LUPINE PUBLISHERS

Journal Of Anthropological And Archaeological Sciences

DOI: 10.32474/JAAS.2022.06.000249

ISSN: 2690-5752

Research Article

Analysis of the Bones from the Han Lingkun Tomb in Xilai Village, Ci County and Preliminary Hypothesis on his Death

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Received: April 14, 2022 **Published:** April 22, 2022

Abstract

In 2013, the tomb of Han Lingkun (923-968 AD) was discovered in the construction process of Ci County, Handan City, Hebei Province. Han Lingkun was a famous general of the Northern Song dynasty (960-1127). Records of his tombstone evidenced that he died from the back disease at the age of 45. Several black bones from an adult were unearthed in the tomb. Scanning Electron Microscope analysis showed that nanoscale cinnabar was detected both on the surface and interior of the black bone. This paper puts forward some possible explanations about the appearance of cinnabar in the black bone:

a. Cinnabar entered Han's bones before his death. In this case, cinnabar may be related to the cause of his death.

b. Cinnabar was used in the funeral of Han Lingkun.

c. The bone was contaminated by the cinnabar from the environment.

Amongst these explanations, the first has the most possibility. This research may provide preliminary clues for the death of Han Lingkun, and also devotes to the study of funeral culture in the Song dynasty as well as the toxicology.

Keywords: Han Lingkun; Human Bone; Microscopic Analysis; Cinnabar

Introduction

Archaeology is the study of ancient society and technology through objects excavated from the ancient sites. Relevant archaeological information could be collected from biological remaining, stratum, environment, artefact, architecture and cultural landscape. Amongst them, animal bones, especially human bones, could be used to study the living conditions of ancestors, such as the diet [1] and disease [2]. In the spring of 2011, a tomb was found during the construction of Yiquan North Road (in the northwest of Xilai Village, Cizhou Town, Ci County, Handan City, Hebei Province). The tomb had been damaged heavily when it was discovered. To protect this cultural heritage, archaeological excavation was carried out, as shown in Figure 1. After the preliminary cleaning, the tomb was found to be a masonry tomb of the Song dynasty. The whole tomb was constructed from north to south and its door was facing south. The tomb consists of the tomb passage, the front room, the middle room, and the back room as well as the east and west chambers on both sides of the middle room. The plan of the tomb is shown in Figure 2. The top of the tomb had almost been destroyed. Only a few parts of the tomb including the passage and the lower parts of walls had been preserved. Some wall paintings were also found in the tomb. Some parts of the wall paintings had been preserved well, as shown in Figure 3. In the front room, a headstone made of bluestone was discovered. It is 93.5 cm long, 92 cm wide and 28 cm high. The title of epitaph on the stone is 'the tomb of Nanyang King'. The whole epitaph is 54 lines, around 2800 words. They are all written in regular script. According to the contents, the headstone was engraved in 968 AD and the owner of this tomb was Han Lingkun.

Figure 1: Excavation site of the tomb of Han Lingkun.

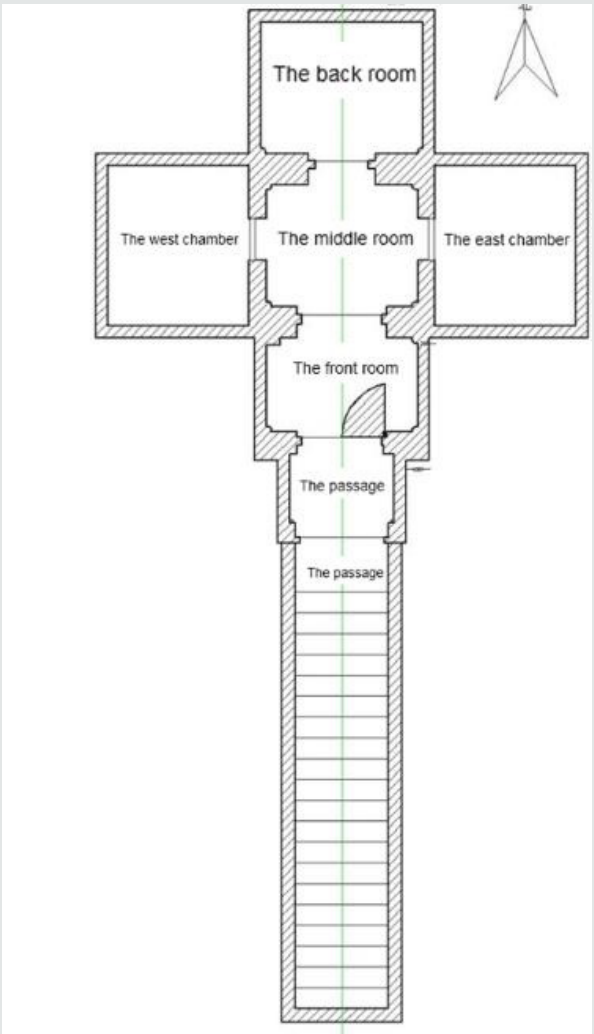

Figure 2: The plan of the tomb of Han Lingkun in Xilai Village.

Figure 3: The wall paintings after cleaning up.

According to historical records, Han Lingkun (923-968 AD) was a general of the Northern Song dynasty. He was born in Cizhou, Wu'an (now Wu'an City, Hebei Province, currently located in the northwest of Handan City). First, Han Lingkun was a subordinate general of Guo Wei (904-954 AD), Emperor Taizu of the Later Zhou (951-960 AD) during the Five Dynasties and Ten Kingdoms period (907-979 AD). After Chai Rong, also known as Emperor Shizong of the Later Zhou, ascended the throne. Lingkun was given the post of Dianqiandouyuhouthe (senior commander of the palace guards). He participated in the war of Chai Rong against Huainan (the area south of the Huai River and north of the Changjiang River). He captured Yangzhou and Taizhou area. He was promoted to the post of Jianjiaotaiwei (the grand commander of the palace guards) and Zhenan Army Jiedushi (regional military governor).

After then, Lingkun followed Chai Rong and had a series of glorious achievements in wars against Southern Tang (937-975 AD) and Khitan. After the founding of the Northern Song dynasty, he was transferred to Taiping army. He was also promoted to the post of Shiweimabujundouzhihuishi (grand commander of the palace guard cavalry and infantry) as well as Tongpingzhangshi (chancellor). When Zhao Kuangyin (927-976 AD), Emperor Taizu of the Song dynasty, started the war against Li Yun, Lingkun led the troops and defended Heyang under Kuangyin's order. Then, he followed Kuangyin and participated in the war against Li Chongjin in Yangzhou. In the spring of 961, Lingkun went back to the capital and was deprived of the military power to command the Palace troops. Not long after being given the post of Chengde Army Jiedushi, Lingkun died of back disease. Besides wall paintings, some human bones were unearthed during the excavation. They were cleaned and photographed to extract the archaeological information. The bones are shown in Figure 4. During the cleaning and sorting process, some black substances were observed in these human bones. Some of the black substances are distributed in sheets on the surface, and some are distributed in dots in the deep interior. To learn the chemical composition of the black substances, analyses were carried out on one of the black bones.

Figure 4: The human bones after cleaning and the black bone samples.

Samples and Methods

Samples preparation

The human bones unearthed from the tomb were chaotic and cracked. Amongst these bones, there are skulls, limbs, and ribs. According to the anthropological study, they belong to two people: one is an adult, about 40 years old, and the other is a child. One of the black bones belonging to the adult, as shown in Figure 4, was analysed for the identification of the black substances. Bone samples with the black substances were collected from the external and internal areas of the black human bone by a scalpel.

Analysis methods

Scanning electron microscopy (SEM) was applied to observe different parts of black bones. The elemental composition was analysed by energy dispersive X-ray spectrometry (EDS). Instrument: FEI Quanta 200 ESEM, voltage 15kV, spot 5.0.

Results and Discussion

The black human bone was studied, including the exterior and interior. High magnification observation was also applied on the interior parts.

Observation of bone samples from the exterior

SEM was applied to observe these samples. As shown in Figure 5, the dark parts of the sample have lower atomic numbers while the light parts have higher atomic numbers when observed in the backscattering spectrum. EDS was applied on the dark parts (District 4 marked in Figure 5) of the bone samples. The results in Figure 5 show that this part is mainly composed of calcium, phosphorus, carbon and oxygen. These elements may come from hydroxyapatite, which is the main components of the bones. The other elements, which have very low contents, maybe from the contamination. Then, tests were carried out on the light parts (Districts 1, 2 and 3 marked in Figure 6). The results of elemental analysis in Figure 6 show that these three parts are all mainly composed of calcium, phosphorus, carbon and oxygen. Sulphur and mercury, which may be from mercuric sulphide, were also found in these areas, especially in District 3.

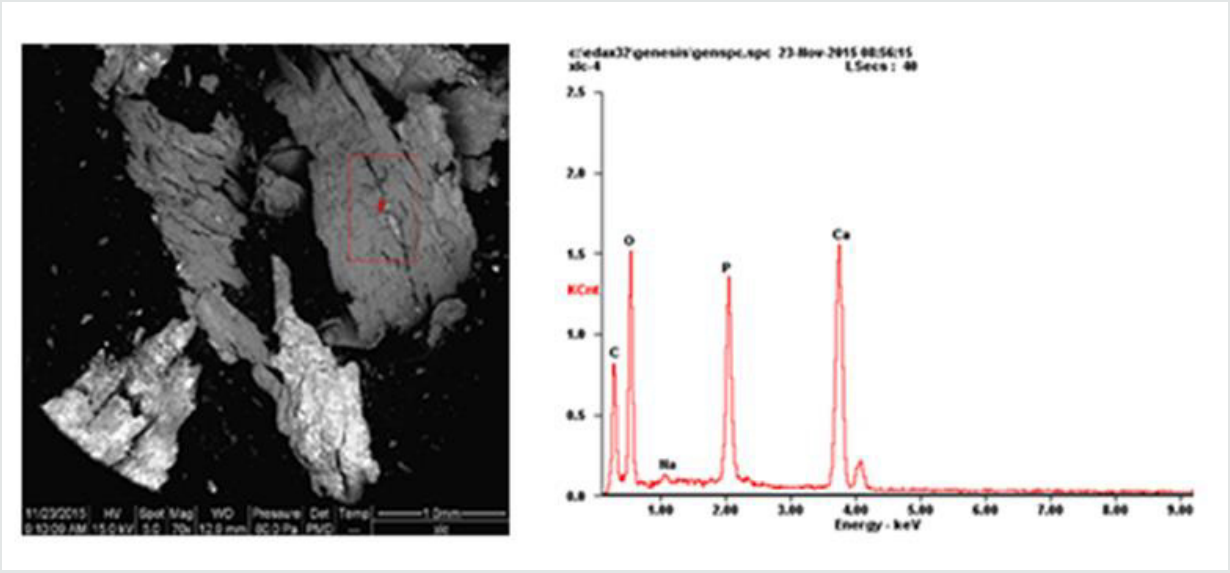

Figure 5: District 4 in samples from the exterior parts of the bone and its energy spectrum.

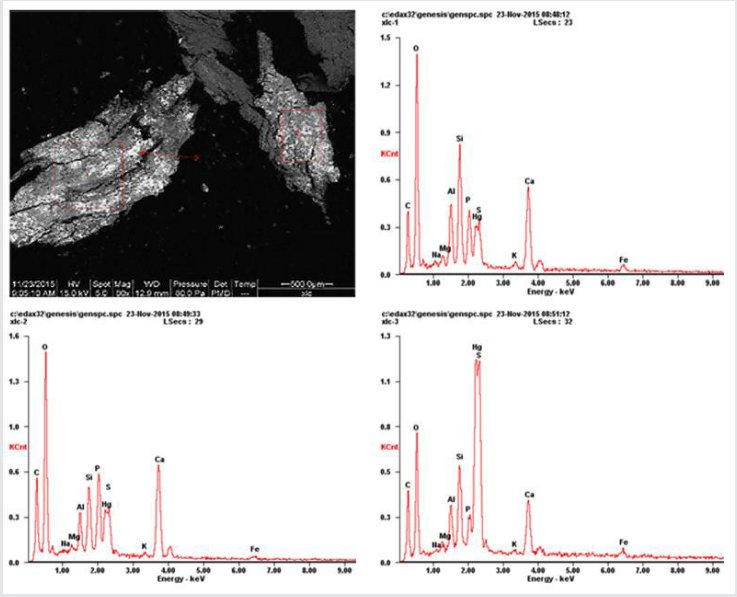

Figure 6: Districts 1, 2 and 3 in samples from the exterior parts of the bone and their energy spectra.

Observation of bone samples from the interior

Tests were also carried out on the internal parts of the human bone to detect the existence of sulphur and mercury. The SEM results at high magnification are shown in Figure 7, in which the directional trace of bone growth and the rough surface after erosion could be observed. EDS was carried out on both depression and protrusion parts (Districts 5 and 6 marked in Figure 7). The results in Figure 7 show that hydroxyapatite is the main component in these two areas. Backscattering spectrum was applied on samples from the interior parts of the bone to search the presence of sulphur and mercury. Some bright dots could be observed in the image, as shown in Figure 8. Some dots are concentrated, while others are separated. The sizes of these bright dots range from small to large. EDS was carried out on one dot (District 7 marked in Figure 8) to learn its elemental composition. The results are shown in Figure 8. Besides hydroxyapatite, mercuric sulphide could be found in these bright dots. The size of granule containing mercuric sulphide was measured at high magnification. The particle sizes of these granules are all around 119 nm, as shown in Figure 9.

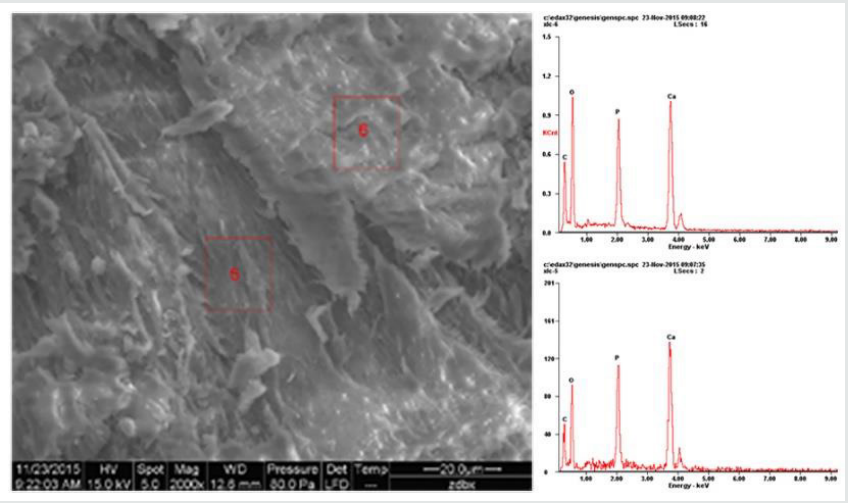

Figure 7: Districts 5 and 6 in samples from the interior parts of the bone at high magnification and their energy spectra.

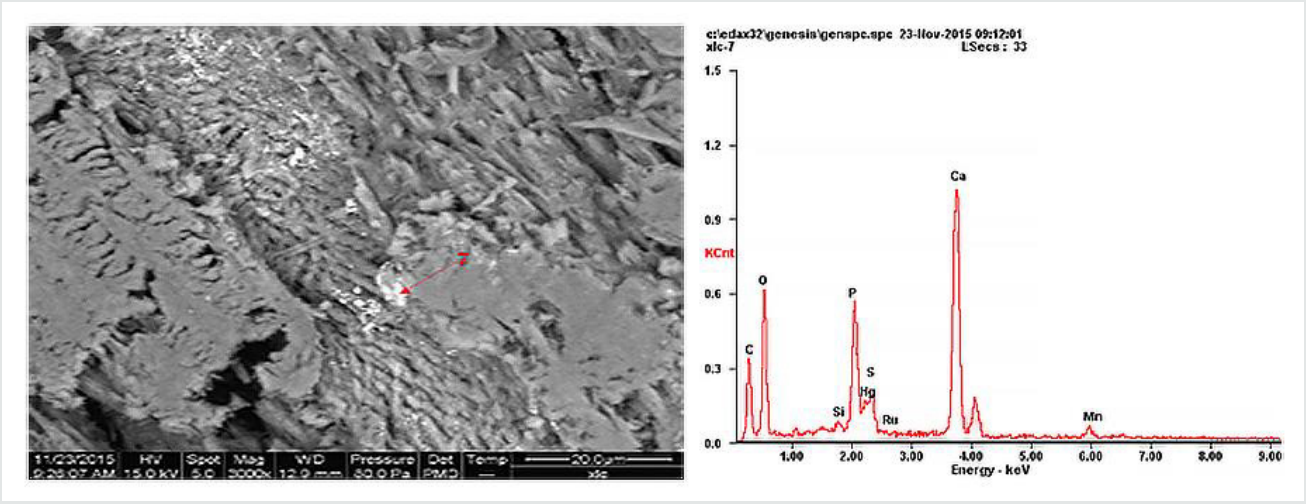

Figure 8: District 7 in samples from the interior parts of the bone at high magnification in the backscattering spectrum.

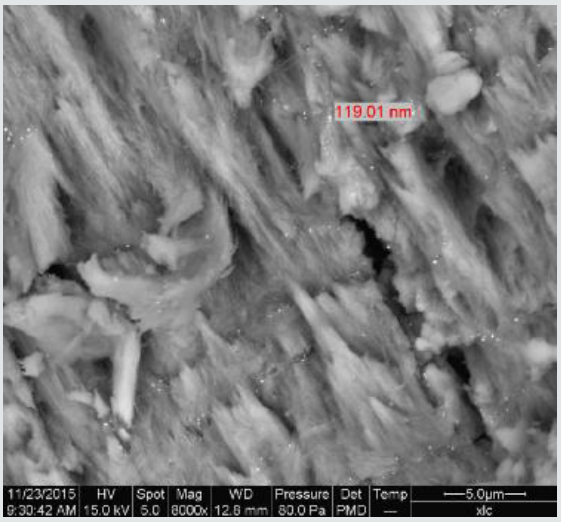

Figure 9: The size of particles in samples from the interior parts of the bone at high magnification.

Discussion on the existence of mercuric sulphide in human bone

Cinnabar is also known as Chensha, Dansha, Chidan, and Gongsha in China. The natural cinnabar ore is bright red, with a diamond to metallic lustre, belonging to the trigonal system. Cinnabar is mainly composed of mercuric sulphide, and often mixed with realgar, apatite, asphaltene etc. [3]. Cinnabar is a traditional Chinese mineral medicine, which has the functions of calming nerves and detoxifying. It could be externally used for the treatment of diseases such as swelling, ulcer and sore throat, also internally used for the treatment of palpitation, insomnia, restlessness etc. Modern pharmacological research shows that cinnabar has some sedative effects, which could reduce the sensitivity of the brain centre, and inhibit and kill skin fungi for external use [4].

Many studies have been carried out on the toxicology of cinnabar and its existing form inside the human body. [5] believe that cinnabar may produce methyl mercury when it reacts with methylated substances in the human intestinal tract. Methyl mercury has strong neurotoxicity and is highly liposoluble. It can be almost 100% absorbed, causing irreversible damage in brain tissue. However, there is no experimental data to support this conclusion [6]. [7] pointed out that when the experimental animals take cinnabar for a long time, the mercury will be accumulated in the kidney, brain and liver, especially in the kidney and brain. [8] studied the

dissolution of cinnabar in vitro. The research shows that there are conditions for the formation of mercury polysulfide in the human intestinal tract, including weak alkaline environment (pH=8.4) and a large amount of H2S (mainly in the form of HS-) produced by intestinal bacterial decomposition. Therefore, it can be inferred that the mercury polysulfide complex may be an important form of cinnabar in vivo. The cause of Han Lingkun's death is recorded as a back gangrene. There are three possible explanations for the existence of mercury in the bone:

a. Han Lingkun used drugs containing cinnabar due to his back gangrene. Mercury entered the bone before he died. In this case, cinnabar may be related to his death.

b. cinnabar was used in Han Lingkun's funeral, and later, it infiltrated into Han Lingkun's remains. In Chinese and foreign funeral cultures, there are customs of using red pigments such as cinnabar, either directly on human bones, or on bodies and tombs, or funeral objects [9].

c. mercury comes from environmental contamination. As no obvious trace of cinnabar is found in the tomb, the first interpretation is more likely to be the truth.

However, [10] mentioned in their study that if mercury enters into bones before death, it should be in the form of mercury phosphate. Therefore, further study should be carried out on the existing form of mercury when it enters bones. The toxicology study of cinnabar should be combined. Besides, the cause of bone blackening also needs to be further explored. The skeleton of the young child in the tomb may be from Han Lingkun's early dead child. To show affection, they are buried in the same tomb. Another possible explanation is that the skeleton is from the dead children buried nearby which were disturbed during excavation and mixed with the skeleton of the tomb. As the relationship between the child and Han Lingkun is unclear, further research, such as DNA analysis, is needed.

Conclusion

Human bones including an adult around 40 and a child were unearthed in the tomb of Han Lingkun tomb in Xilai Village, Ci County. Some black substances were observed in parts of adult human bones. SEM and EDS were applied to one of these black bones. Mercury in the form of mercuric sulphide was found in the bone. The particles are very small and distributed in both the exterior and interior of the bone. It is speculated that the most likely reason is that Han Lingkun used drugs containing cinnabar before death. The mercury sulphide penetrated the bone during his alive. Besides, it is not ruled out that mercury sulphide came from the tomb or the environment and entered Han Lingkun's remains after his death. Further analysis and research are needed to confirm the hypothesis.

Conflict of Interests

The authors declare that they do not have any commercial or associative interest that represents a conflict of interests in connection with the work submitted.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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DOI: 10.32474/JAAS.2022.06.000249