

Select bibliography

- Chen Meidong 陈美东 (2001). *Zhongguo kexue jishu shi tianwenjuan* 中国科学技术史天文卷 [History of Science and Technology in China, Astronomy Volume]. Beijing: Science Press.
- Cullen, Christopher (1996). *Astronomy and Mathematics in Ancient China: the Zhou bi suan jing*. Cambridge: Cambridge University Press.
- Feng Shi 冯时 (2007). *Zhongguo kaogu tianwenxue* 中国考古天文学 [Chinese Archaeoastronomy]. Beijing: Social Science Press.
- Jeon Sang-woon (1998). *A History of Science in Korea*. Seoul: Jimoondang.
- Needham, Joseph (1959). *Science and Civilisation in China*, Volume III: Mathematics and the Sciences of the Heavens and Earth. Cambridge: Cambridge University Press.
- Needham, Joseph (1971). *Science and Civilisation in China*, Volume IV: Physics and Physical Technology, Part 3: Civil Engineering and Nautics. Cambridge: Cambridge University Press.
- Nha Il-Seong (2001). “Silla’s Cheomseongdae”, *Korea Journal* 41(4), 269–281.
- Park Seong-Rae (2000). “History of astronomy in Korea”, in *Astronomy across Cultures*, edited by Helaine Selin, 409–421. Dordrecht: Kluwer.
- Renshaw, Steven and Saori Ihara (1999). “Archaeoastronomy and astronomy in culture in Japan: paving the way to interdisciplinary study”, *Archaeoastronomy* 14(1), 59–88.
- Renshaw, Steven and Saori Ihara (2000). “A cultural history of astronomy in Japan”, in *Astronomy across Cultures*, edited by Helaine Selin, 385–407. Dordrecht: Kluwer.
- Sivin, Nathan (2009). *Granting the Seasons: the Chinese Astronomical Reform of 1280, with a Study of its Many Dimensions and a Translation of its Records: Shou shih li cong kao*. New York: Springer.
- Sun Xiaochun and Jacob Kistemaker (1997). *The Chinese Sky during the Han: Constellating Stars and Society*. New York: E.J. Brill.
- Xu Zhentao, David Pankenier, and Jiang Yaotiao (2000). *East Asian Archaeoastronomy: Historical Records of Astronomical Observations of China, Japan and Korea*. Amsterdam: Gordon and Breach.

Case Study 5.1: Taosi Observatory, China

Xu Fengxian and He Nu

Presentation and analysis of the site

Geographical position: Xiangfen County, Shanxi province, China

Location: Latitude 35° 52′ 55.9″ N, longitude 111° 29′ 54.9″ E. Elevation 573m above mean sea level.

General description: Taosi ancient observatory forms part of the Taosi archaeological site, one of the most famous of the eighty or so Longshan Culture (c. 3000–2000 BC) sites in north

China. At the Taosi site, a small walled-town of the Early Taosi Period (23rd and 22nd centuries BC) was superseded by two walled-towns of the Middle Period (21st century BC), the larger of which occupied 2.8km² and is the largest known walled-town in prehistoric China. The observatory is located within the lesser Middle Period walled-town, close to the inner south-eastern wall of the larger one.

Inventory of the remains: A semi-circular platform about 1,000m² in area, measuring 40m across from east to west and about 29m from north to south, appears to have consisted of three concentric terraces. The innermost, with a radius of about 21m, has a rammed-earth retaining wall 22.5m long, 1.1m wide and 2.7m high, which contains a series of eleven rammed-earth pillars arranged along the arc. These were formed by cutting ten U- or V-shaped slots into the top of the wall foundation, which survive to a depth of about 4–17 cm and are filled with soft earth. Most are 15–20 cm in width, the southernmost two being slightly wider. A rammed-earth block on the second terrace has been slotted in a similar manner, to form two further pillars.

Slightly to the west of the geometrical centre of the platform archaeologists have found a round foundation-pit and three concentric rammed-earth circles. As viewed from this point, the series of 11 pillars with 10 slots on the third terrace and the 2 pillars with 1 slot on the second terrace appeared to form a single line of 13 pillars and 12 slots (the gap between the south pillar on the second terrace and the north pillar on the third terrace forming the additional slot) against the skyline formed by Taer Hill, or Chong Hill, a prominent chain of peaks (up to 1493m in elevation) about 7 to 10km to the east.

Calculations and experimental observations indicate that 4000 years ago the sun would have risen in the northernmost slot at the June solstice, and in the slot next to the southernmost at the December solstice. Slot no. 7 (counting from south to north) could possibly have been used to determine the spring and autumn equinoxes: nowadays the sun can be seen as rising in this slot on March 18 and September 25. The southernmost slot could not have been used to observe sunrise, although it did indicate the position of southernmost ('major standstill') moonrise.

The fact that a clear archaeological structure has been discovered at the point where the centre-lines of the 12 slots converge implies that the twelve slots and the observation point must have been designed carefully and formed an integrated observation system.

History of the site: The observatory was constructed and used during the Middle Taosi Period (21st century BC) and was deliberately demolished during the Late Taosi Period (20th century BC).

Cultural and symbolic dimension: According to Chinese classical literature, the tradition of 'observing the phenomena to bestow the seasons' goes back to ancient times. The earliest historically recorded method for determining the seasons is by measuring the lengths of the sun's shadow at noon. Little was recorded about the method of observing the direction of sunrise in order to determine the seasons, but the Taosi observatory implies that a tradition of making such observations had already been established for a very long time.

The Taosi site is believed to be the capital of King Yao, who ruled before the time of the Xia Dynasty, the first Dynasty in Chinese history. About a third of the *Yao Dian [Canon of Yao]*, a classical Chinese text said to be King Yao's document, is devoted to describing the Great King's policy and achievements in astronomy. In particular, he commanded astronomical officials to "make a calendar to delineate the regularities of the sun, moon, stars, and constellations, and to bestow respectfully to the people the seasons for observance" and accordingly he sent four of them to observe the culminating stars at the two equinoxes and the two solstices. The Taosi observatory could have been used to identify these four special days, thus demonstrating that the ancient Chinese carried out astronomical observations carefully as long as 4100 years ago.

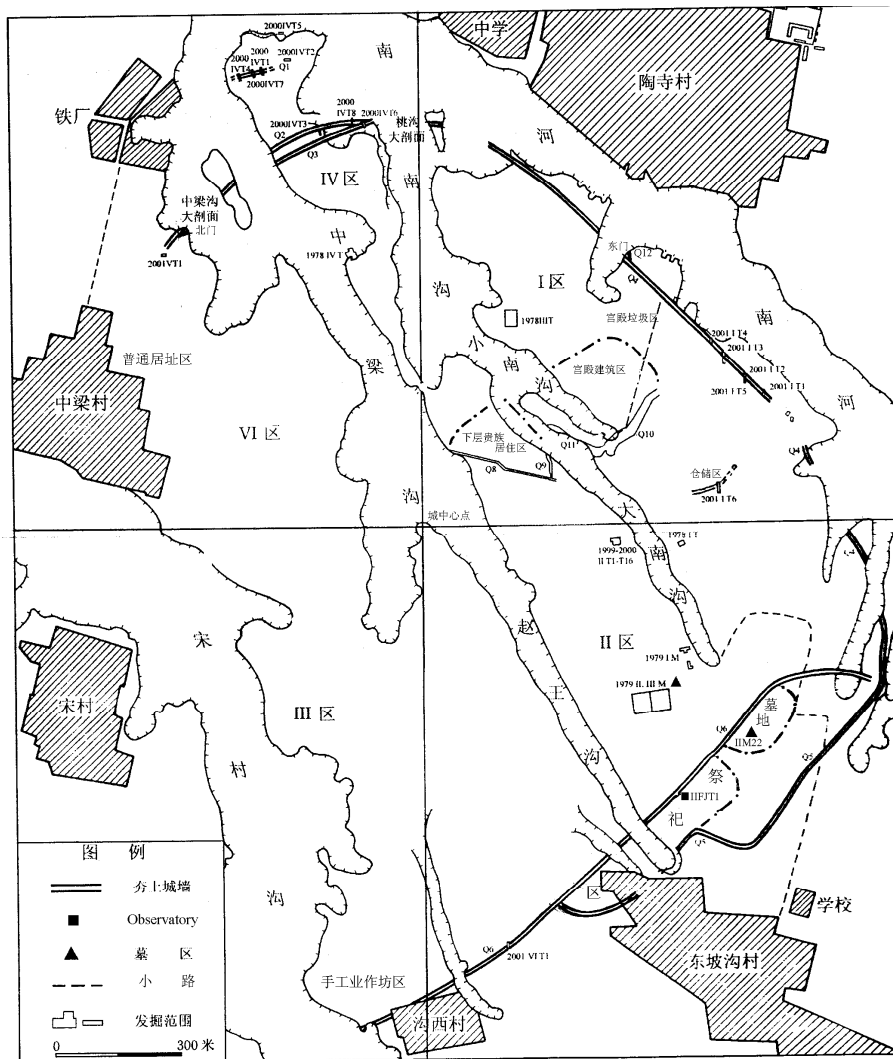


Fig. 5.1.1. Location of Taosi Observatory (identified as feature IIFJT1) within the Taosi site. After He Nu and Shanxi Xiangfen (2009), “Taosi chengzhi zhongqi wang ji da mu IIM22 chutu qigan guichi gongneng shitan [On the gnomon shadow template function of the lacquer stick from the royal tomb IIM22 at Taosi walled-town of Middle Period]”, *Ziran kexueshi yanjiu [Studies in the history of natural sciences]*, 28(3), 261–276.

Authenticity and integrity: The foundations of the pillars have been preserved under the ground surface for 4000 years until rediscovered by excavation in 2003–04. At that time, the top of the rammed-earth was about 1m under the ground surface.

Documentation and archives: Historical records and local traditions demonstrate that the Taosi area was the hinterland of the territory of the King Yao and the Xia dynasty. Given this, the astronomical rituals documented in such ancient books as *The Canon of Yao* and the *Small Calendar of the Xia* may well have been performed at this site.

Present site management

Present use: The Taosi observatory site is used by several local villagers as a wheat field. Archaeologists and historians of astronomy have reconstructed a temporary building on the site with brick structures imitating the ancient pillars and slots. The aim is to simulate observations and further research.



Fig. 5.1.2. Top: Aerial view of the observatory. North is to the right. **Bottom left:** Foundations of the pillars and slots. **Bottom right:** The observation point. Photographs © He Nu.

Protection: After the excavation and surveys were completed, the observatory site was buried some 2–3 m beneath the ground surface.

State of conservation: See above.

Context and environment: The Taosi site is situated on the south-eastern part of the Yellow Earth Plateau, between five modern villages including Taosi Village, from which it took its name.

Archaeological/historical/heritage research: The Taosi site was first discovered in the 1950s. During the late 1970s and early 1980s, archaeologists excavated nine chiefly tombs with rich grave goods, together with large numbers of common burials and dwelling foundations. Archaeologists first discovered the walled towns of the Early and Middle Periods in 1999.

The remains of the observatory were first discovered in 2003 and totally uncovered in 2004. Archaeoastronomical surveys were undertaken in 2005. This work has been published in a variety of Chinese journals.

Chinese archaeoastronomers and archaeologists are currently conducting further collaborative research at Taosi Observatory, sponsored jointly by the Committee of Natural Science of China and the Academy of Science of China. The project, which is due to finish in 2011, has purchased the right to occupy the main field of the observatory site for two years.

Main threats or potential threats to the sites: The most critical potential threat to the observatory site itself is from the burials of native villagers, which are placed randomly.

The skyline formed by Taer Hill, which is a crucial part of the visual landscape since it contains the sunrise points, is potentially threatened by mining, which could cause the collapse of parts of the top of the hill. The government of Xiangfen County is currently trying to shut down some of the mines, but it is unclear whether a ban on mining could be policed effectively in the longer term.

Management, interpretation and outreach: The county government is trying to purchase the land from the local farmers in order to carry out a conservation project as soon as possible. The buffer zone is handled by the Cultural Relics Bureau of Xiangfen County, but it has no right to control the use of this land. The Legal General Conservation Project of the entire Taosi Site, which includes the Observatory site, has been ready since 2003 but has not yet been implemented. In this project, the entire Taosi Site would be designated an archaeological park, and the observatory would be reconstructed permanently, for both public and scientific use, in a manner that would ensure the conservation of the original remains.

Case Study 5.2: Dengfeng Observatory, China

Xu Fengxian

Presentation and analysis of the site

Geographical position: The observatory lies to the north of Gaocheng Town, 12 km south-east of Dengfeng City, Henan Province, China.

Location: Latitude 34° 23′ 52″N, longitude 113° 8′ 44″E. Elevation 253m above mean sea level.

Heritage context: Dengfeng Observatory forms a part of a property that has been on China's Tentative List since 2008, under the general name 'Historic Monuments of Mount Song'. This includes the ancient architectural complex at Mount Song and the site of the Xia-dynasty capital. They are situated in and around Mount Songshan in Henan Province in China. The complex consists of the following 13 ancient structures and sites: Taishi, Shaoshi and Qimu Towers; the pagodas of Songyue and the pagoda of Master Jingzang; the Observatory itself; the Chuzu Temple; the pagoda forest of Shaolin Monastery; the Huishan Temple and the Songyang Academy; the Zhongyue Temple; the Shaolin Monastery; and the site of the Xia-