Analysis of Ancient Astronomical Phenomena in Samguksagi

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Abstract

There are a lot of records on astronomical phenomena in ancient Korean Historical Books. The most oldest record as official documentation is Samguksagi which was written Kim Bu-sik in 1174. It is historical records of three kingdom period between 57 BC and 992 AD. The records contain many astronomical phenomena and natural disasters as well as historical events.

We selected astronomical phenomena among the records, which are solar eclipses, comets, meteorites, movements of planets, solar observations, nova, and atmospheric appearances. All of the records are 240 which number of eclipses is 69, comets 49, meteorites 47, planets 41, sun 6, stars 6, atmosphere 18, and others 4. Especially most of records are identified as real phenomena by computer calculation.

We analyzed the records concerning on classification by type of astronomical events, observing frequency for duration, comparison with Chinese, and relation with political situation. We found that most of the records are correlated with many kinds of domestic affairs and accidents. The types of events are related with king, war, revolt, natural disaster, and domestic affair.

We concluded that most of phenomena are closely related with many events in ancient society. Therefore most of records in the ancient historical book are real and correct writing.

I. Introduction

Samguksagi(三國史記) was written by Kim Bu-sik in 1174 during Goryeo Dynasty (918-1392 AD). The Book were compiled from the many kinds of ancient historical records those were descendent before the time in Korea (Kim 1174). It is mainly historical records during Three Kingdom Period (57 BC - 935 AD). Three Kingdoms are consist of Shilla were founded in 57 BC to 918 AD), Goguryeo from 37 BC to 668 AD), and Baekje from 18 BC to 660 AD.

The book contains 50 volumes and was separated into four parts. First part as main history is consists of 28 volumes, the second is rituals and topography of 9, third is the table of chronicle of 3, and the fourth is the series of biographies of 10. Especially it contains 240 astronomical phenomena among the historical events and accidents.

For our research, we selected the records in the volumes in details and analyses the astronomical phenomena. Most of records were calculated the records using computer programming which are real or imaginary. Among the records, eclipses, planets' motion, meteorite showers and the Moon's positions are possible to verify the real facts or not.

II. Classification of Astronomical Phenomena

1. Classification of astronomical phenomena

As a first procedure, we selected the astronomical phenomena which are related on the Solar or Lunar eclipses, Comets, Meteorites,

planets, and stars among a lot of historical records. Following table is a example for selection of records, which are appeared in the main history of Shilla, volume 1.

Table 1. Selection and classification of astronomical phenomena in Samguksagi, volume 1-st.

Class	Year	King's reign and contents
SE	-53	赫居世四年 四月辛丑朔 日有食之
CO	-48	赫居世九年 春三月 有星孛于王良
CO	-43	赫居世十四年 夏四月 有星孛于參
SE	-33	赫居世二十四年 夏六月壬申晦 日有食之
SE	-27	赫居世三十年 夏四月己亥晦 日有食之
SE	-25	赫居世三十二年 秋八月乙卯晦 日有食之
SE	-14	赫居世四十三年 春二月乙酉晦 日有食之
CO	- 3	赫居世五十四年 春二月乙酉 星孛于河鼓
SE	- 1	赫居世五十六年 春五月申丑朔 日有食之
SE	2	赫居世五十九年 秋九月戊申晦 日有食之
SE	6	南海 三年 冬十月丙辰朔 日有食之
ME	14	南海 十一年 樂浪謂內虛 來攻金城甚急 夜有流星 墜於賊營
SE	16	南海 十三年 秋七月戊子晦 日有食之
PL	23	南海 二十年 秋 太白入太微
CO	54	儒理 三十一年 春二月 星孛于紫宮
CO	59	脫解 三年 六月 有星孛于天船
CO	79	脫解 二十三年 春二月 慧星見東方 又見北方 二十日乃滅

Symbol of class are following
SE: Solar eclipse, CO: Comet, ME: Meteorite, PL: Planet, ST: Star

We searched and read the contents and sentences carefully one by one. We selected subjects those are connected with astronomical phenomena among the records in Samguksagi. We classified them into the eight kinds of classes concerning on the astronomical events

and decided frequencies of the event.

Table 2. Number of observations in each type

Phenomena	No. of obs.
Eclipses	69
Comets	49
Meteorites and showers	47
Planets' movements	41
Sun's activities	5
Stars	6
Atmospheric phenomena	18
The others	4
Total	240

Table 2 shows the kinds of astronomical phenomena and number of observed records in the Samguksagi. The type of phenomena are following in the order of frequency which are eclipses, comets, meteorites, planet's motions and so on. The order of frequency means the important appearance of the phenomena. As we know, the solar eclipses among the records are the most important event in the sky.

2. Counting the number of observations

We classified in each type that were recorded in each kingdoms. Fig. 1 shows the recorded number of phenomena in each kingdoms. The total number of observations in each kingdom are following. The kingdom of Shilla is 146 observations as 60.8%, Goguryeo 34 observations as 14.2%, and Baekje 60 observations as 25.0%. Shilla

made the most of observations had been recorded for 992 years, Goguryeo for 705 years, and Baekje for 678 years. Most of historical records had been kept by Unified Shilla, and some of them were lost or destructed. The records on eclipses, comets, and meteorites are dominant phenomena as portion of 69%.

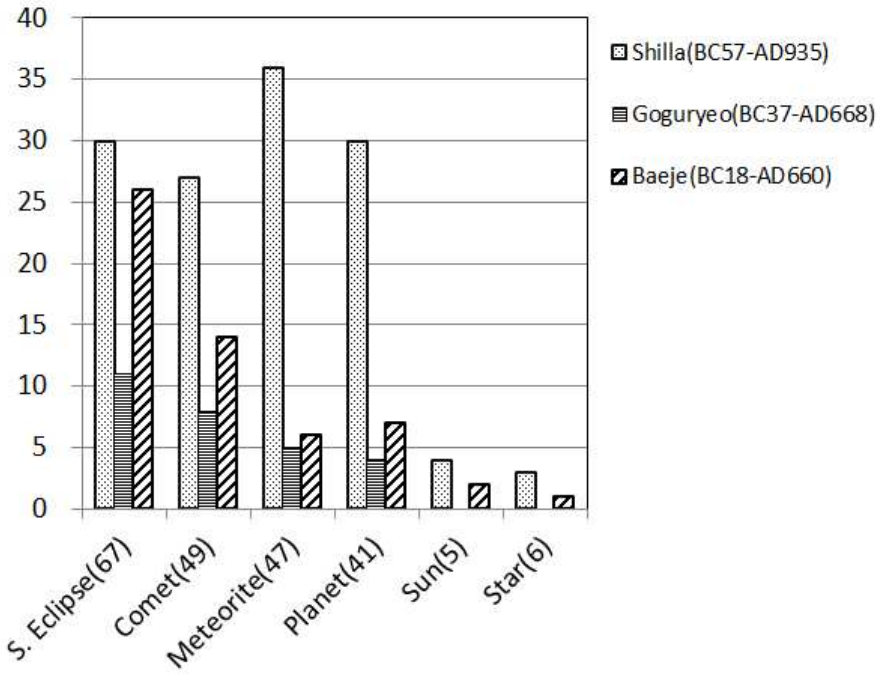

Fig. 1. Astronomical records number of each kingdoms in Samguksagi.

Fig. 1 shows the number of observed records in each astronomical phenomena and in each kingdoms. The records of Shilla are more dominant than the other kingdoms. It would be caused by long duration for observations and the records were compiled by Shilla.

3. Characteristics of each types

The type of the phenomena can be classified which shows in Table 3. Eclipses separated into solar and lunar. Meteorites are divided into

shooting stars, meteor showers, and normal meteorite. In the case of planets' motion, it is classified five characteristics. First case is that the Moon is close to stars or occults stars in the sky. Second case is that the Moon is close to planets or occults them in the sky. Third case is that the planets are close to stars or special constellations.

Table 3. Types of phenomena and its classification

Type	Classification
Eclipses	o Solar eclipses o Lunar eclipses
Comets	o Comets
Meteorites	o Shooting stars o Meteo showers o Meteorites
Planet's movement	o Moon's approach to stars o Moon's approach to planets o Planets' approach to stars o Planets' approach to each other o Venus can be seen in day time
Sun's activities	o White rainbow by the Sun o Solar glow o Sun’s ears by solar activity
Stars	o Supernova o Appearance of Canopus
The others	o White or red glow in the air o Unique atmospheric phenomena

Fourth is that the planets are close to each others or occulted by each other. Fifth is that Venus was seen in day time, which is

unique phenomena. It is believed that the most of phenomena are related to the omen on domestic affair or nature's disasters.

The others are related to solar activity which are white rainbow by the Sun, solar glow, and appearance of the Sun's ears by solar activities. Most of them have close relation to solar activities like as sunspot, flare and prominence. As a rare phenomena, supernova and Canopus were observed. The Canopus almost can be observed at capital of Goryeo Dynasty. Only it is possible to observe at the southern seaside area in Korea, because of its low declination.

III. Analysis of the phenomena

1. Comparison with Chinese records

All of the observed records in Samguksagi were compared with Chinese using the List of Ancient Astronomical Records (江蘇科學技術出版社 1988). We compared all of records in Samguksagi with ancient Chinese. Among the records, most of eclipses are almost coincident with Chinese, that the ratio is almost 94%. It means that most of eclipse data in Samguksagi are compared with Chinese when it was compiled.

However, coincident rate with Chinese of another type records are below 40% that is relatively low rate. The result means that most of records in Samguksagi would be independent observed records during the period of three kingdom. It is not referred or copied data from Chinese records.

Table 4. Comparison with Chinese records

Type	Obs. No, in Samguksagi	Compared with Chinese Records	Ratio (%)
Eclipses	69	63	94.0
Comets	49	24	36.7
Meteorites	47	3	12.5
Planets	41	0	0.0
Sun	5	0	0.0
Stars	6	2	40.0
Atmosphere	18	0	0.0
Others	4		

Especially the records on the planets' movement and Sun's activities are almost found in the Chinese. Such facts show clearly evidence that records in Samguksagi are independent records.

2. Characteristics of observations

Most dominant records are on the solar eclipses, which is connected with king's misfortune in domestic affairs. When the solar eclipses appear in the sky, special ritual performs nationwide to avoid from the unexpected calamity. The ceremony was leaded by king.

It is believed that appearance of comet shows a omen for war, invasion, or rebellion in domestic or from foreign. It is a kind of subjects on fear. Meteorites mean death of king, high official, general, or defeat in war.

Position and movement of planets in constellation happen various accidents and expect misfortune in the country. Records on eclipses,

comets, and meteorites have main portion for all astronomical observations. Therefore those phenomena have important meaning during ancient times.

3. Verification of records as real events

Following the three of kinds of phenomena can be confirmed or verified by computer logics

① Solar and lunar eclipses
② Shooting showers
③ Planets' movement

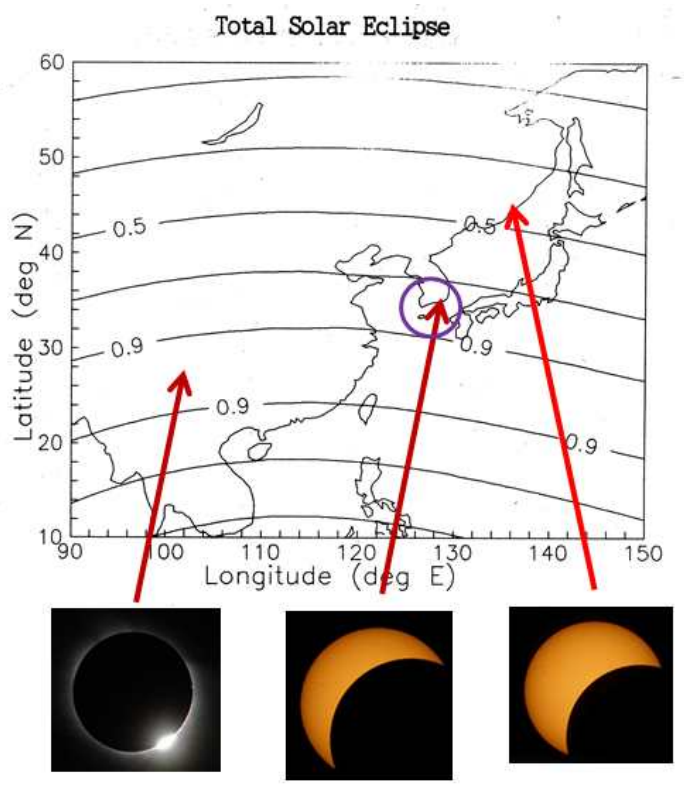

Fig. 2. First record of solar eclipse 54 BC in Samguksagi

Records of shooting showers and meteo showers in Samguksagi

have been already studied by several researchers Yang et. al. 2004, Parkenier, et. al. 2000). Already we conformed the solar eclipses during the period of three kingdom by computer calculation, which are real records or not (Lee, et al. 2005).

The book shows the table for solar eclipses, solar eclipse map, catalogue of solar eclipse during three kingdom period from BC57 till AD935. Now we research reality on another phenomena using the computer calculations which are real events, or not.

Most of solar eclipses were recorded almost as real events. We have proved 53 among 67 records as real eclipses by computer code. The first solar eclipse records in Samguksagi was appeared on the 9th of May in 54 BC in solar Julian calendar as in Fig, 2. The solar eclipse was proceed for 6 minutes and the magnitude was 0.74 by the calculation.

The records on the Venus were already verified by computer programming, which Venus was seen in daytime (Park 2002). Among the six records, the four were calculated. The Venus, one of inferior planets is getting brighten from the position of superior conjunction to interior conjunction. The brightness of the Venus vary in Fig. 3. On the peak brightness of the Venus can be seen even in day time. Calculated records of the Venus in Samguksagi are following which are not appeared in Chinese.

① Main History of Baekje, Winter October in King Gusu 11-year (AD 224), the Venus appeared in the sky during day time.
(百濟本紀 仇首王十一年 冬十月 太白晝見)

② Main History of Baekje, Autumn July in King Ashin 3-year (AD 555), the Venus appeared in the sky during day time.

(百濟本紀 阿莘王三年 秋七月 太白晝見)

③ Main History of Goguryeo, November in King Yangwon 10-year (AD 394), the Venus appeared in the sky during day time.

(高句麗本紀　陽原王十年 十一月 太白晝見)

④ Main History of Shilla, November in King Deokheung 2-year (AD 827), the Venus appeared in the sky during day time

(新羅本紀 興德王二年 秋八月 太白晝見)

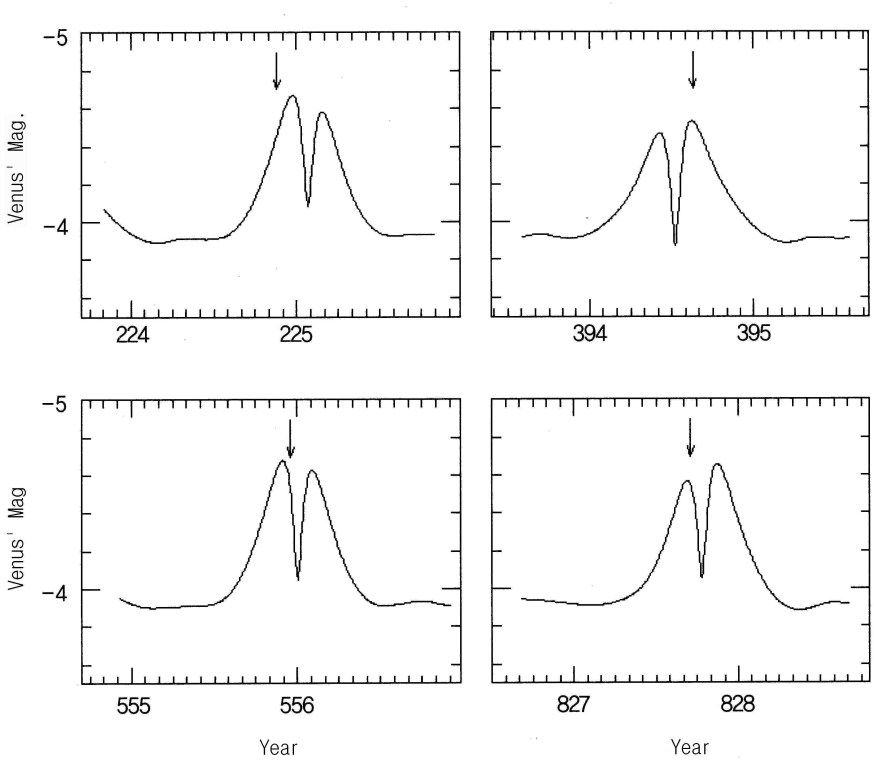

Fig. 3. The brightness variation of the Venus in AD 224, AD 394, AD 555, and AD 827 (Park 2002).

Fig. 3 shows the results calculated by computer code. The sign of arrow means the time of observed records in Samguksagi. It is nearly coincident with peak brightness. The results are evidence that the records are real observational records. However, the four records can't be found in Chinese. It means that the records are

independent, not connected with Chinese.

4. Distribution of astronomical records

We arranged the number of records in Samguksagi with the 50-year intervals. The frequency of the records within interval don't show uniform distribution. There are two peaks of frequency apparently on the late 2nd and 7th century in Table 4. The first peak was appeared in the period for unstable situation among three kingdoms and the second is unifying period by Shilla.

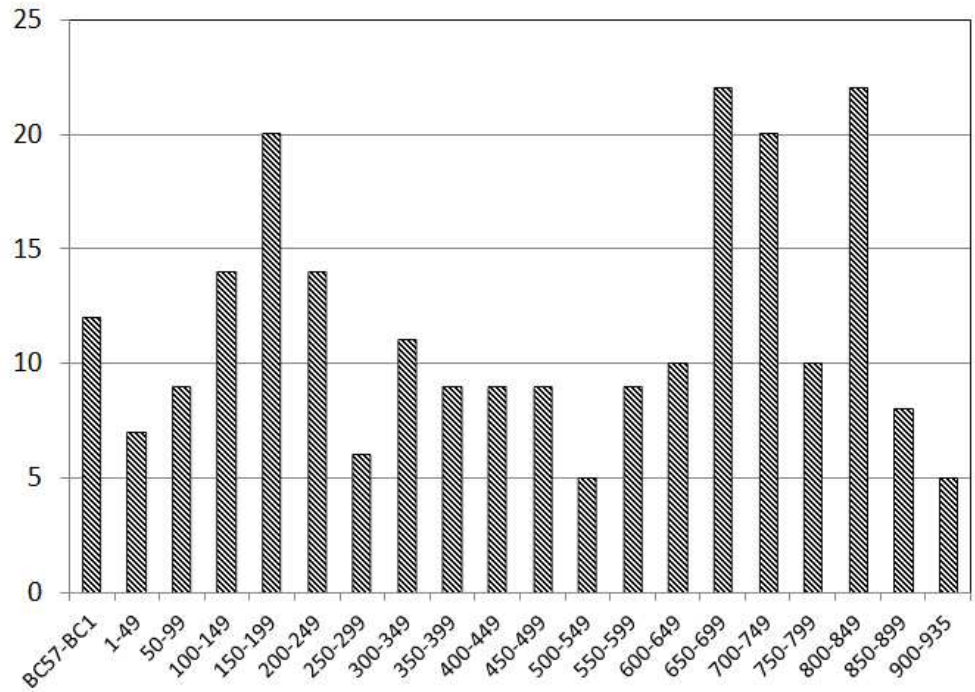

Fig. 4. The distribution of observed astronomical records in the interval of 50 years.

Mean value of frequency in records is nearly 12 observations with interval of 50 years. Exceptionally 12 observations were recorded in BC which are 10 solar eclipses, 3 comets, one white glow and one

star occultation by planet. The records of 12 are consist of 9 in Shilla, 2 in Goguryeo, and 1 in Baekje history. Most of records in BC are almost accorded with Chinese, except one event. The characteristic of the records could be seen in the area of Three Kingdoms and Chinese.

III. Conclusions

Most of astronomical records would be almost real existences which are identified by computer calculations, like as solar eclipses, shooting showers, and planetary movements. Most of the records in Samguksagi are not coincident with Chinese. Therefore the ancient astronomical observations show almost independent records compared with Chinese.

A lot of astronomical records were recorded from the early three kingdom period. However, many records were disappeared or excluded on the compilation of the historical books. Early records like as solar eclipses or comets before BC would be used for decision of chronicles in early three kingdom period. Such phenomena were simultaneously appeared in three kingdoms as well as China.

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