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THEMATIC DOSSIER
EMPIRE UNDER THE NIGHT SKY: RECORDING ASTRAL-COSMOGRAPHY IN QING DYNASTY CHINA, 17TH – 19TH CENTURIES

From *Fenye* to Latitude and Longitude: The Adjustment and Renewal of the Positioning System in Chinese Local Gazetteers during Qing Dynasty

Jiajing Zhang

University of Chinese Academy of Sciences, Beijing, China

zjj@ucas.ac.cn

Abstract: Influenced by a cosmological view of the interconnectedness between heaven and humankind, ancient Chinese astrologers developed the *fenye* (分野, "field allocation") system. This theory envisioned correspondence between heaven and earth and was a prevalent regional positioning system in ancient China. However, during the Qianlong era (1736-1796), *fenye* theory faced skepticism and rejection from official quarters, leading to a significant crisis for this traditional positioning system. With the eastward spread of Western learning, modern European astronomical and geographical knowledge were introduced into China, and Chinese intellectuals began to favor the Western system of latitude and longitude for geographical positioning. In the late Qing period, the gradual popularization of the spherical Earth concept and the latitude and longitude system laid the theoretical foundation for establishing of this system. The public dissemination of latitude and longitude data measured by the imperial astronomical and calendrical institutions, along with mathematicians' calculations based on historical data and the supplementary measurements conducted by local governments, provided data support for the system's establishment. By the end of the Qing dynasty, as the knowledge structures and worldviews of Chinese intellectuals transformed, the traditional celestial-terrestrial correspondence in Chinese local gazetteers was phased out, giving way to the latitude and longitude system.

Keywords: *Fenye* (分野); *Guidu* (晷度); longitude and latitude; Chinese local gazetteers; positioning system

In ancient China, people believed that heaven and earth were interconnected and corresponded to each other. They held that unusual phenomena observed in the heavens in the natural world were related to people in the human world. During the Warring States period (475-221 BCE), early astrologers correlated the celestial region of the sky with the countries and states on earth and deemed the celestial phenomenon that occurred in a certain district foretells the good or bad fortune in the corresponding geographical area. This theory was known as *fenye* (分野, "field allocation").

Since the Song Dynasty (960-1279 CE), traditional Chinese astrology began to decline, and the idea of interpreting the successes or failures of human politics through major unusual phenomena became less popular. The influence of *fenye* on the political sphere also begun to wane. However, *fenye* started to integrate closely with geography. At this time, knowledge of *fenye* entered geographical records, becoming an indispensable geographical attribute when describing a certain region. Because the theory of *fenye* provided a correspondence between the celestial region and the earth region, people gradually developed the idea of relying on *fenye* to identify geographical locations. For example, in the twenty-fifth year of the Jiajing (嘉靖) reign of the Ming Dynasty (1546), Jiang Tingzao (江廷藻) wrote in the preface to the *Juye xianzhi* (钜野縣志, *Gazetteer of Juye County*), "*fenye* in the gazetteer is used to identify the direction and position" (志分野以辨方位).[1]

Since the Song dynasty, Chinese intellectual elites have gradually recognized fallacies in *fenye* theory. For instance, both the regions of *Weiguo* (魏國) and *Yizhou* (益州) were correlated with the same celestial division named *Shishen* (實沈) (includes Turtle Beak Mansion 觜宿 and Three Stars Mansion 參宿), yet their actual geographical locations are vastly separate. Within the theory of *fenye*, only the celestial mansions and divisions corresponding to Chinese territories were considered, excluding areas beyond China. The ceaseless motion of celestial mansions contrasted with the stationary Earth; thus, aligning fixed terrestrial regions with the dynamic celestial mansions was deemed illogical. Additionally, terrestrial administrative boundaries are in constant flux, whereas the corresponding celestial sections remain unchanged, making the supposed celestial-terrestrial correspondences inaccurate.

Since the end of the Ming dynasty, the influx of Western astronomical knowledge into China has intensified doubts about *fenye* theory. For example, the comprehensive celestial charts brought by missionaries introduced numerous celestial bodies visible only from the Southern Hemisphere, which were not accounted for in the traditional *fenye* system, pointing to its incompleteness. According to Western theories of celestial motion, the sun, moon, the five

[1] Huang Weihan 黃維翰, ed., 中國地方志集成 山東府縣志輯83 (道光) 鉅野縣志 [Collection of Chinese Local Gazetteers: Shandong Prefecture and County Gazetteers 83 (Daoguang) Gazetteer of Juye County] (Nanjing: Fenghuang chubanshe, 2004), 4.

major planets, and the twenty-eight mansions rotate from west to east daily, negating any fixed correlation between a celestial mansion and a terrestrial region, thereby undermining the credibility of the *fenye* theory.

Scholars who have published *fenye* theory's research believed that Chinese intellectual elites' introspection regarding the defects and errors of the *fenye* theory, along with the corroborative evidence from Western astronomical knowledge, led to an increasing volume of skepticism and critique among Qing dynasty scholars toward the *fenye* theory. Despite attempts by intellectuals to adjust or refine the theory, it inevitably succumbed to obsolescence by the late nineteenth century.[2] The author of this essay argues that the reasons for the ultimate disappearance of the *fenye* theory, in addition to those already mentioned by predecessors, should also encompass the widespread adoption of the geographic coordinate system—the concept of latitude and longitude—and its application in cartography.

Chinese local gazetteers are geographical works compiled by regional scholars or officials, either officially or semi-officially. They comprise a variety of content about a particular region, including its natural environment, history, and culture, serving as encyclopedic references and guidebooks for those seeking a comprehensive understanding of a specific area. The theory of *fenye* provides the corresponding celestial position for a given locality, and this is a common section found in local gazetteers from Song to Qing dynasties (see figure 1).[3]

Utilizing the LoGaRT (LG)[4] software developed by the Max Planck Institute for the History of Science in Germany and reviewing additional literature, my analysis of Chinese local gazetteers revealed several findings: during the Qianlong (乾隆) period (1736-1795), *fenye* chapters began to be omitted from a few local gazetteers, replaced by a new section named *guidu* (晷度). This new section included latitude and longitude values for a given location, expressed in terms of the *Beiji gaodu* (北極高度, "celestial north pole height") and *Dongxi piandu* (東西偏度, "east-west deviation from the capital"). During the Daoguang (道光) period (1821-

[2] Qiu Jingjia 邱靖嘉, "An Examination Based on the Transmutation of Traditional Political Culture and the Eastern Advance of Western Learning 天文分野說之終結——基於傳統政治文化嬗變及西學東漸思潮的思考," *Historical Research* 曆史研究, no. 6 (2016): 34-51,189-90. Tian Tian 田天, "Follow and Change: The Writing of *Fenye* in Chorography of Shandong Province 因襲與調整: 晚清方志中的分野敘述——以山東方志為例," *Journal of Chinese Historical Geography* 中國歷史地理論叢 25, no. 2 (2010): 84-92,103. Lv Shu'e吕书额, "A Brief Analysis of the Inheritance and Innovation of 'Star Fields' in Three Qing Dynasty General Records of the Capital Area 淺析清3部《畿輔通志》"星野"的因襲與創新," *China Local Chronicles*中國地方志, no. 4 (2020): 59-67.

[3] Zhou Zhi 周植 and Zheng Jianlong 鄭見龍, eds., (*Qianlong) Rugao xianzhi* (乾隆) 如皋縣志 [Qianlong Gazetteer of Rugao County] (1750), juan 1: 5-6. Harvard Library. https://curiosity.lib.harvard.edu/chinese-rare-books/catalog/49-990074686500203941.

[4] Chen, Shih-Pei, Calvin Yeh, Qun Che, and Sean Wang. 2017. *LoGaRT: Local Gazetteers Research Tools* (software). Berlin: Max Planck Institute for the History of Science. https://www.mpiwg-berlin.mpg.de/research/projects/logart-local-gazetteers-research- tools.

1850), maps annotated with latitude and longitude values began to appear in local gazetteers. During the Guangxu (光緒) period (1875-1908), traditional terms like *Dongxi piandu* (東西偏度) and *Beiji gaodu* (北極高度) were gradually updated to "longitude" and "latitude." Entering the Late Qing Dynasty (1901-1911), theories of a spherical Earth and the latitude-longitude system began to disseminate at the grassroots level in China. The mode of locational referencing in local gazetteers underwent a fundamental shift, and *fenye* theory finally met its demise.

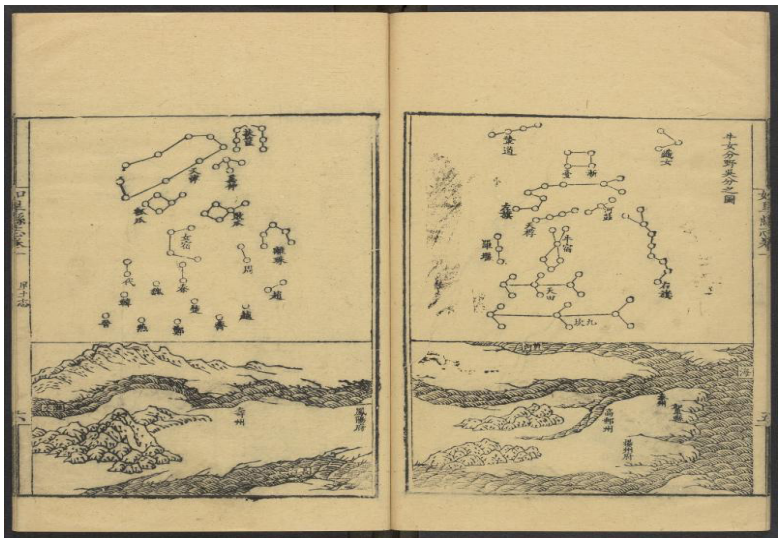

Figure 1. Map of *Wu*'s field allocation. According to the *fenye* theory, the *Wu* region corresponds to two mansions in the sky, the Ox Mansion and the Girl Mansion. From *(Qianlong) Rugao xianzhi* (乾隆)如皋縣志) [(Qianlong) Gazetteer of Rugao County] (1750). Public domain.

In 1755, the Qing court recaptured the Junggar tribe, and in 1759, regained control over the Muslim peoples of the northwest. Against the backdrop of territorial expansion in the Qing Empire, Emperor Qianlong (乾隆帝) began to question the prevailing *fenye* theory. In the thirty-ninth year of his reign (1774), upon reviewing Mao Huang (毛晃)'s *Yugong zhinan* (禹貢指南, *Guide to Yu Gong*), Emperor Qianlong added annotations that critiqued the *fenye* theory and deemed the theory unconvincing and unreliable. Qianlong remarked:

> The twenty-eight mansions in the heavens correspond to the twelve states on earth, but what do regions beyond the twelve states correspond to? The heavens cover all, and the stars, affixed to the heavens, should illuminate every place. Currently, all twelve states reside within China Proper. Hence, are regions outside of China

> proper not included in this realm of brightness? .....Therefore, the theory of *Fenye* is inherently untrustworthy, and the interpretations of omens and prophecies bear a resemblance to *Chenwei* 讖緯 [Confucianist divination texts], are not regarded as the correct principles.
>
> 以二十八宿主十二州，分配無餘，此外更當何屬？夫天無不覆，星麗乎天，亦當無不照。今十二州皆中國之地，豈中國之外，不在此昭昭之內乎?..... 蓋分野之說，本不足信，而災祥則更鄰與讖緯，皆非正道。

Emperor Qianlong was the first supreme ruler to critique the doctrine of *fenye*, and his stance significantly influenced the subsequent compilations of official books. Among the six political tomes complied under Qing court supervision, only *Xu wenxian tongkao* (續文獻通考, *Continuation of General Examination of Literature*) retained *fenye*-related content. The other five books excluded such content, reflecting an official shift in attitude toward the doctrine of *fenye*. This change, initiated from the top, influenced how other books approached content on *fenye*.

A new adjustment: the introduction of *guidu* (晷度)

The connection between *fenye* and latitude and longitude is *guidu* (晷度). In the forty-sixth year of the Qianlong reign (1781), the gazetteer *Qinding rehe zhi* (欽定熱河志, *Gazetteer of Rehe*) was published after twenty-five years of compilation. This book, personally reviewed by Emperor Qianlong, was the first to abandon the *fenye* section found in local gazetteers, replacing it with a new section named *guidu*.

The term *gui* (晷) in ancient China had two meanings: one referred to an instrument composed of a dial and a gnomon, which could determine the true solar time of day based on the direction of the shadow trajectory; the other referred to the shadow itself, specifically the shadow of the gnomon used in the sundial. The length of a location's sundial shadow changes with the seasons: it is shortest at the summer solstice and longest at the winter solstice. These variations allow for the accurate determination of the solstices and, by measuring the intervals between successive longest or shortest shadows, the length of the tropical year. In ancient Chinese astronomy, *guidu* generally referred to the recording data of shadow lengths, which could be used to calculate local seasonal timings and day and night durations for specific locales.

The new *guidu* section in the *Qinding rehe zhi* included data such as the *Beiji gaodu* (北極高度 , "celestial north pole height"), the *Dongxi piandu* (東西偏度, "east-west deviation from the capital"), and the length of the noontime shadow on the solstices and equinoxes for various prefectures, counties within the *Rehe* (熱河) jurisdiction. Following this, the *Qinding huangyu xiyu tuzhi* (欽定皇輿西域圖志, *Atlas of the Western Regions of the Qing Empire*) completed in 1782, adopted this format, replacing *fenye* with *guidu*. This included data on the *Beiji gaodu*

and *Dongxi piandu* for over 110 locations within the Western Regions,[5] as well as the lengths of day and night, the noontime shadow on solstices and equinoxes, and the shadow lengths on the equinoxes.

In the *guidu* section, *Beiji gaodu* and *Dongxi piandu* were terms not commonly seen in local gazetteers, previously appearing mainly in calendrical texts. Ancient Chinese astronomers realized that each location has unique values for these measurements, which are directly related to the length of the sundial shadow, the duration of day and night, the moments of the solstices and equinoxes, and sunrise and sunset times.

In the eleventh year of the Kaiyuan (開元) era during the Tang Dynasty (723), astronomer Monk Yixing (一行, 683-727) utilized an astronomical instrument he invented to observe the celestial North Pole's horizon height from four locations in the Northern Hemisphere. This value, termed *Beiji chudi du* (北極出地度), represents the angle between the horizon's tangent line and the celestial North Pole (the Earth's axis direction).[6] As a place's celestial north pole height is the same as its latitude, Yixing's observations were considered equivalent to geographical latitude measurements.[7] These findings challenged the longstanding theory, dating back to the *Zhou bi suanjing* (周髀算經, *Arithmetic Classic of Zhou Bi*, approximately compiled during the Western Han Dynasty, 206 BC-9 CE), which proposed that a sun shadow's one *cun* (吋) difference indicated a thousand *li* (里) distance (日影千里差一吋).[8] Later, in the sixteenth year of Zhiyuan (至元) era during the Yuan Dynasty (1279), Guo Shoujing (郭守敬, 1231-1316) determined the North Pole height values for 27 localities through his astronomical observations.[9] Additionally, Yelü Chucai (耶律楚材, 1189-1244), who was born in the Jin (金) Dynasty (1115-1234) and served the Mongol Empire, introduced the *Licha* (里差) concept based on lunar eclipse observations. Starting from Samarkand, Yelü Chucai used the "east-west deviation" to indicate the time difference between Samarkand and other locations, which was a method applied in the *Gengwu Calendar* (庚午元曆).[10]

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[5] Western Regions (Xiyu, 西域) was a historical name specified in Ancient Chinese chronicles that referred to the regions west of the Yumen Pass, most often the Tarim Basin in present-day southern Xinjiang (also known as Altishahr) and Central Asia (specifically the easternmost portion around the Ferghana Valley).

[6] Liu Xu 劉昫, *Jiu tangshu* 舊唐書 [Old History Book of Tang Dynasty] (Beijing: Zhonghua shuju, 1975), 1293-308.

[7] In ancient times, before the establishment of modern concepts like the reference ellipsoid and the geoid, latitude was primarily determined by measuring the angles between the celestial north pole and stars, known as the astronomical latitude (ϕ). Within a certain range of precision, the astronomical latitude of a location is numerically equivalent to its modern geographical latitude.

[8] Arthur Beer, *An 8th-Century Meridian Line: I-Hsing's Chain of Gnomons and the Pre-History of the Metric System* (Oxford: Pergamon Press, 1964), 3-28.

[9] Song Lian 宋濂, *Yuanshi* 元史 [History of Yuan Dynasty] (Beijing: Zhonghua shuju, 1976), 1000-01.

[10] Sun Xiaochun 孫小淳, "Consideration of the Transmission into China of the Concepts of Global Earth and Geographical Longitude Based on the Concept of *Licha* 從"里差"看地球、地理經度概

However, before the end of the Ming Dynasty (1368-1644), these concepts were restricted to astronomical spheres, not equated with latitude and longitude, nor used in map-making. Italian missionary Matteo Ricci's (1552-1610) arrival in China in 1583 changed this narrative. He introduced concepts like the spherical Earth, latitude and longitude, and innovative map-making methods through his *Kunyu wanguo quantu* (坤輿萬國全圖, *Great Universal Geographic Map*).[11] At the same time, in order to facilitate people's understanding of the Western calendar, Xu Guangqi (徐光啟, 1562-1633) connected the concepts of *Beiji gaodu* and *Licha*, which had appeared in ancient China, with the concepts of latitude and longitude, by equating *Beiji gaodu* with geographical latitude and *Licha* with geographical longitude.[12]

In *Qinding rehe zhi*, the compilers praised the concepts of *Beiji gaodu* and *Dongxi piandu* for their precision and clarity. In *Qinding huangyu xiyu tuzhi*, the compilers elaborated on these concepts, using them to establish orientation and location. These two terms were explained as follows:

> Humans reside on the Earth's surface, and their positions vary in the north-south direction, resulting in different values of the celestial North Pole's height and variations in the length of day and night. This variation is known as the north-south positional difference. Similarly, human positions vary in the east-west direction, leading to differences in sunrise times. For every degree of eastern deviation, sunrise occurs four minutes later, while for every degree of western deviation, it occurs four minutes earlier. This variation is referred to as the east-west positional difference.
>
> 人居地面有南北, 則北極出地有高低, 而晝夜之長短, 因以不同, 是為南北里差. 人居地面有東西, 則見時刻有早晚, 偏東一度, 見時應遲四分, 偏西一度, 見時應早四分, 是為東西里差。

Coexistence of *fenye* and *guidu* content

Before the g*uidu* section was included in *Qinding rehe zhi*, concepts like *Beiji gaodu* and *Dongxi piandu* already appeared in some local gazetteers, mainly in the *fenye* section.[13] Using LG with

念之傳入中國," *Studies in the History of Natural Sciences* 自然科學史研究 17, no. 4 (1998): 304-11.

[11] Huang Shijian 黃時鑒 and Gong Yingyan 龔纓晏, 利玛窦世界地图研究 [Research on Matteo Ricci's World Map] (Shanghai: Shanghai guji chubanshe, 2004), 87-93.

[12] Yang Fan 楊帆 and Sun Xiaochun 孫小淳, "Measurement of Geographical Longitude and Latitude and Application of 'Western Method' in Chongzhen Calendar Reform 地理經緯度與崇禎改歷 "西法" 的確立," *Science & Culture Review* 科學文化評論 14, no. 4 (2017): 62-75.

[13] Gazetteer that lists the value of *Beiji gaodu* in the chapter of *fenye* or *xingye*, specific examples include*: (Wanli) qiongzhou zhouzhi* (萬曆)瓊州府志 [(Wanli) Gazetteer of Qiongzhou Prefecture], (*Shunzhi) yingzhou zhi* (順治)潁州志 [(Shunzhi) Gazetteer of Yingzhou Prefecture], *(Kangxi) jianshui zhouzhi* (康熙)建水州志 [(Kangxi) Gazetteer of Jianshui Prefecture], *(Yongzheng) chixiu shaanxi tongzhi* (雍正)敕修陝西通志 [(Yongzheng) General Gazetteer of Shaanxi Province], and *(Yongzheng) zhejiang tongzhi* (雍正)浙江通志 [(Yongzheng) General Gazetteer of Zhejiang Province] and so on. Gazetteer

keywords like *Guidu*, *Guijing* (晷景), *Jigao* (極高), *Beiji gao* (北極高), *Beiji gaodu* (北極高度), *Jidu* (極度), *Piandu* (偏度), *Licha* (里差), I searched at the section level and found sixty-nine Qing Dynasty local gazetteers included these sections.

Looking at the compilation of local gazetteers by region, *Guangdong* (廣東) had the highest number with twenty gazetteers, followed by Hebei (河北) with nine, and Shanxi (山西) with seven. The high number of Guangdong gazetteers featuring *gudui* section is attributed to the *Guangdong tongzhi* (廣東通志, *General Gazetteer of Guangdong Province*), compiled during the Daoguang period. This gazetteer followed *Qinding rehe zhi*'s approach, replacing *fenye* with *guidu*, and influenced many subsequent Guangdong gazetteers. Most parts of Rehe during the Qing Dynasty are now in Hebei Province, explaining Hebei gazetteers' significant influence from *Qinding rehe zhi*. For instance, the *Chengde fuzhi* (承德府志, *Gazetteer of Chengde Prefecture*), frequently referenced *Qinding rehe zhi*.[14] Among the seven Shanxi gazetteers included *Guidu* sections, six were compiled by scholar Yang Du (楊篤, 1834-1894), who believed in the important role of *Beiji gaodu* and *Dongxi piandu* for geographical positioning, solar term determination and agricultural applications.[15]

Regarding the compilation years of these gazetteers, there are four during the Qianlong period (1736-1795), three during the Jiaqing period (1796-1820), nine during the Daoguang period (1821-1850), one during the Xianfeng period (1851-1860), seven during the Tongzhi period (1862-1874), forty-five during the Guangxu period (1875-1908), and three during the Xuantong period (1909-1911).

In these gazetteers, which include *guidu* sections or related sections, there are primarily three approaches to addressing the doctrines of *fenye* and coordinate theory. First, the content focused exclusively on *guidu*, with *Fenye* omitted. For example, Yang Du's (Guangxu) *Weizhou zhi* (蔚州志, *Gazetteer of Weizhou Prefecture*) listed the latitude and longitude of Weizhou and cited various literature to explain the concepts without mentioning *fenye*.[16] Similar examples include

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that lists the *Dongxi piandu* in the *Fenye* or *Xingye* chapter, specific examples include: *(Yongzheng) chixiu shaanxi tongzhi* (雍正)敕修陝西通志 [(Yongzheng) General Gazetteer of Shaanxi Province], *(Qianlong) qingyuan fuzhi* (乾隆)慶遠府志 [(Qianlong) Gazetteer of Qingyuan Prefecture], *Qianlong chaozhou fuzhi* (乾隆)潮州府志 [(Qianlong) Gazetteer of Chaozhou Prefecture], *(Qianlong) guangzhou fuzhi* (乾隆)廣州府志*(Qianlong)* [Gazetteer of Guangzhou Prefecture], *(Qianlong) zhijiang fuzhi* (乾隆)芷江府志 [(Qianlong) Gazetteer of Zhijiang Prefecture], *(Qianlong) xiangyang fuzhi* (乾隆)襄陽府志 [(Qianlong) Gazetteer of Xiangyang Prefecture], and so on.

[14] Hai Zhong 海忠, ed., 中國方志叢書 塞北地方 17 (道光)承德府志 [Series of Chinese Local Gazetteers: Northern Border Region 17 (Daoguang) Gazetteer of Chengde Prefecture] (Taibei: chengwen chubanshe, 1968), 428-30.

[15] Yu Qian 豫謙 and Yang Du 楊篤, eds., 中國方志叢書 華北地方 401 (光緒)長子縣志 [Series of Chinese Local Gazetteers: North China Region 401 (Guangxu) Gazetteer of Changzi County] (Taibei: chengwen chubanshe, 1976), 43-44.

[16] Qing Zhijin 慶之金 and Yang Du 楊篤, eds., *(Guangxu) Weizhou zhi* (光緒)蔚州志 [(Guangxu)

the (Guangxu) *Wujixian xuzhi* (無極縣續志, *Sequel Gazetteer of Wuji County*), (Guangxu) *Sihui xianzhi* (四會縣志, *Gazetteer of Sihui County*).

Second, both *guidu* and *fenye* content are listed, but with varying emphases. This method is commonly seen in many gazetteers. Most books prioritize *guidu* and present *fenye* as supplementary information. For example, the *Qinding rehe zhi* did not remove content of *fenye* but included it as additional reference material. Numerous subsequent gazetteers adopted this compromise method. The compilers explain that the retention of the *fenye* doctrine is due to its long history and cultural value, serving as a reference for future generations. Another approach gives priority to the *fenye*, with additional *guidu* information included at the end. Examples of this method can be seen in the *Chaoyang xianzhi* (朝陽縣志, *Gazetteer of Chaoyang County*), *Ningjin xianzhi* (寧津縣志, *Gazetteer of Ningjin County*), *Tunliu xianzhi* (屯留縣志, *Gazetteer of Tunliu County*), and the *Xuxiu luzhou fuzhi* (續修廬州府志, *Sequel Gazetteer of luzhou Prefecture*), from the reign of Guangxu. The compilers acknowledge the theory of *fenye* and believe in its correctness. However, encountered new knowledge of *guidu*, they cannot make judgments or choices between the two, and thus choose to incorporate both.

Third, the section title is *guidu,* but the content is focused on the theory of *fenye*. In the *Xuxiu shulu xianzhi* (續修束鹿縣志, *Sequel Gazetteer of Shulu County*), compilers elaborated the *fenye* content related to *Shulu* 束鹿 in historical official records and local gazetteers,[17] indicating an endorsement of the *fenye* and a lack of understanding of the concept of *guidu*.

These differing approaches reveal gazetteers' varied attitudes toward *guidu* and *fenye*. Generally, when assessing the newly introduced concept of *guidu*, compilers consistently praised for its precision and consistent timekeeping.[18] However, when evaluating *fenye*, the reviews were mixed, with a predominant lean towards criticism. The few commendations acknowledged its ancient origins and long history. In criticizing the *fenye* doctrine, gazetteer compilers highlighted three main deficiencies and errors:

First, axial precession. This phenomenon has altered the mansion distribution, making ancient star distributions unsuitable for current observations. Continuing to use the old *fenye* doctrine to determine current celestial-terrestrial correspondences is inaccurate. The (Daoguang) *Guangdong tongzhi* mentions that the Guangdong region was not within the borders of any states during the Qin (221-207 BCE) and Han (202 BCE-220 CE) dynasties. Additionally,

Gazetteer of Weizhou Prefecture] (Weizhou: Weizhou gongxie, 1877), juan 3, guidu: 15a.

[17] Song Chenshou 宋陳壽, ed., *(Tongzhi) Xiuxu shulu xianzhi* (同治)續修束鹿縣志 [(Tongzhi) Sequel Gazetteer of Shulu County] (1868), juan 1: 1b-2. National Library of China & National Digital Library of China. http://read.nlc.cn/OutOpenBook/OpenObjectBook?aid=403&bid=95113.0

[18] He Zhongjian 賀仲瑊 and Jiang Xiangnan 蔣湘南, eds., 中國方志叢書 華北地方 271 (道光)留壩廳志 [Series of Chinese Local Gazetteers: North China Region 271 (Daoguang) Gazetteer of Liuba Prefecture] (Taibei: chengwen chubanshe, 1969), 16-18.

axial precession was unknown then, leading to differences between current celestial phenomena and ancient ones, as well as territorial discrepancies.[19]

Second, changed political boundaries. The present-day administrative boundaries have significantly changed compared to ancient times, making it impractical to continue using the old *fenye* system. For example, during the Spring and Autumn Period (770-476 BCE), *Chunsho* (鶉首) (includes Well Mansion, Ghosts Mansion, and Willow Mansion) was the corresponding mansions to the Qin region. However, by the Han dynasty, with the establishment of new jurisdictions named Hexi Four Counties (河西四郡) adjacent to Qin, these new areas were also linked to *Chunshou* (鶉首). During the Qing Dynasty (1644-1911), new territories spanning over 20,000 *li* (里) were reclaimed in the Western Regions. Associating these new lands with the Qin-corresponding mansions *Jing* (井) and g*ui* (鬼) (Well Mansion and Ghosts Mansion) would lead to confusion and ambiguity.[20]

Third, *fenye*'s narrow scope. *Fenye* theory mainly elucidated the celestial correspondences for higher-level administration and did not cover lower-level or smaller areas like counties and townships, making it difficult to ascertain their celestial-terrestrial correspondences. For example, compilers of the *Dali xianzhi* (大荔縣志, *Gazetteer of Dali County*) of the Daoguang period stated that *Jingui* (井鬼) was the corresponding field for two states under Qin, not for a single county.[21]

The coexistence of *fenye* and *guidu* in Qing Dynasty gazetteers reflects a transitional period in Chinese astronomical and geographical thought. It captures the dynamic alteration between preserving ancient knowledge and embracing new insights, deepening our understanding of the updating of knowledge structures of local intellectuals in the Qing Dynasty.

Updated: the emergence of latitude and longitude

In the *Qinding rehe zhi* and *Qinding huangyu xiyu tuzhi*, there are explanations of the longitude and latitude concepts and the methods of positioning. However, at that time, latitude was termed *Beiji gaodu* and longitude as *Dongxi piandu*. The terminology began to change starting from the Daoguang period (1821-1850).

[19] Ruan Yuan 阮元, Chen Changqi 陳昌奇, eds., *Guangdong tongzhi* 廣東通志 [General Gazetteer of Guangdong Province] (Shanghai: Shangwu yinshuguan, 1934), juan 89, yudi lve 7: 20.
[20] Fu, *Qingding huangyu xiyu tuzhi* 欽定皇輿西域圖志 [Atlas of the Western Regions of the Qing Empire], juan 6, guidu 1: 2a.
[21] Xiong Zhaolin 熊兆麟, ed., 中國地方志集成 陝西府縣志輯20 (道光)大荔縣志 [Collection of Chinese Local Gazetteers: Shaanxi Prefecture and County Gazetteers 20 (Daoguang) Gazetteer of Dali County] (Nanjing: Fenghuang chubanshe, 2007), 2-3.

Firstly, during the Daoguang era, the terms longitude and latitude began to appear in section titles, and gazetteer maps now had annotations of these values. Terms like "longitude" and "latitude" started replacing *Beiji gaodu* and *Dongxi piandu.* Notable gazetteers, such as the *Liuba tingzhi* (留壩廳志, *Gazetteer of Liuba Prefecture*) (Figure 2)[22] and *Chongxiu Jingyang xianzhi* (重修涇陽縣志, *Revised Gazetteer of Jingyang County*) (Figure 3)[23] from the Daoguang period, listed longitude and latitude values, even illustrating them on maps. In the *Tongzhou fuzhi* (同州府志, *Gazetteer of Tongzhou Prefecture*) of the Daoguang period, not only a complete map of *Tongzhou* Prefecture with longitude and latitude values was drawn, but also a longitude and latitude table for the ten subordinate territories under *Tongzhou*'s jurisdiction was listed, with values precise to seconds.[24]

During this period, the gazetteers containing new knowledge exhibited a clustering effect in geographical terms. The reason is that individual scholars, who were open-minded and receptive to new astronomical and geographical knowledge, reformed the compilation of local gazetteers and the drawing of maps, incorporating new forms and content. This, in turn, influenced the compilation of gazetteers in surrounding areas. For instance, *Liuba* Prefecture, *Jingyang* County, and *Tongzhou* Prefecture are all in *Shaanxi* (陝西) Province. The content related to longitude and latitude appearing in these gazetteers is associated with the compiler Jiang Xiangnan (蔣湘南, 1795-1854).

Jiang Xiangnan was a distinguished Muslim scholar born in *Henan* (河南) Province. In 1835, he passed the imperial examinations and subsequently taught at several academies in Shaanxi Province. In 1826, Jiang traveled to Beijing to take examinations and came into contact with many scholars, like Ruan Yuan (阮元, 1764-1849), Qi Yanhuai (齊彥槐, 1774-1841), Wei Yuan(魏源, 1794-1857), and so on.[25] The new geographical and astronomical knowledge of these scholars had a profound influence on him. Jiang applied the new knowledge and ideas he acquired to the innovation of the content and format of the gazetteers he compiled. Historical records indicate that Jiang was proficient in astronomy, calendrical computation, geography,

[22] He and Jiang, *Series of Chinese Local Gazetteers: North China Region 271 (Daoguang) Gazetteer of Liuba Prefecture* (道光)留壩廳志, 15-16.

[23] Hu Yuanyu 胡元瑛 and Jiang Xiangnan 蔣湘南, eds., *(Daoguang) Chongxiu jingyang xianzhi* (道光)重修涇陽縣志 [Daoguang) Revised Gazetteer of Jingyang County] (Jingyang: jingyang shu, 1842), juan 3: 1-2a.

[24] Wen Lian 文廉 and Jiang Xiangnan 蔣湘南, eds., *(Xianfeng) Tongzhou fuzhi* (咸豐)同州府志 [(Xianfeng) Gazetteer of Tongzhou Prefecture] (Tongzhou: fuyacangban,1852), juan 1, tongzhou fu jiangyu quantu: 1a-2a; juan 4, gaohu biao: 1a-1b.

[25] Gu Yujun 顧玉軍, 明清時期回族教育思想研究 [Research on the Educational Thought of Hui People in the Ming and Qing Dynasties] (Beijing: Minzu chubanshe, 2016), 286-88. Chen Guangyi 陳光貽, 中國方志學史 [History of Chinese Local Gazetteers] (Fuzhou: Fujian renmin chubanshe, 1998), 187.

and agriculture. The gazetteers he compiled were detailed, accurate, well-organized, and clear, and far surpassing other gazetteers in the field.[26]

Jiang recognized the accuracy and uniqueness of latitude and longitude positioning. He realized that the geographic location of a certain area remains constant, but the corresponding celestial stars for that area could change. For instance, *Liuba* had been part of different administrative regions and was assigned to different celestial divisions, but the geographical location of *Liuba* has never changed. Therefore, he believed that the theory of *fenye* was baseless. [27] He adopted the methods of the Imperial Astronomical Bureau (*Qintianjian*, 欽天監) to measure the latitude and longitude values of ten subordinate territories of the Tongzhou Prefecture, as actual measurements of the *Beiji gaodu* were more reliable than *fenye*. [28]

Jiang Xiangnan's pioneering approach influenced the gazetteer compilation in Shaanxi, with subsequent editions retaining his format. The Guangxu edition of the *Lantian xianzhi* (藍田縣志, *Gazetteer of Lantian County*) was a continuation of Jiang Xiangnan's Daoguang edition (1840), retaining the format of "deleting *Fenye*, listing longitude and latitude values."[29] Similarly, many local gazetteers in Guangdong Province include longitude and latitude maps and lists of longitude and latitude values, which are related to the cartographer Li Mingche (李明徹, 1751-1832) of the Daoguang edition of the *Guangdong tongzhi*. [30]

Secondly, upon entering the Guangxu era (1875-1908), the compilers of local gazetteers accelerated their pace of knowledge updating, and the number of gazetteers using longitude and latitude to describe specific locations increased. For instance, *Mianxian zhi* (沔縣志, *Gazetteer of Mian County*) includes a section on "Longitude and Latitude,"[31] and *Lucheng xianzhi* (潞城縣志, *Gazetteer of Lucheng County*) includes a section on "Celestial and Terrestrial Longitude and Latitude table," in which the latitude is called *Beiji gaowei*北極高緯 (North Pole High Latitude) and the longitude is *Diping jingdu* (地平經度, Earth Level Longitude), [32] and

[26] Song Bolu 宋伯魯 and Wu Tingxi 吳廷錫, eds., *Xuxiu shaanxi tongzhigao* 續修陝西通志稿 [Revised Draft of the General Gazetteer of Shaanxi Province] (Xi'an, 1934), juan 85, renwu: 12.

[27] He and Jiang, *Series of Chinese Local Gazetteers: North China Region 271 (Daoguang) Gazetteer of Liuba Prefecture* (道光)留壩廳志, 20-21.

[28] Wen and Jiang, *(Xianfeng) Tongzhou fuzhi* (咸豐)同州府志 [(Xianfeng) Gazetteer of Tongzhou Prefecture], juan 4, gaohu biao: 1a-1b.

[29] Lv Mouxun 呂懋勛, ed., (Guangxu) Lantian xianzhi (光緒)藍田縣志 [(Guangxu) Gazetteer of Lantian County] (Benya cangban, 1875), juan 2, Jingwei: 1-3.

[30] Jiajing Zhang, "The Art of Compromise: New Maps in Local Gazetteers of the Late Qing Dynasty," *Isis* 113, no. 4 (2022): 829-40.

[31] Sun Mingzhong 孫銘鐘 and Peng Ling 彭齡, eds., *(Guangxu) Mianxian zhi* (光緒)沔县志 [(Guangxu) Gazetteer of Mian County] (Mianxian: Bengya cangban, 1883), juan 1: 1a.

[32] Cui Xiaoran 崔曉然 and Yang Du 楊篤, eds., *(Guangxu) Lucheng xianzhi* (光緒)潞城縣志 [(Guangxu) Gazetteer of Lucheng County] (Lucheng: Xianshu cangban, 1884), juan 1, xingdu guidu pu: 1a.

Taoyuan xianzhi (桃源縣志, *Gazetteer of Taoyuan County*) includes *Village Survey Longitude and Latitude Map* (村坊測繪經緯圖). [33]

The *Lai'an xianzhi* (來安縣志, *Gazetteer of Lai'an County*) of the Daoguang period is an intriguing example. When the book was first printed in 1824, it included a *Beiji gaodu* table. By the time of its republication during the Guangxu period, the compilers had already changed the name of the *Beiji gaodu* Table to the Longitude and Latitude Table, and noted that the previous table lacked longitude values, which were added in the new edition, demonstrating that the compilers' understanding of the concepts of longitude and latitude. [34]

Another example is the *Qianzhou zhigao* (乾州志稿, *Gazetteer Draft of Qianzhou Prefecture*), published during the Guangxu period. In 1884, *Qianzhou zhigao* was printed which had the contents of *Fenye*, and also included a sundial chart indicating the *Beiji gaodu* and the *Dongxi piandu*. [35] Just seven years later, the author, Zhou Mingqi (周銘旂, c. 1830-1910), made additions and corrections to the original book. First, Zhou eliminated the content of *fenye*, arguing that to continue listing this knowledge would be to perpetuate the errors of predecessors. Secondly, Zhou added basic geographical knowledge such as the theory of a spherical Earth and latitude and longitude, along with drawing a map with the coordinate (Figure 4). Finally, based on the cartographic standards issued by the *Huidian guan* (會典館, Huidian Institute), Zhou undertook a new territorial survey from October in 1890 to August in 1891, and drew maps using Western mapping methods.[36]

Finally, during the late Qing (1901-1911) and early Republic of China periods, the acceptance of the spherical Earth concept and the use of longitude and latitude among local gazetteer compilers became more widespread. Some gazetteers from Emperor Xuantong's reign completely abandoned *fenye* content, opting instead for a concise and clear presentation of local positions using numerical values of longitude and latitude. For example, the *Changtu fuzhi* (昌圖府志, *Gazetteer of Changtu Prefecture*) included a section on latitude and longitude, which listed the north latitude and east longitude of Changtu Prefecture, as well as the universally recognized world longitude at that time.[37] The *Chengde xianzhishu* (承德縣志書, *Gazetteer of*

[33] Yu Liangdong 余良棟 and Liu Fengbao 劉鳳苞, eds., *(Guangxu) Taoyuan xianzhi* (光緒)桃源縣志 [(Guangxu) Gazetteer of Taoyuan County] (Taoyuan: Benya cangban, 1892), Juanshou, tuxiang: 9-10.
[34] Fu Hongxiu 符鴻修 and Ouyang Quan 歐陽泉, eds., 中國地方志集成 安徽府縣志輯 35 (道光)来安縣志 [Collection of Chinese Local Gazetteers: Anhui Prefecture and County Gazetteers 35 (Daoguang) Gazetteer of Laian County] (Nanjing: Jiangsu guji chubanshe, 1998), 319.
[35] Zhou Mingqi 周銘旂, ed., *(Guangxu) Qianzhou zhigao* (光緒)乾州志稿 [(Guangxu) Gazetteer Draft of Qianzhou Prefecture] (Qianzhou: Qianyang shuyuan, 1884), juan 1, guidu tu: 2b-3a.
[36] Zhou Mingqi 周銘旂, ed., *(Guangxu) Qianzhou zhigao buzheng* (光緒)乾州志稿補正[Supplement and Correction of (Guangxu) Gazetteer Draft of Qianzhou Prefecture] (Qianyang shuyuan, 1891), juan 1, guidu tu: 6b-7a.
[37] Hong Ruchong 洪汝沖, ed., Changtu fuzhi 昌圖府志 [Gazetteer of Changtu Prefecture] (Shengyang:

Chengde County) listed the latitude and longitude of the county seat, as well as the longitude of the easternmost and westernmost areas and the latitude of the northernmost and southernmost areas. [38] The *Shache fuzhi* (莎車府志, *Gazetteer of Shache Prefecture*) also included latitude and longitude values.[39] After the fall of the Qing Dynasty and the establishment of the Republic of China, the practice of describing locations using longitude and latitude values in gazetteers became even more common. A full-text search in the LG database using "latitude and longitude" as the keyword yielded 605 entries, with 436 entries appearing during the Republican era, accounting for 72 percent of the total.

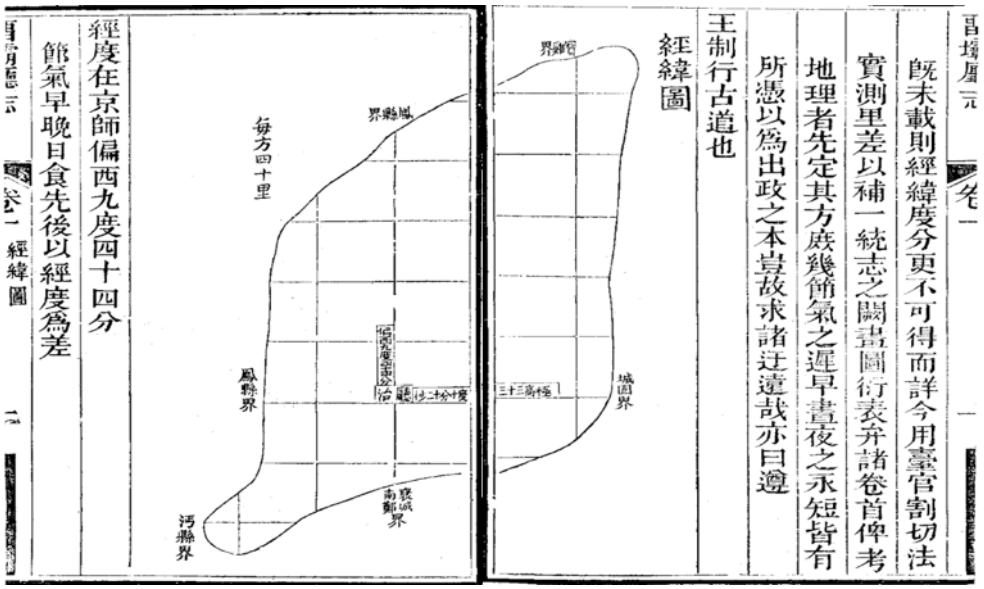

Figure 2. Longitude and latitude maps in the (Daoguang) *Liuba tingzhi* 留壩廳志 [(Daoguang) Gazetteer of Liuba Prefecture] (1842). Public domain.

Fengtian tushu yinshua suo, 1910), 1a-1b.

[38] Du Linbu 都林布, ed., (Xuantong) *Chengde xianzhi shu* (宣統)承德縣誌书 [(Xuantong) Gazetteer of Chengde Prefecture] (Chengde: Chaoben, 1910), juan 1: 3a.

[39] Anonymous 佚名, ed., (*Xuantong) Shache fuzhi* (宣統)莎車府志 [(Xuantong) Gazetteer of Shache Prefecture] (Beijing: shoudu tushuguan, 1985), 7b.

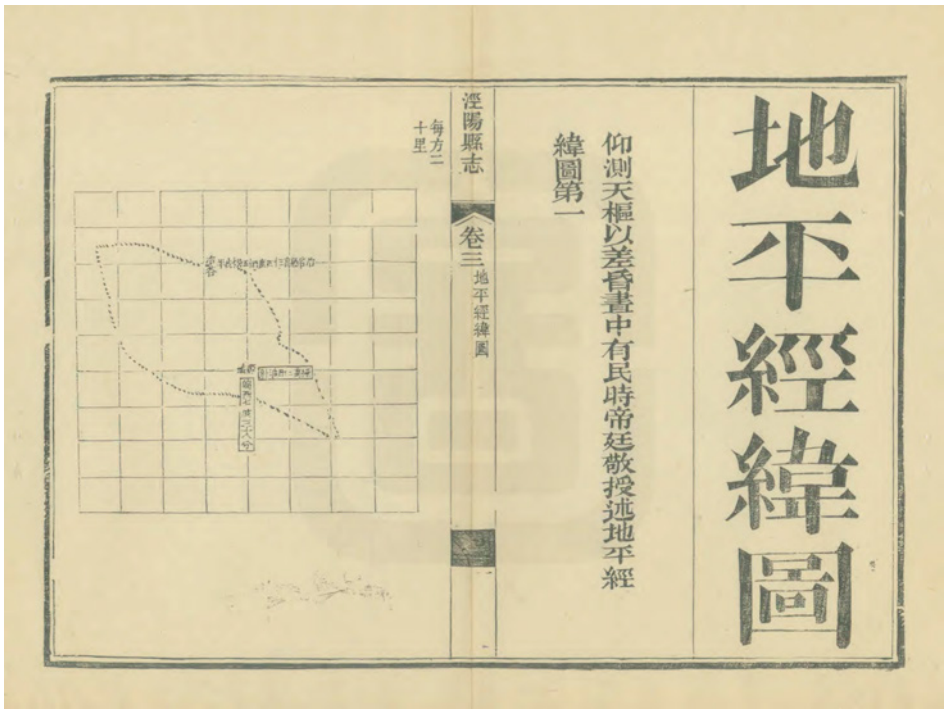

Figure 3. Longitude and latitude map of the ground in the (Daoguang) *Chongxiu jingyang xianzhi* 重修涇陽縣志 [(Daoguang) Revised Gazetteer of Jingyang County] (1842). Public domain.

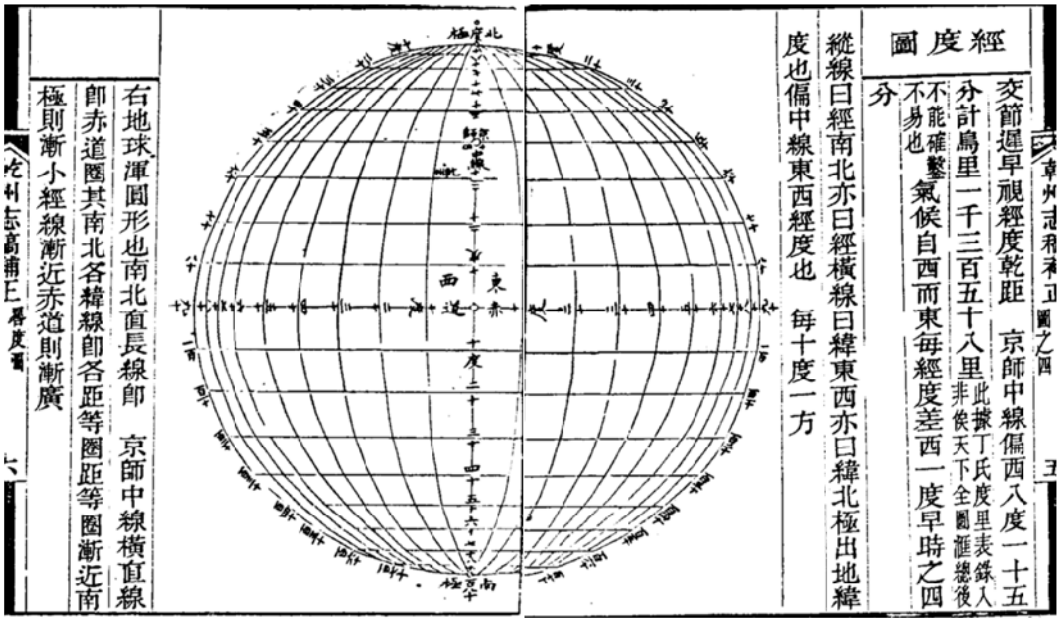

Figure 4. Longitude map in the (Guangxu) *Qianzhou zhigao buzheng* 乾州志稿補正 [Supplement and Correction of (Guangxu) Gazetteer Draft of Qianzhou Prefecture] (1891). Public domain.

Innovation of concepts: the spread of the theory of the earth's sphericity and the latitude and longitude

The replacement of the traditional heaven-earth correspondence system with the geographical coordinate system was facilitated by the widespread acceptance of the spherical Earth concept and the concepts of longitude and latitude, the promotion of measurement methods for these coordinates, and the public availability of longitude and latitude data. There are three levels in which the Spherical Earth concept and the ideas of longitude and latitude were introduced to China, accepted by elites, and then popularized.

First, the introduction of the spherical Earth concept and the theory of longitude and latitude through Western translations in China. The spherical earth was known in China from at least 718 CE when Indian astronomers operated at the Chinese court, but its influence was very limited.[40] The *Yuanshi tianwenzhi* (元史・天文志, *History of Yuan Dynasty: Astronomical Records*) mentioned that the Muslim astronomer Jamal ad-Din (扎馬魯丁, c. 1210-1274) once constructed a globe, which, however, did not influence Chinese people. Muslim astronomers involved in the compilation of the calendar, despite understanding the concept of a spherical Earth, primarily presented their achievements through the calendar itself, leaving scarcely any written records on the spherical Earth concept.

During the late Ming Dynasty, foreign missionaries coming to China began to introduce the latest European scientific knowledge. The translations produced by these missionaries included the concept of a spherical Earth, a foundational aspect of Western astronomy, and also touched upon the concept of longitude and latitude. By the late Ming and early Qing periods, the concept of a spherical Earth started to spread in China and exert its influence eventually.[41] Although some scholars contend that the spherical Earth concept faced challenges in spreading during the Qing Dynasty due to differences between Chinese and Western knowledge systems, it is acknowledged that by the Guangxu period, the concept had become widely accepted.[42] In the late Qing period, as basic geographical knowledge, the concepts of a spherical earth and the latitude and longitude were prevalent. They were found in numerous translations of geography, astronomy, and surveying from European, American, and Japanese works. Notable

[40] Jeffrey Kotyk, "Examining Amoghavajra's Flat-Earth Cosmology: Religious vs. Scientific Worldviews in Buddhist Astrology," *Studies in Chinese Religions* 7, no. 2-3 (2021): 203-20.

[41] Chen Meidong 陳美東 and Chen Hui 陳暉, "Dissemination and Repercussion of the Idea of a Spherical Earth in China from Late Ming to Early Qing 明末清初西方地圓說在中國的傳播與反響," *China Historical Materials of Science and Technology* 中國科技史料 1 (2000): 6-12.

[42] Cao Yi 曹一, "A Study on the Embarrassment of Western Theory of Sphericity of the Earth Transmitting in China According to the Intellectuals Notes in the Qing Dynasty 由清代筆記看西方地圓說在中國傳播困難之原因," *Journal of Guangxi University for Nationalities (Natural Science Edition)* 廣西民族大學學報(自然科學版) 16, no. 1 (2010): 40-44, 57.

examples include J.W. Davis (戴集, ?-?) in his work *Dili lveshuo* (地理略說, *Brief Introduction of Geography*)[43] and Shiga Shigetaka (志賀重昂, 1863-1927) in *Dilixue jiangyi* (地理學講義, *Lectures on Geography*).[44] These works were numerous and played a significant role in disseminating this foundational geographical knowledge in China, illustrating the profound impact of Western science on Chinese academia and knowledge systems.

Second, the assimilation of the spherical Earth concept and understanding of latitude and longitude among Qing Dynasty intellectuals. Since the late Ming Dynasty, Chinese intellectuals began to progressively grasp and endorse the Western concept of the spherical Earth, along with the associated concepts of latitude and longitude. Pioneering scholars like Xu Guangqi and Li Zhizao (李之藻, 1571-1630) wrote treatises affirming the spherical earth was correct.[45] The Qing government's official publication, *Shixian Calendar* (時憲曆, later renamed *Shixian Book* 時憲書), mentioned that the shape of the earth is spherical (地體渾圓 Diti Hunyuan). When introducing the solar terms timings for each province, the order was based on the geographical longitudes of the provinces, introduced from east to west. Similarly, when explaining the sun's rising and setting times, and the duration of day and night across different locations, the sequence followed was based on the latitudes of those places, introduced from north to south.[46]

During the reign of Emperor Jiaqing (嘉慶, 1796-1820), scholar Jiao Tinghu (焦廷琥, 1782-1821) wrote a book titled *Diyuan Shuo* (地圓說, *Spherical Earth Theory*). In this book, Jiao not only compiled discussions of the spherical Earth from ancient Chinese literature, like *Zhoubi suanjing* (周髀算經) and *Jinshu tianwen zhi* (晉書·天文志, *History of Jin Dynasty: Astronomical Records*) but also cited thoughts of renowned Chinese intellectuals such as Zhang Heng (張衡, 78-139), Ma Rong (馬融, 79-166), Cai Yong (蔡邕, 133-192), Ge Hong (葛洪, c. 284-364), the two Chengs (二程) —Cheng Hao (程顥, 1032-1085) and Cheng Yi (程頤, 1033-1107)—, and Zhu Xi (朱熹, 1130-1200). Furthermore, Jiao Tinghu gathered knowledge on the spherical earth from Western translations he had encountered. These included books translated by Matteo Ricci (1552-1610), Sabatino de Ursis (1575-1620), Emmanuel Diaz Junior (1574-1659), Giulio Aleni (1582-1649), and Michel Benoist (1715-1774).[47]

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[43] John Davis 戴集, *Dili Lveshuo* 地理略说 [Brief Introduction of Geography] (Shanghai: Huamei shuguan, 1888), 1-2.

[44] Shiga Shigeang 志賀重昂, *Dilixue Jiangyi* 地理学講義 [Lectures on Geography], trans. Sa Rui 薩瑞 (Shanghai: Jinsuzhai, 1901), 1-5.

[45] Chen Meidong 陳美東 and Chen Hui 陳暉, "Dissemination and Repercussion."

[46] The authors reviewed more than fifteen Qing dynasty calendars from the Shunzhi, Kangxi, Yongzheng, Qianlong, Daoguang, Jiaqing, Xianfeng, Tongzhi, Guangxu, and Xuantong periods of the Qing dynasty.

[47] Jiao Tinghu 焦廷琥, *Diyuan shuo* 地圓說 [Spherical Earth Theory] (1815). National Library of China & National Digital Library of China. http://read.nlc.cn/OutOpenBook/OpenObjectBook?aid=892&bid=46384.0

Taoist scholar Li Mingche (李明徹, 1751-1832), renowned for compiling the geographical section in the *Guangdong Tongzhi* during the Daoguang period, and also authored the *Yuantian tushuo* (圜天圖說, *Illustrated Atlas of the Spherical Sky*). In *Yuantian tushuo*, Li drew maps showing the *Beiji chudi* of Beijing and Guangdong. Those maps not only provide a visual representation of the spherical Earth but also illustrate the relationships between latitude and solar terms, the length of day and night, and twilight and dawn shadows. This method of mapping demonstrates how Li Mingche learned from and assimilated content from Western translations. Additionally, he discussed the earth's shape, its surface's latitude and longitude, and more. A significant portion of his content references Emmanuel Diaz Junior's *Tianwen lve* (天問略, *Epitome of Questions on the Heavens*) and Sabatino de Ursis's *Jianpingyi shuo* (簡平儀說, *Introduction of Celestial Planiglobe*).[48]

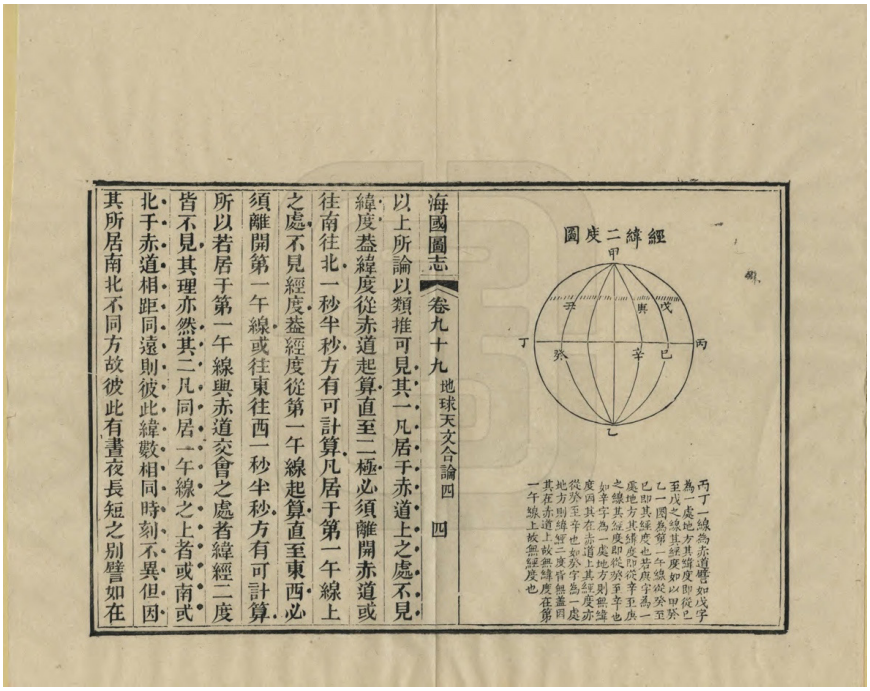

Figure 5. Longitude and Latitude Map in the *Haiguo tuzhi*海國圖志 [Illustrated Treatise on the Maritime Kingdoms] (1852). Public domain.

Wei Yuan (魏源, 1794-1857)'s *Haiguo tuzhi* (海國圖志, *Illustrated Treatise on the Maritime Kingdoms*) stands as a monumental work in China's intellectual history. Liang Qichao (梁啟超, 1873-1929) suggested that it was from this book that Chinese intellectuals began to

[48] Li Mingche 李明徹, *Yuantian tushuo* 圜天图说 [Illustrated Atlas of the Spherical Sky] (Songmeixuan, 1819), juan 2-3.

understand the world geography.[49] In its first edition in 1844, the *Haiguo tuzhi* included maps of both the eastern and western hemispheres, marked with longitude and latitude, featuring Matteo Ricci's map theory, which explained the spherical Earth theory and the concepts of longitude and latitude.[50] During the Xianfeng period's reprint, the fourth section on the combination of geography and astronomy included a special chapter titled *Jingwei erdu lun* (經緯二度論, *Discussion of Longitude and Latitude)* (Figure 5). This content was extracted from Jose Martins-Marquez' *Diqiu zonglu* (地球總論, *The General Theory of the Earth*) written by Jose Martins-Marquez (1810-1867).[51] The *Haiguo tuzhi* was published multiple times and played a crucial role in popularizing the spherical Earth theory and the concepts of longitude and latitude.

Lastly, the popularization of the spherical Earth concept and longitude and latitude in late Qing Dynasty geography textbooks. In the early twentieth century, the Qing government attempted to mitigate both domestic and foreign challenges through self-rescue efforts, initiated a comprehensive top-down reform known as the "New Policies of the Late Qing Dynasty" (清末新政). These reforms spanned multiple areas, including education, politics, economics, and military. In the realm of education, the Qing government abolished the age-old imperial examination system, and established a new education system known as the *Guimao School System* (癸卯學制). Geography became an independent discipline and was integrated into the educational system. There are approximately 110 surviving geography textbooks and reference materials from the late Qing period, utilized at various educational levels, including primary and secondary schools, normal colleges, and universities.[52] The concepts of spherical Earth and the latitude and longitude, as foundational knowledge in those geography textbooks, were widely disseminated. For instance, Zou Daijun (鄒代鈞, 1854-1908), in his lecture notes at Peking University, divided geography into three categories: mathematical, astronomical, and political geography. The section on astronomical geography included discussions on the Earth's shape and methods for determining the locations of various places on the Earth's surface.[53] Other geography textbooks, such as *Xinti zhongguo dili* (新體中國地理, *New-style Chinese*

[49] Liang Qichao梁啟超, 中國近三百年學術史 [A History of Chinese Scholarship in the Last Three Hundred Years] (Shanghai: Zhonghua shuju, 1936), 323-24.

[50] Wei Yuan 魏源, *Haiguo Tuzhi* 海國圖志 [Illustrated Treatise on the Maritime Kingdoms] (Weishi guweitang, 1844), juan 46, limadou ditu: 1a, 2a-2b.

[51] Wei Yuan 魏源, *Haiguo Tuzhi* 海國圖志 [Illustrated Treatise on the Maritime Kingdoms] (Guweitang, 1852), juan 99, tianwen dili helun 4: 1-6. Xiong Yuezhi 熊月之, "Research on the Cited Western Books in Haiguo tuzhi 海國圖志征引西書考釋," *Journal of Chinese Literature and History* 中華文史論叢 55 (1996): 235-58.

[52] Wang Youpeng 王有朋, 中國近代中小學教科書總目 [Chinese Modern Primary and Secondary School Textbook Catalogue] (Shanghai: Shanghai cishu chubanshe, 2010), 239-60, 584-613, 796-98, 879, 905.

[53] Zou Daijun鄒代鈞, *Jingshi daxuetang zhongguo dilixue jiangyi* 京師大學堂中國地理學講義 [Chinese Geography Lecture Notes of Peking University] (Beijing: Xuewu chu guanshuju, 1902).

Geography),[54] *Zhongguo jinshi yudi tushuo* (中國近世輿地圖說, *Chinese Modern Geography and Maps*),[55] *Yinghuan Quanzhi* (瀛寰全志, *Global Geography*),[56] they provided detailed explanations of the spherical Earth theory and the concept of latitude and longitude.

Data support: acquisition of latitude and longitude data

Understanding the concept of a spherical Earth and grasping the notion of latitude and longitude is insufficient for local gazetteer compilers to utilize the latitude and longitude system to determine the geographic location of a place. The latitude and longitude values for each location are indispensable data. The sources of latitude and longitude data in local gazetteers primarily come from three avenues: 1) data obtained through actual surveying and mapping by the official Astronomical Bureau; 2) data calculated based on central government data or maps; and 3) data obtained from local government surveys.

On-site data measurement by the official Astronomical Bureau

Latitude and longitude data from official astronomical Bureau can be categorized into three types: pre-Qing Dynasty data, Kangxi period data, and Qianlong period western regions data. Regarding the pre-Qing Dynasty data, the Astronomical Bureaus of the Tang and Yuan Dynasties undertook geodetic measurements to amend the calendar. Monk Yixing of the Tang Dynasty and Guo Shoujing of the Yuan Dynasty both measured the *Beiji gaodu* (latitude), and the data they obtained were preserved in official histories and continuously transcribed. For instance, the Ming Dynasty's (Wanli) *Leizhou fuzhi* (雷州府志, *Gazetteer of Leizhou Prefecture*) mentions that Leizhou's *Beiji chudi* is slightly more than twenty degrees, and the *Qiongzhou fuzhi* (瓊州府志, *Gazetteer of Qiongzhou Prefecture*) from the same era states that Naihai (南海)'s *Beiji chudi* is fifteen degrees, with the data both originating from Guo Shoujing's survey.[57] At the end of the Ming dynasty, Xu Guangqi used Western methods to measure the latitudes of Beijing (北京), Nanjing (南京), Nanchang (南昌), and Guangzhou (廣州) for calendar

[54] Zang Lihe 臧励龢, *Xinti zhongguo dili* 新體中國地理 [New-style Chinese Geography] (Shanghai: Shangwu yinshu guan, 1909), 8-14.

[55] Luo Runan 羅汝楠, *Zhongguo jinshi yudi tushuo* 中國近世輿地圖說 [Chinese Modern Geography and Maps] (Guanzhou: Guangdong jiaozhong xuetang, 1909), 1: 3-8.

[56] Zia Hong-lai 謝洪賚, *Yinghuan quanzhi* 瀛寰全志 [Global Geography] (Shanghai: Shangwu yinshuguan, 1906), 15-16.

[57] 日本藏中國罕見地方志叢刊 [Series of Rare Chinese Local Gazetteers Collected in Japan]. (Wanli) Leizhou fuzhi (萬曆)雷州府志 [(Wanli) Gazetteer of Leizhou Prefecture] (Beijing: Shumu wenxian chuban she, 1990), 3: 173. 日本藏中國罕見地方志叢刊 [Series of Rare Chinese Local Gazetteers Collected in Japan]. (Wanli) Qiongzhou fuzhi (萬曆)瓊州府志 [(Wanli) Gazetteer of Qiongzhou Prefecture] (Beijing: Shumu wenxian chubanshe, 1990), 3: 28. Song, *Yuan shi* 元史 [History of Yuan Dynasty], 1000-01.

revision, and calculated the latitudes and longitudes for eleven other provincial capitals based on the *Guangyu tu* (廣輿圖, *Enlarged Terrestrial Atlas*). These data are recorded in books like the *Chongzhen Calendar* (崇禎曆書). Later, when the Qing Dynasty scholar Qin Huitian (秦蕙田, 1702-1764) composed the ritual book *Wuli tongkao* (五禮通考, *Encyclopedia for the Five Rituals*, 1761), he included all the above data, providing a data reference for local gazetteer compilation. For example, during the Kangxi period, some local gazetteers such as the *Xijiang zhi* (西江志, *Gazetteer of Jiangxi Province*)[58] and the *Jianshui tingzhi* (建水廳志, *Gazetteer of Jianshui Prefecture*)[59] adopted the survey data from Yixing and Guo Shoujing when listing the *Beiji chudi du* (北極出地度).

From the forty-seventh to the fifty-eight year of the Kangxi era (1708-1719), Emperor Kangxi presided over a nationwide geodetic survey, establishing for the first time a latitude and longitude network centered in Beijing. The survey determined the latitude and longitude values for 641 locations, leading to the creation of the *Huangyu quanlan tu* (皇輿全覽圖, *Overview maps of Imperial Territories*), which applied latitude and longitude positioning to mapmaking.[60] For a long time, scholars believed that the geodetic data obtained during the Kangxi period were taken to Europe by missionaries and then published by Jean-Baptiste du Halde in his book. However, within the Qing Empire, these data were kept confidential within the Qing court and not disclosed publicly.[61] In fact, during the compilation of the *Yuzhi lixiang kaocheng* (御製曆象考成, *Compiled Examination of Imperial Calendars and Astronomical Observations*), the measured data of *Beiji Gaodu* values and calculated data of *Dongxi piandu* for each provincial capital were recorded.[62] A comparison reveals that the latitude and longitude values in the *Yuzhi lixiang kaocheng* are more accurate than Xu Guangqi's data, and mostly align with the data in Du Halde's book, with minor discrepancies for some provinces. The longitude and latitude data measured during the Kangxi period can also be found in Qi Zhaonan's 齊召南 *Shuidao tigang* (水道提綱, *Outline of the Topographical Features of Rivers and Seas*). [63]

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[58] Zha Shenxing 查愼行, ed., *(Kangxi) Xijiang zhi* (康熙)西江志 [(Kangxi) Gazetteer of Jiangxi Province] (1720), juan 1, xingye: 9b. Harvard Library. https://iiif.lib.harvard.edu/manifests/view/drs:428485120$51i.

[59] Chen Zhaokui 陳肇奎 and Ye Lai 葉淶, eds., "*(Kangxi) Jianshui zhouzhi* (康熙)建水州志 [(Kangxi) Gazetteer of Jianshui Prefecture]" in 北京圖書館古籍珍本叢刊 45 [Collection of Rare Ancient Books from the Beijing Library 45], Ancient Books Publishing and Editing Group of Beijing Library北京圖書館古籍出版編輯組, ed., 647-876 (Beijing: shumu wenxian chubanshe, 1998), 658.

[60] Jean-Baptiste du Halde, *Description Géographique, Historique, Chronologique, Politique et Physique de L'empire de la Chine et de la Tartarie*, vol. 4 (Paris: Le Mercier, 1735), 588-606.

[61] Xue Zhang, "The Plurality of Reception: Latitude and Longitude in Early Modern China, 1700–1900," *Isis* 113, no. 3 (2022): 537-58. Mario Cams, *Companions in Geography: East-West Collaboration in the Mapping of Qing China (c.1685-1735)* (Leiden ; Boston: Brill, 2017), 99-136.

[62] Yunlu 允祿, ed., *Yuzhi lixiang kaocheng* 御製曆象考成 [Compiled Examination of Imperial Calendars and Astronomical Observations] (Beijing: wuyingdian, 1725), part 1, juan 4, beiji gaodu: 6a, 7a-7b.

[63] Qi Zhaonan齊召南, *Shuidao tigang* 水道提綱 [Outline of the Topographical Features of Rivers and Seas] (Fujing shuwu, 1776), qi xu: 2-3.

The measured latitude and longitude data from the Kangxi period were cited in some Qing dynasty local gazetteers. For example, (Yongzheng) *Chixiu Shaanxi tongzhi* (敕修陝西通志, *Imperially Ordered Revision of the General Gazetteer of Shaanxi Province*) cited data from *Yuzhi lixiang kaocheng* to list the *Beiji gaodu* in various locations in Shaanxi as well as the *Dongxi piandu* values.[64] The *Ninghai zhouzhi* (寧海州志, *Gazetteer of Ninghai Prefecture*) compiled during the Tongzhi period included discussions on the spherical Earth and longitude and latitude, listing the longitude and latitude of the prefectural seat, and even featured a Map of the Earth's Longitude and Latitude[65], with explanations indicating that the information was derived from the *Yuzhi lixiang kaocheng*.[66]

During the Qianlong period, around the time the Qing court was reasserting control over Xinjiang, the Qing court undertook two extensive surveys in the Western regions, supplementing latitude and longitude data for over 110 sites. These survey results were compiled in the *Qinding huangyu xiyu tuzhi*, which became widely disseminated.[67] The *Table of Beiji gaodu and Dongxi piandu in Provinces* preserved in the Qianlong Imperial Household, contained the latitude and longitude data for seventeen provincial capitals, thirty-nine locations in Mongolia, tewnty locations in *Yili* (伊犁), and twenty-six locations in the Hui regions, with data from field surveys during the Kangxi and Qianlong periods. [68]

The *Huangchao tongzhi* (皇朝通志, *General Gazetteer of the Imperial Qing Dynasty*), completed in 1787, elucidated the concepts of *Beiji gaodu* and *Dongxi piandu*, listed the latitude and longitude data, the length of day and night during the summer solstice, and timing of solar terms for important cities.[69] Meanwhile, during the Daoguang era, *Rishi xicao* (日食細草, *Detailed Information on Solar Eclipses*) written by Official Astronomical Bureau officer Fang

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[64] Zha Lang'a查郎阿 and Shen Qingya沈青崖, eds., *(Yongzheng) Chixiu shaanxi tongzhi* (雍正)敕修陝西通志[Imperially Ordered Revision of the General Gazetteer of Shaanxi Province] (1735), juan 1, xingye: 70-71. National Library of China & National Digital Library of China. http://read.nlc.cn/OutOpenBook/OpenObjectBook?aid=403&bid=51087.0

[65] Shu Kung'an舒孔安 and Wang Houjie王厚階, eds., *(Tongzhi) Ninghai zhouzhi* (同治)寧海州志[(Tongzhi) Gazetteer of Ninghai] Prefecture (Mouping shuyuan, 1864), juan 1, tianwen: 6b-20.

[66] Ibid., juan 1, fan li: 1a.

[67] Feng Lisheng 馮立升, "Astronomical Geodesy and Its Significance in Northwest China During the Qianlong Period 乾隆時期西北地區的天文大地測量及其意義," *China's Borderland History and Geography Studies* 中國邊疆史地研究, no. 3 (1999): 60-68.

[68] Anonymous佚名, *Yuzhi zhongxing genglu sanyuan hengxing tushuo gesheng beiji gaodu piandu biao* 御制中星更錄三垣恒星圖說各省北極高度偏度表 [Imperial Edition of the Records of the Central Star, Illustrations and Explanations of the Three Enclosures of Constant Stars, and Tables of Beiji gaodu and Dongxi piandu in Various Provinces] (Beijing: qianlong neifu, 1744), 90-99. National Library of China & National Digital Library of China. http://read.nlc.cn/OutOpenBook/OpenObjectBook?aid=892&bid=228031.0.

[69] Ji Huang 嵇璜 and Liu Yong 刘墉, eds., *Huangchao tongzhi* 皇朝通志[General Gazetteer of the Imperial Qing Dynasty] (Beijing: wuyingdian, 1787), juan 22, tianwen zhilve: 5.

Lvheng (方履亨, active in 1821-1850), also included the latitude and longitude data of major cities.[70]

Some scholars believe that the latitude and longitude data obtained through measurements during the Kangxi and Qianlong periods, before 1832, appeared only in numerical form in books by scholars who had the privilege to see the actual imperial maps from that era. They argue that this was a symbol of these scholars' proximity to imperial power, serving no other purpose and without citing sources.[71] However, the *Qinding huangyu xiyu tuzhi* offers a more comprehensive view of the era's surveying endeavors. The compilers of *Qinding huangyu xiyu tuzhi* not only briefly described the survey process of the Western Regions but also recorded the obtained latitude and longitude values of significant locations in the Western Regions, used to determine the positions, daylight durations, and the timings of equinoxes and solstices of those locations.

Latitude and longitude estimations derived from official data and maps

With regards to the latitude and longitude estimations derived from official data and maps, the large-scale geodetic survey organized by the imperial court could not encompass every single prefecture and county within the Qing Empire's territory. For those areas lacking actual measured latitude and longitude data, estimations could be made based on the known values of nearby regions. This method represented the second source for local gazetteer compilers to obtain geographical data.

Regarding the methods of calculating latitude and longitude values, there were already books introducing them by the late Ming and early Qing dynasties. In Li Zhizao's (李之藻, 1571-1630) *Hungai tongxian tushuo* (渾蓋通憲圖說, *Illustrated Explanation of the Armillary Sphere*) and Ferdinand Verbiest (1623-1688)'s *Lingtai yixiang zhi* (靈台儀象志, *Introduction of Astronomical Instruments on the Observatory*) from the late Ming era, there were conversion tables the relationship between the length of one degree on the altitude circle and one degree at the equator. During the Kangxi period, the mathematician Mei Wending (梅文鼎, 1633-1721) conducted specialized research on the methods of calculating latitude and longitude. He innovated a method using spherical trigonometry to measure the distance between two places and a method to deduce longitude using the latitudes and distances of two locations.[72]

[70] 四庫未收書輯刊編纂委員會 [Compilation Committee of Books Not Collected in the Four Treasuries], ed. 四庫未收書輯刊第四輯 [Compilation and Publication of Books Not Collected in the Four Treasuries: Series Four] (Beijing: Beijing chubanshe, 2000), 493.

[71] Zhang, "The Plurality of Reception," 537-58.

[72] Yan Dunjie 嚴敦傑, "The Mathematical and Astronomical Work of Mei Wending 梅文鼎的數學

These methods provided means for calculating longitude and correcting errors in geodetic measurements during the Kangxi era and also offered subsequent generations methodologies for calculating latitude and longitude.

In the fourth year of the Qianlong reign (1739), Liu Maoji (劉茂吉, c. 1736-1795) compiled the *Table of Beiji gaodu* (北極高度表) based on Kangxi-era data. This work briefly recounts the spherical Earth theory and the concepts of latitude and longitude from the *Yuzhi lixiang kaocheng*. More importantly, it lists data of *Beiji gaodu* for over 1800 locations.[73] Searches in the LG database reveal that over twenty Qing dynasty gazetteers referenced and cited Liu Maoji's data, primarily from Jiangsu, Anhui, and Hunan. This is likely related to Liu Maoji being from Jingde in Anhui, where his book was published and widely circulated in Anhui and the neighboring provinces of Jiangsu and Hunan.

During the reign of Emperor Daoguang, the previously guarded maps from the Kangxi and Qianlong periods began to circulate among the public, significantly influencing the compilation and drawing of maps in the subsequent Qing dynasty. Examples include the *Huangchao yitong yudi quantu* (皇朝一統輿地全圖 *Imperial Complete Map of All under Heaven*), the *Huangchao zhongwai yitong yutu* (皇朝中外一統輿圖 *Terrestrial Map of the Unification of China and Foreign Counties by the Imperial Dynasty*), and the *Huangqing dili tu* (皇清地理圖 *Geographical Map of the Qing Empire*), all of which were drawn based on these earlier maps. These maps, marking latitude and longitude values, provided a basis for calculating these coordinates and served as crucial geographical references for compilers of local gazetteers in the late Qing dynasty.

Following Liu Maoji, Qi Yanhuai (齊彥槐, 1774-1841) calculated the latitude and longitude values of over one thousand locations across the Qing Empire and compiled these results into the *Beiji jingwei dufen quanbiao shuo* (北極經緯度分全表說 *Complete Table of North Pole Latitude and Longitude*). Based on Qi Yanhuai's work, Zhang Zuonan (張作楠, 1772-1850) compiled another table named *Beiji jingwei dufen quanbiao* (北極經緯度分全表 *Complete Table of North Pole Latitude and Longitude*), which listed the coordinates of 1,714 locations. Later, Ding Quzhong (丁取忠, 1810-1877) had access to the maps drawn during the Qianlong period, adding calculated latitude and longitude values for the Western Regions, and published the *Yudi jingwei duli biao* (輿地經緯度里表 *Table of Geographical Latitude and Longitude*) in

和天文學工作," *Studies in the History of Natural Sciences* 自然科學史研究 8, no. 2 (1989): 99-107.

[73] Liu Maoji 劉茂吉, *Beiji gaodu biao* 北極高度表 [Table of Beiji gaodu] (1739), 5-30. Tohoku University Digital Archives. https://touda.tohoku.ac.jp/collection/database/library/public/10020000010670

1852,[74] which included latitude and longitude values for over two thousand locations within and outside the Qing Empire.[75]

The latitude and longitude data on the "Complete Map of the Territory of Tongzhou Prefecture" in the (Xianfeng) *Tongzhou fuzhi* were derived from Zhang Zuonan's book. Additionally, the *Jifu tongzhi* (畿輔通志, *General Gazetteer of Jifu*) notes that previous geographical and astronomical books only provided the latitude and longitude values for the capital and provincial capitals, lacking data for other cities. Consequently, the compilers turned to data of Zhang Zuonan's book to fill this gap, illustrating the importance and influence of Zhang's work during that period. [76]

On-Site Measurement of Longitude and Latitude by Local Governments

In addition to referencing existing latitude and longitude data, some local governments initiated their own field surveys to obtain these values, providing a new method for local positioning. This approach became the third source for compilers of local gazetteers to acquire latitude and longitude data.

How are longitude and latitude measured? Matteo Ricci recorded two methods for measuring latitude in the blank space of the *Kunyu Wanguo Quantu*. The first method involved using an astronomical instrument known as the "Celestial Measuring Ruler," while the second one involved measuring the length of a gnomon shadow at noon and then referring to a "Seasonal Tables" to determine the latitude.[77] In the *Xiyang xinfa lishu* (西洋新法曆書, *Western New Method Calendar*), a simplified method for determining the latitude is succinctly documented: by measuring the altitude of the sun at noon using a quadrant, one can ascertain the latitude value. Alternatively, by observing the height of stars near the North Celestial Pole, the latitude can also be determined. As for longitude, it is derived by calculating the time difference between lunar eclipse observations made at two different locations longitudinally.[78]

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[74] Ding Quzhong 丁取忠, 白芙堂算學叢書 [Baifutang Mathematical Collection], *Yudi jingwei duli biao* 輿地經緯度里表 [Table of Geographical Latitude and Longitude] (Changsha: Changsha gu hehuachi jingshe, 1874), 5-99.

[75] Ruan Yuan 阮元 et al., 畴人传合编校注 [Annotated Compilation of Biographies of Mathematicians and Astronomers] (Zhengzhou: Zhongzhou guji chubanshe, 2012), 479-80, 521, 70-72. Yang Binyong 楊彬鏞, "*Qing Dynasty Mathematicians and the Calculation of Longitude and Latitude Nationwide* 清代疇人與全國經緯度測算," *Survey World* 经纬天地, no. 2 (2016): 77-81.

[76] Huang Pengnian 黃彭年 and Li Hongzhang 李鴻章, eds., *(Tongzhi) Jifu tongzhi* (同治)畿辅通志 [(Tongzhi) General Gazetteer of Jifu] (1884), juan 56, guidu: 17a, 17b.

[77] Fang Hao 方豪, 中國交通史 [History of Chinese Transportation] (Changsha: Yuelu shushe, 1987), 825.

[78] Xu Guangqi 徐光啟, 西洋新法歷書 [New Western Astronomical Methods and Calendarsı, in 故宫

During the geodetic surveying process in the Kangxi period, the first step involved astronomical observations to obtain the latitude and longitude of certain locations. The astronomical methods used at that time included determining latitudes by observing the sun, establishing longitudes by observing lunar eclipses, and measuring both latitude and longitude by observing Jupiter's occultation of a specific star. The second step involved using the astronomically observed points as base points and employing triangulation to calculate the latitude and longitude of other locations. The *Yuzhi lixiang kao cheng* from the same period, recorded these methods for measuring latitude and longitude, providing a methodology for subsequent local gazetteers, such as *Ninghai zhouzhi* [79] and *Liuba tingzhi* [80] from the Tongzhi period.

In the fifteenth year of the Guangxu period (1889), the Qing government established the *Huidian Guan* (會典館, the agency to compile the Qing Code), which included a mapping department. The main task of this department was the compilation and drawing of precise national atlas. When the *Huidian Guan* required provincial governments to survey and map sub-maps with latitude and longitude values, geographer Zou Daijun provided a detailed report to the *Huidian Guan* on the methods of measuring latitude and longitude.[81] This report facilitated the learning of new surveying techniques and the understanding of the concepts of latitude and longitude across various regions. For instance, provinces like Hubei (湖北), Anhui (安徽), and Jiangxi (江西) purchased Western instruments such as theodolites to measure the latitude and longitude values of provincial capitals and other prefectural and county cities.[82]

During the late Qing dynasty, the Qing government formed modern military forces; due to the important role that surveying and mapping play in military affairs, the government began cultivating surveying and mapping talent through military academies while also establishing specialized surveying and mapping institutions. Professional surveyors from these academies and institutions also participated in the measurement of latitudes and longitudes in various locations. For instance, surveyors from the Tianjin Naval Academy and the Fujian Shipyard's Institute, contributed to major projects like Guangxu's *Huidian Yutu* (會典輿圖, *Atlas of the*

珍本叢刊 383 [The Palace Museum Rare Books Series 383], Palace Museum 故宫博物院, ed., 1-412 (Haikou: Hainan chubanshe, 2000), 263.

[79] Kung and Wang, *(Tongzhi) Ninghai zhouzhi* (同治)寧海州志 [(Tongzhi) Gazetteer of Ninghai Prefecture], fanli: 1a.

[80] He and Jiang, (道光)留壩廳志 [Series of Chinese Local Gazetteers: North China Region 271 (Daoguang) Gazetteer of Liuba Prefecture], 16-18.

[81] Zou Daijun 鄒代鈞, "Mapping and Surveying Books Submitted to the Huidian Guan 上會典館言測繪地圖書," *Gezhi huibian* 格致彙編 *Chinese Scientific and Industrial Magazine* Spring, no. 7 (1892): 15-17.

[82] Wang Yifan 王一帆, 清末地理大測繪: 以光緒《會典輿圖》為中心的研究 [Great Geographic Surveying and Mapping in the Late Qing Dynasty: A Study Centered on the Guangxu Edition of Huidian Yutu (Atlas of the Qing Code)] (PhD diss., Fudan University, 2011), 110-112.

Qing Code).[83] During the Xuantong period, teachers and students from the survey school in Guangdong participated in mapping numerous local regional maps, providing precise latitude and longitude coordinates for the local areas. In these local gazetteers containing maps based on field survey, the traditional content of *fenye* vanished, indicating that the system of corresponding heaven and earth had been supplanted by the latitude and longitude system.

Conclusion

In ancient China, astrologers developed the theory of terrestrial-celestial correspondence against the backdrop of the cosmological view of the interconnection between heaven and the humankind. Utilizing this theory, the ancients identified the celestial counterparts to their terrestrial locations. From the perspective of modern science, this correlation between heaven and earth is quite nebulous and hardly serves as a reliable means of determining direction. However, for the ancient Chinese, the position of a terrestrial location's corresponding celestial mansions was considered an essential natural and cultural characteristic of that place, as well as a spiritual belonging place for its inhabitants.

However, with the advancement of astronomy and changes in China's territorial boundaries, the theory of terrestrial-celestial correspondence frequently exhibited flaws, and its system of heaven-earth correlations faced continuous challenges. During the Qianlong period of the Qing dynasty, following the subjugation of the Zunghar and Muslim peoples of the northwest, the Qing Empire's territory significantly expanded. Nevertheless, the celestial mansions remained unchanged, leading Emperor Qianlong to question and subsequently reject the theory of terrestrial-celestial correspondence, initiating the decline of China's traditional positioning system.

During the time when Western knowledge began to spread to the East, the Western positioning system—latitude and longitude—was introduced to China along with the concept of the spherical Earth. In the early stages of its introduction, to facilitate acceptance among the Chinese, intellectuals utilized existing terms from Chinese traditional astronomy, naming latitude and longitude after the concepts of *Beiji gaodu* and *Dongxi piandu*, respectively.

In the late Qing period, with the introduction of Western astronomical, geographical, and cartographical theories, the concepts of a spherical earth and latitude and longitude began to gain popularity. Concurrently, the latitude and longitude data from official surveys during the Kangxi and Qianlong eras started to circulate among the public, with new survey data continually emerging, laying the groundwork for the establishment of the latitude and longitude system.

[83] Ibid.112.

By the end of the Qing dynasty, local gazetteers began to feature latitude and longitude maps, with these numerical values replacing the *fenye* theory as the primary natural geographic element of locations. The content related to the *fenye* system began to vanish from these gazetteers; where they remained, they were merely transcribed as a cultural remnant, as the *fenye* had entirely lost its positioning function.

Local gazetteers represent the crystallization of knowledge from local intellectuals and officials, reflecting their knowledge structures and worldviews. The disappearance of the *fenye* in these gazetteers indicates that the traditional Chinese cosmological view of interaction between heaven and humankind had faded among the Chinese elite. In contrast, the emergence of the latitude and longitude system demonstrates the local intellectuals' acceptance of modern science.

The *fenye* and the latitude-longitude system are not simply in opposition, nor are they in an antagonistic conflict. They are positioning systems that emerged under two distinct worldviews. The choices of the compilers of local gazetteers were not binary. Under the influence of traditional Chinese cosmology, which emphasizes the interconnectedness of heaven and humans, local intellectuals once believed in the *fenye* system for its symbolic positioning capabilities. However, with the introduction of Western knowledge into China, these intellectuals' worldviews were transformed, leading them to gradually comprehend and appreciate the latitude and longitude system. They began to favor this system, which offered precise and practical positioning, over the vague and symbolic *fenye* theory. This transition from vague, symbolic positioning to precise, practical positioning reflects the gradual development of a modern scientific perspective among local Chinese intellectuals. It also demonstrates the significant impact Western knowledge had on China's grassroots level, showing a shift in how local intellectuals engaged with and understood their world.

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