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Characterization of the incense sacrificed to the sarira of Sakyamuni from Famen Royal Temple during the ninth century in China

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Incense has played a critical role in daily life, medication, rituals, and religions since antiquity. With the opening up of the Silk Road, incense became one of precious trade products between China and other civilizations. Although many historical literatures record the introduction and use of exotic incense in China, archaeological evidence has been rarely found, and little is known about their composition, origin, and function. Famen Royal Temple, renowned for storing the sacred finger bone sarira of Sakyamuni Buddha, was venerated by some emperors during the Tang dynasty (618 to 907 CE), and a lot of incense had been sacrificed during the luxurious royal greeting ceremonies for Buddha's sarira according to historic records. In this study, we present the results of chemical analyses on three types of incense discovered in the underground palace of Famen Temple. Elemi resin and highly scented agarwood were identified in two sarira containers. In particular, elemi was first reported in Buddhist activities and in ancient China. The fragrant powder kept in a small silver container was a mixture of agarwood and frankincense, providing the earliest direct evidence of making *Hexiang* (blending of aromatics) in ancient China, also reflecting the contemporary knowledge of exotic incense. Our findings offer a glimpse into incense offerings in royal rituals associated with sarira worship during the ninth century and reflect the impact of the incense trade along the Silk Road in historical China.

the Silk Road | Buddhism | elemi | agarwood | frankincense

Significance

Incense has been linked to ceremonies, religions, medicines, and cosmetics worldwide for thousands of years. While Chinese texts in the Tang dynasty (618 to 907 CE) indicate that numerous exotic aromatic substances were already being introduced into China through the land and maritime Silk Road, this has been rarely demonstrated archaeologically. This study identifies three types of incense associated with the sacred sarira of Sakyamuni Budda from the underground palace of Famen Royal Temple in central China, providing direct evidence of aromatics including elemi, agarwood, and frankincense as well as their composite product, namely *Hexiang* (blending of aromatics), in Buddhist activities, which may have promoted the spread of incense and the development of aromatic knowledge systems in medieval China.

Aromatic substances and their products were highly prized in antiquity with widespread use in religions, ceremonies, and funerals as well as in medicine, cosmetics, perfumes, and facial treatment; thus, incense plays a critical role in the long-distance trade (1, 2). In particular, frankincense and myrrh—both of which are aromatic resins obtained from trees in the Burseraceae family native to the regions of northeast Africa, the Arabian Peninsula, and India (3, 4)—have long been proposed as main commodities in ancient incense trade. The demands for these items in both Western and Eastern societies have promoted the development of what are known today as the Incense Routes. Originating from Arabia, this network of trade routes was also an important part of the Silk Road, connecting ancient Arabian, Somalia, Egypt, India, Europe, Southeast Asia, and China through routes across both land and sea (2, 5–7). This essential network served more than just as a channel for trading of luxury goods such as incense, spices, silk, gold, and precious stones but also for the exchange and distribution of religions, art, languages, and technologies worldwide (7, 8).

Incense culture has a long history in China approximately dating back to the pre-Qin period (before 221 BCE) and played a prominent role in ancient Chinese religions and court activities, as well as in many aspects of their daily lives (9). Local herbs such as fragrant thoroughwort, lily magnolia, and mugwort were mainly used by ancient Chinese until the Western Han dynasty (202 BCE to 8 CE), and they were often mentioned in historical records such as *Shi Jing* (*Book of Songs*) and *Chu Ci* (*Elegies of the South*) (10). With the opening up of the Silk Road in the late second century BCE, exotic incense was gradually introduced into China through land passageways from the Western Regions (9, 11). Since then, the use of incense was becoming prevalent in the upper classes, involving court etiquette, indoor incense, entertainment, and purification, etc., which might have facilitated the appearance of incense burners, typically represented by *Boshanlu* (mountain censer). Meanwhile, such exotic items also appeared in south China through the maritime routes, and some scholars believe that frankincense may have appeared in China no later than the Western Han dynasty based on the aromatic resin discovered in the Nanyue King's mausoleum (whose occupier was the second king of Nanyue State ruling from 137 to 122 BCE), which was identified closest to frankincense by infrared spectroscopy (12, 13).

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The exploitation of extraterritorial aromatic resins and fragrant woods had been recorded in many historical books and ancient medical prescriptions since the Eastern Han dynasty (25 to 220 CE), such as *San Guo Zhi* (*Records of the Three Kingdoms*), *Hou Han Shu* (*Book of the Later Han*), *Xin Xiu Ben Cao* (*Newly Revised Materia Medica*), *Ben Cao Shi Yi* (*Supplements to Materia Medica*), and *Ben Cao Gang Mu* (*Compendium of Materia Medica*). Although these descriptions and records were sufficient and detailed, they inevitably had some deficiencies, since some exotic aromatic items were recorded by multiple names in ancient Chinese texts, many of which were different from those used today. In addition, most incenses were amorphous resins and sometimes were made into powder for further processing, and thus the source and nature of these substances cannot be determined from visual observation. Chemical analysis of archaeological incense has shown great potential for determining the ingredients, sources, and utilization of these products. To date, these studies are primarily restricted in Egypt (14–17), Yemen (18–20), and some sites in Europe (21–23); detailed scientific analyses of aromatics and their products in ancient China were scarce. Only a few studies have provided preliminary identification of archaeological aromatic samples dating back to the Song dynasty (960 to 1279 CE). For example, the fragrant wood found in the shipwreck of Quanzhou Bay in the Song dynasty were recognized as *Dalbergia sissoo* (24). Two types of incense unearthed from the underground palace of the Grand Baoen Temple in Nanjing of the North Song dynasty (960 to 1127 CE) were identified as *Aquilaria sinensis* and a natural resin similar to frankincense (10). Very little hard evidence of incense is available from earlier periods, despite their high value and widespread use, partly due to frequent degradation and poor preservation.

In this study, multiple analytical methods were adopted to characterize the incense samples discovered in the underground palace of Famen Temple of the Tang dynasty (618 to 907 CE). The temple is located at Famen Town of Fufeng County (Fig. 1), west of Xi'an, and it was constructed between 499 and 532 CE to house the finger bone sarira of Sakyamuni, the founder of Buddhism. The temple was originally named "Ashoka Temple" and renamed "Famen Temple" in 618 CE. The rulers of the Tang government advocated Buddhism, and the emperors of different periods believed that the worship of Buddhist relics could generate great merit, thereby guaranteeing national security and a stable life for the people. Thus, Famen Temple was esteemed by many Tang emperors and even became the royal temple (25, 26). Inside it, a four-level wooden pagoda of the Tang dynasty was renovated to a 13-floor brick octagonal pagoda during the Ming dynasty (1368 to 1644 CE) (27). In August 1981, half of the brick pagoda collapsed after incessant heavy rains (28) (*SI Appendix*, Fig. S1). Then, Shaanxi Provincial Institute of Archaeology, Baoji Municipal Administration of Cultural Heritage, and Fufeng County Museum formed a joint archeological team to dismantle the remainder of the pagoda and excavate the foundation and surroundings. During this excavation, an elaborate underground palace housing the Buddhist finger bone sarira was accidentally discovered in 1987 (Fig. 2*A* and *SI Appendix*, *Supplementary Information Text*).

This underground palace is the largest and most important one among all temples and stupas discovered thus far in China (detailed layout of the underground palace is described in *SI Appendix*, *Supplementary Information Text* and Fig. S1). A total of four Buddhist finger bones were found, and the third one was determined to be the only authentic Buddha's finger bone sarira, which was concealed in a five-layered marble chest in the sanctum in the back chamber of the underground palace. The other three bones, so-called shadow bones, may have been imitations that the Tang emperors fabricated to protect the real one (27, 28). More importantly, thousands of exquisite artifacts, including goldware, silverware, glass, porcelain, silk fabric, and carved stone as well as censers, incense containers, silver sachets, and aromatics (*SI Appendix*, Fig. S2) were unearthed from the underground palace, and they were placed in a certain pattern, probably following the Buddhist rules (27–30). During the Tang dynasty, eight emperors opened the underground palace of Famen Temple and brought the sarira back to the contemporary capital Chang'an (present-day Xi'an) or the eastern capital Luoyang for salute and worship. The last recorded and largest ceremony of greeting Buddha's sarira took place in 873 CE during the reign of Emperor Yizong (reigned from 859 to 873 CE), and these magnificent objects mostly came from this royal ritual (27).

The three incense samples analyzed in this study were found in different containers in the back chamber with stacked relics, which is the core part of the underground palace (27, 28) (Fig. 2*B* and *SI Appendix*, Fig. S1 and *Supplementary Information Text*). One of the shadow bones was stored in the small gold pagoda of the innermost "eight-nested boxes" (Fig. 2*C*) offered by Emperor Yizong. They were composed of eight elaborately decorated boxes of decreasing size placed one inside another, whose outermost layer was made of wood and was degraded during burial. Yellow aromatic substances (Sample I in Fig. 2*D*) were found in the seventh container (a silver gilt box, code: FD5: 011-2, height: 23.5 cm, side length: 20 cm). Fig. 2*E* is one of the two sarira containers (one gold and one silver) offered by the eminent Tantric monk Zhihuilun in the 12th year of the Xiantong reign (871 CE) of Emperor Yizong from its inscription. This monk was appointed as the Imperial Preceptor by emperors Yizong and Xizong (reigned from 859 to 888 CE) of the late Tang dynasty, and he hosted the last greeting ceremony for the Buddha's sarira. Scented wood pieces (Sample II, Fig. 2 *F* and *G*) were found in this silver container (code: FD5: 042-1, length: 18.9 cm, width: 18.5 cm, height: 22 cm). The small begonia-shaped silver container (Fig. 2*H*, code: FD5: 094, length: 5 cm, width: 3.8 cm, height: 2.2 cm) was filled with brown fragrant powder (Sample III, Fig. 2*I*). Pale yellow particles can be observed in this sample (Fig. 2*J*), indicating that it may be a mixture of different materials.

Results

After preliminary examination by Fourier-transform infrared spectroscopy (FTIR) analysis, the archaeological samples were analyzed using gas chromatography/mass spectrometry (GC/MS) or pyrolysis GC/MS (Py-GC/MS) in terms of the available sample amounts in order to detect the organic components and their possible source. The FTIR results indicate that Sample I (*SI Appendix*, Fig. S3 and Table S1) is related to triterpenoid resins in comparison with literature data (18, 31). The chromatogram of Sample I is shown in Fig. 3*A*, and the compounds detected mainly include pentacyclic triterpenoids (in the 50- to 60-min region; detailed molecular information is listed in *SI Appendix*, Table S2) (18, 32), abundant with α- and β-amyrin (compounds **4** and **3,** respectively). In addition, olean-9(11),12-dien-3-ol (compound **1**) and ursa-9(11),12-dien-3-ol (compound **2**) are the oxidation products of amyrins, which might be developed during long-term aging (32, 33). Although the mass spectrum of compound **6** (*SI Appendix*, Fig. S4) shows a great match with ursa-9(11),12-dien-3-one, its retention time should not be later than that of ursa-9(11),12-dien-3-ol

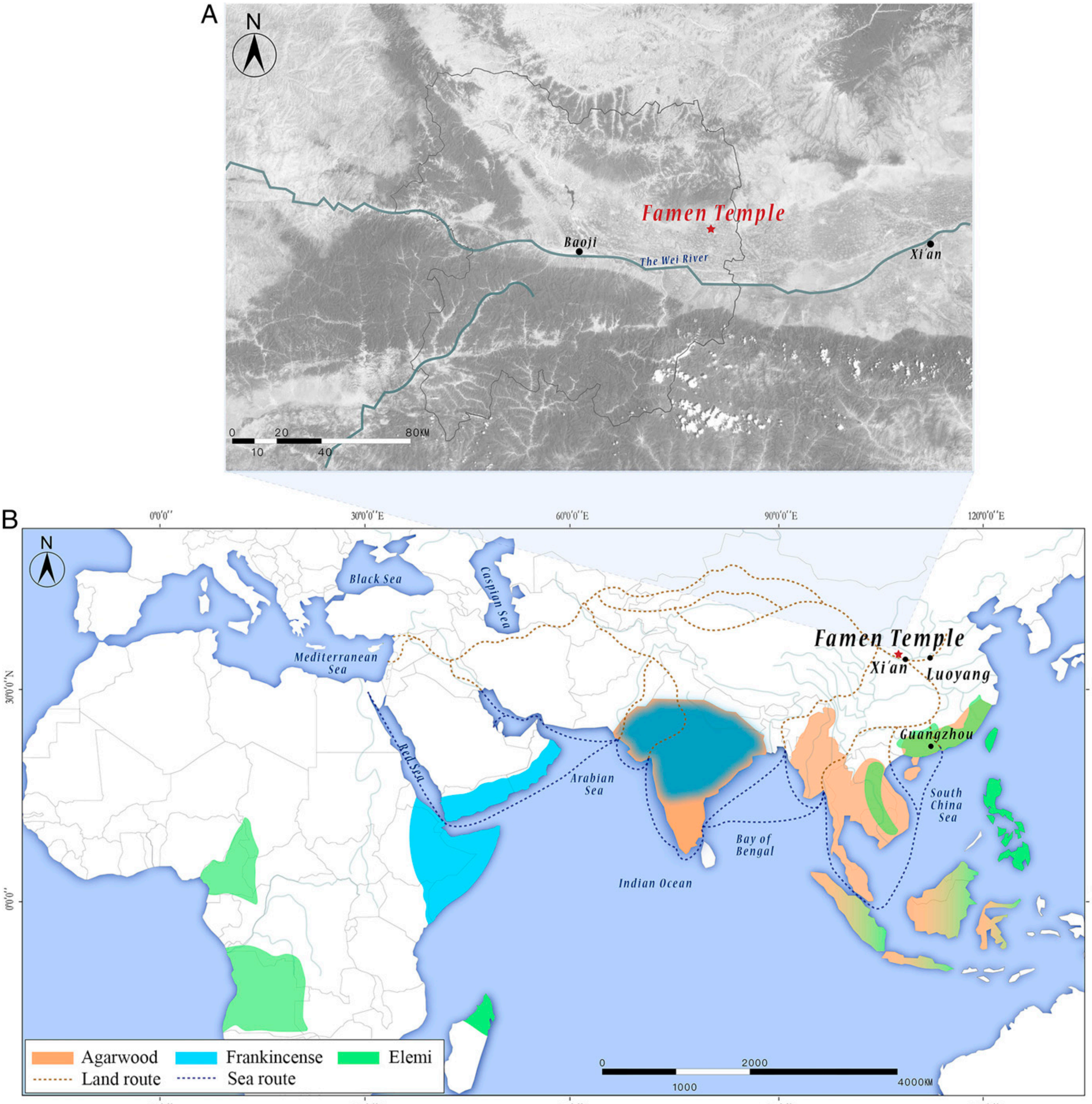

Fig. 1. Famen Temple and the Silk Road. (*A*) Map showing the geographical location of Famen Temple. (*B*) The land and sea routes of the Silk Road as well as the main regions of the incense discussed in this study (18, 50, 56–58, 61–63).

(compound **2**), indicating that compound **6** may be a different triterpenoid, but it was not clearly identified. The general distribution of these compounds indicates the presence of resin deriving from the Burseraceae family, especially elemi, which is a pale yellow and opaque resin with a rich and pleasant aroma and can be obtained from several trees belonging to the Burseraceae family (32–34).

Reference samples of modern elemi collected from the Philippines (E1) and Guangdong Province in southern China (E2) have also been analyzed repeatedly by GC/MS (Fig. 3 *B* and *C* and *SI Appendix*, Fig. S5 and Table S2). In archaeological resins, the triterpenoids are more stable owing to their lower volatility than the mono- and sesquiterpenoids, and they are more indicative for characterizing aged triterpenoid resins. Thus, the comparison of the chemical composition in different samples has been focused on the triterpenoid fraction. Triterpenoids including β-amyrin (compound **3**), α-amyrin (compound **4**), and lupeol (compound **5**) were detected in the archaeological Sample I and both modern elemi resins from different origins, while compounds **1** and **2**, the oxidation products of amyrins, were absent in modern samples. Compound **7** with significant content presented in the Guangdong resin was not clearly identified, and its mass spectral fragmentation pattern has not been observed in either the Philippines resin or the archaeological sample; however, the absence of compound **7** in the archaeological Sample I may result from natural aging processes. It should also be noted that replicates of modern resins showed that the content of different compositions in the same sample

Fig. 2. The incense and containers discovered in the underground palace of Famen Temple. (*A*) The plane graph of the underground palace, with the red rectangle showing the location of the back chamber. (*B*) Artifacts unearthed in the back chamber, with rectangles indicating the locations of three containers for samples I through III. (*C* and *D*) The "eight-nested boxes" (the outermost is a wooden box and was degraded during burial) offered by Emperor Yizong, and the yellow amorphous resin (Sample I) in the seventh container (FD5: 011-2). (*E*–*G*) The silver sarira container (FD5: 042-1) offered by eminent monk Zhihuilun, with the aromatic wood (Sample II) inside. (*H*–*J*) the begonia-shaped silver container (FD5: 094), with the aromatic powder (Sample III) inside.

varies more or less, especially the reference sample collected from southern China (*SI Appendix*, Fig. S5), reflecting the heterogeneity of the resin; thus, it will be difficult to distinguish the origin of elemi solely using the ratios of the triterpene molecules.

As for Sample II, a microstructural examination by synchrotron radiation microtomography (SR-μCT) and scanning electron microscopy was first carried out (*SI Appendix*, Fig. S6); however, massive resin deposition obscured its morphological characteristic. Thus, the organic material inside this wood sample was extracted and analyzed using GC/MS. Several aromatic compounds such as benzylacetone were detected in this sample (Fig. 4 and *SI Appendix*, Table S3). Compared with the published literature (35–41), it is confirmed that the chromatographic peaks I to X corresponding to the fraction in 40 to 50 min are 2-(2-phenylethyl)chromones (Fig. 4 and *SI Appendix*, Table S4), which are the main active constituents existing in the scented parts of agarwood. Agarwood is the fragrant resinous heartwood from certain trees in the genus *Aquilaria* within the family Thymelaeaceae, which cannot be formed in healthy wood tissues but may be generated when the *Aquilaria* plants are injured by insects, physical cuts, chemical stimulation, or bacterial infections, and it is generally believed that high-quality agarwood is that with more resin content and a longer time of aroma formation (36, 42–44). Apart from agarwood, 2-(2-phenylethyl)chromone compounds have only been detected in small quantities in *Bothriochloa ischemum* (45) and *Cucumis melo* L. var. *reticulatus* (46). Sample II has a large amount of 2-(2-phenylethyl) chromones, indicating that these fragrant wood pieces found in the silver container (FD5: 042-1) is agarwood with high resin content.

The FTIR spectrum of Sample III shows a basic structure similar to that of Sample II (*SI Appendix*, Fig. S3 and Table S1), with characteristic bands correspond to wood components (47–49), suggesting that Sample III consisted largely of wood powder. Due to very limited sample amounts available for analyzing, the identification of this aromatic powder was carried out using Py-GC/MS. The pyrogram obtained from Sample III (Fig. 5) shows three distinguishable areas that correspond to lignin pyrolysis products (with retention times of 5 to 20 min; the compounds identified are listed in *SI Appendix*, Table S6), 2-(2-phenylethyl)chromone compounds (with retention time of 20 to 30 min; Fig. 5*B* and *SI Appendix*, Table S4), and triterpenoid components (with retention time of 30 to 40 min; Fig. 5*D* and *SI Appendix*, Table S5). The detection of 2-(2-phenylethyl)chromones, which are the characteristic constituents of agarwood as mentioned above, together with the presence of lignin pyrolysates, indicates the presence of agarwood. Apart from the components related to this fragrant wood, triterpenoids were mainly recognized through comparisons of mass spectra with literature data (16, 17, 50). In Fig. 5*D*, 24-noroleana-3,9(11),12-triene (compound **8**) and 24-noroleana-3,12-diene (compound **10**) are pyrolysates of α-boswellic acids and their derivatives; 24-norursa-3,9(11),12-triene (compound **9**), 24-norursa-3,12-diene (compound **11**), and 24-norursa-3,12-dien-11-one (compound **12**) are pyrolysates of β-boswellic acids and their derivatives (17, 50). These compounds are characteristic of frankincense, and two compounds (**10** and **11**) were identified previously as constituents detected in the archaeological frankincense using Py-GC/MS (16, 17).

Furthermore, modern frankincense and agarwood samples were also analyzed by Py-GC/MS in order to corroborate and

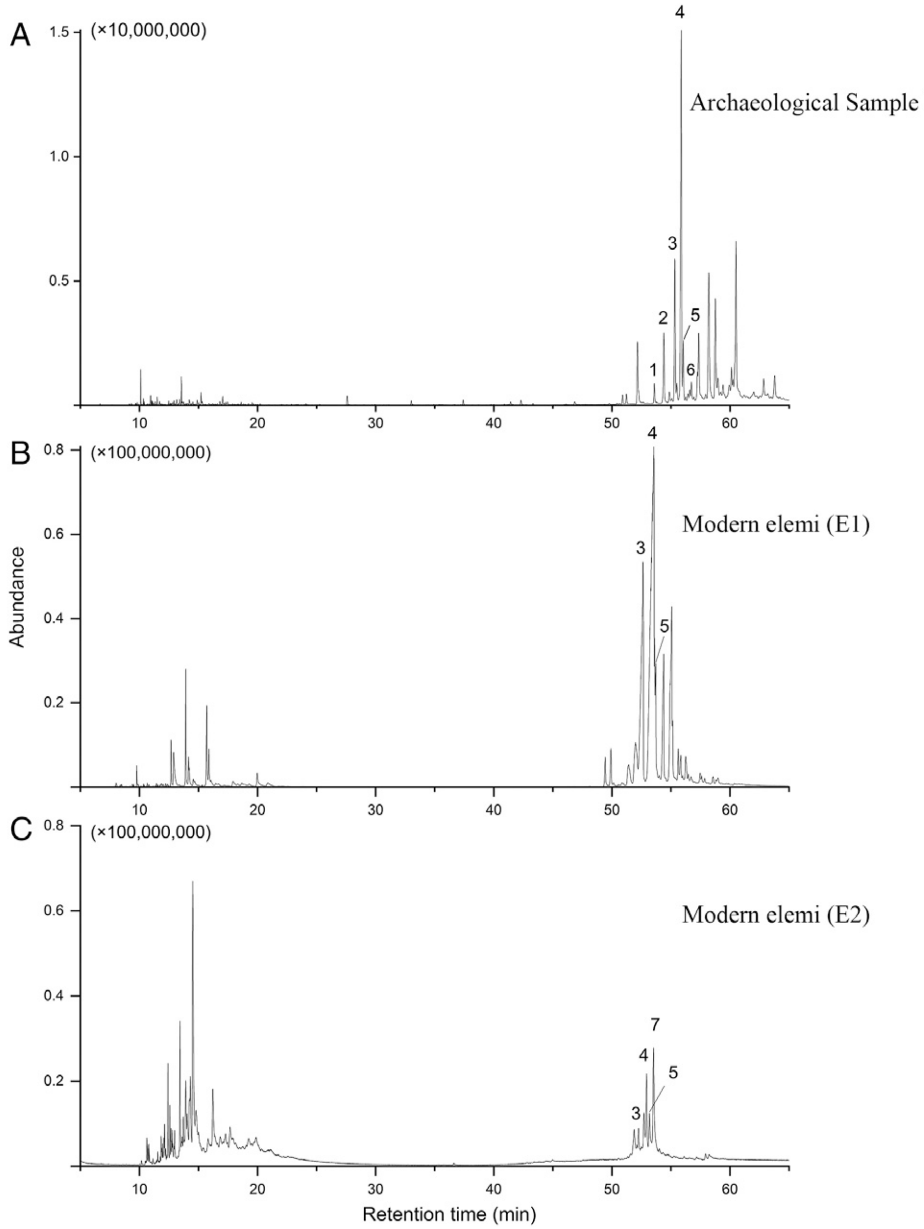

Fig. 3. Total ion current chromatograms of the archaeological and modern elemi samples. (*A*) Chromatogram of Sample I. (*B* and *C*) Chromatograms of modern elemi samples collected from (*B*) the Philippines and (*C*) southern China (labeled as E1 and E2, respectively). **1** = olean-9(11),12-dien-3-ol, TMS derivative, **2** = ursa-9(11),12-dien-3-ol, TMS derivative, **3** = β-amyrin, TMS derivative, **4** = α-amyrin, TMS derivative, **5** = lupeol, TMS derivative; compounds **6** and **7** were not clearly identified.

complement the results of Sample III. Fig. 5 *C* and *E* show the partial chromatograms of 2-(2-phenylethyl)chromone compounds and triterpenoids identified in modern agarwood and frankincense, respectively. These data are in line with those of the archaeological sample. The combination of the characteristic molecular components of agarwood and frankincense detected in Sample III, together with the comparisons with both modern samples, demonstrates that the aromatic powder kept in the begonia-shaped silver container (FD5: 094) should be a mixture of agarwood and frankincense.

Discussion

Buddhism, which originated in southern Asia and spread into China along the Silk Road around the first century CE, flourished during the Tang dynasty and became one of the most important religions in China (51, 52). *Sarira* is a Sanskrit word referring to Buddhist relics. Since the time of the Buddha's nirvana, Buddhists expressed their devotion by building stupas to bury sarira in north part of southern Asia. The development and spread of Buddhism during the Han dynasty attracted many Buddhist monks to China to propagate the Buddhist sutras and teachings, and they also brought sarira and promoted the construction of stupas and pagodas as well (8, 53). Sarira worship became increasingly prevalent and reached a peak during the Tang dynasty, and thus Famen Temple was inevitably a Buddhist pilgrimage center due to housing the sacred Buddha's finger bone sarira (25, 26). Incense can create a sacred religious atmosphere and help participants enter a state of peace and silence, etc.; therefore, they are indispensable in various Buddhist rituals and are endowed with a unique connotation of Buddhist incense culture. A wide variety of aromatics such as agarwood, sandalwood, frankincense, and clove often appear in Buddhist sutras with elaborations of their usage. Extremely

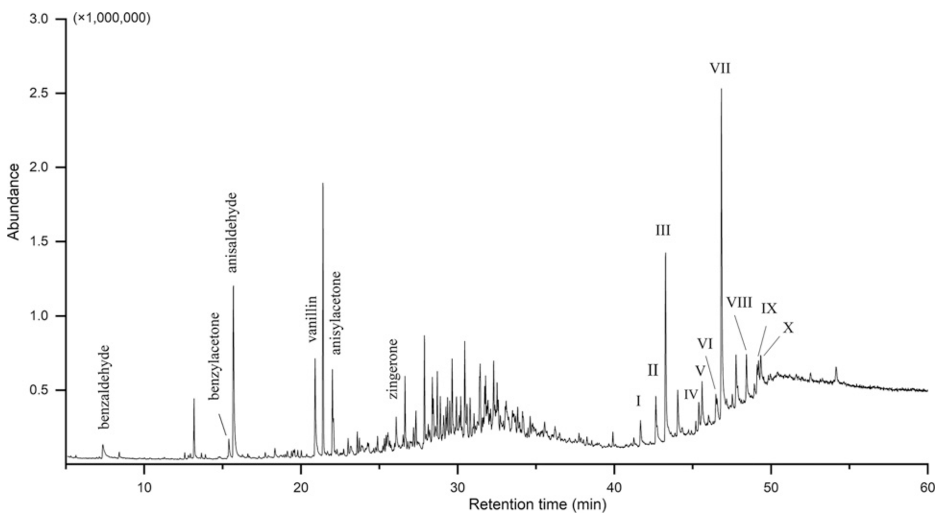

Fig. 4. TIC chromatogram of Sample II. Compounds I to X are 2-(2-phenylethyl)chromones, and the peak numbers refer to compounds listed in *SI Appendix*, Table S4.

large amounts of incense were consumed in Buddhist activities, especially in the royal greeting ceremonies held by the Tang emperors to enshrine and worship the finger bone sarira. The demand for scents and incense by the Buddhists also facilitated the spread of exotic incense in ancient China (54).

Natural resins have frequently been used as incense, adhesives, and binding media materials over the course of history; however, elemi resin was less studied and rarely reported archaeologically. The resinous materials in some Nabataean textile fragments probably used to wrap dead bodies about the first century CE were inferred to be elemi resin, providing the analytical evidence for the use of elemi in funeral practices (32, 55). Elemi resin is the generic term applied to various fragrant resins obtained from the Burseraceae family, including *Canarium* spp., *Bursera* spp., *Amyris* spp., *Protium* spp., and *Dacryodes* spp. (32, 56), among which Manila elemi exuding from *Canarium luzonicum* A. Gray growing in the Philippines is the most common (56). The resin harvested from *Canarium commune* L., native to Indonesia and Vietnam, is also known as elemi and was probably called *tram-trang* in Annamese (ancient Vietnamese) (18). In addition, *Canarium album* (Lour.) and *Canarium pimela* Leenh distributed in some regions of southern China, such as Guangdong, Guangxi, Fujian, and Taiwan provinces, also yield aromatic resins (57, 58). *Bursera*, *Amyris*, and *Protium* species of elemi mainly grow in Central and South America and could be excluded (32). The resin from the *Dacryodes hexandra* has also been sometimes given the name elemi; it is normally found in the West Indies (56, 59) and could also be excluded. In addition, lupeol and *epi*-lupeol were identified as major constituents of African elemi, resins from *Boswellia* trees (particularly *Boswellia frereana*), in earlier work (15, 19). Moreover, small amounts of boswellic acids and their respective derivatives were also detected in B. *frereana* resin (50). However, Sample I does not contain the chemical markers of B. *frereana* resin, suggesting that *B. frereana* is not present. In general, the results in our study seem to indicate that Sample I may be the elemi from *Canarium* trees mainly distributed in southeast Asia and southern China.

Elemi has the lemon- and pine-like scent, making it suitable for Buddhist rituals; however, to our knowledge, elemi resin has not been reported in association with archaeological findings in China, and its religious use and its function as incense remain poorly understood. Moreover, there is no exact record regarding elemi as incense in the Tang dynasty up to the present. The closest might be *Ganlantang* recorded in the historical geographic book *Ling Biao Lu Yi*, in which it was described as black gum obtained by decocting bark, branches, and leaves from trees of *Canarium* in southern China; it was mainly used as waterproofing and caulking agents for ships by the locals. The usage of *Ganlangtang* recorded in these ancient texts implies that it was unlikely to be served in the royal rituals for worship purposes, and thus there is a possibility that the well-preserved elemi in the Famen underground palace might be imported. Given that the large-scale trade items were well-documented in the Tang dynasty, such as frankincense, agarwood, and moschus (*She Xiang*), the absence of a record of elemi in ancient Chinese literature suggests that this aromatic resin was not widely used at that time. The extremely high rank of its containers further reflects the high quality of Sample I. Nonetheless, the presence of elemi in central China is not unexpected considering the frequent interactions between China and the southeastern periphery of the Tang Empire, as well as the widespread use of incense during this period (7, 11, 60). In short, this study provides physical evidence for elemi as incense in ancient China and its introduction in ritual practices associated with Buddhism.

Agarwood, or *Chenxiang* in Chinese, is harvested from specific trees in the genus *Aquilaria* of the Thymelaeaceae family, including *A. sinensis* growing in Hainan, Guangdong, and Fujian provinces in China and *Aquilaria malaccensis* and *Aquilaria crassna* grown in Malaysia, Indonesia, Vietnam, Myanmar, Cambodia, and India (61–63). A detailed description of the flower, fruit, and leaves of agarwood trees was first recorded in *Xin Xiu Ben Cao* (*Newly Revised Materia Medica*), a book of materia medica in ancient China written in 659 CE, which shows a heightened knowledge of exotic species during the Tang dynasty. However, *Ben Cao Shi Yi* (*Supplements to Materia Medica*) in 739 CE offers some different descriptions of agarwood, probably due to the variety of its species and origins. Agarwood is recorded as the foremost incense in Buddhist scriptures and was especially appreciated in the religious rituals. Due to the influence of Buddhist culture, agarwood occupied a prominent position in the incense trade during the Tang dynasty. According to *Tang Liu Dian* (*Six Code in Tang Dynasty*) and other historical documents, the domestic agarwood (*A. sinensis*) from southern China, also called *Tuchenxiang*, *Guanxiang*, or *Baimuxiang*, was officially listed as a

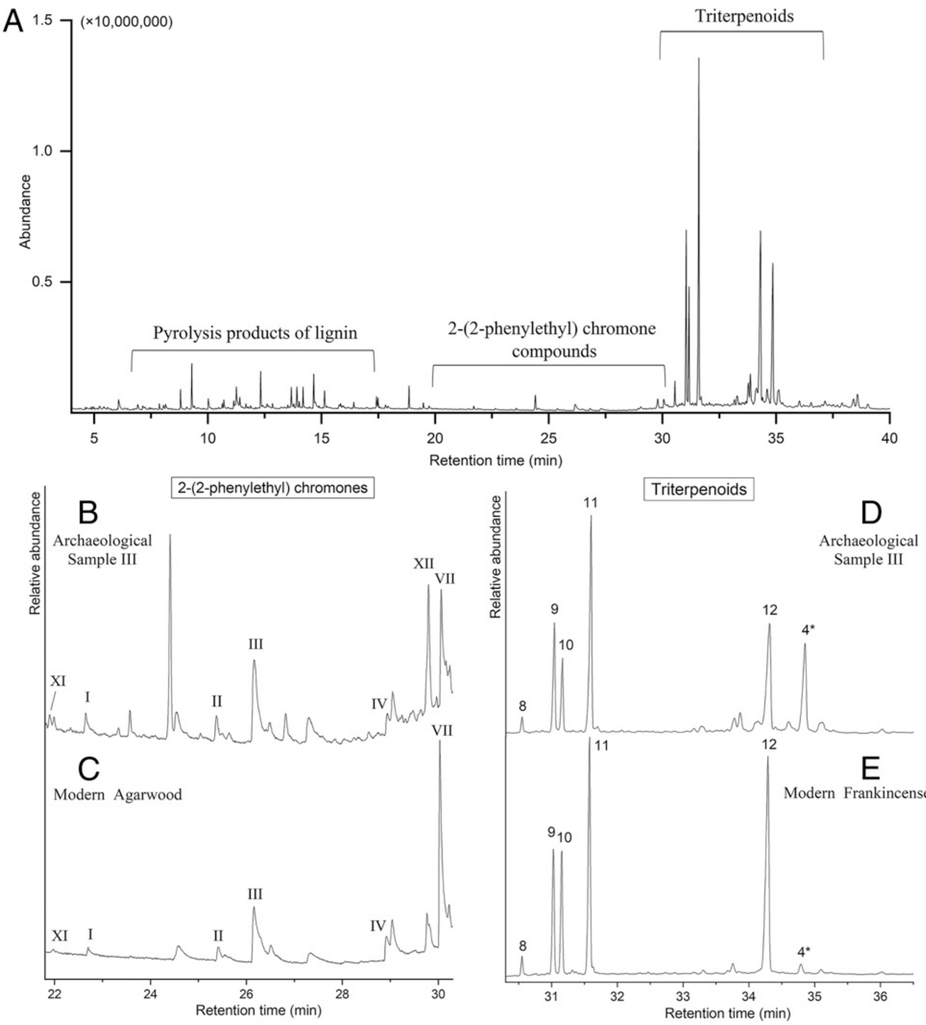

Fig. 5. Pyrograms of the archaeological and modern samples. (*A*) Pyrogram of Sample III showing the presence of lignin pyrolysates, 2-(2-phenylethyl)chromones, and triterpenoids. (*B* and *C*) Partial chromatograms of the 2-(2-phenylethyl)chromone compounds of (*B*) Sample III and (*C*) modern agarwood; the peak numbers refer to compounds listed in *SI Appendix*, Table S4. (*D* and *E*) Partial chromatograms of the triterpenoids of (*D*) Sample III and (*E*) modern frankincense; **8** = 24-noroleana-3,9(11),12-triene, **9** = 24-norursa-3,9(11),12-triene, **10** = 24-noroleana-3,12-diene, **11** = 24-norursa-3,12-diene, **12** = 24-norursa-3,12-dien-11-one, **4*** = α-amyrin.

tribute during the Tang dynasty. In addition, numerous agarwoods from Malaysia, Indonesia, Vietnam, Myanmar, Cambodia, India, and other foreign countries were continuously exported into China through a trade and tributary system (11, 64). *Xin Tang Shu* (*New Book of Tang*) includes a treatise on 30 countries in Southeast Asia, among which the *Linyi* kingdom (now in southern Vietnam) was the main country that used agarwood to pay tribute to China during the Early Tang period. *Ce Fu Yuan Gui* also states that the envoys and merchants of *Linyi* offered agarwood to the Tang dynasty in the 22nd year of Kaiyuan reign (734 CE) and the eighth year of Tianbao reign (749 CE). The agarwood in the underground palace of Famen Temple was kept inside a silver sarira container offered by an eminent monk, further demonstrating the important role this aromatic wood has played in Buddhist rituals.

Frankincense, also known as olibanum, is an aromatic resin derived from specific trees in the genus *Boswellia* of the Burseraceae family, which comprises ∼20 species, such as *Boswellia carterii* Birdw., *Boswellia bhau-dajiana* Birdw. and *Boswellia frereana* Birdw. in Somalia (50), *Boswellia sacra* Flueck. in South Arabia, and *Boswellia serrata* Roxb. in India (50, 65). This aromatic resin was called as *ruxiang* or *xunluxiang* in ancient China, with *xunluxiang* often used in documents before and during the Tang dynasty, whereas *ruxiang* more commonly used after the Song dynasty. *Xunlu* might be transliterated from *kunda* or *kundur* in Sanskrit, and *ruxiang* was a rough translation from *luban* in Arabic (which approximately means "from milking") into Chinese to describe the shape or color of the resin (66, 67). In ancient Chinese texts, *ruxiang* was recorded as originating in several foreign countries, such as *Daqin* (Rome), *Dashi* (Arab), *Persia* (Iran), and *Tianzhu* (India), among which *Tianzhu* was closely associated with Buddhism. However, *Daqin*, which is the ancient Chinese name for the Roman empire and the Near East in general, is not the geographical sources of frankincense (68). It should be mentioned that mastic, the aromatic resin secreted by plants of *Pistacia* species growing mainly along the Mediterranean coast (69), was also called as *ruxiang* (or *yangruxiang*) in Chinese and was sometimes misleading in ancient times. Thus, there is a possibility that *ruxiang* recorded in ancient Chinese books as originating in *Daqin* might be mastic.

It has long been proposed that the introduction of frankincense into China was potentially dated back to the Western Han dynasty; however, the earliest archaeological evidence requires further study. The frankincense sample discovered in the Nanyue King's tomb in Guangzhou, Guangdong Province was only analyzed by infrared spectroscopy, and the resulting spectra were compared with those of modern frankincense and rosin. The spectra of this sample are different from those of rosin and not identical to those of modern frankincense, and the difference between ancient and modern frankincense was speculated to arise from the long burial (13). Although infrared spectroscopy can be used to distinguish between diterpenoid resins (such as rosin) and triterpenoid resins (such as frankincense), most triterpenoid resins exhibit similar infrared characteristics (18, 31), and the complexity of archeological samples makes it more difficult to accurately identify unearthed aromatics using infrared spectroscopy alone, for example the discrimination between frankincense and mastic. In our study, frankincense was first identified as one of the main components in the aromatic powder, which is a product of *Hexiang* in ancient China, thus providing the earliest hard evidence of frankincense use in China, as well as indicating the extensive knowledge about this exotic incense by Chinese people in the ninth century.

Hexiang refers specifically to the product of blending various incense in Chinese and probably originated from the practices of burning various herbs. The four-hole connected censer unearthed in the Nanyue King's mausoleum of the Western Han dynasty could burn four kinds of different incense at the same time, resulting in the mixing of fragrance (13). However, this kind of multicavity censer was no longer used once the real *Hexiang* products appeared. With the increased importation of exotic incense, *Hexiang* became prevalent in the Tang dynasty, and a variety of products such as fragrant powder, pellets, and ointment appeared. They were recorded in some Tang materia medica, suggesting that *Hexiang* technology was closely related to the traditional Chinese pharmaceutical practices. The development of making *Hexiang* reached its peak in the Song dynasty, represented by the emergence of a large amount of specialized literature regarding *Hexiang* (70). The discovery in our study is of considerable significance as it provides the earliest archaeological evidence of *Hexiang* in China, which was determined to be composed of agarwood and frankincense. The combination of agarwood and frankincense also laid a foundation for the production of *Hexiang* in later periods. For example, *Song Shu* (*Song Annals*) mentions that agarwood could be blended with many incenses and was the foremost in many ancient *Hexiang* recipes. *Tian Xiang Zhuang* also records agarwood and frankincense as the main incense used in official sacrifices during the Song dynasty. Many recipes for making *Hexiang* were excerpted from Buddhist scriptures (71), in which both agarwood and frankincense were considered to be of high importance in Buddhist activities. The aromatic powder kept in the small exquisite silver container was offered to Buddhas and Bodhisattvas in Famen Temple, which was probably used as *vilepana* (smearing incense). According to Tantric texts, applying incense on the body imparts various Buddhist merits, cools and cleanses the body, and relieves distress. In addition, incense containers have been widely used in Buddhist activities, approximately from the Northern Wei dynasty (386 to 534 CE) (71), and their images are often seen in Buddhist murals (72, 73).

Incense and spices occupied a prominent position in ancient tribute and trade activities, which profoundly supported and influenced the development of the Silk Road (7, 11). The prospering of the land and maritime routes enabled the entry of exotic incense into central China from the western regions and through port cities such as Guangzhou, Quanzhou, and Yangzhou (74–76). Incense is particularly indispensable in various Buddhist activities for creating a sacred religious atmosphere and spiritual experience, as well as for gaining merits (9, 77). The growing consumption of incense in the Tang dynasty was closely related to the prosperity of Buddhism, which facilitated the spread of exotic incense in medieval China, and exerted great influence upon religious rituals, court activities, and secular lives then.

Conclusions

This study is a systematic analysis of three incense samples unearthed from the underground palace of Famen Royal Temple, which were sacrificed by the emperors and eminent monks to worship Buddha's sarira in the Tang dynasty. The yellow aromatic resin inside the seventh of the "eight-nested boxes," a set of sarira containers offered by Emperor Yizong, was identified as elemi, providing the earliest evidence of elemi employed as incense associated with Buddhist rituals. The extremely high quality of these containers also revealed the rarity and value of this fragrant resin in China over 1,000 y ago. Pieces of fragrant wood placed in a silver container offered by the Tantric monk Zhihuilun in the late Tang period were found to be agarwood, which served an important role in sarira worship activities. The aromatic powder stored in the begonia-shaped silver container was a mixture of agarwood and frankincense, which has first revealed the main ingredients of *Hexiang* in ancient China and accordingly its function in the specified Buddhist rituals of the royal family in the Tang dynasty. These incense samples are mainly from extraterritorial or possibly from the southern periphery of China, and they were transported to the capital Chang'an and the eastern capital Luoyang of the Tang dynasty through the land and/or maritime Silk Road, thus shedding light on incense trading and its functions in Buddhist worship practices during the Tang dynasty.

Materials and Methods

FTIR Analysis. Micro samples were preliminary investigated by FTIR analysis using a Nicolet micro-FTIR spectrometer (Thermo Scientific) in transmission mode. Spectra were acquired over the range of 4,000 to 550 cm^{-1}, with a resolution of 4 cm^{-1}, and the spectra were analyzed with OMNIC Picta software.

Micromorphological Examination. After preliminary microscopic observation of the aromatic wood (Sample II) through a stereomicroscope, three sections (transverse, radial, and tangential) of this sample were cut and scanned under a scanning electron microscope (ZEISS EVO MA 25). Sample II was also scanned by SR-μCT at the beamline station BL13W of the Shanghai Synchrotron Radiation Facility, Shanghai, China. The space resolution of the charge-coupled device detector was 3.7 μm, with a source energy setting of 12 keV.

GC/MS Analysis. An amount of 1 to 3 mg of the aromatic resin (Sample I) was extracted using 3 mL of chloroform/methanol (2:1 vol/vol) in ultrasonic baths for 20 min. The extract was then derivatized with 50 μL of BSTFA [bis(trimethylsilyl)-trifluoroacetamide with 1% trimethylchlorosilane] by heating at 70 °C for 1 h. Afterward, the derivatization reagent was evaporated under a stream of nitrogen and redissolved in 1 mL of hexane. GC/MS analysis was performed with a 7890A gas chromatograph and 5975C mass detector (Agilent Technologies) in electron ionization mode (70 eV). A capillary column HP-5MS (30 m × 0.25 mm × 0.25 μm) was used to perform the separation for the archaeological samples and DB-5HT (30 m × 0.25 mm × 0.1 μm) for modern Burseraceae resin samples. The same temperature program and split ratio were adopted for both columns. A 1-μL volume of the sample was injected in split mode of 20:1. The temperature program was as follows: initial temperature 50 °C for 2 min, increased to 150 °C at 10 °C/min, then up to 295 °C at 3 °C/min, with 10-min isothermal. Helium was used as the carrier gas in a constant flow rate of 1.0 mL/min. The MS ion source temperature was 230 °C; the interface temperature was

280 °C; the MS quadrupole temperature was 150 °C. The spectrometer is run in scan mode, detecting ions from 50 to 600 *m/z*. The blank extraction was also carried out under the same protocol in order to check the contamination. The compound identification was based on the comparison with the NIST library and interpretation of the main fragmentations.

About 5 to 10 mg of aromatic wood (Sample II) was used for GC/MS analysis, and the solvent extraction was not trimethylsilylated. It was injected in the split mode with a split ratio of 10:1. The oven temperature program was as follows: initial temperature 50 °C, increased to 290 °C at 5 °C/min, maintained for 20 min. Other conditions are the same as above. The compound identification was based on the comparison with NIST library and with published literature (35–41).

Py-GC/MS Analysis. Sample III is on display in the museum, and very limited sample amounts are available for destructive analysis. Py-GC/MS was adopted for determining the compositions of this aromatic powder, mainly because a smaller sample size is required, and a wide range of components can be identified in the sample at one time. Py-GC/MS analysis was performed using an integrated system of EGA/PY-3030D pyrolyzer (Frontier Laboratories) and 7890B/5977A gas chromatograph/mass spectrometer (Agilent Technologies). The GC system was equipped with an Ultra-ALLOY-5-30M-0.25F capillary column. About 0.3 mg of Sample III was placed in a stainless-steel sample cup. The cup was placed on top of the pyrolyzer and then started the temperature program of the GC oven. The pyrolysis was performed at 300 °C for 30 s. Helium was used as the carrier gas at a flow rate of 1.0 mL/min and split of 10:1. The injector and GC/MS transfer line were set at 300 °C. The GC oven temperature program was 35 °C for 2 min, 8 °C/min up to 240 °C, 3 °C/min up to 250 °C, 4-min isothermal, then 20 °C/min up to 300 °C, 10-min isothermal. The mass spectrometer was operated in electron ionization mode (70 eV) with *m/z* range of 29 to 600; ion source temperature was 230 °C and quadrupole temperature was 150 °C. The NIST library and published literature (17, 50) were used for identifying the compounds.

Data Availability. All study data are included in the article and/or *SI Appendix*.

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1. H. Pirenne, *Economic and Social History of Medieval Europe*, Lewen, trans. (Shanghai People's Publishing House, Shanghai, 2001).
2. X. Wang, Frankincense and Silk Roads—Oman's early communication with China. *J. Tsinghua University (Philosophy and Social Sciences)* **35**, 1–14 (2020).
3. F. N. Hepper, Arabian and African frankincense trees. *J. Egypt. Archaeol.* **55**, 66–72 (1969).
4. N. Groom, *Frankincense and Myrrh: A Study of the Arabian Incense Trade* (Longman, London, 1981).
5. L. Casson, *The Periplus Maris Erythraei: Text with Introduction, Translation, and Commentary* (Princeton University Press, Princeton, 1989).
6. M. Lin, *The Marine Trade Between the East and The West During the Tang and Song Dynasties. Fifteen Lectures on Archaeology of the Silk Roads* (Peking University Press, Beijing, 2006), pp. 221–251.
7. E. H. Schafer, *A Study of Tang Exotics*, Y. Wu, trans. (China Social Sciences Press, Beijing, 1995).
8. V. Hansen, *The Silk Road: A New History* (Oxford University Press, London, 2012).
9. D. Shen, Y. Wang, Q. Ma, "Research on aromatics in ancient ritual and aromatic samples unearthed from the underground palace of Dabaoen Temple in Nanjing" in *Preservation Technology of Ancient Gilt and Silverware, Glassware and Spices—Research on the Preservation Technology of Nanjing Ashoka Pagoda and the Unearthed Cultural Relics*, Z. Zhang, Y. Song, D. Shen, Q. Ma, Eds. (Science Press, Beijing, 2014), pp. 113–165.
10. Y. Wang, Q. Ma, Study on the source of aromatics unearthed from Ashoka Pagoda of Baoen Temple in Nanjing. *China Cult. Herit. Sci. Res.* **2**, 87–92 (2012).
11. C. Wen, *Study on Exotic Incenses and Drugs in Medieval China* (Science Press, Beijing, 2016).
12. B. Chen, *Frankincense in the Spices Trade During the Song Dynasty* (Jinan University, Guangzhou, 2000).
13. Guangzhou Cultural Relics Administration Committee; Institute of Archaeology Chinese Academy of Social Sciences; Guangdong Provincial Museum, *Nanyue King's Tomb of the Western Han* (Cultural Relics Publishing House, Beijing, 1991).
14. T. M. Nicholson *et al.*, Enlightening the past: Analytical proof for the use of Pistacia exudates in ancient Egyptian embalming resins. *J. Sep. Sci.* **34**, 3364–3371 (2011).
15. C. Mathe, G. Culioli, P. Archier, C. Vieillescazes, Characterization of archaeological frankincense by gas chromatography-mass spectrometry. *J. Chromatogr. A* **1023**, 277–285 (2004).
16. R. P. Evershed *et al.*, Archaeological frankincense. *Nature* **390**, 667–668 (1997).
17. P. F. van Bergen, T. M. Peakman, E. C. Leigh-Firbank, R. P. Evershed, Chemical evidence for archaeological frankincense: Boswellic acids and their derivatives in solvent soluble and insoluble fractions of resin-like materials. *Tetrahedron Lett.* **38**, 8409–8412 (1997).
18. M. Regert, T. Devièse, A.-S. Le Hô, A. Rougeulle, Reconstructing ancient Yemeni commercial routes during the Middle Ages using structural characterization of terpenoid resins. *Archaeometry* **50**, 668–695 (2008).
19. C. Mathe, J. Connan, P. Archier, M. Mouton, C. Vieillescazes, Analysis of frankincense in archaeological samples by gas chromatography-mass spectrometry. *Ann. Chim.* **97**, 433–445 (2007).
20. S. Hamm, J. Bleton, J. Connan, A. Tchapla, A chemical investigation by headspace SPME and GC-MS of volatile and semi-volatile terpenes in various olibanum samples. *Phytochemistry* **66**, 1499–1514 (2005).
21. R. C. Brettell *et al.*, 'Choicest unguents': Molecular evidence for the use of resinous plant exudates in late Roman mortuary rites in Britain. *J. Archaeol. Sci.* **53**, 639–648 (2015).
22. J. Baeten, K. Deforce, S. Challe, D. De Vos, P. Degryse, Holy smoke in medieval funerary rites: Chemical fingerprints of frankincense in southern Belgian incense burners. *PLoS One* **9**, e113142 (2014).
23. P. Charlier *et al.*, The embalmed heart of Richard the Lionheart (1199 A.D.): A biological and anthropological analysis. *Sci. Rep.* **3**, 1296 (2013).
24. R. Chen, X. Miu, J. Dai, Identification and textual research of Dalbergia wood from shipwreck in the Song Dynasty in Quanzhou Bay. *Shanghai J. Tradit. Chin. Med.* **5**, 55–58 (1979).
25. W. Yang, A brief discussion on Sarira of Buddha's finger bone. *Mt Wutai Res.* **2**, 14–18 (1992).
26. W. Yang, Analysis of Buddha's finger bone Worship in Famen Temple. *J. Northwest Univ. Philos. Soc. Sci. Ed.* **1**, 72–78 (1994).
27. Shaanxi Provincial Institute of Archaeology; Famen Temple Museum; Baoji Municipal Administration of Cultural Heritage; Fufeng County Museum, *Report of Archaeological Excavation at Famen Temple: I* (Cultural Relics Publishing House, Beijing, 2007).
28. Shaanxi Provincial Institute of Archaeology; Famen Temple Museum; Baoji Municipal Administration of Cultural Heritage; Fufeng County Museum, *Report of Archaeological Excavation at Famen Temple: II* (Cultural Relics Publishing House, Beijing, 2007).
29. X. Shi, "The discovery of the treasures from the underground palace of Famen Temple and its related problems" in *First International Symposium on History and Culture of Famen Temple,* Q. Zhang, J. Han, Eds. (Shaanxi People's Education Publishing House, 1992), pp. 6–30.
30. X. Shi, *Treasures from the Underground Palace of Famen Temple* (Shaanxi People's Fine Arts Publishing House, Xi'an, 1988).
31. M. R. Derrick, D. Stulik, J. M. Landry, *Infrared Spectroscopy in Conservation Science* (Getty Publications, 2000).
32. C. Mathe, P. Archier, L. Nehme, C. Vieillescazes, The study of Nabataean organic residues from Madâ'in Sâlih, ancient Hegra, by gas chromatography–mass spectrometry. *Archaeometry* **51**, 626–636 (2009).
33. J. De la Cruz-Cañizares, M. T. Doménech-Carbó, J. V. Gimeno-Adelantado, R. Mateo-Castro, F. Bosch-Reig, Study of Burseraceae resins used in binding media and varnishes from artworks by gas chromatography-mass spectrometry and pyrolysis-gas chromatography-mass spectrometry. *J. Chromatogr. A* **1093**, 177–194 (2005).
34. G. P. Cotterrell, T. G. Halsall, M. J. Wriglesworth, The chemistry of triterpenes and related compounds. Part XLVII. Clarification of the nature of the tetracyclic triterpene acids of elemi resin. *J. Chem. Soc. org.* **5**, 739–743 (1970).
35. W.-L. Mei *et al.*, Characterization and determination of 2-(2-phenylethyl)chromones in agarwood by GC-MS. *Molecules* **18**, 12324–12345 (2013).
36. H.-Q. Chen *et al.*, Chemical constituents of agarwood originating from the endemic genus Aquilaria plants. *Chem. Biodivers.* **9**, 236–250 (2012).
37. R. Naef, The volatile and semi-volatile constituents of agarwood, the infected heartwood of Aquilaria species: A review. *Flavour Fragr. J.* **26**, 73–87 (2011).
38. Y. Chen, B. Jiang, Y. Zeng, Study on chemical constituents of chromones in agarwood. *Modern Chinese Medicine* **1**, 21–22 (2011).
39. W. L. Mei, Y. B. Zeng, J. Liu, H. F. Dai, GC-MS analysis of volatile constituents from five different kinds of Chinese eaglewood. *Zhong Yao Cai* **30**, 551–555 (2007).
40. J. S. Yang, Y. L. Wang, Y. L. Su, Studies on the chemical constituents of *Aquilaria sinensis* (Lour.) Gilg. V. Isolation and characterization of three 2-(2-phenylethyl) chromone derivatives. *Yao Xue Xue Bao* **25**, 186–190 (1990).
41. J. S. Yang, Y. L. Wang, Y. L. Su, Studies on the chemical constituents of *Aquilaria sinensis* (Lour.) Gilg. IV. Isolation and characterization of 2-(2-phenylethyl)chromone derivatives. *Yao Xue Xue Bao* **24**, 678–683 (1989).
42. T. Jing, W. Zhenguo, Medical culture about Lignum Aquilariae Resinatum and its maritime silk road. *Chin. Med. Cult.* **3**, 220–224 (2020).
43. H. Ma, *Studies on Agar Forming Mechanism of Aquilaria sinensis (Lour,) Gilg* (Chinese Academy of Forestry, Beijing, 2013).
44. G. Li, L. Duan, C. Yang, J. Zhao, X. Li, Advances in the research on the technology of agar forming. *J. Anhui Agric. Sci.* **37**, 12012–12013 (2009).
45. T. Wang, L. F. Li, K. Zhang, W. Y. Zhang, Y. H. Pei, New 2-(2-phenylethyl) chromones from *Bothriochloa ischaemum*. *J. Asian Nat. Prod. Res.* **3**, 145–149 (2001).
46. S. R. M. Ibrahim, New 2-(2-phenylethyl)chromone derivatives from the seeds of *Cucumis melo* L var. reticulatus. *Nat. Prod. Commun.* **5**, 403–406 (2010).
47. O. Faix, Classification of lignins from different botanical origins by FT-IR spectroscopy. *Wood Res. Technol.* **45**, 21–28 (1991).

48. X. Colom, F. Carrillo, F. Nogués, P. Garriga, Structural analysis of photodegraded wood by means of FTIR spectroscopy. *Polym. Degrad. Stab.* **80**, 543–549 (2003).
49. A. Naumann, S. Peddireddi, U. Kües, A. Polle, "Fourier transform infrared microscopy in wood analysis" in *Wood Production, Wood Technology, and Biotechnological Impacts*, U. Kües, Ed. (Universitätsveralg Göttingen, 2007), pp. 179–196.
50. S. Basar, *Phytochemical Investigations on Boswellia Species: Comparative Studies on the Essential Oils, Pyrolysates and Boswellic Acids of Boswellia carterii Birdw., Boswellia serrata Roxb., Boswellia frereana Birdw., Boswellia neglecta S. Moore and Boswellia rivae Engl* (University of Hamburg, Hamburg, 2005).
51. J. Xu, The White Horse Temple in Luoyang. *Cult. Relics* **6**, 88–90 (1981).
52. J. Li, *Research on the Religions Along the Silk Road* (Xinjiang People's Publishing House, Urumchi, 2010).
53. W. Ran, *Study on Sarira Bury System in Ancient China* (Cultural Relics Publishing House, Beijing, 2013).
54. B. Jiang, *Dunhuang-Turfan Documents and the Silk Road* (Cultural Relics Publishing House, Beijing, 1994).
55. A. Chr *et al.*, Report on the 2004, Fourth Season, of the Saudi-French Archaeological Project at Madâ'in Sâlih. *Atlal* **20**, 197–220 (2010).
56. J. Mills, R. White, *Organic Chemistry of Museum Objects* (Routledge, London, ed. 2, 1999).
57. M. Gao, *A Study of Ancient Chinese Names of Plants* (Elephant Press, Zhengzhou, 2006).
58. Editorial Board of Flora Reipublicae Popularis Sinicae, *Flora Reipublicae Popularis Sinicae* (Science Press, Beijing, 1997).
59. L. H. Tee *et al.*, Nutritional compositions and bioactivities of *Dacryodes* species: A review. *Food Chem.* **165**, 247–255 (2014).
60. Y. Liao, The relations between China and States in south China Sea during the Han and Tang Dynasties. *Acad. Forum* **11**, 93–96 (2007).
61. J. Q. Huang *et al.*, [Historical records and modern studies on agarwood production method and overall agarwood production method]. *Zhongguo Zhongyao Zazhi* **38**, 302–306 (2013).
62. Editorial Board of Chinese Materia Medica, *The Chinese Materia Medica* (Shanghai Science and Technology Press, Shanghai, 1999).
63. Y. Z. H.-Y. Hashim, P. G. Kerr, P. Abbas, H. Mohd Salleh, *Aquilaria* spp. (agarwood) as source of health beneficial compounds: A review of traditional use, phytochemistry and pharmacology. *J. Ethnopharmacol.* **189**, 331–360 (2016).
64. C. Wen, Study on the history of aromatics and drugs imported into China from the South Sea states in the Han and Tang Dynasties. *Guizhou Soc. Sci.* **3**, 139–144 (2013).
65. M. Z. Siddiqui, Boswellia serrata, a potential antiinflammatory agent: An overview. *Indian J. Pharm. Sci.* **73**, 255–261 (2011).
66. R. Zhao, *Chinese and Foreign Transport History Series: Annotation of Zhufanzhi* (Zhonghua Book, Beijing, 2000).
67. L. Chen, The spices imported into China during the Han and Jin Dynasties. *Collect. Pap. Hist. Stud.* **2**, 8–17 (1986).
68. F. Hirth, *China and the Roman Orient*, J. Zhu, trans. (Elephant Press, Zhengzhou, 2009).
69. A. N. Assimopoulou, V. P. Papageorgiou, GC-MS analysis of penta- and tetra-cyclic triterpenes from resins of *Pistacia* species. Part II. *Pistacia terebinthus* var. Chia. *Biomed. Chromatogr.* **19**, 586–605 (2005).
70. T. Jia, *Chinese Incense* (Zhonghua Book, Beijing, 2018).
71. Z. Yang, *The Knowledge of Incense* (Guangxi Normal University Press, Guilin, 2011).
72. Longmen Antiquities Conservatory, *Chinese Grottoes: Longmen Grottoes* (Cultural Relics Publishing House, Beijing, 1991).
73. Northwest University Archaeological Team, *Cishansi Temple and Linxiqiao: Investigation Report on Grottoes and Niches of Buddhist Statues* (Science Press, Beijing, 2002).
74. J. Wang, *Cultural Exchange between China and Southeast Asia* (Shanghai People's Publishing House, Shanghai, 1998).
75. M. Wu, *A Preliminary Study of the Formation of Exotic Aromatics Knowledge in the Tang Dynasty* (National Tsing Hua University, 2012).
76. C. Wu, *Archaeological and Historical Exploration of Marine Heritage* (Maritime Press, Beijing, 2016).
77. X. Yan, Buddhism and incense burning. *China Religion* **5**, 45–47 (2008).