Analysis of astronomical records of King Wu's Conquest

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Abstract All related astronomical records of King Wu's Conquest have been searched and analysed comprehensively. Constrained by the newest conclusions of archeology, philology and history in the Xia-Shang-Zhou Chronology Project and based mainly on dates in *Wucheng*, Jupiter's position in *Guoyu* and information on the season, our first choice of the date of King Wu's Conquest is Jun. 20, BC1046. This conclusion explains properly most relevant literature.

Keywords: chronology, ancient astronomical records, history of astronomy, Chinese history.

King Wu conquered King Zhou and founded a new dynasty——West Zhou. This is an important event in Chinese history. However, the date of this event, a key component of Xia-Shang-Zhou Chronology Project (XSZ Project), has so far remained a mystery. Even though there are a variety of chronological and astronomical records related to the mystery, they are usually too concise to yield a sole, less vague and self-consistent interpretation. Different selection criteria, interpretations and deduction methods have led to different conclusions. Previous investigations have generated as many as 44 different conclusions for the duration BC1130—1020[1]. A significant progress has been made by the XSZ Project for examining all the results, and our present paper singles out the contribution made by investigating related astronomical records.

Zhou and Liu[2] have had a full search for the astronomical records relevant to King Wu's Conquest. We list in the following some major ones.

1. Bronze *Ligui*: King Wu conquered Shang in the morning of day Jiazi (1). Jupiter was just at the right place.

2. *Wucheng*: The first month, day Renchen (29), it was Pang-Siba. The next day was Guisi (30); King Wu departed from Zhou (state) to crusade against King Zhou (of Shang State). Counting from the day Ji-Siba of the second month, the fifth day was Jiazi (1) when King Zhou was killed. Counting from the day Jipang-Shengba of the fourth month, the sixth day was Gengxu (47) when King Wu prayed at the Grand Temple of Zhou (state). The next day, Xinhai (48), King prayed to Heaven. The 5th day Yimao (52) King sacrificed prisoners of the war at the temple.

3. *Guoyu*: When King Wu conquered King Zhou, Jupiter was in constellation Chunhuo; the Moon was near stars Tiansi; the Sun was in cons. Ximu; "Chen" was near stars Doubing; "the star" was in cons. Tianyuan. The star, Sun and Chen were all in the north lunar mansions.

4. *Huainanzi*: When King Wu went to attack King Zhou, Jupiter appeared to the east; …… a comet appeared and its handle was in the hands of Yin (Shang, it means the handle was to the east). *Yizi*: Jupiter was in the north.

5. *Bamboo Chronicle* (current version): In the 32nd year, the five planets gathered in constellation Fang. *Songshu*: Early spring, 6 Xun (10 days), the five planets gathered in Fang.

6. *Xinlun*: On the day Jiazi (1), the sun and the moon combined like jade; the five planets were like a string of pears. Before dawn, King Wu came to the battlefront···.

7. *Yizhoushu*: In the 35th year of King Wen, the King said: on the full moon day Bingzi (13) of the first month, an eclipse happened in disorder.

8. Other dates. *Taishi*: In the 11th year, King Wu conquered Yin. On the day Wuwu (55) of the first month, the troop crossed Mengjin. *Wucheng*: The troop crossed Mengjin on day Wuwu; arrived in Shang on day Guihai (60); began to hit before dawn of day Jiazi (1). *Shiji*: On day Wuwu (55), 12th month, 11th year, the troop crossed Mengjin; before dawn of day Jiazi (1), King Wu arrived in Shang.

Apparently, we have to add our explanations in translating those ancient literatures into English.

Our purpose of this paper is (i) to analyse the above records using astronomical methods and (ii) to provide a chronological conclusion based on the historical results of the XSZ Project.

1 Dates in *Wucheng*

From *Wucheng* we obtain three dates containing month, sexagenary day and lunar phase:

A: 1st month, day Renchen (29), Pang Siba

B: 2nd month, day Gengshen (57), Ji Siba

C: 4th month, day Yisi (42), Jipang Shengba.

Conventionally, the first month would contain the winter solstice[5]; the 60-day cycle has been continually countered up to now. To be consistent with conclusions[4,20] from other research groups of the XSZ Project, we explain those lunar terms as follows. Ji-Siba stands for lunar calendar day (lcd) 17—19; Pang-Siba lcd 18—20; Jipang-Shengba lcd 3—5. The archaeological discovery of the Project has constrained the date of King Wu's Conquest to be in BC1050—BC1020[6]. Based on our early comprehensive analysis[3], we list those dates that fit the *Wucheng* records in table 1. In each group, 6 dates are given. The sexagenary numbers are shown within the parentheses. Under dates A, B, C are the lunar calendar days (showing lunar phase). The first day of a month is the luni-solar conjunction day. Using L to denote lunar phase in *Wucheng*, the last column represents our judgement. We define a "good" identification by ● if all dates A, B and C fall into previous definitions, and an "OK" identification by ○ if one of the dates goes out by one day.

Table 1 shows that 9 groups are good and 9 are OK to *Wucheng*. The other two items (J and S) will be used for later discussions.

2 The celestial phenomena in *Guoyu*

Records in *Guoyu* came from an officer, Lingzhoujiu, who used to talk to King Jing (reigned in BC544—BC520). Although his words were typical statements and knowledge of Waring States (BC475—BC221), we believe that Lingzhoujiu (or even later persons) in fact passed the information in his own style[7].

In the times Waring States, the 12 zodiac constellations, where in Jupiter stayed, were often used for an indicator of year. However, modern astronomical computation has indicated that all 10 such earlier records in *Chunqiu* and *Guoyu* may be incorrect[8,9], resulting from inaccurate

calculations (a Jupiter cycle is not exact 12 years). The fact is that those records were gathered in two periods (BC655—BC636, BC545—BC510). So it is possible that the record "Jupiter in Chunhuo" came from the other source. This event certainly warrants consideration.

Table 1 The dates fitting *Wucheng*

No.	1st day of the 1st month	A lcd	1st day of 2nd month	B lcd	1st day of 4th month	C lcd	L	J	S
1	1094.12.10(13)	17	1.8(42)	16	3.7(41)	2	○	●	●
2	1083.12.8(9)	21	1.7(39)	19	3.6(37)	6	○	●	●
3	1078.11.13(10)	20	12.12(39)	19	2.9(38)	5	●	●	
4	1077.1.11(9)	21	2.9(38)	20	4.9(38)	5	○		
5	1073.12.17(11)	19	1.15(40)	18	3.15(39)	4	●	○	
6	1068.11.22(12)	18	12.21(41)	17	2.18(40)	3	●	●	
7	1067.1.20(11)	19	2.18(40)	18	4.18(39)	4	●		
8	1063.12.26(12)	18	1.25(42)	16	3.25(41)	2	○		
9	1057. 1.30(13)	17	2.28(42)	16	4.27(41)	2	○	○	
10	1052.12.24(8)	22	1.23(38)	20	3.23(37)	6	○		
11	1047.11.30(10)	20	12.30(40)	18	2.27(39)	4	●	●	●
12	1046.1.28(9)	21	2.27(39)	19	4.26(37)	6	○	●	
13	1042.11.5(11)	19	12.4(40)	18	2.1(39)	4	●	○	
14	1041.1.3(10)	20	2.1(39)	19	4.1(39)	4	●		
15	1037.12.9(12)	18	1.7(41)	17	3.8(41)	2	○	●	
16	1031.1.12(12)	18	2.10(41)	17	4.10(40)	3	●		
17	1021.11.12(9)	21	12.12(39)	19	2.9(38)	5	●	●	
18	1020.1.11(9)	21	2.9(38)	20	4.9(37)	6	○		

Ancient scholars explained "Chen" as conjunction of the Sun and the Moon, "star" as Mercury. Obviously, the four events are doubtful[10]: when the Sun and the Moon "Chen" together near Doubing, the Moon could not be in another place, Tiansi. Moreover, how could ancient people see the details of the constellations wherein the Sun was staying?

Jiang[11] offered a hypothesis. One day, the Moon was seen in Tiansi (the head of Scorpius) and the Sun was in Ximu (one of the 12 zodiac constellations, the tail of Scorpius and whole Sagittarius). Two or three days later, they "Chen" together in Doubing (Sagittarius). This is a signal of King Wu's departure. Then, in the 3—4 month's process of the war, Mercury was seen in Tianyuan (Aquarius). We shall discuss more about this hypothesis.

The Moon passes Tiansi once a month, so the event indicates a day. The Sun passes Ximu once a year, so the event indicates a month, 11.9—12.9, around BC1050 by modern astronomical computation. The Sun passed Doubing during 11.14—11.21. This is a more strict limit than the saying that the Sun passed Ximu. Considering the places where Sun stayed could not be seen, this is only a rough statement, and so we only discuss Ximu.

Mercury could usually be seen twice in a 116 days cycle. In the process of the war, the Sun passed Sagittarius and Capricornus. There was a very large possibility that Mercury was seen in Aquarius.

In fact, the four events from Lingzhoujiu indicate only one fact: the Sun was in Ximu (11.9—12.9) when King Wu departed. Other statements are not independent (except Doubing). If we believe Lingzhoujiu passed on original information with his own diction and knowledge, the message must be saying that King Wu departed in the early winter. This coincides with *Wucheng* (the first month). This suggests that the message Lingzhoujiu conveyed probably came from *Wucheng*!

3 Jupiter phenomena

Zhang[12] has given every year when Jupiter was in Chunhuo in the times of King Wu. However, they are not exactly identical. Here we provide the years and months when Jupiter stayed in Chunhuo:

BC1095.9—BC1093.5, BC1083.8—BC1081.6, BC1071.8—BC1071.9, BC1069.2—BC1069.5, BC1059.7—BC1058.9, BC1047.7—BC1046.8, BC1035.6—BC1034.8, BC1023.5—BC1022.7

As we can see that Jupiter wandered in Chenhuo for almost two years sometimes.

Also, there is a corresponding 12-year cycle for a transit, direction and magnitude of Jupiter.

Zhang[13] explained the words in *Ligui*, "Jupiter was just in the right place", and deduced that "the place" meant "just in Chunhuo". Li[14], however, gave a different suggestion, "just at the meridian (transit)". Here we discuss Li's suggestion. Jupiter, just as every star in the sky, transits every day. We have already known that the day of King Wu's Conquest (day Jiazi) was in the middle of winter, i.e. 1.5—2.5 (Jan.5—Feb.5). We can see Jupiter at the meridian at night every 6—7 years during a 12-year cycle. During BC1100—BC1020 they were

BC1096—BC1090, BC1084—BC1078, BC1072—BC1067, BC1060—BC1055,
BC1048—BC1043, BC1037—BC1031, BC1025—BC1020.

The Jupiter's phenomena gradually change during a 6—7 years period. Table 2 is an example for BC1048—BC1043.

Table 2 Jupiter phenomena on January 20th in BC1048—BC1034 (Beijing time, Xi'an phenomenon, sunrise 7:58, sunset 17:58)

BC	1048	1047	C1046	1045	1044	1043
Transit	19:39	21:56	0:33	2:27	4:55	6:45
Rise/set	13:01/2:21	14:48/5:05	17:16/7:46	20:03/9:47	22:35/11:12	1:02/12:28
Mag.	-2.37	-2.49	-2.53	-2.42	-2.26	-2.10
Pheno.	A	A-B	B	B	B-C	C
Height	69	78	80	72	61	49

Phenomenon A: Jupiter transited at dusk; it was seen in the western sky before midnight. B: Jupiter transited at mid-night; it was seen in the eastern sky before mid-night and then in the western sky. C: Jupiter transited at dawn; it was seen in the eastern sky after mid-night.

Other historic periods are similar to those in table 2. For example, BC1096, BC1084, BC1072 are similar to BC1048; BC1090, BC1078, BC1067 to BC1043. The above analysis shows that, "Jupiter in Chunhuo" and "Jupiter transits at dawn" could not occur on the same day in January or February.

4 Other celestial phenomena

4.1 Conjunction of the five planets

We have researched the planetary movements during BC1100—BC1018. The results are shown in table 3. The condition is that, all 5 planets are on the same side of the Sun, forming a string 10—70 degrees from the Sun. The events that took place in BC1059 and BC1039 may be called "gathering" while the others may be called "string of pears". Two of them will be discussed.

May 20 BC1059 was a new moon day, when the 5 planets gathered in a string of 14 degrees. This can be described as "the Sun and the Moon combined like jade, and the five planets

were like a string of pears". This occurred, however, on the day Bingchen (53) rather than on Jiazi (1). After sunset on May 28, BC1059 the five planets gathered in a string of 6 degrees in the western sky. The event was very rare and splendid astronomically. Another event *Songshu* can be explained as starting "from the early spring and lasting for 60 days". But it was in Jing rather than in Fang.

Table 3 Conjunctions of the 5 planets, BC1110—1018

Date	Range(deg.)	Constellation	Situation
BC1097.1.5—1.9	46	Yi, Zhen, Jiao	west, dusk
BC1059.4.25—6.10	6	Jing	west, dusk
BC1039.3.1—4.2	17	Shi	east, dawn
BC1037.5.15—5.19	47	Wei, Bi, Mao	east, dawn
BC1019.8.21—9.24	26	Di, Fang, Xin	west, dusk

At the end of July 1019BC, Jupiter and Saturn were in Fang (the head of Scorpius). They transited in dusk and it was also quite splendid. Mars and Venus were in the western sky. In August and September, Fang moved to the west; Mars and Venus quickly ran to Jupiter and Saturn while the latter two slowly moved to Xin (the heart of Scorpius). On 17th of September, the four planets gathered in 5 degrees in Xin, while Mercury appeared 20 degrees away. This may be called "the five planets gathered in Fang" (since the stars could not be seen at dusk, people still kept the old image).

The early records of conjunction of the five planets are usually suspected because of their astrological meaning. Almost all such records before the 7th century were likely to be incorrect. Events from these records sometimes happened to be true but the time of them was mis-identified by several years[15]. Perhaps the constellations for the events were falsified because Zhou people adored Fang. It appears that it is difficult to obtain chronological results from those records.

4.2 Lunar eclipse on day Bingzi

We have searched all lunar eclipses on days Yihai (12), Bingzi (13) and Dingchou (14) during BC1100—BC1020, and obtained table 4. The most probable one was on March 13 BC1065. Ancient Chinese usually defined a day as starting from dawn[16], so this eclipse should be attributed to the last day, Bingzi (13). According to later Chinese calendars, winter solstice was in the 11th month, and March 13 was just the full moon day of the first month of the year. However, winter solstice is usually considered to be in the 1st month at that time and "1st month" must have been mistaken as the "3rd month". The two Chinese characters are quite similar.

Table 4 Lunar eclipses on the 3 days during BC1110—BC1020 (Beijing time, Xi'an phenomena)

Date (BC)	Sexagenary day	Time	Magnitude	Azimuth/altitude
1091, July.26	12	21:19	0.46	126/11
1086, May 3	14	22:55	1.33	148/36
1065, March 13	14	3:21	1.51	232/51
1060, June.13	12	21:56	0.53	135/18
1044, Jan.20	12	19:59	0.46	75/19
1040, Oct.28	14	13:58	1.33	Invisible
1039, Apr.24	13	17:35	1.16	Invisible

4.3 Comet

Via investigation into the orbital evolution of Halley's comet, Zhang[17] pointed out that King Wu's Conquest could possibly be in BC1057—1056 if the comet seen at that time was Halley's comet. Lu[18], however, disagreed with this possibility. We can often see brilliant comets, while Halley's comet only accounts for an extremely small percentage. How can we suggest that the comet appearing in King Wu's journey was Hallay's comet?

5 Dates of King Wu's conquest

We have analyzed the feature of various astronomical phenomena related. The most direct information is the dairy *Wucheng*, "Jupiter in Chunhuo" and "Sun in Ximu". Now we complete the last column in table 1 by shading circles in J sub-column and S sub-column respectively for "good" identification for "Jupiter in Chunhuo" and "good" identification for "Sun in Ximu". It remains an open circle if the identification is "OK", similar to L (lunar phase). We say "good" if Jupiter was just in Chunhuo, and "OK" if Jupiter was close to Chunhuo by half year's journey. We also say "good" if the first day of the first month was during Nov.11—Dec.11, and "OK" if the same time was during Nov.1—Dec.21. For example, group 11 (BC1047—BC1046) in table 1 is "good"; both groups 1 and 2 are "OK". Group 12 is 60 days later than group 11, so except the item S it is fairly "good".

Table 5 gives three positions of either the Sun and the Moon, "the Moon near Tiansi", "Sun in Ximu" and "Chen near Doubing". We use M to stand for the longitude/latitude of the Moon, D_m for the distance between the Moon and Tiansi, S for the longitude of the Sun, and finally D_s for the distance between Sun/Moon and Doubing. According to Jiang's explanation, the moon was near Tiansi (longitude 200.6) in one morning before the new moon day of the first month, while the Sun was in Ximu (longitude 218—248) at the same time. They were in conjunction near Doubing (longitude 231—238). We thus find that group 11 is the best one in all 3 groupings.

Table 5 Sun and Moon on the days before King Wu's departed

Group	Date(BC)	M	D_m	S	Date(BC)	S	D_s
11	1047.Nov.27	200/-3.2	+1	236	1047.Nov.30	239	1
2	1083.Dec.05	206/-4.9	-5	244	1083.Dec.08	247	9
1	1094.Dec.07	207/+2.6	-6	245	1094.Dec.10	248	10

Astronomical computation indicated that Mercury could be seen in all the three periods, BC1046.Jan.16—Jan.28 (western sky), BC1083.Dec.20 (eastern sky), BC1093.Feb.1—Feb.13 (western sky). They were all roughly in or near constellation Tianyuan (group 11, 2 were better).

Now let us see Jupiter's position on the days Jiazi of the tree candidates listed in table 6. They are quite similar, because they are in the same position in the 12 years Jupiter's cycle, i.e. in Chunhuo. They are all in accordance with the three conditions: Jupiter was in Chunhuo, Jupiter was seen in the eastern sky and transited in the night.

In summary, our astronomical investigations have provided the strongest evidence that group 11 is the most favourable one. If this result is consistent with the newest archaeological discovery which constrains the dates of King Wu's conquest in BC1050—1020, our choice is group 11.

Table 6 Jupiter phenomenon on 3 Jiazi days

Group	Date(BC)	Rise/set time	Transit time/height	Magnitude	Lunar mansion
11	1046.Jan.20	16:53/7:30	0:14/79	-2.5	Xing-2
2	1082.Jan.29	15:11/5:53	22:30/79	-2.5	Liu-1
1	1093.Jan.27	17:34/7:58	0:48/77	-2.5	Zhang-10

Fig.1 shows the southern sky at midnight of day Jiazi (1) at Shang. The splendid Jupiter nearly reached the top of the sky, close to Regulus, an important star in Chinese astrology. The constellations on meridian were just Chunhuo. We could assume that this was the moment, recorded in *Shanglu* historically, when King Wu made his famous address *Mushi* before his military combat. Table 7 provides the chronological events in comparison with ancient literatures and astronomical computations. In the column Date and Literature, "m" denotes Chinese month; "d" denotes lunar day, and the sexagenary day numbers are in the parentheses.

Table 7 The chronology process of King Wu's war

Date (Julian/Chinese)	Literature	Computation
BC1047		
11.27/12m28d(7)	Moon near Tiansi	Moon in southeast sky near Tiansi
11.30/1m1d(10)	"Chen" near Doubing	Lunisolar conjunction, near Doubing
12.14/15d(24)		Full moon
12.19/20d(29)	1mRenchen(29)PangSiba	5 days after full moon
12.20/21d(30)	next day was Guisi(30), King Wu departed	
12.30/2m1d(40)		winter solstice
BC1046		
1.13/2m15d(54)		full moon
1.14/16d(55)	crossing Mengjin	
1.16/18d(57)	2m JiSiba	3 days after full moon
1.20/22d(1)	5th day, Jiazi(1), King Zhou was killed. Jupiter at the place	Jupiter transited in midnight, near zenith. Jupiter in Chunhuo
1.28/3m1d(9)		
2.27/4m1d(39)		
3.2/4d(42)	4mYisi(42) JipangShengba	3 days after new moon
3.7/9d(47)	6th day, Gengxu(47), pray at temple 2nd day, Xinhai(48), pray sky	
3.8/10d(48)	5th day, Yimao(52), sacrifice	
3.12/14d(52)		

1) During the period considered, Jupiter appeared in the eastern sky before midnight. It fits "Jupiter to the east" of *Huainanzi*.

2) Mercury could be seen in the western sky after dusk during BC1046.Jan.16—Jan.28, in Tianyuan. It fits "the star in Tianyuan" of *Guoyu*.

3) Jupiter was in the center of Chunhuo. It fits "Jupiter in Chunhuo" of *Guoyu*.

4) The Sun and Mercury stayed in the "North 7 mansions" during the 3 months. It fits *Guoyu*.

5) The Sun stayed in Ximu during BC1047.11.9—12.9. "Moon near Tiansi" and "lunar-solar conjunction near Doubing" took place in this period. It fits *Guoyu*.

6 Discussion

1) Generally speaking, the first month would contain the winter solstice according to the regulations of West Zhou. In table 7, the winter solstice (December 30) was on the first day of the second month. It is acceptable since astronomical observations at that time were very rough.

2) Crossing Mengjin on day Wuwu (55). Different months have been recorded in *Taishi* (1st month) and *Shiji* (12th month). We believe that it was in the 2nd month. The problem is unresolvable so far.

3) *Yizhoushu* has similar records of *Wucheng*. However, the first pair of sexagenary days are different. Historians usually consider *Wucheng* to be correct.

4) The records in *Guoyu* are skeptical. Our analysis has show that once the war occurred in winter or the Sun was in Ximu when King Wu departed, all the others (moon near Tiansi, Chen near Doubing, the star in Tianyuan, Star-Sun-Chen in the north mansions) are basically inevitable. In fact, there are only two pieces of independent information by Lingzhoujiu in *Guoyu*: "Jupiter in Chunhuo" and "the Sun in Ximu".

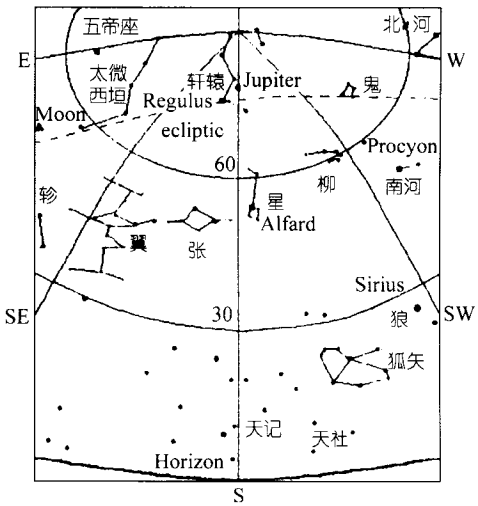

Fig. 1. The southern sky in midnight of BC1046. Jan.20.

5) As stated in *Guoyu*, it was raining when King Wu massed his army before his massive attack. *Huainanzi* mentioned flood. They implied that it was not in winter. This is a contradiction in literatures.

6) The dates and lunar phases in *Wucheng* are our main basis. Because the sexagenary cycle is very close to two months, we have other two groups of candidates such as group 12 in table 1, which has a time difference of 60 days before and after the groups we have chosen. They are usually consistent with "Jupiter in Chunhuo" but far from "Sun in Ximu".

7) We have discussed Jiang's explanation to the Sun, Moon, "Chen" and Star of *Guoyu*, although our conclusion is not dependent on it. Nevertheless, those statements support the calendar convention "winter solstice was in the first month".

8) Although archeologists have constrained the King Wu's Conquest in the period of BC1050—BC1020, we discussed all events in a wider period of BC1100—BC1020, because we want to show the general regulations of those astronomical phenomena.

9) *Bamboo Chronicle* has a quote, "It has been 257 years since King Wu's conquest of King You". This appears to indicate that King Wu's conquest was in BC1027. However, that year is not in accordance with nearly all astronomical records. This turns out to be our biggest difficulty.

10) Pankenier[19] has offered BC1046 as the year of King Wu's conquest. His conclusion was based on the link to Bingzi Lunar eclipse (BC1065) and the conjunction of the five planets (BC1059).

7 Summary

Based on all related results by different research groups in Xia-Shang-Zhou Chronology Project (archeology, philology, paleography, astronomy), we analyzed the astronomical records and obtained the most favourable choice: on the day Jan. 20, BC1046. King Wu defeated King Zhou (table 7). Our choice is mainly based on the dates and lunar phases in *Wucheng*, Jupiter's position in *Guoyu* and the implication of season (winter) in various literatures.

Our conclusion fits most literatures, and it is consistent with conclusions derived from other groups of the Project. Our result has been adopted by the Project as its formal key conclusion[20].

The ancient information we relied on is too concise, vague, incomplete and sometimes contradictory to each other. Conclusions must then be subject to interpretations, selection criteria and deduction method. We have indicated our difficulties in sec.6 and expect to seek new evidence and carry on further investigations.

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