three times since the end of the "Age of the Gods" (in terms of the opening words of the *Popol Vuh*). The need to question the axial inclination became clear on reading an essay by Euan MacKie, which I will discuss further below.

Let me suggest that after 3147 BC the inclination of the rotational axis of the Earth (to the plane of its orbit) might have been 25 or 26 degrees. The pyramids and the Sphinx, representing some of the earliest of Egypt's constructions, hint at this.

It is possible to suggest that the Sphinx was constructed to face the rising Sun at the solstice, when the current real Sun replaced Jupiter after Jupiter entered the asteroid belt at the end of the first dynasty in about 2860 BC (as I calculate it). If the inclination of the Earth's axis was 25 or 26 degrees, the most northerly location of the rising Sun, at the summer solstice, would occur at 29 to 30 degrees north latitude, which is the location of the Sphinx.

Assuming the virtual disappearance of Jupiter as the Midnight Sun after the end of the first dynasty, it could be suggested that the Sphinx was specifically constructed after the end of the first dynasty as a beacon to watch for the return of the Midnight Sun, Jupiter, which also traveled on the ecliptic, like the Sun.

Jupiter moves very slowly on its path around the zodiac. The location directly east from the Giza plateau would be where Jupiter was seen at the extreme of the ecliptic, and thus also at its earliest. If Jupiter had nearly disappeared, that is, had lost its giant lower mountain because it had entered the asteroid belt and no longer looked like Osiris moving through the sky as a mummified form, then perhaps the Sphinx was an attempt to coax his return. That would place the construction of the

Sphinx after the start of the second dynasty, after 2860 BC.

Colin Reader, in "Giza Before the Fourth Dynasty" JACF (2002), suggests that the Sphinx dates from the first or second dynasty -- long before the Giza pyramids were constructed (in the fourth dynasty). It existed before the building of Khafre's causeway and mortuary temple. The walls of Khafre's mortuary temple are wedged into the enclosing wall of the Sphinx temple (the temple building actually is also a late construction). Khafre's mortuary temple was likely built after the Sphinx's temple building was constructed. The Sphinx itself is older than either.

The other suggestion for the placement of the Sphinx, might be as a vigil for Horus the hawk who had flown from east to west every day or night for 4000 years, although actually this was Saturn seeming to revolve around the Earth (due to the Earth's rotation). Saturn as Horus would also have appeared on the ecliptic, at least, apparently so. This concept might place the construction of the Sphinx at an even earlier time. A much earlier construction of the Sphinx (5000 BC to 9000 BC) was suggested by Robert Schoch, writing in *Voices of the Rocks* (1999), based on water damage. See the chapter "Pyramids and Henges" for a discussion on dating the Sphinx.

For the Giza plateau construction of the Sphinx a 25- or 26-degree inclination would suffice to suggest that the Sun traveled a completely different path at an earlier date. A 25- or 26-degree axial inclination could then be suggested as the initial condition of the inclination of the Earth's axis after release from Saturn in 3147 BC.

Saturn's inclination to its orbit is 26.7 degrees, but this is likely a numerical coincidence to the early inclination of the Earth's orbit. It would always have been this value. The 25-degree axial inclination of the Earth is with respect to the new (and current) orbit, and would have been something different when the orbit of the Earth paralleled the orbit of Saturn. [note 1]

A 25-degree inclination accounts well for the construction of the Sphinx as resulting from a change in the celestial display of the mountain of Jupiter which disappeared in about 2860 BC. At that time Jupiter entered the asteroid belt and its huge lower form disappeared. The coma would have become smaller in diameter. It is almost certain that this was the crisis that exchanged the second dynasty for the first. Current estimates list the end of the first dynasty as 2890 BC. We think political influences, but of overriding importance in antiquity was religious concepts.

It accounts well, however, if it can be agreed that the Egyptians considered the overhead passage of the Sun as considerably more important than its easterly rising. This duplicates the attitudes of the Olmecs of Mesoamerica, who, following the theories of Clyde Winters, likely had North African origins.

Nekhen, the center of early religious activity in Egypt, is at 25.1 degrees north latitude. At Nekhen the Sun would have traveled to stand directly overhead (90 degrees) at noon at the spring and fall equinox if the Earth's axial inclination had been 25.1 or 25.2 degrees. This is because Nekhen is located at a latitude equal to the axial inclination of the Earth.

About Nekhen, Wikipedia reports:

"[Nekhen] was the religious and political capital of Upper Egypt at the end of the Predynastic period (c. 3200-3100 BC) and probably also during the Early Dynastic Period (c. 3100-2686 BC). Some authors suggest occupation dates that should begin thousands of years earlier."

As I have previously pointed out, the inclination of Earth's axis and the rotational axis of Saturn did not match in the era before 3147 BC. The ancients insisted that the earlier polar apparition rotated in a circle "without cease," but this would have consisted of Saturn traveling in a circle in the north sky. It would not be the rotation of Saturn about itself.

It is the difference in the inclination of the rotational axis of Earth and Saturn which would have seemed to make Saturn rotate in the sky. The inclination of the rotational axis of the Earth to this original orbit (inclined at 4.51 degrees to the Sun's equatorial, like Saturn's orbit) would thus have been 28.5 degrees. The difference from the absolute inclination of Saturn is not much, only about 2.5 degrees. But this would result in a 5-degree diameter circle that Saturn would have traveled in the north sky. This is still 10 diameters of the Moon. [note 2]

Despite a certain elegance of the above speculations, there are problems with these concepts. For one, the axial inclination was 30 degrees after 1492 BC. The 30 degree inclination might have been in effect since 3147 BC (although I doubt that). Calendars and orbits will not indicate any of those possible changes. The only secondary indication would be the occupation by humans of the region above the Arctic Circle, but this will be influenced by the overall climate, which was considerable better before 1492 BC.

At this point I would suggest that after 3147 BC the Earth might have had an axial inclination of 25.2 degrees (following G.F.Dodwell). Released from Saturn, it started on an orbit around the Sun, where the location of the release constituted the aphelion of the orbit -- May 28th, apparently. This would be the location Earth would return to yearly until the orbit changed again at a later date.

When did the inclination change to 30 degrees? I would suggest that most likely this happened in 1492 BC. The Earth apparently not only tilted to a horizontal position, but it took the Earth 13 months to upright itself again. There are enough incidental memories and legends to substantiate this last. The number of months varies, but is much larger than expected for a gyroscopic reaction. The massive gyroscopic reaction torque suggests the possibility of large changes in orbital parameters, and in fact the Earth's orbit became 30 percent larger.

Additional Changes

The need for considering possible changes in the axial inclination was initiated by an essay by Euan MacKie, "Megalithic Astronomy and Catastrophism," in *Pensee* magazine (1974). MacKie based his information on the research of Alexander Thom as reported in Thom's *Megalithic Sites in Britain* (1967).

Absolutely typical of the befuddled attitude expressed by both MacKie and Thom, which does not seem to ever question what both learned in grade school, is the insistence on determining calendars over and over again with 300 separate alignments of stones, and the insistence that these were all to the benefit of farmers, "so they would know when to plant."

So I tackled the question of why so many stone arrays and circles needed to be set up in Great Britain over a period of 200 years, and then abandoned almost completely. I looked at the possibility of a change in the axial inclination of the Earth (although generally humans do not care about that), the path of the Sun and the path of the Moon (although, again, no one cares), and finally, the possibility

that this represented another set of destructive close calls by Mars.

I should warn the reader that I do not, in the following, reach a definitive conclusion about megalithic astronomy, or the inclination of the Earth's rotational axis. Intrusions by Mars, however, fit well with other archaeological data.

Introduction

MacKie discusses two locations in Scotland, three standing stones at Ballochroy (55.70 north latitude), aligned parallel with three mountain peaks 18 miles (29 km) away, and one at Kintraw farm (Argyll) at 56.12 north latitude facing southwest to a mountain peak 28 miles (32 km) away.



[Image: Standing stones at Ballochroy, Scotland. After stonesofwonder.com.]

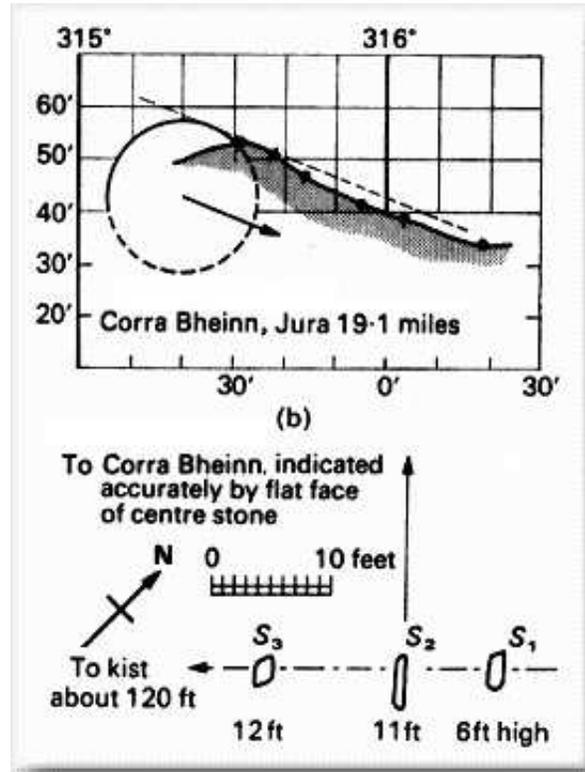
MacKie introduces his article with the following:

"The dating of the megalithic observatories to the period from about 2000-1800 B.C. seems fairly secure and puts them firmly into the epoch preceding Velikovsky's major cataclysms of the 15th century B.C. In spite of this, the alignments so far identified do fit well with the present celestial system retrojected to the period concerned."

Despite further hemming and hawing, here is how the article was understood by followers of Velikovsky: it dismissed Velikovsky's claims to changes in the inclination of the Earth's axis, changes in the length of the year, relocation of the geographic pole, and a number of other changes. I will attempt to clear some of this up.

Let me also point out that Dwardu Cardona, in "The Cairns Of Kintraw" (*Kronos* 1979), and in a second article, all but demolished the contention of a megalithic alignment with the Sun at the solstice at these particular locations, summing it up as, "... given enough stones and a mountainous horizon, some celestial occurrences are apt to line up with something," and this despite the fact that Thom initially considered these two locations (Kintraw and Ballochroy) to be the most important

solstitial sites. More on this further below.

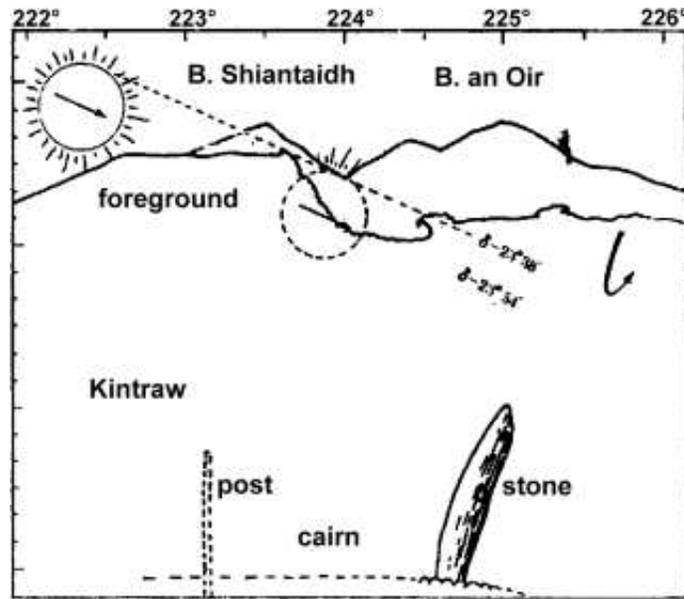


[Image: Progress of the Ballochroy solstice sunset; after Thom.]

I was similarly ready to dismiss the alignments found by Thom, especially since a perusal of Thom's writings shows him expanding his ideas well beyond what might otherwise be acceptable. One secondary result of his investigations has been the definition of a "megalithic yard," for which, more than anything else, he has been faulted. But a megalithic yard is easier to mock than his proposed alignments, since almost no one knows anything about axial inclinations, solar declinations, and the equation of precession.

The claims that megalithic alignments like these are seen throughout the world during this period (meaning, as usual, throughout Europe or the UK), are not meaningful. This could easily be another resurgence of the insane interest in circles of our ancestors which had been interrupted in 2193 BC.

The evidence brought forward by Thom is that the inclination of the Earth's rotational axis with the normal to the plane of the orbit (which I will simply call "inclination" or "axial inclination") could be derived from today's value of 23.5 degrees in a series of minute changes resulting in an "average" inclination of 23.9 degrees -- 0.4 degrees more than today. Suggesting a total change of 0.4 degrees in 4000 years is an extraordinary uniformitarian claim. MacKie attempted to verify this for the two locations discussed here, one for a summer solstice position at Ballochroy, the other for a midwinter solstice at Kintraw.



[Image: Standing stone at Kintraw, Scotland. After Thom.]

I had established earlier in these texts that the inclination of the axis was 30 degrees before 685 BC, and was ready to suggest that this might have continued without interruption from 3147 BC. Here, however, is different information, comfortably fitting Establishment assumptions that the inclination of the axis has always been the same as today, or nearly so.

What I should point out, first, is that the obsession with finding these solstitial sunsets existed only in the period from 2000 BC to about 1800 BC, and second, that the reported values of the axial inclination (actually the Sun's declination from the equatorial, which accounts for uneven horizons) are not all that close to the expected values. Retrocalculation from today places the best values in 1800 BC, says Thom (others have suggested 1600 BC). For the three standing stones at Ballochroy, MacKie arrives at a series of values which ranged from about 20 degrees to 24 degrees. Thom used an "averaged" inclination of 23.9 degrees, only 0.4 degrees different from today, but apparently based on a wider range of observations than these two.

The dating via a retrocalculation is based on observations made in 1909 of a slight tendency for the Earth's axis to move to the vertical. The span of observations for this tendency was less than a decade, but the data is expected to hold for 3800 years into the past. The total change during that 3800-year period amounts to less than a half degree -- about the width of the Sun. Carbon-14 dating of the sites results in dates of about the same order. This is a fortunate coincidence for the researchers, but of course has nothing to do with the inclination of the Earth's axis.

A Critique by Cardona

In two articles in *Kronos* in 1979, "The Stones of Ballochroy" and "The Cairns of Kintraw," Dwardu Cardona critiques the alignments cited above. About Ballochroy Cardona writes:

"In fact, despite the latitude of 55.7 degrees, the 90 degree angle which separates the two sunsets at this locality as it is shown in Thom's plan, is only a myth. Neither the stone row nor the orientation of the stones 'points' directly to either of the two sunsets under consideration."

The "90 degrees," mentioned above, is derived from the fact that the solstitial sunsets at midsummer and midwinter are each 45 degrees north or south of west at this latitude for an axial inclination of 23.9 degrees. Actually the summer and winter sunsets are 87.8 degrees apart for a latitude of 55.7 degrees, and 89.0 degrees for a latitude of 56.12 north. We could say "about 90 degrees." But there is more.

For the sightings at Kintraw, Cardona points out that the intended target, an island 18 miles away, could not be seen from the location of the menhirs. Additionally he writes:

"Then, in 1969, Thom gave us a new diagram with a new set of lines. The line from the twelve foot menhir which runs through the centre of the stone 'circle' is no longer shown as indicating Beinn Shiantaidh. It is now shown as pointing to Dubh Beinn. What was a solar sight line has now become a lunar one."

At this point that Cardona makes his observation about "... given enough stones"

Skipping most of these critiques, let me instead simply point out that if Thom held these two sites to be the most valid of the 300 studied, the critique could be extended to all the other data, and suggest that none of the other observations are valid alignments of solstice sunsets for an axial inclination of 23.5 or 23.9 degrees.

Calendars

The expressed notion of these two reputable researchers and astronomers is that all the solstitial markers (throughout Scotland and England) represented efforts at establishing a calendar. It is hard to take this seriously. We are even told that this was to the benefit of local farmers, who would then know when to plant their crops, and even, as one unrelated astronomer of note claims about calendars, "when to harvest." Do reputable astronomers ever plant flowers in their front yard? [note 3]

Certainly it is not likely that any of this represented efforts at establishing a calendar, despite the fact that China, Babylon (in a late retelling), the Olmecs, and the Hebrews (as implied in Exodus) all recall settling on a calendar after 2349 BC -- and in many cases settling on a revised calendar. But, more important, calendars are not used by farmers, who plant by the weather, but are used to determine religious feast days. Archaeologists forget that our ancestors were absolutely obsessed with religious observances.

The date of the equinox is much easier to find than the date of the solstice. In fact, from what we know of ancient calendars, it appears that the year almost universally started with the fall equinox, or with the culmination of the Pleiades, two days later -- even with later revised calendars. The culmination of the Pleiades also remained a major religious feast day. For this a calendar, or the determination of the date of the solstice, would not be needed. It would be very obvious from a look at the skies.

The repeated sighting locations for the solstitial sunset (if these are what these standing stones represent) look like absolutely desperate attempts at determining the course of the Sun as it changed its travel in the sky. I should add "or something," because maybe it was not the Sun that was being tracked.

Retrocalculation

The reader will have asked, how can the uniformitarian approach determine that 1800 BC is an exact extension backward of today's celestial parameters and conditions? This is called "retrocalculation" (Mackie calls it "retrojection") and involves the conviction that the year has always been 365.24 days long, that the Moon has always taken 29.5 days to complete a month, and that the established precession of the equinox has always been in effect. Thus Thom will claim that we are looking at the sky of 1800 BC, which, however, cannot be identified from the locations of the Sun or Moon, but only from the stars -- of which he identifies one, Spica, which he later withdraws from consideration.

It is this last, the precession of the equinox (along with the inclination of the axis), which determines where the Sun would rise or set against the backdrop of the stars. As an exercise in applied uniformitarian astronomy, this is easy to find. So the proper coincidence of horizon sunsets at the summer solstice in the remote past is simply the application of the current value of the precession (measured, for example, in years per degree, as below) to today's skies. That will rotate the skies (the stars) about 52 degrees along the horizon in order to reach 1800 BC -- although there is no way to check that.

Thom's value, determined from AD 1967 (when his book was published), would be:

$$(1800 + 1967) / 72 = 52.3 \text{ degrees}$$

This value, which has been independently derived by Thom and by others, can be checked against what I hold to be the case: (1) there was no precession of the equinox before 747 BC, and (2) in 685 BC the dome of the skies moved 15 days forward.

$$(747 + 1967) / 72 + 15 = 52.7 \text{ degrees}$$

Is that close enough? The change in the equinox in 685 BC, which has been solidly established in previous texts, is completely responsible for presenting to archaeologists a picture of absolute uniformity.

I should point out that Thom's calculations are actually not quite as simple as this. He uses a slight adjustment in the value (in degrees per year), originally derived by Simon Newcomb between AD 1900 and 1909, and assumes that this can be extended backward in time by nearly 4000 years. The problem is that this adjustment formula has almost no guarantee of validity, both because of the limited data on which it is based and especially since historically the precession of the equinox has been recognized as varying. [note 4]

I must say I have no idea how such certainty about the date of 1800 BC was arrived at. But it is of great interest that the 15-day shift into the future in 685 BC can account for all of the change since 1800 BC.

Considering Mars

I have considered the possibility that the monuments might have something to do with the Sun, or with the Moon, but except for the muddled set of changing observations, these two tell nothing. I therefore considered Mars and Mercury. This possibility has already been broached in the chapter "The Day of the Dead." It involves close approaches of Mars during the end of the Early Bronze Age.

No reputation of insane destructiveness ever became attached to Mercury. The burning and melting of hilltop forts or citadels in Scotland was entirely due to Mars having inched south along its tilted orbit, but moderated by the greater distance between Mars and Earth at the higher level.

Scotland did not have the populous cities of the Eastern Mediterranean region. Some 60 stone structures were damaged in Scotland, with additional ones in northern Europe (there are about 200 in total).

The destructions in Scotland involves one of the sets of dates for Middle Eastern destructions recorded by Claude Schaeffer in *Stratigraphie Comparée et Chronologie de L'Asie Occidentale* (1948). He lists (among other things) a date of 1700 BC when many urban centers in the Middle East were destroyed. The date of 1700 BC is one from his series of dates which cannot easily be moved to a different period, for instance, by imposing our knowledge of the fictional Greek "Dark Ages."

To be included in Schaeffer's listing of cataclysmic archaeological conditions, the disturbing elements had to include earthquakes and firestorms. This would signify close contacts with Mars -- very close. This had been the case for a period of 300 years some 1200 or 1300 years earlier starting in about 3070 BC. This would happen again for a period of (only) 120 years, some 1000 or 1100 years later, starting in 806 BC. Others have pointed out that fires were the predominant cause of destruction.

Adding the known starting date (3067 BC) for the close passes of Mars after 3147 BC, and the start of close passes in the 8th and 7th century BC (806 BC), and dividing by two, results in a starting date of 1936 BC as a likely unset of this set of "contacts" by Mars. This falls in the center of Thom's era of investigation, and will match Schaeffer's date if this represents a midpoint.

I am suggesting, therefore, that close passes by Mars were the concern among the Scots and many other people -- China, India, and portions of northern and central Europe.

Why would the solstice be involved, if indeed it was? Actually, only two dates would qualify for a close contact by Mars. That would be dates near the equinoxes. I think the solstice had nothing to do with any of the monumental constructions.

The condition of Mars overrunning the orbit of Earth would continue as long as the perihelion of Mars's orbit fell inside the orbit of Earth. Lynn Rose and Raymond Vaughan in 1994, in proposing a solution to the data of the *Venus Tablets of Ammizaduga*, reported that in 670 BC (some years after the nova event of 685 BC) the eccentricity of the Earth's orbit changed significantly (from 0.10 to 0.0+). This means the orbit of Earth became nearly circular, and was no longer overrun by Mars.

Summary

Is the conviction of uniformitarian astronomers that the Earth's axis was inclined (as it was supposed to be) at 23.9 degrees in 1800 BC correct?

Not likely. All indications are that a different axial inclination was in effect since remote antiquity, and perhaps since before the beginning date of the era of interest to Alexander Thom.

Can this be squared with my conviction that after 1492 BC the inclination of the axis would have to be 30 degrees, and remained at that value until 685 BC?

It can, although that is another matter. I am on an entirely different path from Thom and MacKie. I can only reconcile their finding as some sort of mistaken reading of the facts. Frankly, I do not see how the finding of an "average alignment of 23.9 degrees" could be derived except through a driving conviction in the dominant paradigm of uniformitarian archaeology. It is a convincing fiction only in the eyes of those who wish it to be that way.

What might be the reason for the 200 years of activities, erecting circles and lines of large standing stones as well as single stones, by the tribes of Scotland (and apparently throughout northern and central Europe)?

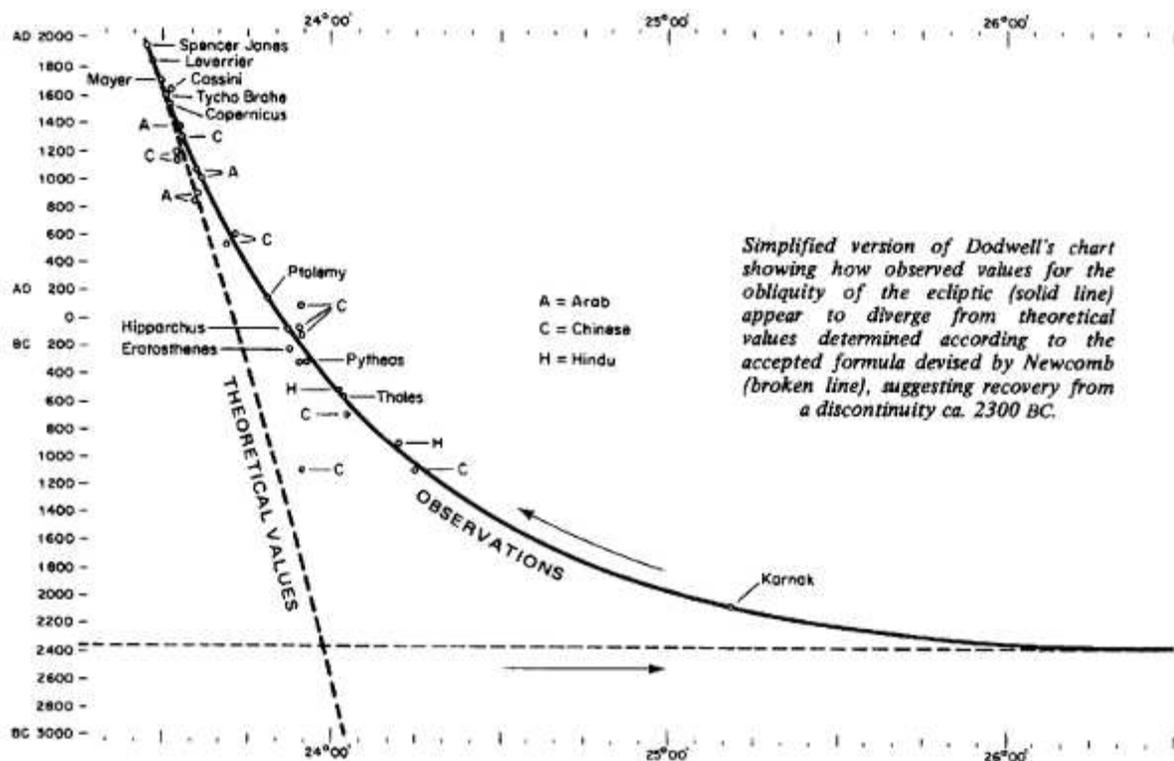
It was most likely the interference of Mars with Earth between 2000 BC (I calculate this as 1936 BC) and 1800 BC. Since Mars traveled on an orbit inclined by 1.85 degrees to the orbit of Earth (the ecliptic), Mars would have inched down (to the south) over the course of one or two days when Earth and Mars were close together at the spring equinox (and the reverse in the fall). Mercury was located some 100,000 miles above Mars, and electrical contacts with Earth would not have been likely.

Endnotes

Note 1 --

Quoted from <http://www.science-frontiers.com/sf030/index.htm>:

"Australian astronomer G.F. Dodwell has analyzed the observational records compiled for the many gnomons erected all over the civilized world during the past 4,000 years. Gnomons are vertical markers that cast shadows from which the local latitudes can be computed. (All one needs are the measurements of the shadow lengths on the longest and shortest days of the year.) The earth's tilt or obliquity of the ecliptic may also be calculated from gnomon data -- and therein lies the anomaly. The tilt of the earth's axis is supposed to vary cyclically between 22 and 24.5° over a period of some 40,000 years due to the pulls of the moon, the sun, and the planets on the earth's equatorial bulge..."



[Image: Obliquity data since 2300 BC, after Dodwell.]

"Tilt angles computed from ancient gnomon observations deviate markedly from the theoretical curve. The alignment of the ancient Egyptian temple at Karnak and other oriented sites extend the deviation toward the date 2345 B.C. [This is the asymptotic date for the plotted data.] Either the ancient observations were systematically in error all over the world or the earth's tilt angle changed in historical times."

Dodwell's earliest inclination is 25.2 degrees, derived from a pylon at the temple of Karnak, built in 2045 BC. Dodwell assumes an exponentially declining sine curve for the values, as if the Earth was impacted in about 2345 BC and wobbled back and forth in decreasing swings. Not entertained is the possibility that the Earth's tilt always was 25.2 degrees.

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Note 2 --

Since the orbit of Saturn is inclined at 4.51 degrees to the Sun's equator, and the Earth's current orbit is inclined at 7 degrees to the Sun's equator, there is a 2.49 degree difference between the inclination of the Earth's original parallel orbit to Saturn's orbit. This places the inclination of the Earth's axis at 28.5 degrees to the plane of the orbit before 3147 BC.

Compare this to Saturn's inclination to its orbit, which would not have changed since 3147 BC, and it will be seen that the axis of rotation of the two planets did not coincide, although the measures (26.7 and 28.5 degrees) are close, as seen in the sky they are still two finger-widths apart in radius and four in diameter.

The aphelion of the Earth's orbit today is July 4th or 5th (it varies with leap years). The date of May 28th is described in Chapter 34.

[return to text]

Note 3 --

Phillip Pait, in *Death From the Skies* (2008), which sports a *Reader's Digest* version of traditional and consensual knowledge -- what everyone supposedly knows -- writes:

"... astronomy is actually the world's oldest profession: early agricultural civilizations needed to know when to plant their crops and when to harvest, and the changing skies gave them their clues."

"The Sun was worshipped, and the Moon. This evolved into the belief that all the gods lived in the sky."

Could he be any more wrong? The Sun and Moon have never been worshipped anywhere except in the imaginations of astronomers. Additionally, I would award the honors of being "the world's oldest profession" not to astronomers, but to a group of people of a different occupation.

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Note 4 --

Euan MacKie reports:

"... this modern motion, when projected back into the past with the aid of the Newcomb formula, reveals that a solstice of 23 degrees 54 minutes existed at about 1800 B.C., a date which fits very well with the date of the standing stones derived from independent archaeological evidence [Carbon-14 dates]. Clearly, powerful arguments would need to be marshalled against this apparently neat coincidence if a catastrophic interpretation were favored."

Here is the powerful argument: The Newcomb formula determines the multiplier for precession of the equinox as, $(50.2564 + 0.000222) * \{\text{years}\}$, where "50.2564" is the number of seconds of a degree per year, thus 50/3600 degrees, and .000222 is a very small additional multiplier. The inverse of 50/3600 is 72, which is the number of years per degree, and the value I used.

From <http://www.binaryresearchinstitute.org/>, a site which disputes Newcomb's formula, we have:

"Calculated precession rates over the last 100 years show increasing precession rates which produce a declining precession cycle period. There is no reason the relatively constant mass of the Sun and Moon torquing the Earth should produce such figures."

The idea of "the Sun and Moon torquing the Earth" is just made-up science nonsense (first introduced by Newton), which the above quoted text actually acknowledges. I have shown that it is the Moon's repeated entry into the Earth's plasmasphere which is at cause, and therefore precession is a function of the size of the Earth's plasmasphere. This, in turn, is controlled by the Sun's electrical field at the exterior of the Earth's plasmasphere.

[return to text]

*Calculations are in Unix bc notation, where ^ denotes exponentiation; the functions a(rctangent), s(ine), and c(osine) use radians; angle conversions to radians or degrees by the divisors rad=.0174 and deg=57.2958; other functions are shown as f(); tan()=s()/c()
units: million == 1,000,000; billion == 1,000,000,000;
AU == 93,000,000 miles.*



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