ANNALES

ACTA ACADEMIAE SCIENTIARUM INSTITUTI BONONIENSIS

CLASSIS SCIENTIARUM MORALIUM

Bologna
University Press

ANNALES

ACTA ACADEMIAE SCIENTIARUM INSTITUTI BONONIENSIS

CLASSIS SCIENTIARUM MORALIUM

1

Fondazione Bologna University Press
Via Saragozza 10, 40123 Bologna
tel. (+39) 051 232 882 – fax (+39) 051 221 019

ISBN: 979-12-5477-370-3
ISBN online: 979-12-5477-371-0
ISSN: 2389-6116
DOI: 10.30682/annalesm2301

www.buponline.com
info@buponline.com

Cover: Pellegrino Tibaldi, *Odysseus and Ino-Leocothea*, 1550-1551,
detail (Bologna, Academy of Sciences)

Layout: Gianluca Bollina-DoppioClickArt (Bologna)

First edition: December 2023

Table of contents

Lead (Pb) Products and Sino-Iranian Relations in Late Antiquity*

Jeffrey Kotyk

Department of Cultural Heritage, University of Bologna

Contribution presented by Antonio C. D. Panaino

Abstract

Lead (Pb) was domestically produced in China since antiquity, but certain types of lead and lead products were imported from Iran, especially starting in the sixth to seventh centuries. The significance of this exchange in a wider Eurasian context remains largely unrecognized. Chinese medicine in the early Tang period expresses an awareness of litharge as a product of Persia. The word in Chinese is a transcription from Middle Persian. We also observe Buddhist magical practices begin using the substance around the same time. Shortly thereafter a domestic production of litharge is documented, which points to a technology transfer having occurred. Chinese metallurgists were also aware that "Persian lead" was of a different quality than the domestic variety. This study argues that lead and lead products constituted a noteworthy example of material exchange between Iran and China in Late Antiquity, which in itself only highlights the significance of Iran to the history of China.

Keywords

China, Iran, Lead (Pb), Metallurgy, Litharge, Persia.

* This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101018750.

Introduction

Material exchanges between China and foreign polities to the west continually occurred throughout history stretching back to ancient times. The Chinese were, of course, well-known as suppliers of silken textiles. The Romans at times lamented that they could not directly access the Chinese market, but instead they had to rely upon Iranians as intermediaries for the products and therefore pay a much undesirable premium that only benefited their rival, the Sasanians. Commercial exchanges accelerated during the Common Era, when overland and maritime trade links grew. This included a significant amount of Sino-Iranian trade.[1] There was a diversity of goods traded back and forth between East and West Asia, but some of the commodities sent eastward are not properly understood today.

In this study, I want to draw attention to lead (Pb) products as a unique case of material culture between Iran and China that has not received sufficient attention. Although China had its own domestic production of lead (*qian* 鉛) and its properties were well-understood by Chinese metalworkers since antiquity, a certain amount of lead and lead-based products were still imported from Iran from around the sixth to seventh centuries. This fact emphasizes the significance of Iran as a source of some metals for the Chinese, but also that these products influenced Chinese culture in identifiable ways. This study will point out the significance of Iran to historical Chinese metallurgy.

Trade Connections and Metals

Although trade certainly occurred between Parthia and China, too few details about this relationship are available based on the available evidence. We know far more about commercial links between Sasanian Iran (Persia) and China. Formal diplomatic connections between the two empires commenced in the year 455 (Rong 2015, 61-80). One of the dynastic histories of China, the *Wei shu* 魏書 (*Book of Wei*), which was compiled by Wei Shou 魏收 (506-572) in 554, offers an early albeit brief overview of Sasanian culture, and lists a number of commodities produced in Persia. The metals of Persia include gold, silver, brass, copper, tin, and mercury, but not lead.[2] Lead, however, was produced in Kucha (*Qiuzi* 龜茲) according to the text.[3]

---

[1] Procopius (1.20), for example, relates that Justinian (r. 527-565) sought that the Ethiopians purchase silk from India and then directly resell it to the Romans. The Romans had to otherwise purchase the silk from the Persians, but this solution was impractical because «it was impossible for the Aethiopians to buy silk from the Indians, for the Persian merchants always locate themselves at the very harbours where the Indian ships first put in, (since they inhabit the adjoining country), and are accustomed to buy the whole cargoes». See translation in Dewing (1961, 193). See also Whitehouse and Williamson (1973, 44). Lieu (2000, 48).

[2] The *Wei shu* is a valuable early Chinese witness to the Sasanian economy and culture. We also see therein discussion of the calendar, among other topics. For relevant discussions on Chinese accounts of Persia, see Daffinà (1983) and Kotyk (2022).

[3] *Wei shu*, 102.2266, 2270-2271. The famous monk Xuanzang 玄奘 (602-664), who travelled to India and back to China, also notes in his travelogue that Kucha (*Quzhi* 屈支) produces lead. See the *Da Tang xiyu ji* 大唐西域記 (*Great Tang Account of the Western Regions*), *T* 2087, 51, 870a17-19. See translation by Li (1996, 17).

Nevertheless, we know that a certain lead product was evidently sourced from Persia because this is denominated using a loanword from Middle Perian, namely *mituoseng* 密陀僧 (Early Middle Chinese: *mit da səŋ*). This is a phonetic transcription of *murdār-sang* (the "dead stone") from Middle Persian, as was already pointed out by Laufer (1919, 508). This is dross of lead or litharge (lead oxide).[4] We might infer that Persia produced litharge in significant quantities, based the fact that the cognate in Syriac stems not from Greek (λῐθᾰ́ργῠρος), but from Middle Persian: «mrdkʾ, mwrdkʾ, mrdsng 'litharge, lead protoxide', MPers. *mord*(*e*)-*sang*» (Ciancaglini 2006).[5]

Materia Medica

We might conjecture that this *murdār-sang* first became known to the Chinese through the translation of *materia medica* from foreign languages (presumably Persian or Syriac) because the medical applications of the substance are related early on and we can identify a parallel with at least one major source of Syriac medicine. As Song (2001, 15) points out, the *Xinxiu bencao* 新修本草 (*Revised Materia Medica*), which was compiled by Su Jing 蘇敬 (599-674) in 659, already discusses *murdār-sang*. The relevant entry specifically states that it is sourced from Persia, and that its medical applications include treatments for persistent diarrhea, hemorrhoids, scars from lacerations, and facial scars. A medicine including the substance could be applied on the face as an ointment. The "minor toxicity" (*you xiaodu* 有小毒) of the substance is also recognized. Su Jing also states the word is a foreign term (*hu yan* 胡言).[6] The use of litharge as a remedy for hemorrhoids parallels a prescription found in the medieval Syriac *Book of Medicines* (*Spar-Sammāné*), which was translated into English by Budge (1913, 511). This work prescribes the use of lead dross as an ingredient in a remedy «for the anus that protrudeth and for the boils in it». The medicinal applications of the substance in Chinese, we might infer, stemmed from a foreign source.

The source of this knowledge in Chinese, however, is difficult to identify with any confidence. A significant amount of Indian medical literature was already translated during the Sui dynasty (581-617) and preceding eras (Xue 2007, 205-212). The bibliography in the dynastic history of the Sui (*Sui shu* 隋書, *Book of the Sui*) includes the titles of a number of medical works dealing with Indian medicine, but we also see a work with a title that we might translate as the *Collected Prescriptions of Eminent Physicians of the Western Regions*. This is noted to have originally been a lengthy twelve fascicles, although it was only four fascicles at the time (perhaps the remaining fascicles had been lost).[7] The original text is not extant, hence we may

[4] See phonetic reconstruction of Middle Chinese pronunciations of characters by Pulleyblank (1991, 213, 272, 314).

[5] There is also the possibility that the Chinese word was transcribed from Syriac, although even in that case the substance was originally known from and presumably produced in Persia.

[6] See the handwritten copy from 1889 in the National Diet Library of Japan (特1-3021). https://dl.ndl.go.jp/info:ndljp/pid/2557930. See also digitized text on CTEXT. The meaning of *hu* 胡 is somewhat ambiguous, but during the Tang period, Sogdians, Persians, and Arabs were called *hu*, in contrast to other ethnonyms, such as *man* 蠻, which referred to diverse peoples of Southeast Asia.

[7] The Chinese title is *Xiyu mingyi suoji yaofang* 西域名醫所集要方. See *Sui shu* 34.1047-1048. Wang (2022).

only speculate about its contents based on the title. This may not have been exclusively Indian medicine, since the "Western Regions" also denoted every other land westward to Byzantium. It has been pointed out by some scholars that Syriac Christian (*Jingjiao* 景教) clergymen also practiced medicine in China. The Church formally arrived in China in 635, and then firmly established itself following the recognition by the court only a few years later. There was certainly ample opportunity to translate for the court works on medicine from West Asian languages, especially as multilingual clergy became active in China.[8]

Buddhist Works

Turning to Buddhist texts, the sangha already used the phonetic transcription of *murdār-sang* starting around the seventh century, a fact which would only point to the West Asian source of the word, because otherwise we would expect a transcription from Sanskrit and not Persian. One prime example of this is found in the *Collection of Dhāraṇīs* (*Tuoluoni ji jing* 陀羅尼集經), translated by Atikūṭa (Adijuduo 阿地瞿多) in the year 654, in which we observe *murdār-sang* alongside transcriptions of Sanskrit terms: «If someone wishes to gain *antardhāna* [invisibility], take both *manaḥśilā* (in China called stone-realgar) and *murdār-sang* in equal portions and pound them together into powder, and then further grind them …». 若人欲得安怛囉二合陀那, 取摩那叱囉唐云石雄黃也蜜陀僧二物等分, 共擣為末, 更細研之 ….[9]

This sort of magical application of *murdār-sang* was translated from a Sanskrit source, but *murdār-sang* was already an accepted word in the common parlance in China. Whether Chinese Buddhists regularly engaged in such spellwork as we read above is uncertain, but in light of the diverse uses of litharge already in the early Tang, and the fact that Chinese metallurgy was highly developed, we should suspect that a domestic production would have quickly developed.

Domestic Production of Litharge

Indeed, at some point during the Tang period (618-907), more likely in an earlier than a later period, litharge was, in fact, domestically produced. This is clear from statements in a Daoist alchemical treatise. This treatise appears to date to the Tang period.[10] Therein we read, «The lead of Jiazhou [Sichuan] and the earths of different provinces are refined into powder [lead carbonate?]. It is roasted into massicot; it also becomes *murdār-sang*; it also becomes lead powder». 嘉州鉛及雜州土鍊成爲粉; 燒成黃丹, 亦成蜜陀僧, 亦成胡粉.[11] Golas (1999, 56) explains that argentiferous lead occurs in the northern mountains of the Mesozoic basin of Sichuan. This perhaps was the source of the "lead of Jiazhou", although this is uncertain.

[8] See studies by Huang (2002) and Nie (2008).

[9] *T* 901, 18, 832c2-7.

[10] The treatise is titled *Yin Zhenjun jinshi wuxiang lei* 陰眞君金石五相類 (*Five Categories of Metals and Stones by True Lord Yin*). The author attributed it to a famous Yin Changsheng 陰長生 (titled *True Lord Yin*, Yin Zhenjun 陰眞君) from the Han period. See Hu (1995, 361-362).

[11] *DZ* 900, 19, 99a20-b1.

"Persian Lead"

This type of lead from Jiazhou is distinguished from what the author calls "Persian lead" (*Bosi qian* 波斯鉛), which is equated to an ambiguous "lead of the shifting sands" (*liusha qian* 流沙鉛). We know that this is a reference to lead sources from the Western Regions (i.e., the Tarim Basin and beyond) because we read, «Although there is blossom from the lead of China, it is light and it cannot attain pure form; it is different from the lead of the shifting sands in the western countries». 漢國鉛雖有華, 輕不得純體, 不同西國流沙鉛.[12] I read this "blossom" as a reference to cupellation, a way of extracting silver metal from lead, but gold could be further extracted. Lead ores differ in their gold content. Craddock (1995, 213) explains that «the gold content of silver from the argentiferous lead ores depends on the particular ore. Silver from the oxidised ores and jarosites can contain several per cent, but the gold content of silver from the primary galena is much lower, typically in the range from 0.01 per cent to 0.1 per cent». Chinese relied on argentiferous galena for their silver, so the higher quality of foreign lead ore is perhaps explained by these facts.[13] Modern mineralogical surveys also help us to understand differences between regional ores. Harrison (1968, 506), for example, points out one source of ore in Iran in which «the lead is argentiferous, some of it containing about 100 oz of silver to the ton of lead concentrate». A metallurgist in Tang China familiar with ores and ingots from different international and domestic sources would have certainly become aware of these types of facts.

The name "Persian lead" still appears in later centuries, although whether this was still a widely used term or not seems unlikely, judging from the extant literature. Li Shizhen 李時珍 (1518-1593) in his work on materia medica, citing *Baozang lun* 寶藏論 (*Treatise of the Gem Repository*) from late antiquity, writes, «There are several types of lead. Persian lead is firm and white. It is foremost in the world». 鉛有數種, 波斯鉛堅白, 為天下第一.[14] It is difficult to say based on this alone that this was applied knowledge on the part of physicians, since it might just as well have been a classical source cited for the sake of comprehensiveness. The term was not widely used, although we can infer that it was used starting around the Sui period (late sixth to early seventh century), when Persia and China were frequently interacting with each other. The transcription of *murdār-sang*, on the other hand, was still used in the Chinese language even into the nineteenth century. Hanbury (1861, 113) included oxide of lead (litharge) in his study of minerals in contemporary Chinese materia medica under this term.

---

[12] *DZ* 900, 19, 100b9-13.

[13] Golas (1999, 109) explains, «Since most of the silver in China was obtained from argentiferous galena, lead must have become widely available in China from the Thang [Tang] period on, when silver came to play a very important role as a medium of exchange in the Chinese economy. The close association of silver and lead was a most convenient coincidence since lead was needed in the cupellation process for refining gold and silver».

[14] See source text in Unschuld (2021: 262-263). Translation of this line by me. The *Baozang lun* appears to date to the Sui period, but only fragments of it are extant in citations. Qing Xiazi 青霞子, the author, also known as Su Yuanming 蘇元明, was a hermit who lived on Mt. Luofu 羅浮山 during the Tang, Jin, or Sui periods. See Hu (1995, 106). Zheng et al. (2018, 561).

Litharge in Paints

One other major use of *murdār-sang* in China and also Japan was in art. Su Jing in his medical text briefly notes the substance «is formed like yellow dragon teeth, but it is firm. It is also white in color, which can be used for preparing stone inscriptions». 形似黃龍齒而堅重, 亦有白色者, 作理石文.[15] Indeed, Golas (1999, 108) points out that in China «the lead oxide litharge was an important component of paints and varnishes, and was also used in external medicines, as was lead carbonate (cerussite)». This carried over to Japan. Yoneda (2015, 302-303) explains that litharge is an attested ingredient in Japanese oil paintings, in which it was used as a firming agent (this type of painting is called *mitsuda e* 密陀絵 in modern Japanese). This knowledge most likely stemmed ultimately from Iran, because the same ingredient was used in oil paintings in Bamiyam in Afghanistan from the mid-seventh century.[16]

Conclusion

It becomes clear from the above discussion that lead products and lead ores were a noteworthy part of Sino-Iranian trade starting from around the late sixth century. Litharge in Middle Chinese was known by a loanword from Middle Persian, *murdār-sang*, a fact that only highlights the origin of the substance. Litharge had a function in Chinese medicine, but the knowledge and applications of the substance most likely were introduced from a West Asian source. Litharge also appears in Chinese Buddhist texts from the seventh century. Instead of using a transcription of a Sanskrit term, translators used the transcription from Persian, a point that would indicate that the loanword had already become a recognized term in the common parlance. Litharge was also used as an ingredient in oil paintings from Bamiyam to Japan. This would likely indicate a transfer of knowledge eastward from Iran. Finally, "Persian lead" became known from the late sixth to early seventh century. This appears to have referred to a type of argentiferous lead ore that was recognized as possessing a different quality from domestic sources in China.

As a final thought, I believe we ought to recognize the significance of metals in commodity exchanges and the transfer of technical knowledge between West and East Asia. This point demonstrates that Iran as a cultural sphere, in fact, influenced China in Late Antiquity in ways which are often left unrecognized, even after Laufer a century ago explained at great length the introduction of any number of things from Iran into China. These influences from Iran have also been detected in fields such as Chinese astrology and its associated iconography.[17] In short, the study of East Asia would benefit from greater consideration of historical interactions between East Asia and Iran in past ages.

---

[15] Hanbury (1876, 273) understood "dragon teeth" as fossilized animal teeth from any number of species, based on scientific examination of specimens at the time. The "form" of litharge in this instance is powdered. The yellow form would refer to massicot.

[16] Taniguchi (2012, 60) in the English abstract of their Japanese paper explains, «The presence of some metal leafs with yellowed varnish, as well as the usage of artificial pigments such as lead white and minium, suggest links with the '*mecca*' technique of medieval Mediterranean art and the '*mitsuda-e*' technique of Shōsōin, which shall be addressed upon reviewing wider cultural interactions between the East and West in the 7th century AD».

[17] For a discussion of Iranian elements in Buddhist astrology in China, see Kotyk (2017).

Acknowledgments

Research for this paper was carried out with funding by the Marie Skłodowska-Curie Actions (H2020-MSCA-IF-2020), EU Commission. Research project: "Sino-Iranica: Investigating Relations Between Medieval China and Sasanian Iran". Grant agreement ID: 101018750. Part of the research of this paper was also carried out between March 7-13, 2023, at the Library of Congress (Asian Reading Room), and January 15-28, 2023, at Columbia University.

Primary Sources

Da Tang xiyu ji. 大唐西域記. *T* 2087.
Sui shu. 隋書. 6 vols. Beijing: Zhonghua shuju, 1973.
Tuoluoni ji jing 陀羅尼集經. *T* 901.
Wei shu 魏書. 8 vols. Beijing: Zhonghua Shuju, 1974.
Xinxiu bencao 新修本草. Handwritten copy dated to 1889. National Diet Library of Japan (特1-3021).
Yin Zhenjun jinshi wuxiang lei. 陰眞君金石五相類. *DZ* 900.

Secondary Sources

Budge, Earnest Alfred Wallis. 1913. *Syrian Anatomy, Pathology and Therapeutics or "The Book of Medicines"*, II. London: Oxford University Press.
Ciancaglini, Claudia A. 2006. "Syriac Language. i. Iranian Loanwords in Syriac". *Encyclopedia Iranica*. https://www.iranicaonline. org/articles/syriac-language-i. Accessed on 08 September 2023.
Craddock, Paul T. 1995. *Early Metal Mining and Production*. Edinburgh: Edinburgh University Press.
Daffinà, Paolo. 1983. "La Persia Sassanide secondo le fonti cinesi". *Rivista degli studi orientali* 57: 121-170.
Dewing, H.B., trans. 1961. *Procopius: With an English Translation by H. B. Dewing, in Seven Volumes, I; History of the Wars, Books I and II*. Cambridge: Harvard University Press.
Golas, Peter J. 1999. *Science and Civilisation in China, Volume 5: Chemistry and Chemical Technology; Part XIII: Mining*. Cambridge: Cambridge University Press.
Hanbury, Daniel. 1861. "Notes on Chinese Materia Medica". *Pharmaceutical Journal and Transactions, Second Series* 2: 109-116.
Hanbury, Daniel. 1876. *Science Papers, Chiefly Pharmacological and Botanical by Daniel Hanbury, F.R.S*. Ed. Joseph Ince. London: MacMillan and Co.
Harrison, J.V. 1968. "Minerals". In *The Cambridge History of Iran: 1, The Land of Iran*, ed. W.B. Fisher, 489-516. Cambridge: Cambridge University Press.
Huang Lanlan 黃蘭蘭. 2002. "Tangdai Qin Minghe wei jingyi kao 唐代秦鳴鶴為景醫考 ". *Zhongshan Daxue xuebao* 中山大學學報 42 (5): 61-67.

Hu Fuchen 胡孚琛, ed. 1995. *Zhonghua Daojiao dacidian* 中華道教大辭典. Beijing: Zhongguo Shehuixue Chubanshe.

Kotyk, Jeffrey. 2022. "Information on the Persian Calendar in the *Wei shu* 魏書 of 554". In *ABĒBĪM "Fearless": Who Was Afraid of the End of the Millennium? New Approaches to the Interpretation of the Traditional Date of Zoroaster; with Contributions by Domenico Agostini, Jeffrey Kotyk, Paolo Ognibene, and Alessia Zubani*, edited by Alessia Zubani. Milano: Mimesis, 209-222.

Kotyk, Jeffrey. 2017. "Iranian Elements in Late-Tang Buddhist Astrology". *Asia Major* 30 (1): 25-58.

Laufer, Berthold. 1919. *Sino-Iranica: Chinese Contributions to the History of Civilization in Ancient Iran, with Special Reference to the History of Cultivated Plants and Products* (Field Museum of Natural History, Publication 201, Anthropological Series, Vol. XV, No. 3). Chicago: The Field Museum of Natural History.

Lieu, Samuel N.C. 2000. "Byzantium, Persia, and China: Interstate Relations on the Eve of the Islamic Conquest". In *Silk Road Studies IV: Realms of the Silk Road, Ancient and Modern*, eds. David Christian and Craig Benjamin. Turnhout: Brepols, 47-65.

Nie Zhijun 聶志軍. 2008. "Jingjiao beizhong Yisi ye shi jingyi kao 景教碑中伊斯也是景醫考 ". *Dunhuangxue jikan* 敦煌學輯刊 3: 119-127.

Pulleyblank, Edwin George. 1991. *Lexicon of Reconstructed Pronunciation in Early Middle Chinese, Late Middle Chinese, and Early Mandarin*. Vancouver: UBC Press.

Rong Xinjiang 榮新江. 2015. *Sichou zhi lu yu dongxi wenhua jiaoliu*. 丝绸之路与东西文化交流. Beijing: Beijing Daxue Chubanshe.

Song Xian 宋岘. 2001. *Gudai Bosi yixue yu Zhongguo*. 古代波斯医学与中国. Beijing: Jingji Ribao Chubanshe.

Taniguchi Yōko. 2012. "Chūō Ajia – Bāmiyān Bukkyō hekigaku no bunseki (1) Shinkurotoron hōshasen wo mochita SR-μFTIR, SR-μXRF/SR-μXRD bunseki". 中央アジア・バーミヤーン仏教壁画の分析(1)シンクロトロン放射光を用いたSR-μFTIR, SR-μXRF/SR-μXRD 分析. *Kokuritsu rekishi minzoku hakubutsukan kenkyū hōkoku* 国立歴史民俗博物館研究報告 177(29-30): 29-60.

Unschuld, Paul U. 2021. *Ben Cao Gang Mu, Volume II: Waters, Fires, Soils, Metals, Jades, Stones, Minerals, Salts*. Oakland: University of California Press.

Wang, Dawei. 2022. "Techniques of the Supramundane: Physician-Monks' Medical Skills during the Early Medieval China (220-589) in China". *Religions* 13 (11): 1044.

Whitehouse, David and Williamson, Andrew. 1973. "Sasanian Maritime Trade". *Iran* 11: 29-49.

Xue Keqiao 薛克翘. 2007. *Zhongguo Yindu wenhua jiaoliu shi* 中国印度文化交流史. Beijing: Kunlun Chubanshe.

Yoneda Kaisuke 米田該典. 2015. *Shōsōin no kōyaku: zaishitsu chōsa kara hozon e* 正倉院の香薬: 材質調査から保存へ. Kyoto: Shibunkaku Shuppan.

Zheng Jinsheng, Nalini Kirk, Paul D. Buell, and Paul U. Unschuld 2018. *Dictionary of the Ben Cao Gang Mu, Volume 3: Persons and Literary Sources*. Oakland: University of California Press.