

Astronomy on Oracle Bone Inscriptions

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SUMMARY

In this paper we review the records of astronomical phenomena on oracle bone inscriptions of the Shang Dynasty. The history of research on the bone inscriptions is less than 100 years from their discovery and articles on oracle bone astronomy are even more recent. Since the people of the Shang Dynasty deeply worshipped the celestial bodies, for example the Sun, Moon and Stars, many bone inscriptions, recording astronomical phenomena, have been found by palaeographers and astronomers. By means of a study of published rubbings, we discuss the astronomical records of bone inscriptions, such as solar and lunar eclipses, solar phenomena, planets, comets, new stars or supernovae and certain fixed stars. In particular some records, such as solar and lunar eclipses, sunspots and comets are discussed in detail. It is concluded that astronomy in the Shang Dynasty (from about 1500–1050 BC) had already attained a fair level. However, the names of some planets and rather bright stars such as Venus and Mars, or Sirius and Vega, have not yet been deciphered from bone inscriptions. We give several suggestions for extending study in this area.

1 INTRODUCTION

The ‘oracle bones’, which have contributed so much to present-day knowledge of ancient Chinese history, were first discovered at Xiao-tun near An-yang, Henan Province, China in AD 1899. These relics of the latter half of the Shang (also known as the Yin) Dynasty (which lasted from 1500–1050 BC) consist of animal bones and turtle shells inscribed with a primitive form of Chinese characters. About 160000 pieces of oracle bone have, so far, been unearthed since the initial discovery. It seems likely that these bones originally formed part of the royal archives kept at the later Shang capital. The city on the site of Xiao-tun was probably the residence of the Shang kings between about 1350 and 1050 BC.

The name ‘oracle bones’ stems from the nature of the bone and shell inscriptions. In these texts, the queries posed to the ancestral spirits and replies judged to have been received as the result of divination were recorded, together with their verified outcomes. The context of each individual oracle inscription generally consisted of four parts: preface, charge, prognostication and verification. The most common ‘preface’ is of the following form: “The divination on...[date] was performed by...[the name of diviner]”. The date is expressed jointly in terms of the lunar calendar and a 60-day cycle. The latter consists of two parts: 10 stems (*tian-gan*) and 12 branches (*di-zhi*) respectively. Use of the 60-day *gan-zhi* cycle is frequently found in bronze inscriptions from both the Shang and Zhou Dynasties as well as in historical

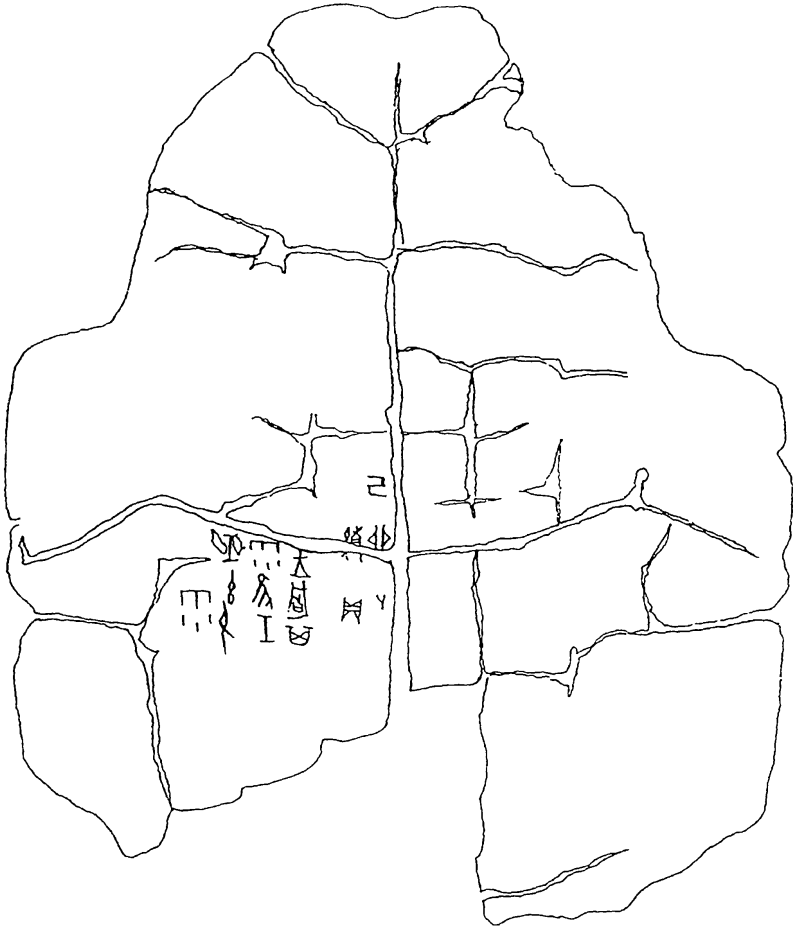


FIG. 1. A complete divination record is inscribed.

works originating from the Zhou and all later dynasties. It seems reasonable to suppose that the cycle has run continuously since Shang times. Whenever the lunar month is mentioned on an oracle text, it is always placed at the end of an entry. Unfortunately, since the year is seldom, if ever, recorded, few texts are accurately datable. The ‘charge’ consists of queries concerning various aspects of Shang life posed during the divination. The ‘prognostication’ contains the results of the divination which were obtained from reading the crack forms on the bone or shell. Finally, the ‘verification’ is a record of what actually occurred following the divination.

Figure 1 shows an example of a turtle shell on which a complete divination record is inscribed. A translation of the record is as follows: “The divination on day ‘*ji-mao*’ was performed by Kuo. The King after examining the crack forms commented that it would rain on day ‘*ren*’. On day ‘*ren-wu*’ indeed it did rain.” It is unfortunate that only a few such records, complete with all four parts of the divination process, are extant. Most surviving texts consist of small broken fragments inscribed with only a few characters. Difficulties in deciphering the primitive characters, many of which are still not understood, have hindered a fuller interpretation of numerous records.

The contents of the oracle inscriptions are very rich. Some texts are devoted to religious ritual and sacrifice; others relate to warfare or hunting;

still others are concerned with journeys made by the kings and the welfare of the royal family. In addition, natural occurrences, such as rain and snow, and unusual phenomena in the sky were recorded. Some of them are important astronomical phenomena. In an earlier paper (I) we gave a brief summary of astronomical records found on the oracle bone texts. Hence in this paper we only give the most typical example ‘under each category’ and discuss several special issues in detail, such as sunspots, comets, solar and lunar eclipses.

2 SAMPLES OF TYPICAL ASTRONOMICAL RECORDS

2.1 *Solar Eclipses*

* It was inquired, The Sun was eclipsed... (*He-ji*, 11480.)

Note: *He-ji* and later references represent the abbreviated names of oracle bone sources cited, see reference (I).

2.2 *Lunar Eclipses*

* Day ‘*ren-shen*’ (9), at night, the Moon was eclipsed. (*He-ji*, 11482.)

Note: (9) is the number in the 60-day cycle; the same convention is used in the other quotations below.

2.3 *Solar Phenomena*

* The divination was on day ‘*ren-zi*’ (49), there was a ‘*ri zhi*’ on day ‘*jia-yin*’ (50). (*Yi-cun*, 384).

* The divination on day ‘*gui-shi*’ (30) inquired: will there be a disaster today? On day ‘*jia-wu*’ (31), there was *yun* (solar halo). (*Bai-gen*, 2.)

2.4 *Lunar Phenomena*

* On day ‘*ren-yin*’ (39) it was inquired: there has been ‘*yue you zhi*’. A sacrifice is to be made to Earth; should a burnt offering of cattle be made? On day ‘*ren-yin*’ (39) it was inquired: there has been ‘*yue you zhi*’. The King did not want the disaster to fall on one person. Yet again, there is a disaster. (*Tun-nan*, 726).

Note: *yue* means the Moon but *you zhi* is in doubt.

2.5 *References to Planets*

* The divination on day ‘*xin-mao*’ (28) was performed by Ji: the King is to make a sacrifice to *sui* [Jupiter]. Will it not rain? (*He-ji*, 25148.)

2.6 *References to Comets*

* A sacrifice was made to the queen of King Gen and also to the *hui* [comet]; by making a sacrifice to queen Gen, will the *hui* [comet] disappear? (*He-ji*, 698.)

2.7 References to New Stars

* On the day ‘*xin-wei*’ (8), there was a sacrifice to *xin xing* [the new star]. (*Yi-zhu*, 1182.)

2.8 References to Stars

* The divination on day ‘*bing-shen*’ (33) was performed by Kou: an offering of wine was made on day ‘*yi-shi*’ (42). Will it rain tomorrow? When a sacrifice was performed, the rain would stop. When a sacrifice was withheld, it would rain again. An offering was made to *niao xing* [*Bird Star*]. (*He-ji*, 11497.)

* There was a divination. An offering was made to *huo* [Antares], in the 5th month. (*Huo-bian*, ii, 374.)

* Day ‘*gui-hai*’ (60); in the night of day ‘*jia*’, a sacrifice was made to *dou* [Northern Dipper]. (*Yi-bian*, 134.)

3 ‘RI ZHI’, ‘RI YOU ZHI’ AND SUNSPOTS

Many oracle bone inscriptions recording certain ‘*ri zhi*’ and ‘*ri you zhi*’ have been found. Typical examples are as follows:

- (1) The divination was on day ‘*xin-si*’ (18). There was *ri zhi* in the western sky, will it bring a disaster? (*He-ji*, 33704.)
- (2) On day ‘*geng-chen*’ (17) it was inquired: there was *ri you zhi* and a sacrifice of nine oxen was made. Should this be reported to King Fu Ding at Lei? On day ‘*geng-chen*’ (17) it was inquired: there was *ri zhi*, should this be reported to *he*? On day ‘*geng-chen*’ (17) it was inquired: there was *ri you zhi*. Will it be a good omen and bring no disaster? (*He-ji*, 33698) (see Fig. 2).
- (3) On day ‘*xin-si*’ (18) it was inquired: there was *ri you zhi*; should this be reported to Fu Ding? (*He-ji*, 33704.)
- (4) It was inquired: there was *ri you zhi*; should this be reported to *he*? (*Nan*, 2·198.)

Note: *ri* means the Sun, but the remaining terms are in doubt.

For the character *zhi* [𠄎] in *ri zhi* and *ri you zhi* there have been different interpretations. Some have thought that it means a reddening of the Sun while others believed that it could mean a solar eclipse (2). However according to Chen’s deciphering, it means a black spot or a black vapour, that is a sunspot (3). We know that representations of sunspots were discovered on the fragments of painted pottery from the Neolithic Age (4).

In the Shang Dynasty, worship of the Sun was in vogue. For example, a bone inscription recorded: “To offer sacrifices to the rising and setting Sun three sacrificial oxen were killed.” This shows that the ancients of the Shang Dynasty made major sacrifices for welcoming and bidding leave to the Sun god. Apparently, daily worship of the Sun was responsible for spontaneous observations of solar phenomena (see above examples: *ri zhi* or *yun*).

It is well known that: (1) large sunspots big enough to be seen with the naked eye occur often on the solar disk; (2) at sunrise or sunset the brightness of sunlight is reduced and hence these times when the ancients offered sacrifices to the Sun would be good times for direct observation.



FIG. 2. An example recording “*ri you zhi*”.

From above, it is shown that the ancients of the Shang Dynasty were in the habit of observing the Sun regularly and thus had rich experience to judge different solar phenomena. Therefore, we conclude that *ri zhi* or *ri you zhi* in bone inscriptions stood for, in fact, sunspots. We believe that *ri zhi* or *ri you zhi* on the bone inscriptions should be the earliest written records of sunspots (5).

4 ‘*HUI*’ AND COMETS

A few researchers have noted that there were cometary records on the bone inscriptions, but this is not generally accepted. The key questions are: (1) Whether there indeed is the character *hui* on the bone inscriptions, representing the synonym of the character 彗 of the regular script; (2) Whether *hui* was a sacrificial object just like the Sun and Moon and stands for a comet.



FIG. 3. An example recording “hui”.

For the first question many scholars, especially Tang Lang and Yang Shuda, have affirmed that the character *hui* (彗) of the oracle inscriptions is just the character 彗 of the regular script today. Its shape is like a broom and its significance is elimination or sweeping away (6, 7).

For the second question, we have selected five kinds of records on the bone inscriptions as follows (8):

- (1) The divination on day ‘*ji-mao*’ inquired: should a person named Xiaozhi make a sacrifice *you* (侑) to *hui* tonight. It was also inquired: should the same sacrifice to *hui* be made again on the next day ‘*geng-chen*’ in the 5th month. (*He-ji*, 3266) (see Fig. 3).
- (2) The divination on day ‘*wu-shen*’ inquired: sacrifices 彗* and *you* to *hui*... (*Qian*, 5.38.3).
- (3) It was inquired: a sacrifice *yan* (祉) to *hui*... (*Dong-hua*, 208).
- (4) A sacrifice 彗* to *hui* by use of a pig (*Cui*, 1595).
- (5) The divination on day ‘*wu-xu*’ inquired: the shape of *hui* has changed. Will it bring darkness upon us? It was a fine day. (*He-ji*, 32915.)

Except for the 5th record, the above texts have given four kinds of sacrifice, such as 侑, 彗, 祉 and 彗. In this case, the character *hui* is regarded as a worshipped star, that is a comet whose shape is like a broom. It is very interesting that the 5th record means, in fact, a change in the appearance of the comet. After analysis of the differences between four shapes of the character *hui*, it has been inferred that the people of the Shang Dynasty may have known four types of comet, including the ‘having head’ type and even a change of shape.

According to Stephenson & Walker (9) there were virtually no cometary records in the BC period from Europe. No Babylonian tablets earlier than the 3rd century BC note possible accounts of comets. Therefore the cometary records on the bone inscriptions represent one of the achievements of Astronomy in the Shang Dynasty.

5 SOLAR AND LUNAR ECLIPSES AND DATING

Although there have been some disputes among a few scholars of bone inscriptions on deciphering reference to eclipses, two records of solar eclipses and five records of lunar eclipses have, in general, been accepted:

* Pronunciation not known.



FIG. 4. A record of a solar eclipse.

For solar eclipses

- (1) On day 'gui-you' it was inquired: the Sun was eclipsed in the evening; is it good? On day 'gui-you' it was inquired: the Sun was eclipsed in the evening; is it bad? (*He-ji*, 33694) (see Fig. 4).
- (2) From day 'yi-mao' to the next day was foggy; three flames ate the Sun and there were big stars. (*He-ji*, 11506.)

In this latter case the event has been interpreted as a reference to the corona during a total eclipse; from the text it may be inferred that the eclipse occurred on the day after 'yi-mao', i.e. 'bing-chen'.



FIG. 5. A record of lunar eclipses.

For lunar eclipses

- (1) The divination on day 'gui-wei' (20) was performed by Zheng: next day, 'jia shen' (21) will change to sunny. That night the Moon was eclipsed. The next day was foggy; it did not rain. (*He-ji*, 11483.)
- (2) The divination on day 'gui-wei' (20) was performed by Zheng: will there be no disaster in the next ten days? On the 3rd day, 'yi-you' (22), at night, an eclipse of the Moon was reported. In the 8th month. (*He-ji*, 11485) (see Fig. 5).
- (3) On the 7th day, 'ji-wei' (56), at night, there was *dou*. On the next day 'geng-shen' (57), the Moon was eclipsed. (*Ku-fang*, 1595.)
- (4) Day 'ren-shen' (9), at night, the Moon was eclipsed. (*He-ji*, 11482.)
- (5) On the 6th day, 'jia-wu' (3), at night, the Moon was eclipsed. (*He-ji*, 11484.)

It can be seen from the above records that no absolute date is ever given. It is common to find only the day given in terms of the 60-day cycle. Occasionally, the month is mentioned. To obtain an exact and unambiguous date for any of these records is a problem that still remains to be overcome. The absence of fully reported dates has compelled researchers to employ various different approaches. Keightley has discussed in some detail the problems associated with the various dating schemes which have been proposed (10).

TABLE I

Dated solar eclipses

Year	Month	Day	Cycle day	LT (h)	Altitude	Magnitude
-1249	3	4	<i>bing-chen</i>	10.1	36	0.92
-1175	8	19	<i>kui-you</i>	17.0	22	0.94

TABLE II

Dated lunar eclipses

Eclipse	Date	First contact		Last contact		Magnitude
		LT (h)	Altitude (°)	LT (h)	Altitude (°)	
-1310	November 23/24	1.6	+61	5.1	+22	1.63
-1281	November 3/4	3.8	+32	7.6	-12	1.62
-1277	February 26/27	0.4	+66	4.3	+28	1.55
-1228	December 16/17	0.1	+77	3.2	+48	0.77
-1226	May 31/June 1	22.8	+31	2.2	+26	1.33

There are only minor differences with the results of Pang *et al.* (13).

In the case of the bones inscribed with astronomical records, one would have hoped that eclipses of both the Sun and Moon would help establish a reliable absolute date. However, the information given in the records is often too scanty for the purpose. The main problem is insufficient information regarding the year and month. Nevertheless, in almost every record, the day of the sexagenary cycle is explicitly mentioned. It is possible that the cyclical day might enable some of the eclipse records to be dated, as has been attempted by a number of authors (11). Considering the newest correction in modern eclipse theory, we have developed a new computer program to calculate solar and lunar eclipses occurring in ancient times. By means of this program a series of data on solar and lunar eclipses observed at An-yang (the capital of the Shang dynasty) was obtained from 1500–1000 BC, including 17 solar eclipses and 31 lunar eclipses.

In our opinion (1) the eclipses recorded in bone inscriptions should be those with large magnitudes (close to 1 for solar eclipses; close to 1 or > 1 for lunar eclipses); (2) two texts stating the month in the bone records provide important conditions for dating. On this basis we have selected the dating results given in Tables I and II (12). For reference, the latitude and longitude of An-yang are as follows: 36.07 deg N; 108.88 deg E. In the tables, the abbreviation LT (h) stands for local time in hours and decimals.

6 BRIEF DISCUSSION

From the above, it is clear that Astronomy in the Shang Dynasty had already attained a fair level but we are aware that research on the bone inscriptions is still a relatively recent topic. The names of some bright planets and stars, such as Venus and Mars or Sirius and Vega have not been found. To extend the study of oracle bone astronomy we would offer three suggestions: (1) to open the comparative research of Astronomy between the

Shang and Zhou Dynasty; (2) to strengthen cooperation between astronomers and scholars on bone inscriptions; (3) to emphasize the importance of deciphering the names of the major planets and bright stars. As space is limited here, we shall discuss these in detail on some future occasion.

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