Early use and production technologies of iron in Southwest China

Volume 1 of 2

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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Abstract

This thesis studied the iron smelting technology of Southwest China. It introduces the natural and human environment of Southwest China and gives a systematic review on the important archaeological sites of Southwest China. A total of 75 iron smelting related sites of Southwest China were surveyed. Five of these sites were excavated and studied in detail including the furnace structures, smelting related materials and their smelting process. A statistical study of over 5,100 iron objects (and bronze and iron bi-metallic objects) in published excavation reports was carried out to understand the pattern and statistical distribution of iron objects excavated in Southwest China. This was followed by metallographic analysis of 66 samples taken from 42 iron objects and slags (mostly from the Lijiaba site, and from the Qiaogoutou site). The slag samples (from the Xuxiebian site) helped to identify the bowl-shaped furnaces, that discovered at the iron smelting sites of Southwest China, as refining furnaces. The results of the metallographic studies helped to characterise the range of technologies that developed in Southwest China primarily during the Han dynasty (202BC-220AD). According to these studies, some issues such as the origin and development of technology, the labourers' identities, the origin of the blacksmiths, and the management and policy of iron production in Southwest China are discussed.

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I would like to express my sincere gratitude to Gill, who shared with me her expertise and knowledge, supported me to publish my research, patiently read my thesis drafts and made invaluable comments, and kept me well on track towards the end of this Ph.D. I know how much trouble I gave Gill for reading my poor written English. I can see that the cross mark on “which” is getting bigger and bigger. Sorry… and thank you!

Last but not the least, I would like to thank my family, my parents LI Hong and XU Hong, my grandparents LI Shixiong and ZHU Yingshu, and my wife HUANG Wan for supporting me spiritually throughout writing this thesis and my life in general.

Though many people contributed to the research reported in this thesis, any errors and oversights are mine alone.

Above is a template that I found on the internet, and the following is going to be written in Chinese. If you cannot read Chinese, too bad! By the way, my gratitude to Dr. Donald Wagner is in the Chinese version.

首先，容我深深叹一口气，终于到了可以写致谢的时节。时光飞逝，从 14 年到 Exeter 以来转眼即将四年。有太多感慨想表达，千言万语却无从说起。然而毕竟这是最后一个长篇致谢，该说的总归要说。

总觉得读书是一场漫长的逃避，逃避社会，逃避责任。但事实上这一场逃避并不轻松。时间是相对自由，但忙碌的时候确也压得自己快喘不过气来。2009 年我从加拿大回到国内，那年暑假正是考古热开始兴起的时候。于是乎心血来潮到川大申请了考古专业的硕士并投入到李映福老师门下。衷心感谢李老师多年来的教导，他不仅教导我如何做事做学问，同时也教会我许多做人处事的道理。

在 2012 年 12 月的冶铁会议上认识了 Gill 和 Don，我也由此开始正式进入冶金考古的学习。特别感谢华爷（Don），他是我金相学的启蒙老师，教会我如何制样如何观察金相样本。对我和琬而言，华爷和他夫人 Annie 是一对慈祥的老夫妻，是我们婚姻的榜样。琬总是觉得华爷就是她心目中圣诞老人的样子。因为身份的原因，12 年硕士毕业后并未能申请博士，于是在家翻译了华爷的 *Iron and steel in ancient China*，加深了我对中国古代铁器以及金相学的认识。一直到 14 年初，Gill 突然告诉我可以尝试申请 Exeter 的博士，没成想最后竟然十分顺利地申请到了奖学金，便在当年 9 月开始了 Exeter 的博士生涯。对 Gill 的感激已表达在了英文里，就不再这里重复。

读博期间遇到了很多人很多事，得到了不少帮助，虽无法一一提及姓名，谨在此衷心谢过。原本以为到写致谢时一定有千言万语，一定要大写特写。但行笔至此却忽然有一种莫名地疲惫感，无心回忆往事，也无力表达情感。只好让自己向前看，博士生涯的结束绝不是学习的终点。愿如梭伦所说，活到老，学到老。最后，我要感谢我的父母和爷爷奶奶，没有你们的包容，我一定无法坚持到最后。特别感谢我的夫人黄琬，你是我前行的原动力！

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Chapter 1: Introduction

The aim of this research is to understand the characteristics of the technology and use of iron and the distribution pattern of ancient iron-smelting sites in Southwest China, by assessing the existing archaeological materials of ancient iron-smelting and obtaining and classifying firsthand materials from regional archaeological surveys and excavations. The project also provides an opportunity to introduce archaeological research in Southwest China to the general public. Iron objects from excavations are usually badly corroded and less attractive and interesting as display material for the public visiting museum. It is also therefore my aim through this study of excavated iron objects to provide more information and understanding for museums when they display iron objects.

It is important to first introduce briefly some background information on the ferrous metallurgy of the world and China. Two routes to producing iron, the direct route and indirect, are recognised in iron metallurgy. The direct route is what often called the bloomery process and the indirect route is that which used the blast furnace (discussion in section 1.1.5). The emergence of iron technology worldwide occurred over a long period. Tylecote (1982, 40) suggests that ironworking was incubating somewhere in the Anatolian-Iranian region during the period of 1500-1000BC, and its spread across parts of Europe, Asia, and North Africa in the following five centuries. Among the ancient European cultures, it is in the sub-Mycenaean context (c.11th-10th centuries BC) that iron working first became common in the eastern Mediterranean, then diffused westward and northward to central Italy, southern Germany and central France, and reached England eventually around the 7th-6th centuries BC. (Collis 1984). The history of early iron smelting, practised by the tribal artisans in different regions of ancient India dates back to 1300-1200BC (Prakash and Tripathi 1989; Chakrabarti 1992, 10-12; Vaish *et al* 2000; Tripathi 2008, 20-70), and Rekesh (2003, 543) suggests that the technology developed independently in the early second millennium BC.

In China, some Chinese archaeologists believe that iron smelting technology originated in the centre of China, in the area we call the Central Plains, where ancient Chinese civilization developed. Thus, most of the past research on the emergence of China’s iron technology focused mainly on the Central Plains, the question is when. Luo Binji (1988) and Zhao Enyu (1989) claim that it was from the Xia dynasty (2000-1600BC), Umehara Suiji (1936, 49-50) and the excavators of Taixicun (HBSWWYJS 1985, 168) say Shang dynasty (1600-1046BC), Yang Kuan (1982), Chen Ge (1989a, 425), and Zhang Hongming (1989, 14) support the Western Zhou dynasty (1046-771BC), and Huang Zhanyue (1957, 93; 1976, 62) believes that it was about the post-Spring and Autumn period (c.770-400BC). The Danish archaeometallurgist Wagner (2007) argues that iron smelting technology in China evolved from highly advanced bronze smelting technology, and was invented in the Wu state about 600-500BC spreading towards the Chu state at about 400BC. On the other hand, other scholars such as Tylecote (1988) consider that China's iron technology was possibly introduced from the west.

Bai Yunxiang (2003, 308; 2005, 41-43; 2006, 30) first suggested that there were two different systems of ancient Chinese iron objects: 1) the 'northwest system', of which the early iron objects excavated are from Xinjiang and nearby areas; and 2) the 'Central Plains system', of which the earliest iron objects have been excavated from western Henan and southern Shanxi, including the areas of the middle and lower reaches of the Yellow River and Yangtze River. Bai indicated that iron smelting technology in ancient China derived and developed separately in Xinjiang and the Central Plains. Chen Jianli *et al* (2012, 49) suggests that it would be appropriate to date the first use of iron in Xinjiang to the 9th century BC.

In fact, regardless of where and when China's iron technology emerged, Southwest China played an important role in the transmission of the technology. Southwest China includes the municipality of Chongqing, the provinces of Sichuan, Yunnan and Guizhou, and the Xizang autonomous region (Fig. 1.1) which are the most important areas where the cultural exchange between the Central Plains and neighboring Asian countries occur (such as modern India, Nepal, Vietnam, Burma, and Cambodia). Especially, during the pre-Qin to Han dynasties (c.200BC-200AD), Southwest China was a highly-developed centre of politics, economics, and cultures. The understanding of the formation, development and transmission of Southwest China's iron smelting technology is vitally meaningful in the study of not only the issues of society, economics and ethnology of Southwest China, but also the emergence of iron technology in China in general.

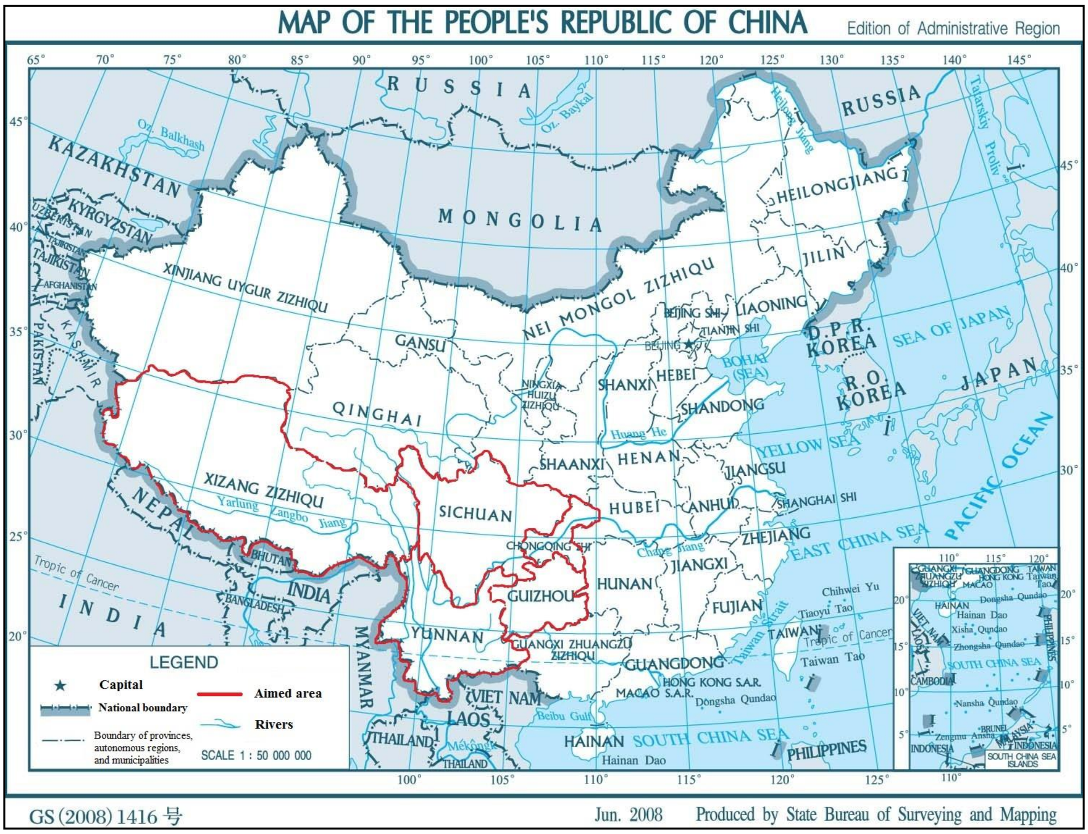


Fig. 1.1 Map of China showing the research area[1] (source: China National Administration of Surveying, Mapping and Geoinformation)

1.1 Background Setting

This section provides a very brief introduction for people who may not be familiar with the Chinese history, on the aspects of social, economy, the Iron Age, and the early iron objects of China from the Shang dynasty (14th century BC) to the Han dynasty (202BC-220AD).

[1] All of the original maps used in this chapter were downloaded from China National Administration of Surveying (国家测绘地理信息局), Mapping and Geoinformation, http://www.sbsm.gov.cn/.

1.1.1 Political history

In the late Bronze Age of ancient China, the Central Plains region was ruled by the Shang people (the 14th century BC), and the Shang dynasty was a form of early nation as it had a clear administration and law system. During the Shang dynasty, there were other tribes in the surrounding areas who paid tribute to the Shang dynasty for protection. However, the Shang dynasty was defeated by a united army of a number of tribes who rose against the ruthless domination of the last Shang emperor in 1046BC. The leading tribe of this army was the Zhou people, who then established the Zhou dynasty in the Central Plains, and other tribes were rewarded with land and wealth, according to their contributions in the campaign. Most of these tribes then paid an annual tribute to the Zhou government. As time went on, about the early 8th century BC, the Zhou dynasty control over those tribes became weak, and some developed to be as powerful as the Zhou dynasty. Social structure fragmented leading to warfare and from then to the Qin’s conquest was called the Spring and Autumn Period (770-476BC) and the Warring States Period (475-221BC). The First Emperor of Qin accomplished the conquest of China in 221BC, but the Qin dynasty only ruled ancient China for 15 years, and then ancient China came under the Han dynasty’s control for the next 400 years (Fig. 1.2).

<table>
<tr><th></th><th>Central Plain</th><th colspan="6">Southwest China</th><th>East China</th></tr>
<tr><td>c.2100 - 1700 BC</td><td>Xia</td><td colspan="6" rowspan="2">Sanxingdui</td><td rowspan="4"></td></tr>
<tr><td rowspan="2">c.1700 - 1100 BC</td><td rowspan="2">Shang</td></tr>
<tr><td rowspan="2">Jinsha</td><td rowspan="2"></td><td colspan="4"></td></tr>
<tr><td>c.1100 - 770 BC</td><td>Western Zhou</td><td rowspan="4">Qin</td><td colspan="3" rowspan="3"></td></tr>
<tr><td>770 - 476 BC</td><td>Spring and Autumn</td><td rowspan="3">Shu</td><td rowspan="3">Ba</td><td rowspan="3">Chu</td></tr>
<tr><td rowspan="2">476 - 221 BC</td><td rowspan="2">Warring States</td></tr>
<tr><td>Jvlan</td><td>Yelang</td><td>Dian</td></tr>
<tr><td>221 - 207 BC</td><td colspan="8">Qin</td></tr>
<tr><td>202 BC - 220 AD</td><td colspan="8">Han</td></tr>
</table>

Fig. 1.2 Time series of the main cultures

1.1.2 Economy

The development of agriculture and crafts industries contributed to the formation of a trade system in the early Shang dynasty (17^{th}-15^{th} centuries BC). The trade system was centralized in the capital of Shang, where the early merchants shipped their goods by cart or ship (river transportation) for other products. In the late Shang dynasty, there were also some people running specialized businesses such as butcher’s stores and restaurants (SiMa 1982c, 1478). Due to the collapse of the Shang dynasty and the rise of other cultures in the first millennium BC, these "centres" of economy and administration developed in every powerful state. These "states" as referred to the "Warring States period", become powerful by conquering other small states. The growth of economy carried forward the social development which increased the cultural exchange as well as the possibility of the spread of iron production technology.

1.1.3 Iron Age of China

The Iron Age is the third principal period of the three-age system created by the Danish antiquarian, Christian Thomsen, to classify ancient societies and prehistoric stages of progress when people started using iron to make their tools and weapons (Glyn 1975, 7). However, Thomsen's terminology of the Iron Age could not be simply applied to the Chinese chronology system, because the Chinese prehistoric period is the time before the mid Shang dynasty (14^{th} century BC). Shang people was a late Bronze Age culture and had its own script. According to the practical situation, the Iron Age of China can be defined as from the late Western Zhou dynasty (c.800BC) to the Eastern Han dynasty (200AD) for most areas. Some areas distant from the control of central government during the pre-historic period, such as Yunnan, entered the Iron Age comparatively late in the early first century AD.

1.1.4 Geographical background

The southwest region is one of the seven administrative divisions of modern China. It includes the municipality of Chongqing, the provinces of Sichuan, Yunnan and Guizhou, and the Xizang (Tibet) autonomous region. Its area is about 2.5 million km^2. It is mainly formed by mountain lands, and there is one basin and two plateaus (Fig. 1.3). It is the most diversified area of China in terms of ethnicity, topography, culture, and natural resources. There are 55 ethnic minorities in China and more than 30 of them can be found living in Southwest

China. The residential population of Southwest China, excluding Tibet, is about 183 million and Tibet has about 3 million[2].

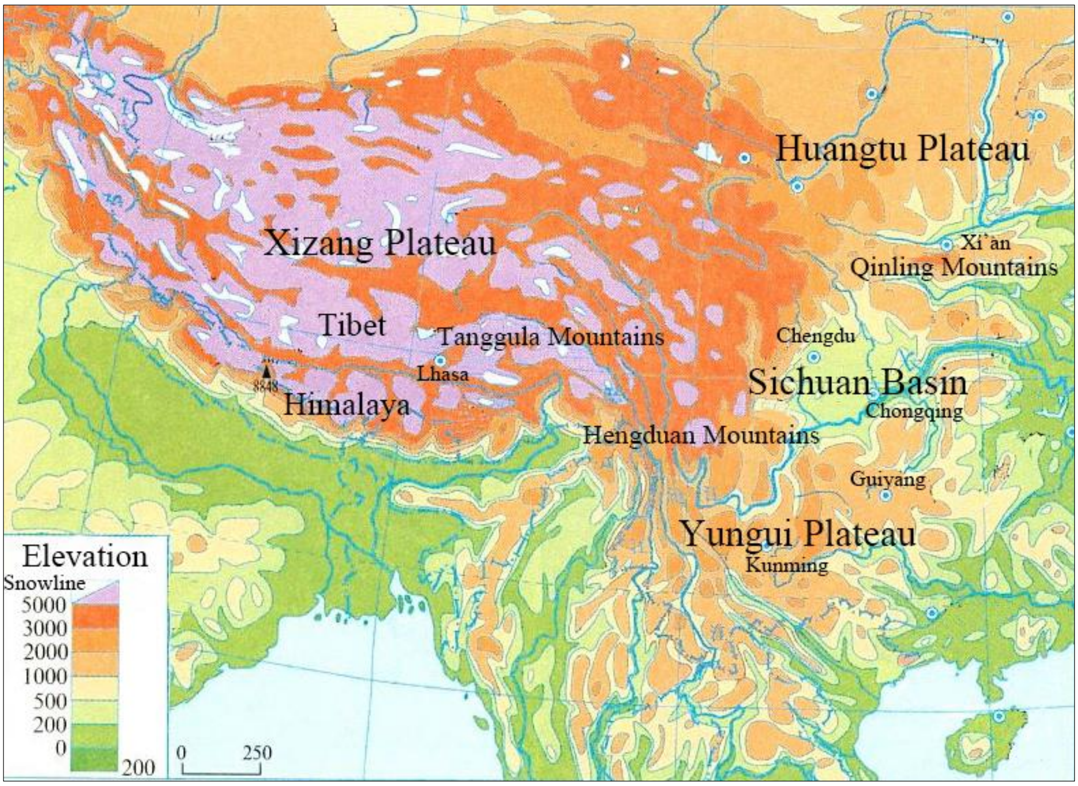


Fig. 1.3 Topographic map of Southwest China (source: http://hanyu.iciba.com)

The Sichuan Basin includes the study area of Sichuan province and the municipality of Chongqing. It is one of the four biggest basins of China, it is densely populated and relatively well-developed in terms of transportation and economy. The Yungui Plateau is a combination of the Yunnan Plateau and the Guizhou Plateau, and it includes the study area of Yunnan and Guizhou provinces. The Tibetan Plateau (Xizang Plateau) refers to part of the Qingzang Plateau where the average altitude exceeds 4,000m. This part of the region is not included in the study.

The southwest region is a fast-developing area of China. It is densely populated, and the landscape and climate are complex because of the various mountain ranges. The natural resources are abundant and include a wide range of metal-bearing minerals.

[2] All population data were quoted from National Bureau of Statistics of the People's Republic of China (中华人民共和国国家统计局 2013 数据), http://www.stats.gov.cn/.

The climate of the Sichuan Basin and Yungui Plateau are generally acknowledged as a humid subtropical monsoon climate, but most of the region within the basin is similar to a temperate marine climate. The Sichuan Basin is one of the most famous agricultural regions of China and the biggest rice and rapeseed producing area of China.

While the Southwest region is rich in terms of agricultural, food production and mineral resources, it is an isolated region with the encircling mountains restricting access in and out of the region until the development of modern transportation system.

1.2 Aims and objectives

The key aim of this research is to understand the distribution pattern of ancient iron smelting sites and the nature of iron production technologies in Southwest China.

Previous research studied three possibilities of the origin of iron smelting in China. Wagner (1993) suggests one possibility that the technology might be introduced from the Wu state (eastern China). He showed that the use of both bronze and iron agricultural implements may spread first from Wu to Chu and only later from Chu to the other states. Perhaps Qin was next, learned the technique from Chu, developed it further, and began producing iron weapons as well as implements (Wagner 1993, 160). Some scholars believe that the technology might be introduced from Turkey to Iran, India (Gordon 1950; Chakrabarti 1992, 10-12; Tewari 2003; Tripathi 2008, 20-70) and then to China. Tylecote (1988, 104) also believes that iron smelting technology was invented at Anatolia Plateau, and spread eastward to Iran and India, possibly to China. Juleff (2009) did a systematic research on the south route of iron technology transmission. She had concluded that the foundation of the technological lineage lies in an evolutionary series of excavated furnaces in Sri Lanka dating from the 4th century BC to the 11th century AD (Juleff 2009, 557), and her work has argued for the possible transmission of technology from South Asia (Sri Lanka) eastwards into Southeast Asia and East Asia, possibly associated with the eastwards transmission of

Buddhism (2009, 575). In addition, Li Yingfu (2014a, 11; 2014b, 75) provided evidence of furnaces and technology in Luhuo county, southern Sichuan and Pingnan county, Guangxi province, which are similar to the ones Juleff had mentioned from Sri Lanka and other areas of south Asia. The third possibility is from Iran via Xinjiang and Gansu to the Central Plains. The new excavated iron artefacts (M444:A7) in Mogou, Gansu province, were identified as wrought iron and dated to the 14th century BC (Chen J. et al. 2012, 52). Also, there are more than 50 early iron artefacts were excavated in the area of Xinjiang, Gansu, Qinghai, Ningxia, and western Shaanxi (Chen J. et al. 2012, 50).

Iron smelting technology in Southwest China has not caught the attention of scholars until this project and the recent work described here. Evidence of the distribution of the iron ores and iron smelting sites (*iron offices*) in Southwest China can be found in many historical documents such as the *Hua Yang Guo Zhi*, the *Shan Hai Jing*, and the *Shi Ji* and the identification of these places and sites can help us to understand iron production technologies in Southwest China.

The study on iron production of Southwest China has become a topic of interest in recent years. There have been studies on the characteristics of both the bowl-shaped furnaces (Li Yingfu 2014c; Li Yingfu 2014b) and blast furnaces (Liu Haifeng *et al* 2017), as well as metallographic and compositional analyses of iron objects excavated from Southwest China (Chen J. *et al* 2008a; Chen J. *et al* 2009b; Li Xiaocen 2011; Li Yingfu *et al* 2016; Li Yingfu *et al* 2018). However, there is a lack of systematic studies of iron smelting sites, as well as the production technologies, and the organization and management of the iron industry of Southwest China. Only two excavation reports of the Tieniucun iron smelting site have been published, but these contain little discussion of the functions of the excavated features and the sites (Zhou Z. *et al* 2008; Zhou Z. *et al* 2011b). This thesis is the first systematic research of all the known and excavated iron smelting sites in Southwest China. It addresses the gaps left by the limited previous studies of early iron objects and iron smelting sites and sets out to provide a substantial contribution towards our knowledge of early use and production technologies of iron in Southwest China. It also provides background to future identification of iron smelting sites and the production technology of Southwest China.

To fulfill these aims:

1. An archaeological survey of metallurgical sites in the Chengdu Plain is carried out in order to understand the site distribution (chapter 3). A statistical analysis is provided to understand the nature of the surveyed sites (section 3.6).
2. Five sites, Gushishan, Xuxiebian, Tieniucun, and Shazitang on the Chengdu Plain, as well as the Chadiping site in Chongqing, are excavated and studied in this thesis (section 3.5.1-3.5.5). Each site has been investigated in a similar way, 1) introduces the excavation project and the discoveries, 2) analyses the excavated archaeological features, pottery and porcelain, refractory materials, ores, slag, and charcoals, and 3) overall reconstruction of the iron smelting technology and the whole process of production based on archaeological evidence and historical documents.
3. Furnace bricks from Tieniucun and the ruining foundation at Gushishan are analysed as well as furnaces excavated in other regions of China to understand the furnace structures.
4. Comparative study is carried out between the Tieniucun site (distant from the central government) and archive photos showing the prisoners' life at Nerchinsk, Siberia in 1891 (section 3.5.3). It provides valuable information of the exiled laboring system near the border of Russia and China, thus suggests a possibility of labourers used in the iron smelting industry in Southwest China in ancient times.
5. A systematic and statistical analysis of iron objects (and bronze and iron bi-metallic objects) in published reports is assessed to examine the patterns of the excavated iron objects of Southwest China. The results provide a general image of the character of the use of different artefact types of Southwest China in different periods of time (chapter 4).
6. Metallographic analysis is studied to understand iron production technology and the quality of the excavated iron objects from Lijiaba and Qiaogoutou (chapter 5).

1.3 Structure of the thesis

This general introduction is followed by chapter 2, which introduces the historical background of Southwest China. A general overview of the history and past archaeological work of each province is first presented. The chapter then introduces the most important archaeological sites or areas of each province to help readers to understand the overall situation of the study area.

The methodologies of the main research chapters 3-5 are introduced in the beginning of each chapter.

Chapter 3 introduces the archaeological field surveys of iron smelting sites in Sichuan and Chongqing. There are 74 iron smelting sites discovered in Sichuan and one in Chongqing. The chapter starts with the survey and excavation methodology (section 3.2-3.3), and then presents five excavated sites (section 3.5.1-3.5.5), 1) Gushishan, 2) Xuxiebian, 3) Tieniucun, 4) Shazitang, and 5) Chadiping (Chongqing). The chapter then presents a statistical analysis of the non-excavated sites (section 3.6). As the bulk of the field data, large information on the non-excavated sites is presented in appendix C7.

Chapter 4 presents the analytical and statistical results of the large quantities of iron objects (and bronze and iron bi-metallic objects) of Southwest China in published excavation reports. A detailed methodology is first given (section 4.2), and then examines and shows the patterns of both iron and bi-metallic objects of Southwest China (section 4.3). This chapter assesses and summarizes the iron (and bi-metallic) objects of Southwest China synthetically for the first time. The results are compared with the situation of the Central Plains and Northern China in order to discuss their relationships and connections.

Chapter 5 provides the results of metallographic analysis of the selected iron objects. The chapter starts with the methodology employed in sample preparing and analyzing (section 5.2). A total of 66 metallographic samples from 36 excavated iron objects from Lijiaba (section 5.3), and five from Qiaogoutou as well as an SEM-EDS analysis of three samples (SK0072, 73, and 74) are then presented (section 5.4). The results are compared by previous metallographic analyses of Southwest China as well as to other analyses of iron objects from the Central Plains and Northern China. These comparisons enable discussion on production technology applied to the iron objects excavated at Lijiaba and Qiaogoutou.

Chapter 6 summarizes the main finds of this study and outlines some avenues of future work.

The appendices include the technological classification scheme of slags, and the detailed information of other smelting sites and smelting related materials mentioned in the discussions in this thesis, for the convenience of readers. It also provides all the primary data used in this study, including the details of the collected samples and the surveyed sites, and the assessed database of iron objects.

Chapter 2: The History and Archaeology of Southwest China

This chapter introduces the historical background of Southwest China by each administrative division. It introduces from two aspects, the history and archaeological work, to help understand the overall situation of the study area.

Ancient human activity in Southwest China can be traced to the Paleolithic Age. Some well-known examples of the early Paleolithic period include the Longgupo site discovered in Chongqing municipality in 1984, dated to about 2.01-2.04 million years ago. Although no human or ape fossils have been excavated there are both lithic tools and the mammalian fossils at the site, clearly indicating that there was human activity (Wu Xianzhu and Zou 2013, 87-89). The Yuanmou Man (*Homoerectus-yuanmouensis*), discovered in the Yunnan province, is dated to at least 1 million years ago (Zhou G. and Hu 1979). The Guanyindong site in west Guizhou province, dates to about 240,000-180,000BP by Uranium-series (Xi 1994, 702). For the late Paleolithic period, the Ziyang Man discovered in Sichuan, is radiocarbon dated, on the tree fossils associated with the artefacts and the mammalian fossils, to about 40,000BP (Li Xuanmin and Zhang 1984, 224). The distribution of the important Paleolithic and Neolithic sites in the study area is shown in Fig. 2.1.

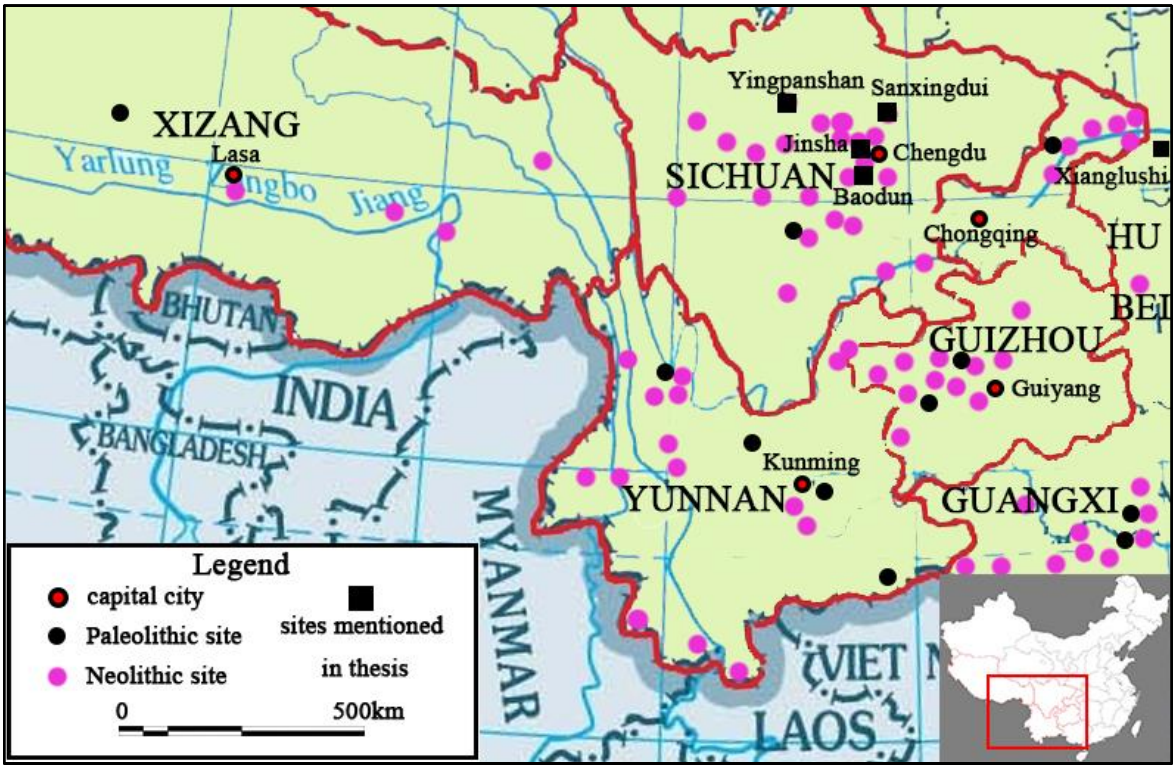


Fig. 2.1 Distribution of some important Paleolithic and Neolithic sites in SW China (source: China National Administration of Surveying, Mapping and Geoinformation)

In Chinese archaeology, "culture" means the archaeological findings from several contemporary sites, which identify similarity in their relics or remains. When the Neolithic Age ends, central China was ruled by the Bronze Age cultures known as Xia, Shang and Zhou. However, besides these dominant cultures in the Central Plains, there were also other contemporary cultures in the southwest of China (Fig. 2.2). For example, the Shu culture in the area of Sichuan province today and the Ba culture in modern Chongqing municipality existed from the Shang Dynasty. Also the Yelang culture and Julan culture in Guizhou province, and time of the Dian culture in Yunnan province existed from the late Warring States Period until the Qin conquest of China at 221BC (Fig. 1.2).

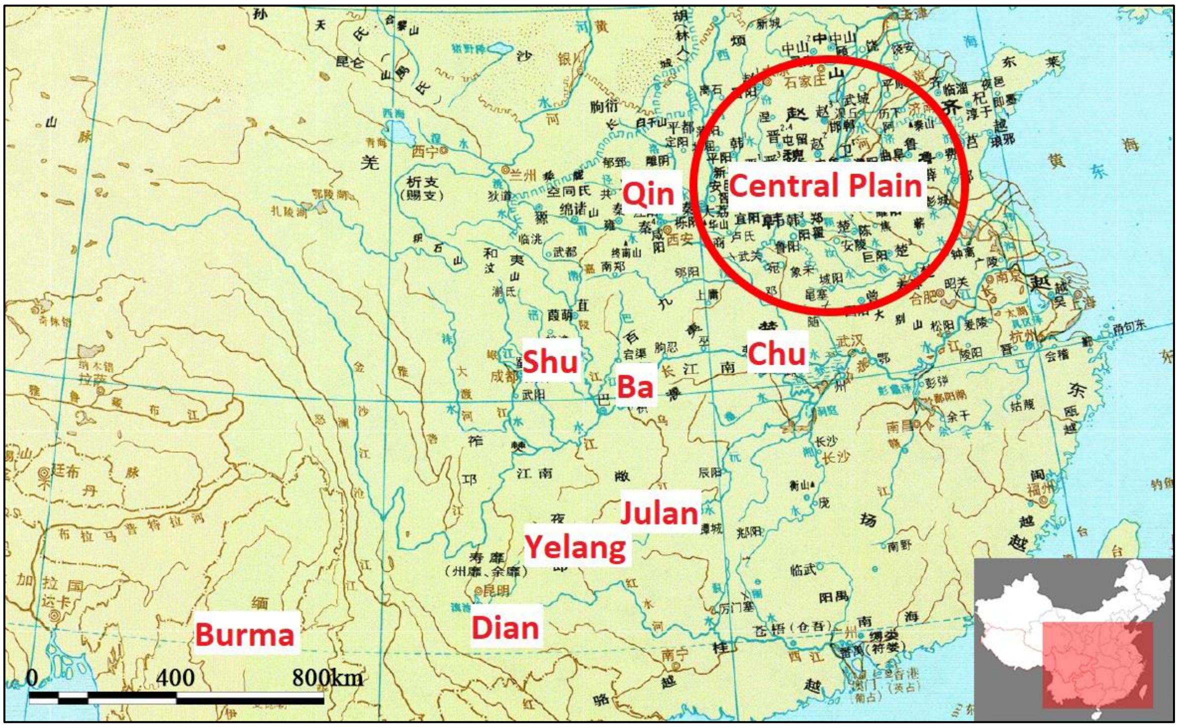


Fig. 2.2 Main cultures of Southwest China in the Warring States Period (Tan X. 1982)

2.1 Sichuan province

2.1.1 Historical review

During the Xia, Shang and Zhou Dynasties, the dominant culture in Sichuan province was the Shu culture. The archaeological sites of the Shu culture were mainly distributed in the area of the Chengdu Plain. The Shu culture can be divided into three phases in this period, the first phase is the Sanxingdui culture, the second phase is the Shierqiao culture, and the third phase is the Warring States Period (Zhou Kehua *et al* 2009, 21).

The Shu culture was the main culture living in the area of Sichuan province from the Xia Dynasty to the Warring States Period. It refers to the people who lived in the areas of the Chengdu Plain and the Ming River, which is roughly the central area of the Sichuan Basin. It also refers to the ancient kingdom of Shu, of which their people believed that their ancestors were the Ran people and the Qiang people. During the period of the 17^{th}-11^{th} centuries BC, three tribes became the leading tribe alternatively, first was the Can Cong's tribe of the Qiang people, the word "Can" means silkworm, and the Can Cong tribe are believed to be good at sericulture. The second leading tribe was the Bo Guan tribe, also of the Qiang people, and "Guan" means irrigation which may indicate that these people were good at cultivation. The third was the Yu Fu tribe of the Ran people. "Yu fu" is a kind of water bird that catches fish, and people of this tribe fish for a living. Their leader, Du Yu, who led his tribe joined the battle of Muye, called themselves Shu, and helped the Zhou people defeat the Shang Dynasty. After the victory of this battle, on 1046BC, Du Yu was canonized by the Zhou Dynasty as the king of Shu, and the ancient kingdom of Shu was first established. Under Du Yu's governance, during the period of 1046-771BC (Western Zhou Dynasty), Shu people were engaged in agriculture, mining (silver), and animal husbandry. From about the 770BC, flood became a serious problem in the Chengdu Plain, a person named Bie Ling, who helped the Shu people solve the flood problem and became the second king of the Shu kingdom. In the legend, Bie Ling built Chengdu city in c.666BC, the most important city in Southwest China until modern times.

Because flooding was well treated, the agriculture continued to develop in Chengdu Plain (Zhongguo 2009a, 490).

In 316BC, the Shu kingdom was defeated by the Qin people, and then became a tributary of Qin. In 277BC, the Qin State made the Shu kingdom one of its counties, and was trying make it as its granary. However, the Chengdu Plain was a frequent natural disasters area, where flood and drought have always been the scourge of the Shu people since ancient times. Therefore, during the period of 256-251BC, a person named Li Bing, was appointed as the magistrate of the Shu county by the king of Qin, and his main quest was to control the flood and reviving agriculture. Li Bing designed and constructed the Dujiangyan irrigation system which protected the Shu people from flood, thousands hectares of lands were irrigated, and the shipping industry was developed. Since then, the Chengdu Plain has been a fertile and stable area which made tremendous contributions in the battles of Qin's conquer of China (ibid., 490). During the Western Han Dynasty (202-9BC), Shu was a county under the Yi state. In 117BC, the salt and iron production were monopolized by the Han government. Three *TieGuan* (a government controlled office responsible for iron smelting and production activities) were set up in different prefectures of the Shu county.

2.1.2 Archaeological review

Before the establishment of People's Republic of China (1949), archaeological investigations in Sichuan province were usually carried out by foreign missionaries and explorers such as A.H. Donnithone and D.C. Graham (Walravens 2006, 251). Since 1949, thousands of archaeological surveys and excavations have been carried out by the Sichuan provincial archaeological institute and the local cultural relics management institutes of the cities and counties.

There are more than a dozen Paleolithic locations and sites discovered in Sichuan province, and most of them are located in the central and eastern areas. The date of these sites was comparatively late, and belong to the late Paleolithic Age. The most famous discovery is the Ziyang Man which is dated to about 40,000BP.

Over one hundred Neolithic sites have been discovered in Sichuan province, mainly distributed in western Sichuan, in the upper stream of the Min, Dadu and Anning Rivers. The most important site discovered in this region is Yingpanshan. On the other hand, in the Chengdu Plain, the most important discoveries of the Neolithic are the Baodun culture (2500-1700BC) and the first phase of the Sanxingdui culture (2800-2000BC).

The archaeological evidence of Shu culture is mainly distributed in Chengdu Plain. The early Shu culture is a local culture that was affected by the Central Plains cultures. It is commonly agreed that early Shu culture includes the 2nd, 3rd and 4th phases of Sanxingdui culture (c.2000-1100BC) and Shierqiao culture (c.1100-500BC). According to the archaeological evidence, the lower boundary of Shu culture was about early-Western Han (1st century AD), and the ancient Shu people migrated from the mountain area in the northwest to the plain area in the centre of the Sichuan Basin as time goes on (Tan J. 1999, 123).

2.1.3 The Neolithic

Yingpanshan

The Yingpanshan site is located in the Mao county, Aba state of Sichuan province. It is the biggest Neolithic site discovered so far in the upper Ming River area. The site is dated to about 5,300-4,600BP. The site is located on the third terrace of the southeast bank of the Ming River, and is 120-200m west-east, about 1000m north-south, at an altitude of 1,650-1,710m, which is about 160m above the river. The archaeologists also discovered tens of contemporary, medium and small late Neolithic settlement sites near the Yingpanshan site (Chen J. 2007, 65).

On the site, in the Neolithic context, 11 house foundations, 9 human sacrificial pits, 17 kilns and hearths, and more than 120 living pits were discovered. The site could be divided into four areas by its different functions, include living area, sacrificial area, pottery making workshops, and lithic workshops. The artefacts at the Yingpanshan site were made of lithic, ceramic, jade, and animal bones. The lithic tools and implements are the main components of the site. The ceramic objects are generally tools and vessels including painted pottery. There are also numbers of tools made of animal bones, and the jade objects are productive tools, personal ornaments, and ritual objects (Jiang C. *et al* 2002).

In conclusion, the Yingpanshan site is a large central settlement in the upper Ming River of the late Neolithic Age. Lithic and jade making was a specialized industry. Agriculture was the main economic activity, but hunting, gathering, and fishing were still engaged as supplementary (Chen J. *et al* 2005, 2).

Baodun

The Baodun site is located in Xinjin county, in western Sichuan Basin. The site is a rectangular walled city (Fig. 2.3), of length is 1,100m, and width 600m. It is the biggest and earliest ancient city site discovered so far in the Chengdu Plain and is believed to be the first capital city of the ancient kingdom of Shu. There are inner and outer city walls, of which the inner wall is about 600m west-east and 1,000m north-south, and the total perimeter of the outer wall is about 6.2km. The total area is approximately 2.7km^2, which is the third largest ancient city site in China. The building of the city wall is dated at about 2500BC and was abandoned about 200 years later, at 2300BC. Most of the artefacts are small polished stone implements, and it is clearly shown that the cutting and boring techniques were well mastered (He K. 2015).

The house foundations found at the Baodun site indicate small rectangular houses (Fig. 2.4), with wooden frame and fired clay walls. The implements were mainly polished stone implements, including a large number of axes, adzes, chisels, and a small number of knives, spades, arrow heads, and spears. The ceramic tools were spindle whorls and fishing net weights.

The artefacts indicate that the Baodun people lived in a settled agriculture based society, combined with gathering, fishing and hunting activities (He K. 2015).

Fig. 2.3 City wall at Baodun (source: He K. 2015, 27)

Fig. 2.4 House foundations at Baodun (source: He K. 2015, 29)

2.1.4 The Bronze Age

Sanxingdui

Sanxingdui is regarded as the type site of the early Shu culture (Chen X. and Chen 1991). The site is located about 4km northeast of Nanxing county, Guanghan prefecture, Sichuan Province, and a trapezoidal walled city. Two large sacrificial pits were discovered and excavated in 1986. The Sanxingdui site is dated to c.2800-1100BC.

Within the area of the city, different type of sites was discovered including house foundations (Fig. 2.5), sacrificial pits, living pits, cemeteries, and handicraft workshops. Thousands of artefacts made by bronze, gold, jade, ivory and ceramic were excavated (Fig. 2.6). The large number and high quality of the bronze wares indicate a highly advanced bronze smelting and casting technology. Its bronze vessels are similar to the ones of the Shang culture in the Central Plains and the bronzes cultures in the middle Long River, but the other artefacts, both in their type and style, are obviously of local characteristics. The standing bronze figure, its facial features, the dressing style, the anklet, are all different from the people of the Central Plains. The frequently seen figures of fish and bird on the artefacts are believed to be the symbols of the ancient Shu people (Chen X. 1989b).

Sanxingdui (excluding phase I) is the first Bronze Age culture discovered in Sichuan. The scale of the site and the city walls, and the distinctive sacrificial artefacts indicate that Sanxingdui was once the political and sacrificial centre of the entire Chengdu Plain.

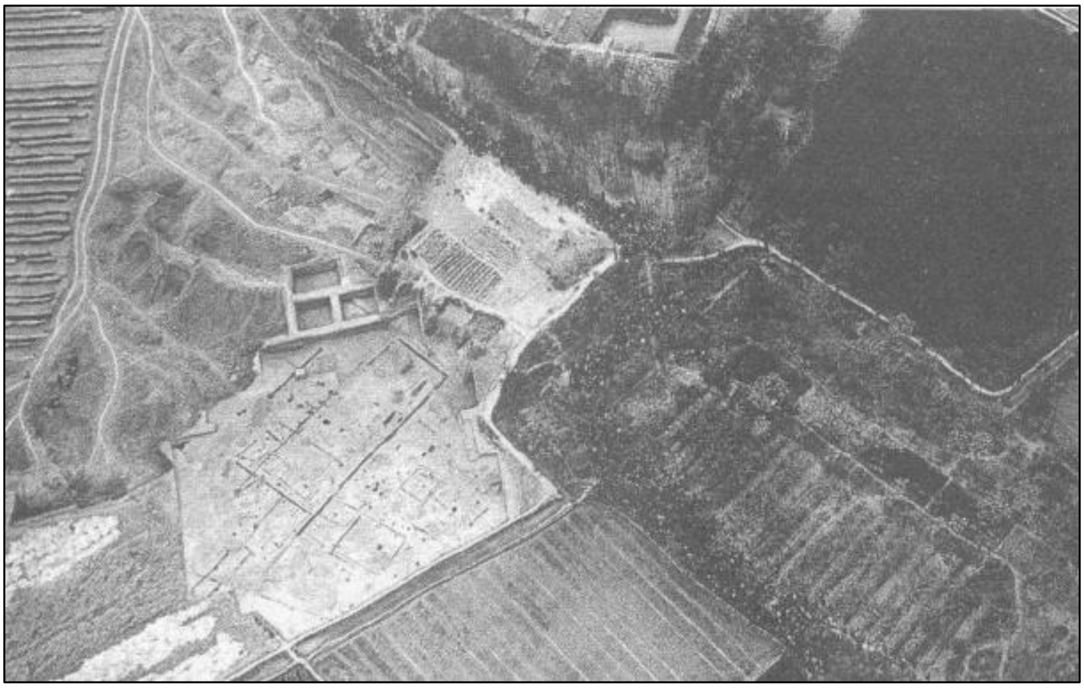


Fig. 2.5 House foundation at Sanxingdui (source: Chen X. 1989b, plate 3)

Fig. 2.6 Excavated artefacts at Sanxingdui
1-4. Bronze figures, K1:2,5,72,293; 5. Bronze dragon, K1:36; 6. Gold staff, K1:1 (source: Shi J. 2004, 169)

Jinsha

Jinsha (and Shierqiao) is a type site of the Shierqiao culture. It was the next central settlement following the Sanxingdui site. Jinsha and Sanxingdui are only about 50km apart. The Jinsha site was discovered in 2001 in urban Chengdu. It is the first major archaeological discovery in China at the beginning of the 21st century, and also a significant archaeological event following the discovery of the Sanxingdui site. Jinsha is dated to the 12th-7th centuries BC and is believed to be a capital of the ancient Shu Kingdom. The site was contemporary with the Shang and Western Zhou Dynasties of the Central Plains (Jiang Z. 2010).

At Jinsha, large-scale palace foundations, sacrificial areas, residential areas, and burials were found. A great variety of artefacts in large numbers were excavated (Fig. 2.7), including more than 5,000 objects of gold, bronze, jade, stone, ivory, and lacquered wood, as well as millions of potsherds, tons of elephant tusks and thousands of boar tusks and deer horns. The artefacts excavated here are similar to the ones found at Sanxingdui, but no city walls were found. For instance, the golden masks found here are very similar to the bronze masks found at Sanxingdui, and the standing bronze figures are similar in appearance. This indicates a transfer of the political centre of the ancient kingdom of Shu. It is evident that after the decline of Sanxingdui, Jinsha was rising as the next centre of politics, economy and culture. It is one of the most important archaeological sites of the pre-Qin period in China (Jiang Z. 2010).

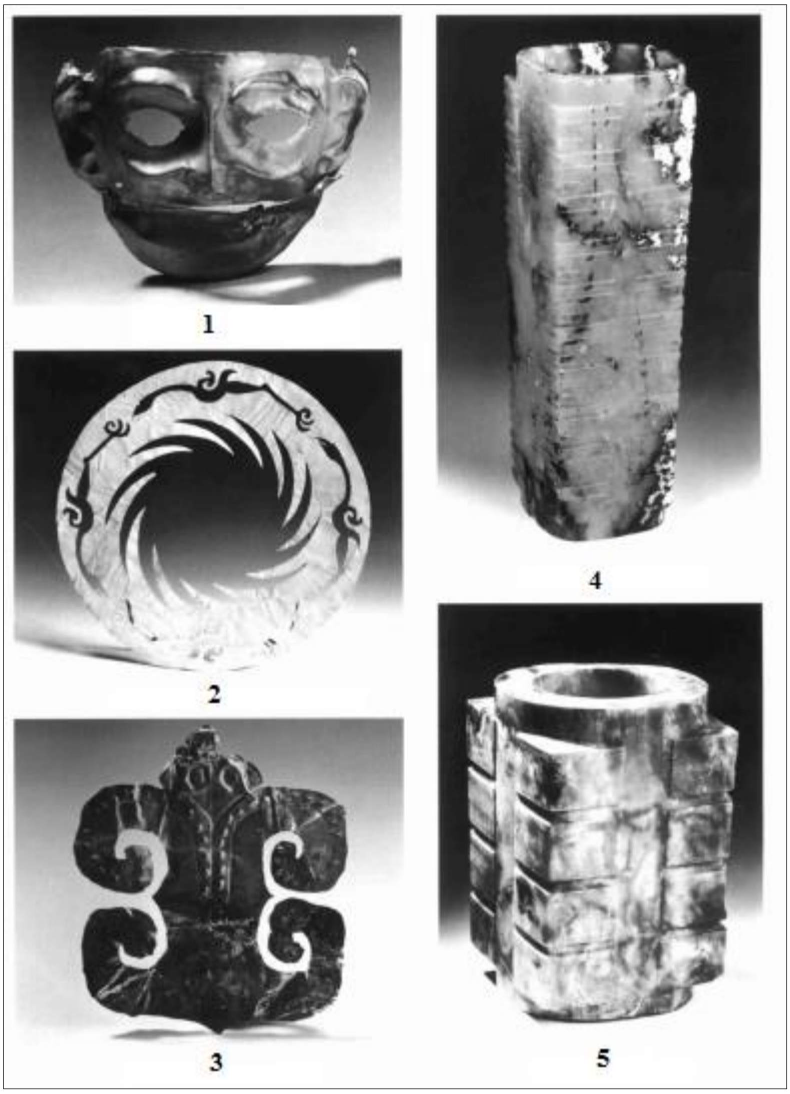


Fig. 2.7 Excavated artefacts at Jinsha
1. Gold mask; 2. Sun and immortal bird (gold); 3. Frog-shaped gold foil; 4-5. Jade *cong*, ritual object (source: Zhu *et al* 2002, plate 1)

The discovery of Jinsha is of great significance for the study of the Shu culture, including its origin, development, and decline. It also provides an explanation for the abrupt disappearance of the Sanxingdui culture. On the other hand, the earliest written records about constructing cities in the areas of Sichuan province could only be traced back to the late Warring States Period (about the 6^{th}-5^{th} centuries BC), the discovery of the Sanxingdui and Jinsha sites have pushed back the time of Sichuan's ancient history.

2.1.5 Iron Smelting in the Sichuan Basin

The archaeological evidence of iron smelting and production in the Sichuan Basin are focused mainly in the Chengdu plain. There are four major reasons for this, the first is that the Chengdu Plain has been the geographic, economic and political centre of the Sichuan Basin since ancient times, and most archaeological fieldwork have been carried out in this area (chapter 3), in association with the infrastructure construction and development in the past several decades. In the *Hua Yang Guo Zhi* ('Treatise on the states south of Mount Hua', compiled by Chang Qu in 348-354AD), it says that the Qin conquered the Ba and Shu in 316BC, then established the Shu county at 277BC, and set salt, iron, and market institutes in the county (Chang Q. 2009, 128; for English cf. Twitchett and Loewe 1986, 160-163).

The second reason is that, there are plenty of iron ore sources in this area. The *Shan Hai Jing* ('Canon of mountains and seas'), an ancient compendium on the physical geography and folklore of the known world of its time, mentions the presence of iron ore in 39 localities (Yuan 1980). Meng Wentong (1981) indicated that some of these locations are in the area of Shu. In addition, in the *Shi Ji* ('Records of the historian', by Sima Qian, who died about 90BC), it records evidence that may refer to the appearance of bog iron in Jiameng (near modern Guangyuan, Sichuan) (SiMa 1982a, 3277-3278; cf. Wagner 1993, 165). More evidence of iron ore can also be found in the *Hua Yang Guo Zhi* ('Treatise on the states south of Mount Hua', compiled by Chang Qu in 348-354AD). Iron ores were recorded discovered in several counties and most of them are in the areas of Sichuan (Fig. 2.8). These counties include Dangqu (Quxian, Sichuan), Linqiong (Qionglai, Sichuan), Guangdu (Shuangliu, Sichuan), Wuyang (Pengshan, Sichuan), Nan'an (Zigong, Sichuan), Taideng (Mian'ning, Sichuan), Buwei (Baoshan, Yunnan), Bigu (Jianshui, Yunnan) (Chang Q. 2009, 49-50,79,128,158,161,175,211,286,302).

Fig. 2.8 The distribution of iron ores recorded in the *Hua Yang Guo Zhi* (adapted from Yunnan Bureau of Surveying, Mapping and Geoinformation and Sichuan Bureau of Surveying, Mapping and Geoinformation)

The third reason is that, in the *Shi Ji*, it is also clearly stated that Zhuo Wangsun's family and Cheng Zheng's family, who were both experts in iron smelting technology, immigrated to the Linqiong prefecture (Qionglai at present, west of the Chengdu Plain) in the Qin Dynasty. This is the first written evidence that iron smelting technology was brought to southwest China (SiMa 1982a, 3277). An English translation of more details about Zhuo and Cheng families is made by Wagner (1993, 165-169).

The final reason is that three *TieGuan* were set up in the Shu county in the early Han dynasty. According to the *Shi Ji*, in 117BC, salt and iron production was monopolized by the government, and three *TieGuan* were setup in the Linqiong, Wuyang, and Nan'an prefectures. In addition, recorded in the *Han Shu*, 'The history of the Former Han dynasty (206BC-23AD)', compiled by Ban Gu in 80AD, *TieGuan* were divided into two classes, large and small, depending on whether or not iron resources can be found within the county where the *TieGuan* was situated (Ban 1999, 976). The one in the Linqiong prefecture was a large *TieGuan* that included the activities of mining, smelting, casting, and selling in one operation.

2.2 Chongqing municipality

2.2.1 Historical review

The Ba culture was the main culture in the area of modern Chongqing from the late Shang Dynasty to the Qin Dynasty. Its character was effected by the local Neolithic culture, mixed with its proximity with the Central Plains cultures and the early Shu culture. The distribution of the Ba culture included the entire Chongqing municipality, the east of Sichuan province, the south of Shaanxi province, the west of Hubei province, and the north of Guizhou province nowadays.

In folklore, before the establishment of the ancient kingdom of Ba, the Ba culture was one united tribe of five powerful local clans. The Ba people were one of the five clans. The economic foundation of the Ba people was sericulture, however, they were also renowned for their mining and smelting, salt production, and merchandise businesses.

Like the Shu culture, the Ba people also joined in the battle against the Shang Dynasty in 1046BC. During the 11^{th}-4^{th} centuries BC, the Ba culture was one of the most powerful cultures in southwest China, and relations between the Ba and

Shu were always strained until both were overwhelmed by the Qin Dynasty (Cai 2005). In 314BC, the ancient kingdom of Ba was conquered by the Qin, and became Ba prefecture, one of the thirty-six counties of Qin. After the Western Han dynasty defeated the Qin Dynasty in 202BC, the Ba remained as a county until the Tang Dynasty when Ba county became Yu state in 618AD. From the Qin and Han Dynasties, people from the Central Plains started immigrating to southwest China for different reasons, and the local cultures were assimilated by the dominant culture gradually as time went on.

2.2.2 Archaeological review

Archaeological investigations in Chongqing municipality can be divided into four major stages. First, from the establishment of People's Republic of China to the 1960s. Second, the 1960s and 1970s. Third, from 1979 to 1997, from the start of Chinese policy reform and openness to Chongqing becoming the fourth municipality of China, and fourth, from 1997 when the biggest archaeological salvage excavation in the Three Gorges region started.

The Three Gorges region of Chongqing is important in the archaeology of the origin of human beings. Since 1949, nearly 100 Paleolithic sites have been discovered in this area and ancient human fossils excavated from 6 locations. The most famous being the Longgupo site in Wushan county, where a part of mandible and an upper incisor were discovered and dated to about 2.01-2.04 mya (Huang Wanbo and Fang 1991).

There are 80 Neolithic sites of different dates discovered in Chongqing. Some important sites include Santuo, Laoguanmiao and Yufupu in Fengjie county; Yuxi and Yuxiping in Fengdu county; Ganjinggou, Zhongba and Shaopengzui in Zhong county; Daxi in Wushan county (Fig. 2.9). These sites were usually located on the first and second terraces of the river bank and were dated from about 10,000BP to about 4,000BP. (Zou 2009, 33-35).

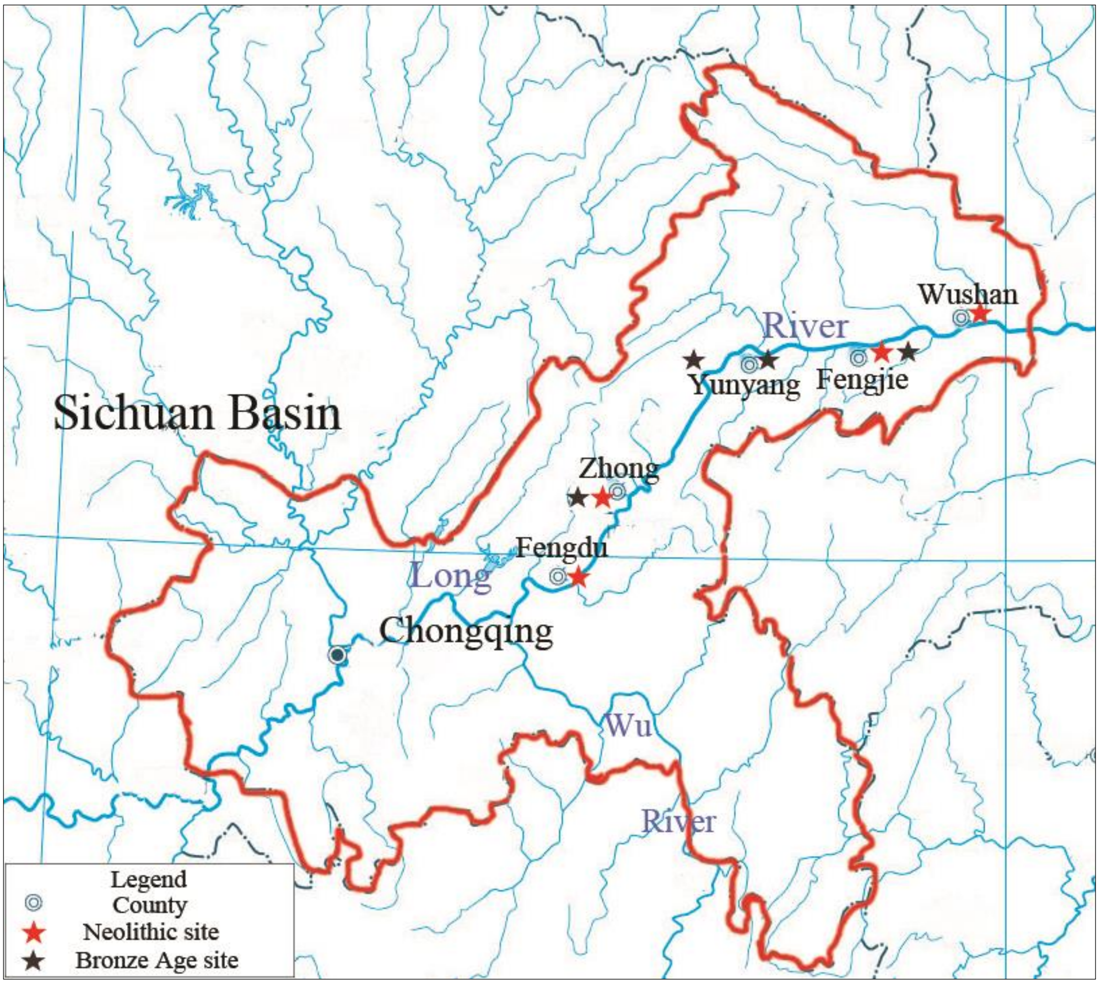


Fig. 2.9 Distribution of some important sites (source: China National Administration of Surveying, Mapping and Geoinformation)

There are 142 early Bronze Age sites recorded in Chongqing. These sites are mainly located along the valleys of the Long River, the Jialing River, the Wu River, and the You River. These early Bronze Age sites can be divided into three stages. First stage, from the Xia Dynasty (about the 21st century BC) to the mid Shang Dynasty (about the 15th century BC). Nearly 20 sites were discovered of this period and some typical sites include Shaopengzui and Zhongba in Zhong county, Zhongbazi in Wanzhou, Dadiping and Silibao in Yunyang county, and Xinpu in Fengjie county. The artefacts of this stage include wide flared mouth jars, contracted mouth jars, small flat bottom jars, long handle plates, bird-head handle spoons, *gui* (food vessel) and *he* (water/wine vessel). Even though some of the artefacts such as *gui* and *he* are Central Plains types, the overall cultural characteristic shows a combination of indigenous culture types of the Three Gorges region (different types of jars) and the Sanxingdui culture of Sichuan (the small flat bottom jar, long handle plate, and bird-head handle spoon). In addition, large numbers of ceramic fishing weights, bone hooks, stone axes and adzes were excavated from these sites, indicating that the main economic lifestyle of this stage was still hunting and fishing (Zou 2009, 35).

The second stage is from the mid Shang Dynasty to the early Western Zhou Period (the early 10th century BC). The most representative site of this stage is Shidiba in Fengdu county. In general, the object types of the early period of the Shidiba site, such as the small flat bottom jars and long necked kettles, are close to the Shierqiao culture of Sichuan, and the object types of the late period such as the rounded bottom jar and sharp bottom cup are local types (Bai J. and Li 2007).

The third stage is from the mid-Western Zhou Dynasty to the Spring and Autumn Period (10th-5th centuries BC). The important sites including Shuangyantang and Tiaoshi in Wushan county, the upper layer of Xinpu in Fengjie county, Zhongbazi in Wanzhou, Zhongba and Wazhadi in Zhong county. The archaeological remains differ between the west and east of the Qutang Gorge of the Long River. The representative sites are Wazhadi and Shuangyantang. The Wazhadi site is located on the west of the Qutang Gorge and is dated by radiocarbon to 1130BC-760BC. In general, the artefact types of Wazhadi are a continuation and evolution of the Shidiba culture in the early period (Sun 1999). On the other hand, the Shuangyantang site is the most representative site of the cultures distributed on the east of the Qutang Gorge of this stage (Zou 2009, 35).

The archaeological evidence of the Ba culture can be found in the areas of the upper-mid Long River, more specifically, the Three Gorges region. Within this region, many archaeological sites of late Neolithic to Han Dynasty were discovered. Based on a statistical study in 2008, there are 79 Neolithic sites, 16 sites of the Xia Dynasty, 74 sites of the Shang Dynasty, 108 sites of the Zhou Dynasty, and 186 sites of the Qin and Han Dynasties (Zheng *et al* 2008). Most of these sites have cultural content which differs from the dominant culture in the Central Plains. The most obvious cultural difference reflected in the archaeology findings is that the Ba culture uses the *fu*-pots and jars as their main cooking vessels, and willow leaf shaped bronze swords and spears, and bronze *ge* (dagger-axe) with tiger decoration as their weapon combinations (Fig. 2.10).

Most of the sites discovered in the Three Gorges region from the Spring and Autumn Period to the Qin and Han Dynasties belong to the late Ba culture. These sites usually have separate living and cemetery areas. The typical sites include Dongsunba in Ba county, Xiaotianxi, Yijiaba and Zhen’an in Fuling county, Daping in Wanzhou county, Lijiaba in Yunyang county, Maituo and Jiangdongzui in Wushan county (Liu Q. and Yang 2013).

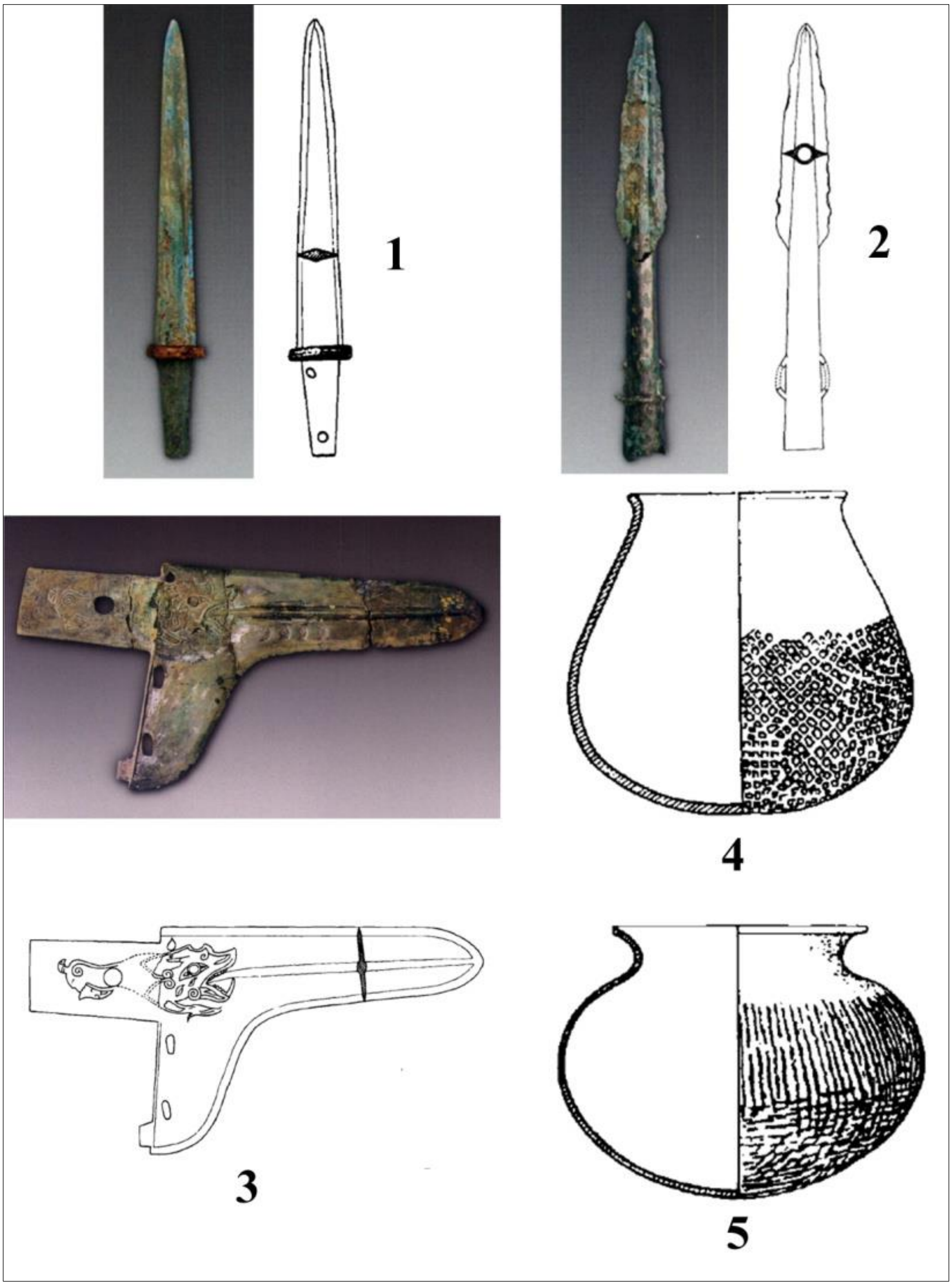


Fig. 2.10 Excavated artefacts of Ba culture

Bronze: 1. Sword (99IIM24:3); 2. Spear (99IIM19:1); 3. *Ge* (99IIM31:13). Ceramic: 4. *Fu*-pot (99IIM11:16); 5. Jar (99IIM28:1) (source: Huang Wei *et al* 2011)

2.2.3 Xianglushi

Xianglushi is one of these sites and its earliest context is dated to about 2000BC. It is the earliest site so far that is believed as a place nearby the first capital city of the ancient Ba culture. Xianglushi is located on the north bank of the Qing River in Yichang city, west of Hubei province. The site is 300m west-east and about 100m north-south (Wang S. 2001, 22-23).

Three excavations in 1988, 1989 and 1995, show the archaeological deposit is over 5m deep and date the site from the Xia Dynasty (about 21st century BC) to the Warring States Period (5th century BC). Seven burials of the Ba culture were discovered, the gravegoods unearthed including sandy ceramic jars, *fu*-pots and oracles. Oracle bones were used for divination in the Shang dynasty. Diviners applied heat to these bones, usually ox scapulae or tortoise plastrons, and interpreted the resulting cracks. Objects from the site exceed ten thousand and include stone tools, animal bone implements, ceramics, bronze objects, and shell money. In particular, there are large numbers of oracles and two ceramic seals of the late Shang Dynasty to the early Zhou Dynasty were excavated on the site (Fig. 2.11).

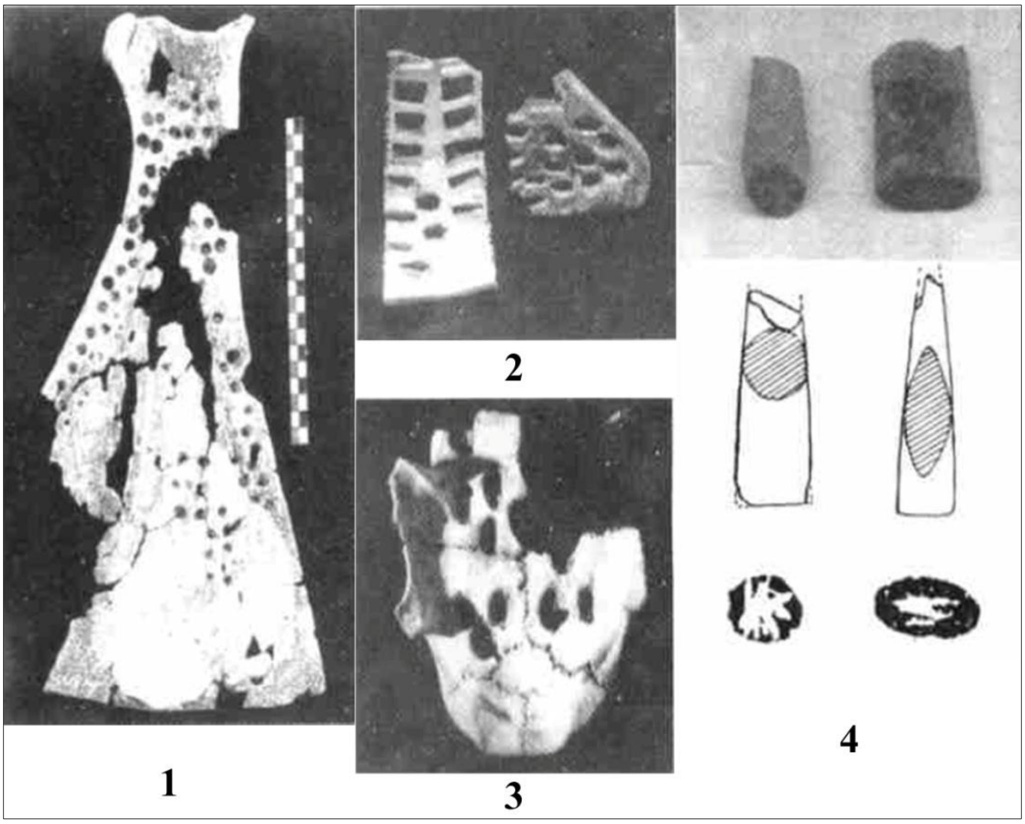


Fig. 2.11 Oracle and ceramic seals at Xianglushi
1. Ox scapulae; 2,3. Tortoise plastrons; 4. Ceramic seals (source: Wang S. 2001)

The most common pottery is brown sandy ware and grayish-brown sandy ware. Some typical main pottery type including flat/round bottom round belly jars, flared mouth round belly round bottom *fu*-pots, and flared mouth slightly round belly sharp bottom cups (Fig. 2.12), which are different from the Xia and Shang cultures of the Central Plains, but similar to objects from nearby contemporary sites in the Three Gorges region (Wang S. 2001, 23).

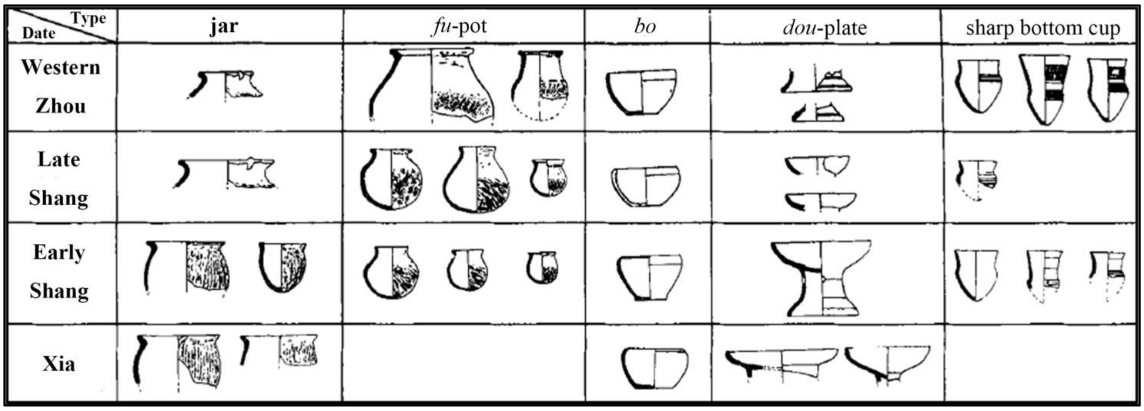


Fig. 2.12 Pottery from Xianglushi (source: Wang S. 2001, 25)

2.2.4 Lijiaba

Lijiaba is located on a terrace of the Pengxi River (a tributary of the Long River) in Yunyang county, Chongqing (Fig. 2.13). The excavators believe that the site is another typical Ba culture site from the Shang dynasty to the Han dynasty. The whole site is about 120,000m^2 and the core area is about 30,000m^2 (Zhou Kelin *et al* 2011a, 369, 424).

There are house foundation remains at Lijiaba indicating at least five complete houses of the Warring States Period (Fig. 2.14). The houses are located on the west side of the site (area I), and one of the excavated houses (F8) is about 192.5m^2 with a rectangular shape (Huang Wei and Bai 2009, 68).

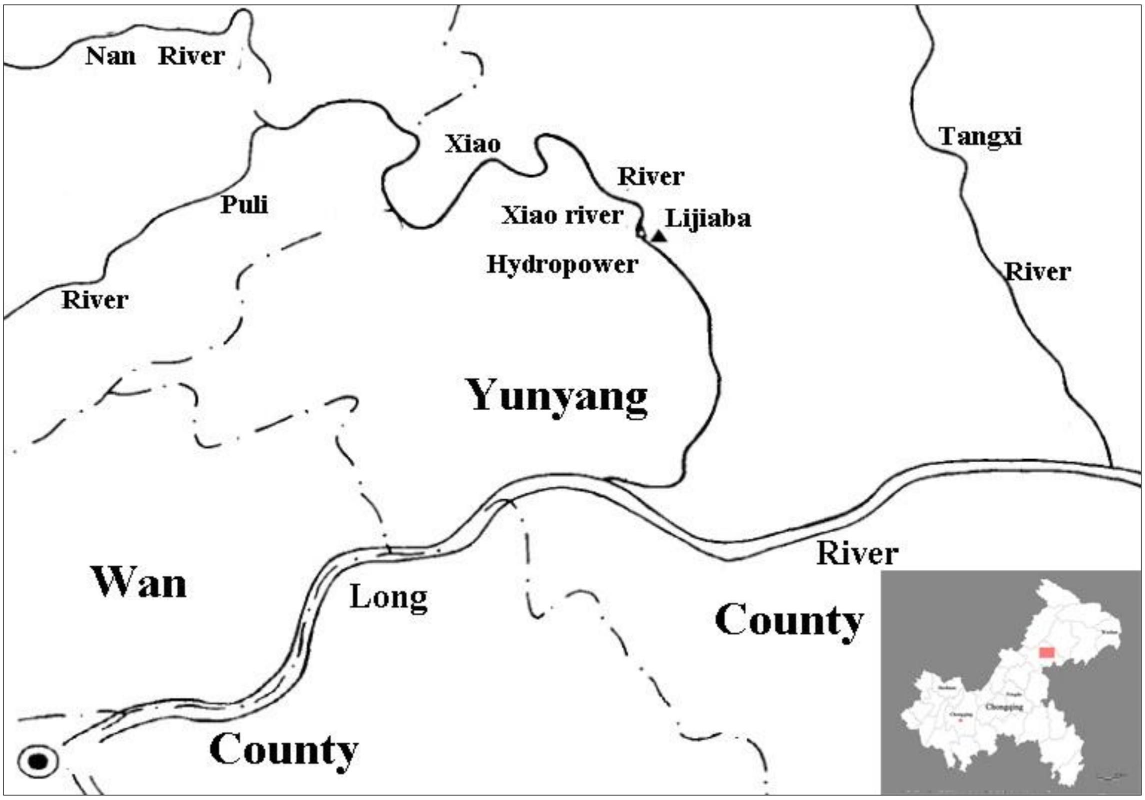


Fig. 2.13 Location of the Lijiaba site (reproduced from: Zhou Kelin *et al* 2011a, 370)

Fig. 2.14 Warring States Period house foundation at Lijiaba (source: Huang Wei and Bai 2009)

A cemetery of about 10,000m^2 is located on the east of the site (area II), with more than 300 burials of the Ba culture and 44 from the Warring States Period (Fig. 2.15). Human sacrifice tradition existed. From these 44 early burials, the gravegoods are either Chu style or Ba style. The Chu style gravegoods including *ding*, jug and long handle plate, either bronze or ceramic. In addition, the inner and outer coffin system is also a tradition used by the Chu culture. The Ba style, mostly are weapons including willow leaf shaped bronze sword and spear, and bronze *ge* (dagger-axe) with tiger decoration (Fig. 2.16). The main cooking vessels used are still *fu*-pot and *mou* (Huang Wei *et al* 2011, 427, 478. fig.16).

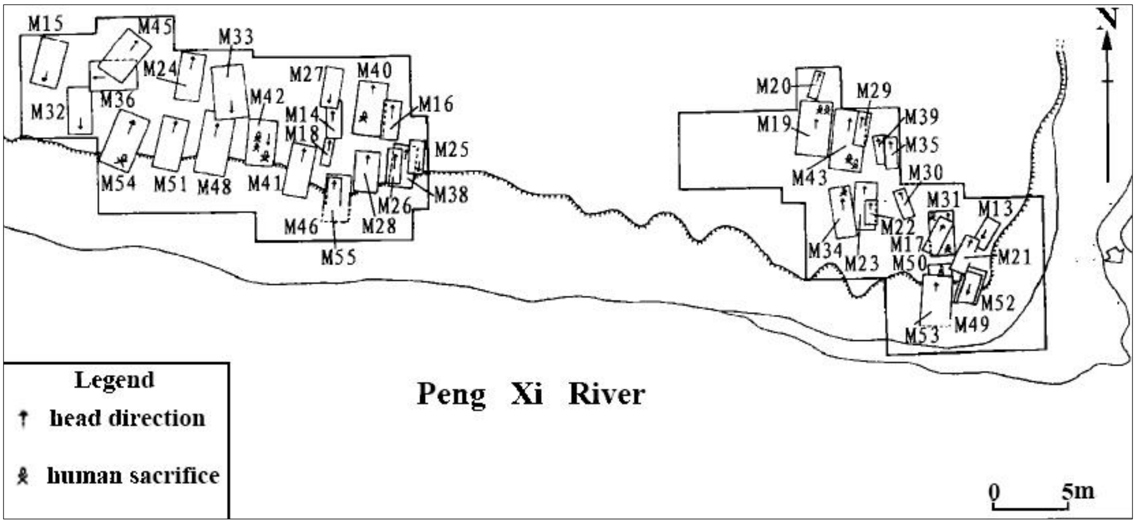


Fig. 2.15 Plan of cemetery area at Lijiaba (source: Luo E. 2002, 62)

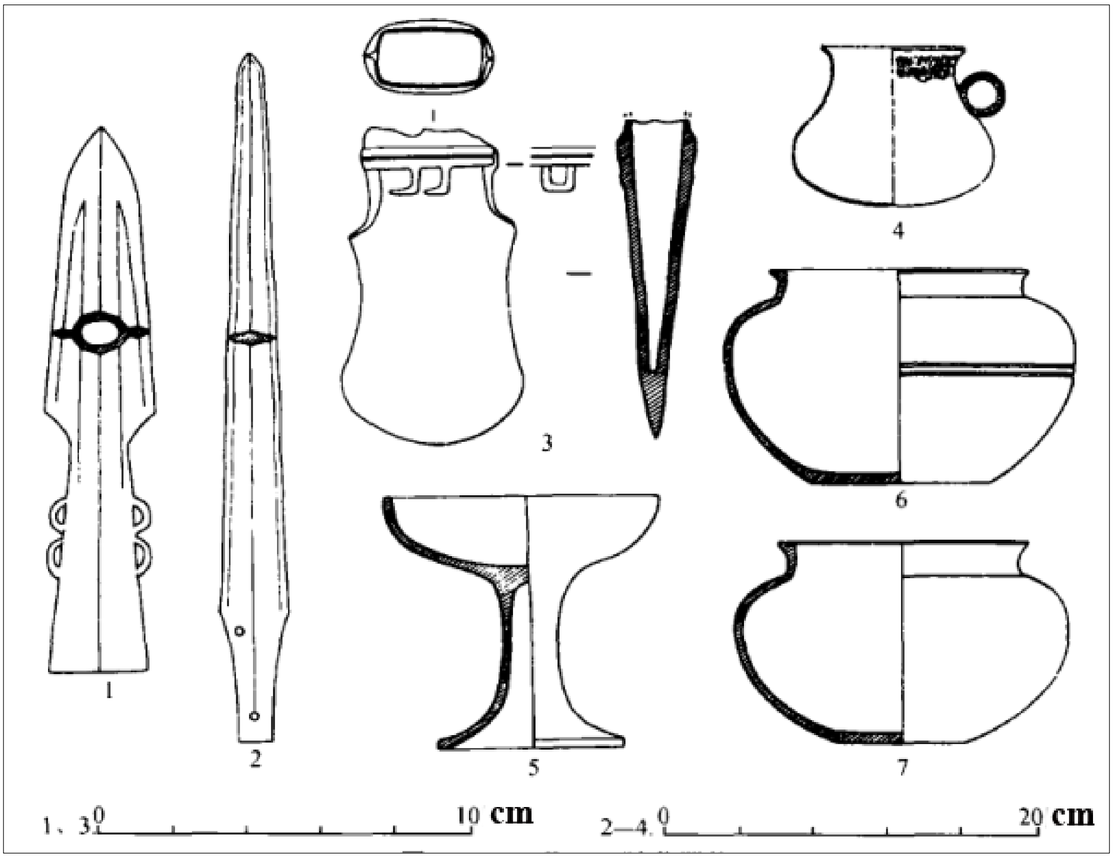


Fig. 2.16 Gravegoods from burial No.14 at Lijiaba (source: Huang Wei *et al* 2011, 447)
Bronze: 1. Spear (99IIM14:1); 2. Sword (99IIM14:2); 3. Broad-ax (99IIM14:3); 4. *Mou* (99IIM14:4)
Ceramic: 5. *Dou* (99IIM14:5); 6. Jar (99IIM14:6); 7. *Yu*-jar (99IIM14:7)

There are also a lot of iron weapons and cooking vessels excavated at Lijiaba. For example, an iron *mou*, an iron sword and an iron knife were excavated from burial No.22 (Fig. 2.17) (Huang Wei *et al* 2011, 476). The Lijiaba Ba culture site continued from the Shang dynasty to the Han and Tang dynasties, and iron artefacts can be found from both burials and other contexts of all different periods of time (section 7.3), which is very important and helpful to understand the use and the development of iron of the Ba culture.

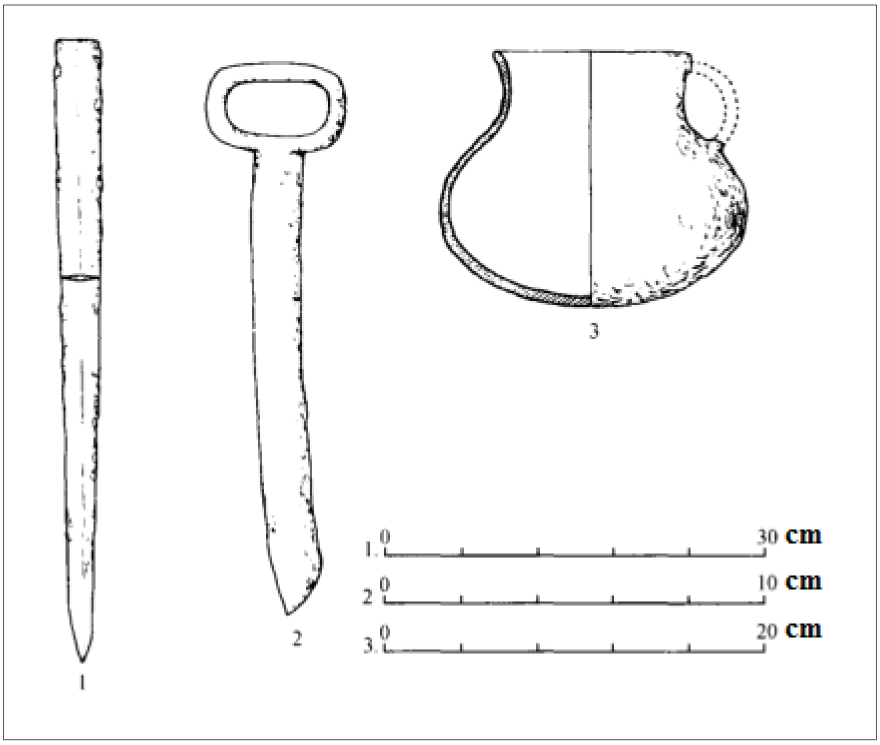


Fig. 2.17 Iron Objects from burial No.22 at Lijiaba (source: Huang Wei *et al* 2011, 476)
1. Iron sword (99IIM22:5); 2. Ring-headed iron knife (99IIM22:6); 3. Iron *mou* (99IIM22:4)

2.2.5 Iron Smelting in Chongqing

In general, the archaeological evidence for iron smelting and iron objects in Chongqing has not drawn too much attention from scholars. Some brief introduction can be made here is that the earliest iron artefacts discovered in Chongqing are from the Spring and Autumn Period. The object types include tools weapons, domestic objects, and agricultural implements. The details are discussed in sections 6.3-6.5 (see also in appendix C4).

In the record of the *Hua Yang Guo Zhi*, in 154AD, the Ba prefecture contains 14 counties, four *YanGuan* (salt office) and one *TieGuan* (iron office) were established in the prefecture. The registered population was 1,875,535, it was growing continuously from the Qin Dynasty to the end of the Han Dynasty. One reason for this is that the abundant salt and iron resources within the area and convenient transportation (Chang Q. 2009, 20-22, 44-45). However, the only iron smelting site in Chongqing excavated so far is dated to the Ming dynasty. The details of the site at Chadiping is discussed in section 5.5.5.

2.3 Yunnan province

2.3.1 Historical Review

In the written records, the Dian culture was the most important culture in Yunnan province and existed from the late Warring States Period until the Qin conquest of China at 221BC. During the Warring States Period (475-221BC), there was an ancient tribe called Dian living in the area of Dian Lake. In 278 BC, general Zhuang Qiao of the Chu State led an army into the Dian Lake area and conquered the Dian tribe (Fig. 2.18).

Fig. 2.18 Location of Qin, Chu, and Dian states (source: China National Administration of Surveying, Mapping and Geoinformation)

On 221BC, Qin completes its conquest of China, declares the establishment of the Qin empire, and then set up 36 counties, one of which is established in the northeast of Yunnan province. To control those new counties in Southwest China, the empire built up roads, called the *Wuchidao*. "*Wuchi*" means five feet, "*dao*" means road. One foot in Qin's measurement is about 23.1cm, which means the road is about 1.16m wide. This road lead to Yunnan, Sichuan and Guizhou provinces. During the Three Kingdom Period (220-280AD), the area of Yunnan province was called as Nanzhong and was conquered by the Shu Kingdom in 225AD. In the 320s AD, Cuan people were in power and ruled the area for about 400 years. During the Tang Dynasty, in 738AD, Khum Borom (the first king of Nanzhao Kingdom) merged the tribes and established Nanzhao Kingdom, and he was conferred the title of the King of Yunnan by the Tang government. In 937AD, Duan's family were in power and established the Dali Kingdom, with its capital at Dali.

2.3.2 Archaeological review

Archaeology in Yunnan province can be divided into three major stages. The first stage is the time before 1949 when there were no official archaeological institutes in Yunnan, and only a few excavation and surveys were carried out by Chinese and foreign institutes and scholars (Li K. 2004, 46). From 1926 to 1927, a central Asia archaeological team, organized by the National Museum of Natural History (Yunnan C. R. a. A. I. *et al* 2005), discovered a Neolithic site and some animal fossils in Yuanmou county. From 1929 to 1930, a survey and excavation of burials from Han dynasty to Jin dynasty was carried out by Chinese archaeologists independently in Zhaotong city, in northeast Yunnan. A Paleolithic survey of the cave sites in Yunnan was conducted in 1938 (Bien and Jia 1938). One year later, some Neolithic sites were discovered in Dali (Wu J. *et al* 1942). In 1941, an excavation of cremation burials was carried out in Jianchuan county (Wan 1957).

The second stage is from 1949 to the 1980s. After the establishment of People's Republic of China in 1949, archaeology in Yunnan made rapid progress, and was distinctly marked by the discovery of the Yuanmou Man, and the excavation and study of Neolithic and Bronze Age cultural remains across the province. In the 1950s, the provincial archaeological team of Yunnan was established, the Neolithic sites in the Dian area were surveyed, the Shizhaishan site in Jinning county was excavated, and the king's tomb of Dian was discovered. This was when the bronze age culture of the Dian was first recognized. In the 1960s and

1970s, small numbers of burials from the Bronze Age to Jin dynasty in Anning city, Chenggong district and Zhaotong city, Daguan county were excavated (Li K. 2004, 46).

The third stage is from the 1980s to the present. Archaeology in Yunnan has reached to a new level. First, the Yunnan Provincial Cultural Relics and Archaeological Institute was established in 1988, and then cultural relic administration offices were established in all counties, towns and villages. From 1981, the second survey of the national cultural relics was carried out and huge numbers of ancient burials and sites were discovered and recorded. By 2004, the number of cultural relics of all kinds from excavations and surveys exceeded 260,000 (Li K. 2004, 46). But it is noteworthy that most of archaeological sites that had been excavated were cemetery sites.

The Bronze Age of Yunnan begins in the Shang Dynasty (about 1600BC), and ends in the late Western Han (202BC-9AD) or the early Eastern Han (25-220AD). Some scholars divide the developed period of the Bronze Age cultures in Yunnan into four main regions including the Dian Lake region, northwest Yunnan, west Yunnan, and the Hong River region (Chinese 1993). The distribution of some important sites in each region is shown in Fig. 2.19. Other scholars divide it into five regions by splitting west Yunnan into the Erhai Lake, and the Nu River and middle-lower reaches of Lancang River regions (Li K. and Hu 2009, 6-7). Xiao Minghua divides the Bronze Age cultures in Yunnan into 6 regions, he believes that the northeast region is a separate region where the culture is likely to be the descendants of the Laoqin people and the Mimo people (Xiao 2001, 8).

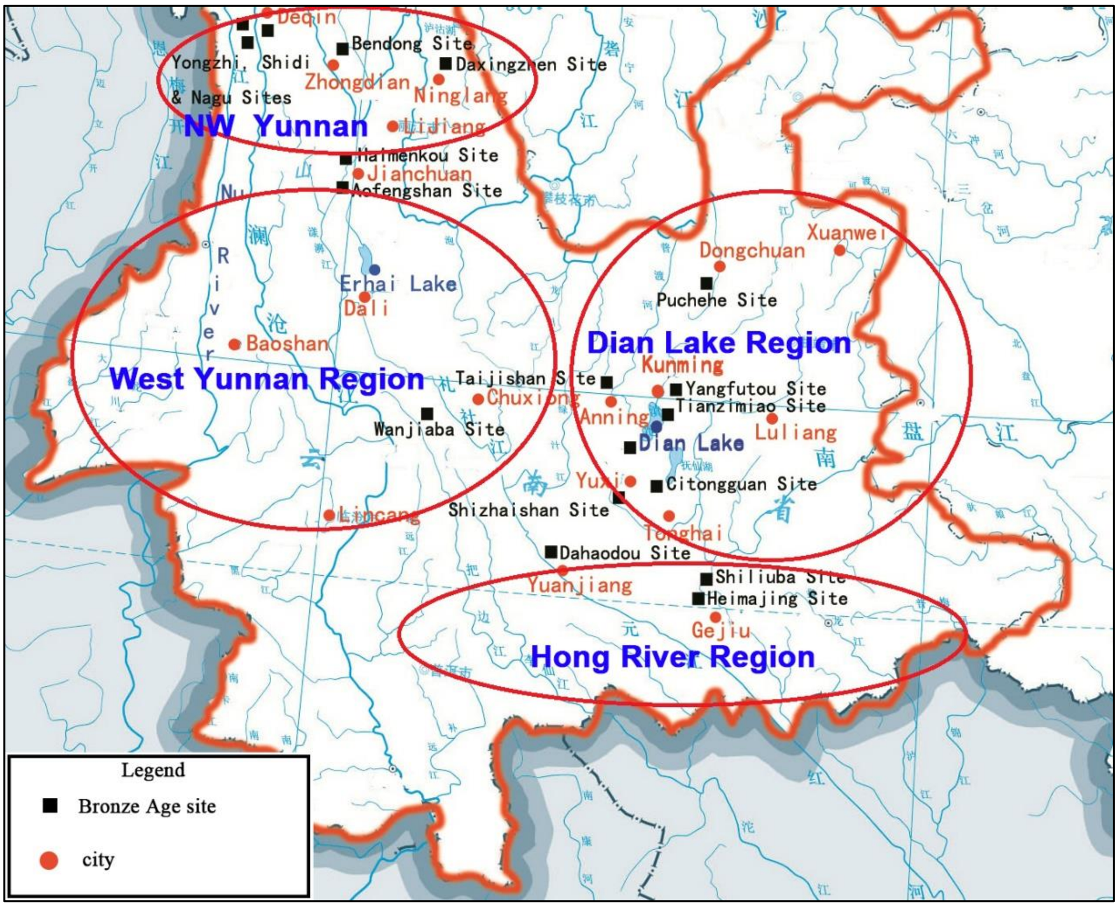


Fig. 2.19 Distribution of some important Bronze Age sites in Yunnan (source: China National Administration of Surveying, Mapping and Geoinformation)

2.3.3 Dian Lake Region

Dian Lake is the centre of Bronze Age cultures of the Dian Lake region (Fig. 2.19). The most representative site in this region is Shizhaishan, which is a cemetery site for the kings of Dian and their royal families from the Warring States Period (475-221BC) to the Han dynasty (202BC-220AD). Shizhaishan has been excavated five times, and more than 10,000 artefacts were excavated. During the second excavation in 1956, there was a golden seal unearthed from M6 (burial No.6) that has an inscription which says the King of Dian ("Dian Wang Zhi Yin", Fig. 2.20) on it which matched the record in the *Shi Ji*.

Fig. 2.20 The King's seal of Dian (source: National Museum of China)

In addition, the jade burial suit that was found in this tomb also matched the burial standards of a federal king of Han Dynasty. This evidence indicates that this tomb belongs to one of the kings of Dian, therefore, the Shizhaishan Bronze Age culture was interpreted as the Dian culture, and the people who created this culture were interpreted as the Dian people. The small burials of the Dian culture were mostly earthen burials, and for large burials there were coffins and outer coffins. The bronze artefacts of the Dian culture were advanced in technology and extremely exquisite. The surfaces of the artefacts were decorated with figures of human activities including hunting, warfare, sacrificial ceremonies, and working scenes (Fig. 2.21). There were also huge numbers of bronze weapons, implements, drums, belt and staff decorations, and chimes unearthed. The Dian culture could be divided into four periods from the Spring and Autumn Period (770-476BC) to the early Eastern Han (25-220AD), and its development could be best represented by the archaeological findings from the Shizhaishan, Lijiashan, Tianzimiao, and Yangfutou sites respectively.

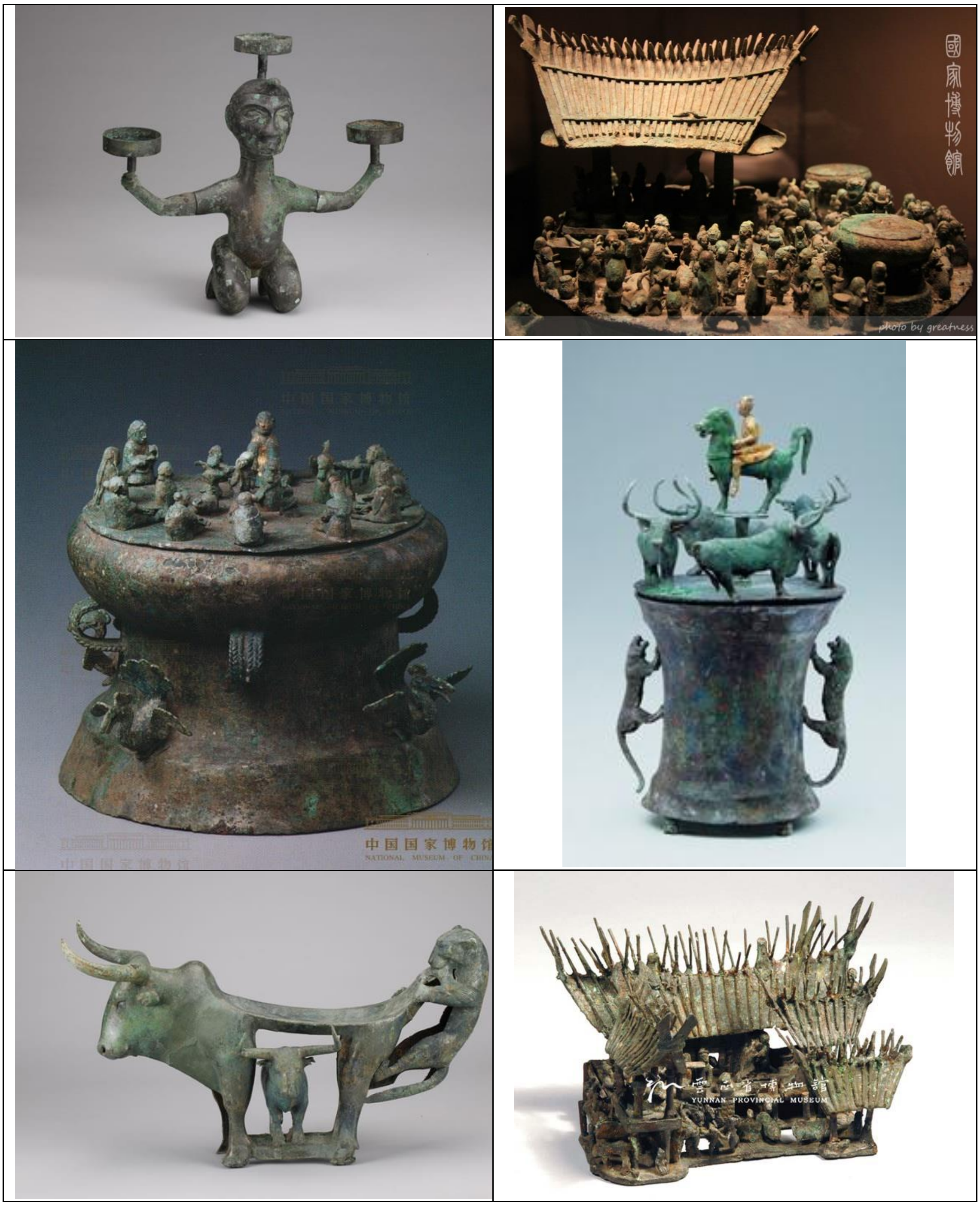


Fig. 2.21 Some typical bronze artefacts excavated at Shizhaishan and Lijiashan (source: National Museum of China and Yunnan Provincial Museum)

2.3.4 Northwest Yunnan Region

The sites of the Bronze Age cultures in the northwest Yunnan region were distributed in the counties of Zhongdian, Deqin, and Ninglang. Most of the burials in this region were found to be stone coffin burials, and earthen burials were the second. The common bronze artefacts are double-ring handled swords, curved handled swords, curved back knives, short handled mirrors, and rounded belt decorations (Fig. 2.22). Some scholars (Zhang Z. 1990) believe that this was the Bronze Age culture called White Wolves people (*42ailing* people) recorded in the *Hou Han Shu* ('The history of the Later Han dynasty [25-220AD]' by Fan Ye).

Double-ring handled sword

Curved handled sword

Fig. 2.22 Some typical artefacts of the northwest Yunnan region (source: author)

2.3.5 West Yunnan Region

Erhai Lake area is the centre of the Bronze Age cultures in west Yunnan (Fig. 2.19). The burials in this region were all earthen burials. The artefacts were characterized by bronze coffins, bronze drums of the Wanjiaba type, E-shaped guard bronze swords, curved blade bronze spears, curved blade bronze dagger-axes, sharp blade bronze broadax, and curved ceramic cups (Fig. 2.23).

The wooden fence post remains which were found at the Haimenkou site indicated that the early people who lived near the lakeshore were possibly living in stilt houses (Yunnan M. 1995). The bronze coffin unearthed at Dabona is constructed of 7 bronze plates and looks like a stilt house (Fig. 2.24).

Bronze drum of the Wanjiaba type

E-shaped guard bronze sword

Curved blade bronze spear

Sharp blade bronze broadax

Fig. 2.23 Some typical artefacts of the west Yunnan region (source: Yunnan Provincial Museum)

Fig. 2.24 Bronze coffin unearthed at the Dabona site (source: Yunnan Provincial Museum)

It is the biggest cast bronze object discovered in Yunnan and reflects the bronze casting technology that the *Kunming* people had achieved. This burial was dated to 465±75 BC which is about the time as the Spring and Autumn Period (770-476BC) and Warring States Period (475-221BC). The burials at Wanjiaba sites were dated to Western Zhou (1046-771BC) to Warring States Period (475-221BC). Some scholars believe that Bronze Age culture in the west Yunnan region is the *Kunming* people which was recorded in *Shiji* as starting in Shang Dynasty (c.1600BC), reaching a high point from the Warring State Period to early Western Han (202BC-9AD), and declined in the late Western Han (Li K. 1998).

2.3.6 Hong River Region

The Bronze Age culture in the Hong River region are distributed in the Honghe state of south Yunnan, Hong River region of Wenshan State, and the Nanpan River region. East to Guangxi and Guizhou provinces, and the south reaches into Vietnam. The burials in this region were all earthen burials. The common types of weapon in this region were sharp blade broadax (*yue*), shoe-shaped broadax, curved blade spear (*mao*), and straight blade dagger-axe (*ge*). The two common types of implements were rounded ferrule axes and long narrow chisels. The common ceramic types were *fu*-pots, jars, and spindle whorls. There are also jade and bronze decoration objects, bronze drums and chimes. Some of the bronze drums were similar to the *Kunming* people's of west Yunnan while others were similar to the Dian culture. The sites were dated from late Spring and Autumn Period (770-476BC) to the Eastern Han Dynasty (25-220AD).

2.3.7 Bronze Drum

The bronze drum is the most representative symbol of Yunnan's Bronze Age cultures, and it is still used by many ethnic groups in South China today. The date of some bronze drums are as early as the Warring State Period, and there is a reason to believe that the bronze drum originated from the indigenous Yunnan bronze cultures (Xiao 2001, 10). Among the bronze cultures of Yunnan, the Dian culture is the strongest and most representative culture. There are objects unearthed from all other cultures which are the same as the objects from the Dian culture. In 109 BC, the king of Dian surrendered to the Han Dynasty, and the Yizhou Prefecture was established. Since then, most of the Yunnan province area was under the control of the system of prefectures and counties of the Han government, and the Bronze Age cultures in Yunnan gradually coalesced and merged into the Han culture.

2.3.8 Iron Age of Yunnan

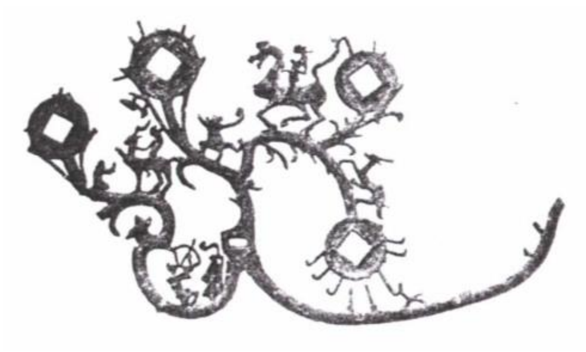
The Iron Age of Yunnan started in the mid-Western Han Dynasty, and ended in the late Qing dynasty (1644-1911AD). Studies of the Iron Age archaeology of Yunnan are usually divided into four periods based on the change of the central government, the mid-late Western Han, the Eastern Han (25-20AD) to early Tang dynasty (618-907AD), the Nanzhao Kingdom (738-902AD) and Dali Kingdom (937-1253AD), and the Yuan dynasty (1368-1644AD) to the Qing dynasty (Li K. 2004, 48-51).

After the establishment of the Yizhou Prefecture, the cultures in Yunnan were affected by the Han culture increasingly over time, and the objects of Yunnan cultures lost their local characteristics by the time of the Sui Dynasty (581-618AD). More and more Han style characteristics appeared in Yunnan, such as the existence of the grave mound, stone chambers, tomb passage and rounded roof (Li K. 2004, 48). The common burial objects of this period were bronze kettles, *fu*-pots, plates, lamps, mirrors, coins, money tree, and also small-scale ceramic models including hearth, well, paddy, and the six domestic animals (Fig. 2.25).

Bronze kettle

Bronze *fu*-pot

Bronze mirror



Bronze money tree (rubbing)

Ceramic model of hearth

Ceramic model of well

Ceramic model of paddy

Ceramic model of the six domestic animals (horse, cattle, sheep, chicken, pig, dog)

Fig. 2.25 Some typical artefacts of the Iron Age of Yunnan (source: National Museum of China)

2.3.9 Iron Smelting in Yunnan

There are many early bi-metallic objects and later pure iron objects which were found in Yunnan (section 4.3.1 and 4.5.1, Fig. 2.26). However, it is rare to see any iron smelting related research for Yunnan, because the early archaeological work in China did not pay enough attention to iron objects, besides, the lack of understanding of iron smelting sites, resulted in minimal published material.

The Chongzipipo site in Gejiu is the only metallurgical site discovered in Yunnan. The site is about 200m^2 in total, it is dated to the Eastern Han Dynasty. A 100m^2 area was excavated in 1993 and 13 post-holes and 1 furnace were found. The furnace was built half-underground, higher in north and lower in south as the mountain sloped with the dimensions of 5.2x2.3x0.97m. The excavator (Hu 1994) mentions two holes facing southwest, and natural wind power smelting was used. Lead and tin were detected in the slag from the furnace wall. There are ceramic jars, proto-porcelain jars, bronze Wuzhu coins (one currency in circulation from 118BC-621AD, “Wuzhu” is a weight unit which equals 3.25g), bronze *fu*-pots, silver bracelets and rings, unidentified iron objects and lead ingots were excavated (Hu 1994). According to my fieldwork investigation in 2017 and some preliminary composition analyses by p-XRF of the slags discovered on the ground surface at the site, the site was likely to be a tin smelting site (Juleff, personal comment).

Thus, it is very important and also necessary to organize and sort the excavated iron objects in Yunnan systematically, and then study them both from a scientific perspective to understand the technology level, and a historical perspective to comprehend the cause of the iron smelting technology and the cultural exchange.

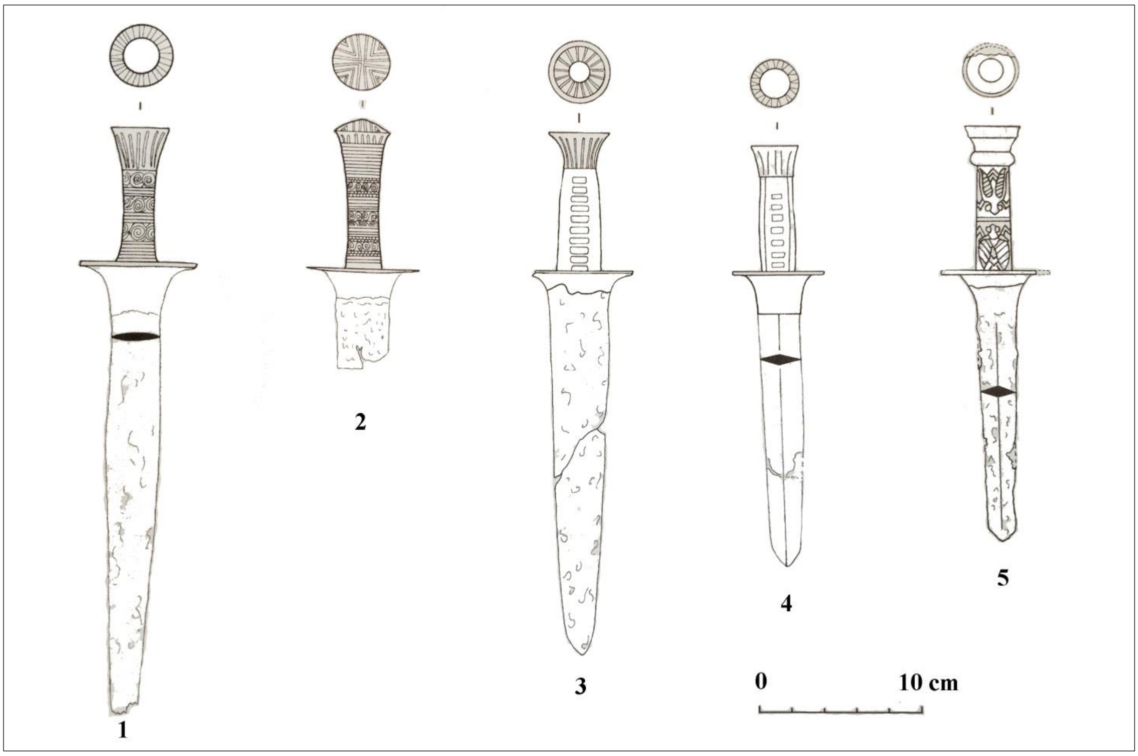


Fig. 2.26 Iron swords with bronze handle from Lijiashan (source: YNSWWKGYJS *et al* 2007, 167)
1.M71:26-1; 2. M68X1:8; 3. M51:111; 4. M82:12; 5. M51:117

2.4 Guizhou province

2.4.1 Historical review

Before the Qin Dynasty, tribes lived in this region were called Nanyi (southern minority). In 1046BC, after the battle against Shang, the Pu tribute established the Zangke kingdom in the Wu River region. After Qin conquered Ba and Shu, it continued to invade the Zangke kingdom. At that time, Zangke changed its name into Yelang and surrendered to Qin (Tian W. 2014, 53).

From the establishment of the Qin Dynasty (221BC), the area of Guizhou became the Qianzhong prefecture including counties such as Yelang and Jvlan. The economic form of the tribes changed from nomadism to agricultural settlements. In 220BC, the Wuchidao of Qin was built and connected to Qianzhong. During the emperor Wu of Han Dynasty (156-87BC), Qianzhong prefecture was renamed Zangke prefecture, which includes 17 counties. During the Three Kingdoms Dynasty and Jin Dynasty (220-420AD), the Guizhou area was under control of the Luodian kingdom. The rise of Luodian kingdom prompted the development of pastoralism in Guizhou. Since the Tang Dynasty (618-907AD), the prefecture including the area of Guizhou changed its name back to Qianzhong. The prefecture was politically a dependency of the central government and under control of the minority leaders.

Since Song Dynasty (960-1279AD), this area started to be called Guizhou, and became one of the provinces established by the Yuan government in 1276AD (Zhongguo 2009c, 306).

2.4.2 Archaeological review

Archaeological investigations in Guizhou province started late in the 1950s, and archaeological achievement was comparatively low before 1990. There are more than 60 Paleolithic locations discovered in Guizhou province, about 30 of which could be classfied as archaeological sites. Most of these sites were cave sites, for example, the Guanyindong cave site, dated to 240,000 to 180,000 years BP (Li Xianyan and Wen 1986); Yanhuidong cave and Xiaohuidong cave, dated to 180,000 to 52,000 years BP; and Maomaodong cave, dated to 18,000 to 12,000 years BP. The Paleolithic sites discovered in Guizhou are all distributed in the mountain areas to the west of the province (Xi 1994, 702).

There are only about ten Neolithic sites which can be clearly identified in Guizhou province. Before 1994, only three of these sites, Feihushan in Pingba county, Qingchangwayao in Bijie county, and Keleliujiagou in Hezhang county were excavated. Some bronze object fragments were excavated from both Qingchangwayao and Keleliujiagou. In addition, also excavated stone moulds for bronze casting at Qingchangwayao. These two sites were dated to the early Shang dynasty and the late Warring States Period respectively, but the excavators identified these two sites as two Neolithic sites because the bronze implements were not widely applied and there are large numbers of polished stone implements discovered at both sites (Xi 1994, 704).

From the Warring States Period to the Qin and Han Dynasties, the Yelang Culture was the most powerful ancient tribe that existed in the area of modern Guizhou.

Again, due to the late start and the lack of archaeological investigation, there are not many Bronze Age archaeological finds. Three most important and typical sites, believed to be Yelang Culture sites, are the Zhongshui cemetery in Weining county (Li Yanyuan *et al* 1981), the Kele cemetery in Hezhang county, and Tonggushan in Pu'an county (Peng 2006, 28).

The Zhongshui cemetery site has multiple locations, 58 burials were excavated from three locations in 1978 and 1979. The site is dated to the mid Warring States Period to the late Western Han Dynasty. The main burial type were earthen burials. The excavated object types include ceramic, bronze, iron, jade and lithic. The ceramic objects include bowls, bottles, jars, *dou*-s (stemmed bowls) and *gu*-s (wine cups) etc. The bronze objects include snake-shape handled swords, dagger-axes, belt hooks, buckle decorations, bells, *fu*-pots, basins and bowls (Li Yanyuan *et al* 1981)(Fig. 2.27). The iron objects include spears, swords and knives (GZSBWG 1993). Most of the gravegoods have local characteristics, but the small number of the iron weapons discovered in the burials show the characteristics of Han weapons (Peng 2006, 28).

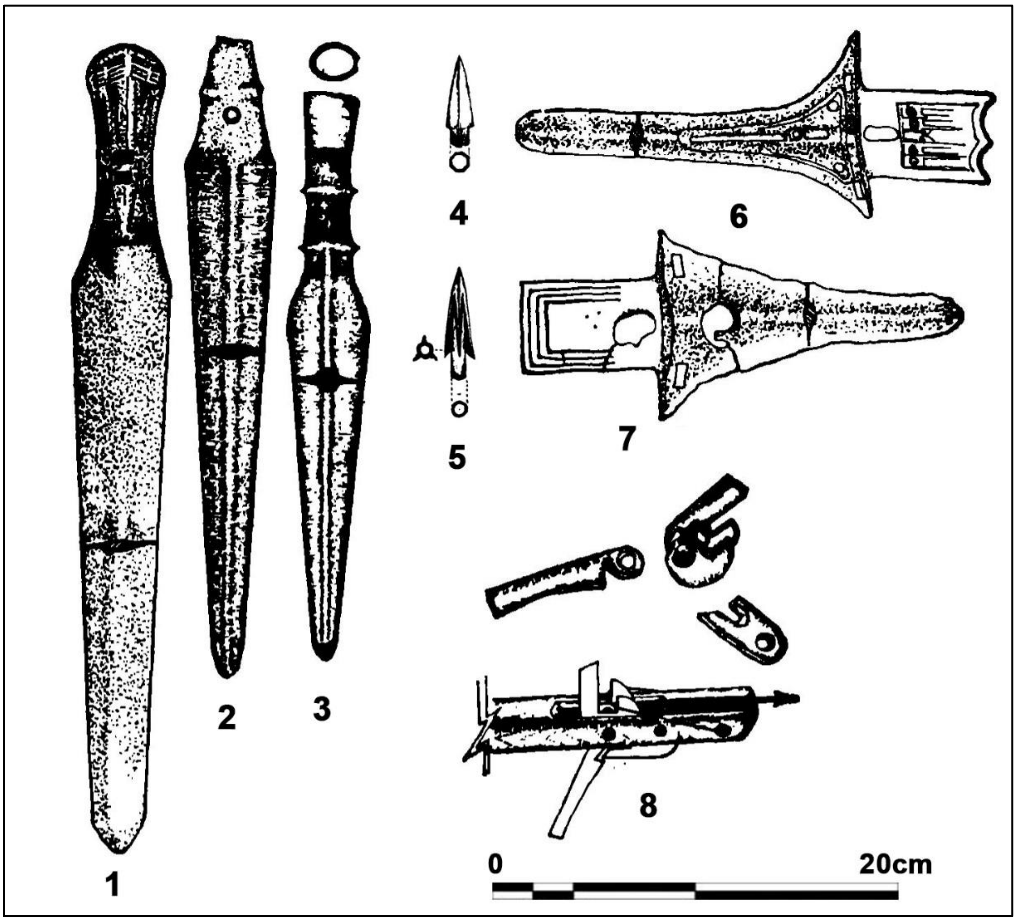


Fig. 2.27 Some bronze objects excavated from Zhongshui, Weining, Guizhou (source: Li Yanyuan *et al* 1981, 228 fig.10)

1-3. swords (M22:1; M1:1; M4:1) 4-5. Arrowheads (M17:3; M24:8) 6-7. *Ge* (M26:1; M26:2) 8. crossbow trigger (M12:1)

The Kele cemetery site includes over ten cemeteries and habitations locations. The site is dated to the late Warring States Period from the late Western Han Dynasty. A small number of the burials have coffins. Most of the gravegood styles are effected by other nearby cultures, and the primary types are bronze and iron objects. The bronze objects include dagger-axes, *fu*-pots, *mou*-pots, drums, belt hooks, buckle decorations, bells, and bracelets. The iron objects include ploughshares, implement caps, knives, swords, axeheads, and *fu*-pots. It is worth mentioning that there is a type of bi-metallic swords which has a richly decorated bronze handle. This kind of sword is very rare to see in other areas of China. In addition, only a small number of ceramic gravegoods were discovered (Song S. *et al* 1986;Liang 2002).

Fig. 2.28 Bronze and iron objects excavated from Kele, Hezhang, Guizhou (source: GZSWWKGYJS 2008, plates)

The Tonggushan site is dated from the Spring and Autumn Period to the mid-Western Han Dynasty. The excavated ceramic objects include *fu*-pots, jars, *dou*-s, bowls, cups, objects feet, spindle whorls, balls, and stands. Over 90% of them are *fu*-pot and jar, and most of them have a rounded bottom. The excavated bronze objects are small and not many, with types include knife, sword, broadax, chisel, drill, fish hook, small ring, hairpin and copper slag. The iron objects include knives, arrowheads, and spears. Also discovered were numbers of stone moulds for casting swords, dagger-axes, knives, bells, fish hooks and chisels. In addition, there observed one or multiple heart shapes carved inside the stone moulds (Liu E. and Xiong 1993).

In general, it is not difficult to see from the gravegood characteristics of these burials that there was a very close and frequent connection and cultural exchange between the Yelang culture and the powerful cultures nearby (Ba and Shu). However, by the different characteristics of the iron objects discovered, it could more or less indicate that during this period of time, the Yelang culture itself was not yet capable to make their own iron objects (section 6.3, appendix C4).

2.5 Xizang (Tibet)

2.5.1 Historical review

Before the establishment of the Tibetan Empire in 632AD, there were pastoral tribes living on the Tibetan Plateau. The 33rd btsan-po of Tibetan Empire, Srong-btsan Sgam-po married the princess Wencheng of Tang in 641AD. Princess Wencheng brought advanced technology, medicine, and Chinese Buddhism of Tang to Tibet, which prompted the development of Tibet in politics, economy, and culture. The good relations between the Tibetan and Tang governments was maintained over 200 years. At the end of Tang Dynasty (early 10th century), the Tibetan Empire split again, with the tribes and tribal groups fighting against each other over 400 years. In 1253AD, the emperor Mongke of Yuan Dynasty sent his troops to Tibet, ended the chaos, and took Tibet as part of the central government officially (Zhongguo 2009b, 150-151).

The Yuan Dynasty, through the Bureau of Buddhist and Tibetan Affairs, or Xuanzheng Yuan, ruled Tibet through a top-level administrative department. One of the department's purposes was to select a 'great administrator', usually appointed by the lama and confirmed by the Mongol emperor in Beijing (Dawa 2001, 139). From the Yuan to Qing Dynasties, Tibet was a caesaropapism area under control of the central government. In 1965 Tibet was established as one of the five autonomous regions by People's Republic of China.

2.5.2 Archaeological review

The first European who entered Tibet in 1325 was a Catholic missionary Theuderic. Early 'archaeological investigations' in Tibet were carried out by these western missionaries between the 1620s and the 1740s (Barbara 1972), but the publication of their work is limited.

During the late 19th century to early 20th century, Tibetan archaeology has drawn close attention from both Chinese and Western scholars. In the first half of the 20th century, archaeological investigation in Tibet was principally done by Western scholars. They obtained some achievements, such as the Italian scholar

Tucci (1950, 1973) and his surveys of Tubo royal tombs, the Swedish scholar Roerich (1930) and his survey in northern Tibet. Even though there appeared shortcomings, their works were still better than those were carried out by non-archaeologists in later times, such as the English mountaineer Richardson (1952) and his survey of Tubo royal tombs and inscriptions, the German mountaineers Aufschnaiter and Harrer (1992) and their excavation of a prehistoric site near Lhasa.

On the other hand, the Englishmen, M.A. Stein and F.W. Thomas, the Russian, S.E. Malov, and the French, P. Pelliot, stole large numbers of Tibetan wooden and bamboo slips (bamboo and wooden slips were the main media for documents in China before the widespread introduction of paper during the first two centuries AD) and shipped them back to their own countries when they were travelling in Xizang, Gansu, and Xinjiang. While their behavior has been criticised, their research was the earliest scientific study of the Tibetan wooden and bamboo slips (Stein 1921).

During this period, archaeological investigation in Tibet consisted of the collection of Tubo inscriptions, the collection of ancient Tibetan wooden slips, mainly excavated from Xinjiang and Central Asia, and the collection of ancient Tibetan bamboo slips from Dunhuang caves. There was no archaeology institute or bureau of cultural relics in Xizang before 1959. Since the establishment of the Bureau of Cultural Relics of Xizang in 1959, Chinese scholars have independently carried out a series of archaeological surveys and excavations at Qamdo Kha-rub and Nangxian Lieshan. The 1990s was an active decade, when Tibetan archaeology developed significantly. The general investigation of ancient monuments across Tibet laid the foundations of future Tibetan archaeology. The excavation of prehistoric sites at Qugong village, Lasa, and the exploration of the ancient Guge city in Ngari and other archaeological projects carried out in the early 21st century showed significant influence in both Chinese and foreign academia (Jia and Huo 2001, 3-5).

There are 8 Paleolithic locations discovered in Xizang up to 2005. Su're in Tingri county (Zhang S. 1976), Zhuluole (An Z. *et al* 1979) and Duogeze (Liu Zechun *et al* 1986) in Xianza county, Ge'ting on the southeast bank of the Selin lake (Qian *et al* 1988), Zhabu and northeast bank of the Xiada lake in Rutog county (Li Yongxian *et al* 1993, 16-20), and Hadong river and Quede river in Gyirong county (Huo *et al* 1993, 15-21). The last three locations were discovered by the survey of cultural relics in Xizang in the 1990s, the rest were discovered by the Chinese natural science scholars between 1959 and early 1980s. However, the exact date of Paleolithic in Xizang is still in a debate (Tong E. 1985, 11; Tang 1999, 46-47).

Most of the Neolithic sites in Xizang belong to the late Neolithic period. Therefore, the transition of Paleolithic to Neolithic in Xizang is not clear. It is commonly agreed that the sites discovered in northwest Tibet are the early Neolithic sites. The characteristic of these sites is that only microlith and small flakes were excavated, but no ceramic, bone, metallic and large-scale chipped stone artefacts. These sites are dated to about 7,500 to 5,000BP. The primary economic activity is hunting (Li Yongxian 1994b). Later important sites include Kha-rub, Qugong, Dngul-mdav, Bang-mkhar, Phreng-sgo, and Stag-lung-brag, dated to about 5,000-3,000 BP.

Metallic artefacts discovered in Tibet were all collected, not excavated, and most of them were recorded by non-professionals. Therefore, it is inadequate to give a specific range for the Bronze Age or Iron Age in Tibet. Tong Enzheng (1985, 14) proposed an idea according to the known evidence that there may have been an Early Metal Age in Tibet, which started in the 10th century BC and ended in the 6th century AD (the rise of Tubo Kingdom).

The first discovery of metal artefacts was in the survey of northern Tibetan Plateau and central Tibet by Roerich (1930) from 1925 to 1928. The metal artefacts including both bronze and iron arrow-head. Tucci (1973) also mentioned one of his collection in Tibet including numbers of bronze belt-hooks, accessories, and small bells with animal decorations in his book, *Transhimalaya*. Other important discoveries include one bronze arrow-head and one bronze mirror with iron handle (Fig. 2.29:1-2) excavated from Qugong (ZGSHKXYKGYJS and XZZZQWWJ 1999b, 141,208-209). Two bronze swords, over 10 bronze accessories, and 1 unidentified iron object (Fig. 2.29:3-9) were excavated from Piyang-Dongga (SCDX and XZZZQWWJ 2008).

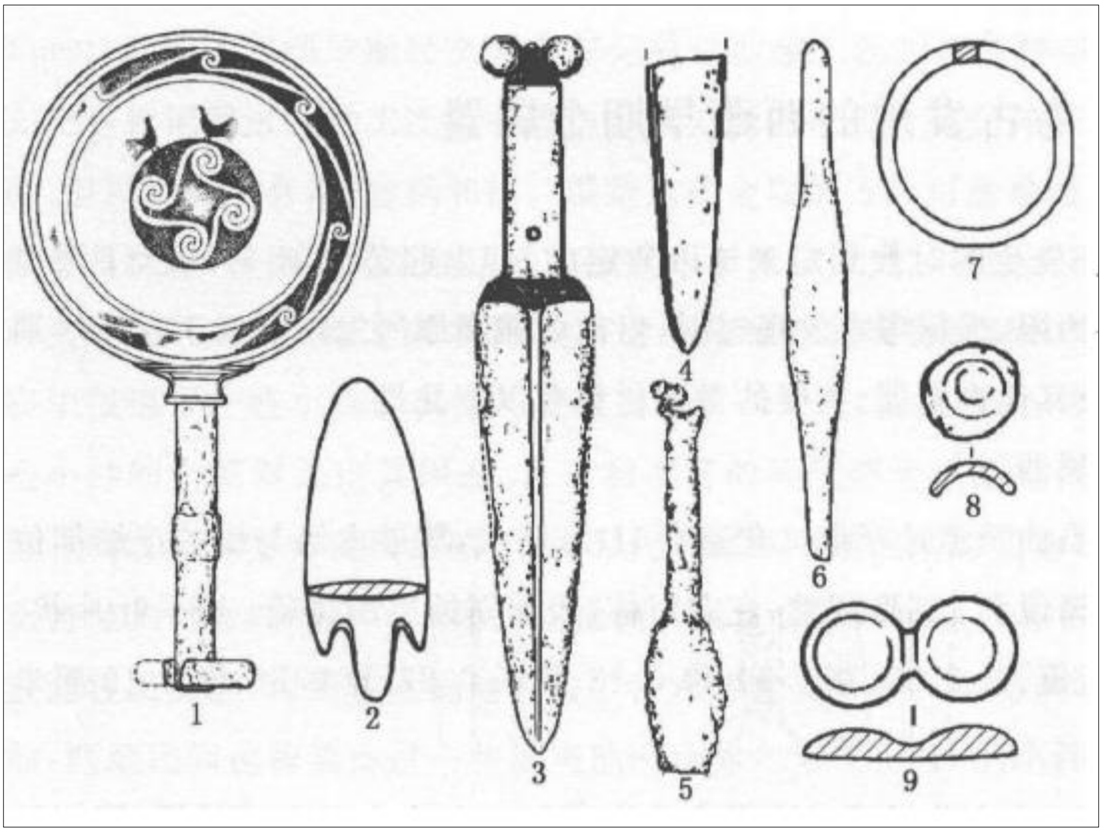


Fig. 2.29 Excavated bronze and iron artefacts from Qugong and Piyang-Dongga
1.Bronze mirror with iron handle (M203:2); 2. Bronze arrow-head (H12:33); 3,4. Bronze swords (PGM6:4, PGM4:1); 5. Iron object (PGM1:1); 6-9. Bronze accessories (PGM5:3, PSM6:1&2, M2, PGM5:5) (source: Huo 2014, 330)

Archaeological studies of the Tubo Kingdom (6th-10th centuries AD) have focused on three aspects, including survey and excavation of Tubo royal tombs, art history, and Buddhism. Many foreign scholars had published their studies on Tubo royal tombs, such as Tucci (1950), Hoffmann (1950), and Richardson (1963). In 1961, Chinese scholar, Wang Yi (1961) published the results of his investigation of Tibetan king tombs, which includes many valuable photographs. The study of art history in Tibet was mainly reflected in the study of cliff painting. Over 60 cliff painting locations were discovered in Tibet by 1994. The paintings were either carved or painted on the cliff. The common scenes are hunting, pastoral, campaign, dancing, worship ceremony, and animals (Xiage and Pu 2005, 211).

2.6 Summary

This chapter has introduced the history and archaeological work of Southwest China by each administrative division. Archaeology in the past, in particular, important sites of both Neolithic and Bronze Age were introduced to help understand the general situation of the research area. As mentioned in section 1.2, there is limitation of current knowledge on the iron production technologies in Southwest China. It is hoped that the case studies of the five excavated sites (chapter 5) and the statistical analysis of published iron objects (chapter 6), as well as the metallographic study of iron objects from Lijiaba and Qiaogoutou (chapter 7) will contribute to a more comprehensive and better understanding of the iron production technologies in Southwest China.

Chapter 3: Iron Smelting Sites

3.1 Introduction

Two routes to producing iron, the direct route and indirect, are recognised in iron metallurgy. The direct route is what often called the bloomery process and the indirect route is that which used the blast furnace. The differences between the two processes are many but the most significant is that the direct or bloomery smelting produces a soft, almost pure iron and the indirect or blast furnace process produces a hard but brittle cast iron. Both products then needed further refining treatments and this section introduces the ironworking technologies that will be involved in this thesis.

Bloomery smelting was the main method used in ancient Europe, India, and Near East Asia (Jobey 1962; Deo 1985; Khakhutaishvili 2009). According to Tylecote (1976, 40-41), the technology of ironworking of the early Iron Age divides into two sections, smelting and hot forging. While the latter could have been known first and practised on meteoric iron.

Pure iron has a melting point of 1,540℃, and this temperature could not be reliably and consistently obtained until the 19th century AD. So, all early wrought iron was produced in the solid state by chemical reduction of iron ore to solid, almost pure iron at about 1,200℃, with the aid of charcoal fuel. The reduced iron was removed as a clod or ‘bloom’, which was a mixture of solid iron, slag, and pieces of unburnt charcoal. In some cases, this lump was broken up and the small pieces of iron were separated by hammering, these could be distinguished from the rest because they were ductile and would flatten on hammering. These were then welded up into a larger piece by heating them in a smith’s forge followed by hot hammering. In some cases, the bloom consisted of coherent iron and could be smithed in one piece. In other cases, the bloom was too large and had to be cut into smaller pieces which were individually smithed (Tylecote 1976, 41).

The earliest evidence of bloomery iron objects in China are two unidentified iron objects dated to the 14th century BC excavated in Gansu province (Chen J. *et al*

2012), but we have not yet discovered any evidence of bloomery smelting before the 5th century BC in China (Li Yingfu 2014c, 65).

However, it was the **cast method** that occupied the main position of iron and steel making technology in ancient China. The earliest cast iron objects appeared in China no later than the Spring and Autumn period (8th century BC) (Han R. 2000, 1178). Contrast to the family-based iron smelting activities in Britain in the second century BC (Cunliffe 1991, 454), whereas ancient China in 117BC, salt and iron production were state monopolized (Wang L. 1958). The iron smelting activities in ancient China at that time were large-scale and well controlled and organized by the central government.

Tylecote indicated that if ratio of fuel to ore is large and the bellows are efficient, the iron can be made to absorb so much carbon that it forms an alloy of iron and carbon or '**cast iron**', which melts at 1,150℃ and forms pools at the bottom of the furnace. These liquated lumps could have been broken up and re-melted in a crucible in a hot smithing fire, and cast like bronze (Tylecote 1976, 41).

The furnaces which produce cast iron in ancient China are called 'iron blast furnace' or '**blast furnace**' in this thesis. A blast furnace produces iron with a high carbon content and therefore a lower melting point. The iron comes from the furnace in the molten state and is cast, either as 'pigs' (ingots) for later remelting, or, in early European practice, directly in moulds for the intended products. A blast furnace is vastly more efficient than a bloomery furnace, and in modern industry virtually all iron is produced in blast furnaces (Wagner 1993, 178).

The blast furnaces discovered in China could be dated to as early as the 3rd century BC, and are inherently an apparatus for large-scale production. It is hardly technically possible to produce less than perhaps a half-ton of iron per day, and efficiency increases dramatically as production increases. Efficiency also requires that the furnace be operated continuously over long periods, under pre-modern conditions, perhaps a week or a month at a time. The operation of a blast furnace thus requires a greater degree of reliability in all aspects of production, especially fuel and ore sources, labour force, markets, and transportation (Wagner 1993, 239). The original size of the Western Han blast furnace from

Guxingzhen, Zhengzhou, Henan province was reconstructed according to the ruining foundation as about 2.7 to 4 meters in diameter and over 6 meters high (Yang K. 1982, 87)(Fig.1.4).

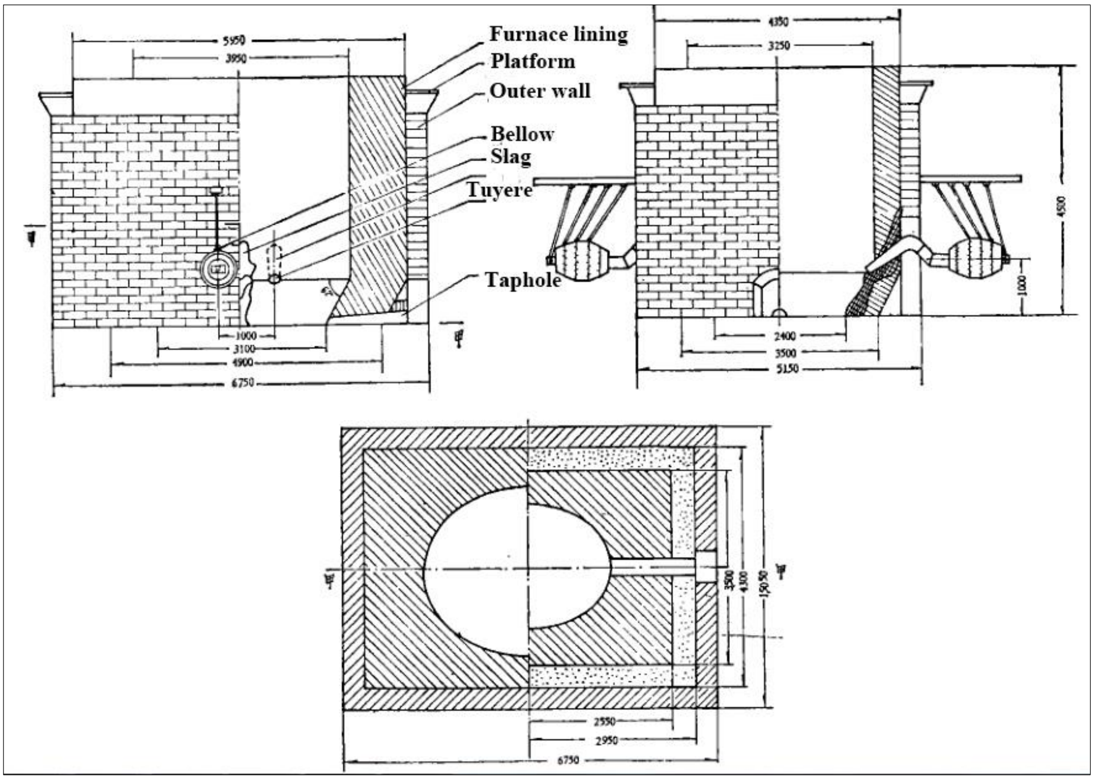


Fig. 3.1 A reconstruction of blast furnace No.1 from Guxingzhen, Henan, Western Han dynasty (source: Henan *et al* 1978, 8)

Wagner (1993, 38) also provides empirical evidence which indicates that a furnace of this size and general construction could be used as an iron blast furnace. He described several very small traditional 'dwarf' blast furnaces used in various parts of China into modern times. Some of these are as small as 30cm high. A type of blast furnace used in southern Henan and northern Hubei had a shaft about 2m high and 0.45m in diameter at its narrowest point. The blast input was only 1.6m^3/min. The ore used was iron sand with about 65% iron and 5.5% silica. About 1.5 times as much charcoal as iron sand was charged. No flux was used, but CaO from the furnace lining may have been important in slag formation. Loss of iron to the slag was very small (c.0.2%). The hearth temperature was normally in the range 1,250-1,300°C. Production was 700-750kg pig iron per 24 hours (Wagner 1993, 39).

As mentioned in chapter 2, Sichuan province is regarded as the most important area for iron smelting and production in Southwest China since the Qin and Han dynasties. From 1981 to 1985, 57 iron smelting related sites in Pujiang county were discovered and recorded in the second National Survey of Cultural Relics of China (He P. 1986). Based on this evidence, from 2005 to 2010, Chengdu Cultural Relics Institute, Sichuan University and Ehime University carried out a regional archaeological survey of ancient metallurgical sites in Pujiang and Qionglai counties. A total of 74 iron smelting related sites and locations were reconfirmed or newly discovered, and four of them were excavated by the team. The sites are distributed in Pujiang county and south of Qionglai county, as shown in Fig. 3.2. There are known of iron ore deposits at both the Great and Small Five Sides Mountains. In addition, one iron smelting site was discovered in Chongqing municipal in 2012 and was excavated by the Chongqing Cultural Heritage Research Institute and Sichuan University in 2014 (Fig. 3.3). The local iron ore deposits and historical background of Chadiping will be discussed separately in section 3.5.5.

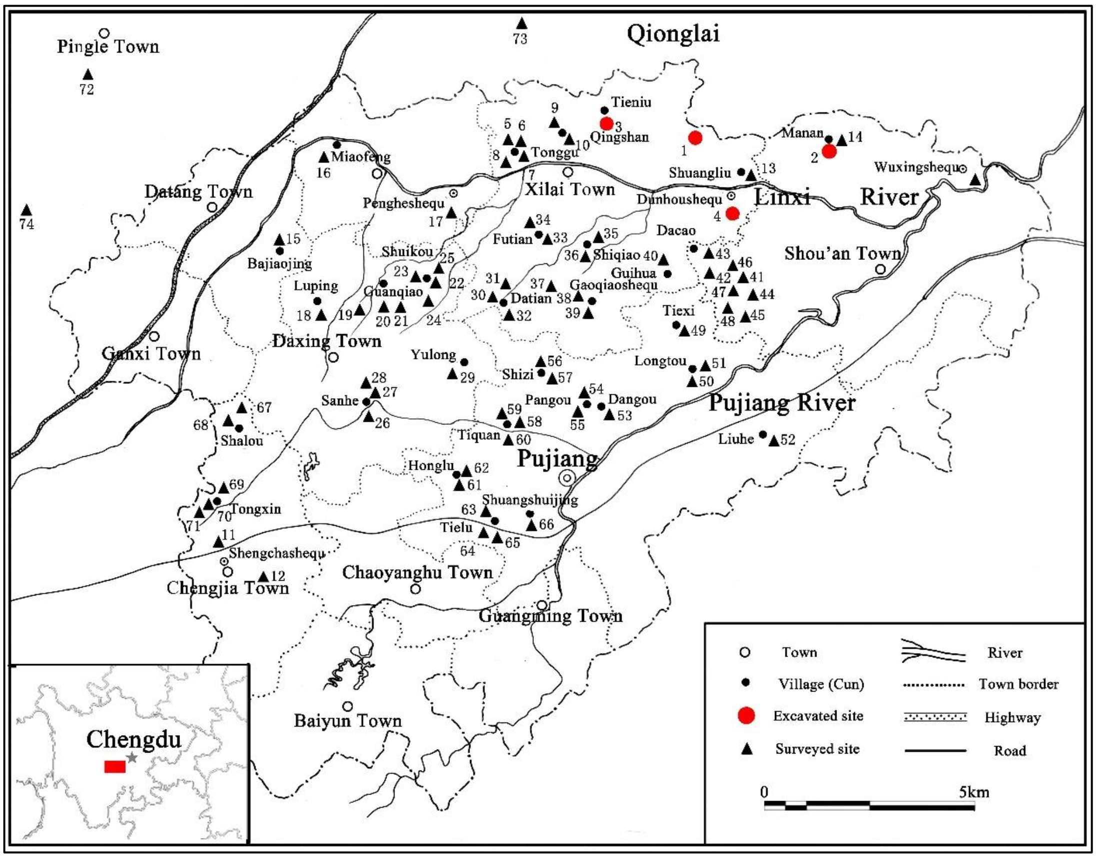


Fig. 3.2 Distribution of iron smelting sites in the Chengdu Plain (source: Ma 2011)

1	Gushishan (excavated site)	26	Yangfenyuan	51	Dengganping
2	Xuxiebian (excavated site)	27	Gaolushan	52	Liuhechang
3	Tieniucun (excavated site)	28	Sanhechang	53	Dangoucun Group 11
4	Shazitang (excavated site)	29	Yulongcun Group 1	54	Pangoucun Group 1
5	Tonggucun Jigongshan	30	Datiancun Gaoluchong	55	Pangoucun Group 4
6	Tonggucun Group 7	31	Datiancun Douyan	56	Shizicun
7	Tonggucun Group 6	32	Wufenyuan	57	Shizicun Group 1
8	Tonggucun Shaziping	33	Futiancun	58	Tiquancun Group 4
9	Qingshancun	34	Futiancun Group 15	59	Tiquancun Group 5 Shazidun
10	Liufenyuan	35	Shiqiaocun Group 8	60	Tiquancun Group 5 Shazidi
11	Shengchashequ Gaoluchong	36	Shiqiaocun Group 12	61	Honglucun Honggaolu
12	Shazitian	37	Yucaicun Group 7	62	Honglucun Gaolushang
13	Shuangliucun	38	Shazidang	63	Gaoluzui
14	Manancun Gaolushan	39	Shaduizi	64	Shaziwan
15	Bajiaojingcun	40	Guihuacun Group 1	65	Gaolubang
16	Miaofengcun	41	Dacaocun Group 11 Luochang	66	Shuangshuijingcun Shaluzui
17	Penghesheequ Tiekuangshan	42	Dacaocun Group 11 Youyugou	67	Shaloucun
18	Lupingcun	43	Dacaocun Group 12	68	Huatouzui
19	Liudalin	44	Dacaocun Group 6	69	Kuangkengshan
20	Guanqiaocun	45	Dacaocun Group 1	70	Jianwan
21	Guanqiaocun Group 3	46	Dacaocun Group 9	71	Wanghe
22	Shazidi	47	Dacaocun Group 13	72	Tieshiba
23	Shixiangzi	48	Dacaocun Group 14 Shazidi	73	Tieshidui

24	Shihuiqiao	49	Tiexicun Group 1	74	Tiechangchong
25	Wangjiashan	50	Longtoucun		

Fig. 3.3 Location of the iron smelting site in Chongqing municipal (source: google earth)

Among the 74 sites in Pujiang and Qionglai, four of them are dated to the Han dynasty (202BC-220AD), 64 are dated to the Tang or Song dynasties (7th-13th centuries AD), and six of them belong to the Yuan, Ming or Qing dynasties (13th to 19th centuries). The site of Chadiping in Chongqing is dated to the Tang or Song dynasties. The five sites that have been excavated will be discussed in detail in the following sections (3.5.1-3.5.5). The remaining sites and locations will be briefly introduced in section 3.5.6. The dates of the sites were determined by the surveyors but no further supporting evidence has been given nor reports published.

3.2 Survey and excavation methodology

3.2.1 Survey methodology

Survey areas were selected based on the findings of the second and third National Survey of the Cultural Relics of China. Large-scale geographical maps were obtained from the local government before fieldwork. In the surveys, the names of the local locations were sometimes a very important clue in finding iron related sites and locations. For example, ‘*Shazi*’ or ‘*Tieshi*’ usually indicate slags, ‘*ping*’ means flat ground, and the two words together can probably lead us to a location where lots of slags can be found on the ground. Some other examples include, ‘*Gaoluchong*’, where ‘*Gaolu*’ means blast furnace, thus the location was probably used to have blast furnaces and some of them are still visible now.

Survey fieldwork is usually guided by staff from the local Cultural Institutes who are familiar with the target area. A survey diary was recorded, including information of weather, survey progress, important locations, people interviewed, findings, and preliminary ideas on site interpretation. As many samples as possible were collected at each location recorded, including pottery and porcelain sherds, slag, furnace brick, and charcoal. The labelling and cleaning of the findings were the same as the excavated findings. All of the collected findings were labelled, cleaned, and taken photos. Drawings were made to some of the typical discoveries. All of the data were input and saved electronically at the end of the surveys.

3.2.2 Excavation methodology

Contour survey and modelling:

Three of the excavated sites, Gushishan, Xuxiebian, and Tieniucun, were surveyed using total station, and the contour map of Chadiping and Shazitang were attained from the local government. The collected coordinate data were used to create 3D landscape models of each site using a software called *Rhinoceros*. The contour intervals of 1m, 50cm, and even 30cm can then be displayed in and exported from the software easily.

Contexts and context recording:

Every layer, historical remain, and deposit on the site was assigned a sequential, unique context number. Context and historical remain recording sheets in Chinese were used as the basic recording tool. Four main categories of information were recorded for each context: administrative, descriptive, stratigraphic and interpretive.

Site diaries:

A wide variety of information was recorded in the site diaries, including weather, excavation progress, findings, preliminary ideas on site interpretation and provided a means for collecting subjective data. However, every excavated feature and artifact was also recorded separately in corresponding sheets.

Labelling:

Excavated trenches: in labelling the excavated trenches, the excavation year, the location, and the type of the trench. For example, for 07PSXTG1; “07” means 2007, the alphabet is from the initial of Chinese Pinyin, which in this case P means Pujiang county; S means Shou’An town, X means the name of the site, Xuxiebian; TG means trench where in other cases T means square; and “1” is the sequence number.

Archaeological features: similar to the labelling rules for the excavated trenches, only the type is now used to indicate the type of feature. For example, for 07PSXH1; 07PSX indicates the excavation year and the location; H stands for pit (ash pit in Chinese); and “1” is the sequence number. The nature of the pit would be discussed separately but not identified in the label. Other features include G for trench, L for furnace, Y for kiln, and D for house foundation pole.

Artifacts: the artifacts were labelled according to their excavated context, with the addition of a sequence number. For example, 07PSXH1:1, which is the first artifact recorded from pit No.1 in the 2007 excavation at Xuxiebian. 07PSXTG1 ②:4, which is the fourth artifact recorded from the second layer of excavation trench No.2 in 2007.

Drawing:

Excavated trenches: one drawing for each layer, including features discovered from the layer, were made on site. The scale is usually 1:20, and stayed the same for each trench so that all the layers can be put together at the end of the excavation. Drawings of each wall of the trench at the same scale were used to represent the sections.

Archaeological features: all features were also drawn separately. Drawings are made on site when a new feature was revealed. The scale is chosen as big as possible to show greater details, especially for furnaces.

3D models:

3D models were created for the landscapes of some of the sites and the blast furnace excavated at Gushishan. Total station survey was applied to collect coordinate data, and then processed in *Rhinoceros*. The model contains the dimensional information which could be used for demonstrating the landscape and the furnace.

3.3 Post-excavation analysis of data

Stratigraphic unification:

Every layer was first recorded onsite corresponding to its excavated trenches. When the excavation is completed, all layers were considered together to give a unified layer description for the whole site as described in the following sections on the excavated sites.

Representative artifacts selecting and reproducing drawings:

The excavated artifacts (e.g. pottery sherds, furnace bricks and slag) were washed and dried naturally. Representative examples were chosen by their characteristics and time periods. Photos were taken and drawings were made for the selected samples. All the drawings including the ones made on site were scanned and edited in *Photoshop*.

Charcoal samples and radiocarbon dating

Charcoal samples were collected and subjected to radiocarbon dating analyses. The charcoal samples from Tieniucun were also submitted for species assessment and their identifications were discussed in section 3.5.3. The radiocarbon dating samples were sent to either the Institute of Accelerator

Analysis (AMS) of Japan or the Peking University of China. The results were discussed separately under each site. OxCal was used to calibrate the result.

Data input:

All of the information on features, layers, and artifacts recorded on site (including all the recordings and site diaries) was input into computer and saved as electronic files. The photos taken on site were sorted by each excavated unit and renamed by their labels. All of the related data were saved on a separated portable hard drive.

3.4 Natural and historical backgrounds of Pujiang and Qionglai

Natural background:

Pujiang county is located in the southwest of the Chengdu Plain, east to Meishan and Pengshan, west to Mingshan, south to Danling, north to Qionglai counties, and about 83km to Chengdu. The total area of Pujiang is 582.86km^2. The Pu and the Linxi rivers are the main rivers flowing through Pujiang, which covers an area of 435.3km^2 and provide convenience of the use of water in ancient iron smelting activities. Qionglai county is located to the north of Pujiang, and about 67km to Chengdu (Fig. 3.4). The total area of Qionglai is 1,384km^2. The Pu, Nan, Jiang, Xiejiang, and Yuxi rivers flow through the county. The great and the small Five Sides mountains which are rich in iron ore deposits are located on the boundary of northern Pujiang and southern Qionglai. The forest coverage rates of Pujiang and Qionglai are c.43%. The main firewood trees within the area are *pine* and *Castanopsis* (Ma 2011, 14).

Fig. 3.4 Map of Chengdu showing Pujiang and Qionglai (adapted from: Sichuan Bureau of Surveying, Mapping and Geoinformation)

Historical background:

As briefly mentioned in chapter 2, two important events record the development of iron smelting and production history of the Chengdu Plain in written records. One was that the Qin government forced the ancestors of the Zhuo and Cheng families, the smelters from north and northeast of China, to move to Shu when Qin conquered the Zhao state in the 3rd century BC, in the *Shi Ji*, it records,

> The ancestors of the Zhuo family of Shu (modern Sichuan) were men of Zhao (a state which included modern Shanxi, Shaanxi, and Hebei) who became rich with an ironworks. When Qin conquered Zhao (228–222BC) Mr. Zhuo was deported. [On the way] he was robbed, and he and his wife, pushing a handcart, arrived alone at the place of deportation. Those deportees who still had some money vied with each other in bribing the officials, seeking to be settled nearby; they were settled in Jiameng (near modern Guangyuan, Sichuan). But Mr. Zhuo said, 'This

> place is too narrow and barren. I have heard that under the marshland at the foot of Minshan Mountain there is *dunchi* (bog iron?). One can live all one's life without being hungry. Common craftsmen trade in the market.' Therefore, he asked to be deported to a distant place. He was sent to Linqiong (modern Qionglai and Pujiang), and was very happy. At an iron mountain he smelted and cast, manipulated his counting rods, dominated [the trade among] the people of Dian (in modern Yunnan) and Shu, and became so rich that he possessed a thousand slaves (SiMa 1982, 3277).
>
> Cheng Zheng was another deportee from east of the [*Hua*] mountains (modern Shandong). He too engaged in iron production, and traded with the people who wear their hair in the mallet-shaped fashion [i.e. non-Chinese aboriginal peoples]. His wealth equalled that of Mr. Zhuo, and they both lived in Linqiong (SiMa 1982a, 3278; translated in Wagner 1993, 165).

The other event was the three *Tieguan* set up in Southwest China (Xia *et al* 1980, 45). It was first mentioned in the *Shi Ji* (SiMa 1982b, 1441) that salt and iron production were monopolized by the Han government in 117BC. *TieGuan*, government controlled office responsible for iron smelting and production activities, were set up in different counties and prefectures by the emperor *Wu* in 110BC. The passage is translated by Watson (1971, 82),

> The following year, the first year of the era *Yuanfeng* (110BC) … Sang Hongyang was made secretary in charge of grain and put in control of the ministry of agriculture, … He therefore proposed that some twenty or thirty assistants be appointed to the ministry of agriculture who would be sent out to supervise the various provinces and kingdoms (counties and prefectures), where they would travel about and set up the necessary transport offices for equalizing prices, as well as salt and iron offices.

Fifty *Tieguan* were set up in different counties and prefectures, of which three were set up in Linqiong (modern Pujiang and Qionglai, Sichuan), Wuyang (modern Pengshan, Sichuan), and Nan'an (modern Zigong, Sichuan) prefectures (Ban 1999, 976)(Fig. 3.5).

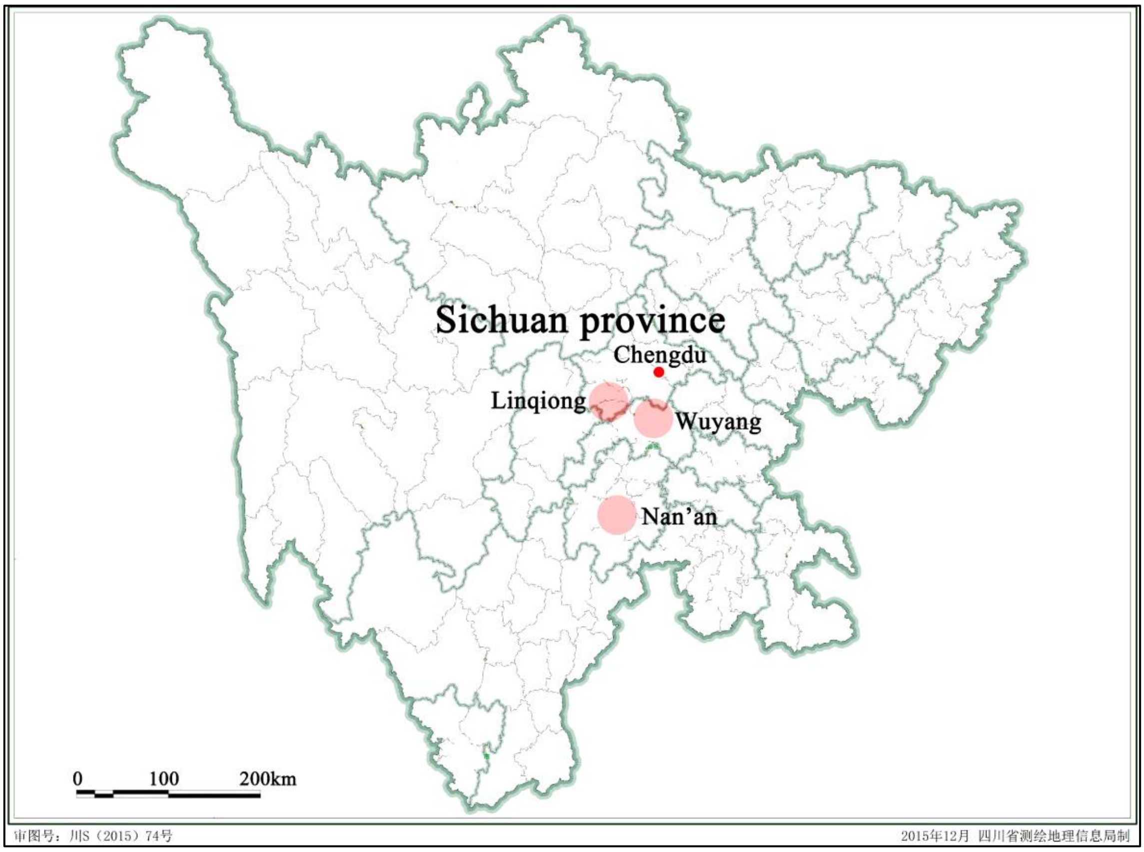


Fig. 3.5 Map of Sichuan showing the prefectures where the three *TieGuan* were set (adapted from: Sichuan Bureau of Surveying, Mapping and Geoinformation)

There is also evidence of iron ore recorded in the historical documents, in the *Hua Yang Guo Zhi*, a passage is recorded as translated below (Wagner 1993, 168):

> In Linqiong (modern Pujiang and Qionglai) … is Gushishan ('Old stone mountain'), where there are [pieces of] ore (bog iron?) as large as garlics. When it is fired it coalesces to form flowing iron, which is very hard. For this reason, an Iron Office has been established there. There is a temple to the Iron Ancestor. In the time of Emperor Wen of Han (ruled 179-155BC) [the rights to] iron and copper were bestowed on the Gentleman-in-attendance Deng Tong. He lent these to the commoner, Zhuo Wangsun, taking [a price of] one thousand bolts of cloth per year. Therefore [Zhuo] Wangsun's wealth multiplied to the extent of hundreds

> of millions. Coins [minted by] Deng Tong also spread throughout the empire (Chang Q. 2009, 148).

In general, according to both natural and historical backgrounds, Pujiang and Qionglai counties are convenient and suitable for iron mining and smelting, and should have a long history since as early as the third century BC.

3.5 Excavated sites

3.5.1 Gushishan

Introduction

The Gushishan site is located at Group 16 of the Mahu village, Xilai town, Pujiang county, Sichuan province (Fig. 3.6). The GPS coordinates are 30° 18′ 49″N, 103° 33′ 03″E, and the elevation is between 519-526m. The archaeological remains were mainly distributed in three locations (A, B and C) within an area of 1,000x100m. Location C is comparatively better preserved than the other two, and there are iron ore deposits discovered about 2km south from the site.

During May and June in 2007, the China-Japan archaeology team (CJAT), consisting of the Archaeological Institute of Chengdu, Sichuan University of China and Ehime University of Japan, did the first excavation of location C. In December 2011, a second excavation and mapping works were carried out by the same team.

Fig. 3.6 Locations A, B and C of the Gushishan site (source: Google earth)

The ground vegetation includes cultivated crops of orange, corn and peanuts. More and more lands were dug to make fishponds since 2009, and the site has been damaged to a large extent by these local farming activities. A total area of 127.5m^2 was excavated in two excavations, details showing in Table 3.1. Two metallurgical furnaces and three kiln-like structures were excavated.

Table 3.1 Details of excavated trenches at Gushishan

Year	Number	Size (meter)
2007	07PGST1	2 x 3
2007	07PGSTG1	2 x 8
2007	07PGSTG2	2.5 x 13
2007	07PGST2	4 x 4
2007	07PGST3	4 x 4
2007	07PGST4	4 x 4
2011	11PGST1	5 x 5
	Total:	**127.5m^2**

3D landscape model

A total of 596 coordinate data points was collected using a total station, and a 3D landscape model of 57,883.5m^2 of the Gushishan site and the nearby area was created. From this, a 0.5m contour map was produced (Fig. 3.7).

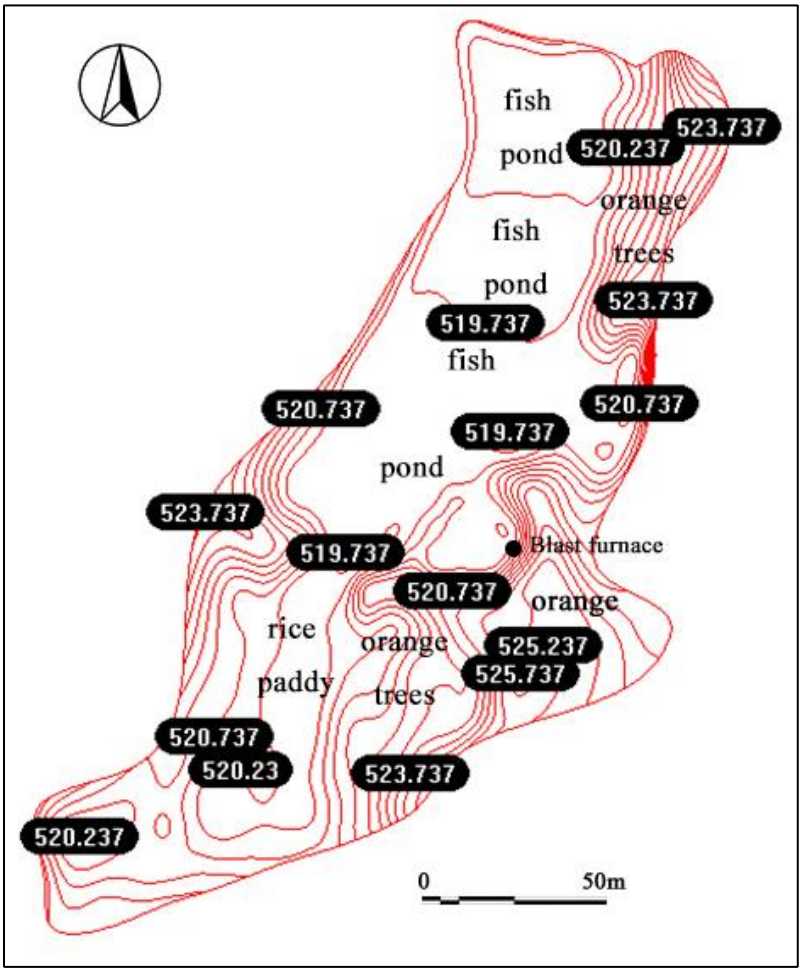


Fig. 3.7 A 0.5m contour map of Gushishan, showing the location of the blast furnace (source: author)

Stratigraphy and deposits of the site

The deposits of the site are disturbed by the local farming and construction activities. The stratigraphy is demonstrated by using the west section of 07PGSTG1 as an example (Fig. 3.8). There are 5 layers excavated in total, and below the fifth layer is the virgin soil. The details are as follow.

①: Modern agricultural layer, yellow clay, loose structure, and 20-25cm thick. The inclusions were plant roots, modern porcelain sherds, and slags.

②: Ming and Qing layer (c.15th-19th centuries AD), reddish brown clay, tight structure, 20-25cm to the ground surface, and 0-35cm thick. The inclusions were blue and white porcelain sherds, and some disturbed clay and sandy clay potteries from the earlier layer below.

③: Han dynasty to Song dynasty layer (c.200BC to the 14th century), reddish brown sandy clay, loose structure, 20-35cm to the ground surface, and 0-28cm thick. The inclusions were slags, limestones, charcoal, pottery sherds of the Han dynasty, porcelain sherds of the Tang and Song dynasties, and large amount of burned soil particles.

④: Pre-Han dynasty layer (before 200BC), yellowish brown clay, tight structure, 40-60cm to the ground surface, and 0-2cm thick. The inclusions were small amount of slags.

⑤: Pre-Han dynasty layer, grey clay, tight structure, 40-80cm to the ground surface, and 0-5cm thick. No cultural inclusion.

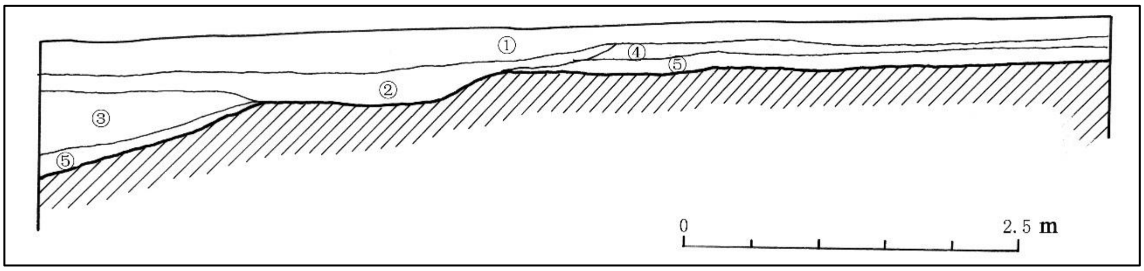


Fig. 3.8 West section of 07PGSTG1 at Gushishan (drawing by: Ma Chunyan)

3D furnace model

A total of 638 coordinate data points was collected to create the model of the elevation where L1 and L2 are located. When the model is created in *Rhinoceros* software, all of the three-dimension coordinate information can be extracted and all features and layers can be labeled clearly and exported easily as grid or vector graphics (Fig. 3.9 and Fig. 3.10). Different colours were used to present different parts of the furnace, and to indicate different temperatures, where orange to red is an oxidizing atmosphere and grey to cyan is a reducing atmosphere.

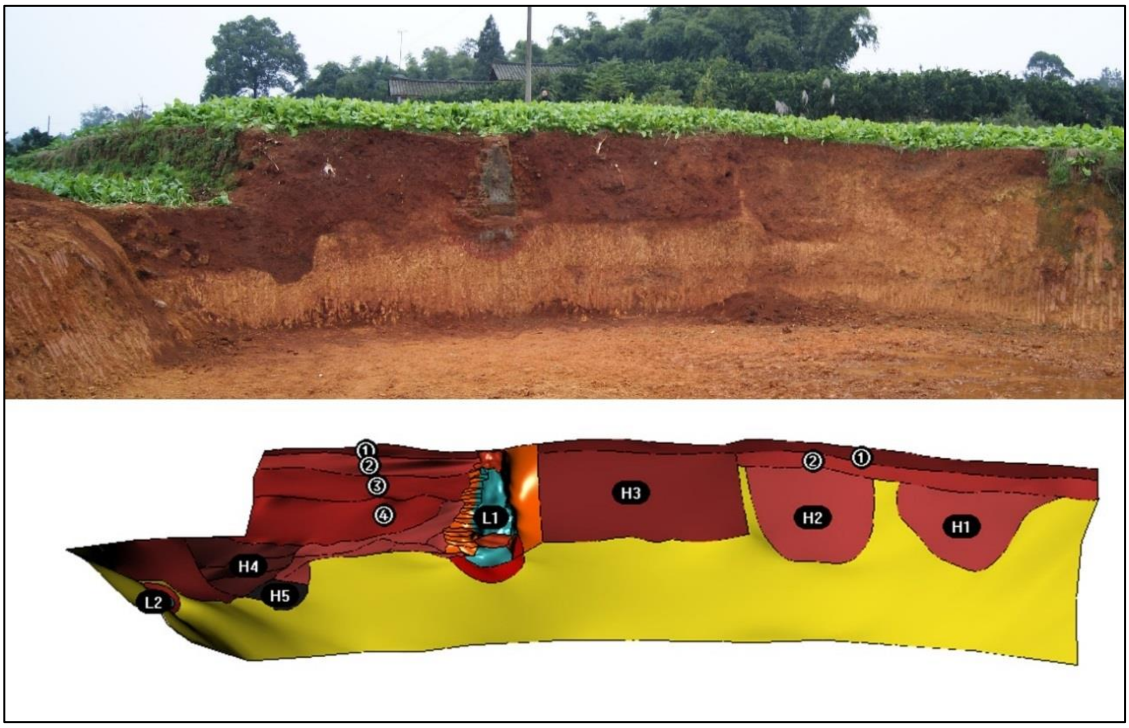


Fig. 3.9 Photo and 3D model of the elevation at Gushishan showing furnace L1, L2 and other features (source: author)

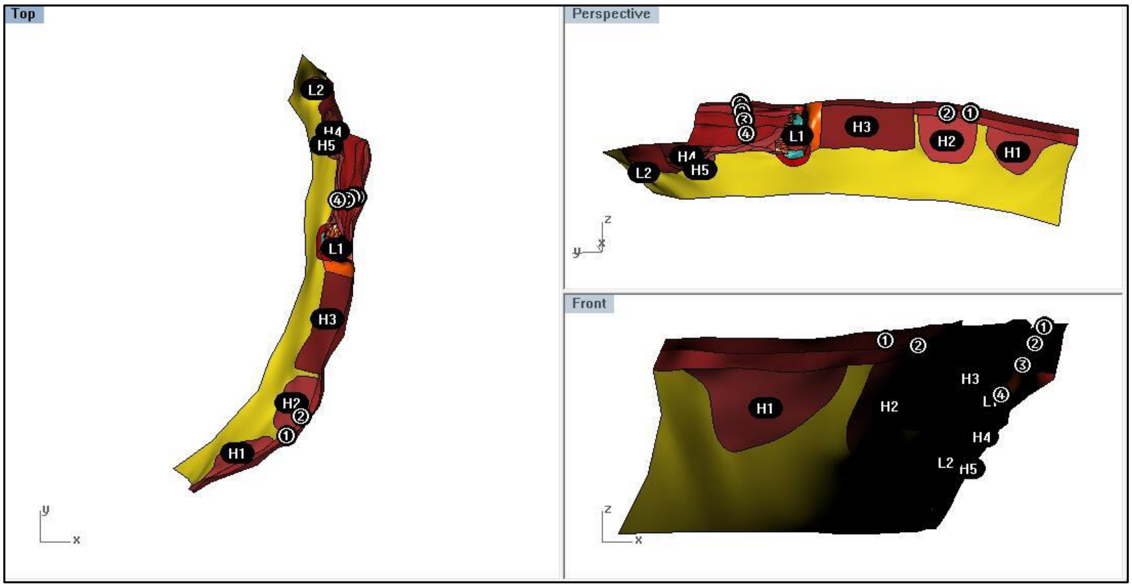


Fig. 3.10 Showing different perspectives of the model in *Rhinoceros* (source: author)

Fig. 3.11 Photo of furnace L1 at Gushishan (source: author)

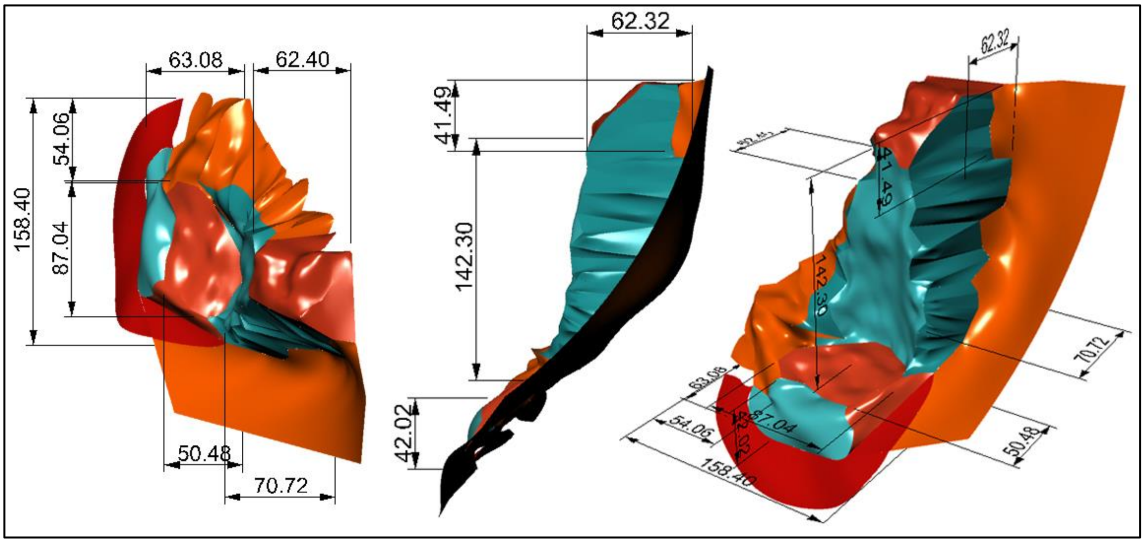


Fig. 3.12 Showing dimensions of furnace L1 in top, side, and perspective views (unit: cm, source: author)

Archaeological features

One blast furnace, three kiln-like structures, and one furnace base were discovered.

Furnaces:

1) **L1(11PGSL1)** is a furnace remain. The furnace was built against the terrace section and was buried partially underneath layer ③ of the site. Most of the dimensional information remains except the original height. The remaining height is about 180cm, and the remaining inner diameter is c.87cm. The external diameter of the foundation is c.158cm, and about 40cm deep. The foundation is a pre-prepared layer which was tamped and burned to strengthen the structure of the furnace. The inner furnace wall is c.40-70cm thick (Fig. 3.12). The whole furnace was constructed with furnace bricks. The bricks were made of a mixture of clay, quartz, and straw. Half of the furnace bottom was destroyed in the nearby road construction. According to the remaining bottom, the original furnace bottom might be sloped for the purpose of tapping, and the inner and outer diameters can be conjectured to 105 and 238cm respectively (Fig. 3.14). The interior surface of the furnace wall is dark grey and vitrified with slags adhering in some areas (Fig. 3.11, Fig. 3.13 and Fig. 3.15).

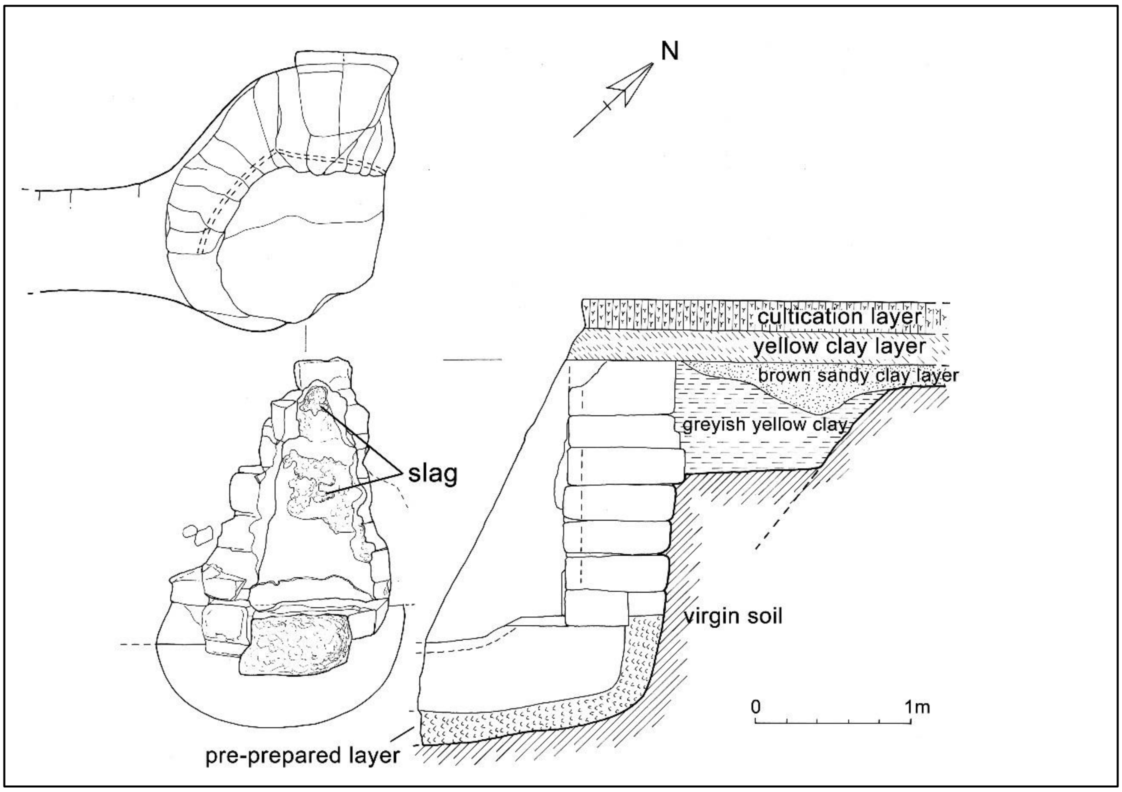


Fig. 3.13 Plan and section views of furnace L1 at Gushishan (drawing by: Ma Chunyan)

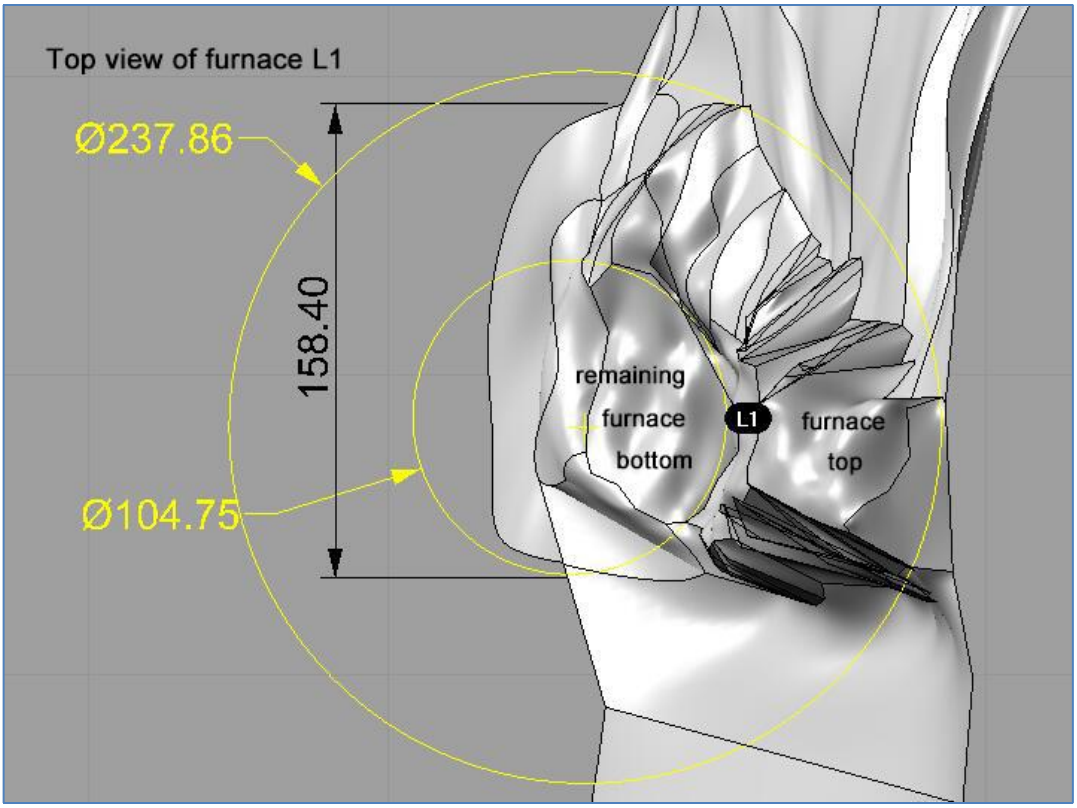


Fig. 3.14 Top view of furnace L1 at Gushishan, showing prediction of the inner and outer diameters of the furnace (source: author)

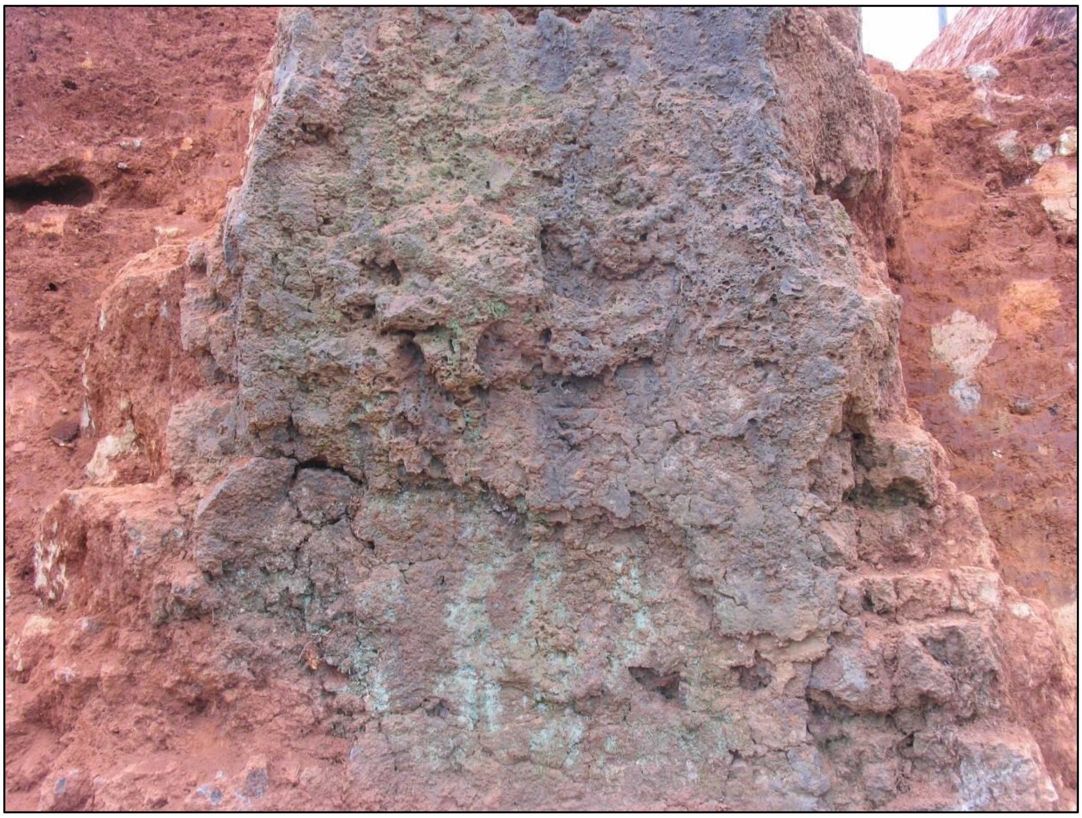


Fig. 3.15 Photo of furnace L1 at Gushishan, showing the vitrified interior surface (source: author)

2) **L2(11PGSL2)** is a furnace foundation with only the base remaining. The furnace was sealed by layer ③. The shape of the bottom is almost circular in plan with a diameter of 93-98cm. The centre of the furnace bottom is an oxidized orange colour, outside the centre there is a layer consisting of dark grey coloured furnace brick, and the most outer layer is an oxidized red colour. This furnace foundation is horizontally parallel to the base of furnace L1 (Fig. 3.16).

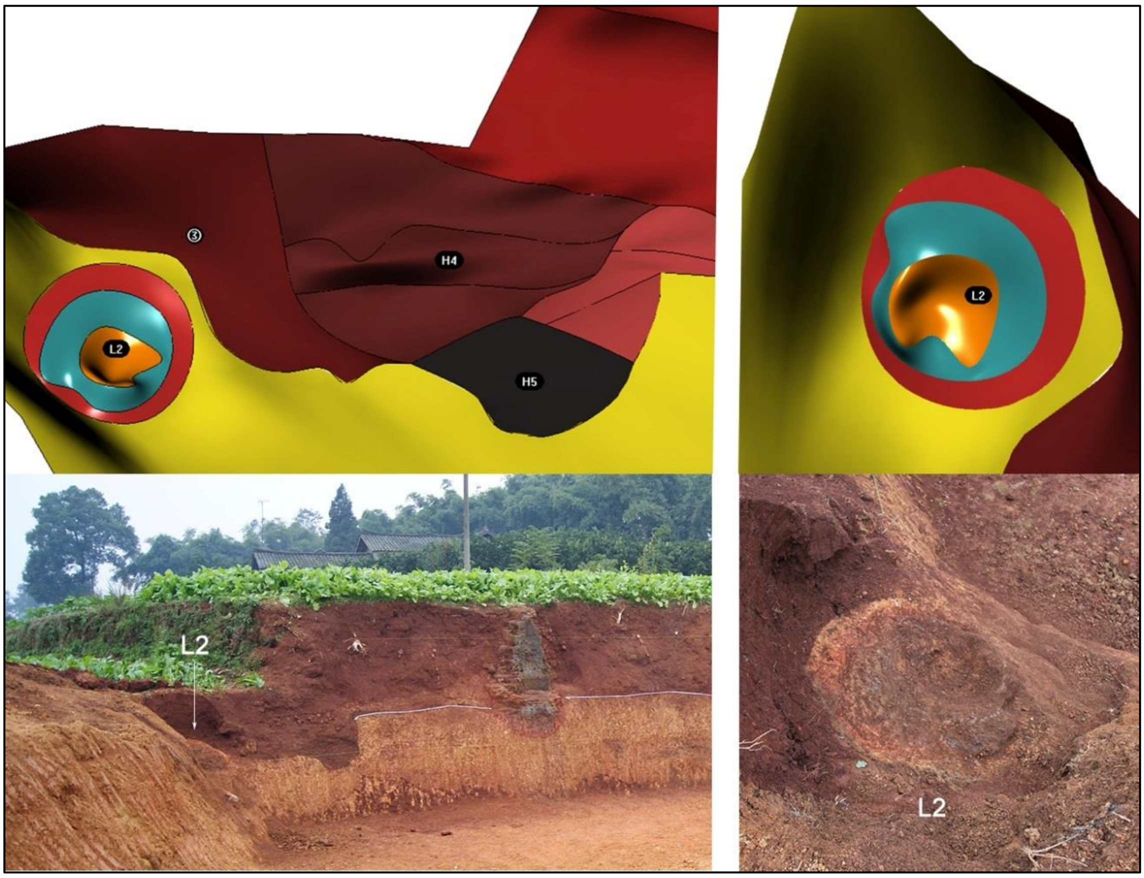


Fig. 3.16 Photo and model of L2 at Gushishan, showing the comparative location and details of the furnace (source: author)

Kiln-like structures:

1) **Y1(07PGSY1)**, this kiln-like structure is consisting of three parts, the mouth, the hearth, and the chimney. It comprised a thin-walled circular clay structure which is exposed on the ground, and the chimney part was sealed by layer ②. The filling earth in the kiln is burned soil (Fig. 3.17). The remaining height of the kiln is 60cm. The bottom of the kiln is flat with an inner diameter of 89cm, and there is a consolidated layer about 5-10cm thick underneath the bottom (Fig. 3.19). The mouth of the kiln is about 30cm wide, and there is a rectangular shaft chimney which is 14cm long and 7-13cm wide at the back of the kiln (Fig. 3.18).

Fig. 3.17 Photo of kiln Y1 at Gushishan, showing before and in progress of excavation (photo by: Ma Chunyan)

Fig. 3.18 Photo of kiln Y1 at Gushishan, excavated (photo by: Ma Chunyan)

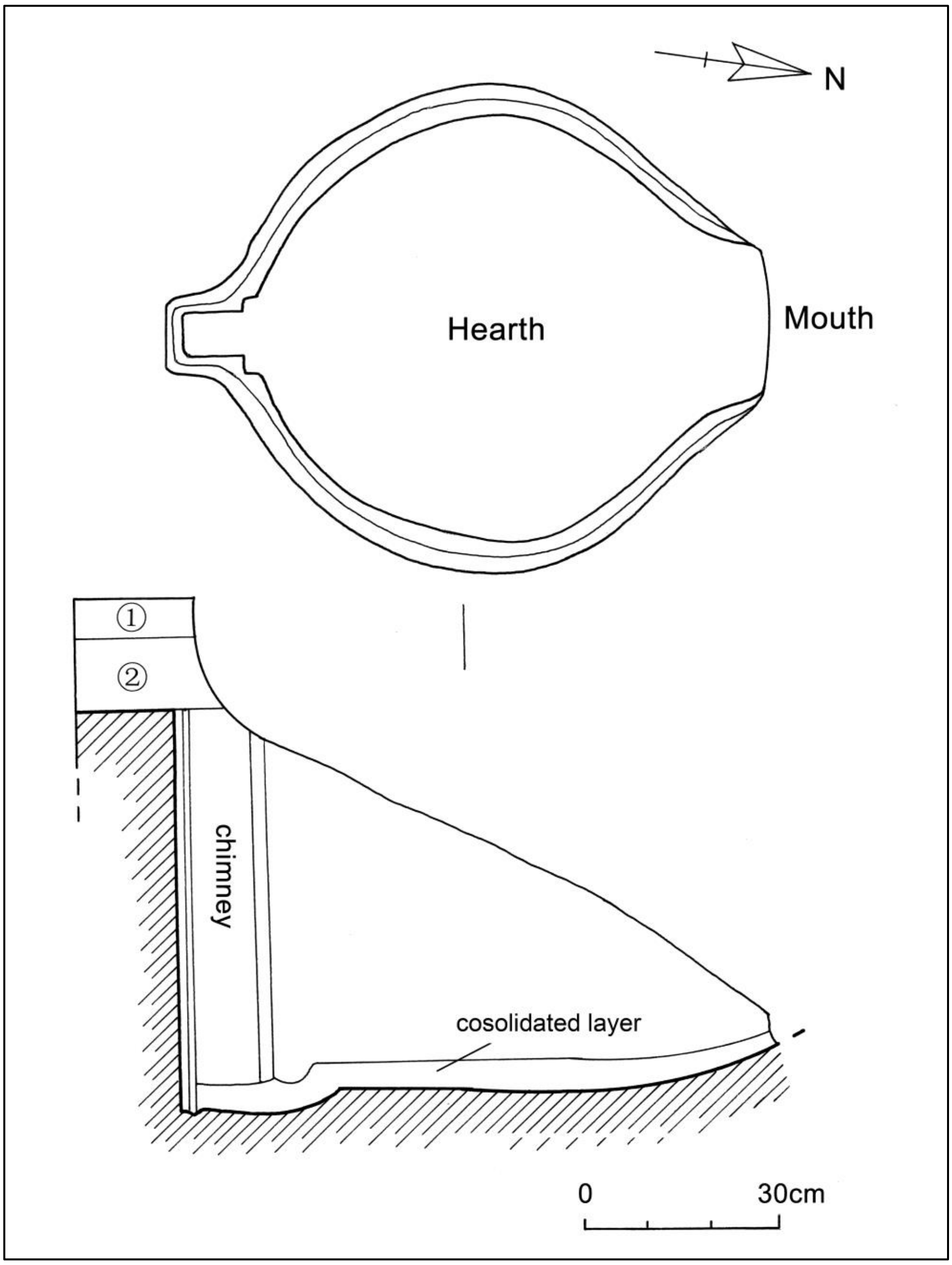


Fig. 3.19 Plan and section view of Y1 at Gushishan (drawing by: Ma Chunyan)

2) **Y2(07PGSY2)**, the overall structure of this kiln is similar to Y1. The shape of the kiln is elliptic (Fig. 3.20). The remaining height is 13-47cm, the inner diameter at the bottom is 102-117cm, and the chimney is 16cm long and 12cm wide. There is also a consolidated layer about 10cm thick underneath the bottom.

3) **Y3(07PGSY3)**, the overall structure of this kiln is similar to the other two. The shape of the kiln is sub-round (Fig. 3.21). The remaining height is 62cm, the inner

diameter at the bottom is 104-116cm, and the chimney is 16cm long and 13cm wide. There is also a consolidated layer about 10cm thick underneath the bottom.

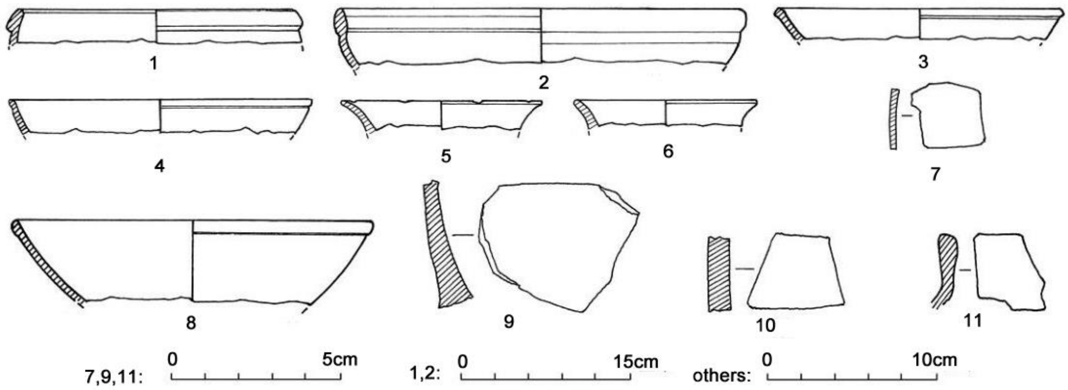
Fig. 3.20 Photo of kiln Y2 at Gushishan, excavated (photo by: Ma Chunyan)

Fig. 3.21 Photo of kiln Y3 at Gushishan, excavated (photo by: Ma Chunyan)

Finds

Small amount of pottery and porcelain sherds and large amount smelting related objects (refractory material, slag, ore, and charcoal) were excavated.

Pottery and porcelain: some object types could be identified from the pottery and porcelain sherds excavated. The types included jar, bowl, jug, basin and vase, which are all very commonly used domestic object types. The drawings are shown in Fig. 3.22 and the detailed descriptions are listed in appendix C3.



Pottery: 1. bowl (07PGSTG4②:1) 2. basin (07PGSTG1②:16) 7,9,10. sherds (07PGSTG1③:5, 07PGSTG4②:2, 07PGSTG1②:1) 8. bowl (07PGSTG1①:6) 11. jug (07PGSTG1②:6)

Porcelain: 3,4. bowl (07PGSTG1②:5, 07PGSTG3①:3) 5,6. vase (07PGSTG3①:2, 07PGSTG3①:1)

Fig. 3.22 Potteries and porcelains excavated from Gushishan (source: Zhou *et al* 2008)

Refractory material:

Three furnace bricks and one furnace lining were discovered.

07PGSL1:1, fragmented brick with red colouration on the surface. It is probably from somewhere near the top of the furnace because of its irregular shape and there is no adhering slag. The remaining dimensions are 27x23.6x15.8cm (Fig. 3.23:1).

07PGSTG1③:7, a clay-made rectangular brick with red colouration on the surface. According to the oxidizing colour and no adhering slag, this brick may also be from the top part of the furnace. The remaining dimensions are 35x20x15cm, and weight 4.68kg (Fig. 3.23:2).

06PGSB, collected on ground surface. Limestone made brick with a brown coloured broken section. The remaining length is 14.5cm, and the width and thickness were intact, which are 10cm and 7cm respectively. All surfaces except the broken section are coated with a thin layer of slag, which is black, non-magnetic and highly vitrified. On one of the surfaces, there is nodule-like adhering slag, which contains charcoal impressions and is partially magnetic. This brick is possibly from the belly part of the furnace, which the surface of the adhering slag is the interior surface and indicating a reduction temperature during the smelting (Fig. 3.24).

07PGSC, collected on ground surface, this furnace lining is a mixture of clay, quartz and organics with dimensions of 18x16.5x4.5cm. One side of the furnace lining is eroded by slags and un-smelted ores. The slags are non-magnetic, some of them are black and highly vitrified, and they penetrate the furnace lining c.3.5cm from the section view. The other side is flat with a thin layer of cracking texture clay. This furnace lining is presumably built inside the furnace wall, which the flat side is pasted to the inner furnace wall to prevent direct damage from the heat penetration and slag erosion (Fig. 3.25).

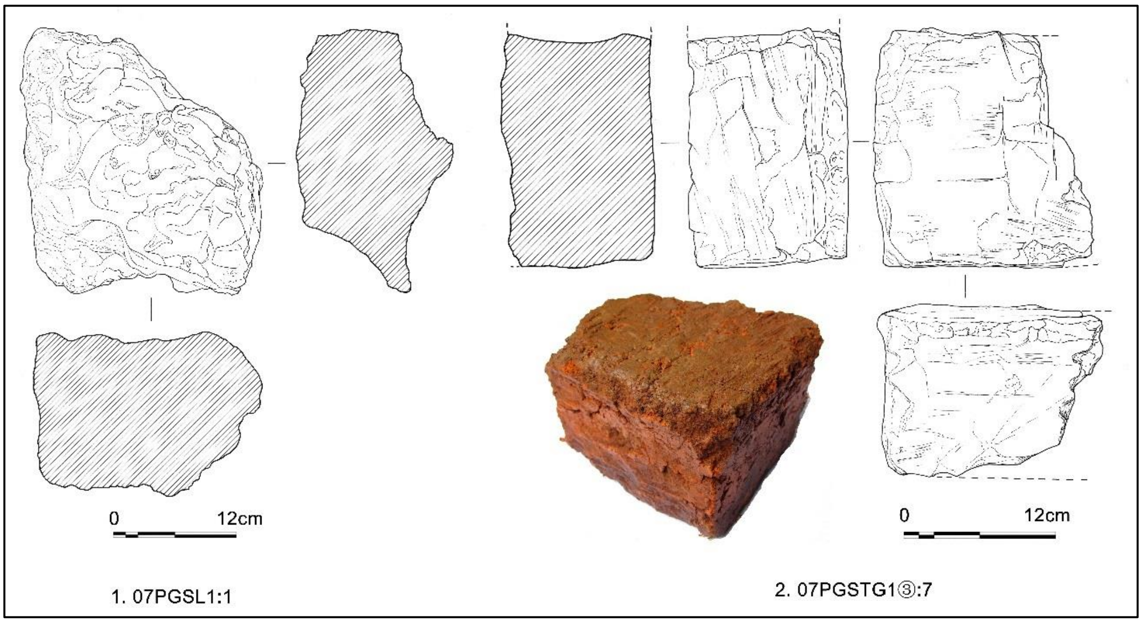


Fig. 3.23 Drawings of furnace bricks from Gushishan (drawing by: Ma Chunyan; photo by: author)

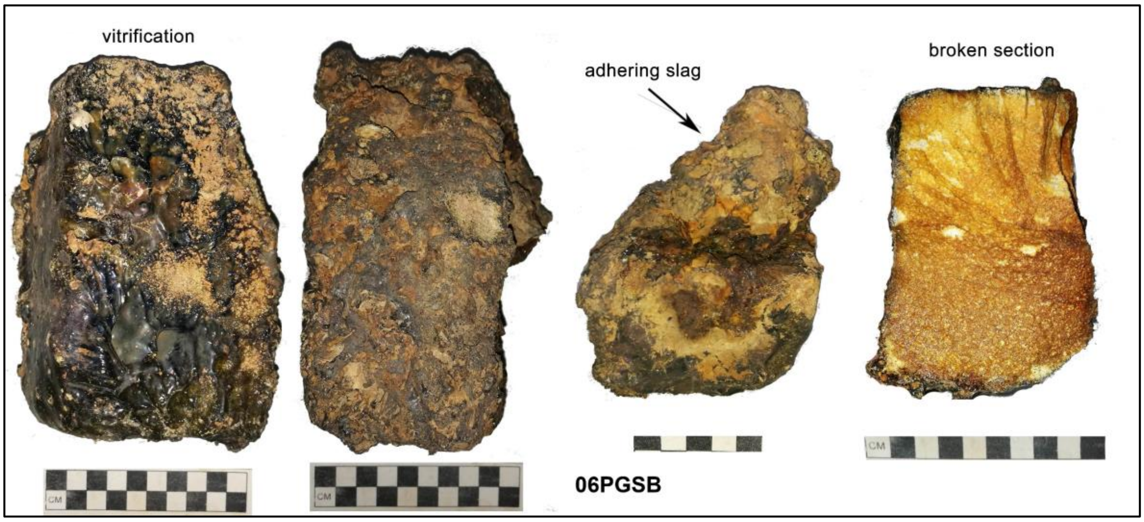


Fig. 3.24 Photos of furnace brick 06PGSB from Gushishan, showing vitrification, adhering slag, and section (source: author)

Fig. 3.25 Photos of furnace lining 07PGSC from Gushishan, showing both surfaces and section (source: author)

Slag:

Most of the slags discovered from Gushishan are furnace slag. These furnace slags are large, usually with a length larger than 10cm, and sometimes over 30cm. They have a high porosity proportion with a spherical shape, light in weight, partially magnetic, and contains large amount of charcoal impressions.

Sample **07PGSTG1③:9** is a furnace slag that is 28cm long, 19.5cm wide, 10cm thick, and weighted 1,925g. The colour is mainly brown with some grey. There are many charcoal impressions on the surface. The surface is abraded, partially vitrified, and partially magnetic (Fig. 3.26:1).

Sample **07PGSC** is an intact furnace slag collected from location C of Gushishan. The colour is mainly grey with some brown. Its dimensions are 26x19x17cm. A high porosity proportion with spherical shapes that are 2-10mm in diameters. The slag is highly abraded and partially magnetic (Fig. 3.26:2). Surprisingly, there is only one example of tap slag discovered at Gushishan.

Sample **07PGSTG1③:1** is a tap slag, grey and brown colours, 5cm long, 3.5cm wide, and 3cm thick. The slag has a low density and high porosity proportion with spherical shapes which are 2-10mm in diameters. The surface is rough with a charcoal impression (Fig. 3.26:3). More details of the slags can be found in appendix C1.

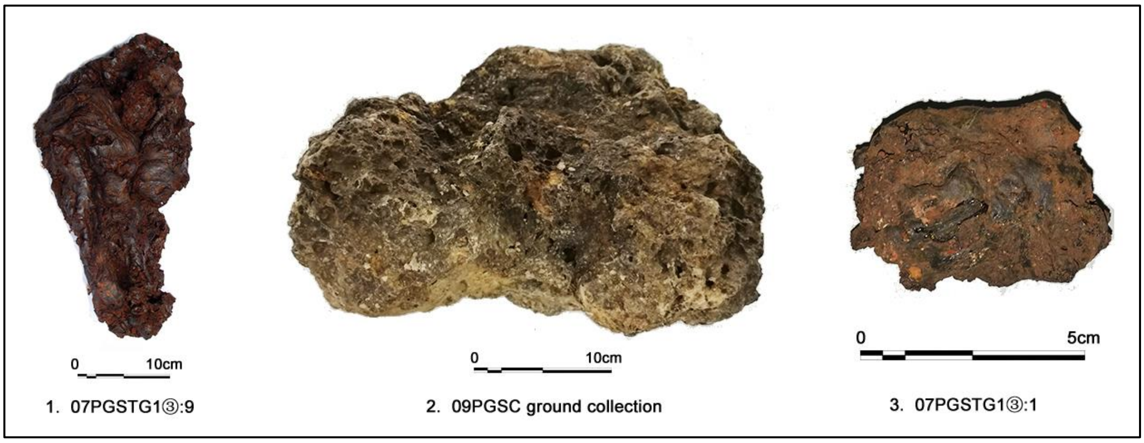


Fig. 3.26 Photo of furnace slags from Gushishan (source: author)

Ore:

Most of the iron ores discovered at Gushishan are reddish brown with sizes of 5-6cm, and the surfaces are abraded.

Sample **07PGSTG1③:12** is presumably roasted with a reddish brown colouration, 6x5.5x2.7cm in dimensions, and weighted 145g.

Sample **07PGSGC1** is half-melted with a grey colouration and brown in some areas. The size is 6.5x5x4cm, high density, and moderate magnetic (Fig. 3.27). Details of the collected ore samples are listed in appendix C2.

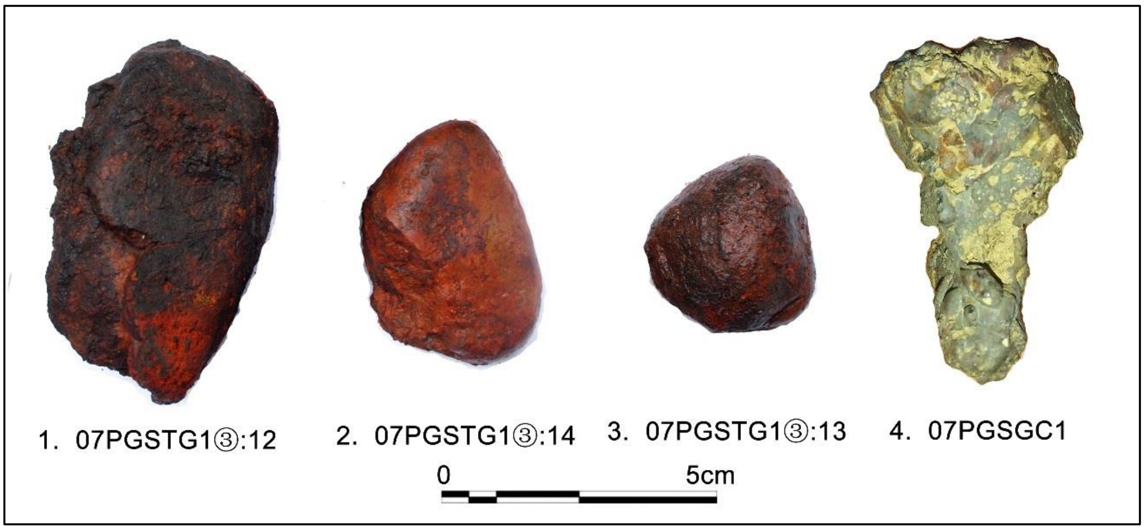


Fig. 3.27 Photos of iron ores from Gushishan (source: 1-5 from Zhou *et al* 2008, no scale; 6 author)

Charcoal:

Some thin stick shaped charcoals were excavated from context ③ of the Gushishan site (Fig. 3.28).

Fig. 3.28 Charcoal excavated from Gushishan (source: Ma Chunyan, no scale)

Radiocarbon dating

Two charcoal samples were collected for radiocarbon dating analysis. One of the sample was collected from the interior furnace wall of L1 and sent to the Institute of Accelerator Analysis (AMS), Japan. The original result is shown in Table 3.2. The result is calibrated using OxCal v4.2.4 (Bronk Ramsey and Lee 2013) and IntCal13 atmospheric curve (Reimer *et al* 2013). The other sample was collected from the fills of L2 and sent to the Peking University, China. The calibrated result is shown in Table 3.3. The result is calibrated using OxCal v3.10 (Bronk Ramsey 2005) and IntCal04 (Reimer *et al* 2004). The half-life of carbon 14 used at the Peking University is 5568 years and the BP is referring to a reference date of 1950.

Table 3.2 Original C14 result of the sample from Gushishan by Institute of Accelerator Analysis (AMS), Japan (source: CJAT, unpublished)

Lab No.	name	context	sample type	method	$\delta^{13}C$ (‰) (AMS)	$\delta^{13}C$	
						Libby Age (yrBP)	pMC (%)
IAAA-133584	AIC-2	GSS (collected from the inner wall of the blast furnace found at Gushishan)	charcoal	AAA	-23.95±0.29	1,900±20	78.89±0.23

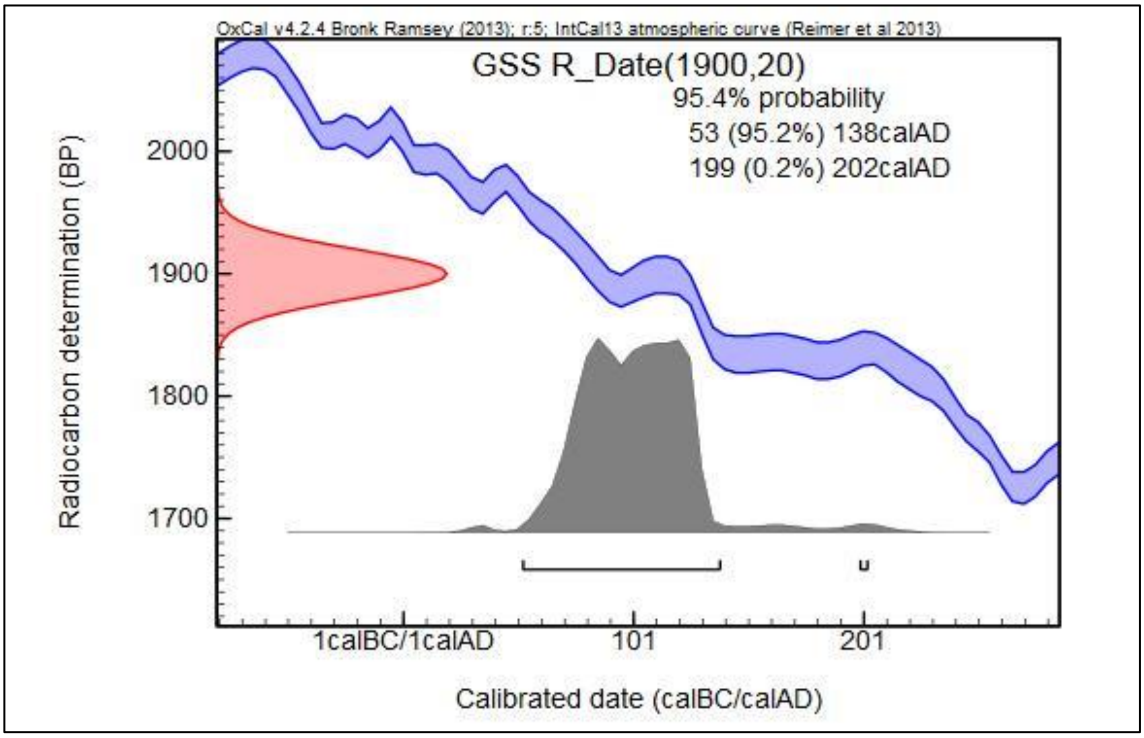


Fig. 3.29 Calibrated C14 result from OxCal, single plot

Table 3.3 Calibrated C14 result of the sample from Gushishan by Peking University, China (source: CJAT, unpublished)

Lab No.	Name	Sample type	Context	C14 (BP)	Calibrated	
					(68.2%)	(95.4%)
BA132114	PGSS1	charcoal	GSS (collected from the fills of L2 at Gushishan)	280±20	1520AD(29.0%)1550AD 1630AD(39.2%)1660AD	1520AD(48.6%)1600AD 1620AD(46.8%)1670AD

Discussion

Due to the limited area excavated and the original deposits were extensively destroyed by the local cultivation and road construction activities, the dating of the Gushishan site is consequently difficult. However, some issues can be discussed based on the excavated information, which might be helpful in the indirect dating of the site.

Firstly, furnace L1 discovered at the Gushishan site was constructed with furnace bricks. The furnace brick is made of clay with inclusions of quartz and straw (or other organic fibres). The first step to build the furnace is probably to dig a pit at the base of a terrace to make the bottom of the furnace, and then strengthen the bottom by firing and tamping. This structure gives better support to the furnace and is more convenient when charging raw materials. The second step is to build the furnace with bricks, and put the clay-made furnace lining on both the interior and exterior furnace walls to extend the service life of the furnace. Noticeably, thicker furnace bricks are usually used to construct the lower temperature areas such as the furnace top, and thinner bricks are usually applied to build the high temperature areas such as the furnace belly. The thinner bricks can possibly reduce the damage to the whole furnace when a damage has been made to the brick itself by the high temperature.

Some information of the excavated blast furnace of the Han dynasty is given in appendix B1, and some indirect prediction of the furnace diameters depending on the curved furnace bricks discovered on site is given in appendix B2. According to the information from the tables, the inner diameters of the circular shaped blast furnaces of the Han dynasty (202BC-220AD) are varied from 90 to 200cm with an average of 159.75cm. The evidence of blast furnace discovered at Tieniucun shows a predicted inner diameter of 100cm (will be discussed in section 3.5.3). The inner diameter of furnace L1 discovered at Gushishan is about 105cm (at the bottom) and the diameter of the belly should be reasonably bigger but less than 238cm (the outer diameter), and the overall constructional structure is conformed to the characteristics of these Han dynasty blast furnaces.

Secondly, the kiln-like structures. The fills of all three kilns discovered at Gushishan is burned soil, and some charcoal debris were found at the bottom of each kiln. There is no other cultural relics such as pottery sherd was discovered in the context of the kiln, and no operating surface was found in front of the kilns (Li J. 1991, 75, fig. 59). Some scholars believed these kiln-like structures were charcoal making kilns. However, from the colour and the size of the kilns, they are more like pottery making kilns. Iron smelting demands large amounts of charcoal, which is more often made in the forest and then transported to the smelting sites.

There were two iron smelting sites of the Western Han dynasty in Henan province, which their excavators claimed that coal was used as one type of the fuels at both Tieshenggou (Zhao Q. and Zhao 1962, 38) and Guxingzhen (ZZSBWG 1978, 38). The excavator of Tieshenggou mentioned that coal cake (made from a combination of coal powder, clay, quartz and limestone particles) and coal slag were discovered both on the ground and inside the furnace No.13 and No.14. However, both furnaces were identified as bloomery furnaces and very few evidence of high Sulphur content in the iron objects was discovered. Besides these two cases, the primary use of fuel in iron smelting activities was charcoal before the beginning of the second century BC. On the other hand, coke was used as fuel in iron smelting at latest since the 11th century AD (Wu Xiaoyu 1986, 100).

Furthermore, the species of the charcoal excavated from context ③ of the Gushishan site is identified as chestnut class by the excavator (Zhou Z. *et al* 2008, 26), and no evidence of bamboo, coal or coke were found. It could be indirectly indicating the operating date of the site is no later than the 11th century AD.

Thirdly, the pottery and porcelain sherds. According to the local pottery assemblage, the pottery sherds excavated from layer ③ can be dated as early as the Han dynasty (202BC-220AD), and the porcelain sherds excavated from the same layer were dated to the Song dynasty (10^{th}-13^{th} centuries AD) (Zhou Z. *et al* 2008, 25). Although it might be indeterminate to use the excavated pottery and porcelain to date the furnace because the contemporary issue of the furnace and the excavated objects from an iron smelting site is sometimes debatable. However, the pottery dating here wasn't contradict the other evidence discovered, which might suggest the site was started operating from about the 2^{nd}-1^{st} century BC and was abandoned at sometime between the 11^{th}-13^{th} century AD.

Fourthly, there were two charcoal samples subjected to a radiocarbon dating analysis. The sample collected from the interior furnace wall of L1 gives a date between 53BC-202AD, which supports our assumptions made above. On the other hand, the sample collected from the fills of L2 gives a date between 1520-1670AD, which is much later than the abandoned date we assume. However, this is the only counter evidence, and the sample was collected from the fills but not directly from the furnace.

Finally, as mentioned in the beginning of this chapter, in the *Hua Yang Guo Zhi*, "Gushishan" was recorded as a place that has abundant iron ore resource. The Gushishan site was nearby the iron ore deposits and the blast furnace excavated is very likely to be dated as early as the 2^{nd}-1^{st} centuries BC. On the whole, take account of the biographies in the passage, we believe that our Gushishan is the 'Gushishan' mentioned in the *Hua Yang Guo Zhi*, and the site was one of the iron smelting sites managed by the Linqiong *TieGuan* set up in Shu county by the central government. However, unlike the other iron smelting sites of the Han dynasty, which large amounts of ceramic or iron moulds were discovered (Zhao Q. and Zhao 1962; An J. and Li 1992; Li Yufang *et al* 1995; Huang K. and Dang 1988; ZZSBWG 1978; Li Yingfu *et al* 2016), we found no moulds of any kind at the Gushishan site. It is likely that the function of Gushishan is only to smelt iron ore to pig iron ingots, and the ingots are transported to other places for further production. The ores used in the smelting were crushed into a size less than 6cm, and the smelting slags were possibly applied in other uses such as road paving rather than simply discarded nearby.

3.5.2 Xuxiebian

Introduction

The Xuxiebian site is located on the top of a hill at Group 4 of the Manan village, Shou'An town, Pujiang county, Sichuan province (Fig. 3.30). The GPS coordinates are 30° 19′ 08″N, 103° 35′ 39″E, and the elevation is 505.5-513.5m. The site is 37m E-W and 45.5m N-S, of a total area about 1,700m^2. Slag, refractory material, and iron sand are everywhere on the ground within the site area (Fig. 3.31).

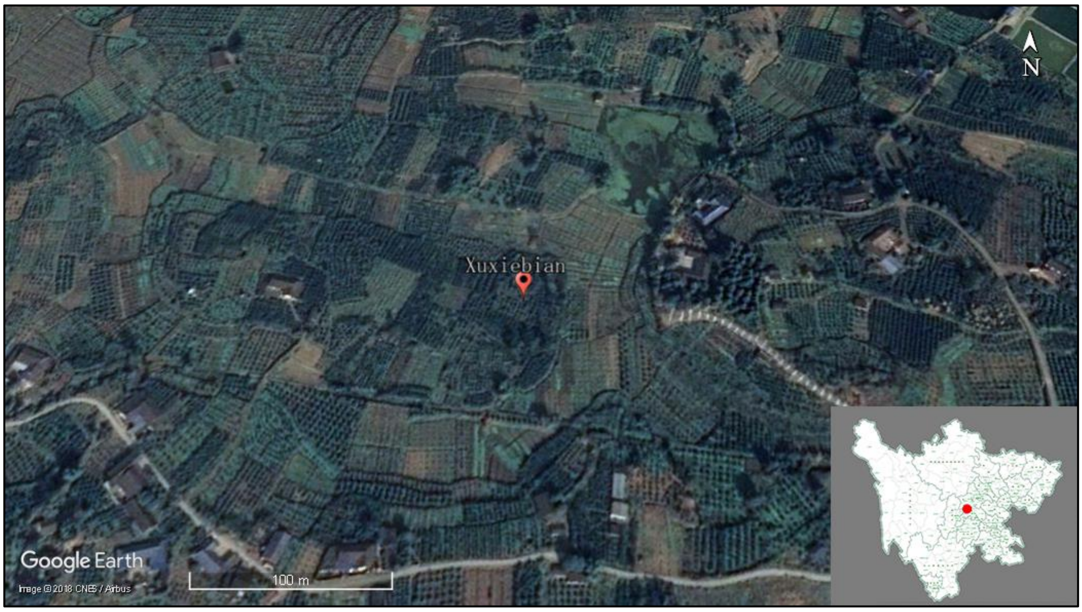


Fig. 3.30 Location of the Xuxiebian site (base map: Google Earth)

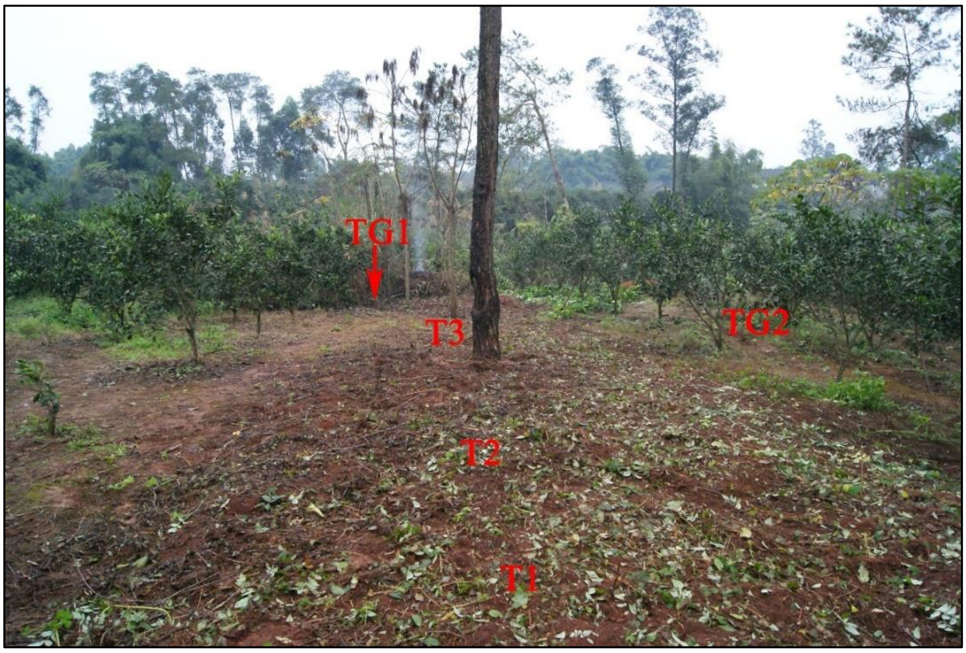


Fig. 3.31 Photo of the Xuxiebian site, before excavation (looking from south to north, photo by: author)

The local cultivation includes orange and pepper. Two excavations were carried out during the May/June of 2007 and the December of 2011. Details of the excavated trenches are showing in Table 3.4 (Fig. 3.32). A total of 4 furnaces and 6 pits were discovered in the two excavations.

Table 3.4 Details of the excavated trenches at Xuxiebian

Year	Number	Size (m)
2007	07PSXTG1	4 x 2
2007	07PSXTG2	4 x 2
2007	07PSXTG3	4 x 2
2011	11PSXT1 (Fig. 3.33)	4 x 4
2011	11PSXT2 (Fig. 3.34)	4 x 4
2011	11PSXT3 (Fig. 3.34)	4 x 4
2011	11PGSTG1 (Fig. 3.35)	2 x 4
2011	11PGSTG2 (Fig. 3.36)	2.5 x 6

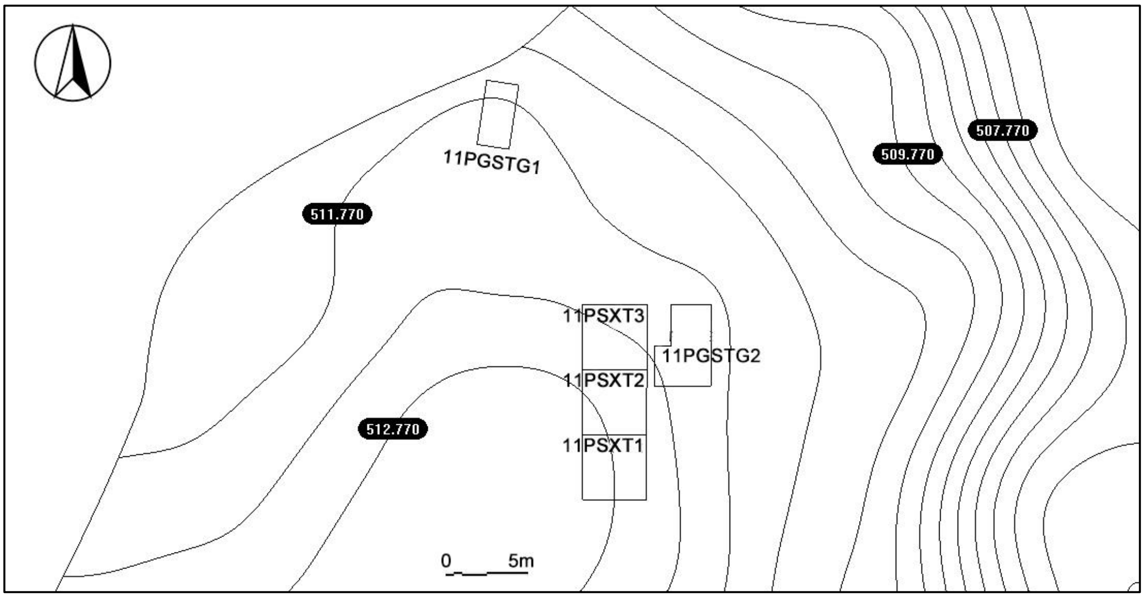


Fig. 3.32 Map showing the excavated trenches at Xuxiebian in 2011 (source: author)

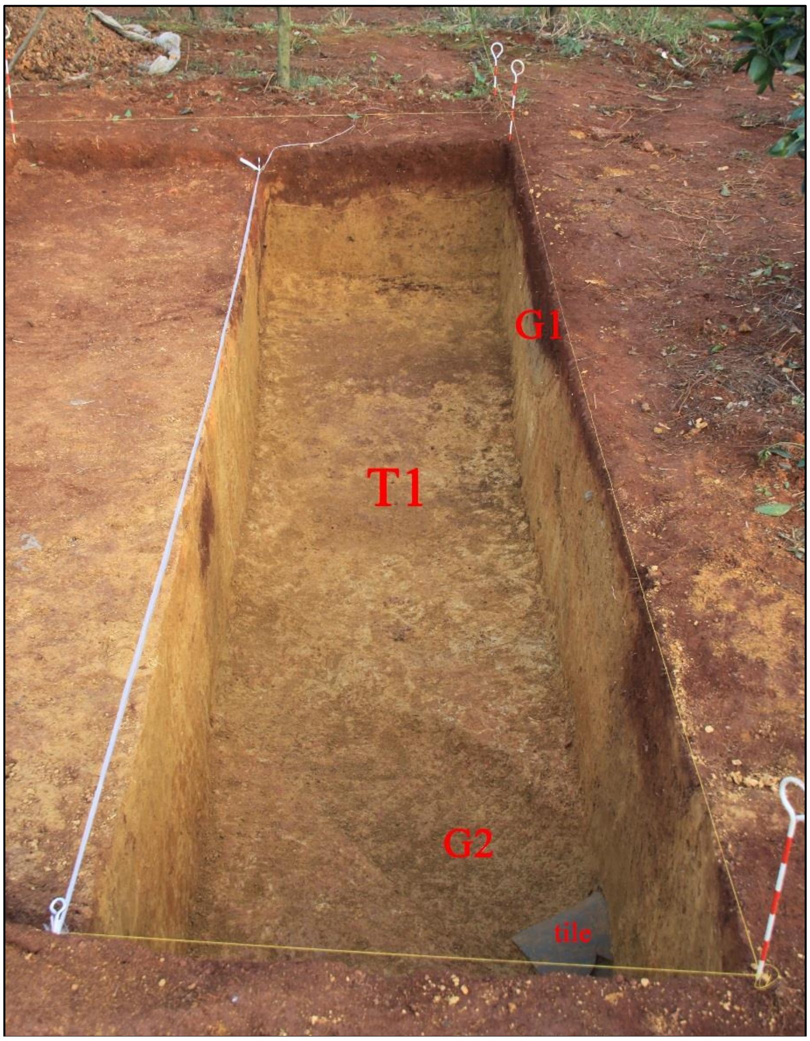


Fig. 3.33 Photo of 11PSXT1 at Xuxiebian (west to east, photo by: author)

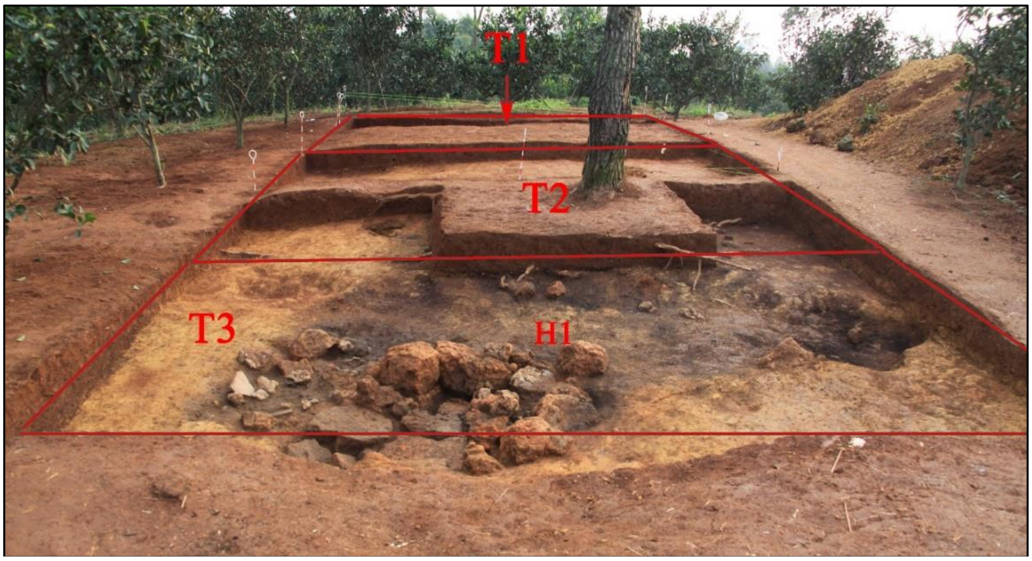


Fig. 3.34 Photo of 11PSXT1, T2 and T3 at Xuxiebian (north to south, photo by: author)

11PSXTG1 west to east

11PSXTG1 east to west

Fig. 3.35 Photo of 11PSXTG1 at Xuxiebian (photo by: author)

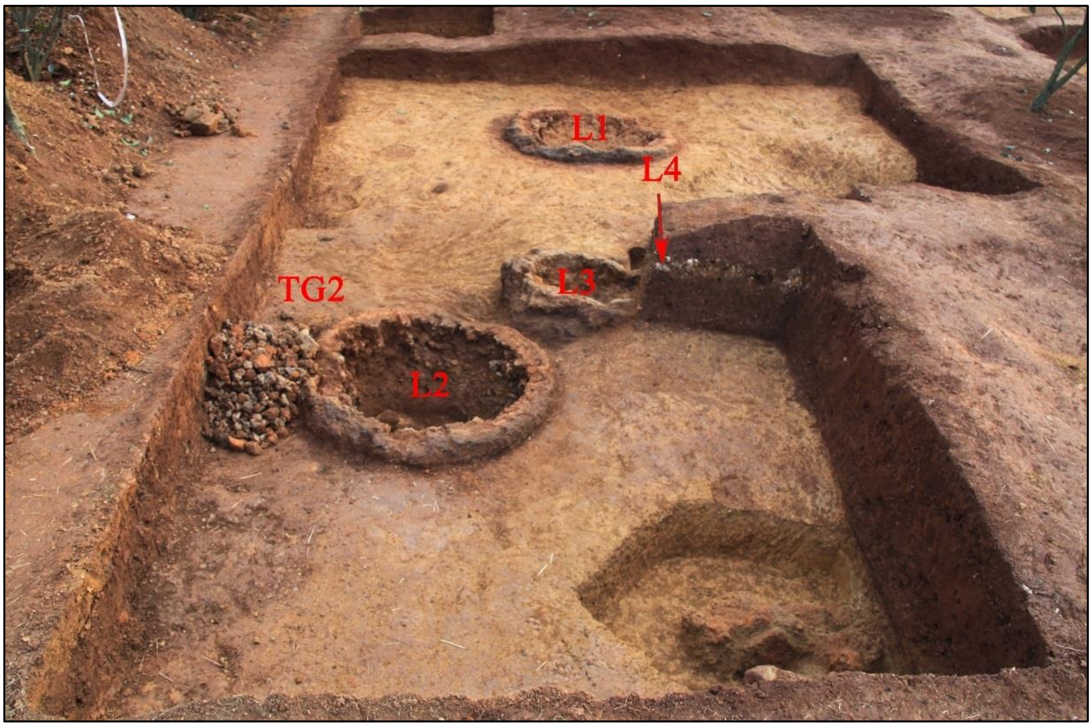


Fig. 3.36 Photo of 11PSXTG2 at Xuexiebian (north to south, photo by: author)

3D landscape model

Landscape model: A total of 408 coordinate data were collected by using a total station. One 3D landscape model of 9,524m^2 of the Xuxiebian site and the nearby area was created. A 0.5m contour map was produced (Fig. 3.37).

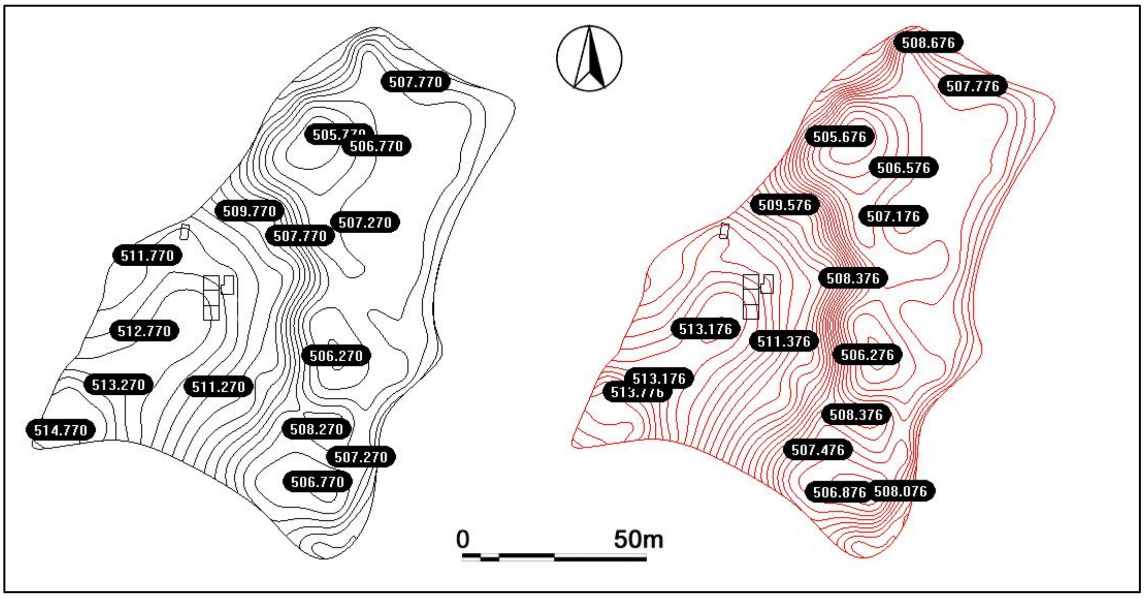


Fig. 3.37 A 0.5m and 0.3m contour maps of Xuxiebian, showing the excavated areas of 2011 (source: author)

Stratigraphy and deposits of the site

The stratigraphy and deposits of the site are demonstrated by using the north section of 11PSXTG2 as an example (Fig. 3.38). There are 4 layers excavated in total, and below the fourth layer is the virgin soil. The details are as follow.

①: Modern agricultural layer, yellow and brown clay, loose structure, and 5-18cm thick. The inclusions are plant roots, modern porcelain sherds, rocks, iron ores, and slags.

②: Modern disturbed layer, reddish brown clay, loose structure, 5-18cm to the ground surface, and 14-36cm thick. The inclusions are plant roots, rocks, blue and white porcelain sherds, furnace bricks, charcoal, and slags.

③: Tang and Song dynasties layer (c.7th-14th centuries AD), brown sandy clay, loose structure, 20-42cm to the ground surface, and 6-16cm thick. The inclusions are slags, charcoal, porcelain sherds of the Tang and Song dynasties, and furnace bricks.

④: Han to Jin dynasties layer (c.200BC-400AD), yellow clay, tight structure, 27-46cm to the ground surface, and 0-10cm thick. The inclusions are iron ores, refractory materials, small amount of charcoal, clay potteries, and slags.

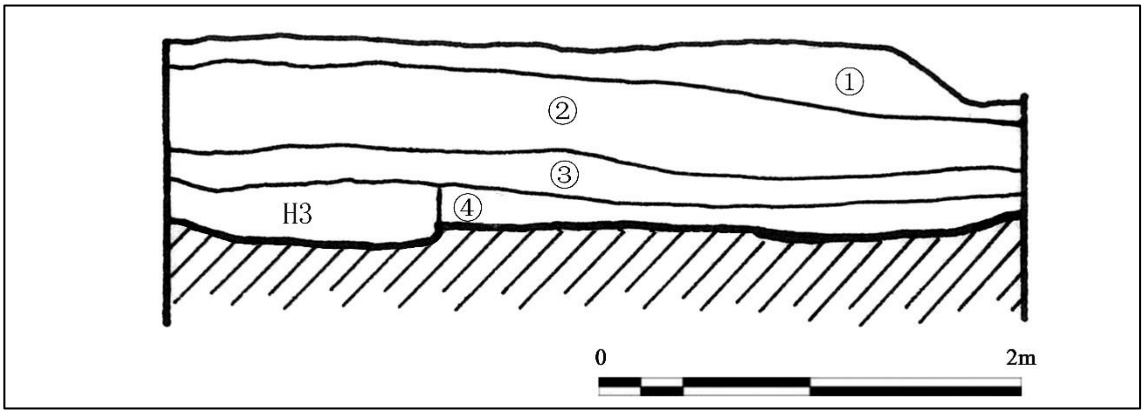


Fig. 3.38 North section of 11PSXTG2 at Xuxiebian (drawing by: author)

Archaeological features

In the excavations of 2007 and 2011 by the CJAT, five pits (07PSXH1, 11PSXH2,3,4), two trench (11PSXG1,2), one foundation pole (11PSXD1), four furnaces (11PSXL1-L4, which L1 was first excavated in 2007 and re-excavated in 2011 and renamed as 11PSXL1) were excavated (Fig. 3.39).

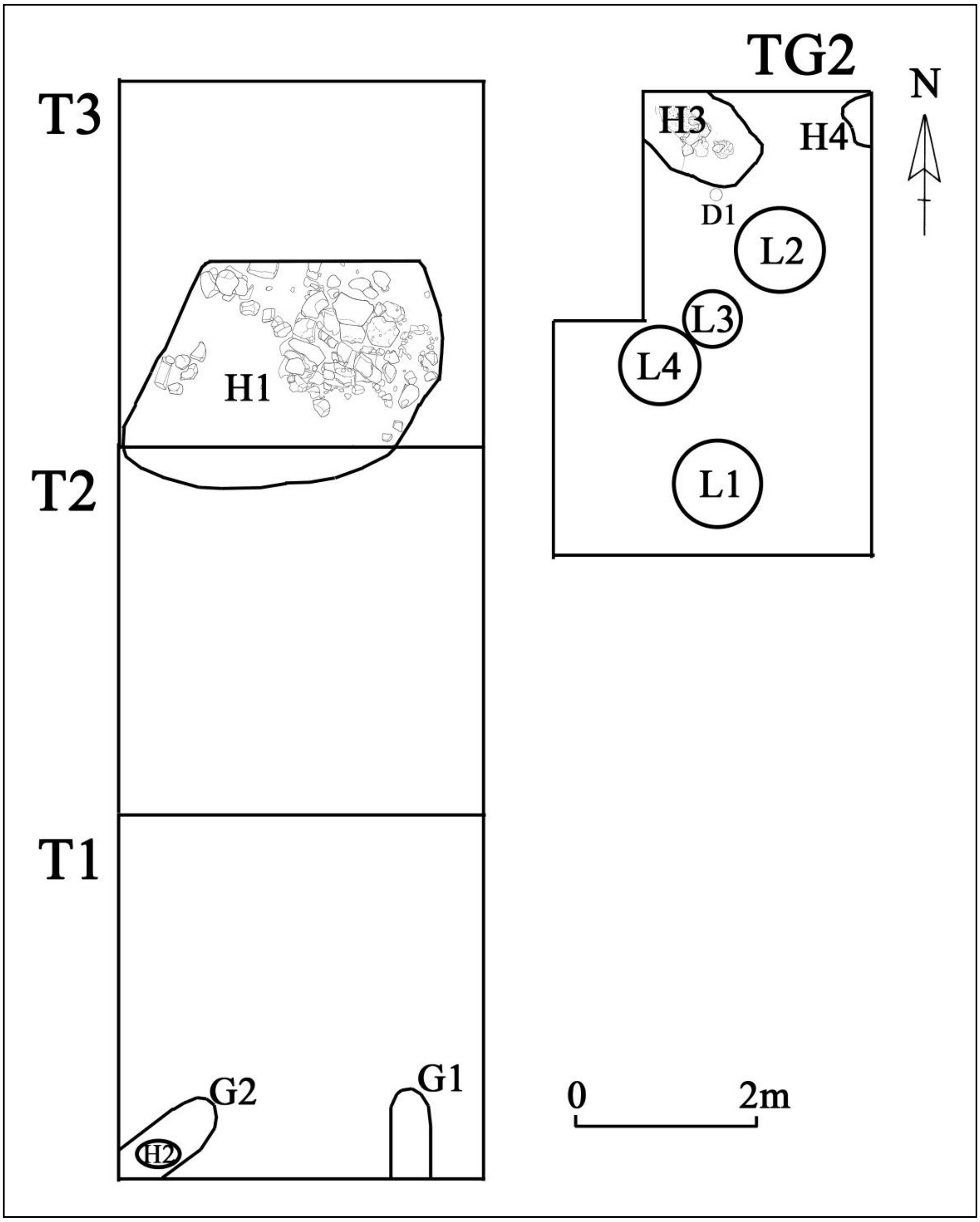


Fig. 3.39 Plan of the Xuxiebian site showing the locations of all the features excavated in 2011 (source: author)

Pits:

1) **07PSXH1** (renamed as H5), was located in the north of 07PSXTG3, and sealed by layer ③ (Fig. 3.40:1). Rectangular in plan, large amounts of pottery and porcelain sherds and smelting related remains including charcoal debris, burned soil, and slags. This pit was discovered in the trial excavation in 2007 and was not excavated completely for a systematic excavation in the future.

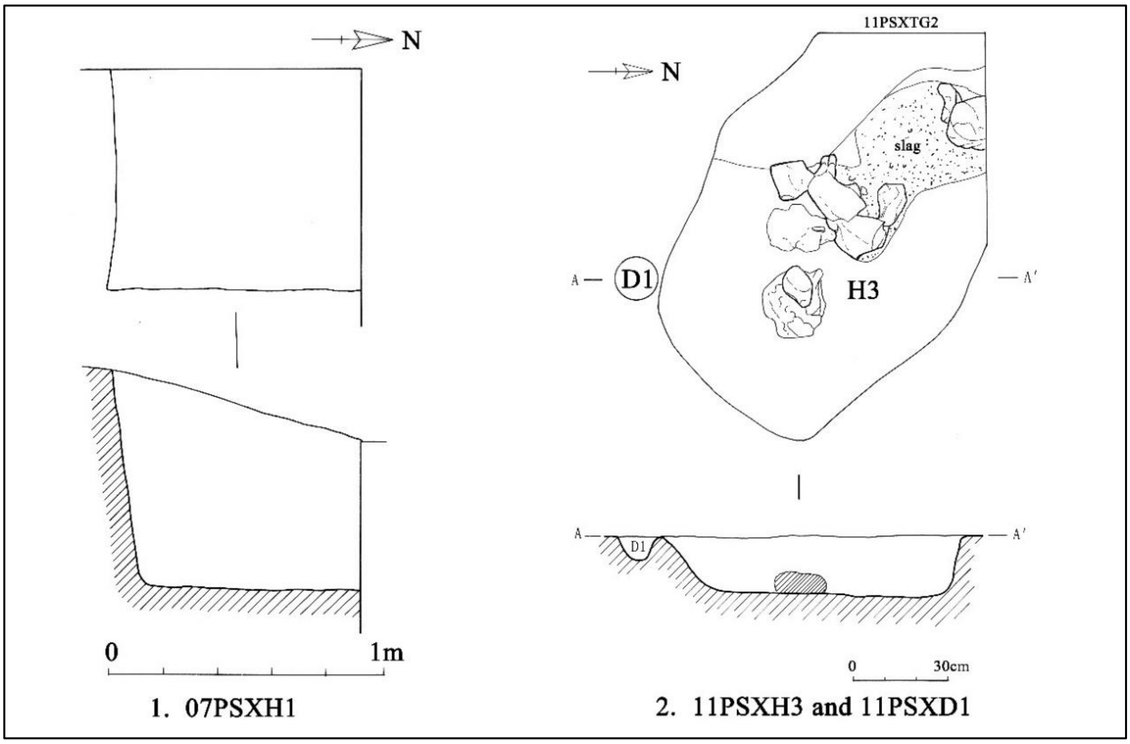


Fig. 3.40 Plan and section views of 07PSXH1 (H5), 11PSXH3 and 11PSXD1 at Xuxiebian (drawing by: Ma Chunyan)

2) **11PSXH1**, was located in the north of 11PSXT2 and the south of 11PSXT3, and sealed by layer ③. Irregular in plan, slightly U-shaped in section, straight wall, and flat bottom (Fig. 3.41). The pit is 28-59 in depth and 10-28cm from the surface. The deposit of the pit has three layers, the first layer is reddish brown clay with inclusions of 5-10cm sizes irregular slags, small limestone bars, furnace bricks, and cylindrical charcoals. The second layer is charcoal deposit layer, most of the charcoal fragments are up to 15cm long and 4cm in diameter, and one of the charcoal has a diameter of 8cm. The inclusions of the third layer are similar to the first layer except the furnace bricks found in this layer have a more intact shape of square with a diameter about 30cm. There is a rectangular shaped foundation discovered on the east of the pit.

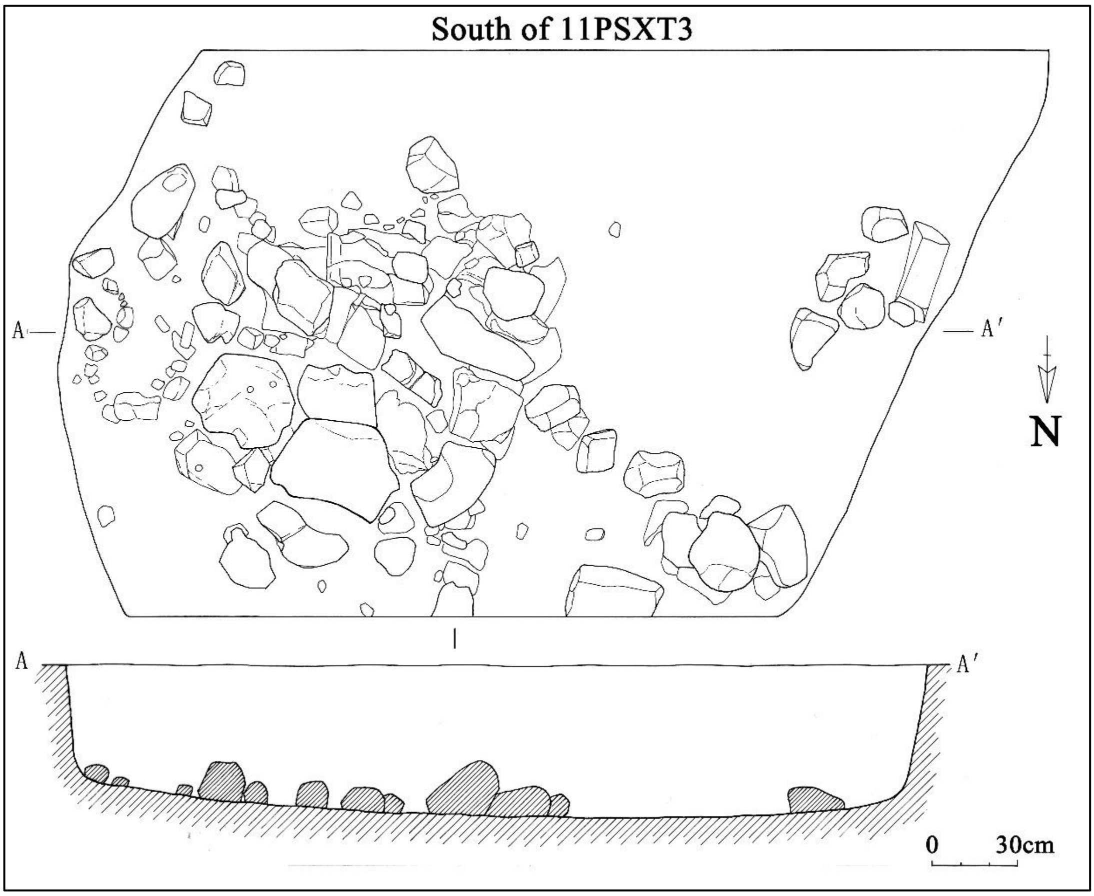


Fig. 3.41 Plan and section views of 11PSXH1 at Xuxiebian (drawing by: Ma Chunyan)

3) **11PSXH2**, was located in the southwest of 11PSXT1, and sealed by layer ②. Elliptic in plan, U-shaped in section, curved wall, and flat bottom. The pit is 10-12cm in depth and 11-13cm from the surface. The deposit is dark grey sandy soil with a loose structure. The inclusions are 5cm size slags, and 5-15cm sizes broken furnace bricks with different colours of red and grey.

4) **11PSXH3**, was located in the northwest of 11PSXTG2, and sealed by layer ③. Irregular rectangular shape in plan, slightly U-shaped in section, straight wall, flat bottom (Fig. 3.40:2). The pit is 9-20cm in depth and 40-42cm from the surface. The deposit is grey and yellow clays with a tight structure. The inclusions are 2-10cm sizes slags, and 5-20cm broken furnace bricks with colours in red, orange and grey.

5) **11PSXH4**, was located in the northeast of 11PSXTG2, and sealed by layer ②. Half-elliptic in plan, slightly U-shaped in section, straight wall, and flat bottom (Fig. 3.42). The pit is 7-17cm in depth and 22-24cm from the surface. The deposit is

dark red clay with a loose structure. The inclusions are porcelain sherds, 2-4cm sizes slags, 2-4cm sizes broken furnace bricks.

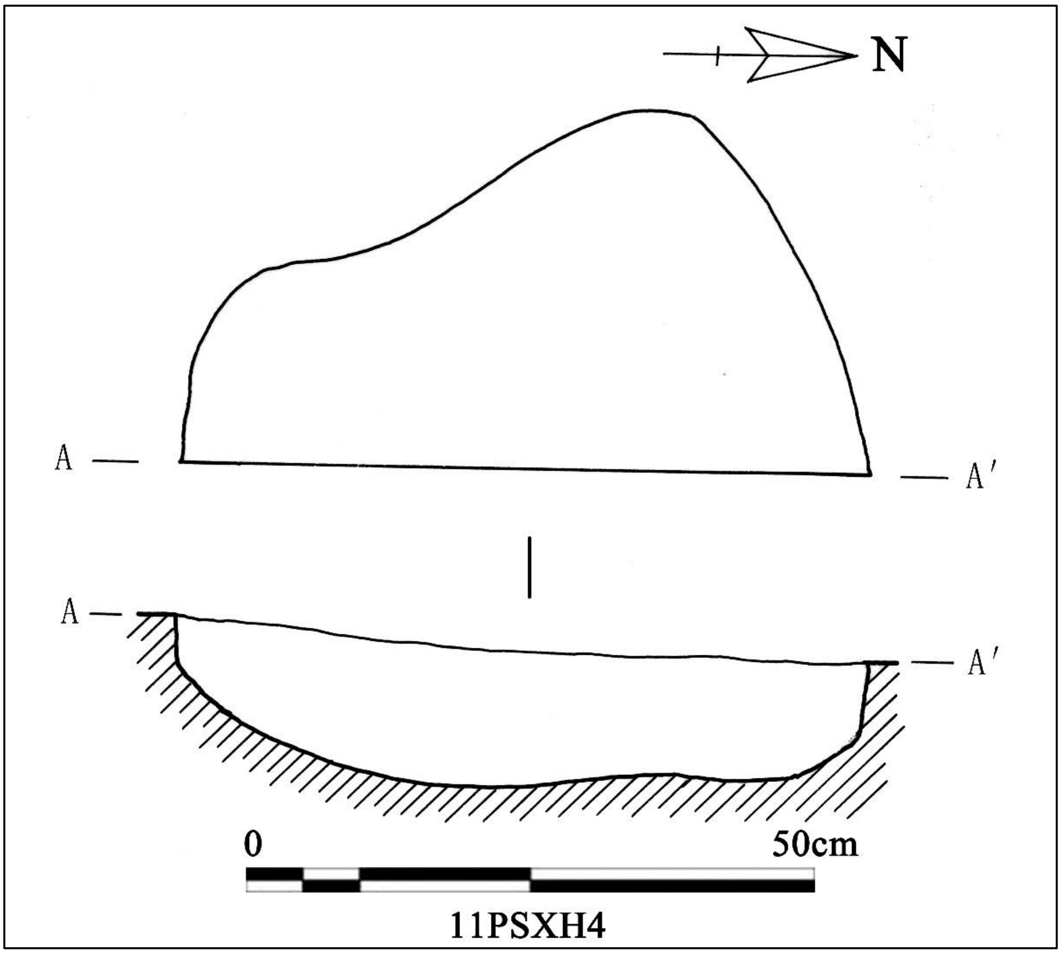


Fig. 3.42 Plan and section views of 11PSXH4 at Xuxiebian (source: author)

Trenches:

1) **11PSXG1**, was located in the east of 11PSXT1, and sealed by layer ②. Rectangular in plan, curved wall and bottom. The trench is 12-21cm in depth and 10-22cm from the surface. The deposit has two layers, the first layer is reddish brown clay with small amount of charcoal debris, and the second layer is grey sandy soil with no inclusions.

2) **11PSXG2**, was located in the west of 11PSXT1, and sealed by layer ②. Rectangular in plan, straight wall, and curved bottom. The trench is 60-82cm in depth and 7-17cm from the surface. The deposit has two layers, the first layer is reddish brown clay with a tight structure, and the second layer is yellowish brown clay with a loose structure. Both layers have no inclusions.

Post hole:

11PSXD1, was located in the northwest of 11PSXTG2 and is northwest to 11PSXH3, and sealed by layer ③ (Fig. 3.40:2). Circular in plan with a diameter of 13cm, straight wall and curved bottom with 8cm in depth. The deposit of the trench is reddish brown and yellow clays with a loose structure and no inclusions.

Furnaces:

1) **11PSXL1**, was located in the south of 11PSXTG2, and sealed by layer ③. Circular in plan with a diameter of 100-105cm. The furnace wall is about 5-9cm thick and constructed with clay bricks. The colours of the furnace wall in plan from outside to inside are dark grey, orange and red. The surrounding area of the furnace wall has an orange layer of 5-7cm. The interior furnace wall is fully covered by a slag layer, which is magnetic and thicker in the north part. There are two rectangular gaps about 10-15cm wide on the northern furnace wall. Limestone bars about 2.7cm long and 0.9cm wide, and small nodules of 0.9cm diameter were discovered distributing around the left gap (west). The remaining depth of the furnace is 56cm (Fig. 3.43). The furnace fill is reddish brown sandy clay with inclusions of slags, iron ores, furnace bricks made of rocks, and limestone.

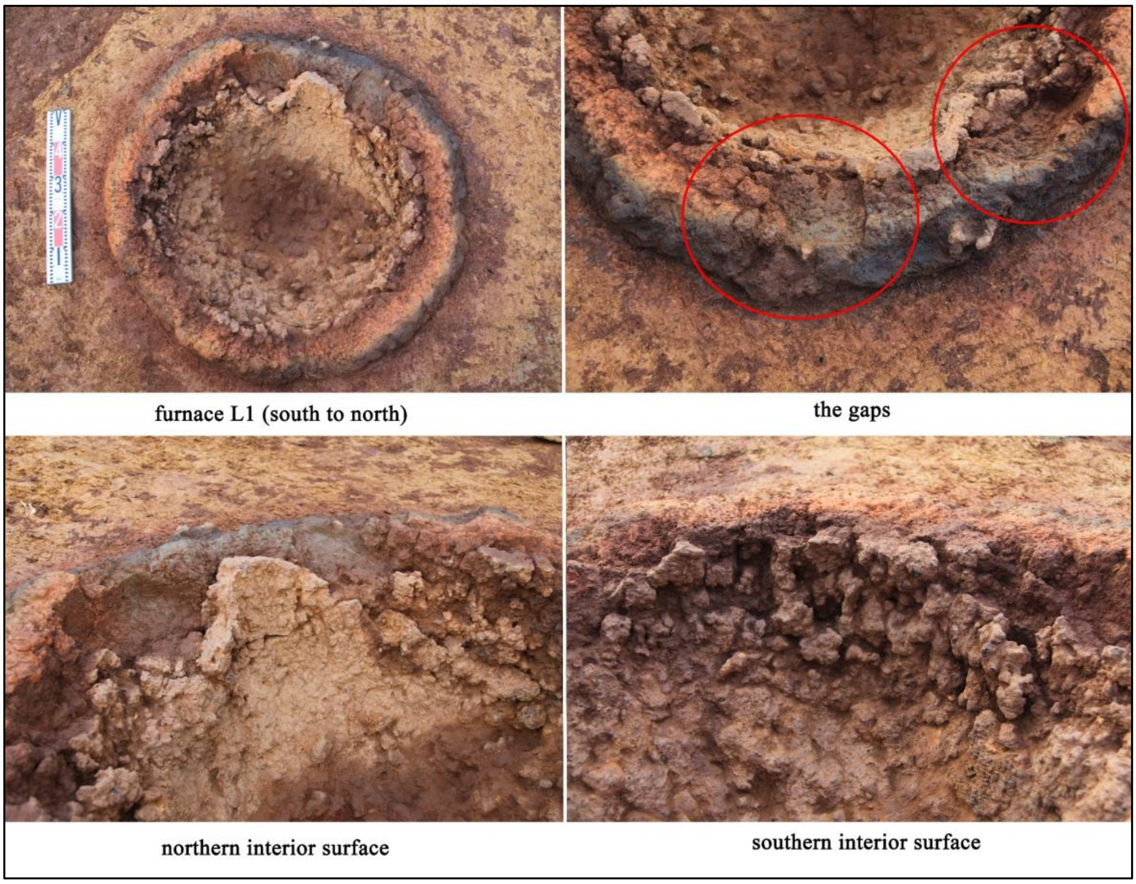


Fig. 3.43 Photos of furnace L1 at Xuxiebian, showing different details (source: author)

2) 11PSXL2, was located in the east of 11PSXTG2, and sealed by layer ③. The overall structure of furnace L2 is the same as L1 with a diameter of 90-92cm. There are also two rectangular gaps about 10-15cm wide on the northern furnace wall. The remaining depth of the furnace is 35cm (Fig. 3.44). The furnace fill is reddish brown sandy soil with inclusions of slags with 2-10cm sizes, furnace bricks made of red clay with 2-10cm sizes, and limestone.

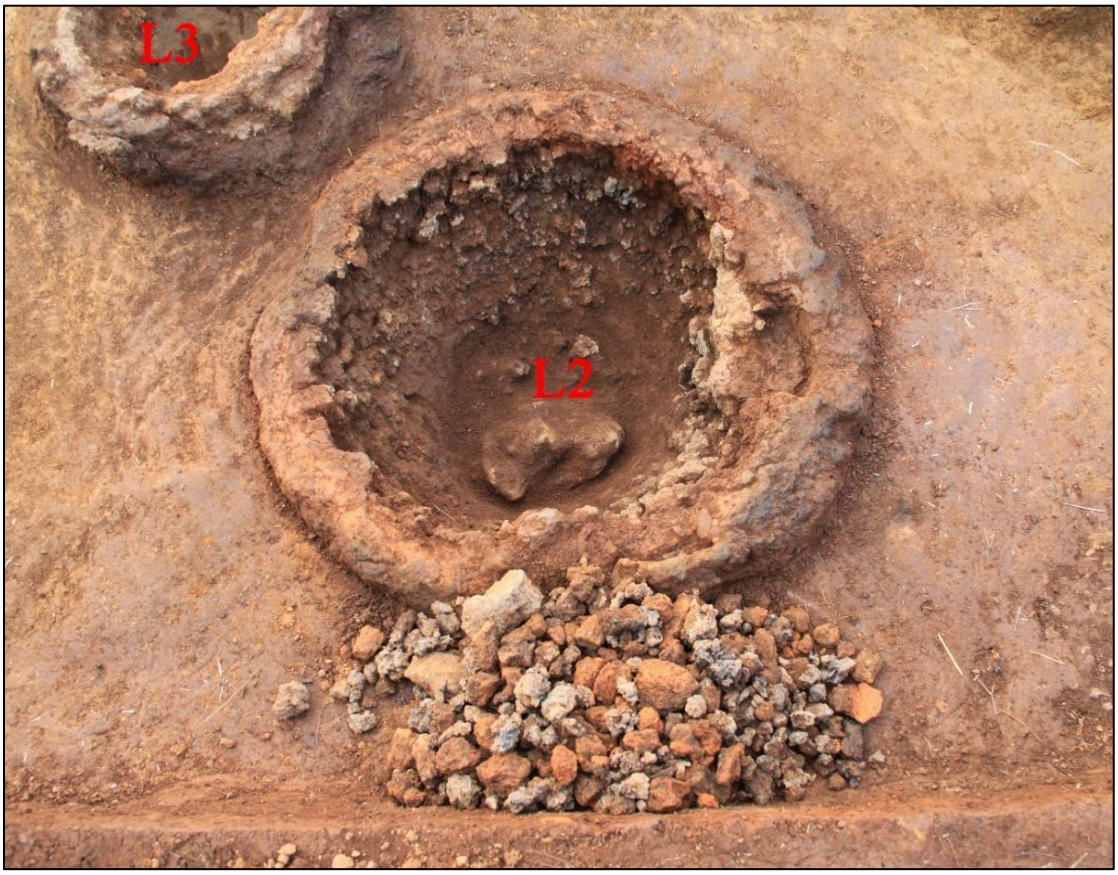


Fig. 3.44 Photo of furnace L2 at Xuxiebian, showing plan view and furnace fill (east to west, source: author)

3) **11PSXL3**, was located in the southwest of 11PSXTG2, between furnace L2 and L4, and was sealed by layer ③. The overall structure of L3 is the same as L1 and L2, with a smaller remaining diameter of 59-61cm and 24cm in remaining depth (Fig. 3.45). No gap like L1 and L2 was discovered on furnace L3. The furnace fill is reddish brown sandy soil with inclusions of slags with 3-5cm sizes, broken furnace bricks made of red clay with 2-10cm sizes, and small limestones. Most of the limestones are small with a size of 5cm, but one is cylindrical shape with adhering slags with a length of 20cm and diameter of 10cm.

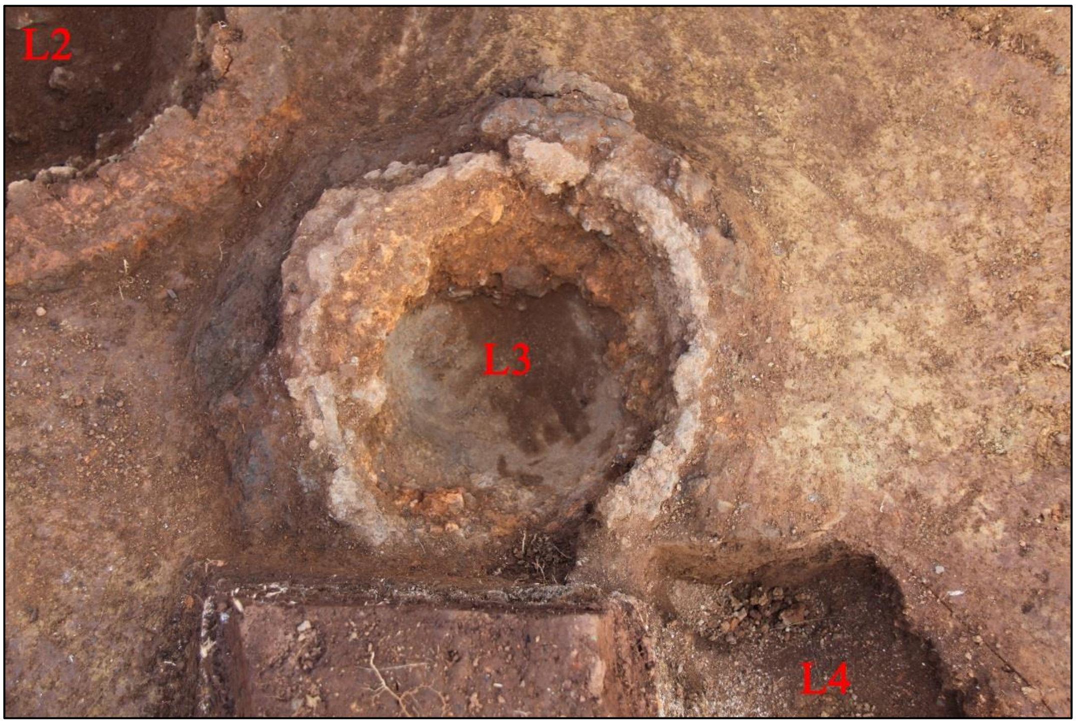


Fig. 3.45 Photo of furnace L3 at Xuxiebian (west to east, source: author)

4) **11PSXL4**, was located in the southwest of 11PSXTG2, and sealed by layer ③. The overall structure of L4 is the same as the other three, with a diameter of 90cm. The remaining depth is 28cm (Fig. 3.46). The furnace fill is reddish brown sandy soil with inclusions of slags with 3-8cm sizes, and broken furnace bricks made of red clay with 3-10cm sizes.

Fig. 3.46 Photo of furnace L4 at Xuxiebian (west to east, source: author)

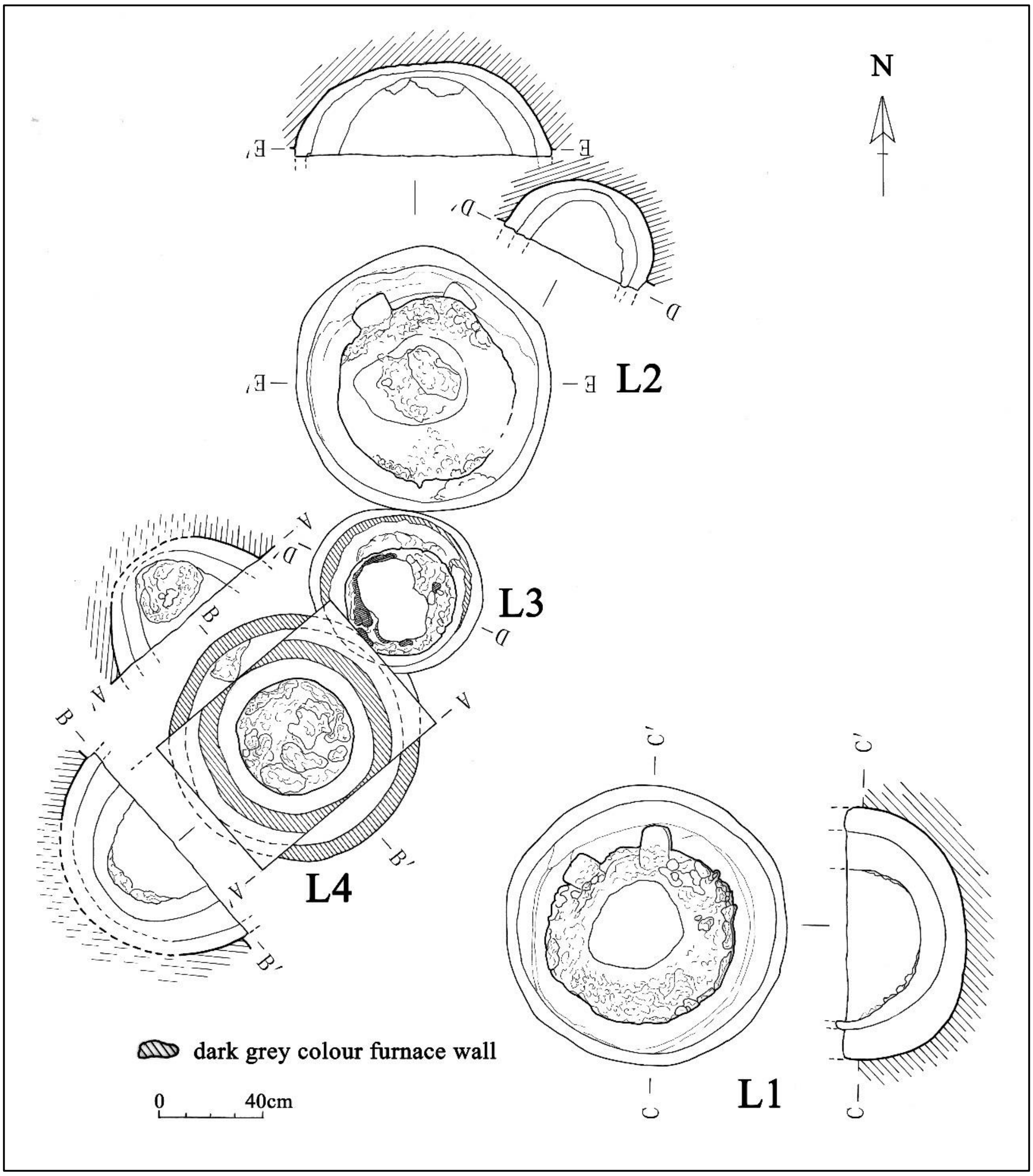


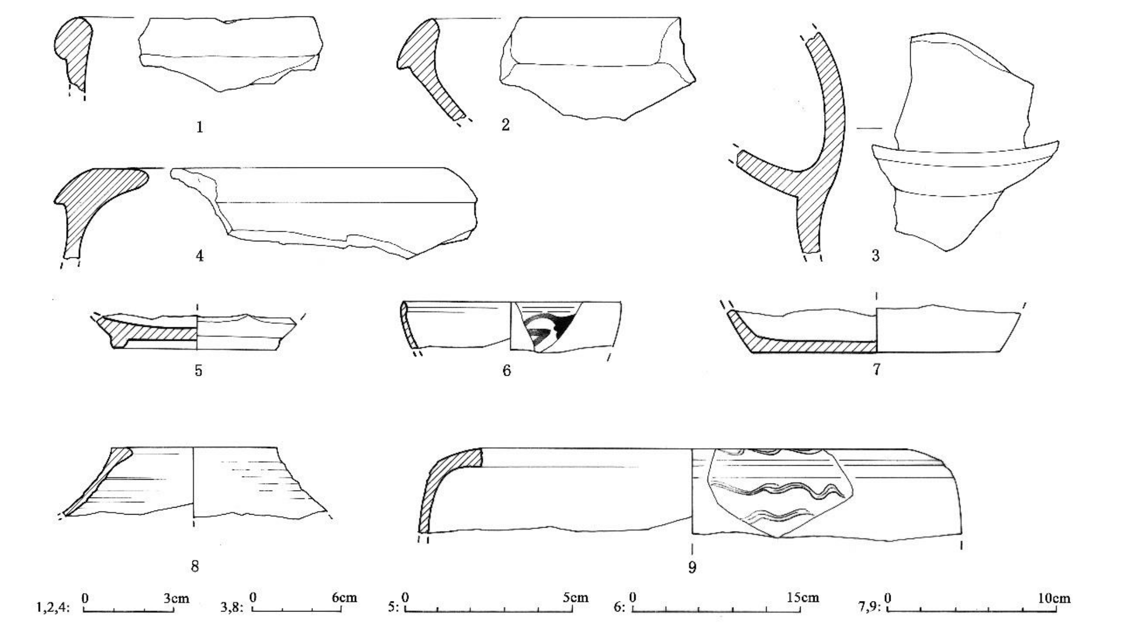
Fig. 3.47 Plan and section drawings of furnace L1-L4 at Xuxiebian (drawing by: Ma Chunyan)

Finds

A small amount of pottery and porcelain sherds, and a large amount of refractory material, slag, iron ore, and flux were excavated.

Pottery and porcelain:

Some object types can be identified from the pottery and porcelain sherds excavated. The types include urn, vat, jar, bowl, jug, basin and vase, which are commonly used domestic object types. The drawings are shown in Fig. 3.48 and the detailed descriptions are listed in appendix C3.



Pottery: 1. vat (11T2②:3) 2. basin (11T3②:1) 7. object bottom (11TG1④:1)
Porcelain: 3. jar (11TG④:1) 4. object ear (11TG1③:1) 5. object bottom (07TG1②:4)
6. bowl (07TG1②:2) 8,9. basin (11TG1⑤:3, 07TG2③:1)

Fig. 3.48 Potteries and porcelains excavated from Xuxiebian (drawing by: Ma Chunyan)

Tuyeres:

Three broken tuyeres were excavated from Xuxiebian in 2011 and one was collected from the ground surface in 2007. The tuyeres excavated in 2011 are all made of ceramic, and the one collected in 2007 is lithic. **11PSXTG1③:5**, **11PSXTG1⑤:8**, and **11PSXTG1④:10** are ceramic tuyeres with a reddish brown colour. The remaining length of **11PSXTG1③:5** is 22cm, 17.8cm wide, and 3.2-6cm thick (Fig. 3.49:3). **11PSXTG1④:10** has a remaining length of 22cm, width 19.2cm, and thickness of 8-10cm. **07PSXC:9** is made from greyish white sandstone. The tuyere is 17cm long, 11.5cm wide, and 9cm thick. It is logged as has a flared mouth and is rectangular in plan, but from its photo it looks like the other circular tuyeres excavated in 2011. There is some black vitrified slag adhering to one of the ends, which is possibly the side that attached into the furnace (Fig. 3.49:1).

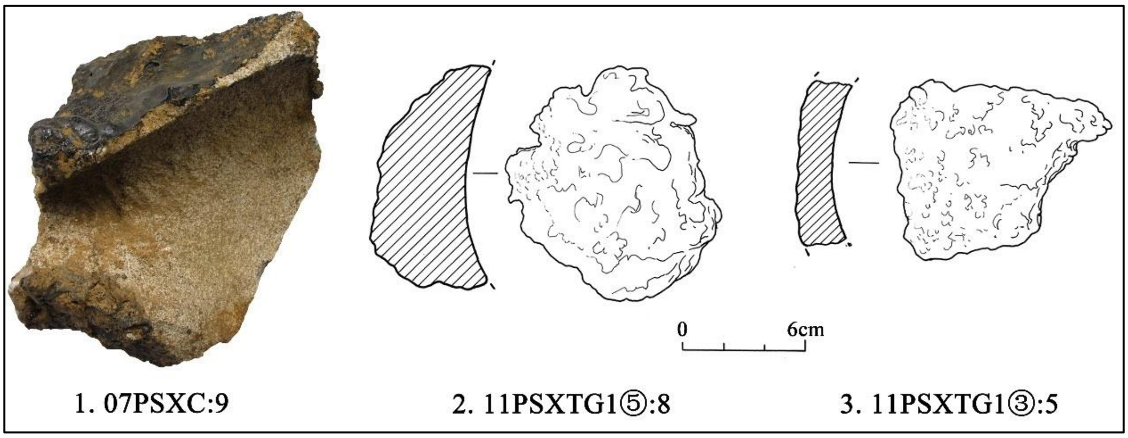


Fig. 3.49 Photo and drawing of tuyeres excavated from Xuxiebian (photo by: author; drawing by: Zhao Wenyu)

Refractory material:

A total number of 69 furnace bricks and 2 furnace linings were collected and recorded from the Xuxiebian site (appendix C2). The furnace bricks excavated from Xuxiebian are made of three types, clay (48%), sandstone (27%), and limestone (25%).

There are 32 excavated clay bricks. Generally, the clay type is made of clays with inclusions of small stones and organic fibres. They are neatly done with a regular rectangular shape. The colours usually varies from red, orange, grey and dark grey depending on which part of furnace they were from. One of the clay bricks is nearly intact (**T1H2:6**) which is clay-made with inclusions of small stones and organic fibres. It has a fine fabric, high density, grey colour, with dimensions of 18x11x4.5cm (Fig. 3.50:1). 79% of the excavated clay bricks (that with intact thickness) have thicknesses between 3.5-4.5cm, and the others are between 8-13cm.

There are 19 sandstone bricks (7 are fragmented) excavated from the site. The bricks have two types, first type is covered with a thin layer of slightly vitrified slag of its surface, and the original thickness was predicted around 10cm (Fig. 3.51:1,2). Seven pieces of the second type discovered in total, has a high density with a U-shaped section. For example, **T2H1③:FB2**, has a burned red colour, high density, U-shaped section, and some tool marks on the flat surface. There is a triangular slag adhering to the curved surface, black colour and non-magnetic. The colours in the section are in different layers as red, dark red, greyish white, and yellow. The shape of the brick is likely made on purpose. It is possibly used to block the tapping hole, and the adhering slag side is close to inner side of the furnace (Fig. 3.51:4). **TG1:FB1**, similar to T2H1③:FB2, yellow colour, U-shaped section, one half of the brick is covered with a very thin layer of black and highly vitrified slag (glassy), and the other side is clean (Fig. 3.51:5).

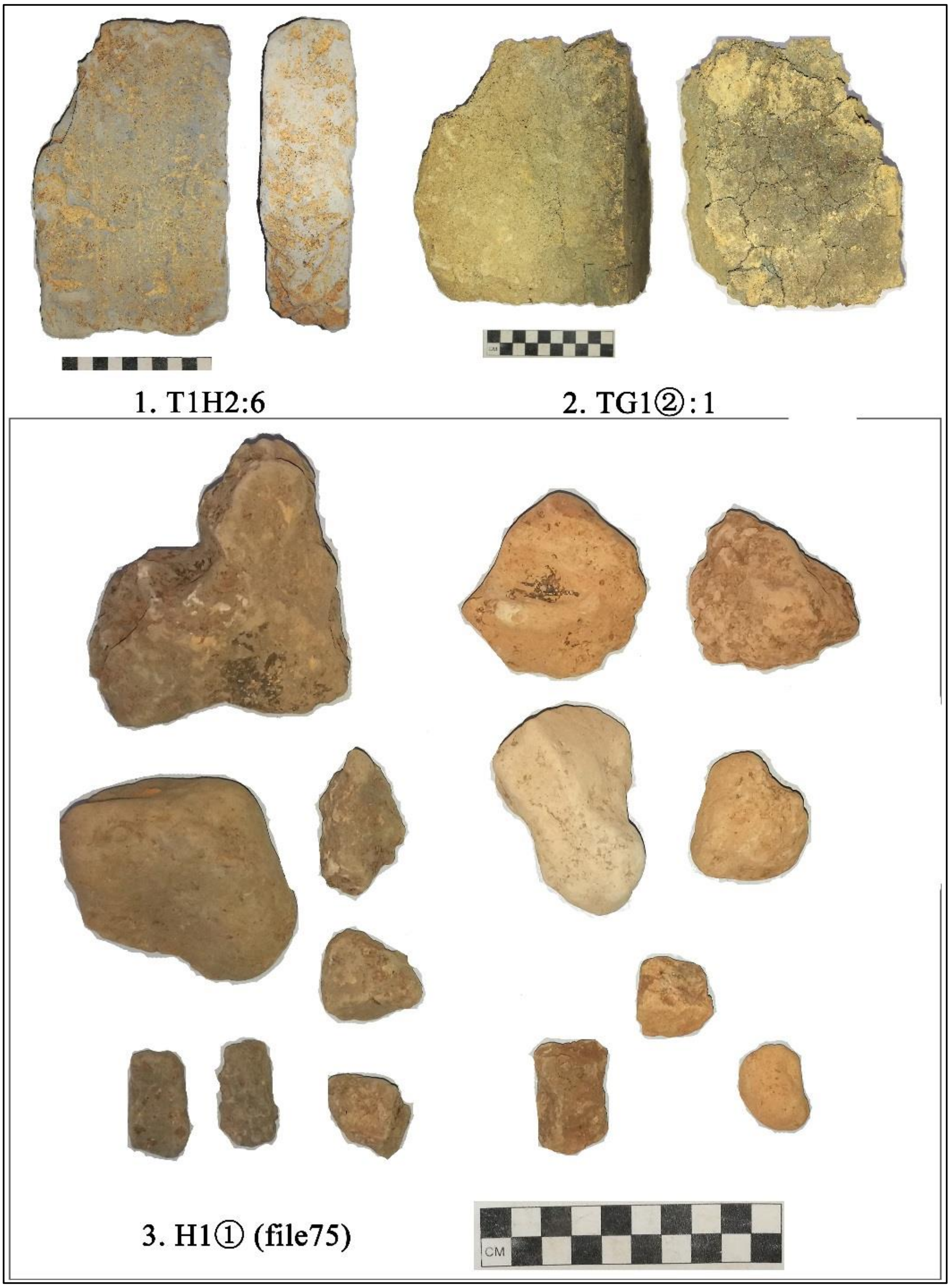


Fig. 3.50 Photo of clay bricks from Xuxiebian (source: author)

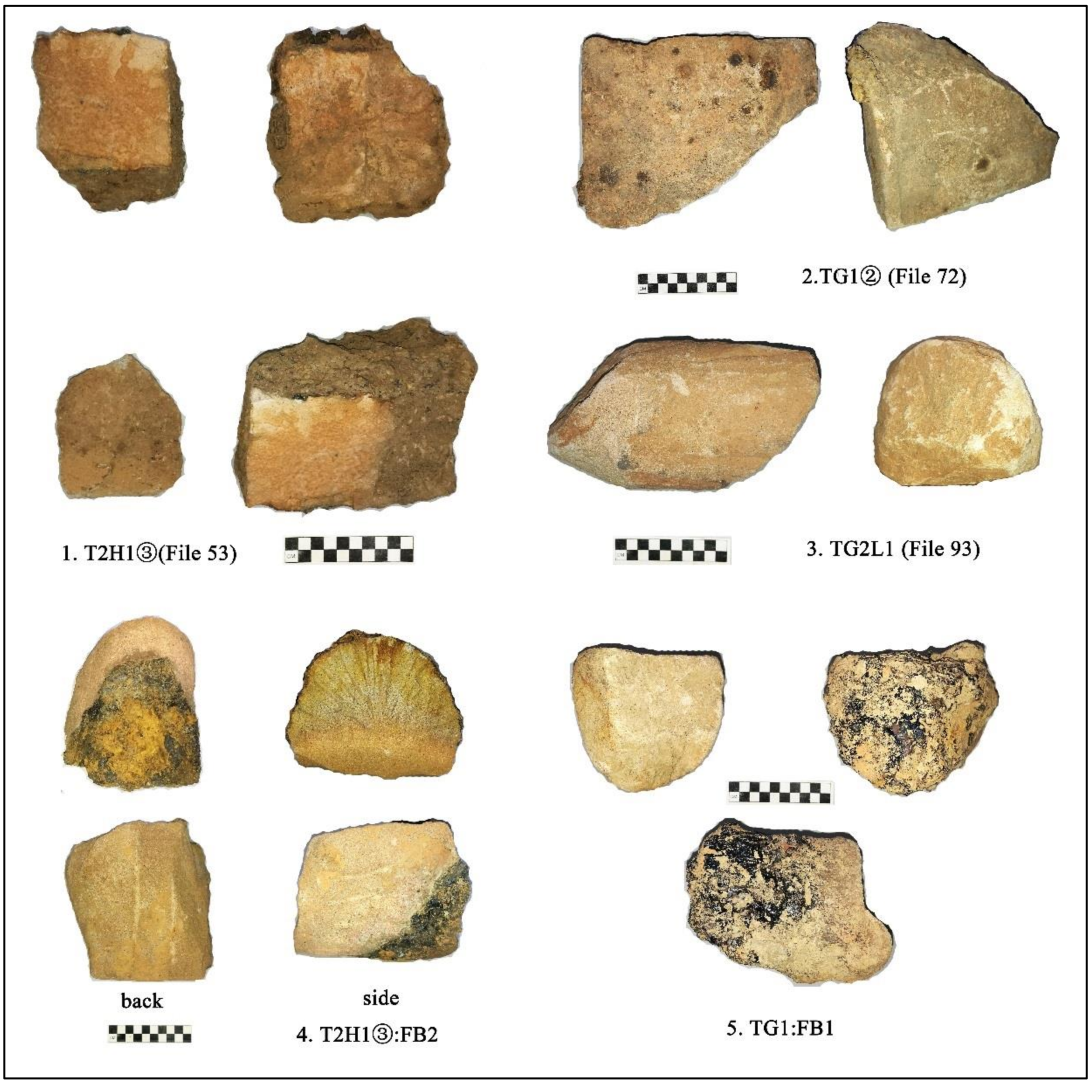


Fig. 3.51 Photo of sandstone bricks from Xuxiebian (source: author)

The limestone bricks discovered are usually thicker, covered with a thin layer of slag, and badly eroded by the slag layer (Fig. 3.52). For example, **T2H1③:FB1**, is all covered with a thin layer of slag except the section, the slag is black and coarse with inclusions of charcoal and small stones, and the thickest part of the slag erosion was about 1cm. The remaining dimensions are 17x16x9.5cm, and white colour in the section (Fig. 3.52:1). **TG1②:FB7**, is all covered with a slag layer, the remaining dimensions are 25x18x10.5cm (with slag) and 19.5x14.5x9cm (without slag). The surface of the brick is eroded by the slag layer about 2mm, one of the sides is eroded badly, and the brick is broken into two pieces from the middle. The colour inside is greyish white (Fig. 3.52:3). On the other hand, there are some small limestone bars (6-10cm long and 2-3cm wide) discovered, which might be the broken pieces from the brick, or it might be applied as a flux in the smelting (Fig. 3.54).

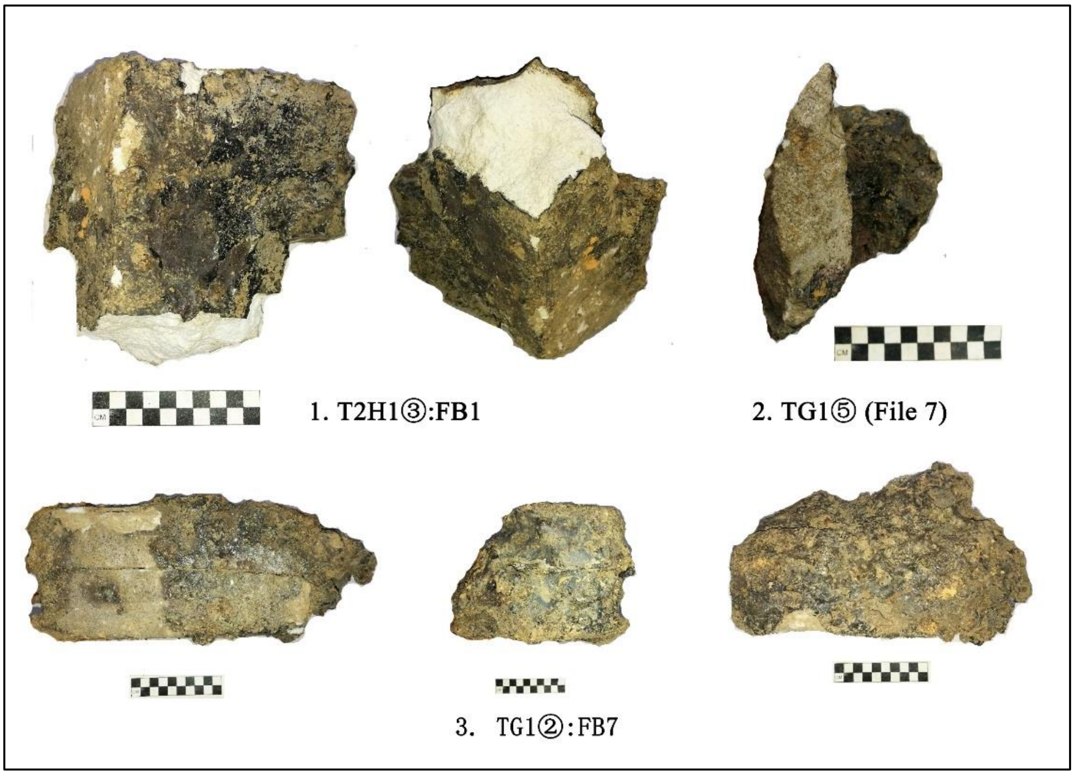


Fig. 3.52 Photo of limestone bricks excavated from Xuxiebian in 2011 (source: author)

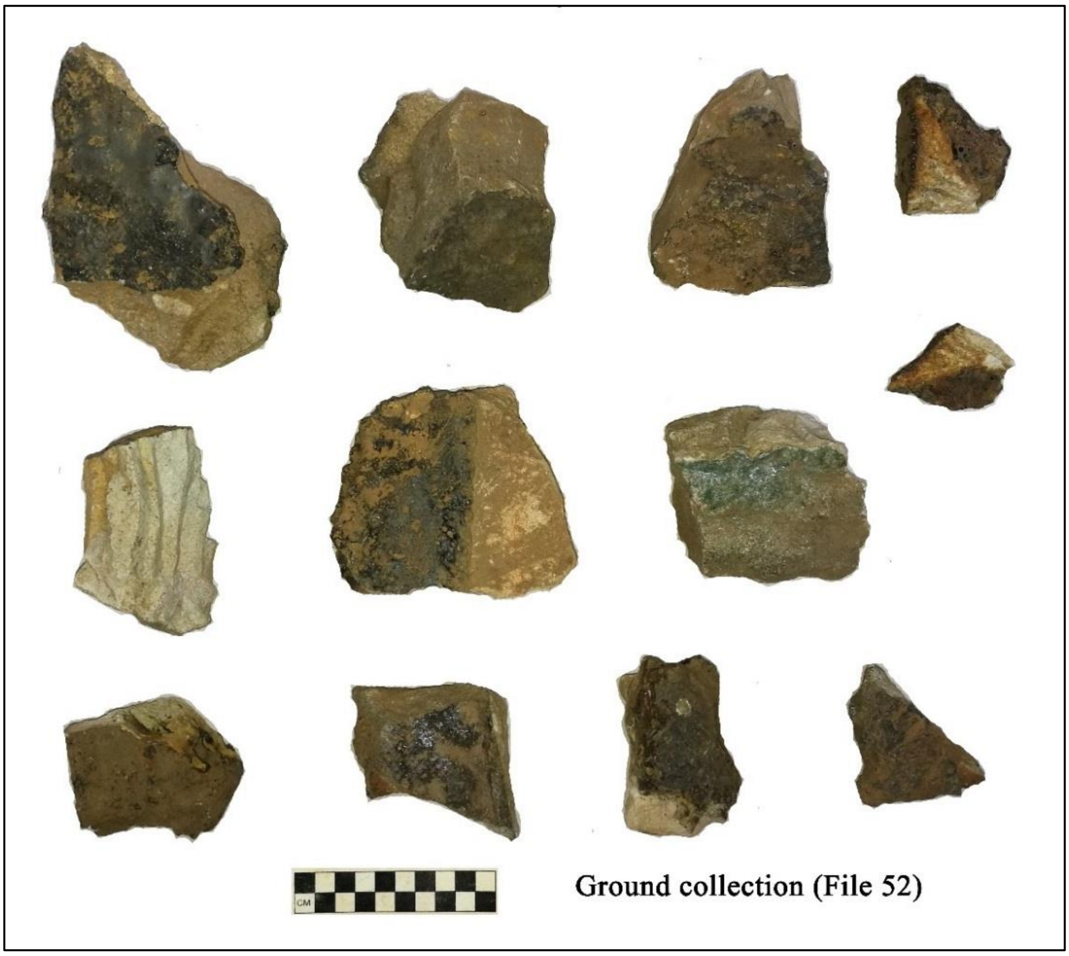


Fig. 3.53 Photo of limestone bricks, collected on ground surface in 2007 (source: author)

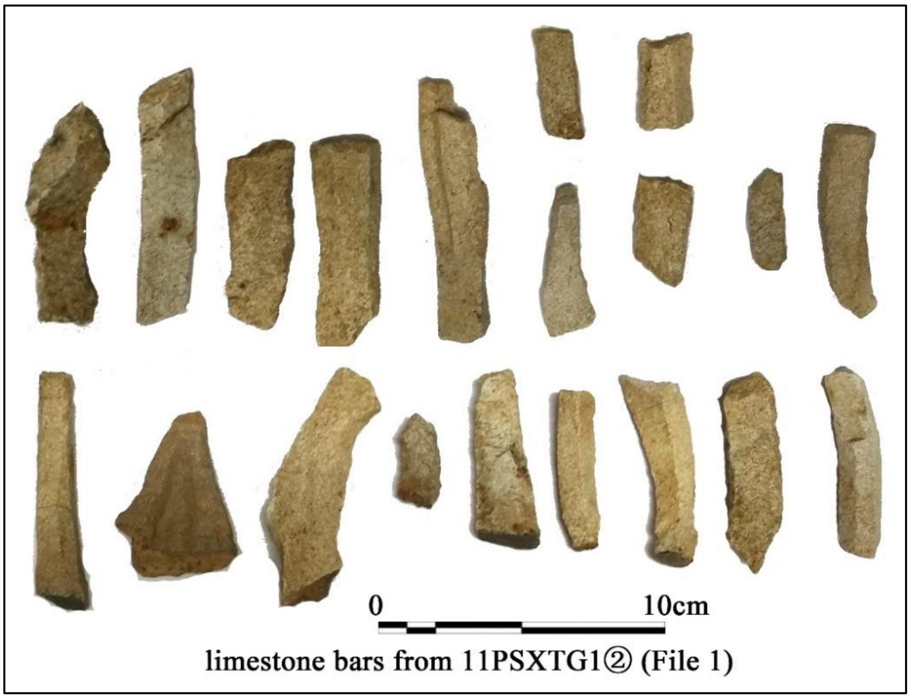


Fig. 3.54 Photo of limestone bars at Xuxiebian (source: author)

On the other hand, there are two furnace linings excavated from the site. **T2H1③:FL1** is a burned clay with inclusions of small amount of charcoal debris. It has a very tight structure, and dark red colour of the section. It is possibly particular made refractory furnace lining of the furnace (Fig. 3.55). **T2H1③:FL2** is a burned clay, high density, yellow colour with red in some areas, very tight structure, some tamping marks. It is possibly part of the strengthened ground before building the furnace (Fig. 3.55:1).

Fig. 3.55 Photo of furnace lining excavated from Xuxiebian (source: author)

Ore:

There are 19 iron ore samples collected from the Xuxiebian site, the details are listed in appendix C2. Most of the collected iron ore samples have a grey and some metallic colours with a melted surface and an average size of 4.2cm (Fig. 3.56). Samples excavated from 11PGSTG2②, are grey and some metallic in colour with a half-melted surface, moderate porosity proportion with sizes 1-2mm, and are strongly magnetic (Fig. 3.56:1). There are two samples from the same context which had a fired red colour on the surface but contain lots of impurities and are non-magnetic (Fig. 3.56 bottom left).

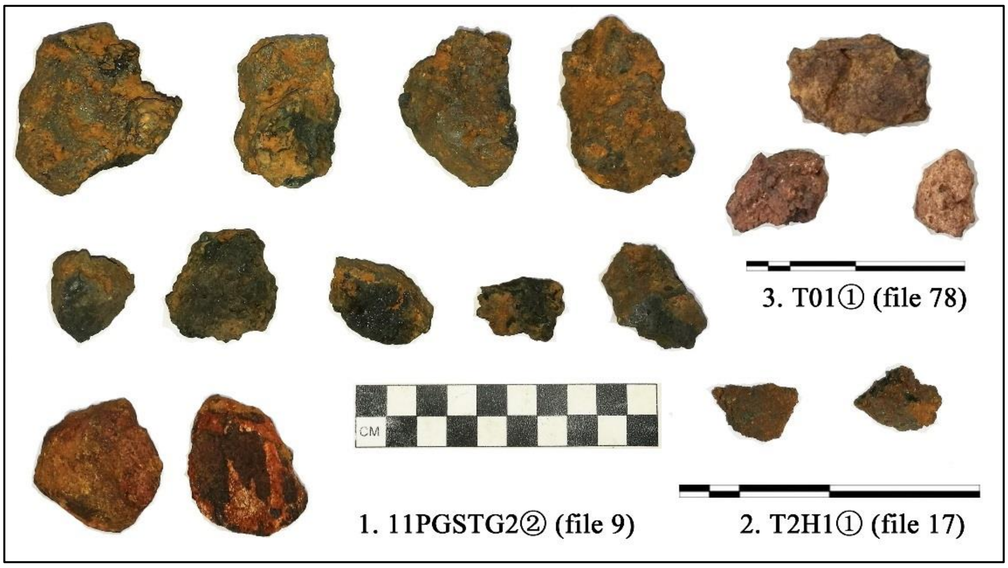


Fig. 3.56 Photo of iron ores collected from Xuxiebian (source: author)

Slag:

A total of 123 slags were collected and analyzed from the Xuxiebian site. A detailed description of the collected slags is provided in appendix C1. There are three different types of slag discovered at Xuxiebian. The first type (I) is tap slag (about 55%), generally grey colour, low to moderate density (It has 20-40% porosity and pores are 2-10mm and spherical), smooth or rough surface texture, moderate viscosity, low or non-magnetic, and an average dimension of 8.2x6.0x4.1cm (Fig. 3.57).

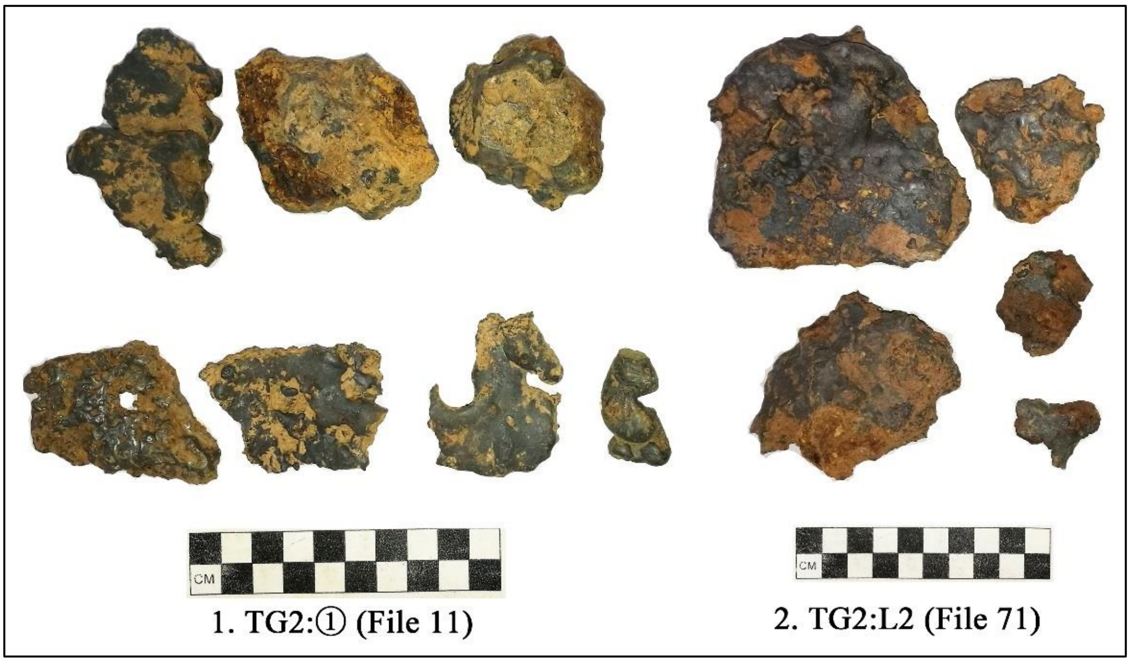


Fig. 3.57 Photo of type I slag from Xuxiebian (source: author)

The second type (II) differs from the first type by their black colour, lower density, usually moderate or partially magnetic, and large amount of charcoal impressions on their surface. This type is about 38% of the total collected samples, and has a close average dimensions to the tap slags which is 8.4x6.1x4.2cm (Fig. 3.58).

The third type (III) is only about 7% of the total collected samples. Their sizes are slightly larger than the other two types, which has a length of 10-12cm, width of 7.5-11cm, and thickness of 3-8cm. This type has a much higher density than the other two, very low proportion of porosity, shiny and smooth section, and usually are strongly magnetic (Fig. 3.59). One of them was cut and subjected to a metallographic analysis (SK0037, Fig. 3.59:2).

Sample SK0037 is cut from the edge of a type III slag excavated from furnace L2 at the Xuxiebian site (Fig. 3.60). The section is shiny and smooth, and highly magnetic.

The slag sample was prepared as the same as the iron object samples. The sample was etched with 2% nital but there were no significant changes before and after etching.

At low magnification, there are large number of slightly circular white structure, which should be magnetite consider that the slag is highly magnetic. The dark grey structure is glassy phase and the light grey structure is possible fayalite. There is a crack and many circular holes in different sizes throughout the section.

From its metallographic structure, this type of slags is very possible to be hearth slags from either refining or smithing (Crew 1996). According to the contexts where type III slags were usually found (inside furnace L1, L2, and L3) and the possible pre-smithing area located about 5m away from the furnace, the slag is more likely to be refining slags.

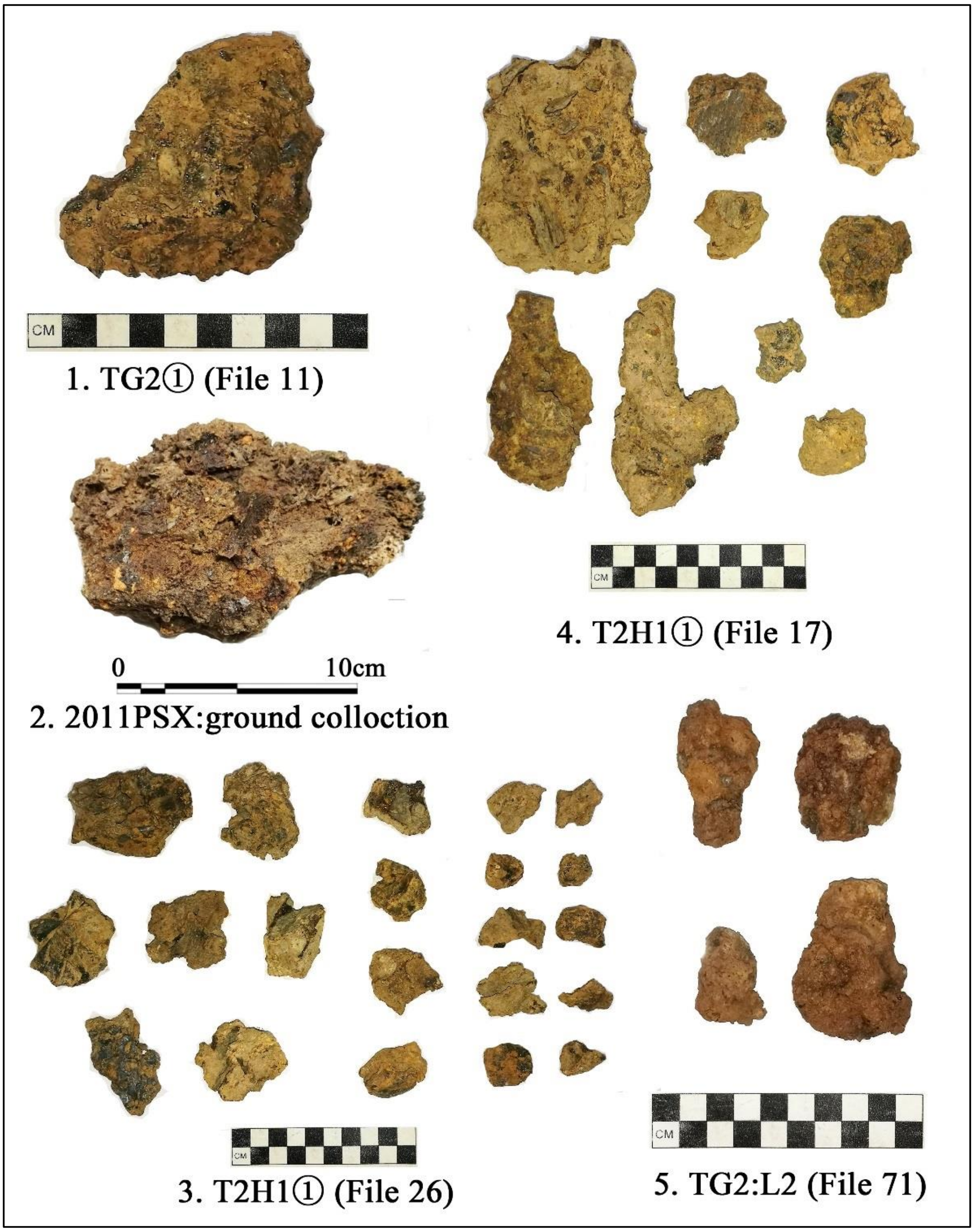


Fig. 3.58 Photo of type II slag from Xuxiebian (source: author)

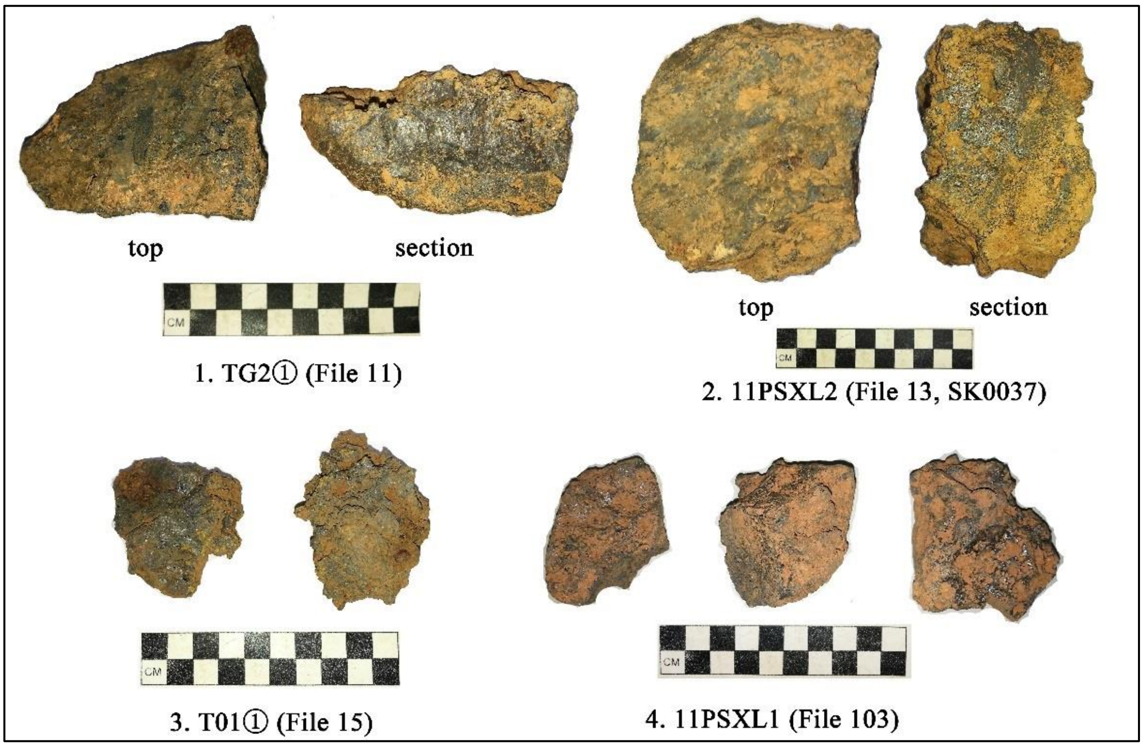


Fig. 3.59 Photo of type III slag from Xuxiebian (source: author)

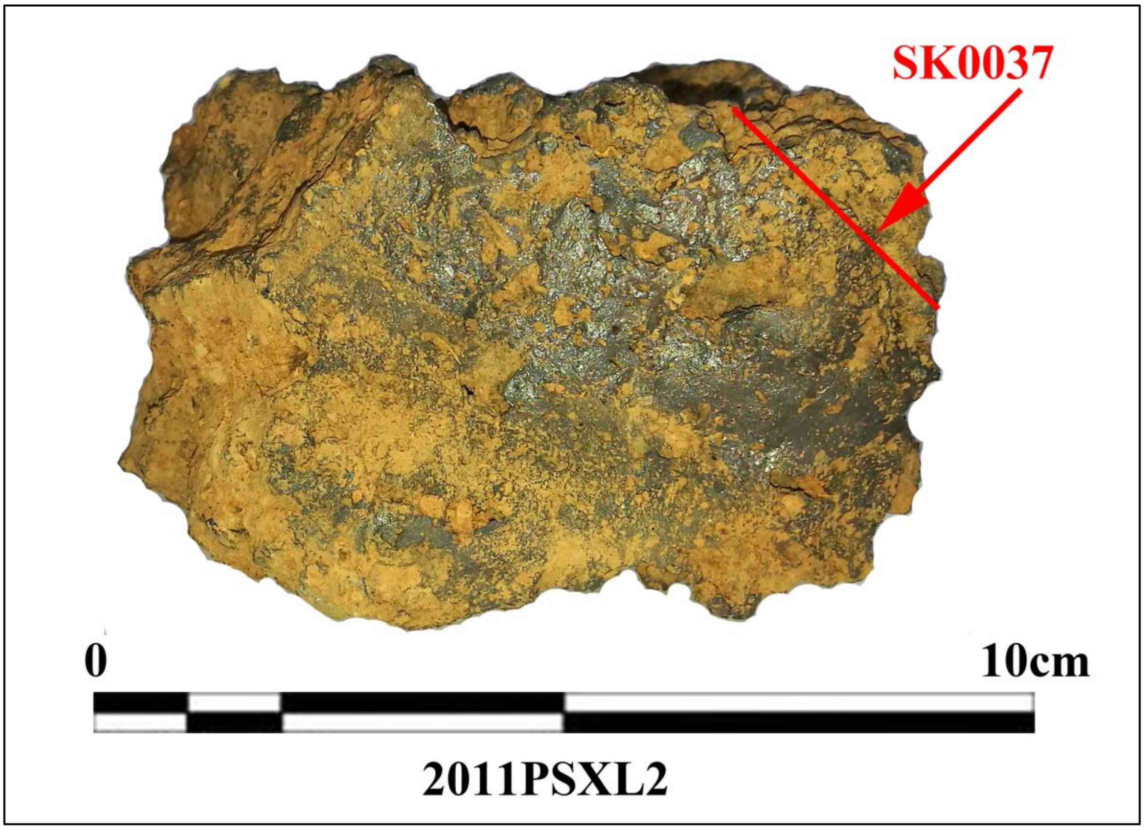


Fig. 3.60 Photo of slag sample excavated from furnace L2 at Xuxiebian showing the sampling spot of SK0037 (source: author)

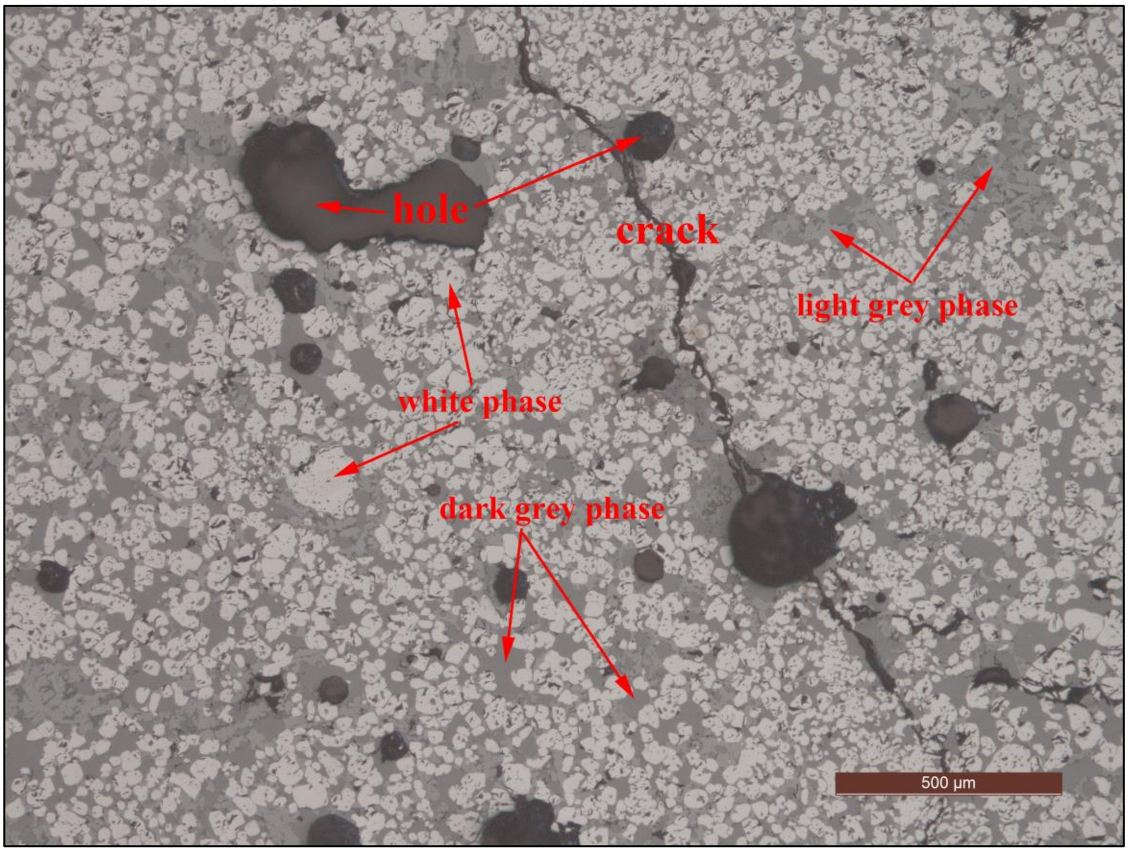


Fig. 3.61 Section from SK0037. Etch 2% nital, scale bar 500μm (source: author)

Radiocarbon dating

There is only one charcoal sample collected from Xuxiebian and was send to the Peking University for radiocarbon dating analysis. The calibrated result is shown in Table 3.5. The result is calibrated using OxCal v3.10 (Bronk Ramsey 2005) and IntCal04 (Reimer *et al* 2004). The half-life of carbon 14 used at the Peking University is 5568 years and the BP is referring to a reference date of 1950.

Table 3.5 Calibrated C14 result of sample collected from Xuxiebian by Peking University, China (source: CJAT, unpublished)

Lab No.	Name	Sample type	Context	C14 (BP)	Calibrated	
					(68.2%)	(95.4%)
BA132113	PXXB1	charcoal	2011PSXT2 H1	300±20	1520AD(50.8%) 1580AD 1630AD(17.4%) 1650AD	1510AD(69.1%) 1600AD 1610AD(26.3%) 1650AD

Discussion

First of all, the furnaces. Type III slags excavated from furnaces L1, L2 and L3 provide direct evidence that the four furnaces discovered at Xuxiebian are refining furnaces. To build the furnace, first step is to dig a bowl-shaped pit on the ground, tamped hard; then use refractory, usually a mixture of clay, river sand and straw (or other organic fibres) to strengthen the interior surface. Then build a circular or rectangular shaped furnace wall above the ground with clay or stone bricks; set up the bellow on one side and connect the tuyeres to the centre of the furnace; finally cover more than half of the furnace top with clay or stone plate. There are two gaps (10-15cm) on both of the northern furnace walls of furnace L1 and L2. In addition, there are two furnace bricks with a U-shaped section excavated from furnace L1 (TG2L1, file 93), these are possibly the evidence of where the smelters set up the bellows. Therefore, the refining furnaces excavated at Xuxiebian were possibly operated from the south and bellows on the north side. However, there is another possibility of these special shaped bricks which is to block the tapping hole of the blast furnace.

The structure of these refining furnaces at Xuxiebian is similar to a modern type refining furnace which was popular for a long time in Shanxi province (Yang K. 1982, fig. 10).

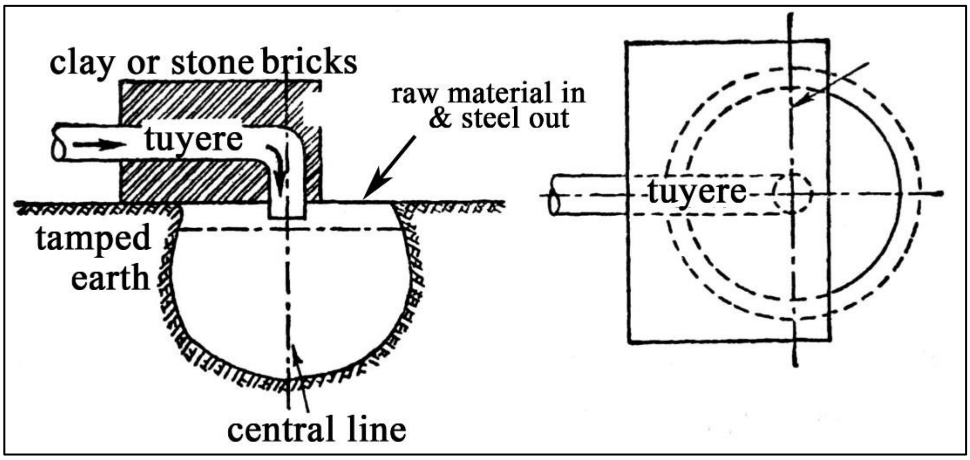


Fig. 3.62 Diagram of a modern type refining furnace popular in Shanxi province (source: Yang Kuan 1982, 238)

However, this modern type has a contracted furnace mouth (C-shaped rather than U-shaped in section), while all of the Xuxiebian type have a half circular shape. This is possibly an advance structure by leading the hot wind from the furnace go upwards rather than directly against the smelters. Otherwise it is necessary to build another wall against the furnace mouth (no evidence was found near the furnaces at Xuxiebian) or they must stop bellowing when the materials in the furnace need to be stirred, which would lower the operating efficiency.

On the other hand, there is one refining furnace of the mid-late Western Han dynasty (c.150BC-50AD) excavated from Tieshenggou, Gongxian, Henan province. The furnace L17 is elliptic in plan, top part destroyed, and with a remaining diameter of 28-37cm and remaining height of 15cm (Fig. 3.63). The Tieshenggou iron smelting site was excavated in 1958, the excavator predicted that the refining furnace was possibly like the low temperature top bellowing refining furnaces widely applied in Henan and Shanxi provinces in the 1950s. The excavator also believed that the furnace should have a contracted mouth (C-shaped) originally, although the furnace was badly damaged and it was not very clear in the low-resolution diagram. However, if it is true, then the furnace structure of the Central Plains is somewhat more advanced than what we have found at Xuxiebian. There are some other examples of this type of the Han dynasty, one found at Wafangzhuang (Li J. 1991, 82, fig. 63), and six found at Zhaohecun, both from Henan province (Zhao Q. and Zhao 1962, 11). But unfortunately, none of them could provide more information of the top part of the structure.

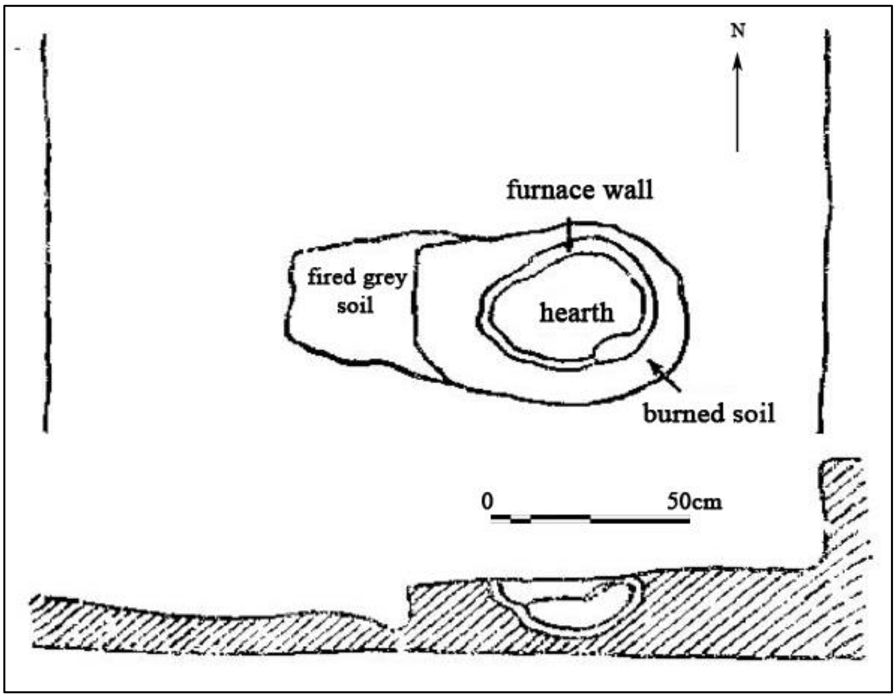


Fig. 3.63 Diagram of refining furnace L17 excavated from Tieshenggou, Henan province (source: Zhao 1962, 13, fig. 10)

Secondly, the pits, according to the discoveries from each of the four pits excavated in 2011, pits 11PSXH2 and H4 were possibly formed by discarding the wastes from the smelting, and pits H1 and H3 were likely the primary smithing area. The fined iron from the refining furnace would need to be hammered immediately while hot to consolidate the metal and expel the trapped slags. The primary smithing was often carried out at the smelting site and nearby the refining furnace. A reconstruction of the fining process based on the excavation of the iron smelting site of Han dynasty at Wafangzhuang, Henan province was made by Li Jinghua (Fig. 3.64).

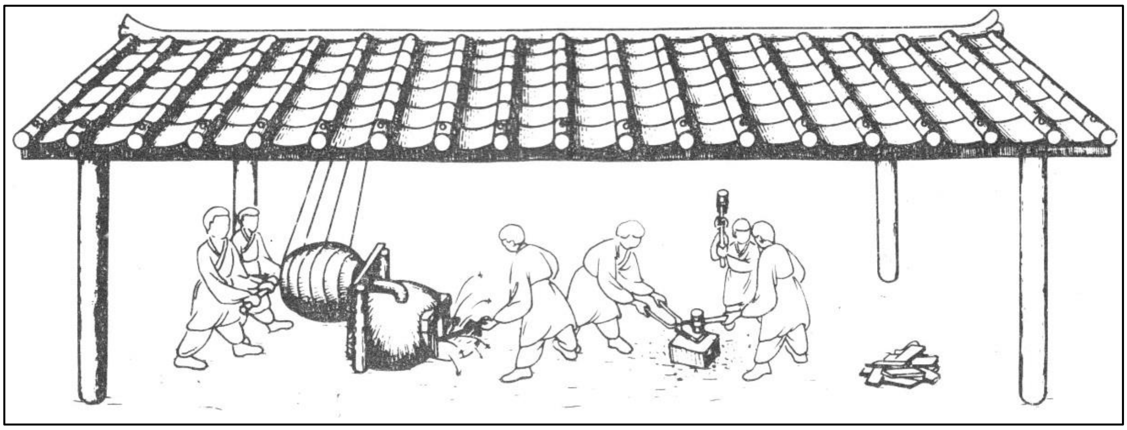


Fig. 3.64 A reconstruction of the fining process of Han dynasty (source: Li Jinghua 1991, 82)

The surface of pit 11PSXH1 is black coloured with large amount of slags and charcoal debris. There is a small rectangular area about 30x80cm at the middle of the pit, which according to Li's reconstruction might be where the anvil was set up. On the other hand, in Europe, the repeated heating that was required in the primary smithing process could take place in a separate hearth, sometimes known as the chafery, which was introduced to speed the fining process up as early as the 15th century (Awty 2007, 784). The rectangular shaped foundation east of pit 11PSXH1 was probably one of this separate hearth, which collapsed east when abandoned (Fig. 3.65). The post hole (11PSXD1) indicates that this fining process area was possibly sheltered.

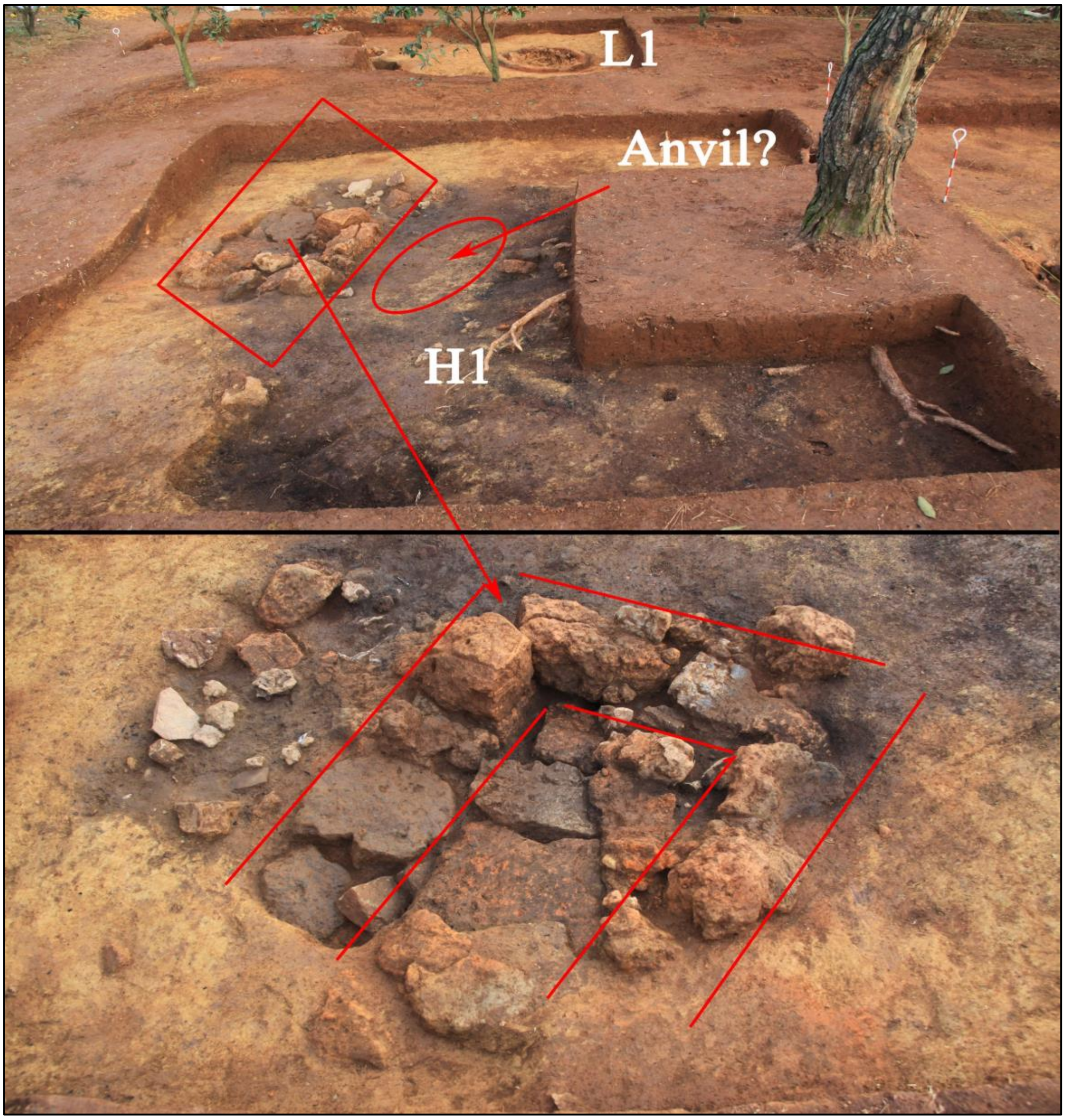


Fig. 3.65 Photo of 11PSXH1 at Xuxiebian, showing another possible furnace and the primary smithing area (source: author)

Thirdly, although no blast furnace or blast furnace foundation was discovered at Xuxiebian, according to the amount of furnace bricks excavated from the site and the volume of the smelting waste deposits discovered at 11PSXTG1, we believe that, there were likely more than one blast furnaces operated at the same time at Xuxiebian in the ancient time. The furnaces were possibly located on the south of the site (Fig. 3.66).

Finally, the dating. The pottery and porcelain sherds excavated from the site could provide some reference in dating the site. According to the local pottery assemblage, the pottery sherds excavated from layer ④ of 11PSXTG2 could be dated to the Eastern Han dynasty (25-220AD), and the porcelain sherds excavated from layer ③ of 11PSXTG2 belong to the Tang dynasty (618-907 AD) but not the Northern and Southern dynasties (420-589AD). The excavator of 2007 dated the site to 220-420AD (Zhou Z. *et al* 2008, 25). All of the four refining furnaces were covered by layer ③, which I think there is no problem for the lower boundary, but the excavator was probably being too cautious to date the upper limit to 220AD. The fining processes were known at latest as the 1st century BC in the mid-late Western Han dynasty (Yang K. 1982, 311), the Xuxiebian site was probably later the Western Han dynasty but was reasonably activate since the mid-late Eastern Han dynasty.

The only radio-carbon dating result gives a date between 1510-1650AD (calibrated, 2σ). There are two notes to be made on this result. Firstly, the charcoal sample was collected from 11PSXH1 that was a big and complicated primary smithing area, which the sample was possibly mistaken from the upper layer. Secondly, many excavators relied too much on the pottery assemblage dating, which they usually take the C14 result as a support of their pottery dating, and will simply dump the result when it shows otherwise. At least one sample from each of the layers and contexts would form a much more reliable C14 sequence of the site.

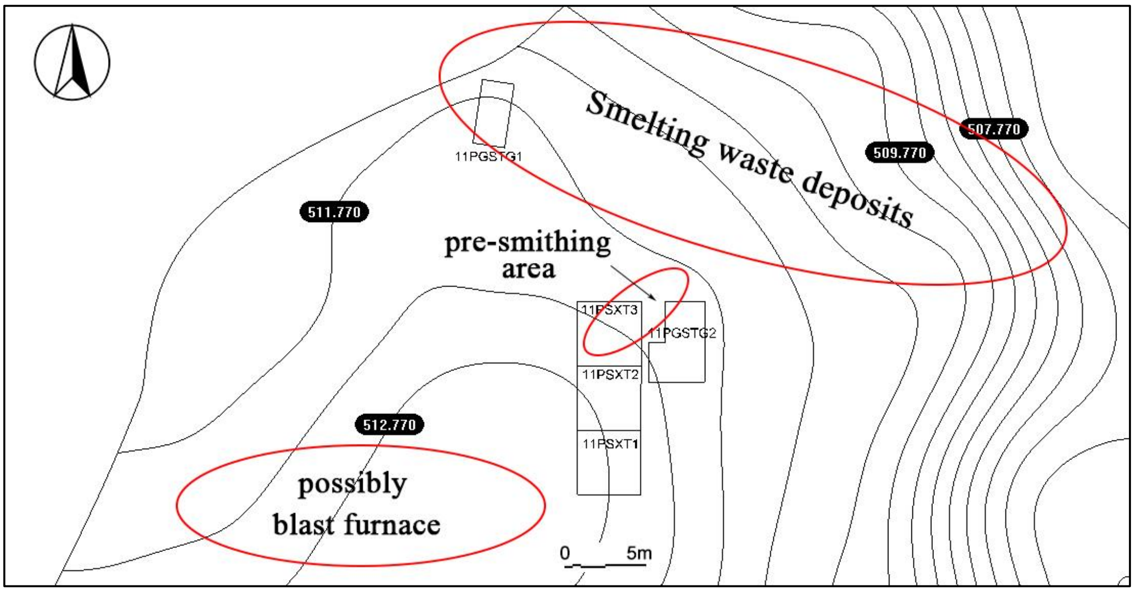


Fig. 3.66 The overall structure of Xuxiebian and a predicted location of the blast furnaces (source: author)

In general, we believe that Xuxiebian is an iron smelting and refining site operated no later than the late Eastern Han dynasty (c.150-200AD) and was abandoned at some point before 420AD. Again, there is no moulds of any kind discovered at Xuxiebian. The function of the Xuxiebian site is to produce pig iron and refine the pig iron to wrought iron. It may possibly reflect the management and policy of the central government on the iron industry of Southwest China during the Han dynasty. The iron ores used in the smelting at Xuxiebian were crushed into small pieces of 4-6cm and possibly being roasted before charging into the furnace. A flux of limestone bars was possibly applied in the smelting, and the slags and other wastes from the smelting were discarded together on the lower side of the site.

3.5.3 Tieniucun

Introduction

The Tieniucun site is located on the slope of a hill at the intersection of Group 3 and 7 of the Tieniu village, Xilai town, Pujiang county, Sichuan province (Fig. 3.67). The GPS coordinates are 30° 19′ 24″N, 103° 31′ 52″E, and the elevation is 524.0-531.5m. The site can be divided into three zones with a total area about 1,440m^2. There is a small canal passing by at the bottom of the hill. Slag, refractory material, charcoal, and burned soil are everywhere on the ground within the site area.

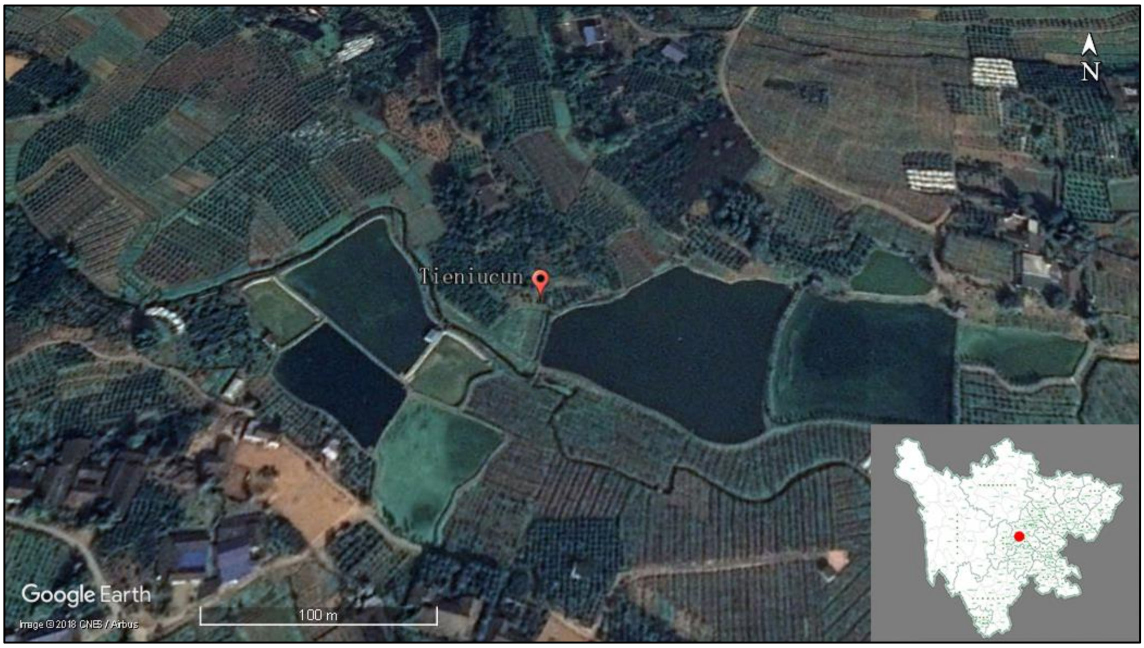


Fig. 3.67 Location of the Tieniucun site (source: Google Earth)

The local cultivation includes sapling, orange, and rape flower. The west of the site is collapsed in the reforming of the sloping field. Pottery sherds and refractory materials can be clearly observed in the section. To understand the date and the deposit of the site, a trial excavation was carried out in the May of 2007 (Zhou Z. *et al* 2008). In the Decembers of 2007 (Zhou Z. *et al* 2011b), 2009 and 2010, the CJAT excavated the site three times, during which a total area of 333.25m^2 was excavated. In the four excavations, 8 furnaces, 1 house foundation, 5 pits, 1 trench, and large amount of refractory material, slag, charcoal, iron ore, and pottery were discovered.

The discussion of the findings in this section is based on the onsite recordings by the CJAT 2007 and 2009 and the analysis of the collected samples by the author. However, both the recordings and the collected samples are inadequate and limited considering the total amount discovered at Tieniucun. Especially for furnace bricks and slags, of which only one or two examples of each type were collected and recorded. A more specific description and an explanation of the relation to the total discoveries is needed in the future fieldworks.

3D landscape model

The archaeological features are widely distributed in the area, and the Tieniucun site was excavated and recorded in three zones (Fig. 3.68).

A total of 336 coordinate data were collected using a total station survey. A 3D landscape model of 45,818.9m^2 of the Tieniucun site and the nearby area was created. A 0.3m contour map showing the distribution of the excavation zones and the location of the large ox head shaped ‘salamander’ or consolidated furnace base was produced (Fig. 3.69).

Fig. 3.68 View of the Tieniucun site (source: CJAT)

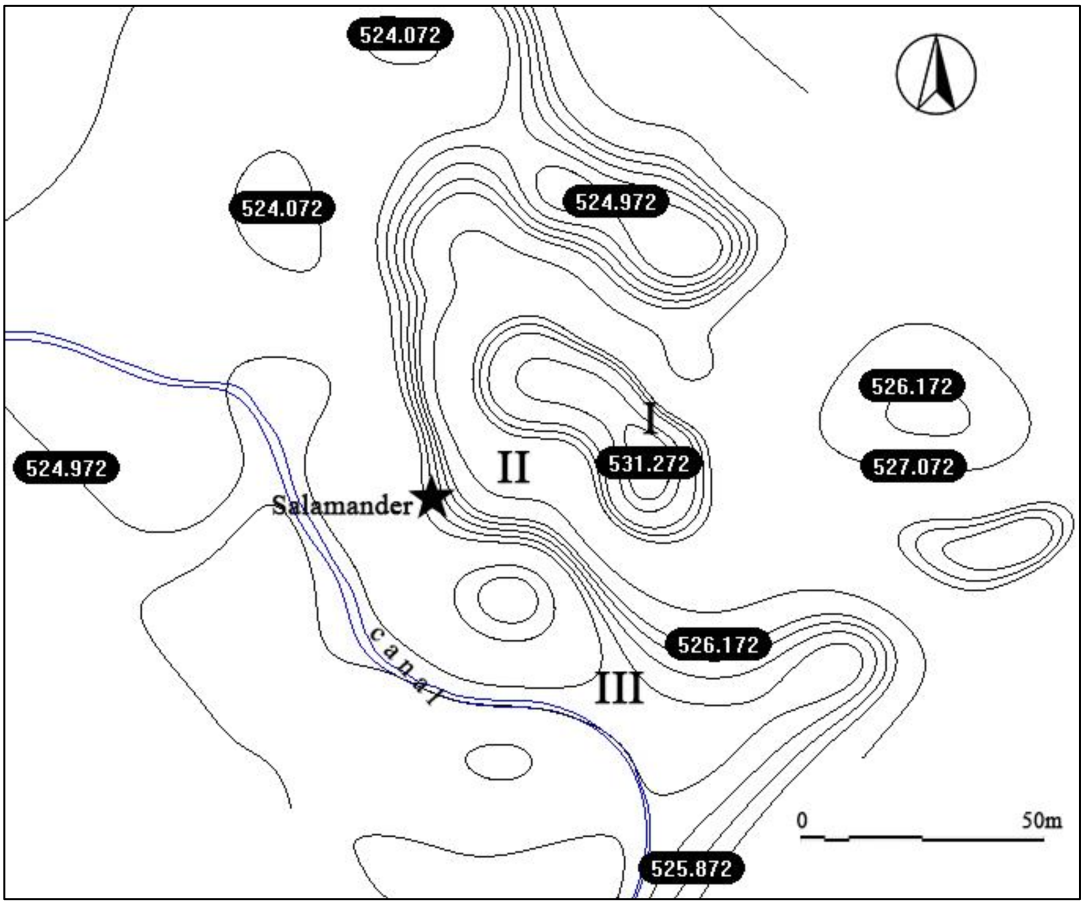


Fig. 3.69 Contour map of Tieniucun, showing the excavation zones and the location of the salamander (source: author)

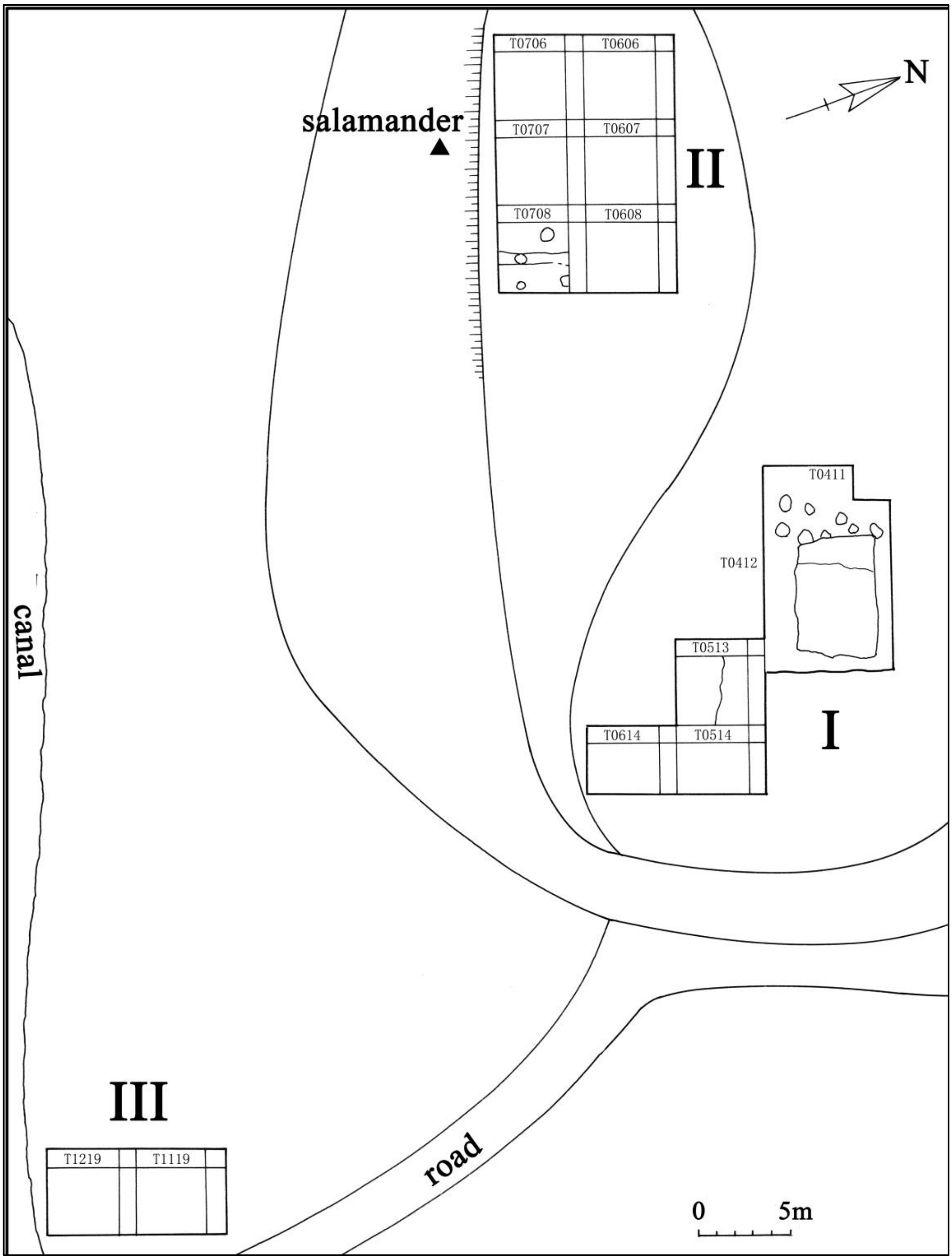


Fig. 3.70 Plan view of Tieniucun, showing the excavated trenches (source: author)

Zone I:

The excavated trenches of Zone I were situated on the top of the hill. Two 3x3m trenches were excavated (07PXTTG3, 07PXTTG4) in the trial excavation of May

2007. In the excavations of the December 2007, 2009 and 2010, five 5x5m trenches with an extended area of 1.5x5.5m were excavated (Fig. 3.70).

Stratigraphy and deposits

The stratigraphy and deposits of Zone I are demonstrated by using the north section of 07PXTT0614 as an example (Fig. 3.71). There are 8 layers excavated in total, below the eighth layer is the virgin soil. The details are as follow:

①: Modern agricultural layer, brown clay, loose structure, and 13-34cm thick. The ground vegetation is orange.

②: Modern layer, reddish brown clay, tight structure, 13-34cm to the ground surface, and 0-25cm thick. Not much inclusion.

③: Han dynasty layer (c.200BC-200AD), black and brown clay, tight structure, 20-62cm to the ground surface, and 0-33cm thick. The inclusions are slags, iron ores, furnace bricks, and pottery sherds of the Han dynasty.

④: Han dynasty layer, reddish yellow clay, tight structure, 23-25cm to the ground surface, and 0-40cm thick. This layer is distributed in the south part of the trench and is missing on the north section. The inclusions are refractory materials.

⑤: Han dynasty layer, large amount of charcoal and small amount of yellow clay, loose structure, 75-80cm to the ground surface, and 15-50cm thick. The inclusions are iron ores, furnace bricks, and slags.

⑥: Han dynasty layer, reddish brown clay including small amount of charcoal debris, tight structure, 90-120cm to the ground surface, and 0-40cm thick. The inclusions are furnace bricks, and slags.

⑦: Han dynasty layer, yellowish brown clay including small amount of charcoal debris, tight structure, 95-140cm to the ground surface, and 0-47cm thick. The inclusions are furnace bricks, and slags.

⑧: Pre-Han dynasty layer (before 200BC), reddish brown clay including little charcoal debris, tight structure, 110-150cm to the ground surface, and 0-20cm thick. Not much inclusion.

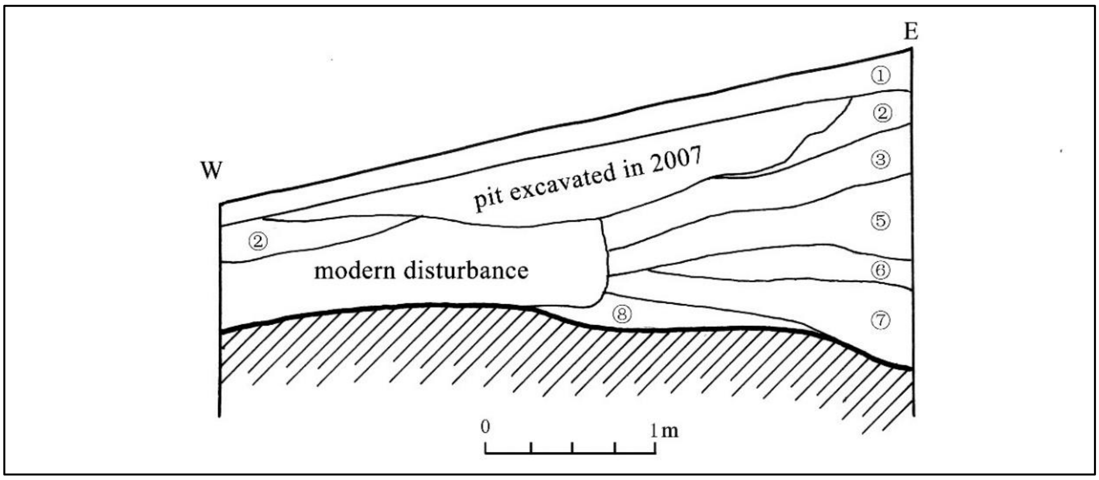


Fig. 3.71 North section of 07PXTT0614 at Tieniucun (reproduced from Ma Chunyan)

Archaeological features

The excavated features of Zone I were mainly located on the northeast of the area. Three pits and 8 furnaces were excavated.

Pits:

07PXTH1, this pit was first discovered in the trial excavation of 2007. Large amount of furnace bricks and charcoal debris were found in the pit. Full excavation was carried out in 2009 and 2010. The pit was located in the southeast of 07PXTT0411, cutting through furnace 07PXTL3 and cut by 07PXTL2, 07PXTL8 and 07PXTH2. Rectangular shape in plan with 420-445cm north-south length and 80-194cm west-east width. The depth of the pit is 67cm and the upper surface of the pit is 23cm to the ground surface (Fig. 3.72). The pit has six different layers of deposits and can be identified as follow:

① greyish brown clay, tight structure, about 8-24cm thick and was 23cm to the ground surface. This layer contains charcoal debris less than 2cm, furnace brick fragments between 1 to 10cm, and burned soil particles.

② greyish brown clay, about 8-24cm thick and was 31-54cm to the ground surface. This layer contains charcoal debris less than 2cm, furnace brick fragments less than 1cm and around 10cm, and burned soil particles.

③ greyish brown clay, about 8-15cm thick and was 66cm to the ground surface. This layer contains charcoal debris less than 2cm, and furnace brick fragments between 2-3cm.

④ greyish brown clay, tight structure, about 0-38cm thick and was 62-85cm to the ground surface. This layer contains charcoal debris less than 1cm, and furnace brick fragments around 5cm.

⑤ greyish brown clay with some sandy soil, loose structure, and 0-47cm thick. This layer contains many furnace brick fragments larger than 10cm and charcoal debris larger than 5cm diameter, and few smaller brick fragments and charcoal debris less than 2cm.

⑥ greyish brown sandy soil, loose structure, about 0-31cm thick and 46-100cmm to the ground surface. This layer contains some furnace bricks with minor fracture.

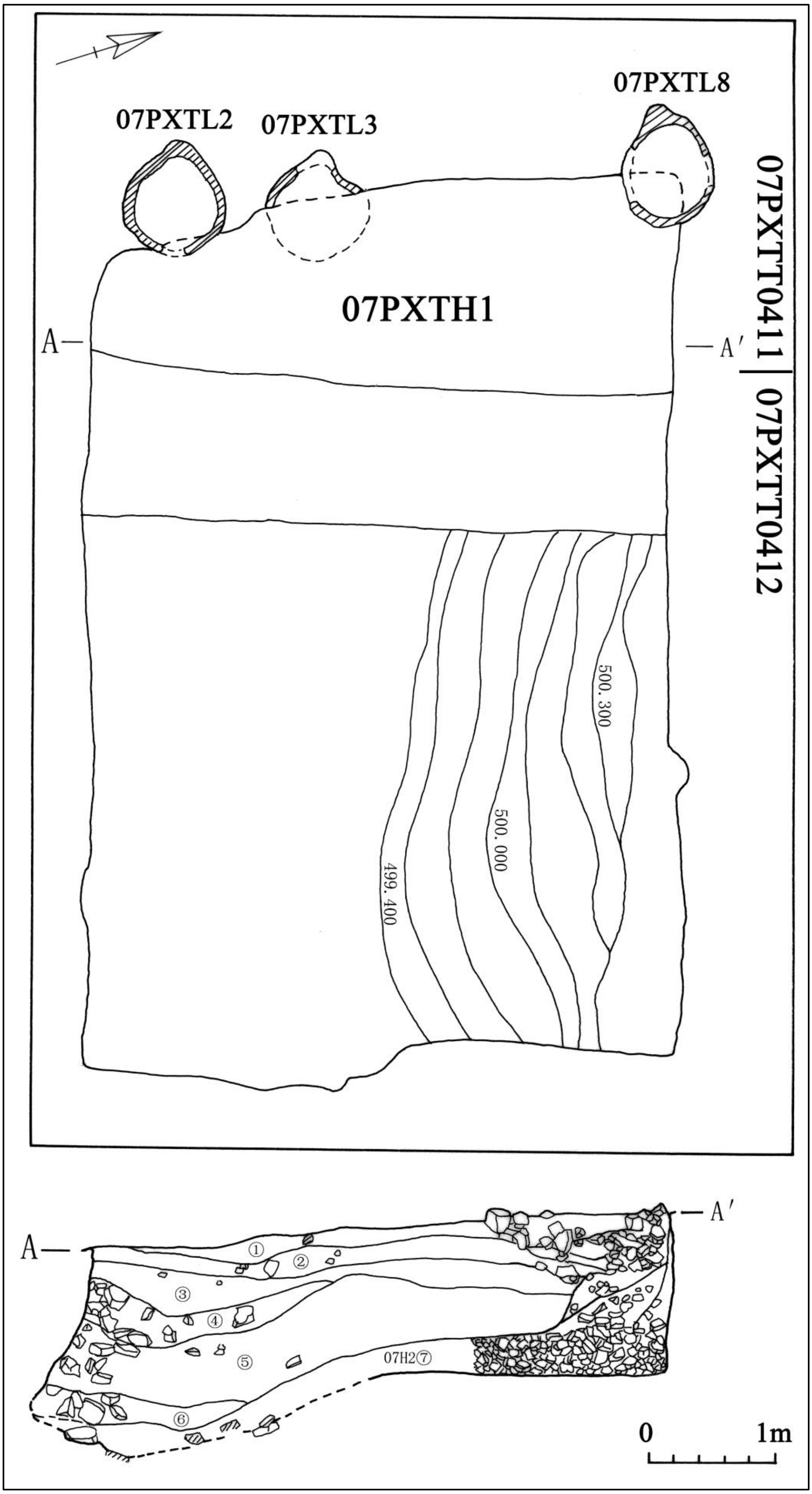

07PXTL2
07PXTL3
07PXTL8
07PXTH1
A
A′
07PXTT0411
07PXTT0412
500.300
500.000
499.400
①
②
③
④
⑤
⑥
07H2⑦
0
1m

Fig. 3.72 Plan and section views of 07PXTH1 at Tieniucun (source: CJAT)

07PXTH2, this pit was located in 07PXTT0412, cutting through 07PXTH1. Rectangular shaped in plan with 686cm north-south length and 470cm west-east width. The depth of the pit is 196-210cm and the upper surface of the pit is about 1-15cm to the ground surface. The pit was digged on purpose with a wider bottom (Fig. 3.73). The deposits of the pit can be divided into 8 different layers as follow:

① greyish brown sandy clay, tight structure, 8-62cm thick and 23-104cm to the ground surface. This layer contains many charcoal debris (1-10cm), and few furnace brick fragments (2-3cm) and burned soil particles.

② black and brown sandy clay, loose structure, 0-30cm thick and 31-104cm to the ground surface. This layer contains many furnace bricks fragments (around 10cm) and charcoal debris (less than 2cm), and few pottery sherds.

③ greyish brown sandy clay with some yellowish-brown clay, tight structure, 0-48cm thick and 86-128cm to the ground surface. This layer only contains few charcoal debris and furnace brick fragments, and some pottery sherds.

④ black and brown sandy clay, loose structure, 20-72cm thick and 120-172cm to the ground surface. This layer contains many charcoal debris (1-5cm, mostly 3-5cm), furnace brick fragments (around 5cm), burned soil particles, slags, and some pottery sherds.

⑤ yellowish brown sandy clay, tight structure, 16-34cm thick and 136-206 to the ground surface. This layer contains few slags, burned soil particles, charcoal debris (2-4cm), furnace brick fragments (2-4cm), and some pottery sherds.

⑥ yellowish brown clay, tight structure, 0-92cm thick and 10-236cm to the ground surface. This layer contains few furnace brick fragments (1-2cm) and charcoal debris (less than 1cm).

⑦ furnace bricks, 0-6cm thick and 108-236cm to the ground surface. This layer contains furnace bricks about 10-20cm sizes (mostly 15cm), slags, charcoal debris less than 5cm, and some pottery sherds.

⑧ furnace bricks, 0-42cm thick and 166-236cm to the ground surface. The sizes of the furnace bricks are 30-60cm, and there is dark grey silt in between the bricks.

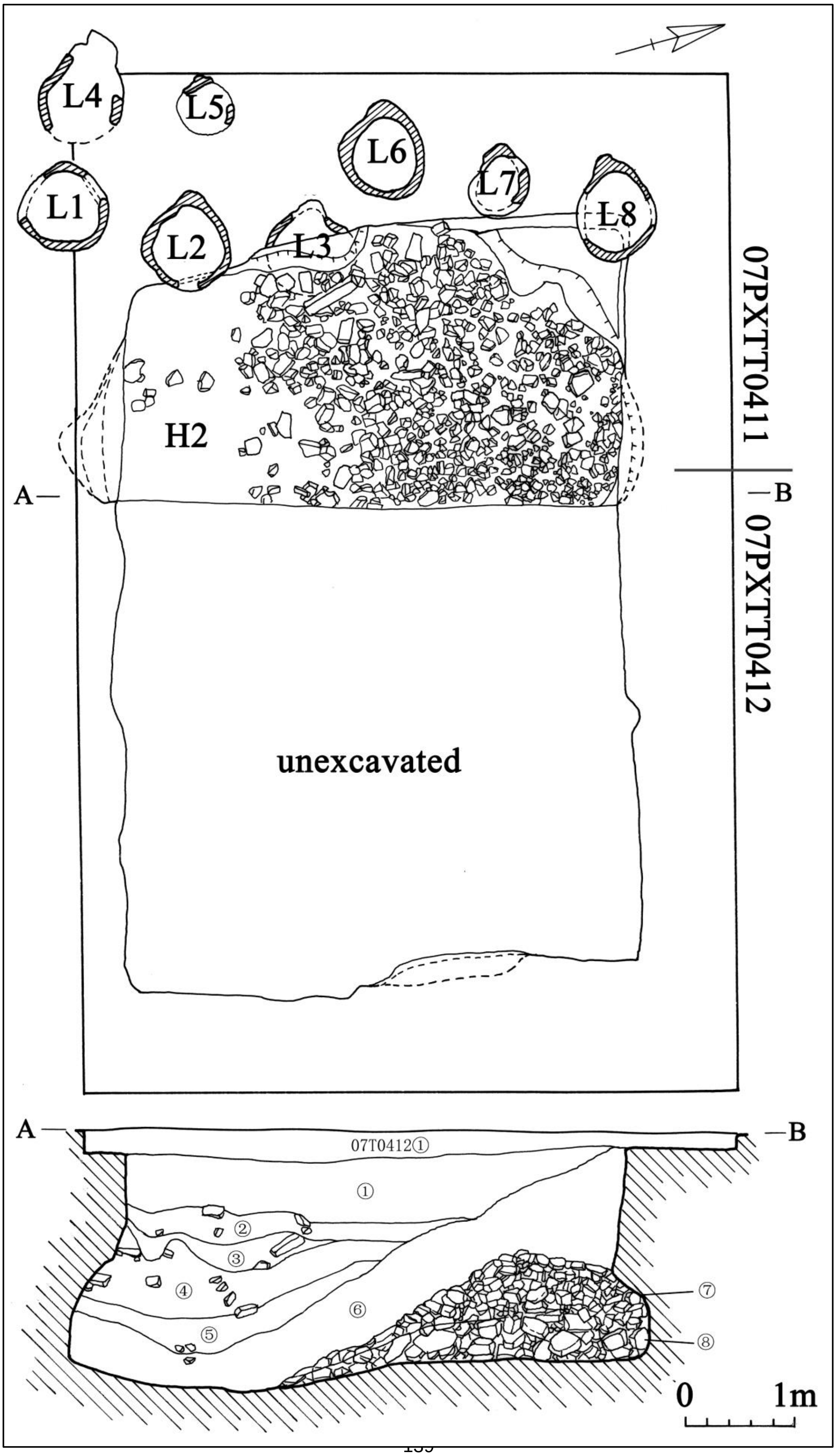

L1
L2
L3
L4
L5
L6
L7
L8
H2
07PXTT0411
07PXTT0412
A
B
unexcavated
07T0412①
①
②
③
④
⑤
⑥
⑦
⑧
0
1m

Fig. 3.73 Plan and section views of 07PXTH2 at Tieniucun (source: CJAT)

07PXTH3, this pit was located in the south of 07PXTT0513, cut by a modern burial. The pit was partially excavated with an irregular rectangular shape in plan (400cm long and 200-225cm wide) and a straight wall on the north. The deposits of the pit can be divided into 4 layers as follow. The layers are sloped from the north to the south (Fig. 3.74).

① black and brown clay, tight structure, and 25-50cm thick. This layer contains slags, furnace brick fragments, and pottery sherds. It was mainly distributed in the south and west of the pit.

② reddish brown clay, tight structure, and 10-30cm thick. This layer contains slags, iron ores, furnace brick fragments, and pottery sherds.

③ black and brown clay, tight structure, and 20-30cm thick. This layer contains slags, iron ores, furnace brick fragments, and large amount of charcoal debris.

④ yellowish brown clay and black charcoal layer, loose structure, and 35-45cm thick. This layer contains slags, iron ores, furnace brick fragments.

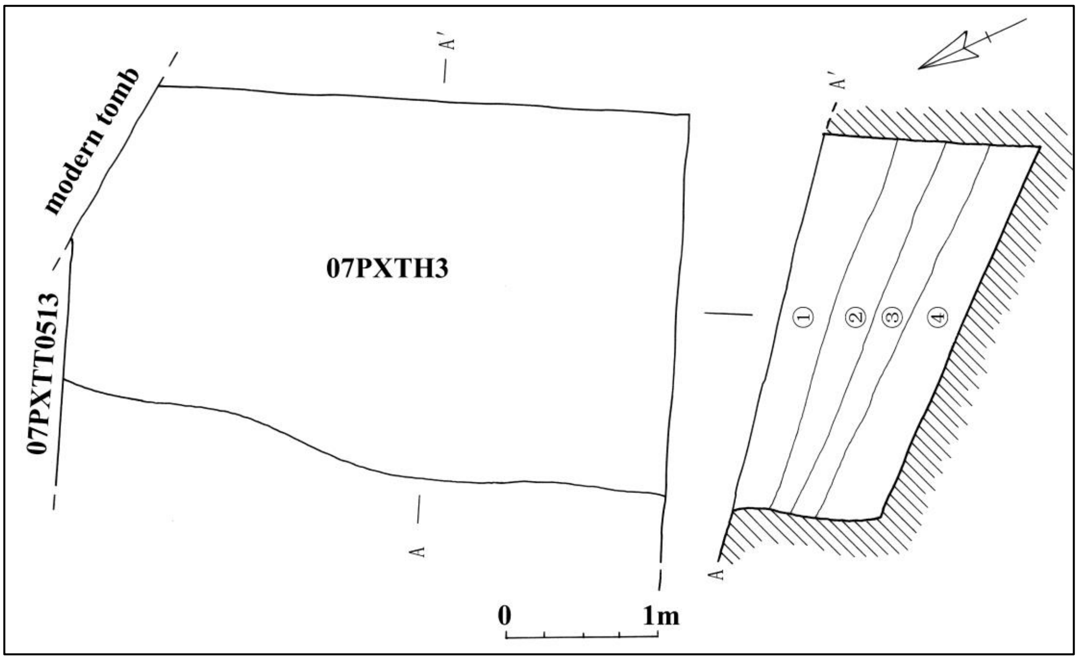


Fig. 3.74 Plan and section views of 07PXTH3 at Tieniucun (source: CJAT)

Furnace bases:

L1, was located in the west of 07PXTT0411 (Fig. 3.75). Circular shaped in plan with a remaining diameter of 80-82cm. The remaining depth of the furnace is 15-20cm, and the furnace wall is 5-8cm thick (Fig. 3.76:1). The fill contains charcoal debris, slags, burned soil particles, and pottery sherds.

L2, was located in the middle-south of 07PXTT0411 (Fig. 3.75), and cutting through 07PXTH1. Circular shaped in plan with a remaining diameter of 80-92cm. The remaining depth of the furnace is 8-28cm, and the furnace wall is 6-8cm thick (Fig. 3.76:2). The fill contains charcoal debris and burned soil particles.

L3, was located in the middle of 07PXTT0411 (Fig. 3.75), and cut by 07PXTH1. Circular shaped in plan. The remaining depth of the furnace is 2-14cm, and the furnace wall is 5-7cm thick (Fig. 3.76:3). The fill contains charcoal debris and porcelain sherds.

L4, was located in the west of 07PXTT0411 (Fig. 3.75). Circular shaped in plan with a remaining diameter of 78-106cm. The remaining depth of the furnace is 10-24cm, and the furnace wall is 6-10cm thick (Fig. 3.76:4). The fill contains charcoal debris and porcelain sherds.

L5, was located in the middle of 07PXTT0411 (Fig. 3.75). Circular shaped in plan with a remaining diameter of 50-63cm. The remaining depth of the furnace is 4-10cm, and the furnace wall is 5-8cm thick (Fig. 3.76:5). The fill contains charcoal debris and slags.

L6, was located in the east of 07PXTT0411 (Fig. 3.75). Circular shaped in plan with a remaining diameter of 76-88cm. The remaining depth of the furnace is 10-24cm, and the furnace wall is 5-10cm (Fig. 3.76:6). The fill contains charcoal debris, burned soil particles, and slags.

L7, was located partially in the east of 07PXTT0411 and the extended area (Fig. 3.75). Circular shaped in plan with a remaining diameter of 56-68cm. The remaining depth of the furnace is 4-10cm, and the furnace wall is 4-8cm (Fig. 3.76:7). The fill contains some charcoal debris.

L8, was located in the extended area of 07PXTT0411, and cutting through 07PXTH1 (Fig. 3.75). Circular shaped in plan with a remaining diameter of 72-100cm. The remaining depth of the furnace is 8-16cm, and the furnace wall is 3-6cm thick (Fig. 3.76:8). The fill contains charcoal debris and porcelain sherds.

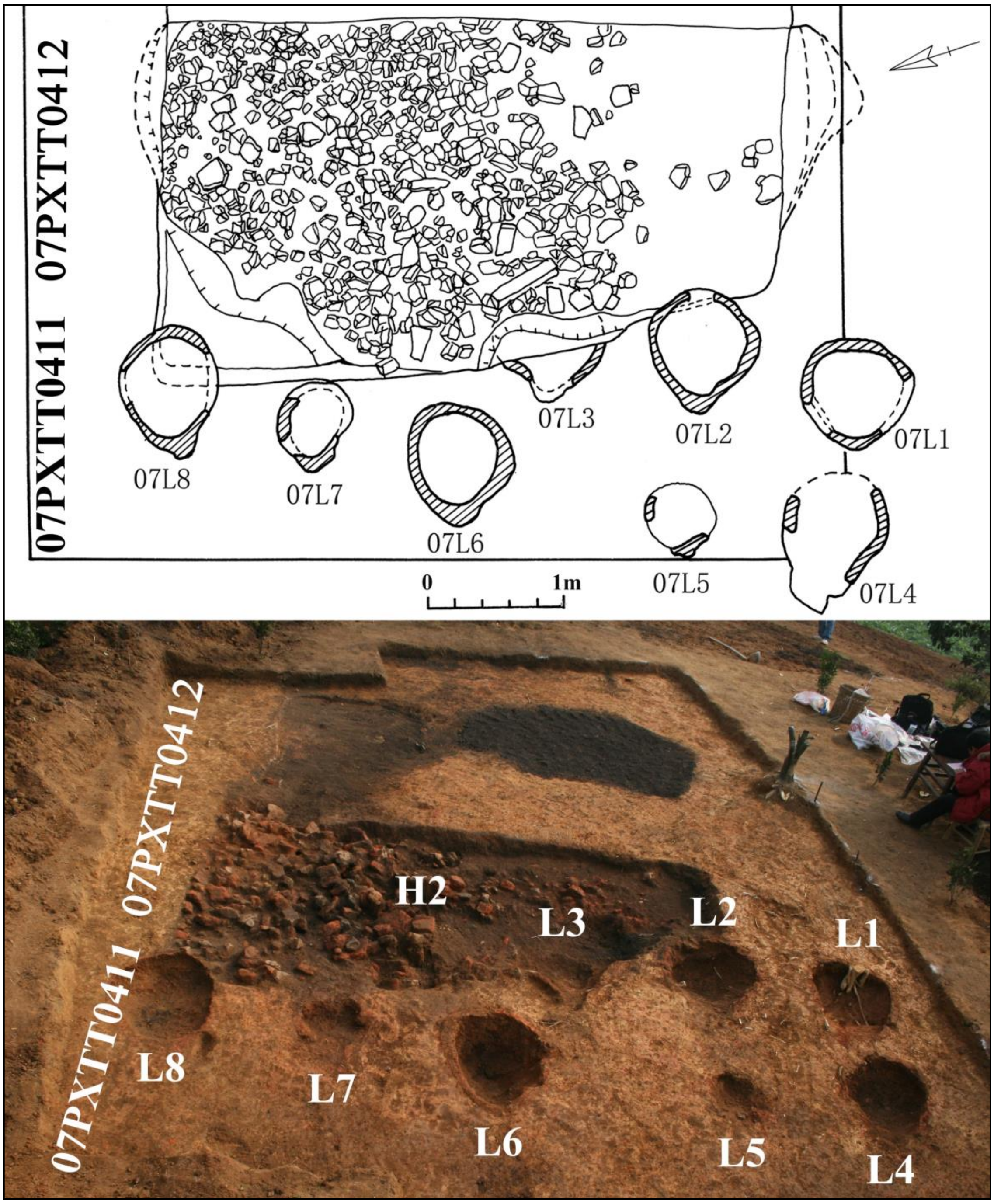


Fig. 3.75 Distribution of the furnace bases excavated at Tieniucun (source: CJAT)

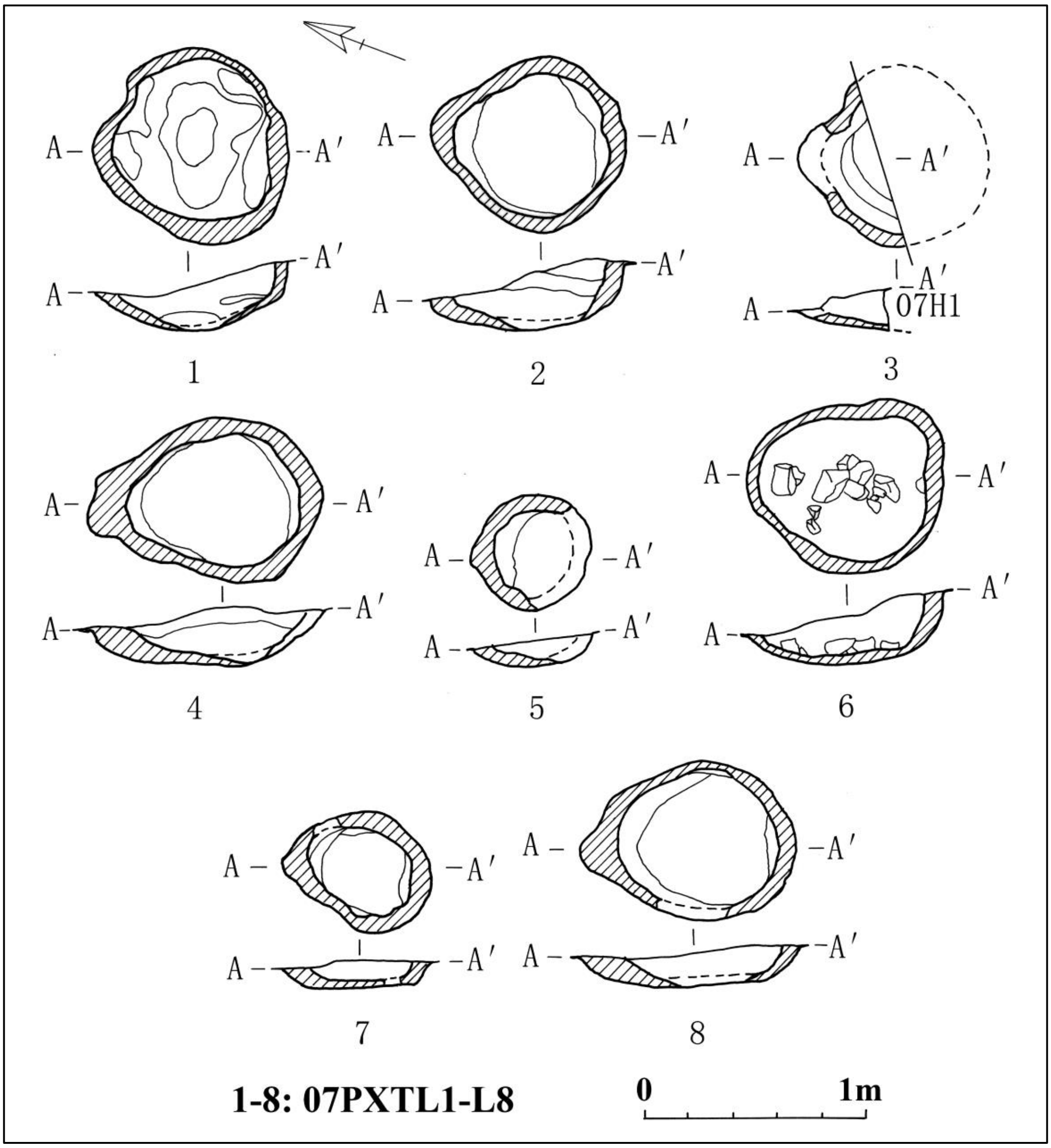


Fig. 3.76 Plan and section views of furnace bases L1-L8 at Tieniucun (source: CJAT)

Finds

Small amount of pottery and porcelain sherds and tuyeres, and large amount of furnace bricks from the Han dynasty layers were excavated in Zone I.

Pottery and porcelain:

Most of the pottery sherds excavated in Zone I were sandy clay pottery, and few were clay pottery. There are two bowls, three jars, five basins, four object bottoms can be identified, and 14 unidentified sherds. There are also few unidentified porcelain sherds excavated. The drawings are shown in Fig. 3.77 and the detailed descriptions are listed in appendix C3.

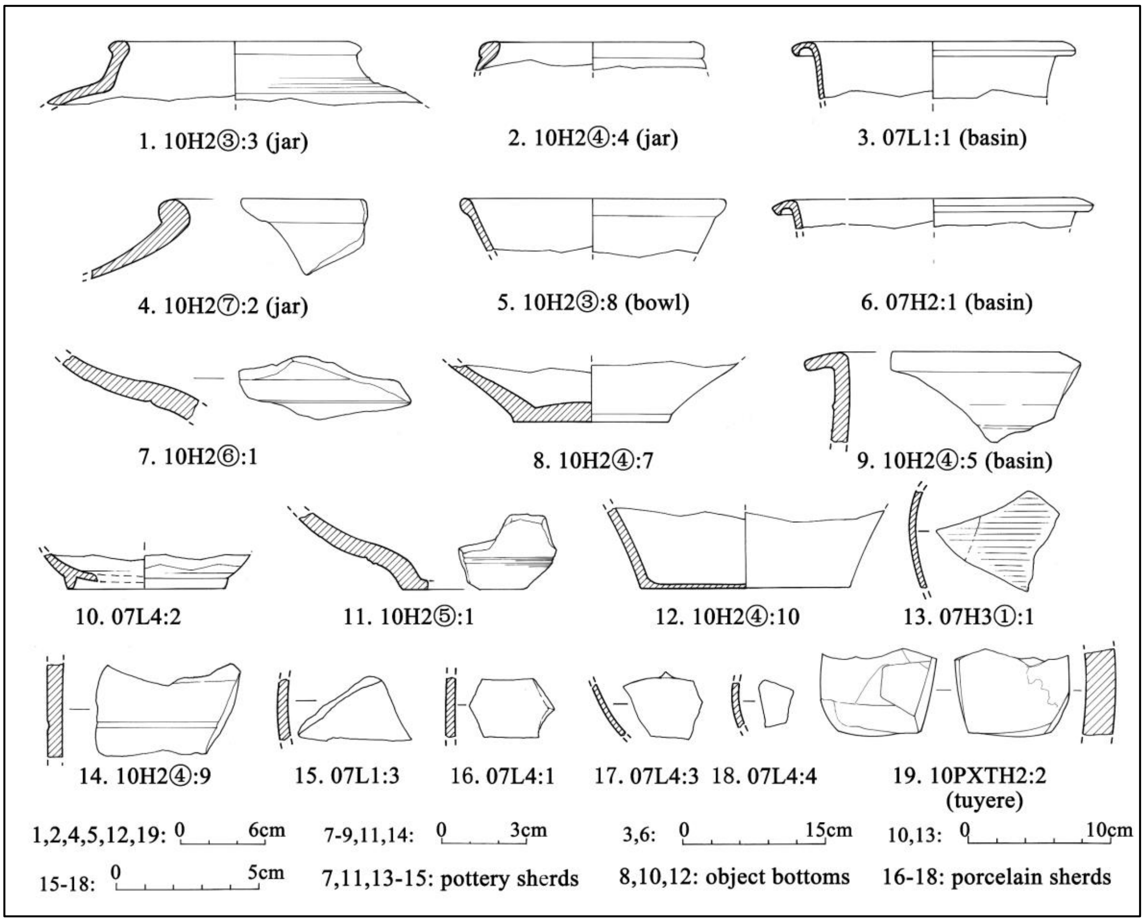


Fig. 3.77 Pottery and porcelain excavated from Tieniucun Zone I (source: CJAT)

Tuyeres:

Two ceramic tuyeres were excavated. Sample **10H2②:2**, dark grey colour with one end melted by high temperature. The remaining length is 8.1cm and 6cm height (Fig. 3.77:19).

Refractory material:

Large amounts of furnace bricks were excavated at Tieniucun. The furnace bricks can be divided into four types, according to their shapes, surface texture, and material. Large amounts of each type were excavated in Zone I. Most of the bricks were made of clay with inclusions of sand. Type A bricks were clay-made, trapezoid in plan with an orange and reddish brown colouration on the exterior end (wider and usually better preserved) and grey and black on the interior end (shorter and usually incomplete or melted). Adhering clay and charcoal debris usually on the surface and sometimes cord impressions. The intact length is about 33-36cm, 8-14cm wide, 13-17cm height, and weighed 6-8kg. All the edges of this type were bevelled (a cut that is made at a 45° angle to the adjacent principal faces). Typical examples of type A brick are shown in Fig. 3.78. Sample **09H2③:2** is almost intact and is 33cm long, 8.7-13.2cm wide, and 13.5cm height (Fig. 3.78:1). Sample **10H2②:6** is missing the shorter end, which the remaining length is 22.4cm, 10.5-12.5cm wide, and 13.3cm height (Fig. 3.78:2).

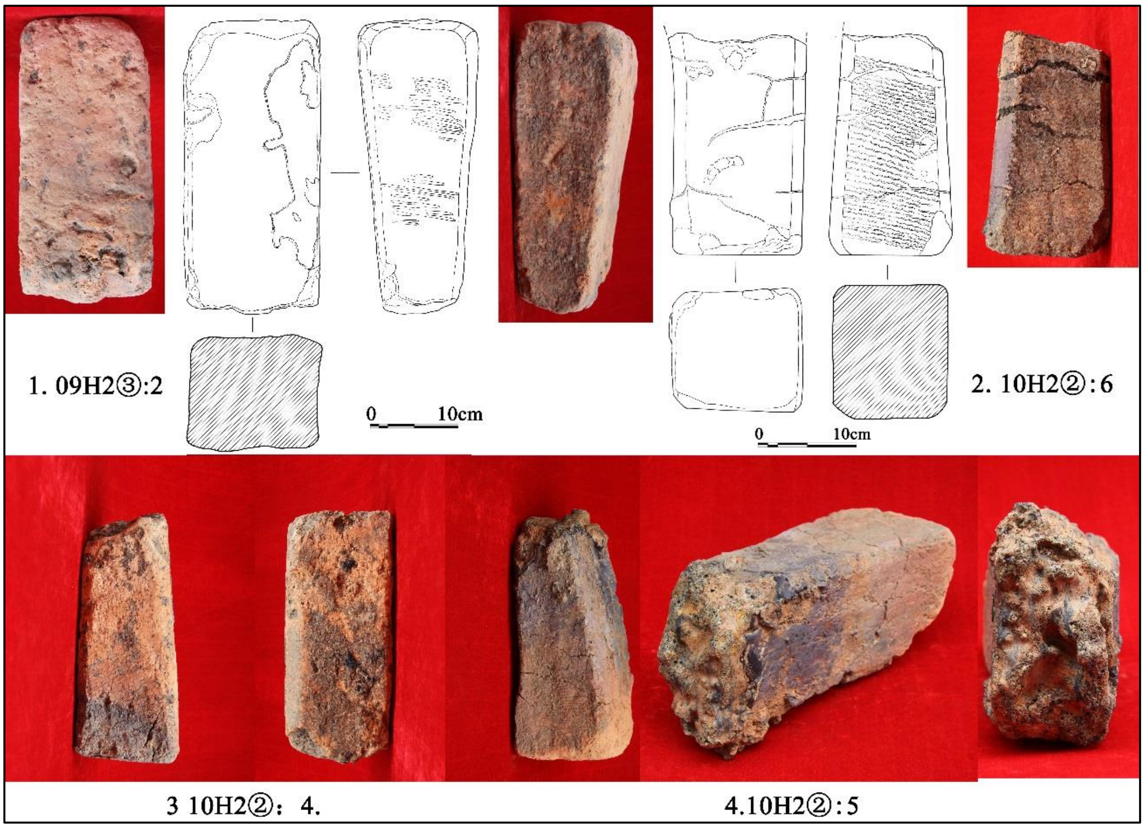


Fig. 3.78 Typical examples of type A bricks from Tieniucun (source: CJAT)

Type B bricks were clay-made, and have large amount of tamping impressions on their surfaces. The amount of the tamping impressions on each surface vary from several to dozens with smaller sizes between 0.8-1.8cm and larger sizes between 6-7cm. This type usually has an orange colouration and fragmented with two or more missing surfaces. Typical examples are shown in Fig. 3.79. Sample **10H2④:22** weighed 7.9kg. The brick has an orange colour and a remaining dimension of 22x21x17cm in length, width and height. There are 3 tamping impressions with diameter of 7cm on one surface, and more than 60 impressions with diameter of 1.3cm on the other two surfaces (Fig. 3.79:8). Sample **10H2⑦:50** weighed 6.6kg. The brick has a grey and brown colour on one surface (slightly melted) and a remaining dimension of 13.4x12x7cm. There are more than 20 tamping impressions with diameter of 1.9cm on the melted surface (Fig. 3.79:11).

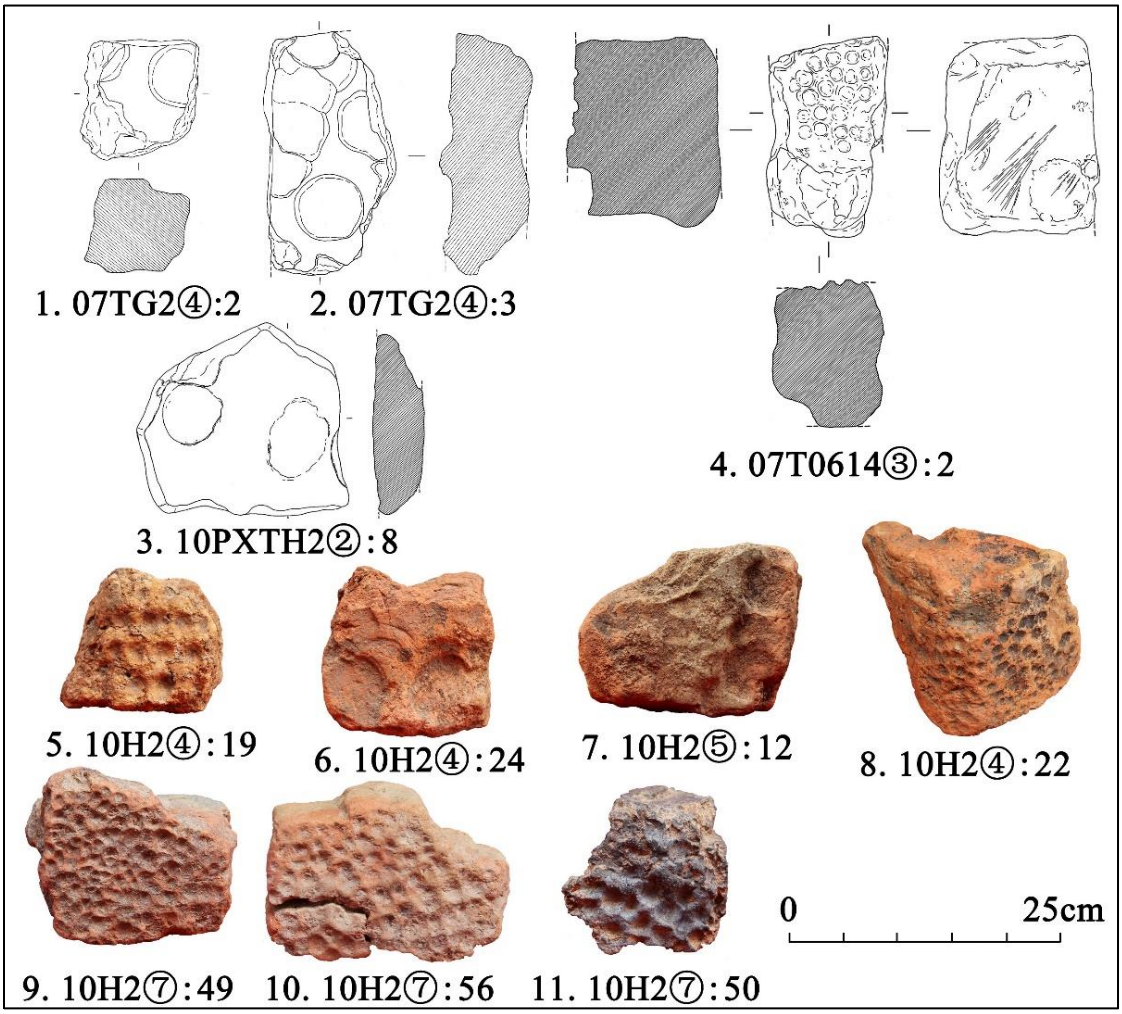


Fig. 3.79 Typical examples of type B bricks from Tieniucun (source: CJAT)

Type C bricks were made of iron and silica-rich rocks and usually have one curved side. These rocks were believed to be furnace brick rather than iron ore because they appear to be shaped intentionally and there are thin layers of adhering clay with cracked patterns on their surfaces. Typical samples are shown in Fig. 3.80. Sample **09H2③:1** is curved and weighed 2.7kg. The brick has a reddish brown colouration with some adhering clays on its surface. The concave surface is melted with some grey and black colours. The remaining length is 19cm and 6.3cm in thickness. The predicted inner diameter is about 101cm (Fig. 3.80:1). Sample **10H2⑦:20** is curved and weighed 2.5kg. The brick has a reddish brown colouration with a melted surface. The remaining length is 26.5cm and 7.5cm in thickness. The predicted inner diameter is about 62cm (Fig. 3.80:2).

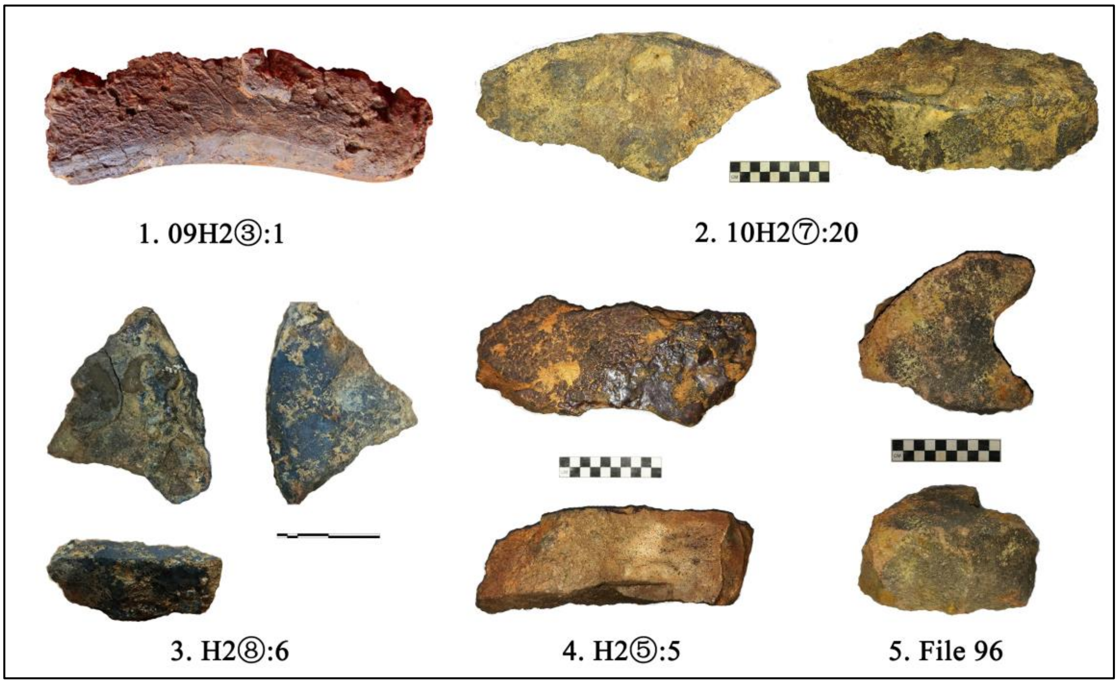


Fig. 3.80 Typical examples of type C bricks from Tieniucun (source: author)

Type D bricks were mostly clay-made and fragmentary so that their original dimensions were usually undetermined. Massive amounts of these fragmentary bricks were excavated from pit 07PXTH2 (Fig. 3.81).

Fig. 3.81 Furnace bricks excavated from pit 07PXTH2 at Tieniucun (source: author)

In addition, there were some furnace linings discovered during the surveys before the excavation. For example, a sample collected from location 2 in 2007 (file 36) has a dark grey to black colouration with inclusions of small stones and organic fibres. There is a thin layer of black slag adhering to one surface. The remaining dimensions are 11.5cm long, 7.5cm wide, and 4.5cm thick (Fig. 3.82:1). Samples collected in 2006 (file 39) have an orange to red colouration with inclusions of small stones, charcoal debris and organic fibres. The remaining dimensions are 10x7.5x2.5cm and 10x4x2.5cm (Fig. 3.82:2).

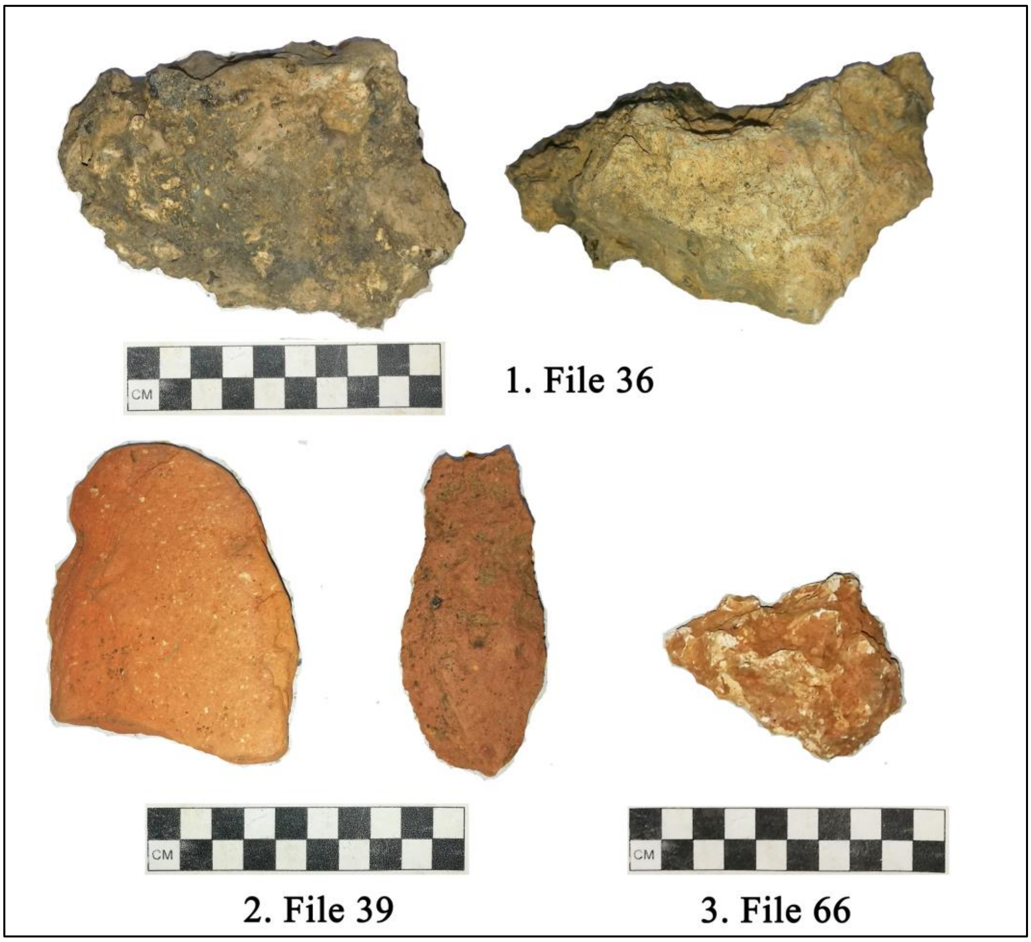


Fig. 3.82 Furnace lining discovered in the surveys at Tieniucun (source: author)

Slag:

According to Ma (2011, 59-60), 129 slags were discovered and excavated in Zones I and II but only 12 of them were recorded with descriptions. Tap slag, furnace slag and refining slag can be identified by the provided descriptions and pictures. Tap slags were excavated from both Zone I and II. They are mostly plate shape with a ropy surface texture (Fig. 3.83:9-11). Furnace slags were also excavated from both Zone I and II. These can be divided into two sub-types. One sub-type is highly vitrified with a black colouration and larger porosity proportion (Fig. 3.83:3,4,6). The other sub-type has brown and dark grey colours and is moderately magnetic (Fig. 3.83:5). Sample **07T0614③:11** and **07GC:2** are refining slags excavated in Zone I and collected from the ground surface (Fig. 3.83:1-2).

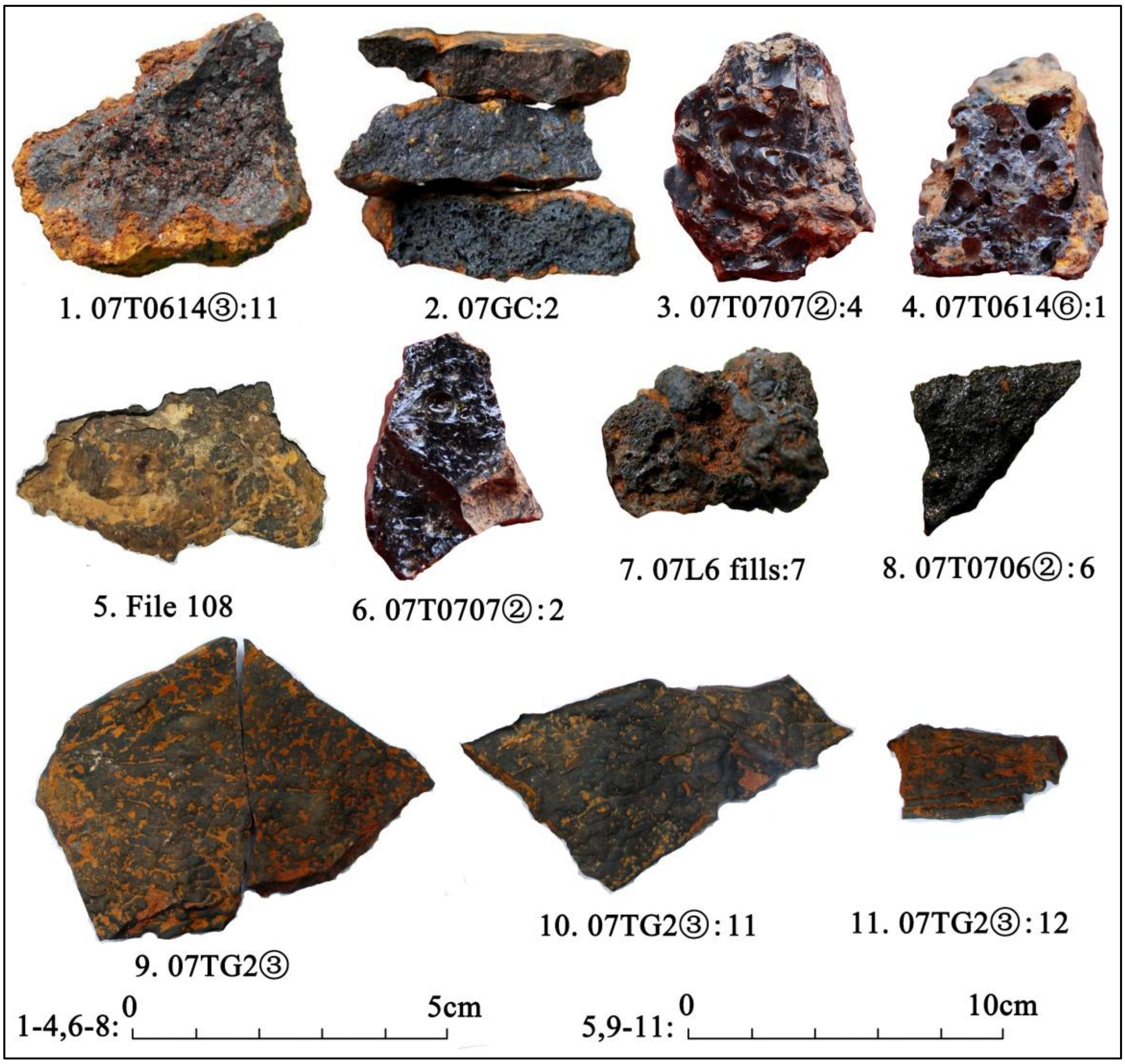


Fig. 3.83 Photo of slags excavated from Tieniucun (source: CJAT)

Ore:

Large amounts of iron ores were discovered from Zone I and II at Tieniucun (Fig. 3.84). The ores have a reddish brown and black colouration, and most of the them were 2-6cm in size with one exception which was 10.5cm. Five samples were sent to the lab of the School of Archaeology and Museology of Peking University to identify their elementary composition using ICP-AES and to the Analytical & Testing Center of Sichuan University for X-ray diffraction to identify their type using D/max-rA. The details of the samples and their analyses are shown in Table 3.6 and Table 3.7.

Fig. 3.84 Iron ores excavated from Tieniucun (source: CJAT)

Table 3.6 Iron ore samples from *Tieniucun* (translated from Chen J. *et al* 2009b, 266 table 4)

No.	Sample No.	Context	Description	Notes
1	P1	southwest wall section	black and redish brown color	Fig. 3.84-7
2	P5	4^{th} layer T0614	red sandy stone with black stripes inclusion	Fig. 3.84-5
3	P6	3^{rd} layer T0614	black and red color	Fig. 3.84-2
4	P7	11^{th} layer T0411-L6	black brown color iron ore	Fig. 3.84-3
5	P8	T0411-L1	redish brown iron ore	Fig. 3.84-6

Table 3.7 Type and inclusion analysis of iron ore samples from *Tieniucun* (Wt%) (translated from Chen J. *et al* 2009b, 267 table 5)

Sample No.	Elementary composition						Type	
	Fe	Mn	As	Al_2O_3	MgO	K_2O	XRD result	Ore type
P1	52.31	5.30	0.07	2.89	0.02	0.13	α-Fe_2O_3, Fe_3O_4, α-SiO_2	Magnetite, hematite
P5	53.17	0.92	0.08	1.34		0.04	Fe_3O_4, α-SiO_2, SiO_2	Magnetite
P6	46.77	1.29	0.11	4.24	0.04	0.37	Fe_3O_4, α-SiO_2, α-Fe_2O_3	Magnetite, hematite
P7	41.32	0.37	0.07	6.87	0.16	0.52	α-FeO(OH), α-SiO_2	Goethite
P8	44.87	0.67	0.06	4.43	0.05	0.16	α-SiO_2, α-Fe_2O_3	Hematite

Charcoal:

Few charcoal samples were collected, three of them were sent to the Wood Science Research Center of Nanjing Forestry University and subjected to a tree species identification test. Most of the charcoal discovered at Tieniucun were cut into small pieces of 3-5cm, and some smaller ones were made from tree branches of 2-3cm diameters.

Zone II:

The excavated trenches of Zone II were situated on the terrace at the middle of the hill. One 3x3m test-trench (07PXTTG2) was excavated in 2007. In December 2007, a total of 150m^2 with six 5x5m trenches were excavated (Fig. 3.70).

Stratigraphy and deposits

The stratigraphy and deposits of Zone II are demonstrated by using the north section of 07PXTT0706 as an example (Fig. 3.85). There are 5 layers excavated in total, and the details are as follow.

①: Modern agricultural layer, greyish yellow clay, loose structure, and 8-35cm thick. The inclusions are modern porcelain and pottery sherds, plant roots, rocks, refractory materials, and slags.

②: Ming and Qing layer (c.15th-19th centuries AD), grey and black clay including large amount of charcoal debris, loose structure, 8-35cm to the ground surface, and 0-39cm thick. The inclusions are iron ores, furnace bricks, slags, and pottery and porcelain sherds of the Ming and Qing dynasties.

③: Tang and Song dynasties layer (c.7th-14th centuries AD), reddish brown clay, tight structure, 42-55cm to the ground surface, and 0-32cm thick. The inclusions are refractory materials.

⑤ : Tang and Song dynasties layer, brownish yellow clay, tight structure, 23-25cm to the ground surface, and 0-40cm thick. This layer is distributed in the south part of the trench and is missing on the north section. The inclusions are refractory materials.

⑤: Han dynasty layer (c.200BC-200AD), large amount of charcoal, loose structure, 51-78cm to the ground surface, and 0-16cm thick. The inclusions are small amount of potteries and slags.

Noticeably, there is a hardened surface consisting small slags beneath the fifth layer.

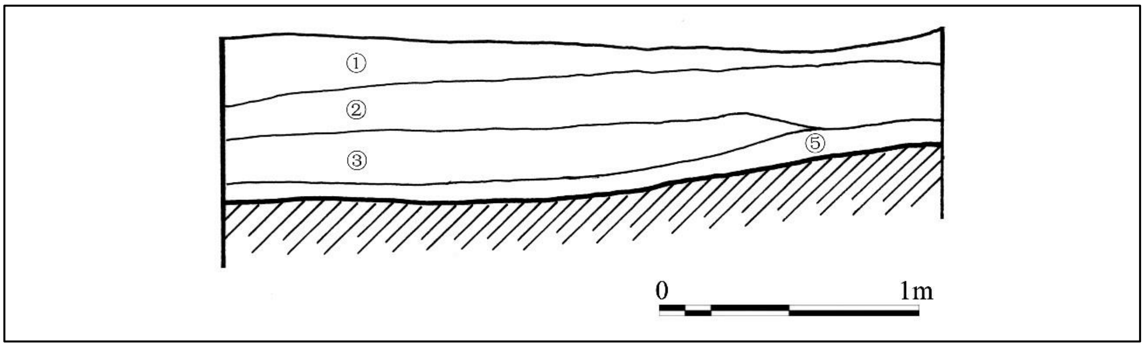


Fig. 3.85 North section of 07PXTT0706 at Tieniucun (reproduced from Ma Chunyan)

Archaeological features

The archaeological features of Zone II were mainly distributed on the east. Four post-holes and one trench were excavated.

Post-holes:

D1, was located in the east of 07PXTT0708, and sealed by layer ②. Nearly a squared shape in plan with a side length of 52cm and a remaining depth of 38cm

(Fig. 3.86). The section of the post-hole is C-shaped (U-shaped with a slightly contracted mouth). The fill contains furnace brick fragments, slags, charcoal debris, and burned soil particles.

D2-D4, were not excavated. Circular shaped in plan with diameters of 45cm, 32cm, and 42cm respectively (Fig. 3.86).

Trench:

G1, was located in the middle of 07PXTT0708, and sealed by layer ②. Northeast to southwest direction with an excavated length of 400cm and depth of 73cm. Trapezoid shaped in the section with a wider bottom (Fig. 3.86). The fill contains large amount of small furnace brick fragments, slags, iron ores, and small charcoal debris. There were foundation poles discovered in the trench, which might indicate the trench was a house foundation.

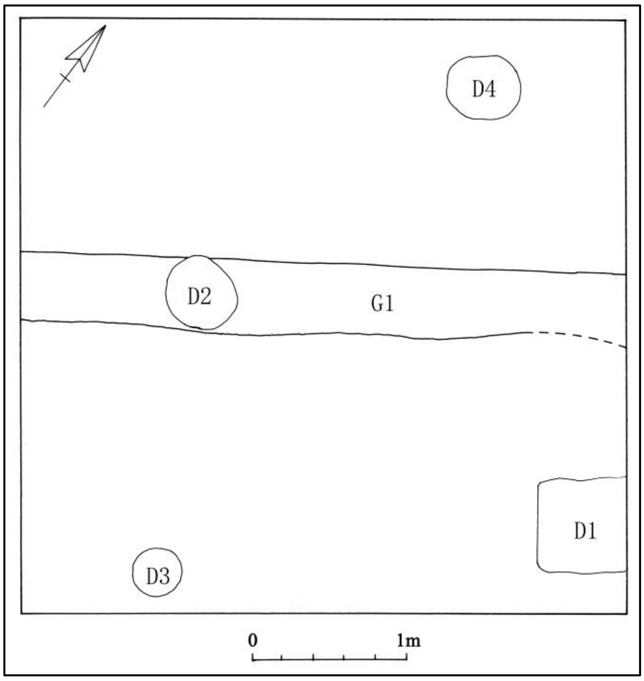


Fig. 3.86 Plan view of the house foundation post-holes in Zone II at Tieniucun (source: CJAT)

Finds

Small amount of pottery and porcelain sherds, iron objects, furnace bricks, and slags from the Han dynasty layers were excavated. There is a big lump of 'salamander' or consolidated furnace base discovered on the surface in Zone II.

Pottery and porcelain:

Most of the pottery sherds excavated at Zone II were sandy clay pottery, and few were clay pottery. There are three pottery jars, one urn, five basins can be identified, and 10 unidentified sherds and bases. There are also some porcelain objects excavated including types of jar, urn, basin, and unidentified sherds. The drawings are shown in Fig. 3.87 and the detailed descriptions are listed in appendix C3.

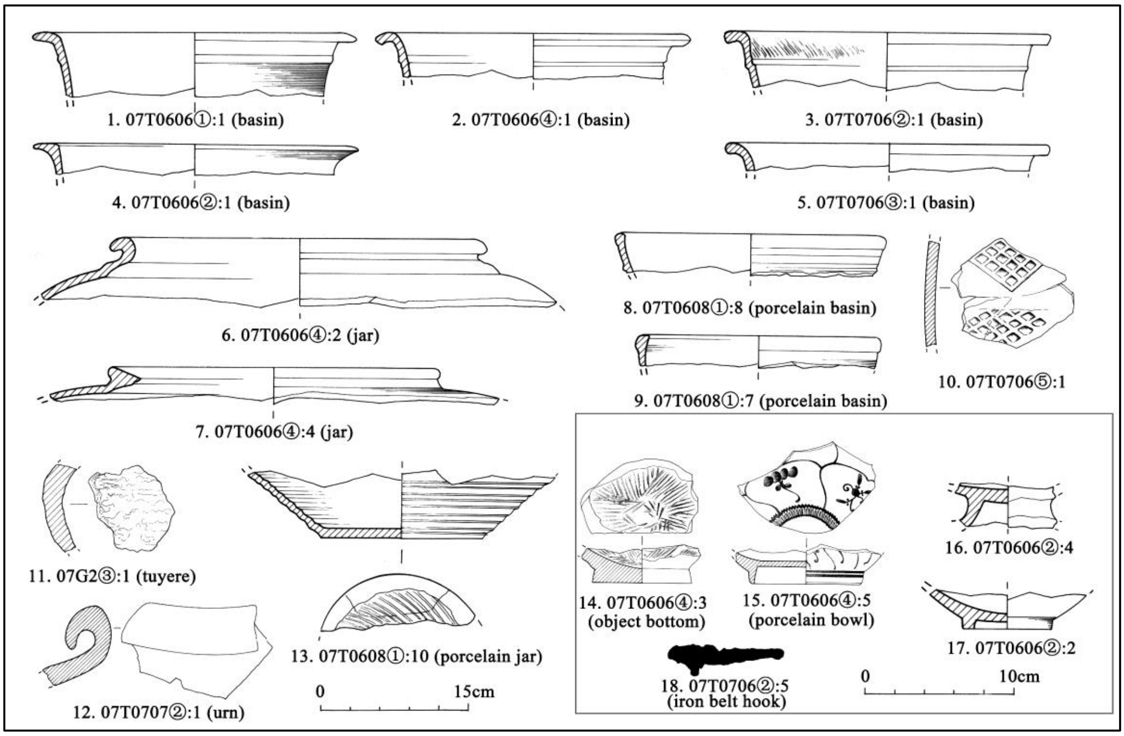


Fig. 3.87 Pottery and porcelain excavated from Tieniucun Zone II (source: CJAT)

Tuyere:

One ceramic tuyere was discovered, sample **07G2③:1**, fragmentary, about 2cm thick, a thin layer of adhering slag on the exterior surface, the original diameter was about 20cm (Fig. 3.87:11).

Refractory material: very few furnace bricks were excavated from Zone II. One type A brick, sample **07T0606①:13** was clay-made, trapezoid in plan with an orange and reddish brown colouration. The edges were bevelled, and the remaining length is 13.8cm, 8.2-10cm wide, and 7.2cm thick (Fig. 3.88:2). Three type B brick, sample **07TG2④:1** was fragmentary, orange colour, and weighed 2.4kg. There are 3 tamping impressions with a diameter of 7cm on one surface and 2 same size impressions on the other surface (Fig. 3.88:1). Some type D unidentified brick fragments such as sample **07T0606④:6**, which has a remaining length of 11.8cm, 9.8cm wide and 6.4cm thick (Fig. 3.88:3).

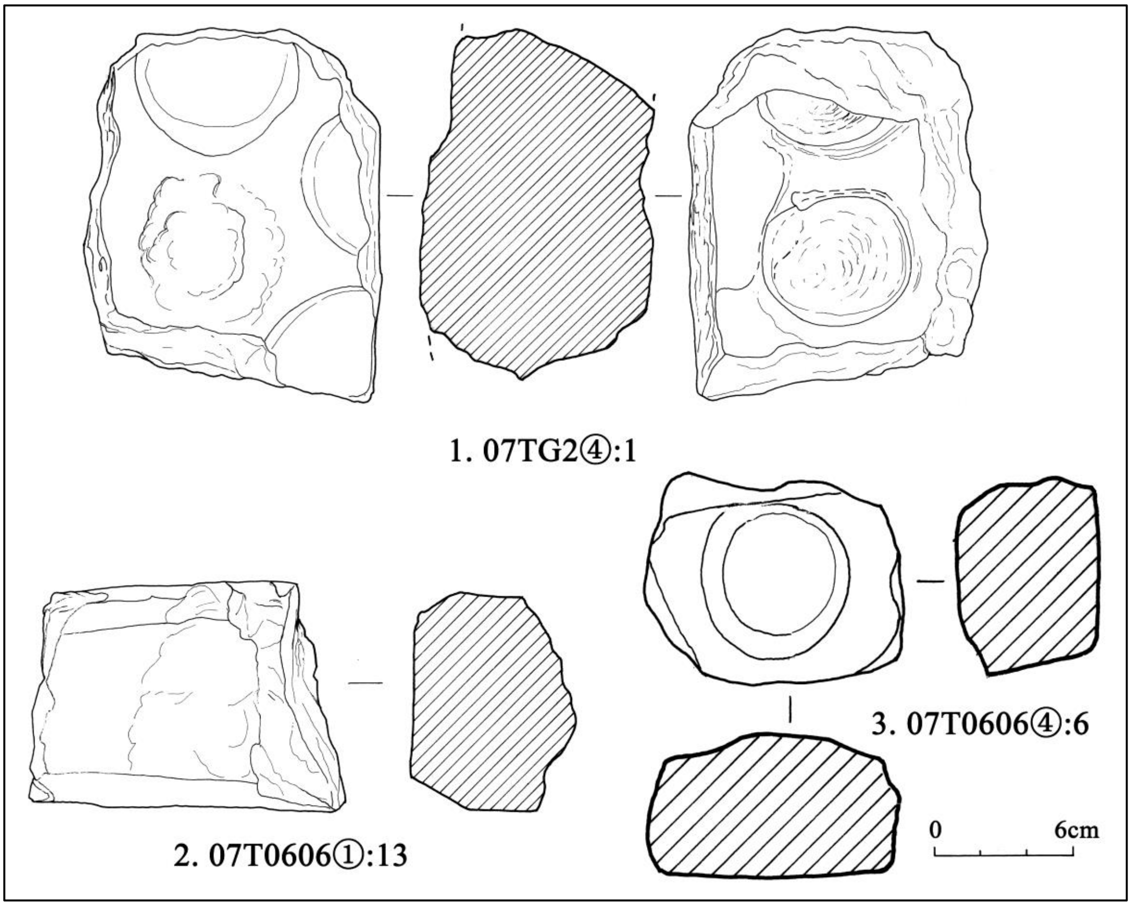


Fig. 3.88 Furnace bricks excavated from Tieniucun Zone II (source: CJAT)

Iron object:

One iron belt hook was excavated from layer ② of 07T0706. Sample **07T0706 ②:5**, is badly corroded with a length of 8cm (Fig. 3.87:18). The metallographic analysis indicated it was a decarburized steel from pig iron with a carbon content of 0.1% and no slag inclusions (Ma 2011, 99 fig.3).

Sample **07T0606②:5**, an unidentified iron fragment which has large amount of charcoal impressions on its surface (Fig. 3.89). The metallographic analysis shows a pearlite matrix with graphite flakes indicating a grey cast iron structure (Chen J. *et al* 2009b).

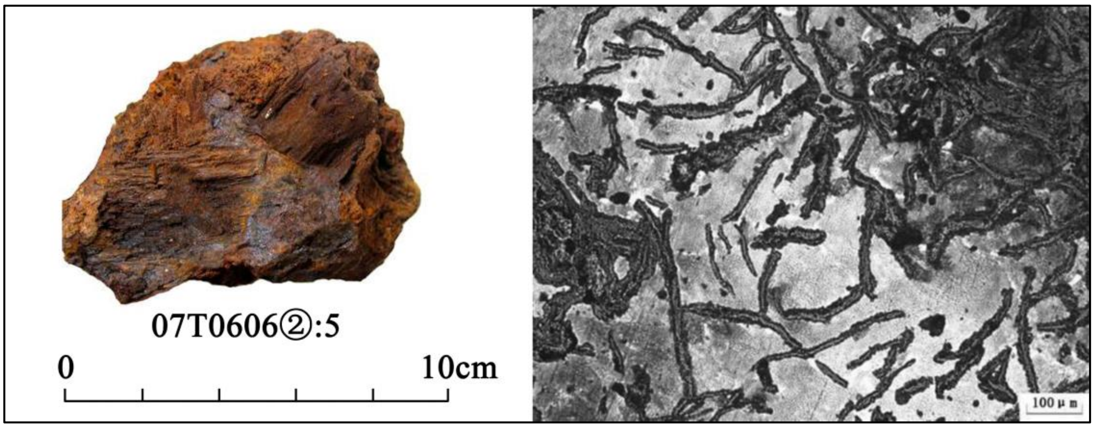


Fig. 3.89 Photo and micro-structure of 07T0606②:5 excavated from Tieniucun (source: CJAT)

The 'salamander' (consolidated furnace base):

07TG2③:10, was found at the bottom of the hill on the southwest of T0707. The shape of the salamander looks like an ox head, which was the reason the village was named ('*Tieniu*' as iron ox in Chinese). The lump is 167cm long, 50-107cm wide, and 37-92cm thick (Fig. 3.90). It was formed at the bottom of a blast furnace, and fell down to the current position later.

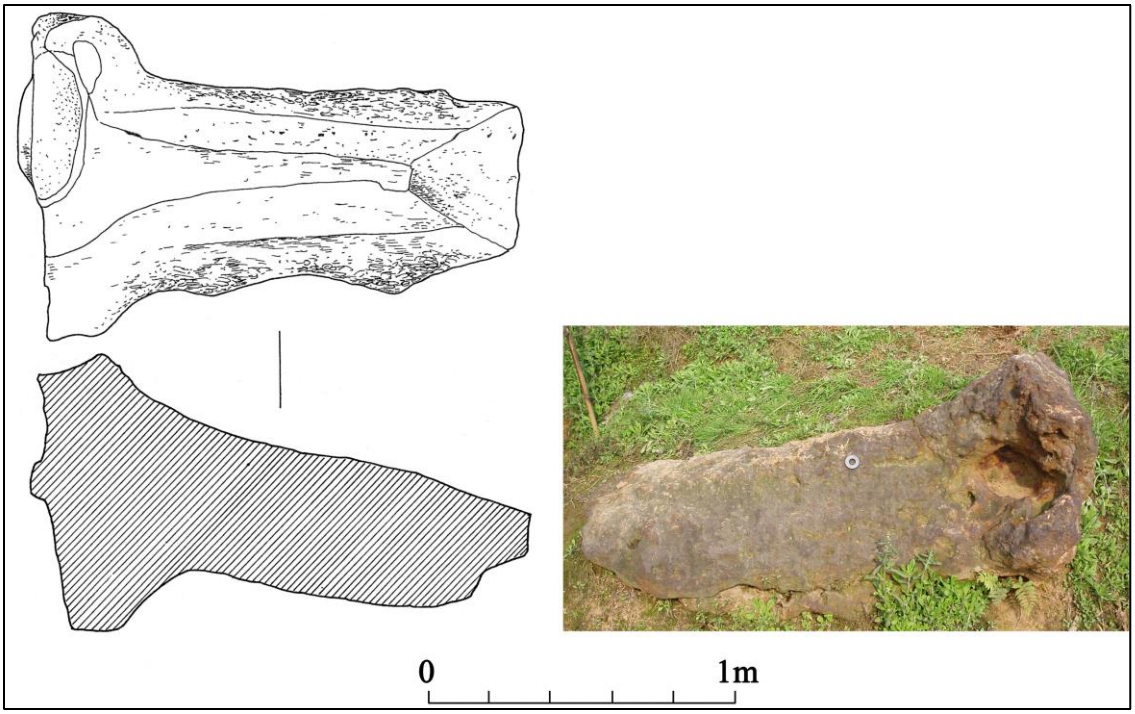


Fig. 3.90 Plan and section views of the salamander discovered from Tieniucun (drawing by: Ma Chunyan; photo by: author)

Zone III:

The excavated trenches of Zone III are located near the river at the bottom of the hill. One 2x2m test-trench (07PXTTG1) was excavated in the May of 2007. In the December of 2007, two 5x5m trenches (07T1119 and 07T1219) were excavated (Fig. 3.70).

Stratigraphy and deposits

The stratigraphy and deposits of Zone III are demonstrated by using the north section of 07PXTT1119 as an example (Fig. 3.91). There are 6 layers excavated in total, below the sixth layer there is a pebble layer which is commonly seen in the Chengdu plain. The details are as follow.

①: Modern agricultural layer, brown clay, loose structure, and 25-35cm thick. The inclusions are plant roots and rubbish.

②: Ming and Qing layer (c.15th-19th centuries AD), yellow and brown clay including small amount of burned soil particles, loose structure, 20-50cm to the ground surface, and 40-70cm thick. The inclusions are furnace bricks, slags, and porcelain sherds of the Ming and Qing dynasties.

③: Tang and Song dynasties layer (c.7th-14th centuries AD), grey clay, tight structure, 70-90cm to the ground surface, and 45-65cm thick. The inclusions are slags and porcelain sherds of the Tang and Song dynasties.

④: Han dynasty layer (c.200BC-200AD), black and brown layer consisting of iron slags and iron ores, tight structure, 135-160cm to the ground surface, and 30-90cm thick.

⑤: Han dynasty layer (c.200BC-200AD), a grey layer consisting of small rocks, slags and small amount of pottery sherds, tight structure, 175-200cm to the ground surface, and 0-25cm thick.

⑥: Han dynasty layer (c.200BC-200AD), grey and white plaster like clay, tight structure, 165-210cm to the ground surface, and 8-50cm thick. The inclusions are large amount of rotten wood, bamboo, leaves, and small amount of slags and pottery sherds.

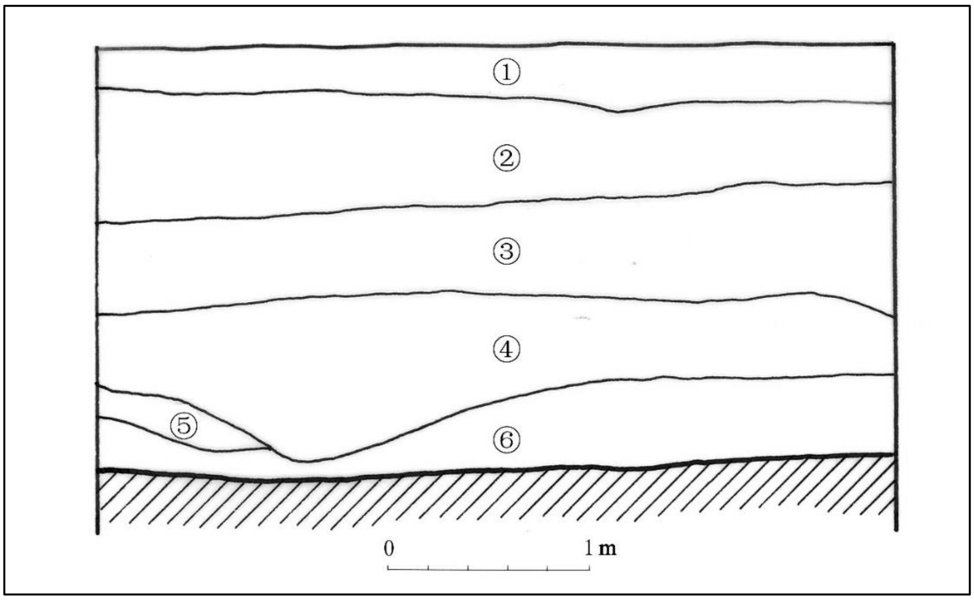


Fig. 3.91 North section of 07PXTT1119 at Tieniucun (reproduced from Ma Chunyan)

Finds

Some pottery sherds, furnace bricks, iron ores, and slags were excavated from the Han dynasty layers in Zone III.

Pottery: most of the pottery sherds excavated at Zone III were clay pottery, and few were sandy clay pottery. There are four basins, one jar, one steamer, one bowl, and two *fu*-pots can be identified, and 5 unidentified sherds. The drawings are shown in Fig. 3.92 and the detailed descriptions are listed in appendix C3.

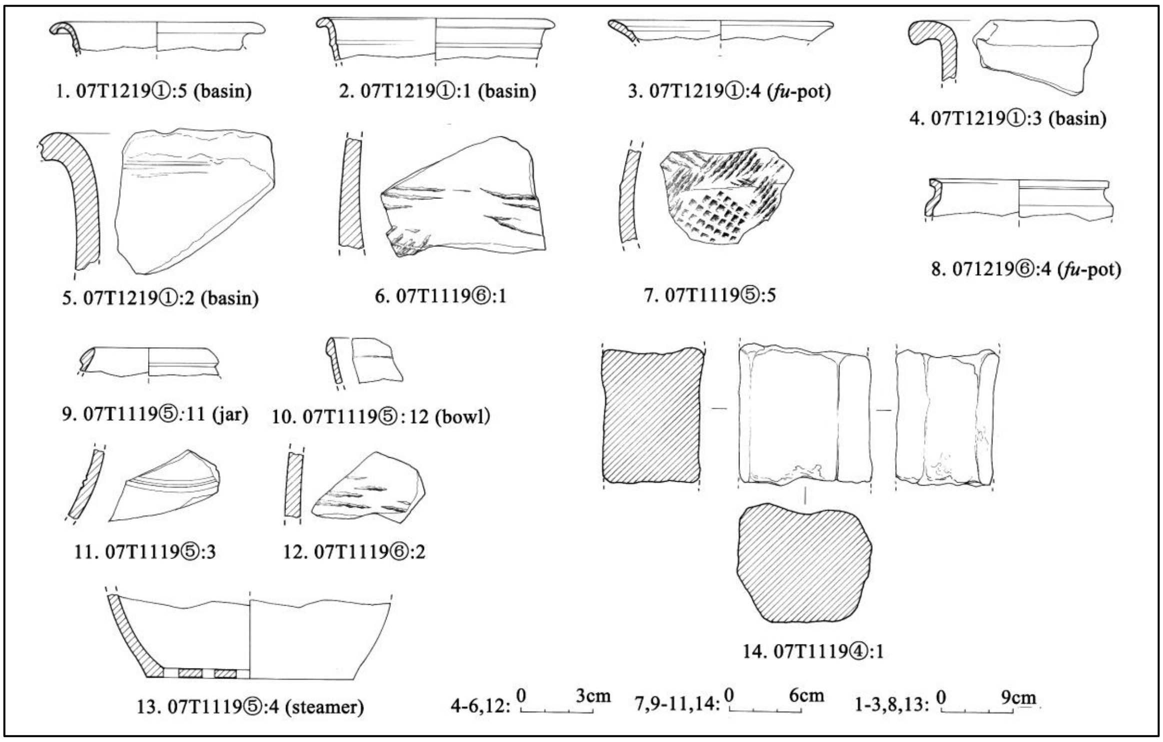


Fig. 3.92 Pottery and furnace brick excavated from Tieniucun Zone III (source: CJAT)

Refractory material: only one type A brick was discovered in Zone III. Sample **07T1119④:1** is trapezoid in plan, bevelled edges with a reddish brown colouration. The remaining dimension is 10.8x10x7.2cm in length, width and height (Fig. 3.92:14).

Radiocarbon dating

Ten charcoal samples were collected from different contexts of Zones I and II in 2007, and four charcoal samples were collected from different layers of the discarded deposit of trench PXTTG2 in 2010 (Fig. 3.93). All samples were sent to the Peking University for radiocarbon dating analysis. The results were calibrated using OxCal v4.3.2 (Bronk Ramsey 2017) and IntCal13 (Reimer *et al* 2013). The half-life of carbon 14 used at the Peking University is 5,568 years and the BP is referring to a reference date of 1950. The result is shown in Table 3.8.

Fig. 3.93 Photo of 2010PXTTG2 at Tieniucun showing layers of this waste deposit (source: author)

Table 3.8 Calibrated C14 result of samples collected from Tieniucun by Peking University, China (1-4: CJAT, unpublished; 5-14: Zhou *et al* 2011, 325)

No.	Lab No.	Sample type	Context	C14 (BP)	Calibrated	
					(68.2%)	(95.4%)
1	BA132101	charcoal	2010CPXTK④	2195±25	355BC(46.8%)288BC 233BC(21.4%)202BC	361BC(95.4%)194BC
2	BA132102	charcoal	2010CPXTK①	2115±20	181BC(68.2%)106BC	199BC(88.7%)87BC 78BC(6.7%)56BC
3	BA132103	charcoal	2010CPXTK⑥	2120±25	192BC(68.2%)111BC	334BC(0.5%)330BC 204BC(94.9%)53BC
4	BA132104	charcoal	2010CPXTK⑤	2030±35	90BC(8.5%)73BC 59BC(59.7%)22AD	160BC(5.2%)132BC 118BC(90.2%)54AD
5	BA08318	charcoal	07H1	1850±35	126AD(68.2%)222AD	78AD(95.4%)240AD
6	BA08321	charcoal	07T1119④	1845±35	129AD(68.2%) 220AD	78AD(95.4%)244AD

No.	Lab No.	Sample type	Context	C14 (BP)	Calibrated	
					(68.2%)	(95.4%)
7	BA08322	charcoal	07T1119⑤	1865±35	86AD(55.1%)176AD 190AD(13.1%)212AD	71AD(95.4%)235AD
8	BA08323	charcoal	07T1119⑥	1875±35	78AD(59.6%)170AD 194AD(8.6%)210AD	65AD(95.4%)230AD
9	BA08324	charcoal	07H3③	1880±40	73AD(60.3%)170AD 194AD(7.9%)210AD	52AD(95.4%)236AD
10	BA08325	charcoal	07H3④	1880±35	74AD(55.1%)142AD 155AD(6.0%)168AD 195AD(7.1%)209AD	59AD(95.4%)228AD
11	BA08326	charcoal	07T0614③	1820±35	138AD(68.2%)235AD	87AD(2.6%)106AD 120AD(85.7%)258AD 282AD(7.1%)324AD
12	BA08327	charcoal	07T0614⑤	1735±40	248AD(66.3%)345AD 72AD(1.9%)376AD	180AD(0.3%)185AD 14AD(95.1%)404AD
13	BA08328	charcoal	07T0412H2	1905±35	60AD(68.2%)130AD	23AD(95.4%)214AD
14	BA08329	charcoal	SW terrace section	1845±35	129AD(68.2%)220AD	78AD(95.4%)244AD

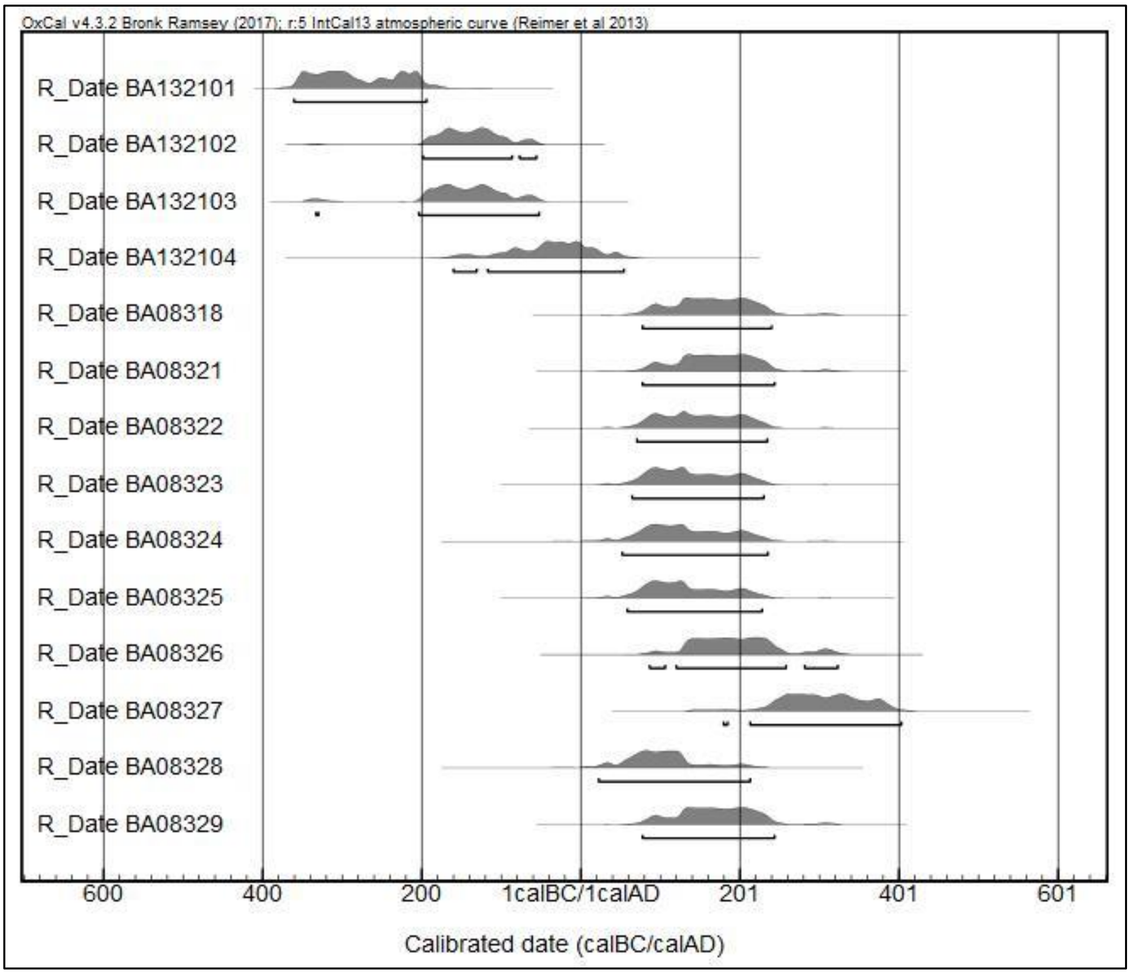
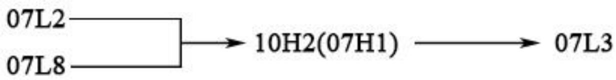


Fig. 3.94 Multiple plot of the calibrated dates of Tieniucun (source: author)

Discussion

Firstly, the study of the excavated pottery from Tieniucun and the other archaeological sites in the Chengdu plain (Ma 2011, 66-67) showed that some of the rounded object bottoms belong to the late Warring States period (4^{th}-3^{rd} centuries BC), most of the pottery jars, basins and bowls belong to the mid-late Western Han dynasty (c.150BC-50AD), and the *fu*-pot and the long neck vase were commonly seen in western Sichuan during the Eastern Han dynasty (c. 20-220AD, Zhou Z. *et al* 2008, 25). The radiocarbon dating result indicated a time range between the 4^{th} century BC to the 3^{rd} century AD. Combining both sources of evidence, the main operating period of the Tieniucun site was probably between 150BC to 200AD, which was the mid-late Western Han dynasty to the Eastern Han dynasty.

Secondly, the structure of the eight furnaces excavated at Tieniucun are similar to the refining furnaces excavated at Xuxiebian, and the discovery of refining slags indicate that the eight furnaces are refining furnaces. Only the bottom part of the furnaces was excavated at Tieniucun, and there is no evidence of tuyeres set up at the remaining height of the furnaces. These refining furnaces were probably blown from above type, like the discoveries at Xuxiebian. The furnaces have a same structure and were arranged in two lines indicating possible contemporaneity. In addition, pit **10H2**(07H1) was cut by furnace **07L2** and **07L8**, and was cutting through **07L3** (following diagram). The pottery excavated from **10H2** was dated to the late Western Han to the early Eastern Han dynasties. Thus, the refining furnaces discovered at Tieniucun could be evidentially dated to c.100BC-200AD.



Although no blast furnace remain was discovered at Tieniucun, but the refining furnace remains and the large amount of furnace bricks and highly vitrified slags excavated, indicated that there were probably more than one blast furnaces when the site was operating.

Type A bricks were carefully made, which were presumably used in construction of blast furnaces. The edges were bevelled which helps to strengthen the furnace structure by allowing for differences in edge height when bricks are butted together.

Type B bricks were tamped using different diameter sticks in wooden moulds. The bricks were made of clay with refractory inclusions and possibly dried naturally. The tamping impressions on multiple surfaces indicated that the bricks were also shaped without moulds. This type of bricks and type D bricks (also clay-made but no tamping impression) were commonly discovered applied in building blast furnaces during the Han dynasty. The bricks were butted together to build the furnace wall, and the wall was strengthened with the refractory clays as furnace lining from both inside and outside.

The blast furnaces at Tieniucun were presumably built using both type A and B bricks, which type A bricks were probably an advanced substitution of type B bricks. A reconstruction using the type A brick **09H2③:2** is demonstrated in Fig. 3.95. A total of 33-34 bricks could form a circular structure with an inner diameter about 100cm. Subtracting a 10-15cm for the interior furnace lining, the original inner diameter of the furnace was probably 85-90cm. The diameter-height ratio of a small modern blast furnace is about 1:3.7-4.5, from which we may presume the original height of the furnace at Tieniucun was about 320-400cm.

There were few slags discovered at Tieniucun, but large amounts of abraded slags were found at a village less than 1km, suggesting that the slags produced at Tieniucun were likely to be applied as road paving in nearby regions. A composition analysis of slags from both places is suggested in the future works.

On the other hand, all of the discovered tuyere fragments of Tieniucun were ceramic with one melted end, which indicated the tuyeres were attached into the furnace. Very few tuyere fragments were discovered at Tieniucun. This was also the general situation of the other iron smelting sites of Han dynasty such as Tieshenggou (Zhao Q. and Zhao 1962), Wangchenggang (Liu Haiwang and Zhao 2002), Xiahewan (Song G. 2009) and Guxingzhen (ZZSBWG 1978) of Henan province. It suggests that for most of the ancient Chinese iron smelting system especially before 200AD, only one tuyere was set up for bellowing. Unlike the monsoon wind-powered iron smelting site of Sri Lanka (Juleff 1998) and other Asian linear furnaces with multiple tuyeres of Cambodia (Bronson and Charoenwongsa 1986), Malaysia (Gasing and Davenport 1997), Burma (Hudson 2004, 200-201) and Japan (Rostoker *et al* 1989), where large amounts of tuyeres were discovered.

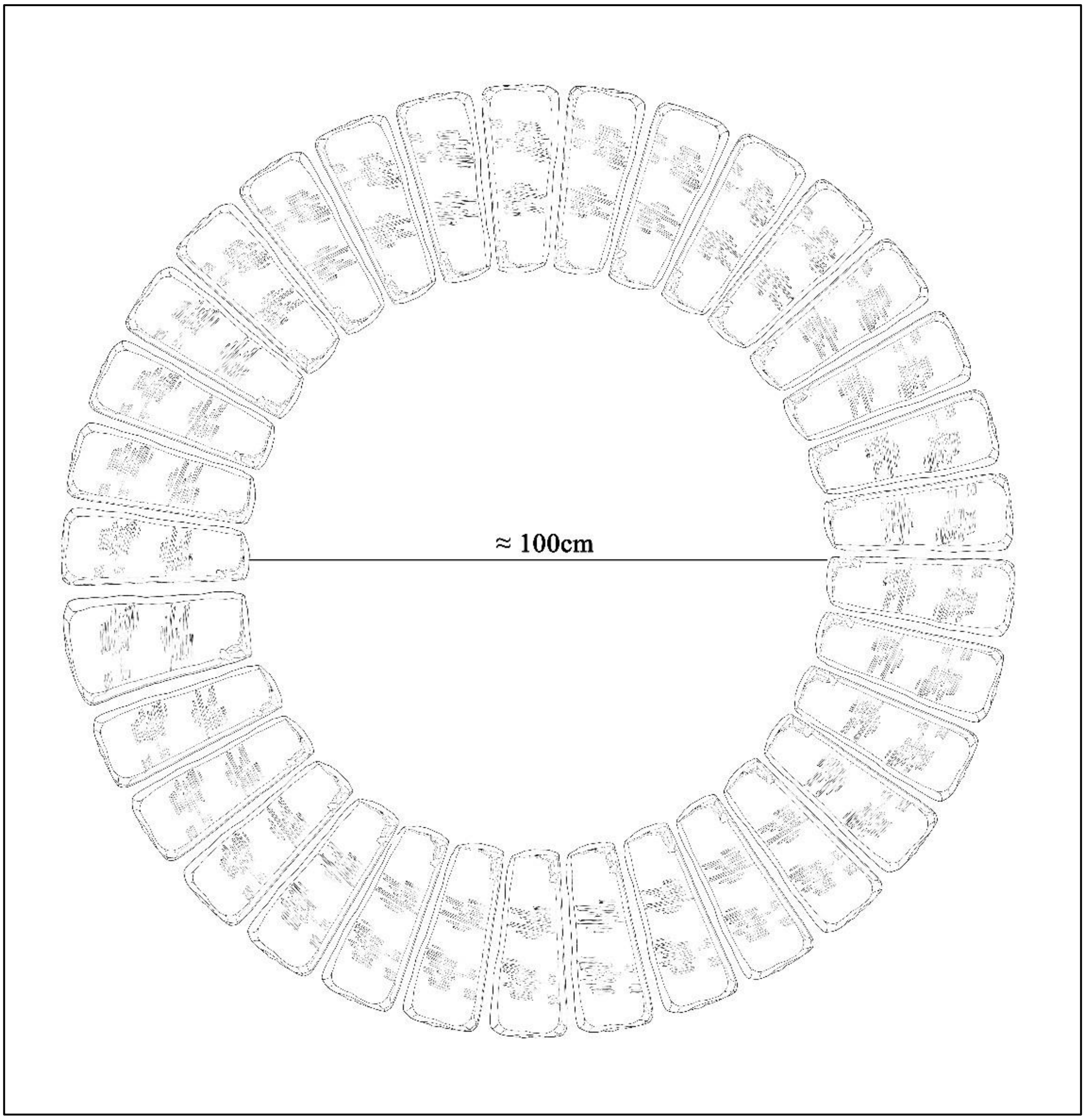


Fig. 3.95 A reconstruction of furnace plan structure of type A bricks excavated from Tieniucun (source: author)

According to the location and topography of the site, manpower was likely to be the bellowing method and no evidence of waterpower or animal power was discovered.

Charcoal was applied as the fuel at Tieniucun, and no evidence of coal, coke and bamboo was discovered. Three samples were sent to the Wood Science Research Center of Nanjing Forestry University and subjected to a tree species identification test. The samples were examined under the stereomicroscope (HIROX 3D Microscope). The result is shown in Table 3.9.

Table 3.9 Tree species identification results of charcoal sample from Tieniucun (translated from Chen J. *et al* 2009b, 267 table 6)

Name	No.	Context	Species identification
Charcoal	1	07PXTH3④ (fourth layer of pit 3)	Euphorbiaceae, *Endospermum*, *Endospermum Chinese*
Charcoal	2	07PXTT1119⑤ (fifth layer of trench N11E19)	Euphorbiaceae, *Sapium*, *Sapium sebiferum*
Charcoal	3	07PXTT0514③ (third layer of trench N05E14)	Fagaceae, *Castanopsis*, *Castanopsis sp.*

The species of tree used in making charcoal at Tieniucun include *Endospermum Chinese*, *Sapium sebiferum*, and *Castanopsis sp.*, which are the common species in the area. Besides these high efficiency charcoal types, one of the main excavators indicated that there was also low efficiency charcoal type such as *Magnoliaceae* discovered at the site (Ma 2011, 65-66). She concluded that the iron smelting activity at Tieniucun used both high and low efficiency charcoal types, which proved the smelting scale at the time was very large. However, she only mentioned the species identification test was done by the Research Center of Ancient East Asian Iron Culture of Ehime University, but did not give any further information. However, it was certain that charcoal was the only type of fuel applied at Tieniucun, most of them were cut into small pieces of 3-5cm before charging, and the wood could be found locally.

The iron ores used at Tieniucun were magnetite and hematite. The iron content is 40-50%, but it is very possible to be rejected ore left on site and therefore not representative of the ore smelted. The ore used for smelting at Tieniucun would be better than these left ore and may has an iron content higher than 60-70%.

Most of the ores have a reddish brown and black colouration and were usually crushed into 2-6cm pieces.

Thirdly, the pits. All three pits were dug on purpose. The clay from these pits may have been probably used to make furnace bricks and other refractory materials. The smelting related deposits dumped in different layers may indicate continuous smelting operation at Tieniucun. The pit wall of **H2** was straight at the top and flared at the bottom. It was probably a water pond and the bottom was eroded by the water before it was abandoned, which also explains the dark grey silt discovered at the bottom layer of the pit. The dumping direction was from east to west, which indicates the blast furnaces and the smelting were once on the east of the pit.

Fourthly, the salamander and the house foundation remain. A ‘salamander’ was formed at the base of a blast furnace. The liquid iron and slags gradually eat their way downward during several years of continuous operation, into the clay brick hearth and even into the tamped foundation beneath, sometimes weighing several tons. It is difficult and pointless to move the salamander thus they are usually discovered at their original position. The ‘salamander’ discovered at Tieniucun was 167cm long, 50-107cm wide, 37-92cm thick, and possibly weighing over 10 tons. There were no furnace remains or operating surface discovered around the ‘salamander’. It therefore possibly fell from the top of the hill on the north which means there was presumably a blast furnace 10-15m to the north of the house foundation remains. Unfortunately, the land was badly disturbed by the local farming activities.

There were four post-holes and one trench excavated from Zone II. The post-holes were possibly distributed in a circular shape originally with a total area around 30m^2. It was too small to be a living residence for the smelters and no tiles or house building bricks were discovered onsite. In addition, the ceramic objects excavated at Tieniucun were commonly seen daily use objects, which were possibly used by the smelters for eating and drinking during the smelting operation but their residence was somewhere else. This house foundation might be a shelter for the supervisors or officers to rest during the smelting operation and for storing smelting materials. There were large amount of slags, charcoal debris, and furnace brick fragments found both in the fills and at the bottom of the foundation poles as part of the structure, which indicated the shelter was built later than the smelting operation in Zone II.

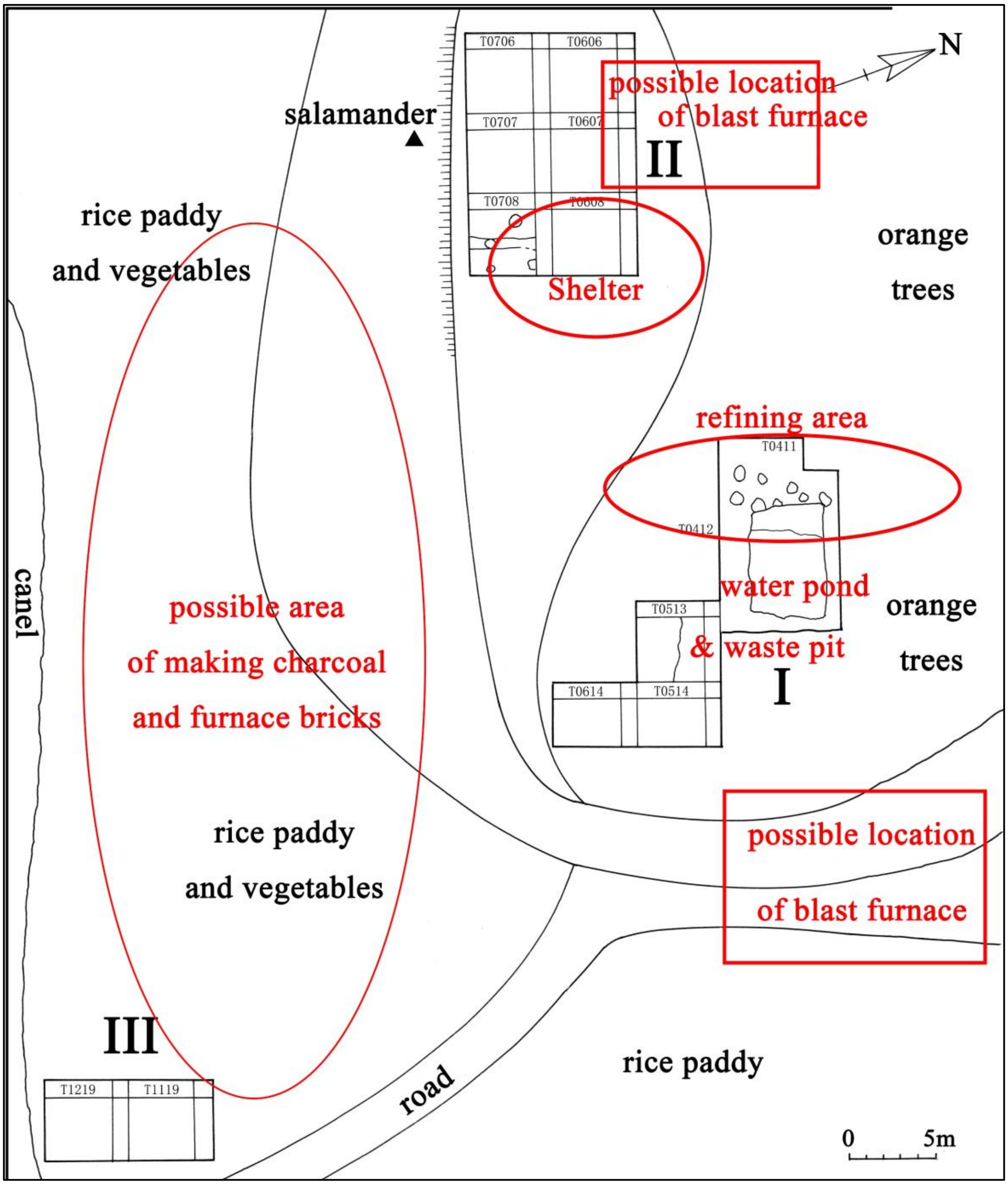


Fig. 3.96 Possible distribution of functional areas of Tieniucun (source: author)

It is interesting and important to know the identity of the smelters at the iron smelting sites. Tieniucun is about 60km away from Chengdu (which was also the location of the ancient Chengdu city), which would possibly take more than one or two days to travel in the past. Since the Han dynasty (202BC-220AD), as the improvement in development of blast furnace, the scale of the iron smelting and production became very large, requiring a large and reliable supply of charcoal. Therefore, most of the smelting locations at the time were located in deep mountains, one of the reasons was there were plenty of forest and space to make charcoal onsite. This situation was mentioned in the *Yan Tie Lun*, 'Discourses on salt and iron', written by Huan Kuan between 73 and 49 BC (Huan 1919, 12a). Gale (1967, 35) has the passages translated as below:

> The conscripted laborers (conscript and prisoners in the original texts) receive food and clothing from the district magistrates and they make and mould iron implements in great plenty to meet the need, with no hindrance from the people.
>
> ……
>
> Formerly (before the introduction of the state monopoly on salt and iron in 117 BC) the great families, aggressive and powerful, obtained control of the profit of the mountains and sea, mined iron at *Shih-ku* and smelted it, and manufactured salt. One family would collect a host of over a thousand men, mostly exiles who had gone far from their native hamlets, abandoning the tombs of their ancestors. Attaching themselves to a great house and collecting wickedness and counterfeiting their business, seeking to build up the power of their clique. Their readiness to do evil was also great.

Some important information could be extract from above, 1), prisoners were used both in the official and private iron smelting activities; 2), the iron smelting sites were usually located in isolated areas away from the cites. At such locations in deep mountains, using or hiring the prisoners or exiles could minimize the cost for the government or the owners. Southwest China was an undeveloped region compare with the Central Plains during the Han dynasty, where the central government would send the exiles to. In addition, like the other two iron smelting sites of Han dynasty at Gushishan and Xuxiebian, there was no moulds discovered at Tieniucun. This may indicate that the governmental strategy and policy of the Han dynasty to the Southwest China was allowing exploiting and smelting of iron but forbidding casting and forging onsite. It was presumably because that the smelters used in Southwest China were exiles and prisoners, which would be too risky to leave any opportunity for them to acquire iron weapons.

However, there was no evidence of residential sites of the Han dynasty found in the nearby region of Tieniucun. To understand where did the smelters live and what was their living environment requires more work in the future. There were some archive photos showing the prisoners' life at Nerchinsk, Siberia in 1891. It may give us some idea of the exiled laboring system (Fig. 3.97). The Akatuevskaya prison was located near the border of Russia and China (Fig. 3.97:a). The soldiers and the prisoners and their families formed a small society including facilities such as hospital, church, and even children's shelter. The prisoners were chained and lived in small rooms together (Fig. 3.97:b). The males were assigned to different works including iron smelting (Fig. 3.97:d), blacksmithing (Fig. 3.97:c), silver and lead smelting (Fig. 3.98:a), and the female prisoners were assigned to carry water and grow vegetables (Fig. 3.98:c). The products were transported to the nearby military base (Fig. 3.98:b). The supervisors were also lived here in a much better environment (Fig. 3.98:d). The difference was the government had no concern of the prisoners to produce iron objects onsite.

Fig. 3.97 Photos showing prisoners' life at Akatuevskaya prison (Anonymous 1891)

Fig. 3.98 More photos showing prisoners' life at Akatuevskaya prison (Anonymous 1891)

3.5.4 Shazitang

Introduction

The Shazitang site is located at Group 4 of the Mahu village, Xilai town, Pujiang county, Sichuan province (Fig. 3.99). The GPS coordinates are 30° 17′ 00″N, 103° 33′ 21″E, and the elevation is about 535m. The site is about 567m^2 and the deposit is about 1m thick.

The site was discovered during the third national survey of the cultural relics of China. Because one of the furnaces was exposed on the ground and was vulnerable to damage, a rescue excavation was carried out by the CJAT in 2009. A 6x6m archaeological trench (09PXST1) was excavated, in which 2 furnaces were revealed (Fig. 3.100).

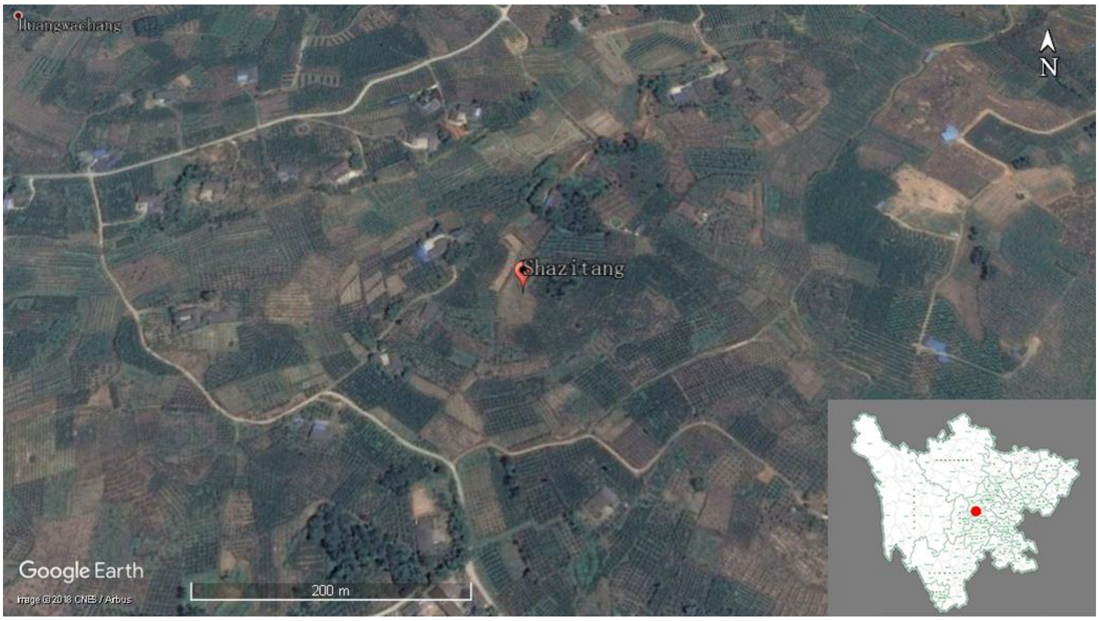


Fig. 3.99 Location of the Shazitang site (source: Google Earth)

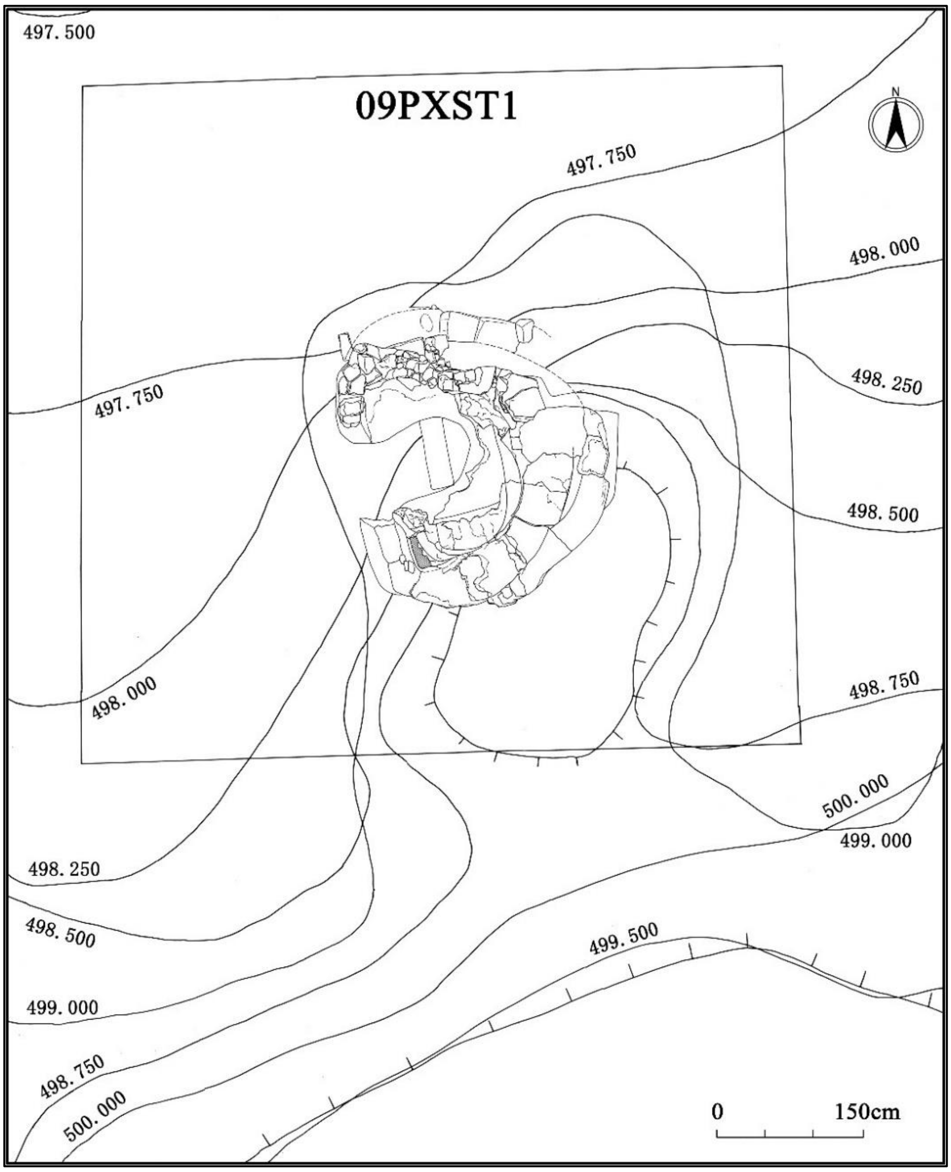


Fig. 3.100 Location of the furnace and contour of surrounding area at Shazitang (drawing by: Ma Chunyan)

Stratigraphy and deposits of the site

The stratigraphy of the excavated trench was unclear because the original deposits were disturbed and destroyed by local farming activities. Furnace 1 (L1) was built on top of furnace 2 (L2) after L2 was abandoned. The deposits of the surrounding area of the furnaces can be identified as nine layers (Fig. 3.101, Fig. 3.103 top left). The details are as follow.

①: Modern agricultural layer, yellowish brown clay, loose structure, and 0-22cm thick. No inclusions.

②: Modern layer, yellowish brown clay including small amount of plant roots, loose structure, 0-22cm to the ground surface, and 11-39cm thick.

③: Modern layer, yellowish brown clay, comparatively loose structure, 11-33cm to the ground surface, and 0-22cm thick. No inclusions.

④: Yellowish brown clay, comparatively tight structure, and 61cm thick. No inclusions.

⑤: Redish brown clay, tight structure, and 67cm thick. This deposit is possibly the refractory lining of the furnaces.

⑥: Yellowish brown clay, comparatively tight structure, 67cm to the ground surface, and 0-20cm thick. No inclusions.

⑦: Yellow and brown clay, comparatively tight structure, 11-22cm to the ground surface, and 33-45cm thick. The inclusion is small amount of porcelain sherds of the Tang and Song dynasties.

⑧: Yellowish brown clay, tight structure, 45-67cm to the ground surface, and 0-34cm thick. No inclusions.

⑨: Yellowish brown clay, loose structure, 23-50cm to the ground surface, and 0-95cm thick. The inclusion is small amount of white porcelain sherds.

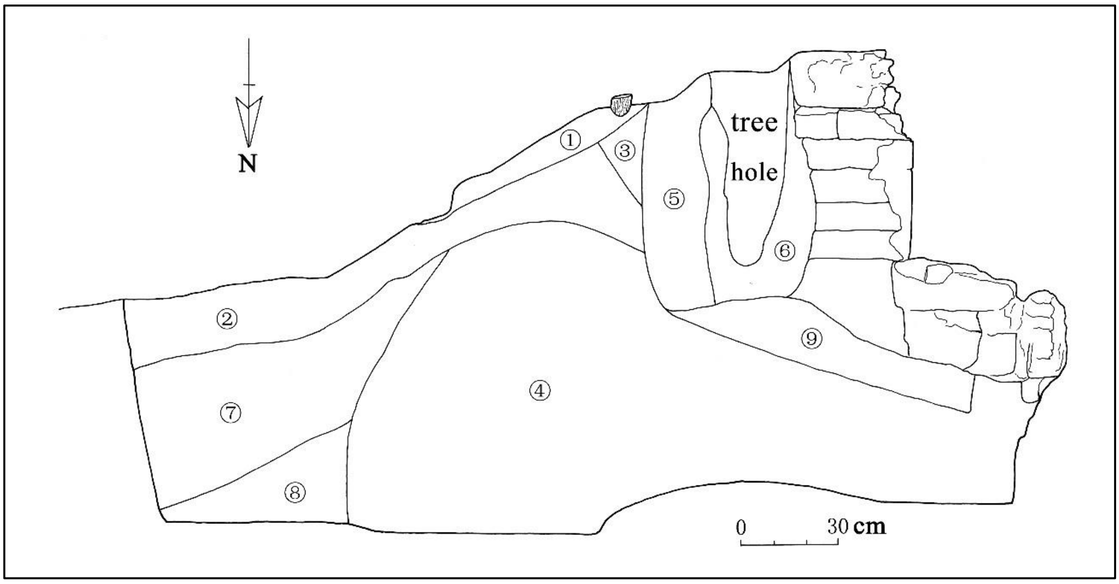


Fig. 3.101 Section of the surrounding area of furnaces L1 and L2 at Shazitang (drawing by: Ma Chunyan)

Archaeological features

Two furnaces were excavated by the CJAT in 2009.

Furnaces:

L1, the furnace was built against the terrace section and was buried partially underneath layer ②. The remaining foundation of the furnace is U-shaped in plan with a diameter of 172-260cm and a remaining height about 110cm. The southeast furnace wall reused the earlier furnace wall of L2. The furnace wall comprised two layers, both constructed with furnace bricks. The inner wall is 10-28cm thick, and the outer wall is 23-28cm thick. Refractory clays were used between the layers and the bricks. The length of furnace bricks is unclear because of weathering, the width is about 25-28cm which is same as the thickness of the furnace wall, and the thickness of the bricks is 15cm. There is a burned clay layer of 4-5cm with many adhering slags on the interior furnace wall (Fig. 3.103 bottom right). Most of the furnace bottom was destroyed, the original bottom was bowl shaped according to the remaining part and about 65cm higher than the bottom of furnace L2. The furnace bottom is about 10cm thick (Fig. 3.102 and Fig. 3.103 bottom left).

L2, the furnace overlapped by furnace L1. The furnace top is circular in plan, and the furnace wall structure is the similar as L1. The inner wall is about 40cm thick, and the outer wall is 20-25cm thick. There is also a burned clay layer of 4-5cm with adhering slags on the interior furnace wall, which is covered by the layer of L1 and partially exposed. The furnace bottom was partially destroyed, and the original bottom was flat and squared in plan with a side length about 100cm. Below the furnace bottom is the rock bed instead of virgin soil. The remaining height of the furnace is 160cm (Fig. 3.102 and Fig. 3.103 top right).

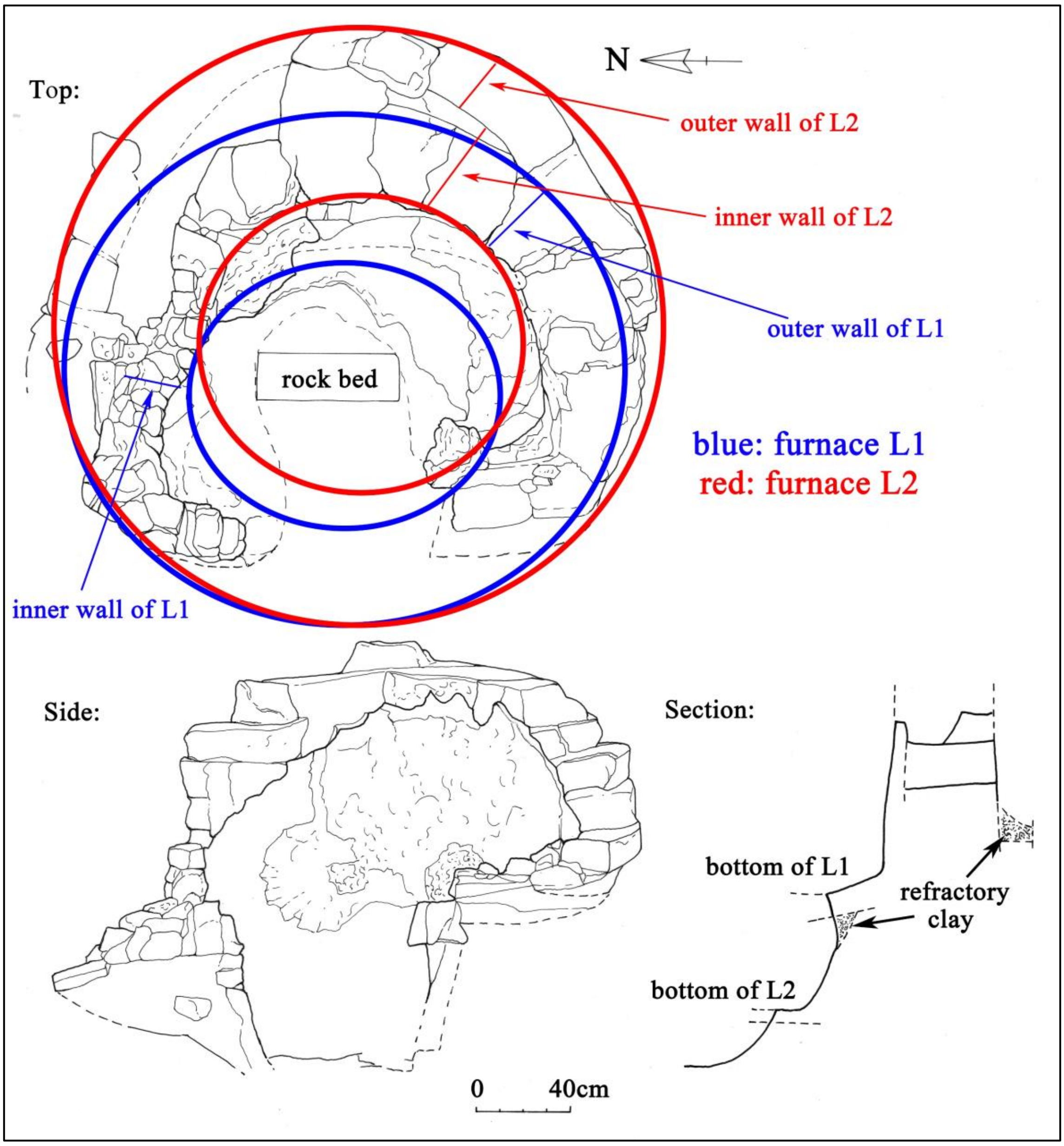


Fig. 3.102 Plan and section of furnaces L1 and L2 at Shazitang (drawing by: Ma Chunyan)

Fig. 3.103 Details of furnaces L1 and L2 at Shazitang (photo by: Ma Chunyan)

Finds

The cultural deposit around the furnaces was completely disturbed by local farming activities. Only two ceramic tuyeres, some white porcelain sherds and one porcelain artifact bottom were excavated.

Tuyeres:

The tuyeres discovered were fragment, about 10-15cm size with a clear arc in the section, rough on the exterior surface and smooth on the interior surface (Fig. 3.104:2-3). The porcelain artifact bottom is shown in Fig. 3.104:1, and the white porcelain sheds could be dated to the Tang and Song dynasty (7th-14th centuries AD).

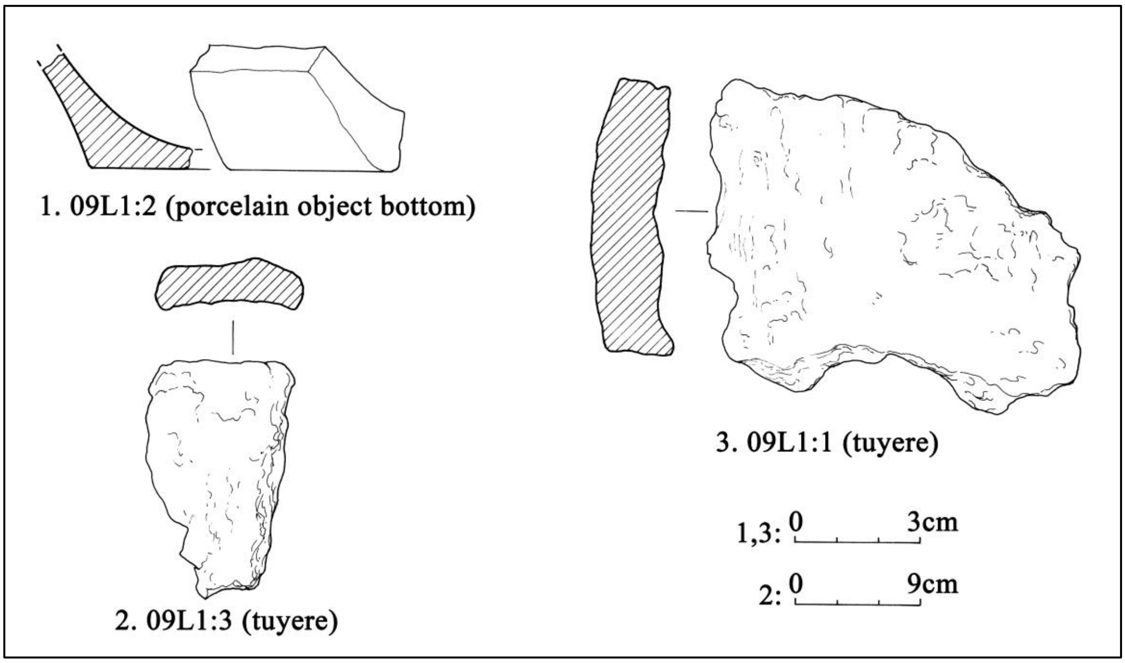


Fig. 3.104 Porcelain and tuyeres discovered at Shazitang (source: Ma Chunyan)

Refractory material:

Few fragments of limestone furnace brick were discovered and recorded.

The limestone furnace brick fragments were similar to the discoveries at Xuxiebian. A thin layer of slags on the surface. The sections have different colours of greyish white, yellow and orange indicating different temperatures. There was one bigger slag adhering to one of the surface, which contains many charcoal fragments (Fig. 3.105:1).

Slag:

Few furnace slags were discovered at Shazitang. Furnace slags, brown and grey colours with abraded surface texture and were partially magnetic (Fig. 3.105:3).

Others:

There were some limestone bars discovered at Shazitang, which were possibly used as flux (Fig. 3.105:2). One curved plate with dimension of 11x9x1.5cm (09PXSL1:8), greyish white colour on the surface, brown and black with some metallic colours on the section, which its function was unidentified (Fig. 3.105:4).

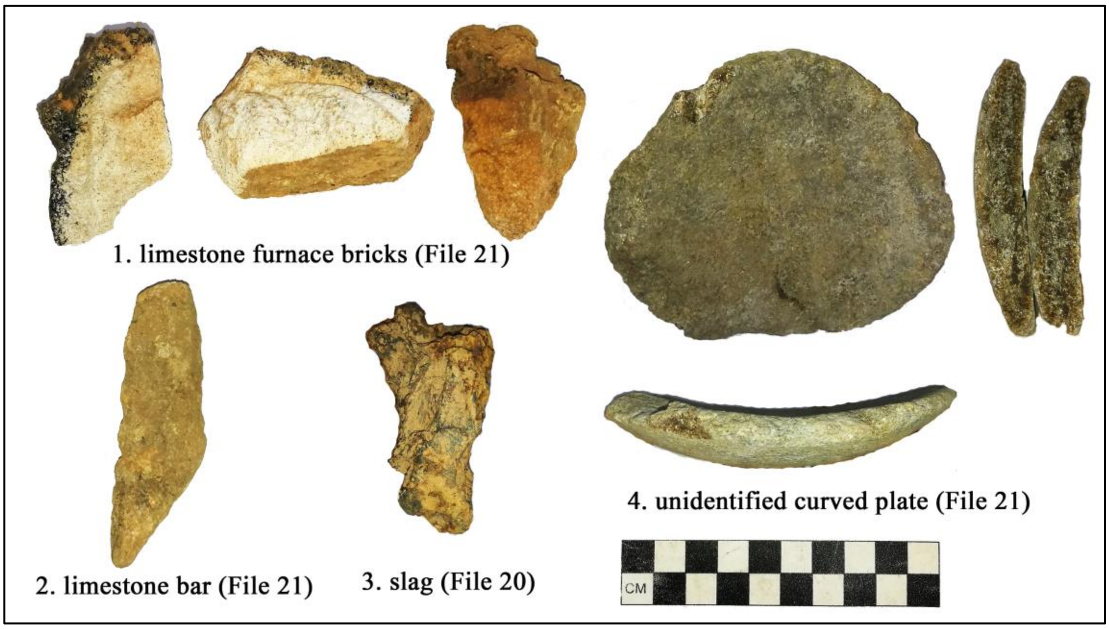


Fig. 3.105 Refractory and slag discovered at Shazitang (source: author)

Radiocarbon dating

There was only one charcoal sample collected from Shazitang and sent to the Peking University for radiocarbon dating analysis. The calibrated result is shown in Table 3.10. The result was calibrated using OxCal v3.10 (Bronk Ramsey 2005) and IntCal04 (Reimer *et al* 2004). The half-life of carbon 14 used at the Peking University is 5,568 years and the BP is referring to a reference date of 1950.

Table 3.10 Calibrated C14 result of sample collected from Shazitang by Peking University, China (source: CJAT, unpublished)

Lab No.	Name	Sample type	Context	C14 (BP)	Calibrated	
					(68.2%)	(95.4%)
BA132 112	PSZT1	charcoal	furnace L1 from 09XDST1	495±20	1415AD(68.2%) 1435AD	1410AD(95.4%) 1445AD

Discussion

The Shazitang site was one of the earliest archaeometallurgy fieldwork investigation carried out in Southwest China. The site had been badly disturbed, and the lack of excavating experience and methods of metallurgic site resulted a very limited recording of slags and refractory materials. Most of the work was concentrated on finding and excavating the furnaces.

According to the remaining structure of the furnaces, the furnaces were built similarly to the other Han dynasty blast furnaces discovered in Southwest China. Firstly, dig a pit along the terrace section and fire the pit. Secondly, build the furnace wall inside the pit using clay bricks. Lastly, strengthen both the interior and exterior furnace wall with additional layers of refractory clay.

There were two squared holes about 25cm long connected with a trench impression about 30cm away on the flat (west) side of the U-shaped furnace (Fig. 3.106). It was probably the evidence of where the wooden structure of the bellows was set up. A similar structure was discovered at the Wangchenggang Han dynasty iron smelting site in Henan province (Liu Haiwang and Zhao 2002, 4 fig.2 and p.11). It was reasonable to bellow on the shorter diameter side for a higher efficiency. Based on this assumption, manpower was applied for bellowing.

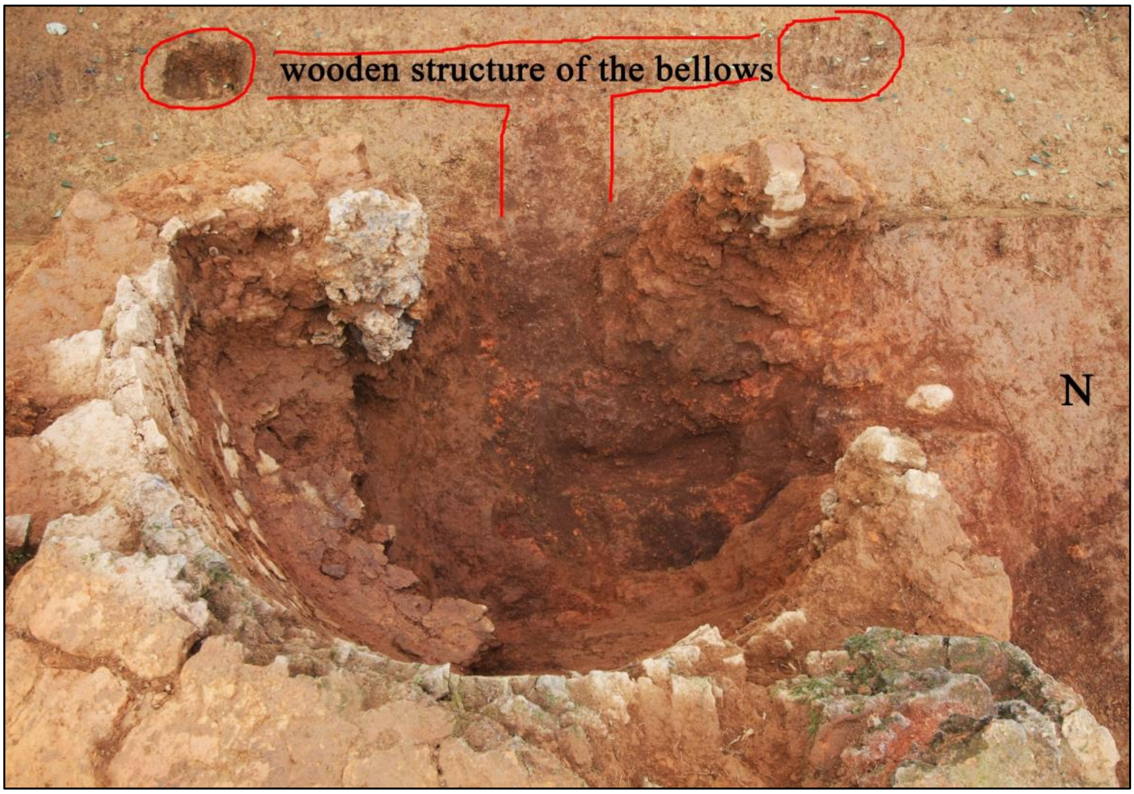


Fig. 3.106 Evidence of the wooden structure of the bellows at Shazitang (east to west, photo by: Ma Chunyan)

The tapping hole and working ground were probably on the northern side of the furnace. There is a hilly deposit with no archaeological inclusions on the east of the furnace, which might be constructed for the convenience of charging fuels and raw materials (Fig. 3.107). The reason of the broken bottom of furnace L2 was possibly because that the tuyeres were collected and reused by the smelter.

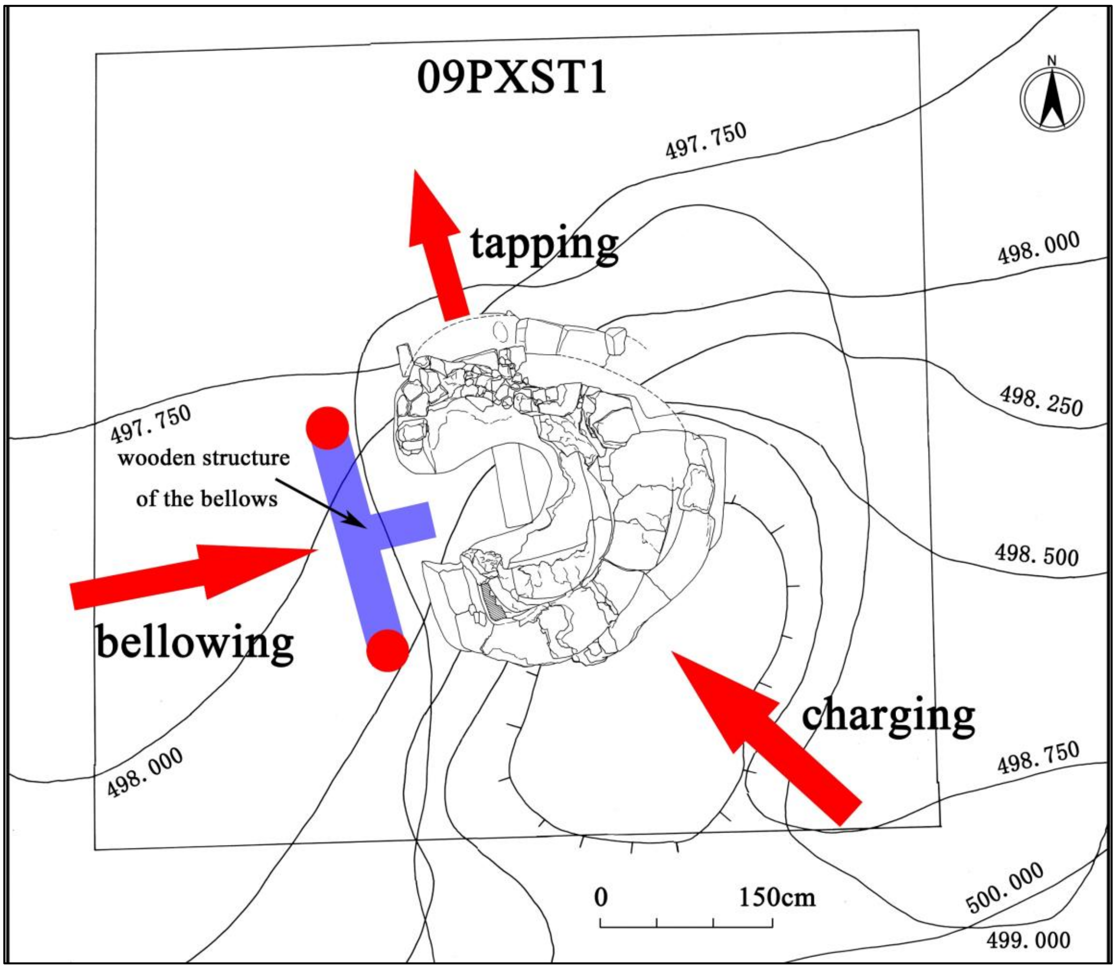


Fig. 3.107 Diagram showing the details of the smelting at Shazitang (base picture: Ma Chunyan)

The radiocarbon dating result of the charcoal sample collected from furnace L1 provided a 95.4% confidence interval between 1410-1445AD. The typology study of the limited excavated porcelain suggested a time period from the 10^{th} to the 14^{th} century AD (Ma 2011, 88). Although the structure of the blast furnace seemed probably older than these dates, there were not enough evidence to conclude the definite date of the Shazitang site. However, it was certain that the site was a cast iron smelting site.

3.5.5 Chadiping

Introduction

The Chadiping site was located on a steep hillside at Group 8 of the Linjiangshequ, Pengshui county, Chongqing (Fig. 3.3). The GPS coordinates are 29° 21′ 10″N, 108° 07′ 24″E, and the elevation is about 355m. The site is on the west bank of the Wu river, which is a main tributary of the Yangtze river. The direct distance from the site to the Wu river is less than 500m (Fig. 3.108).

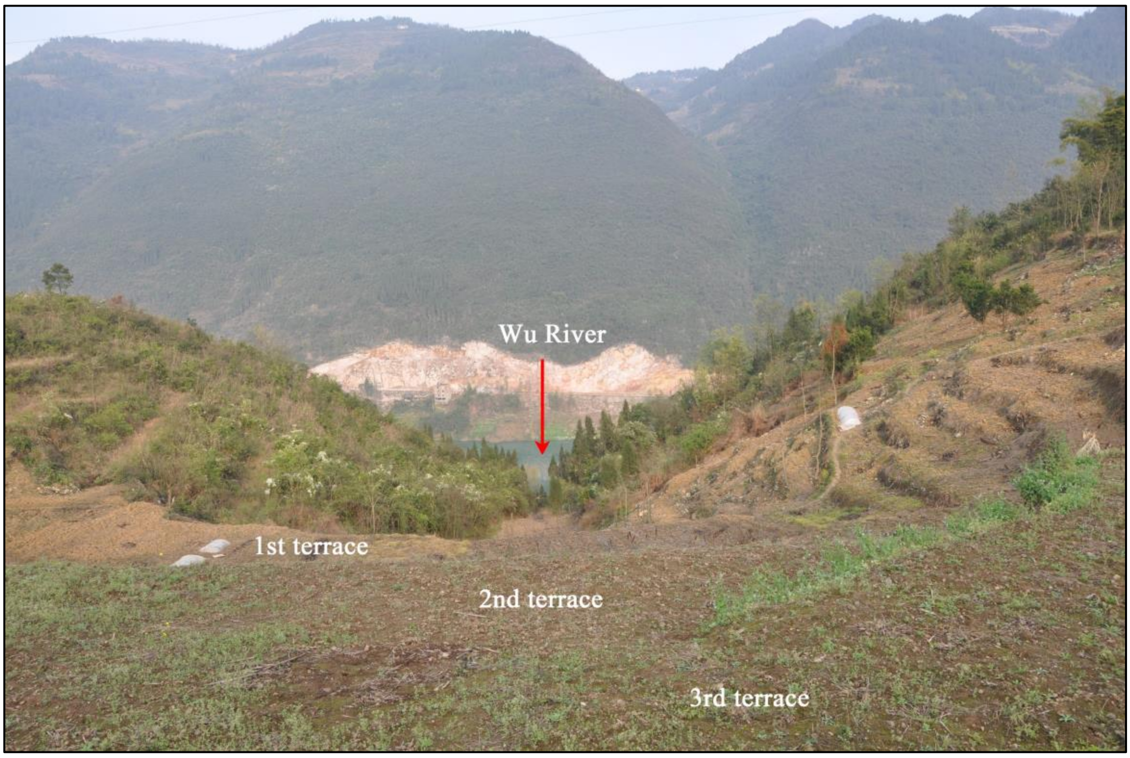


Fig. 3.108 Overview of Chadiping site (west to east, source: author)

The site was first recorded as the 'Datian' site in the third national survey on the cultural relics of China. In 2012, the Chongqing Cultural Heritage Research Institute carried out some preliminary survey at the site and discovered 21 furnaces. In the December of 2014, the Sichuan University and the Chongqing Cultural Heritage Research Institute re-investigated the site, during which 10 furnaces were confirmed and 5 of them were excavated (Fig. 3.109). According to the landowner, there were still more than 100 furnaces distributed on each terrace toward the Wu river in the 1950s, and there was another iron smelting site of the Great Leap Forward (1958-1960) on the northern bank of the Duiwo stream (about 500m north of Chadiping, Fig. 3.139). However, the furnaces of the Great Leap Forward period were all destroyed nowadays.

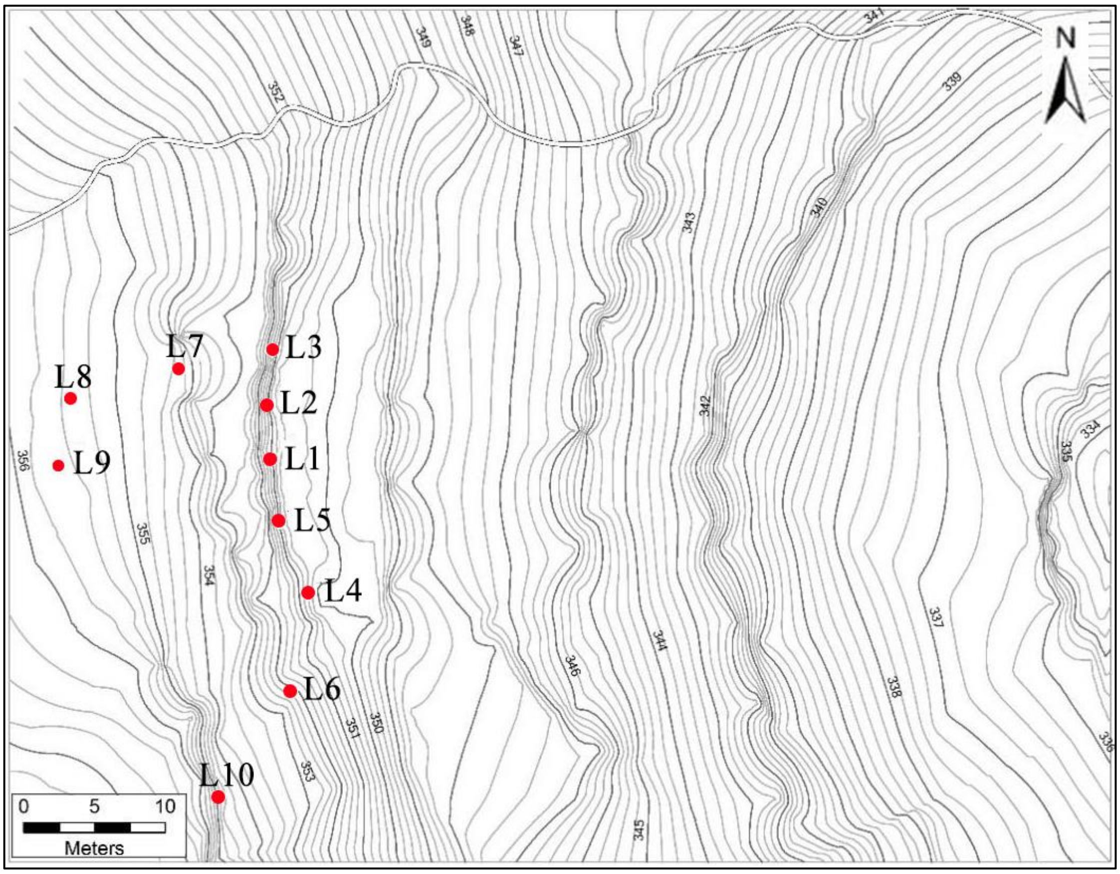


Fig. 3.109 Showing location of furnace 1-10 and the 1m elevation of Chadiping (base map was provided by Pengshui Cultural Relics Institute)

Stratigraphy and deposits of the site

The main discoveries of the Chadiping site were furnaces, which were all exposed on the ground. The furnaces were located in two linear groups, which each group was situated by the section of the terrace. All furnaces were built on top of the virgin soil and now covered by a modern agricultural layer and sometimes discarded deposits (Fig. 3.110). The modern layer was brown clay, loose structure, about 75-200cm thick and contained large amount of plant roots. The discarded deposits, e.g. the fills above L2, contained large amount of broken rocks, charcoal debris and burned soil particles, it was about 6cm thick and 82cm long.

Fig. 3.110 Western side of 2014PLDTG1 showing furnaces L1-5 and surrounding deposits at Chadiping (source: Liu Fang)

Archaeological features

Five furnaces were excavated (L1-L5) and the other five were surveyed and recorded (L6-L10) in the December of 2014.

Excavated furnaces:

L1 was located in the middle part of trench 2014PLDTG1 (TG1), 4m south of L2, and 4m north of L5. The furnace was built against the terrace and cutting through the virgin soil. It was buried underneath layer ③ of trench TG1 (Fig. 3.111:a-b). The furnace was slightly elliptic in plan, which the north-south diameter was 147cm and the west-east diameter was 173cm. The inner diameter was 80-93cm, and the remaining height of the furnace was 158cm. The furnace wall was constructed with refractory clay bricks of a thickness between 17-28cm, and the gaps between the bricks were repaired with refractory clay. Refractory clay was a combination of the sand from crushed sandstone mixed with clay. The refractory clay was also used to construct a 10-15cm furnace lining on the interior furnace wall. There was a layer of adhering slags on the interior furnace wall, which was thicker on the east and west (Fig. 3.111:e-f). The U-shaped tapping hole was on the east of the furnace, which was about 50cm wide and 60cm high (Fig. 3.111:a). The bottom of the furnace was higher in the back and lower at the front. There was a 35x35cm gap on each of the southern and northern furnace wall, which might be where the tuyeres were set up (Fig. 3.111:c-d). The fills were greyish brown sandy clay with inclusions of plant roots, slags, and charcoal debris.

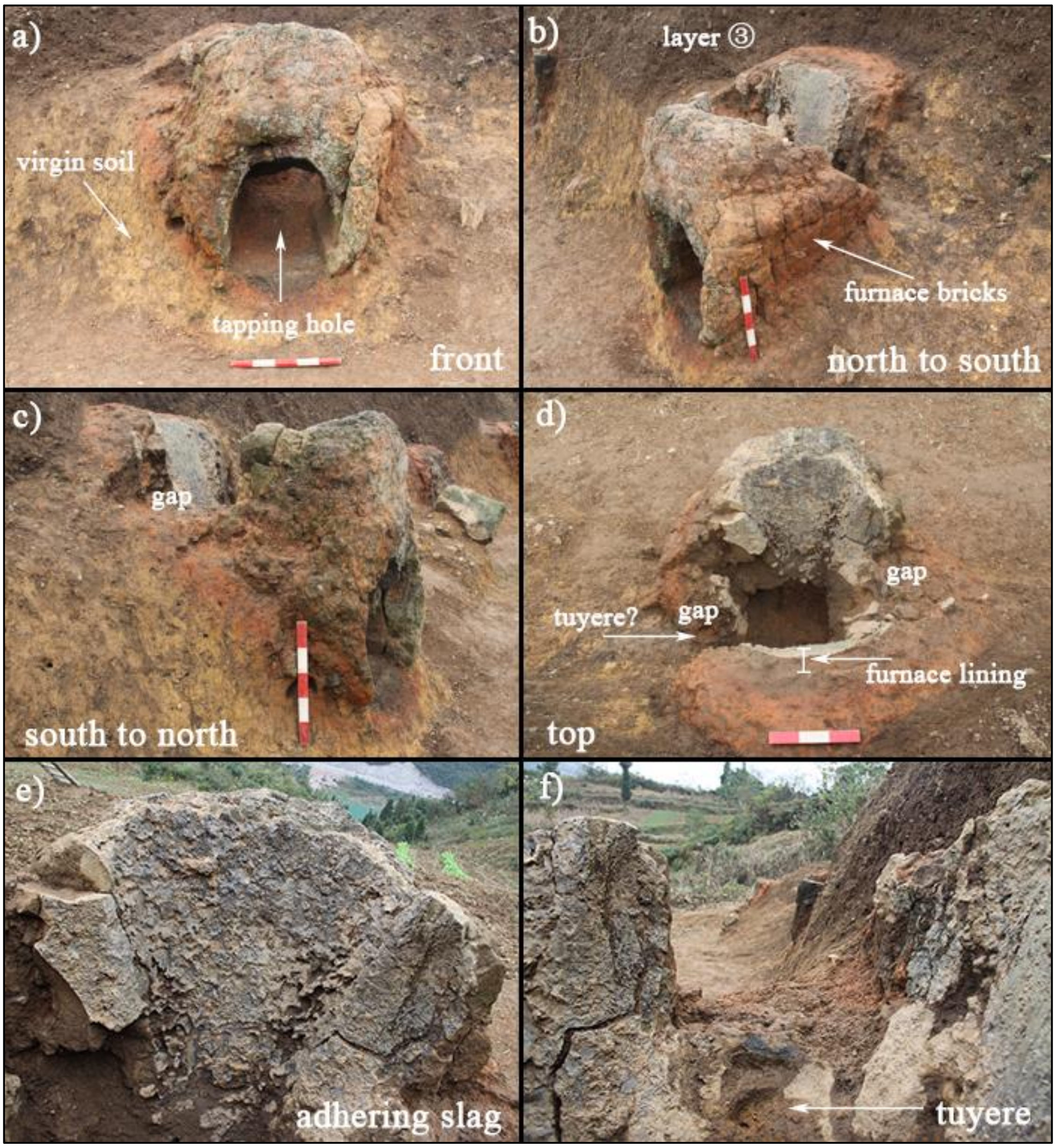


Fig. 3.111 Photos of furnace L1 at Chadiping (source: Liu Fang)

L2 was located in the northern part of trench 2014PLDTG2 (TG2), about 4m south of L3, and 4m north of L1. The furnace was built against the terrace and cutting through the virgin soil (Fig. 3.112:a), only the half of the furnace wall by the terrace was preserved. The furnace was almost square in plan at the bottom, the outer diameter was 142-150cm, the inner diameter was 86cm, and the remaining height was 153cm. The furnace wall was constructed with furnace bricks about 17cm thick. The gaps between the bricks were repaired with refractory clays. The exterior furnace covering was orange colour and about 10-20cm thick (Fig. 3.112:b). Two different interior furnace linings could be identified, the first layer was 17cm thick on the south side and 10cm thick on the north side, dark grey colour consisted with refractory clay and small stones with a thin layer of adhering slags. The second layer overlapped the first furnace lining, yellowish grey colour, which was 5cm thick with a thin layer of adhering slags (Fig. 3.112:c-d). The bottom of the furnace consisted of three layers, from top to bottom was furnace bricks, furnace lining, and charcoal debris. No evidence of tuyeres or tapping hole remained. The fills contained grey and brown sandy soil and plant roots. One charcoal sample was collected from the charcoal layer and subjected to radiocarbon dating.

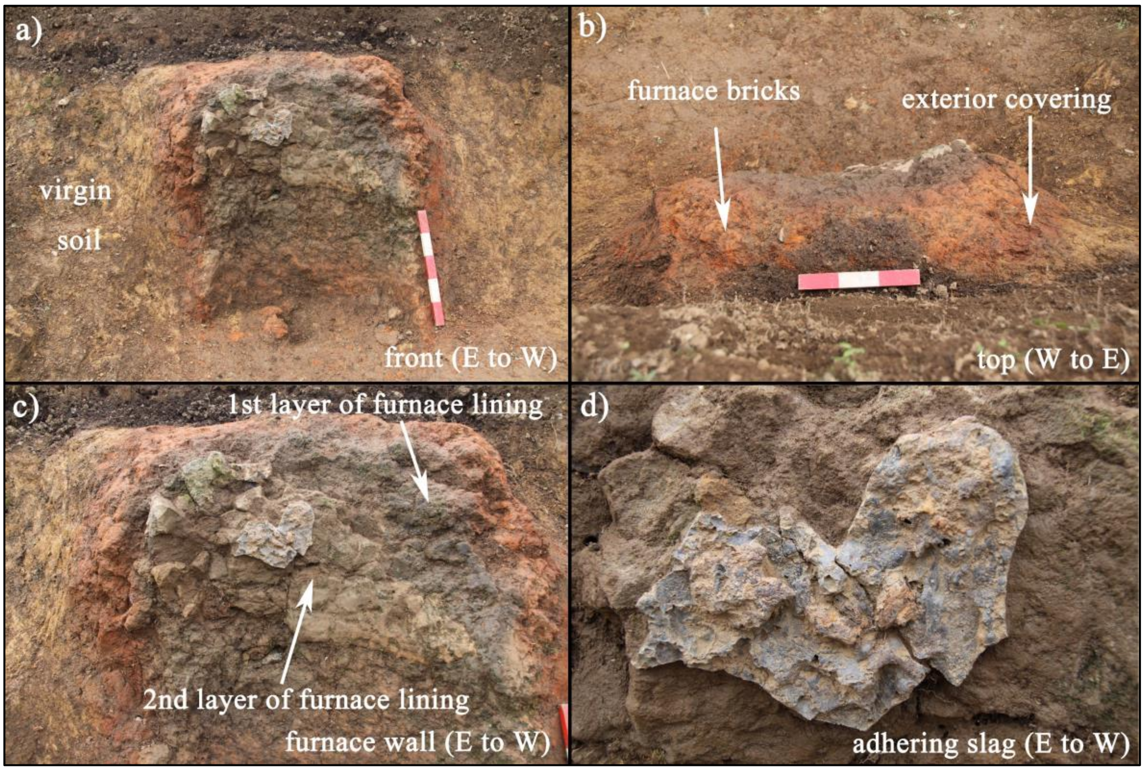


Fig. 3.112 Photos of furnace L2 at Chadiping (source: Liu Fang)

L3 was located in the northern part of trench TG1, about 4m north of L2. The furnace was built against the terrace and cutting through the virgin soil. It was buried underneath layer ① of TG1 (Fig. 3.113:a). The east and south furnace wall were destroyed. The furnace was slightly elliptic in plan, which the north-south outer diameter was 128cm and the west-east diameter was 145cm. The inner diameter was 73-80cm, and the remaining height of the furnace was 150cm. The furnace wall was constructed with refractory clay bricks of a thickness between 20-40cm (Fig. 3.113:b). The gap between the bricks was repaired with refractory clay. The exterior furnace covering was orange colour and about 15cm thick. Two different interior furnace linings could be identified, the first layer was about 8cm thick, dark grey colour consisted with refractory clay and small stones with a thin layer of adhering slags. The second layer was the same as the first layer, about 5-10cm thick with a thin layer of adhering slags (Fig. 3.113:b-c). There was a 10x15cm gap in the northern furnace wall with a 40° angle, which might be where the tuyere was set up (Fig. 3.113:c-d). The tapping hole was on the east of the furnace, but the size was uncertain (Fig. 3.113:a).

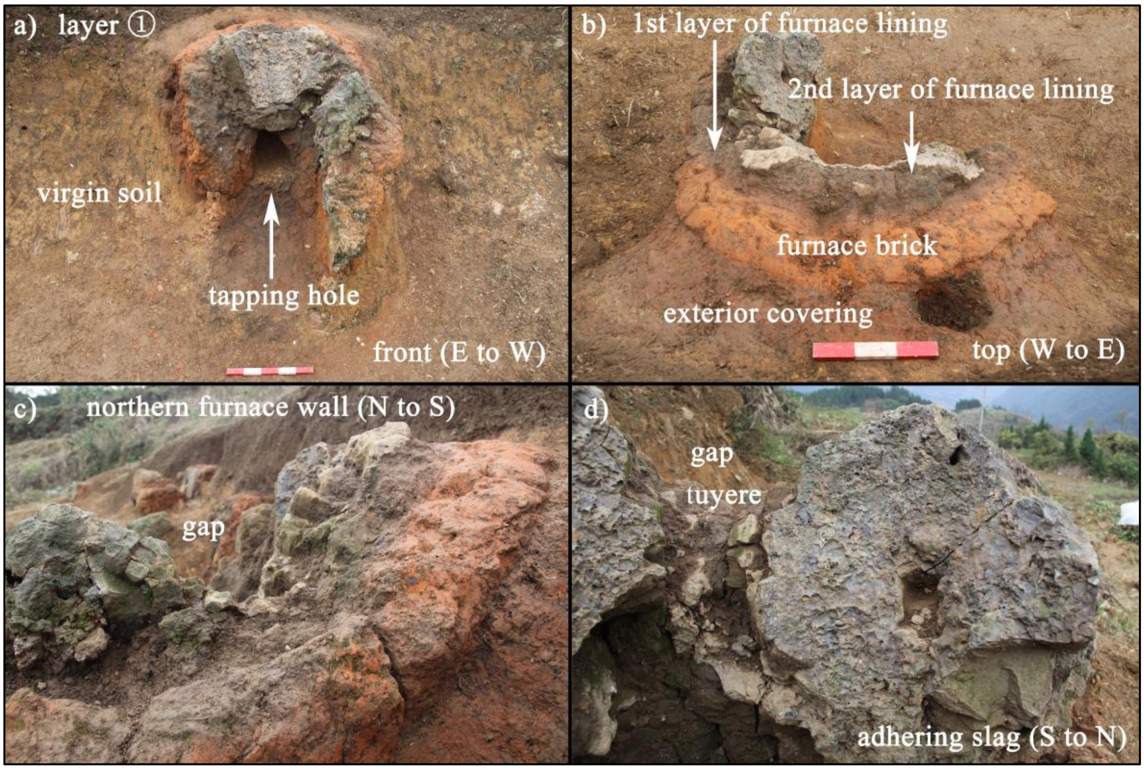


Fig. 3.113 Photos of furnace L3 at Chadiping (source: Liu Fang)

L4 was located in the middle part of trench TG2, about 8m north to L5. The furnace was built against the same terrace where L1-L3 and L5 were built but slightly to the east, and cutting through the virgin soil (Fig. 3.114:a). There were platforms constructed with stones on both south and north of the furnace. Most parts of the furnace were destroyed and only the western furnace wall was preserved. According to the remaining furnace wall, the outer diameter was probably 130cm and the inner diameter was about 70cm. The furnace wall was constructed with refractory clay bricks of a thickness about 25cm. The gaps between the bricks were repaired with refractory clay. The interior furnace lining was about 10cm thick, dark grey colour consisted with refractory clay and small stones with a thin layer of adhering slags (Fig. 3.114:b-d). No evidence of tuyeres or tapping hole remained. The fills contained greyish brown sandy soil and plant roots.

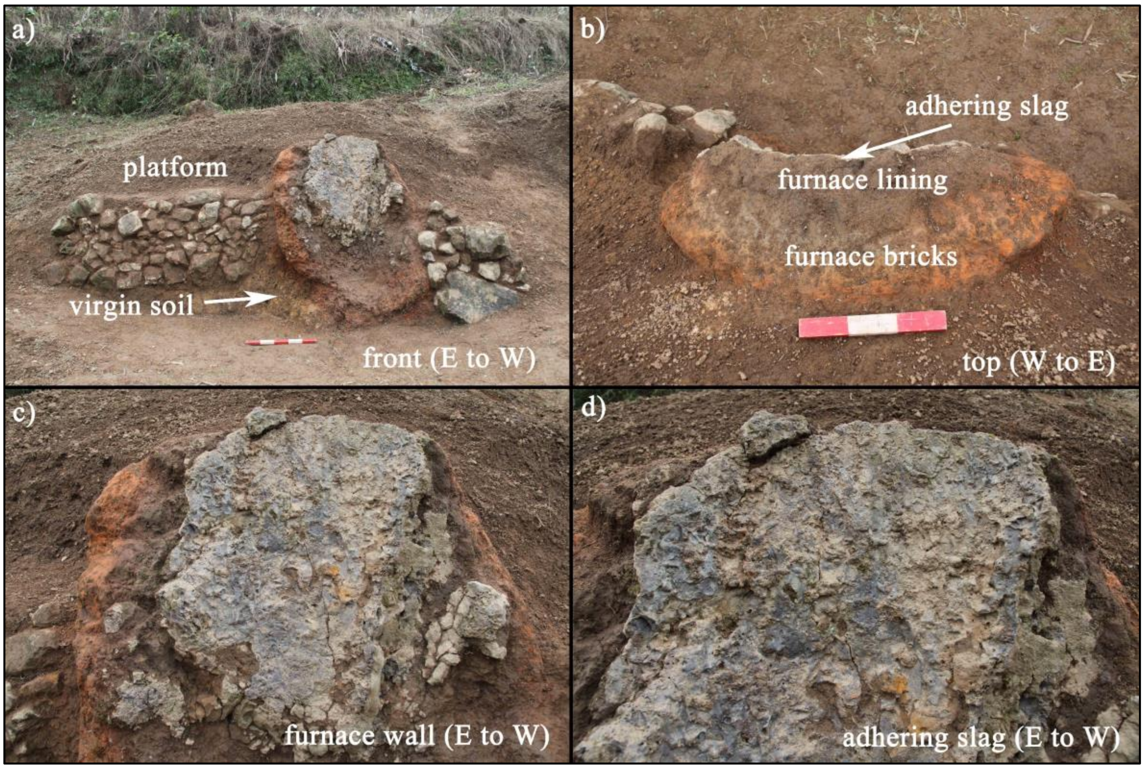


Fig. 3.114 Photos of furnace L4 at Chadiping (source: Liu Fang)

L5 was located in the southern part of trench TG2, about 5m south of L1 and 8m north of L4. The furnace was built against the terrace and cutting through the virgin soil. Most parts of the furnace were destroyed and only the western furnace wall was preserved. According to the remaining furnace wall, the outer diameter was probably 130cm and the inner diameter was about 90cm. The remaining height of the furnace was 120cm. The furnace wall was constructed with refractory clay bricks of a thickness about 10cm. The gaps between the bricks were repaired with refractory clay. The exterior furnace covering was orange colour and about 5cm thick. The interior furnace lining was greyish white colour and consisted of refractory clay and small stones with a thin layer of adhering slags. It was severely destroyed, so that the original thickness was undetermined (Fig. 3.115). No evidence of tuyeres or tapping hole remained.

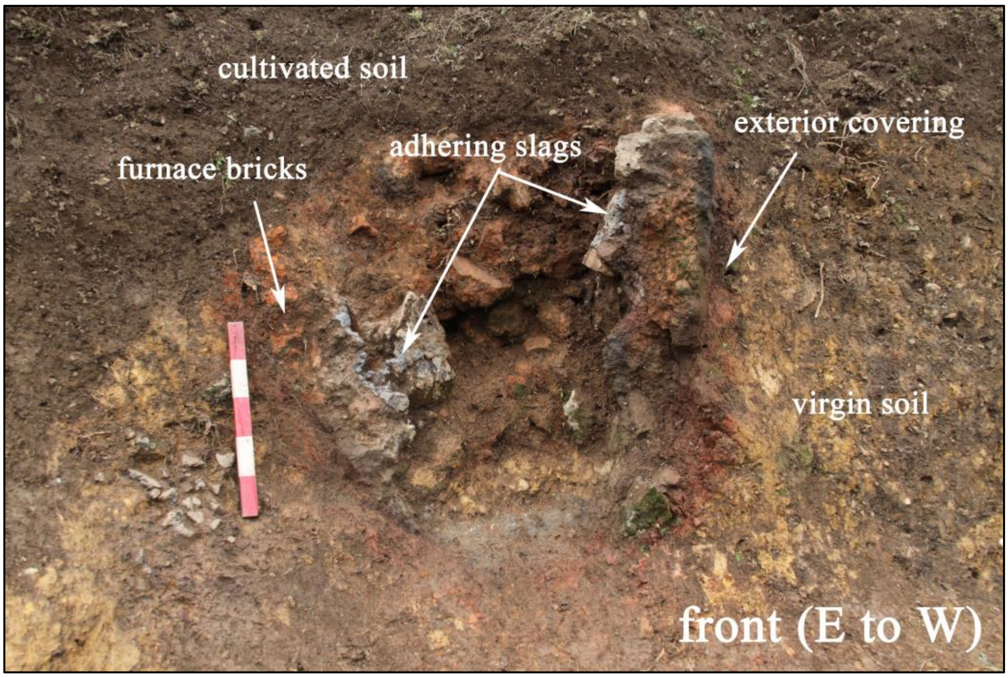


Fig. 3.115 Photos of furnace L5 at Chadiping (source: Liu Fang)

Furnaces surveyed:

L6 was located 4m south of L4, and was built against the terrace. The furnace had collapsed and was partially preserved. The dimension of the furnace north-south was about 185cm, and the remaining height was 200cm. The inner diameter was 60cm. The furnace brick was made with sandstones of a thickness about 25cm. The fills inside the furnace contained iron ores and furnace brick fragments (Fig. 3.116).

Fig. 3.116 Photo of furnace L6 at Chadiping (east to west, source: Liu Fang)

L7 was located west of L3, and was built against the upper terrace of L1-L5. The furnace had collapsed and was partially preserved. The remaining dimension of the furnace north-south was 220cm, and the remaining height was 140cm. There were two different thicknesses of clay bricks discovered in building the furnace, the thinner type was 8-15cm and the thicker type was 20-35cm. There was some adhering slag on the interior furnace wall. The fills contained iron ore and slags (Fig. 3.117).

Fig. 3.117 Photo of furnace L7 at Chadiping (east to west, source: Liu Fang)

L8 was located southwest of L7, and was built along the hill slope. The furnace had collapsed and was partially preserved. The remaining dimension of the furnace north-south was 185cm, and the remaining height was 65cm. There was adhering slag on the interior furnace wall. The fills contained iron ores and slags (Fig. 3.118).

L9 was located south of L8. The furnace was badly destroyed with only a small part was preserved. The remaining dimension north-south was 115cm, and the remaining height was 30cm. The remaining furnace wall was about 15cm thick with some adhering slags. The fills contained iron ores, slags, and furnace brick fragments (Fig. 3.119).

Fig. 3.118 Photo of furnace L8 at Chadiping (east to west, source: Liu Fang)

Fig. 3.119 Photo of furnace L9 at Chadiping (top view, north to south, source: Liu Fang)

L10 was located southwest of L6, and was built against the upper terrace of L6 and L7. The furnace was badly destroyed with only a section of the furnace wall and part of the base preserved. The remaining dimension north-south was 175cm, and the section of furnace wall was about 210cm high. The fills contained charcoal, iron ores, and furnace brick fragments (Fig. 3.120).

Fig. 3.120 Photo of furnace L10 at Chadiping (east to west, source: Liu Fang)

Finds

Pottery and porcelain:

Very few pottery and porcelain sherds were excavated in 2010 and 2014 (Fig. 3.121). The types were unidentified. The details were recorded in appendix C3.

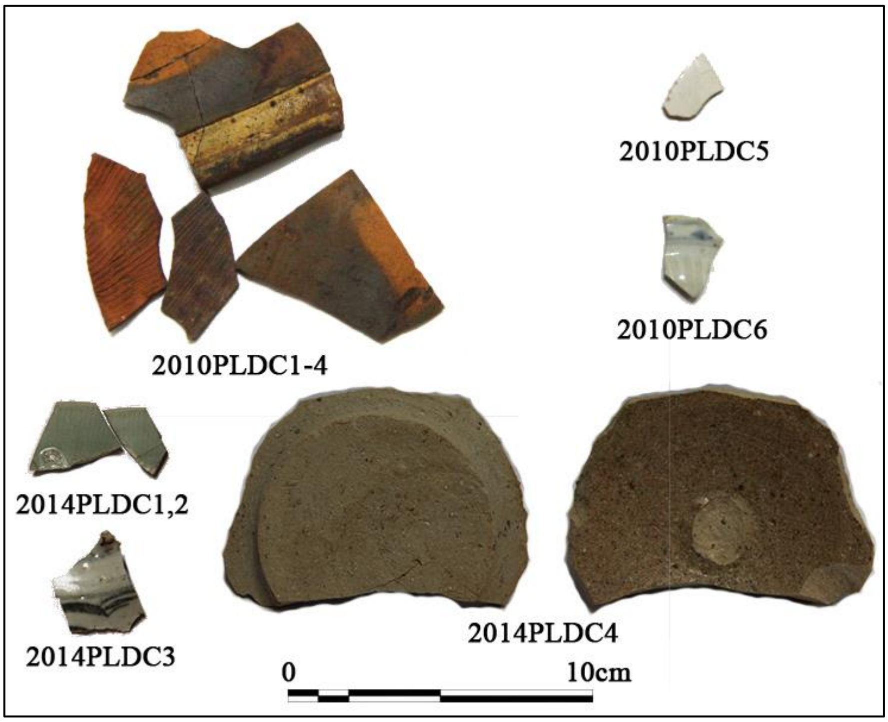


Fig. 3.121 Excavated pottery and porcelain in 2010 and 2014 at Chadiping (source: of 2010, the third National Survey on the Cultural Relics, no scale; of 2014, author)

Refractory material:

The refractory clay used at Chadiping was a combination of fine sand and clay. The refractory clay was used to make furnace bricks, building and repairing the furnace wall, and constructing both interior furnace lining and exterior covering. One sample of refractory material, possibly furnace lining, was collected from furnace L5. The sample had a yellow colouration, about 3cm in size, and had small charcoal debris inclusions. Sample **2014PLDGC:2** was collected from the ground at the site. The sample had an orange and brown colouration, and was about 15cm thick with a 2cm thick layer of adhering slags (Fig. 3.122).

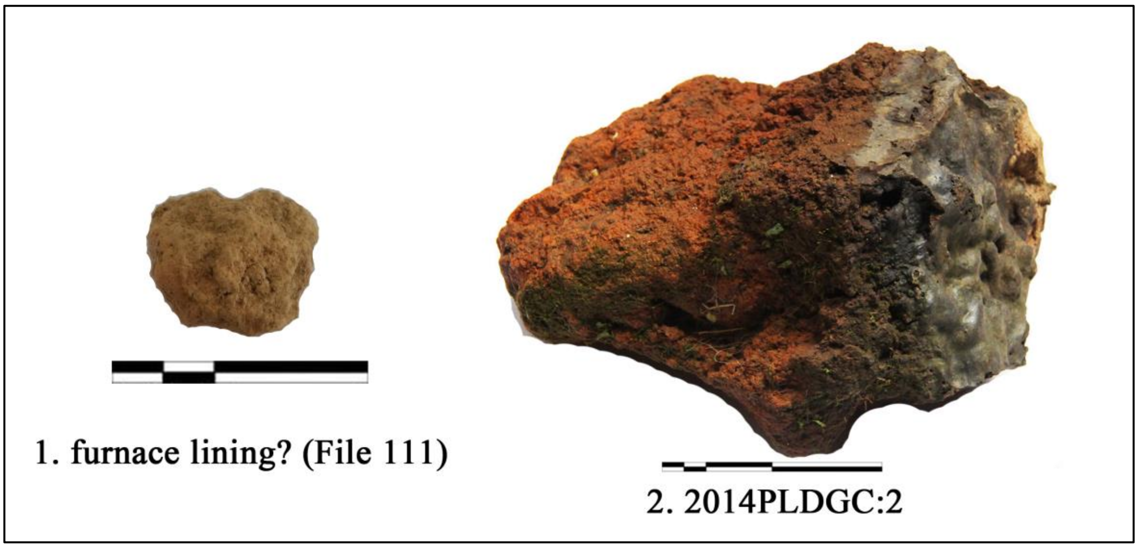


Fig. 3.122 Refractory material possibly furnace lining collected from furnace L5 at Chadiping (source: author)

According to the excavated and surveyed furnace remains, two types of furnace brick were discovered at Chadiping. Type A bricks were made from refractory clays, and the thickness of the bricks varied from 10-40cm. The length and width of the bricks were undetermined because the gaps between the bricks were fixed with refractory clays, which mostly disappeared when the furnaces were heated in the smelting. Some samples of type A bricks were collected from furnace L5. The samples were fragmentary, and have a brown and orange colouration. From the broken section, the bricks were made from a mixture of clay and fine sand (Fig. 3.123).

Type A furnace bricks (collected from furnace L5)

Fig. 3.123 Photo of type A bricks of Chadiping (source: Liu Fang)

Type B bricks were made of sandstone. Furnace L6 and L9 were constructed with type B bricks. The thickness of type B bricks varied from 15-25cm, and there is a layer of adhering slags on one of the surfaces. Sample **2014PLDL6:C1** was collected from furnace L6, it contained two fragments of the type B bricks. The brick is about 5-6cm thick with a greyish white colouration, and there is a thin layer of adhering slags. Sample **2014PLDGC:1** was another example collected from the ground at the site. The brick is about 15cm thick with a yellow and brown colouration, and there is also a thin layer of adhering slags (Fig. 3.124).

Fig. 3.124 Photo of type B bricks of Chadiping (source: author)

Ore:

Large amounts of iron ores were discovered onsite. Most of the ores have a red and brown colorations, and are non-magnetic. The discovery of the ores could be divided into two groups, of which the smaller group were 2-5cm, and the bigger group were 5-12cm (Fig. 3.125). Two samples were subjected to an XRD analysis, the result indicated the ores are hematite and goethite. The details are discussed in the discussion part of this section.

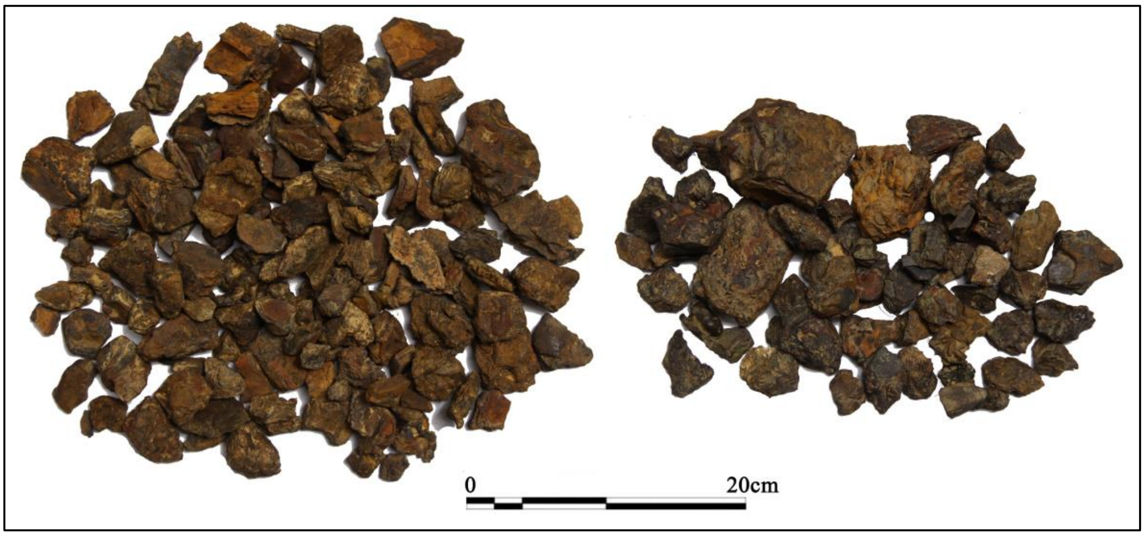


Fig. 3.125 Iron ores collected from Chadiping (source: author)

Slag:

The main type of slags discovered at Chadiping was furnace slag. Most of the furnace slags have a black colouration and high vitrification. The porosity proportion is very low, and the porosity size is very small. The slags are fragment with sizes usually less than 5cm (Fig. 3.126). Three samples collected from furnace L1 and L6 were subjected to metallographic (SK0070 and SK0071) and XRD analyses. The result is discussed together in the discussion part of this section. There were very few tap slags discovered onsite. **2014PLDSGC1** is a tap slag sample collected from the ground at Chadiping. The slag is almost intact with a plano-plano shape and a grey and brown colouration. The slag has a moderate density and the dimensions are 23x20x5cm. The surface of the slag is smooth with broken bubbles and the underside is undulated. The viscosity of the slag is high, and the slag is highly abraded (Fig. 3.127).

Fig. 3.126 Furnace slags collected from furnace L1 at Chadiping (source: Liu Fang)

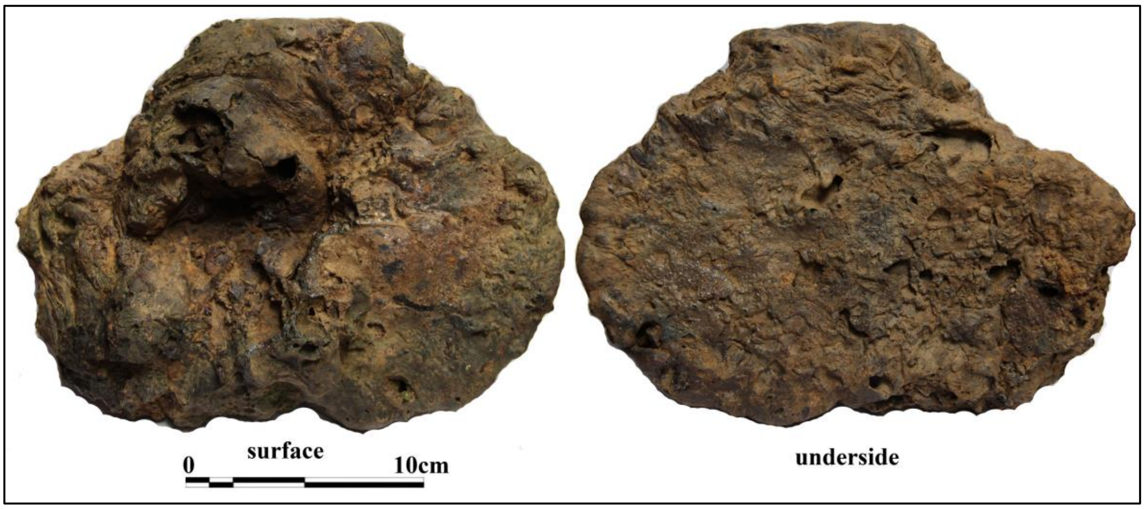


Fig. 3.127 Tap slag collected from ground surface at Chadiping (source: Liu Fang)

Radiocarbon dating

There was only one charcoal sample collected from Chadiping and sent to the Beta Analytic Inc. for radiocarbon dating analysis. The original result is shown in Table 3.11. The result was calculated and calibrated according to Talma (1993) and IntCal13 atmospheric curve (Reimer *et al* 2013).

Table 3.11 Calibrated C14 result of sample collected from Chadiping by Beta Analytic Inc., US (source: CJAT, unpublished)

Lab No.	Sample type	Context	C14 (BP)	Calibrated	
				(68.2%)	(95.4%)
Beta-439347	charcoal	2014PLD furnace L2	320±30	1470AD	1650AD

Survey of the surrounding area

Ancient mine:

The local people call the mountain where the Chadiping site was found as the '*Heishi Shan*' (means black stones mountain), and the area was renowned for producing iron ore. The iron ores in this area are located close to the ground surface, and could be easily exploited. This area was still producing large amount of iron ore until the 1990s, and many people were exploiting and selling the iron ores for a living.

One ancient mine site was discovered at Qinggangbao, which is about 500m southeast of the Chadiping site. Two shaft mines were discovered at the site and labeled as J1 and J2. Mine J1 was circular in plan, and the diameter at the mouth was about 110cm. The remaining depth was 230cm, of which the upper 110cm was the virgin soil and below that was the bedrock (Fig. 3.128). Mine J2 was slightly elliptic in plan, and the diameter was about 180cm at the mouth and about 140cm at the present bottom. The remaining depth is 250cm (Fig. 3.129).

There is also a place called ‘Kuangdong Ping’, which means ancient mine, about 100m northeast of the Qishuwan iron smelting site (see below). Although no mine remains were discovered at the place, it was possible that the place was an ancient mine site.

Fig. 3.128 Photo of ancient mine J1 at Chadiping (SW to NE, source: Liu Fang)

Fig. 3.129 Photo of ancient mine J2 at Chadiping (SE to NW, source: Liu Fang)

Iron smelting sites:

Two iron smelting sites were discovered during the survey of the surrounding area.

The Qishuwan site was located 700m west of the Wu River and about 800m northeast of the Chadiping site. The GPS coordinates are 29° 21′ 25″N, 108° 07′ 15″E, and the elevation is about 335m. The present ground vegetation was corn and sweet potato. There was one furnace discovered at the site. The furnace was mostly destroyed, only the southwestern part remained. The remaining part was about 60x52cm, and 45cm high. The furnace wall was constructed of refractory bricks of 20cm wide, and the interior furnace lining was about 15cm thick. There was a thin layer about 5cm thick of adhering slags on the interior surface.

The Paotian site was located about 600m east of the Chadiping site, and less than 200m west of the Wu River. The GPS coordinates are 29° 21′ 11″N, 108° 07′ 41″E, and the elevation is about 164m. The ground vegetation is now corn. Two furnaces were discovered at the site. Furnace L1 was located 15m east of furnace L2, and only the rare parts of both furnaces remained. The remaining part of L1 was about 98x45cm, and 55cm high. The remaining part of L2 was about 98x33cm, and 40cm high. Both furnace walls were constructed of refractory bricks, with the bricks of furnace L1 and L2 about 25cm and 40cm respectively. The interior furnace linings of L1 and L2 were 7cm and 15cm. No adhering slags was discovered on the interior furnace wall of L1, but a few were found on the interior furnace wall of L2.

Discussion

The furnaces discovered at Chadiping were all built against into terraces. From the preserved parts, the furnaces had a shaft structure. To build the furnace, a pit was a digged first against the terrace, then the bottom was constructed and strengthened using refractory clays (furnace L2 and L5), and there was sometimes a layer of charcoal for a better moisture resistance (furnace L2). The furnace wall was usually about 20-40cm thick and was constructed using either stone bricks or clay bricks. The clay bricks were made from refractory clays, which consist of clays with fine sand. The gaps between the bricks were also fixed using refractory clays. No tamping impression were discovered on the clay bricks at Chadiping. The inner diameter of the furnaces discovered at Chadiping were between 60-100cm. There was a layer of 10-15cm furnace lining of refractory clays on both the interior and exterior furnace wall. A thin layer about 2cm of adhering slags were discovered on most of the interior furnace walls. The furnaces were probably bellowed from both the northern and southern sides of the furnaces (furnace L1), and the tapping holes were on the eastern side. There were platforms built with stones on both the northern and southern sides of furnace L4 to keep the sides at the same level as the terrace. This was possibly the need of the place and the height to set up the bellows. The design of the furnace took advantage of the terrace, which made it much easier for charging the fuel and raw materials.

The size and structure of furnaces L1-L5 were very close, and the size of furnace L6-L10 was slightly bigger. Layer ③ of trench TG1 formed after furnaces L1-L5 were abandoned, which indicated the use of this terrace was earlier than the upper terrace where furnaces L6 and L7 were located, and the date of furnaces L1-L5 was earlier than L6-L10. The charcoal sample collected from the bottom of L2 gave a date between 1470-1650AD. Very few pottery and porcelain were found at Chadiping, and the discovered samples were fragment, which limited information that could be drawn from them. Sample 2014PLDC3, C5 and C6 were blue and white porcelain sherds, which were possibly later than the Song and Yuan dynasties (960-1368AD). More radiocarbon dating samples are needed to be confident on the dating of the furnaces. However, according to the current dating, the furnaces discovered at Chadiping were different than the contemporary furnaces discovered at Shazitang, Sichuan province. The furnaces of Chadiping were smaller and bellowed from both sides of the furnace, while the furnaces of Shazitang were bigger and bellowed only from one side.

Two iron ore samples (OS1 and OS2) collected from the ground surface at Chadiping were analyzed by Mo (2015) using both SEM and XRD (Fig. 3.130). An area scan about 200x250μm of SEM was made on the surface of both samples. The SEM and XRD results are shown in Table 3.12.

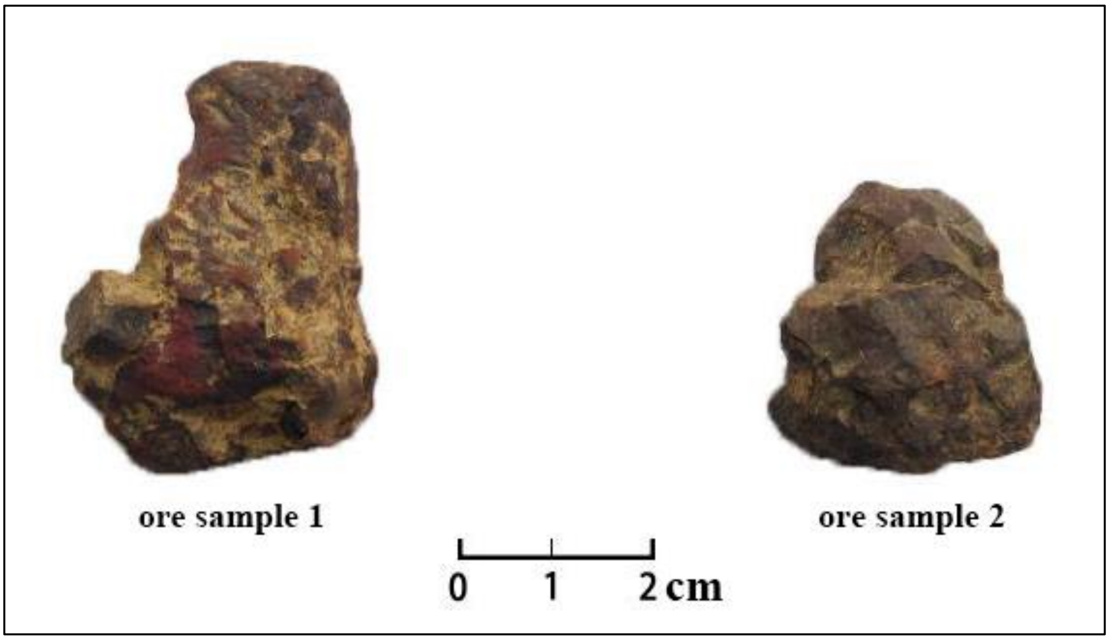


Fig. 3.130 Analyzed iron ore samples from Chadiping (source: Mo 2015)

Table 3.12 Chemical composition of the iron ore samples from Chadiping (source: Mo 2015, 30, 33)

	Analyses	Composition (wt%)						
		Fe	O	Al		Si	K	Ca
OS1	SEM	7.85	51.21	6.68		22.16	3.33	8.78
OS2	SEM	42.86	48.96	-		8.17	-	-
		Na2(CO3)	**FeO(OH)**	**Fe2O3!H2O**	**Fe2O3**	**SiO2**	**Si11.4TiO24.8**	**NiTiO3**
OS1	XRD	11.83	19.53	29.59		11.83	27.22	
OS2	XRD				37.14	41.63		21.22

Mo has concluded that both samples were hematite, and the proportion of Fe_2O_3 in the samples were about 48% (Mo 2015, 27-33). The ore samples were not crushed into powders, which means the SEM result could not really provide much information. The iron content of the two samples could be calculated from the XRD result, which was about 26-34%. The iron content of the ore samples was too low for the smelting, therefore unless the iron ores had a much higher iron content in the ancient time, there might be one or more additional ore selecting processes before the ores being charged into the furnaces. Most of the discovered iron ores at Chadiping had a size between 2-5cm, which indicated that crushing was at least one of these selecting processes.

The main type of slags at Chadiping was the black coloured and highly vitrified furnace slags. Two samples were analyzed by Mo (2015) using both SEM and XRD (Fig. 3.131). An area scan on the surface of the slag samples was made for the SEM analysis, and the samples were then ground into powders and mixed together for the XRD analysis. The SEM result is shown in Table 3.13, and the XRD result is shown in Fig. 3.132.

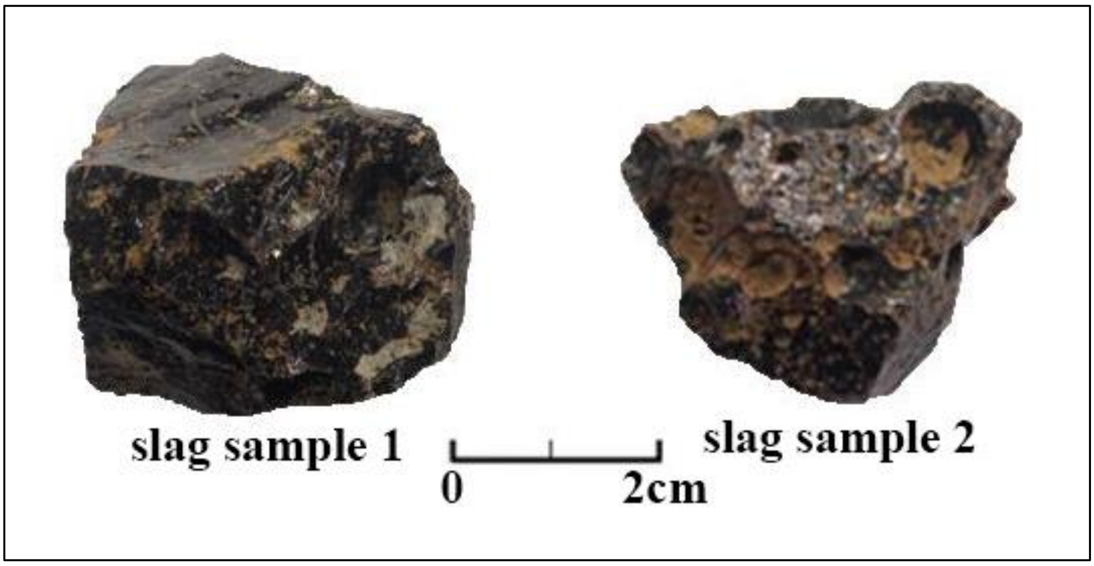


Fig. 3.131 Analyzed slag samples from Chadiping (source: Mo 2015)

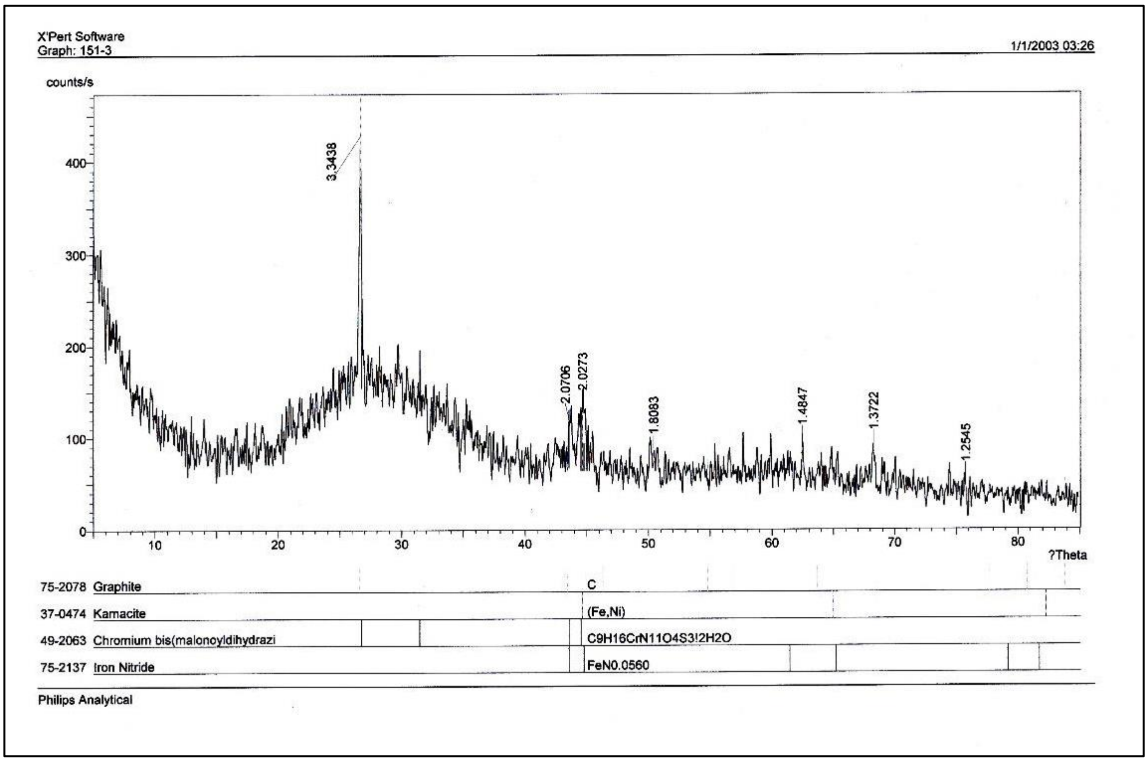


Fig. 3.132 XRD result of the mixed powder of the slag samples (source: Mo 2015, 36)

Table 3.13 Chemical composition of the slag samples from Chadiping (source: Mo 2015, 33, 36)

	Analyses	Composition (wt%)				
		O	Al	Si	Ca	Fe
slag sample 1	SEM	50.3	9.21	28.93	4.3	7.26
slag sample 2	SEM	43.92		10.75		45.33

The method of the sample preparation was not clearly stated in Mo's thesis, and the SEM was again analyzed on the surface of the samples. The high iron content in the SEM result was probably because the surface of the slag had contact with the liquid iron during the smelting. Although there were imperfections of Mo's analyses, some of his conclusion seemed to be reasonable, which the fuel used at Chadiping was charcoal because no Sulphur (S) was detected in either SEM or XRD, and the smelting was efficient because no more Fe_2O_3 was found in the slags.

Two more slag samples were analyzed by the author for their microstructures.

One of the slag samples was excavated from furnace L1 at Chadiping, which has a black colouration, highly vitrified and partially strong magnetic. Sample SK0070 is cut from the magnetic spot of the slag (Fig. 3.133).

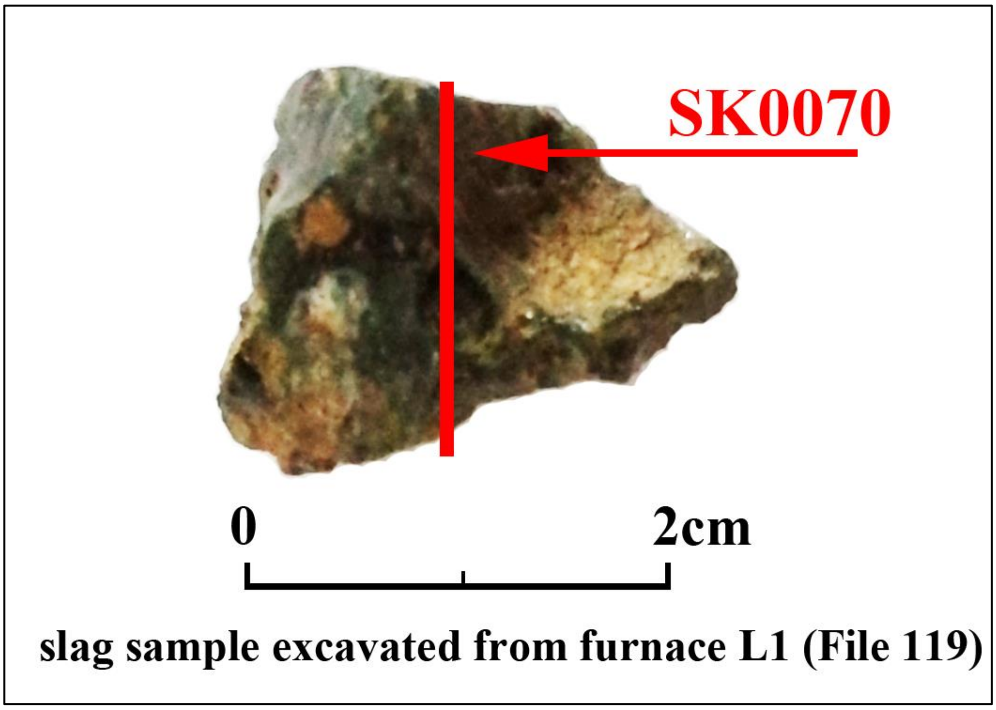


Fig. 3.133 Photo of slag sample excavated from furnace L1 at Chadiping showing the sampling spot of SK0070 (source: author)

There are no significant changes before and after etching with 2% nital. At low magnification, there are large number of graphite-like flakes throughout the section and some very small metal-like structures (Fig. 3.134). At a higher magnification, there are some pearlite-like lamels (Fig. 3.135). The sample might be cast iron residues which attached to the slag while in liquid form and being cooled down slowly inside the furnace. This may indicate that the furnaces discovered at Chadiping were cast iron smelting furnaces.

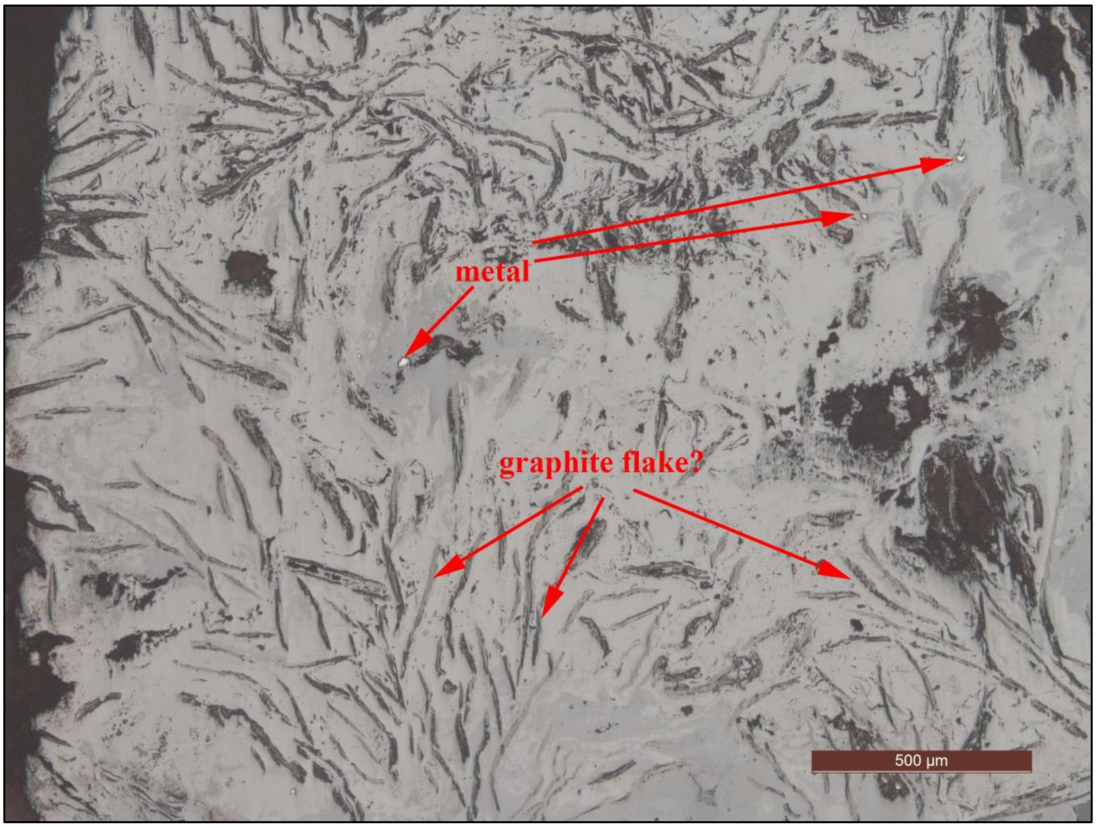


Fig. 3.134 Section from SK0070. Etch 2% nital, scale bar 500μm (source: author)

The other slag sample was excavated from furnace L6 at Chadiping, which has a grey and brown colouration, rough and slightly abraded surface structure with large number of attached charcoal debris and some geological inclusions. The slag is partially magnetic. Sample SK0071 is cut from the magnetic spot of the slag (Fig. 3.136).

There are no significant changes before and after etching with 2% nital. At low magnification, there is no specific structure can be identified (Fig. 3.137). However, at a higher magnification, there are some structures look like ledeburite (Fig. 3.138). The sample was likely a furnace slag, which had contact with the liquid iron during the smelting.

Fig. 3.135 Section from SK0070. Etch 2% nital, scale bar 50μm (source: author)

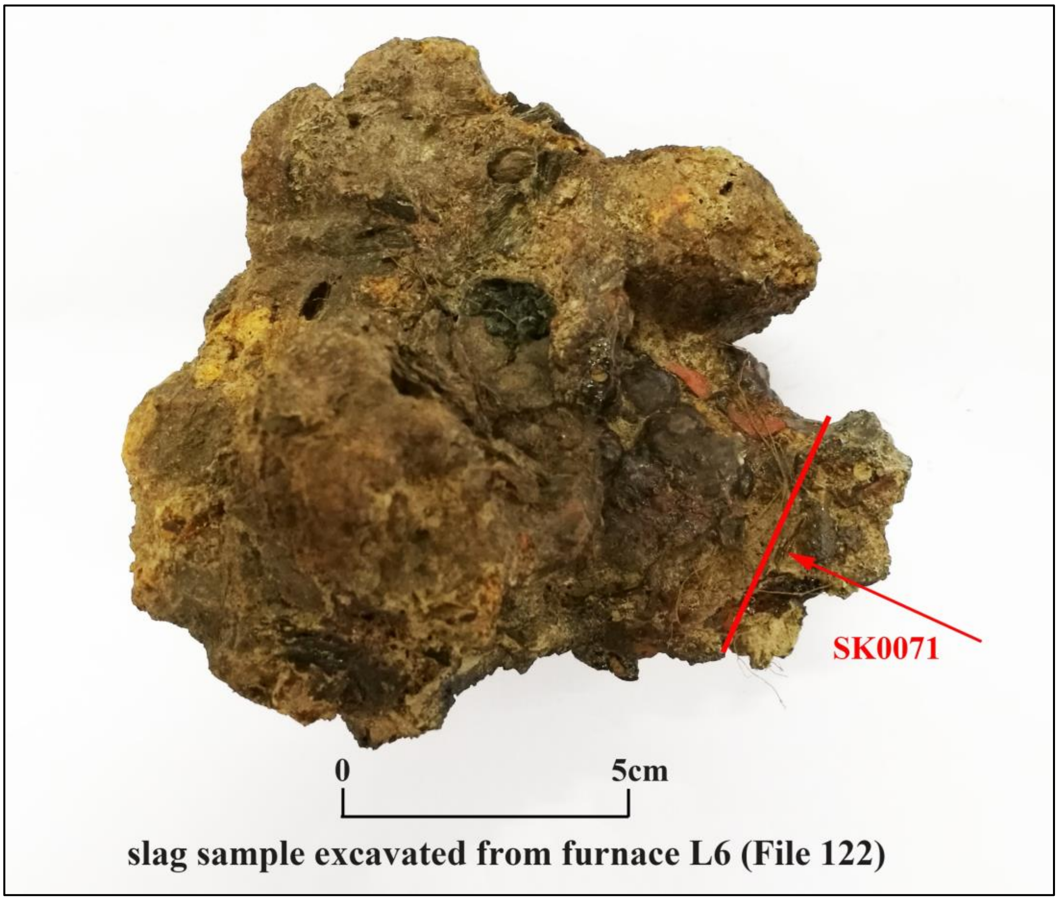


Fig. 3.136 Photo of slag sample excavated from furnace L6 at Chadiping showing the sampling spot of SK0071 (source: author)

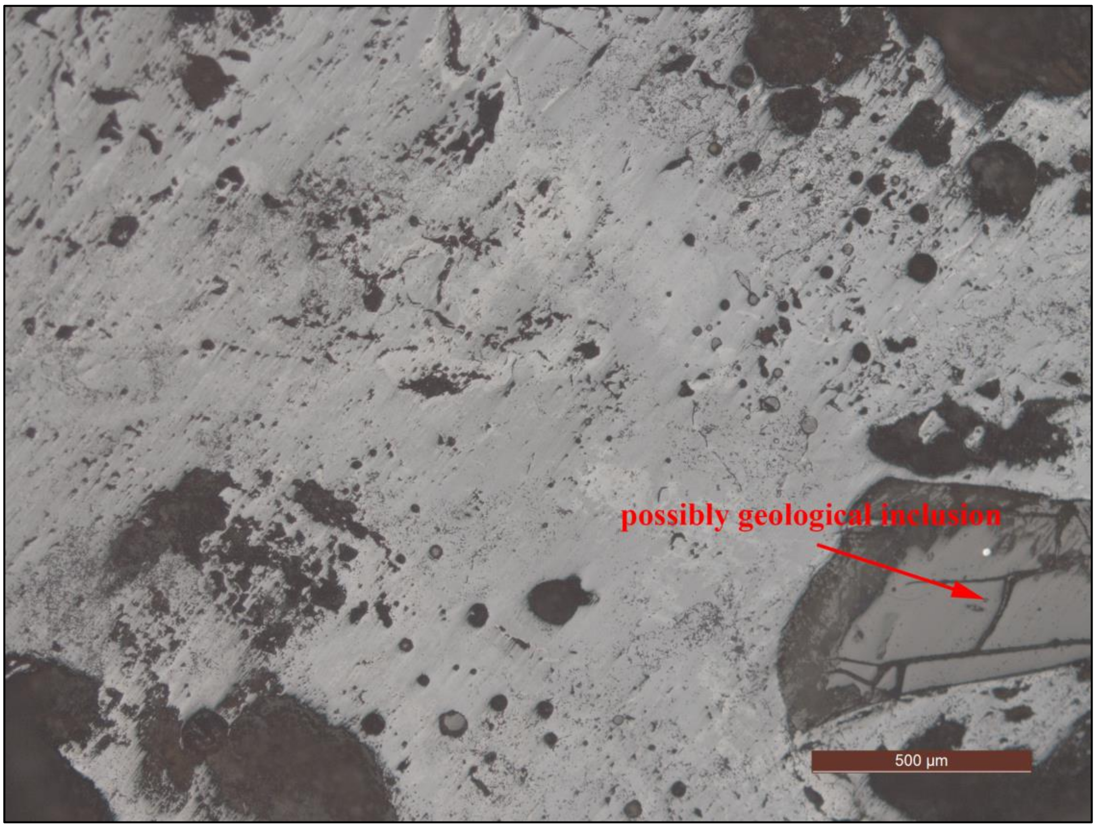


Fig. 3.137 Section from SK0071. Etch 2% nital, scale bar 500µm (source: author)

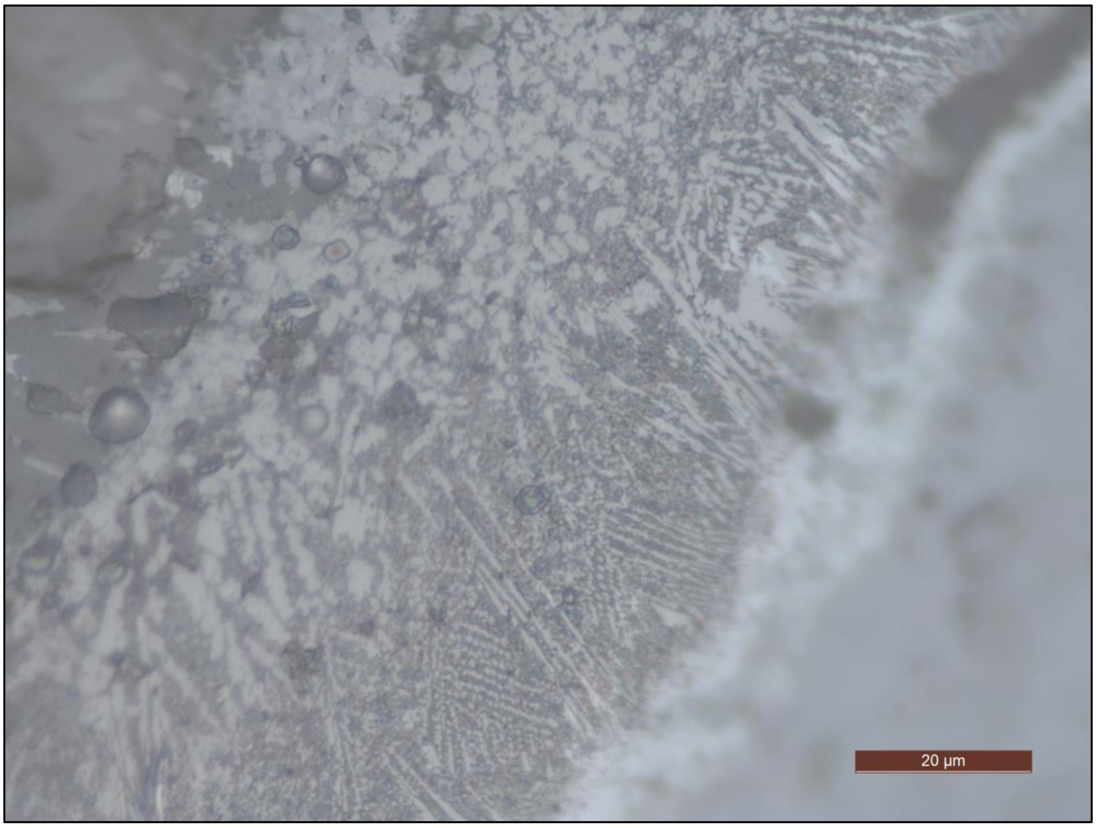


Fig. 3.138 Section from SK0071. Etch 2% nital, scale bar 20μm (source: author)

Except for the iron smelting site of 1958, there were some other ancient mines and iron smelting sites near the Chadiping site (Fig. 3.139). These sites were only briefly recorded in the survey of the hydropower station project of the Wu river, and it is not possible to find out how old these sites were. However, they indicated that the local iron smelting activity was large scale and long lasting.

In summary, Chadiping has abundant resources of iron ore and fuel, and convenient transporting method. The Chadiping iron smelting site probably started operating during the 14th to the 16th century AD and lasted for a long period. The furnaces discovered at Chadiping were cast iron smelting furnaces and were comparatively smaller than the contemporary furnaces discovered in the Sichuan province. The fuel used in the smelting was charcoal, and the iron ores were selected and crushed into small pieces before being charged into the furnaces. No moulds of any kind was discovered at Chadiping, which indicates the site was probably only producing iron ingots but not iron objects. Very few slags were found onsite, which might indicate the slags were removed and used for other purposes.

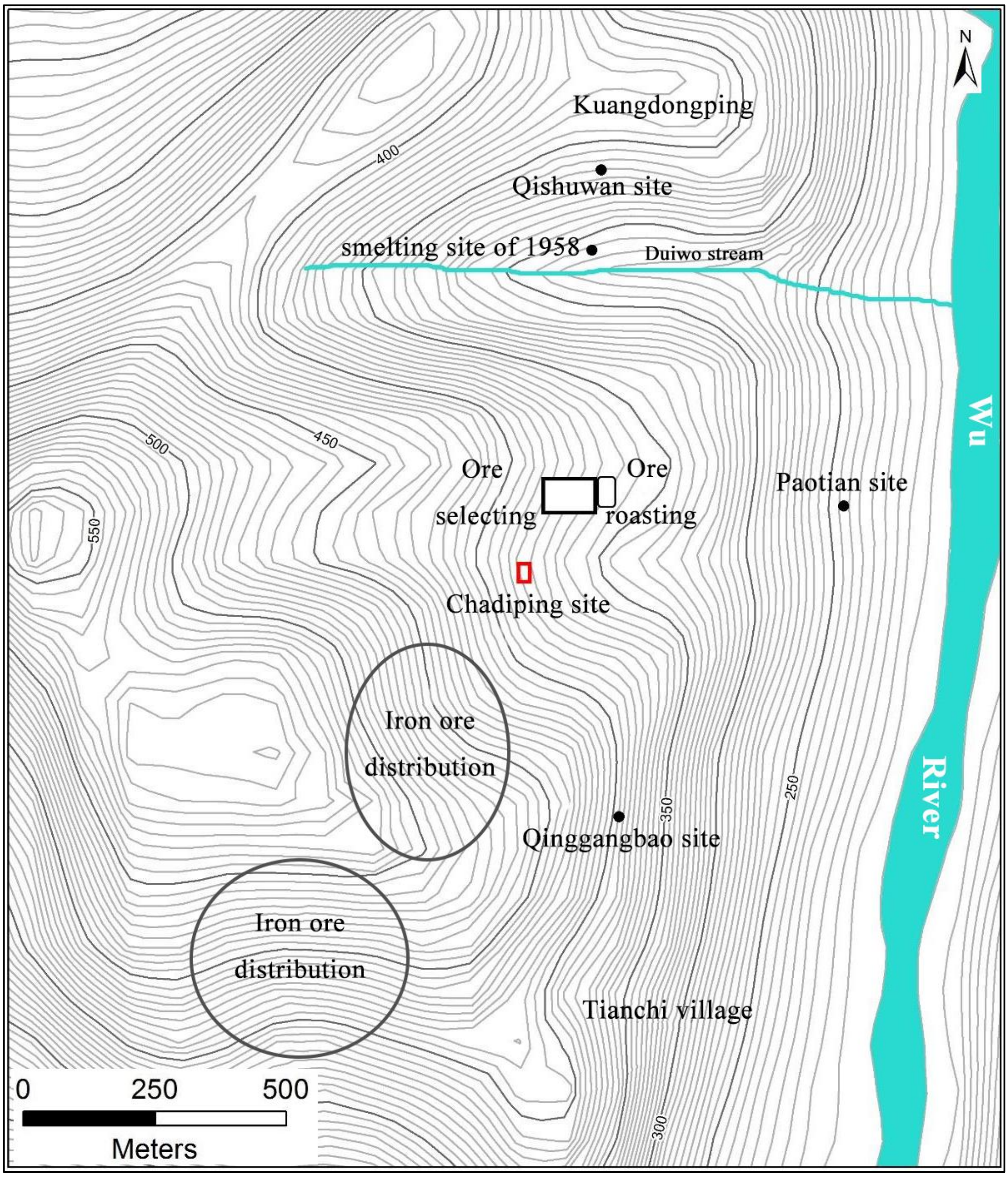


Fig. 3.139 Showing the functional areas of Chadiping, and nearby sites (base map was provided by Pengshui Cultural Relics Institute)

3.6 Surveyed sites

So far, most of the previous and ongoing projects were carried out in the Sichuan province, and very few in Chongqing. Similar research is going to be carried out in the other provinces in the future.

There are 70 surveyed metallurgical sites and locations were discovered in the archaeological surveys in Pujiang and Qionglai counties, Sichuan province, coincided with the description in the written records. The metallurgical sites were identified mostly by the presences of furnaces or discarded slag, and sometimes by the presences of burned soil and iron ore/sand.

In these surveys, the names of the local locations were sometimes a very important clue in finding the iron related sites and locations as mentioned at the beginning of this chapter. Most of the information is taken from the second and the third National Survey on the Cultural Relics and the report of the regional archaeological surveys. The site number (S) and its corresponding information is provided in the appendix C7.

The National Survey on the Cultural Relics of China

The first national survey on the cultural relics of China was started in 1956, however, unfortunately not much information was recorded at the time due to the limitation of research methodology. The second survey was carried out from 1981 to 1985, the scale and the results were much better than the first, more than 400,000 sites and locations of cultural relics were recorded. The third survey was carried out from 2007 to 2011, it was mainly based on the information provided from the previous survey but included more detailed information such as digital camera pictures and GPS points.

It is worth to mention that these sites and locations were mostly recorded by people from the local cultural relics management office, who may not have strong archaeometallurgy nor archaeological backgrounds. Among the 70 surveyed sites and locations, only one of them (S5) is from the Han dynasty (202BC-220AD), 63 are from the Tang or Song dynasties (7th to 13th centuries AD), and the other 6 sites (S12, 31, 52, 64, 67 and 68) are later than the 14th century as recorded in the reports. The dates were often briefly given based on the pottery found onsite, which should be aware and used for reference only. Because it is very difficult to identify the relationship between the pottery and the iron smelting site itself without archaeological excavation, thus the given dates are often not very accurate (normally much later than what it actually is). More works and further studies are required to understand the real dates of these sites and locations.

Site size, elevation distribution and onsite discovery

In general, site size was recorded by measuring the lateral north-south extent of the presence of a slag or other artifacts found on the ground or by augering. From this, the approximate coverage of the deposit in m^2 was estimated. Three size categories, large >4,000m^2, medium 1,000-4,000m^2 and small <1,000m^2, were defined to cover all the sites in the Chengdu Plain. In determine the size categories, S69 and S72 were considered as outliers which the two sites were 60,000 and 57,500m^2. This might be happened due to the recorder estimated the size too broadly or the site may be divided into two or more separated sites (Fig. 3.140). For those small sites, it was also possible that the sites had been disturbed. For example, S16 is only 68m^2 as recorded, but the deposit depth is over 400cm. The site was close to a modern house and the slag, furnace brick, charcoal and burned soil were discovered all piled up together.

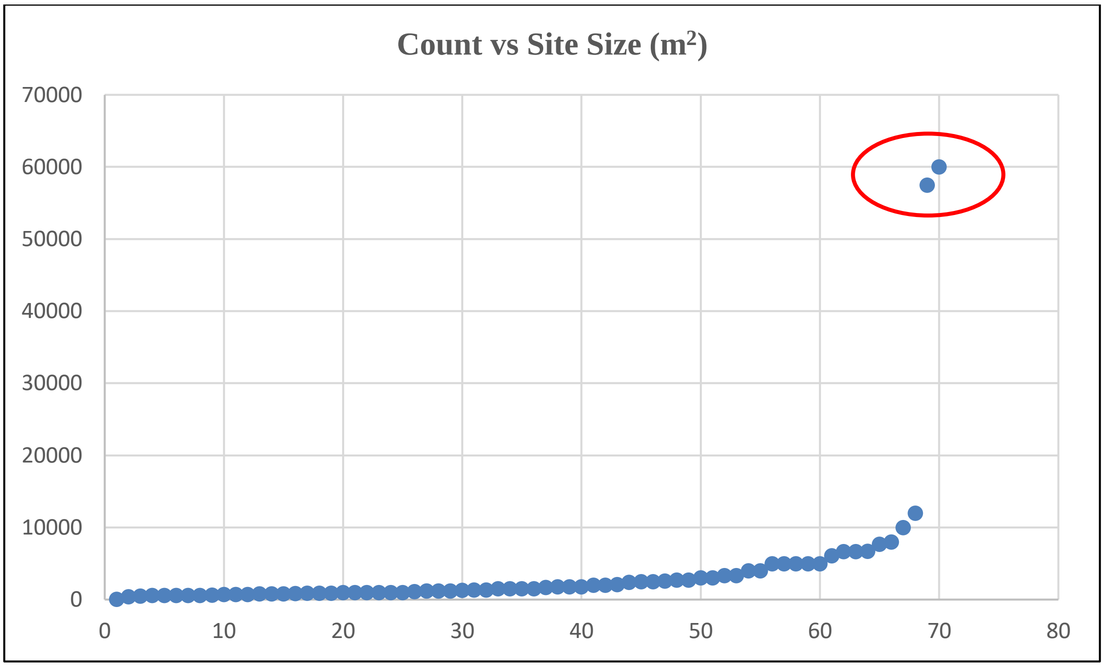


Fig. 3.140 Possible outliers of site size (n=69, source: author)

54% of the site sizes were concentrated in the medium group which was between the range of 1,000 to 4,000m^2, 19% were in the small group which was less than

1,000m^2, and 27% were in the large group which was greater than 4,000m^2 (Fig. 3.142).

The distribution of the sites by elevation follows a normal distribution (Fig. 3.143), a bivariate correlation test was analyzed in SPSS using elevation as an independent variable, the result showed the correlation between elevation and site size was significant and moderate positive (0.320) at a 99% confident level (Table 3.14). Which means the site size was likely larger at a higher elevation.

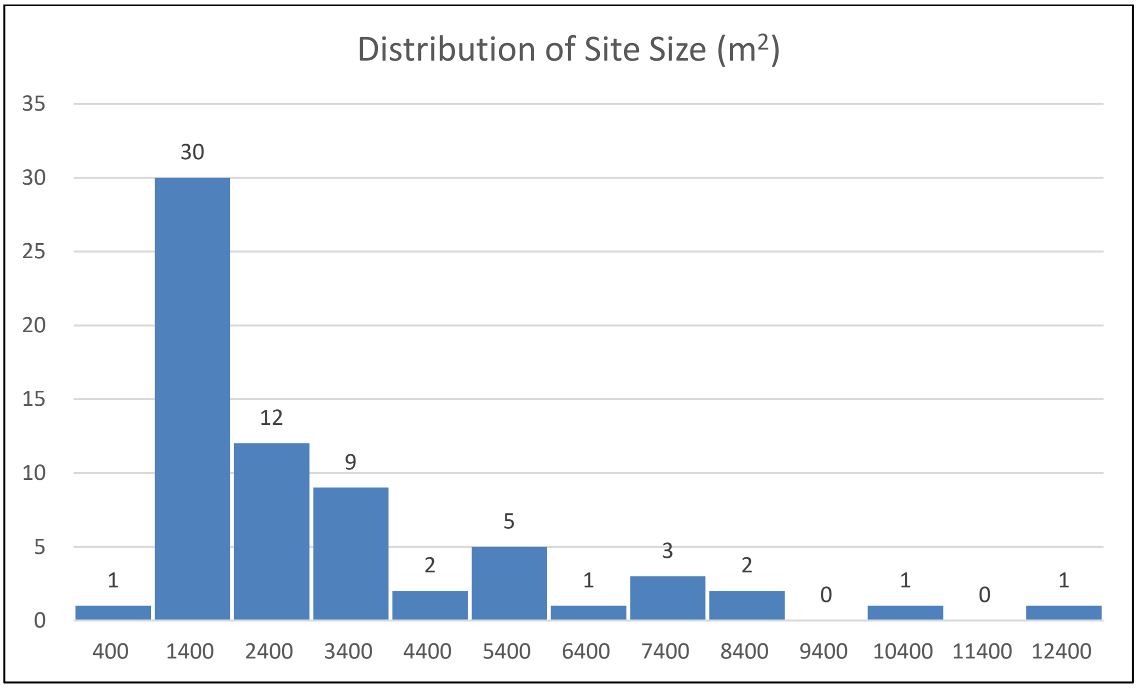


Fig. 3.141 Distribution of the size of the surveyed sites (n=67, source: author)

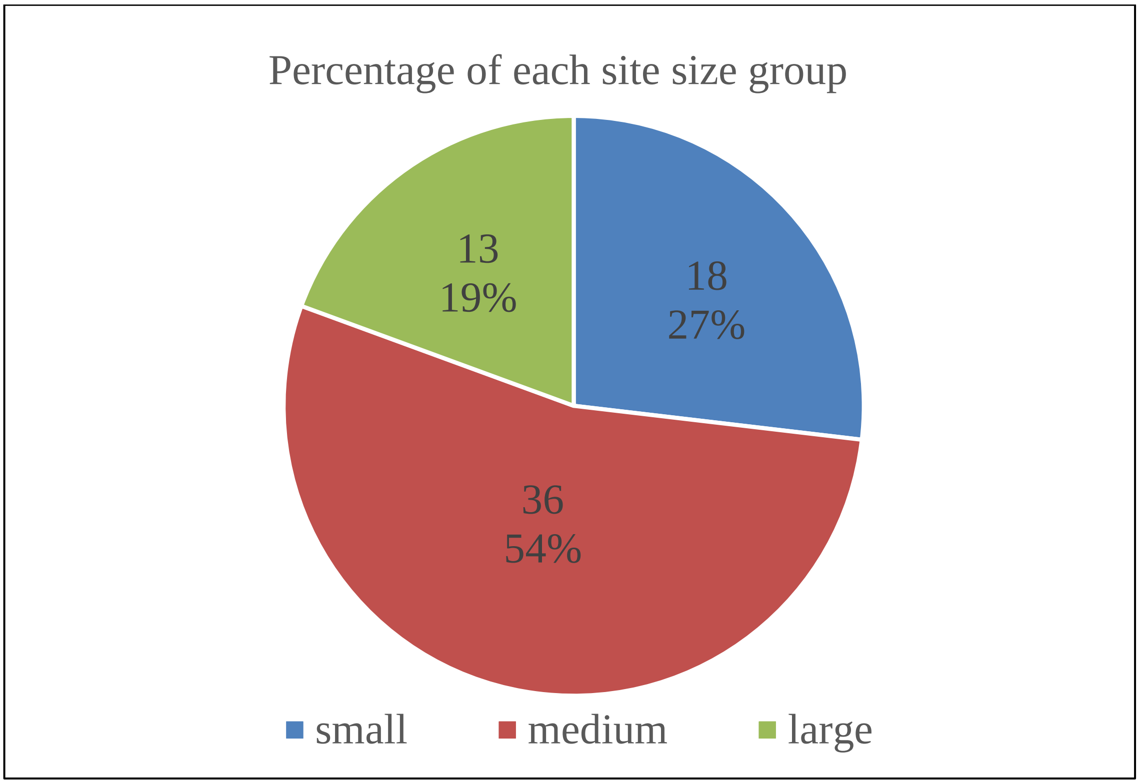


Fig. 3.142 Percentage of each site size group (n=67, source: author)

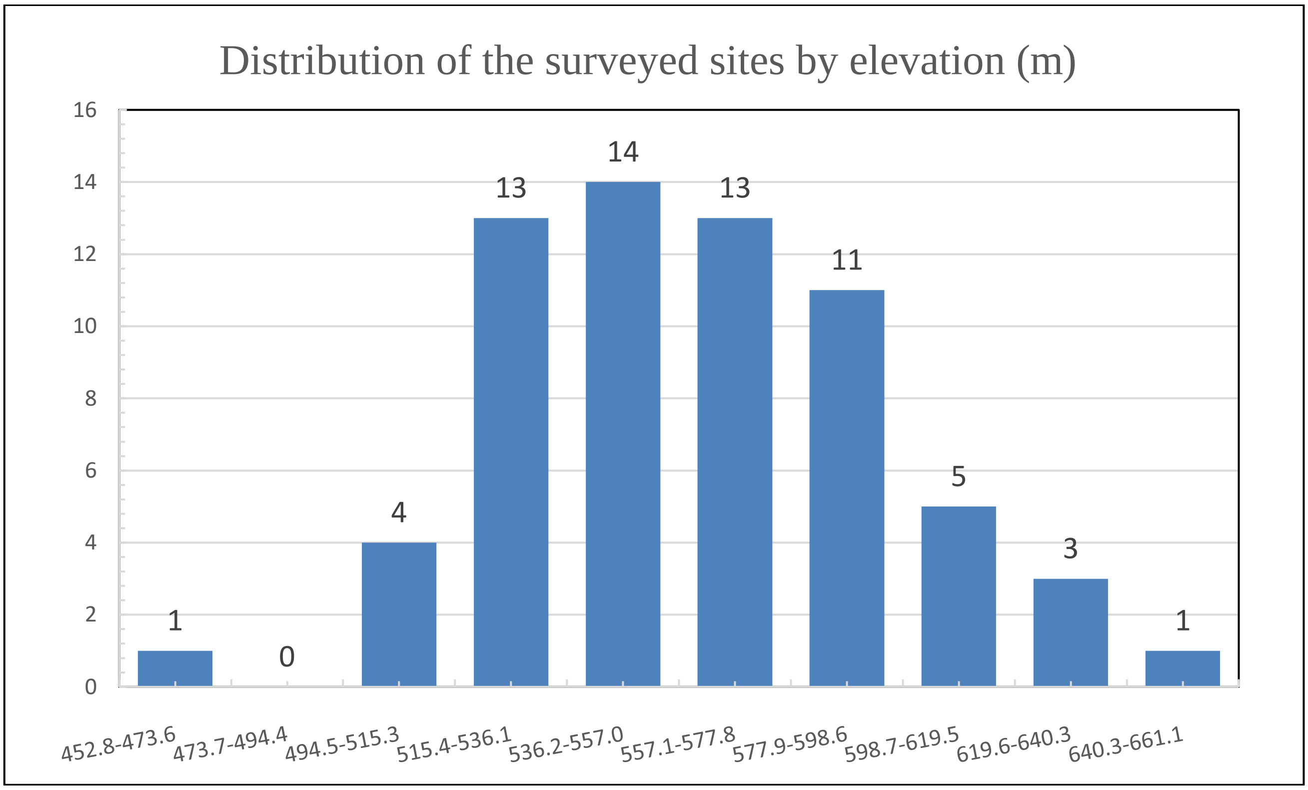


Fig. 3.143 Distribution of the surveyed sites by elevation (n=65, source: author)

Table 3.14 SPSS result of correlation between elevation and site size (source: author)

Correlations

		elevation	size
elevation	Pearson Correlation	1	.320**
	Sig. (2-tailed)		.009
	N	65	65
size	Pearson Correlation	.320**	1
	Sig. (2-tailed)	.009	
	N	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

On the other hand, more bivariate correlation tests were carried out to determine the relations between variables including burned soil, slag, iron sand, iron ore, charcoal, refractory materials and furnace that discovered on each site. The results are shown in Table 3.15 and Table 3.16.

Table 3.15 Statistics of iron smelting related materials discovered on site (source: author)

Descriptive Statistics

	Mean	Std. Deviation	N
elevation	558.769	33.1270	62
size	2609.24	2520.992	62
BS	.50	.504	62
Slag	.81	.398	62
Sand	.37	.487	62
Ore	.03	.178	62
RM	.61	.491	62
Char	.26	.441	62
Furnace	.19	.398	62

From the information given in Table 3.15, slag was found on 81% of the sites, refractory materials 61%, burned soil 50%, iron sand 37%, charcoal 26%, broken furnace 19% and iron ore only 3%. Slag and refractory materials have a bigger proportion because they were the most obvious materials to define a metallurgical site. Burned soil was usually combined with one of the other discoveries such as slag, iron sand/ore, charcoal or broken furnace. It is quite interesting that there was more iron sand discovered than iron ore in the recording, because according to both historical documents and other excavations, only crushed iron ore but not iron sand was applied in the iron smelting in Southwest China. Unfortunately, both the descriptions and the pictures in the survey do not show clearly what exactly the “iron sand” was, and all the recording was made by the same group of people. It was likely that the “iron sand” here indicates small pieces of crushed iron ore but not really the sand iron.

Broken furnaces were sometimes discovered but in a poor condition, for instance, only two pieces of furnace base were discovered at S39, which the larger one was 0.4m long, 0.38m wide, and 0.23m thick. Furthermore, many of the remaining furnaces were destroyed permanently in the local farming activities in the following few years after they had been recorded. For example, one broken furnace and an ancient mine were discovered in 2007 at S38, which the remaining height of the furnace was 2.2m and the inner diameter was about 1.4m, but it was gone in the re-survey in 2012. Another broken furnace was discovered at S45 and now disappeared, which was recorded as 1.4m high and the furnace wall was 0.65m thick. The furnace was cylindrical and was constructed with refractory bricks. It is very difficult to preserve these metallurgical sites in the countryside which people do not understand and realize the importance of the sites. Sometimes, the furnaces were destroyed when the farmers were digging a fish pond or plant crops.

Table 3.16 Results of bivariate Pearson correlation of iron smelting related materials discovered on site (source: author)

Correlations										
		elevation	size	BS	Slag	Sand	Ore	FL	Char	Furnace
elevation	Pearson Correlation	1	.183	.132	-.333**	.285*	.191	-.208	.031	.096
	Sig. (2-tailed)		.156	.305	.008	.025	.137	.105	.811	.460
	N	62	62	62	62	62	62	62	62	62

Correlations

		elevation	size	BS	Slag	Sand	Ore	FL	Char	Furnace
size	Pearson Correlation	.183	1	.133	-.149	.234	.218	-.160	-.143	-.032
	Sig. (2-tailed)	.156		.303	.247	.067	.088	.216	.268	.808
	N	62	62	62	62	62	62	62	62	62
BS	Pearson Correlation	.132	.133	1	-.082	-.033	.183	.000	.000	-.082
	Sig. (2-tailed)	.305	.303		.528	.797	.156	1.000	1.000	.528
	N	62	62	62	62	62	62	62	62	62
Slag	Pearson Correlation	-.333**	-.149	-.082	1	-.300*	.089	.281*	.102	.137
	Sig. (2-tailed)	.008	.247	.528		.018	.489	.027	.429	.290
	N	62	62	62	62	62	62	62	62	62
Sand	Pearson Correlation	.285*	.234	-.033	-.300*	1	-.140	-.075	-.300*	-.123
	Sig. (2-tailed)	.025	.067	.797	.018		.277	.561	.018	.342
	N	62	62	62	62	62	62	62	62	62
Ore	Pearson Correlation	.191	.218	.183	.089	-.140	1	-.042	.101	.373**
	Sig. (2-tailed)	.137	.088	.156	.489	.277		.744	.435	.003
	N	62	62	62	62	62	62	62	62	62
FL	Pearson Correlation	-.208	-.160	.000	.281*	-.075	-.042	1	-.061	.054
	Sig. (2-tailed)	.105	.216	1.000	.027	.561	.744		.637	.676
	N	62	62	62	62	62	62	62	62	62
Char	Pearson Correlation	.031	-.143	.000	.102	-.300*	.101	-.061	1	.178
	Sig. (2-tailed)	.811	.268	1.000	.429	.018	.435	.637		.167
	N	62	62	62	62	62	62	62	62	62
Furnace	Pearson Correlation	.096	-.032	-.082	.137	-.123	.373**	.054	.178	1
	Sig. (2-tailed)	.460	.808	.528	.290	.342	.003	.676	.167	
	N	62	62	62	62	62	62	62	62	62

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Following is an interpretation of Table 3.16. Statistically, some correlations between two variables were significant at different confident levels, in each pair of variables a positive correlation indicates the appearance of one variable would increase the possibility of the other, and a negative correlation would indicate the other way around. There was a moderate negative correlation (-0.333) between elevation and slag discovered at a 95% confident level, in another word, there was less possibility to find slag when the site elevation increases. There was a weak positive correlation (0.285) between elevation and iron sand at a 99% confident level, which means there might be a better chance to find iron sand at a higher elevation sites. There was a moderate negative correlation (-0.300) between slag and iron sand discovered, a weak positive correlation (0.281) between slag and refractory materials, a moderate negative correlation (-0.300) between iron sand and charcoal at a 95% confident level, and a moderate positive correlation (0.373) between iron ore and furnace at a 99% confident level.

Slag morphology

The slag collected from the surveyed sites were recorded and analyzed according to the classification scheme (see appendix A1). There were 92 entries of detailed descriptions recorded from 18 surveyed sites.

64% of the surveyed slag are tap slag and the other 36% are furnace slag (Fig. 3.144). 75% of the surveyed slag are undiagnostic fragments and 25% are presented with both upper surface and base.

70% of the slag shape is amorphous; 17% of the slag has a plano shape, which both the surface and the base are comparatively flat; 10% of the slag is plano-concave, which the surface is flat and the base is concave up; and 3% of slag has a shape of a single rod (Fig. 3.145).

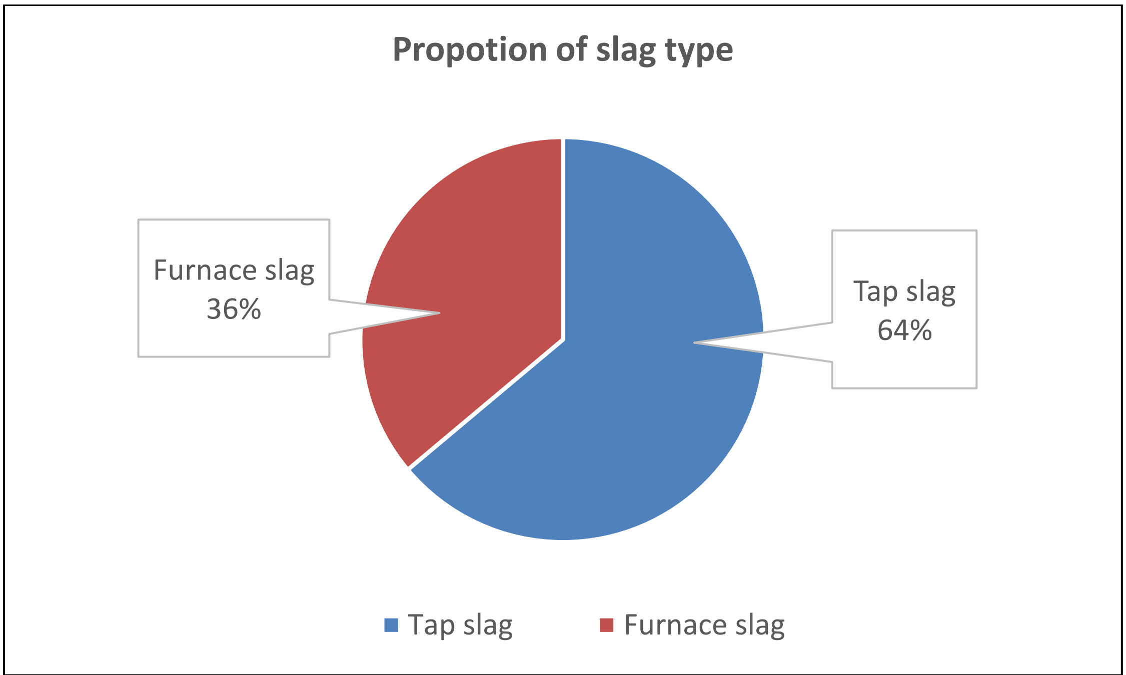


Fig. 3.144 Proportion of slag type of the surveyed sites (n=92, source: author)

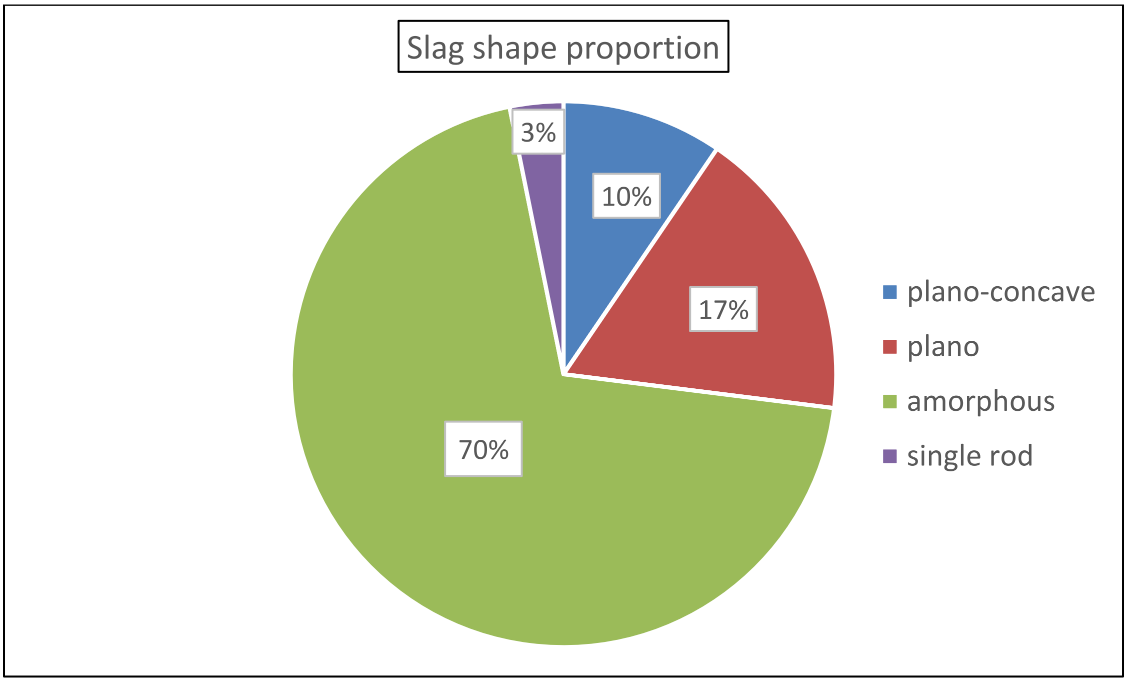


Fig. 3.145 Proportion of slag shape of the surveyed sites (n=92, source: author)

The range of the slag length, width and height are between 2.0-19.0cm, 1.5-14.0cm and 1.0-9.0cm. The averages are 7.6, 5.6 and 3.8cm respectively. 80% of the surveyed slag has a moderate density, 14% low, and 3% both for high and very low (Fig. 3.146). Sample number (SN) 36 contains two tap slags collected from Honggaolu (S61) in 2006, which have a very low density, high porosity proportion, moderate porosity size, spherical porosity shape, rough surface texture, black and grey colours, high vitrification level and non-magnetic (Fig. 3.147). SN1 and SN92 are tap slags both collected from Tieshiba (S72) in 2010. Both samples have a high density, very low porosity proportion, moderate porosity size, both elongated and spherical porosity shape, ropy surface texture, undulated underside texture, grey colour, charcoal inclusion, moderate viscosity, non-magnetic and multiple flow episodes (Fig. 3.148). The porosity proportion is the primary reason of the difference in density.

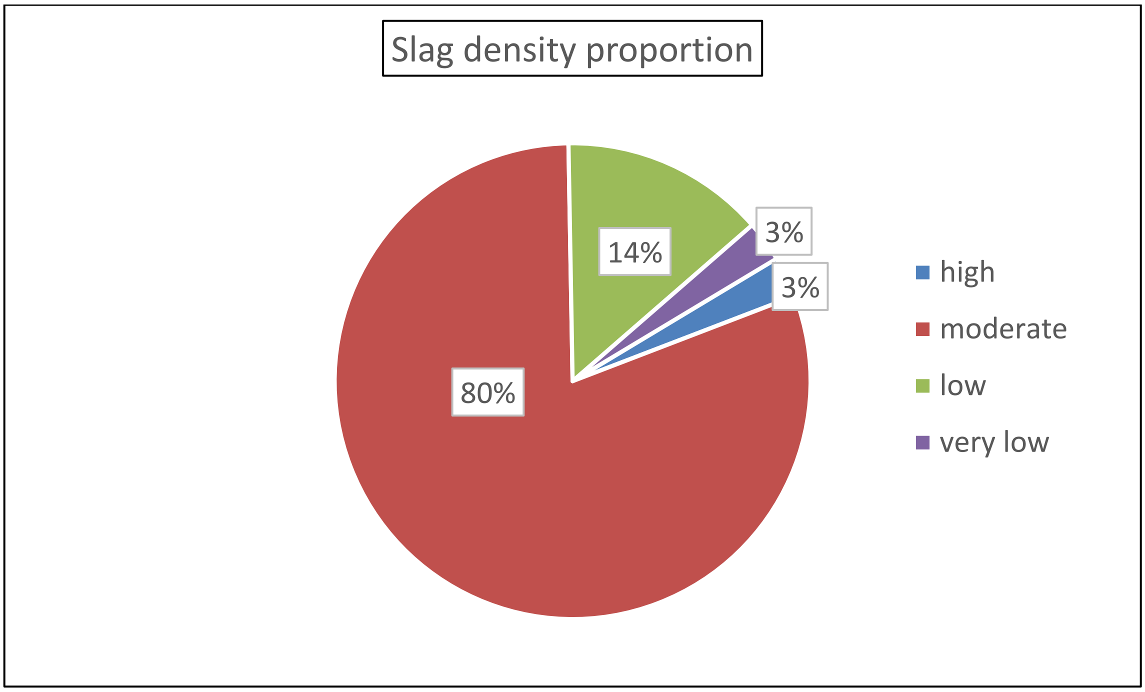


Fig. 3.146 Proportion of slag density of the surveyed sites (n=92, source: author)

Fig. 3.147 SN36 from Honggaolu site (source: author)

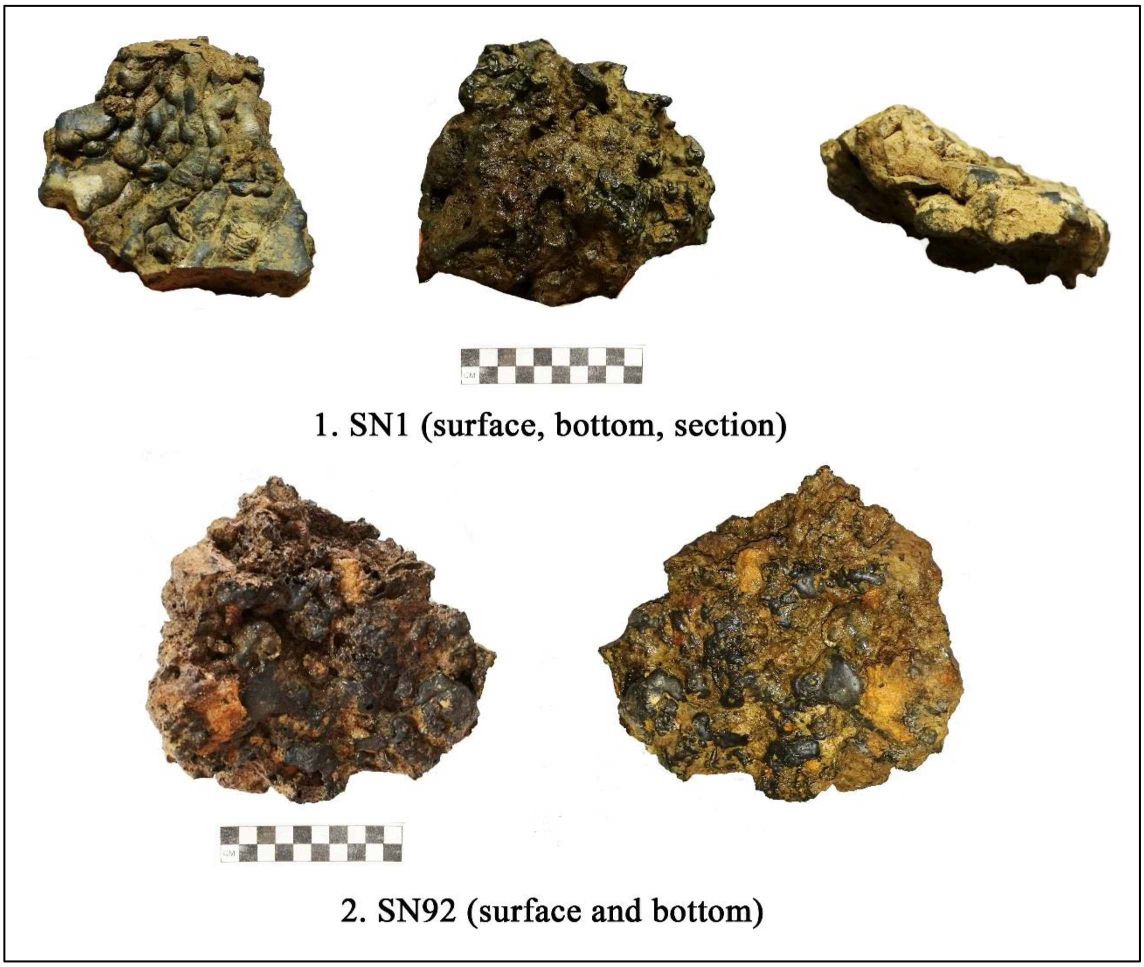


Fig. 3.148 SN1, SN92 from Tieshiba site (source: author)

Table 3.17 Characteristics of the collected slag samples from the surveyed sites

	Shape	Density	Porosity proportion	Porosity size	Porosity shape	Surface texture	Inclusion	Magnetism
Tap slag	plano-concave, plano, amorphous, single rod	very low, low, moderate, high	5% - 60%	1-10mm	elongated, spherical, random	smooth, ropy, broken bubbles, rough, abraded	charcoal, geological	non-magnetic
Furnace slag	amorphous	moderate	20%-60%	1-10mm	elongated, spherical	rough, abraded	charcoal, geological	moderate, low, non-magnetic, isolated areas

The collected slag samples are mostly fragmented which all edges are missing. Some characteristics drawn from the database are shown in Table 3.17. The most common colour of tap slag is grey, and sometimes black and brown. The most common colour of furnace slag is grey and brown. All tap slags are non-magnetic except SN3 and SN24. SN24 is the only sample from tap slags which had a low magnetism. The sample was collected from Pangoucun Group 1 (S54) in 2007, mainly grey and some brown and red colours, minor fracture, smooth surface texture with some small broken bubbles, and high viscosity. It is noteworthy that there are at least three stirring like marks on the surface which might indicate the slags were come from a refining furnace. SN3 is magnetic in isolated areas, the sample was collected from Tieshiba (S72) in 2010, grey and brown colours, geological impressions on both surface and underside, minor fracture, and unclear viscosity. There is a clear stirring like mark on its surface, but unlike SN24 this sample looked more like tap slag overall (Fig. 3.149).

SN107 was collected from Mafucun in 2007, which was less than 1km away from the Tieniucun site (S3). The slags were even size, about 40% were 3-4cm and 60% were less than 3cm. Most were non-magnetic, only few small particles were magnetic, and all of the slags were abraded (Fig. 3.150). There was no smelting site discovered in Mafucun, the slag might be transported from the Tieniucun site to pave the road here.

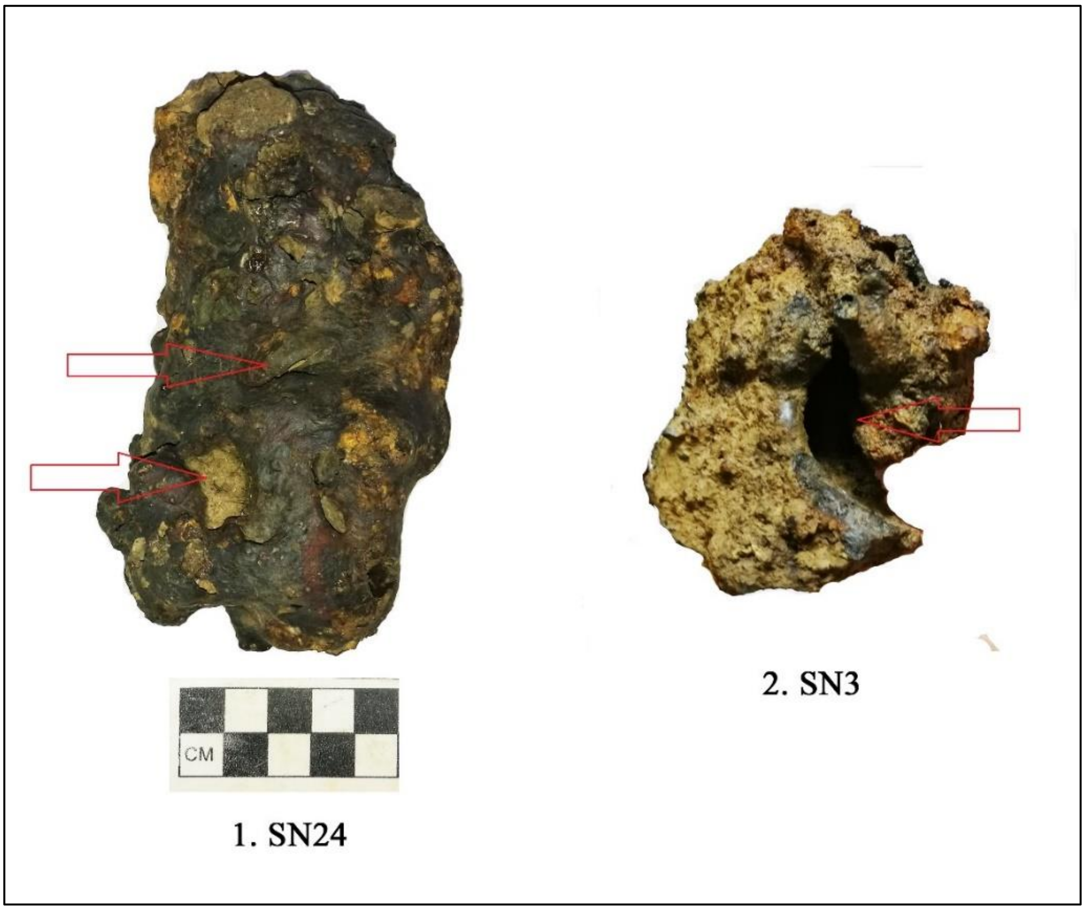


Fig. 3.149 Arrow showing the stirring like marks on SN3 and SN24 (source: author)

Fig. 3.150 SN107 from Mafucun (source: author)

SN115 is one complete slag broken into two pieces (Fig. 3.151). The slag was collected from S72 in 2010, grey colour, fan-shaped, 26cm wide and 8cm thick, 36cm of the arc and about 5cm of the side which connects the tapping hole. The slag is very heavy. There are large number of small stones contacted and a few traces of charcoal on both surface and underside. The stones look like from the bottom of a river with sizes less than 5mm (Fig. 3.152). At least two different layers can be identified from the section view, which the upper layer has less but bigger air bubbles, and the lower layer has more air bubbles between 2-5mm Fig. 3.153. The slag is non-magnetic, comparatively flat, which might indicate that the height between the tapping hole and the ground was not very high and the viscosity was low.

Fig. 3.151 SN115 from S72, surface (source: author)

Sample SN63 from S19 and SN64, 65 from S15 are the same as the refining slags (type III slag) discovered from Xuxiebian (section 3.5.2). The slags are grey with some purple colour, undulated surface but not shining, much heavier than tap slag, and moderate to strong magnetism in most areas. The sizes of SN63 and SN64 are about 14-15x10-11x7cm and SN65 is 6x4.5x4cm. The difference of the three is the porosity proportion, that the areas with more porosity proportion is less magnetic (Fig. 3.154). The discovery of the refining slags indicate that fining process might also applied both at Bajiaojingcun (S15) and Liudalin (S19).

Fig. 3.152 SN115 from S72, underside (source: author)

Fig. 3.153 SN115 from S72, section (source: author)

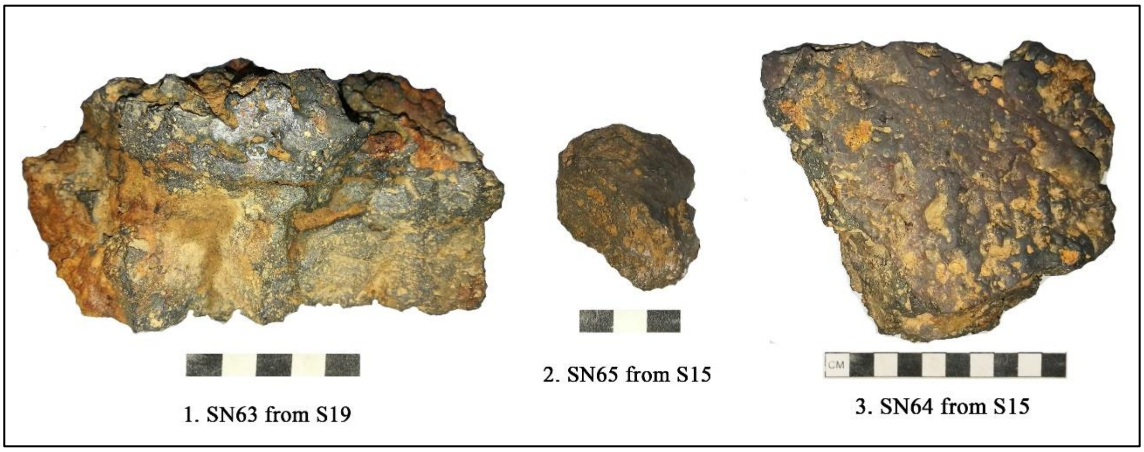


Fig. 3.154 SN63, 64 and 65 (source: author)

Refractory

Besides the 5 excavated sites discussed in the previous sections of this chapter, refractories were discovered from 6 of the surveyed sites. Most of these refractories were processed into bricks before using to build a furnace. The bricks were either made from stone or clay.

Limestone and sandstone are the main types of the stone bricks. Samples from file 19 (F19) are sandstone bricks which were discovered from S8 in 2006. There are many slags attached to the bricks, the slags were non-magnetic and highly vitrified with a black and brownish-red colouration. The bigger sample is about 12x11x13cm, which some of the slags were flowed into the brick gaps (Fig. 3.155:1). Sample from F59 is a limestone brick which was collected from S54 in 2007. The sample size is 9x7x7.5cm with intact thickness. The sample has different degrees of brown colour, all faces except the broken section are covered with a thin layer (1-2mm) of non-magnetic slags (Fig. 3.155:2). Sample from F92 was collected from S61 in 2006, sandstone, 11x6.5x3cm, intact thickness, orange colour, well processed stone brick (Fig. 3.155:3). Samples from F101 were collected from S72 in 2006, limestone, brown colour, high vitrification slag attached to the surface, the slag was 1-2mm thick, black and light green colours, and highly abraded (Fig. 3.155:4).

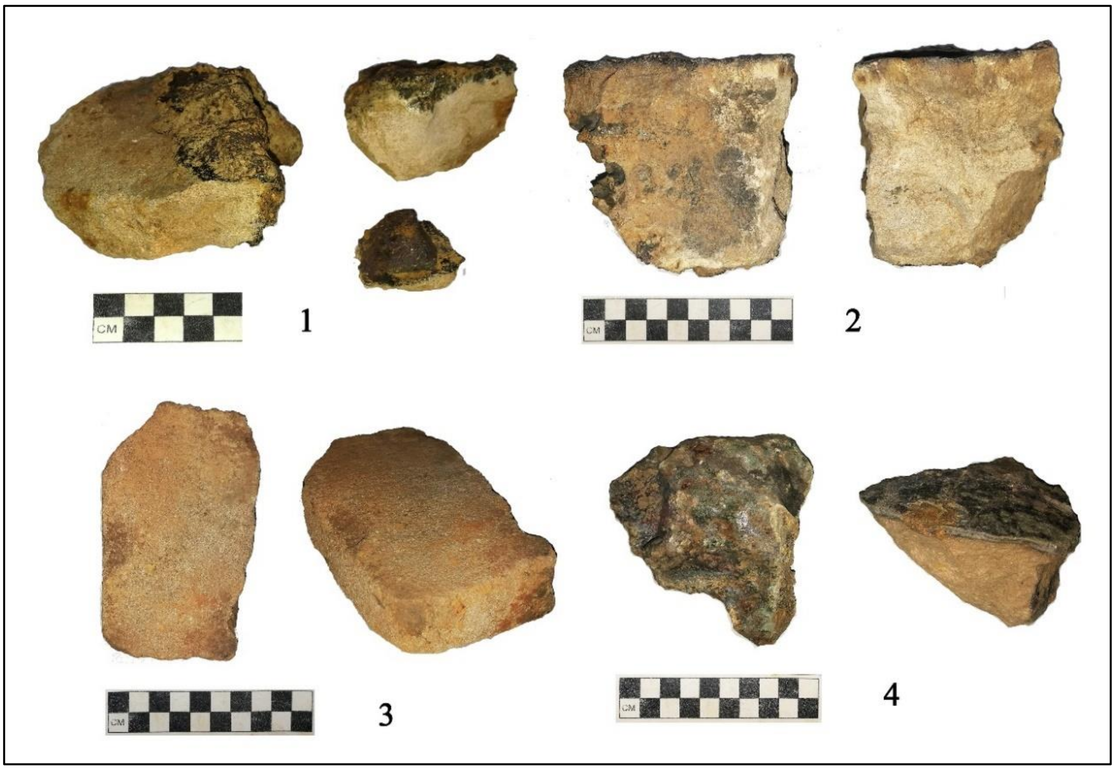


Fig. 3.155 Stone bricks from S8, 54, 61 and 72 (source: author)

The clay bricks have two colours, yellow/orange and grey. The clay used was very fine and the major inclusions were small stones and charcoal. Sample from F61 was collected from S19 in 2006, 12x11x6cm, intact thickness, yellow colour, blacken by smoke on the surface, fine clay with small stones and charcoal power (Fig. 3.156:1). Sample from F69 was collected from S61 in 2006, 10x7x5.5cm, intact thickness, orange colour, fine clay with large amount of small stones, well processed clay brick with slash marks on one surface (Fig. 3.156:2). Sample from F79 was collected from S72 in 2010, yellow colour, fine clay with small amount of small stones, and there was a small magnetic slag about 1.5cm attached to the section of the brick (Fig. 3.156:3). Samples from F109 were collected from S72 in 2010, one grey brick with an intact thickness, 11x7.5x5cm, fine clay with small amount of small stones. The yellow ones are fragments of fine clay bricks with small stones (Fig. 3.156:4).

Fig. 3.156 Clay bricks from S19, 61 and 72 (source: author)

Ore

Small number of ore samples were collected in the re-survey. Most of the samples discovered were being crushed into small pieces about 2-5cm. For example, one ore sample was collected from S12, which has a grey and brownish-red colour, low magnetism, which looks like being crushed and roasted (Fig. 3.157:1). Six samples were collected from S61, 2-3cm, grey and brown colours and moderate density (Fig. 3.157:2). Another ore was discovered at S72, about 4.5-5cm big with a grey and orange colouration and a high density (Fig. 3.157:4). One big piece of ore was discovered at S35, which is 11x7x4.5cm, grey colour in the upper half and brown and orange colours in the lower half. The ore seems not being crushed but clearly burned (Fig. 3.157:3).

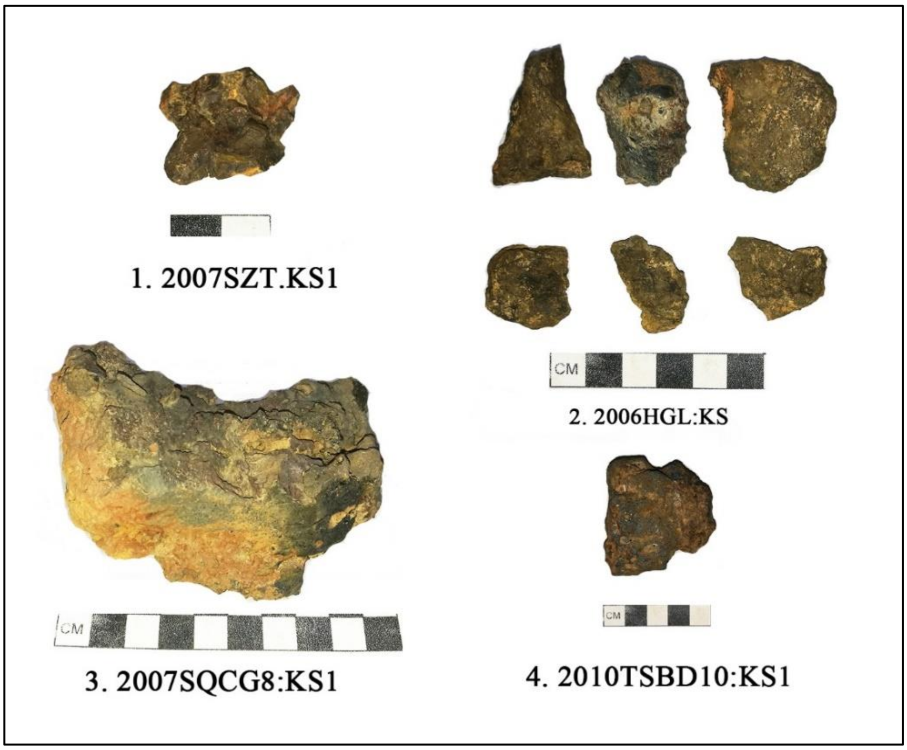


Fig. 3.157 Collected ore samples from the surveyed sites (source: author)

Radiocarbon dating

There are 7 charcoal samples collected from Tieshiba among the surveyed sites. The samples were sent to the Peking University for radiocarbon dating analysis. The calibrated results are shown in Table 3.18. The results were calibrated using OxCal v3.10 (Bronk Ramsey 2005) and IntCal04 (Reimer *et al* 2004). The half-life of carbon 14 used at the Peking University is 5568 years and the BP is referring to a reference date of 1950.

Table 3.18 Calibrated C14 result of samples collected from Tieshiba by Peking University, China (source: CJAT, unpublished)

Lab No.	Name	Sample type	Context	C14 (BP)	Calibrated	
					(68.2%)	(95.4%)
BA132105	QTSB1	charcoal	no specific info	1040±30	985AD(68.2%)1025AD	890AD(7.1%)920AD 940AD(88.3%)1040AD
BA132106	QTSB2	charcoal	inside furnace L1 of 2010QPTT1	1125±20	890AD(7.4%)900AD 915AD(60.8%)970AD	885AD(95.4%)980AD
BA132107	QTSB3	charcoal	at the bottom of furnace L1	1145±25	870AD(23.1%)905AD 915AD(45.1%)970AD	780AD(2.2%)790AD 800AD(93.2%)980AD
BA132108	QTSB4	charcoal	no specific info	1150±20	870AD(28.0%)900AD 915AD(40.2%)965AD	780AD(2.5%)790AD 800AD(92.9%)970AD
BA132109	QTSB5	charcoal	no specific info	1015±25	990AD(68.2%)1025AD	970AD(92.7%)1050AD 1100AD(2.7%)1120AD
BA132110	QTSB6	charcoal	no specific info	1050±30	975AD(68.2%)1020AD	890AD(10.8%)920AD 940AD(84.6%)1030AD
BA132111	QTSB7	charcoal	no specific info	845±30	1160AD(68.2%)1225AD	1050AD(3.2%)1080AD

Lab No.	Name	Sample type	Context	C14 (BP)	Calibrated	
					(68.2%)	(95.4%)
						1150AD(92.2%)1270AD

Discussion

According to the study of the discoveries from the surveyed sites, some characters of iron smelting activities of the surveyed sites could be concluded. Firstly, ores were crushed and roasted before being charged into the furnaces. Secondly, bricks were used to build the furnaces, and these bricks were either limestone/sandstone bricks or clay bricks. Small stones and charcoal were mixed into the clays when making the bricks, and sometimes small pieces of slags were also mixed into the clays. Thirdly, slags were discovered to use to pave road other than simply discarded. According to the C14 result, the Tieshiba iron smelting site could be dated to the Song dynasty (960-1279AD), and the other surveyed sites were mostly dated according to the discoveries of pottery and porcelain sherds found onsite.

As briefly mentioned before, it is very difficult to manage and preserve sites in the countryside, most of the metallurgical sites discovered in the Chengdu Plain were found disturbed. All of the metallurgical sites discovered in the Chengdu Plain are under a very poor condition, they were either partially or totally destroyed in local farming activities, especially for recent years. Local farmers were changing their purpose of land use frequently, crops, orange trees, tea trees and fish ponds whichever is more efficient. Sometimes when our team came back to the site next year, the site was totally destroyed and replaced with fish ponds. It is important to carry out more archaeological works in the countryside to record and collect information as much as we can before they are being destroyed permanently.

Chapter 4: Survey of iron objects from excavations across SW China

4.1 Introduction

The aim of this chapter is to assess the large body of published data to examine the patterns of the excavated iron objects of Southwest China. In the published excavation reports there were over 5,100 iron objects excavated from Southwest China of all periods, and 2,490 of these objects were dated before 200AD. The details of these excavated iron objects are listed in appendix C4. In section 4.3, these excavated objects are analysed systematically and statistically, and the results provide a general image of the character of the use of different artefact types of Southwest China in different periods of time.

4.2 Methodology

Information on excavated iron objects from sites in Southwest China was collected from all of the excavation reports published before 2016. An Excel database in Chinese was created based on the collected information. Each entry includes the artefact name, type, quantity, site location, region, artefact number, description, dating, picture, and reference. The database was translated into English, except for the objects' descriptions and the references (Appendix C4).

A Chinese excavation report usually comprises five parts, 1) a natural and historical background introduction; 2) a general introduction of the site; 3) a detailed introduction of the archaeological features; 4) a detailed introduction of the excavated objects; and 5) the conclusion. Some related research (such as metallography, archaeobotany, and physical anthropology) and the statistics of the archaeological features and excavated objects will all be included in the appendices. When introducing the excavated objects, the objects are separated by different categories such as bronze, ceramic, iron, and gold *etc*. Under each category, the objects are grouped by object types, a total number for the type will be given and usually 1-10 representative objects of the type will be described in detail. The number of representative objects usually depends on the category. Normally, there will be a more complete and detailed introduction and description for the bronze, gold, and jade objects. Usually, only one or two iron objects of each type will be introduced, and the description is mostly very brief due to the poor condition of the iron objects. In many cases, ‘corroded’ is the only recorded description for the selected iron objects.

In this study, a total of 102 reports were processed (Sichuan 33, Chongqing 28, Yunnan 24, Guizhou 8, and Xizang 9), and of these 54 of them (Sichuan 16, Chongqing 22, Yunnan 12, Guizhou 2, Xizang 2) have descriptions of iron objects. Notice that 11 of the reports of Chongqing are collections of brief reports published during 1997 and 2002. The basic structure of a brief report is the same as the full excavation report but with even less description and usually no statistical information.

When assessing the data, some adjustments were made according to translation habits. For example, in Chinese, the term “Tie Dao” were used both for iron knives and iron sabres. In my database, those with width less than 2.5cm and length less than 25cm were identified as iron knives (tools), those with greater dimensions were identified as iron sabres (weapons), and those with insufficient information were logged as unidentified type. Note that the differences between swords and sabres in Chinese is that swords have double blades and sabres have only one blade.

In the database, a fraction may be seen in the “Quantity” column, for example “1/3”, which means there were 3 objects of the type excavated from the site and the entry records one of the three. It may be followed with another entry with quantity “2/3”, which indicates this is the second object of the three. The capital letters “Y” (yes) or “N” (no) in the “Pic” column indicates whether a picture was provided in the report. The pictures were saved in a separated portable hard drive.

There were over 5,100 iron objects (population size) of all periods mentioned in published excavation reports, and 1,931 of those were with descriptions. The statistical analysis in this section was based on these 1,931 entries (sample size). Statistically, this would be a limitation as the samples were not chosen “randomly” but depending on the habits of the report editors. However, the appoach avoids including potential false data when there were no given descriptions of the objects.

Moreover, this limitation will be reduced when the sample size is big and 1,931 could be regarded as a big sample size. Charts and graphs were applied to demonstrate the sorted data.

4.3 Statistical analysis of the published excavated iron objects

This section shows the patterns discovered in the statistical analysis. First bi-metallic objects and then iron objects.

4.3.1 Bi-metallic objects

In the archaeological reports, 'bi-metallic' artefact usually refers to those bronze and iron bi-metallic objects and sometimes jade or gold were applied instead of bronze. There were 319 entries for bi-metallic artefacts of Southwest China in the database, which were all bronze and iron bi-metallic objects except one inlaid iron object excavated from Jiangchuan Lijiashan, Yunnan province. Most of the bi-metallic objects were excavated from burials (Fig. 4.1).

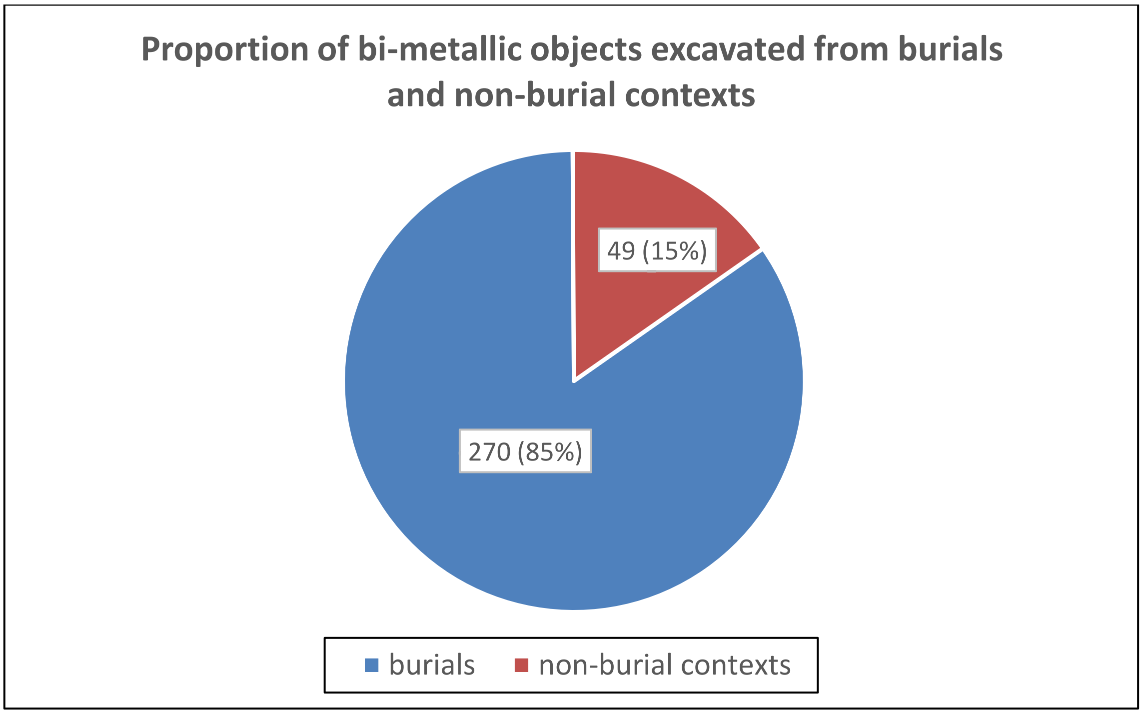


Fig. 4.1 Proportion of the bi-metallic objects excavated from burials and non-burial contexts (source: author)

According to the database, 83% of the bi-metallic objects of Southwest China were excavated in Yunnan province, 11% were excavated from Sichuan, and only 6% were excavated from Chongqing, Guizhou and Xizang combined (Fig. 4.2).

Based on the dates given in the published reports, the bi-metallic objects were dated from the mid-Warring States period to the Eastern Han dynasty (c.350BC to 220AD) except for one bronze mirror with iron handle (Fig. 4.3) which was excavated from Lasa Qugong, Xizang, and which dated to the 8th century BC (Fig. 4.4, Table 4.1).

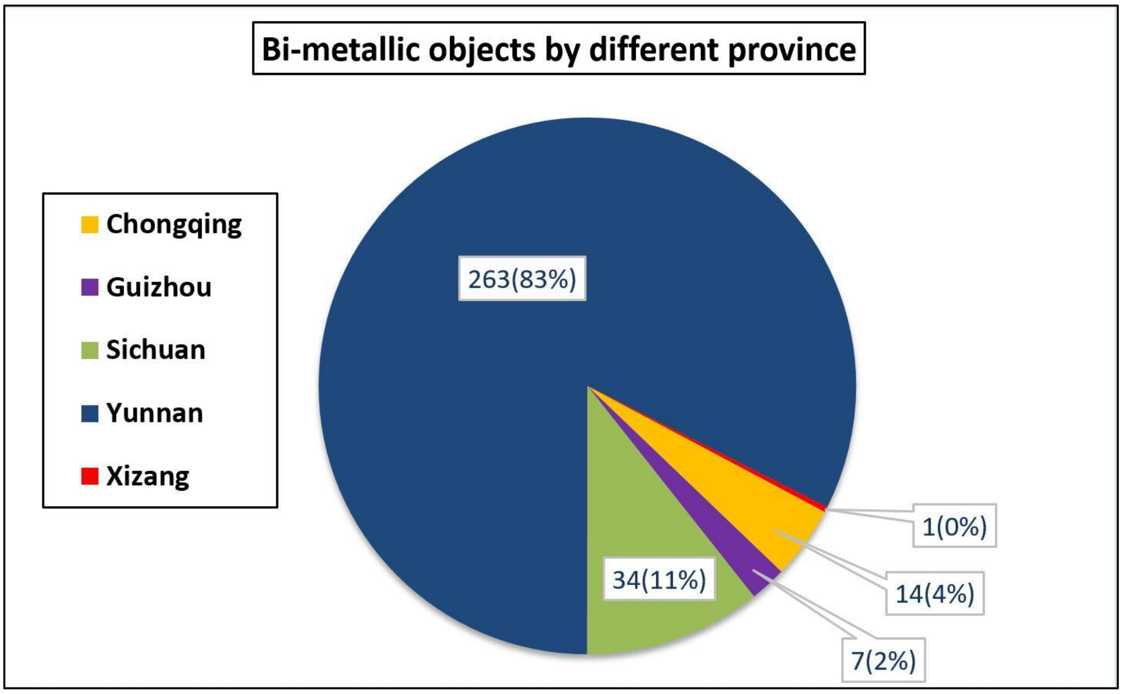


Fig. 4.2 Bi-metallic objects by province (source: author)

Table 4.1 Dates of the bi-metallic objects excavated from burials and non-burial contexts

	burials	%	non-burial contexts	%	total	%
8th-3rd century BC	**10**	*3.7*	**2**	*4.1*	**12**	*3.8*
202BC-8AD (Western Han)	**231**	*85.6*	**25**	*51.0*	**256**	*80.3*
25AD-220AD (Eastern Han)	**15**	*5.6*	**0**	*0.0*	**15**	*4.7*
undated	**14**	*5.2*	**22**	*44.9*	**36**	*11.3*
total	**270**	*84.6*	**49**	*15.4*	**319**	

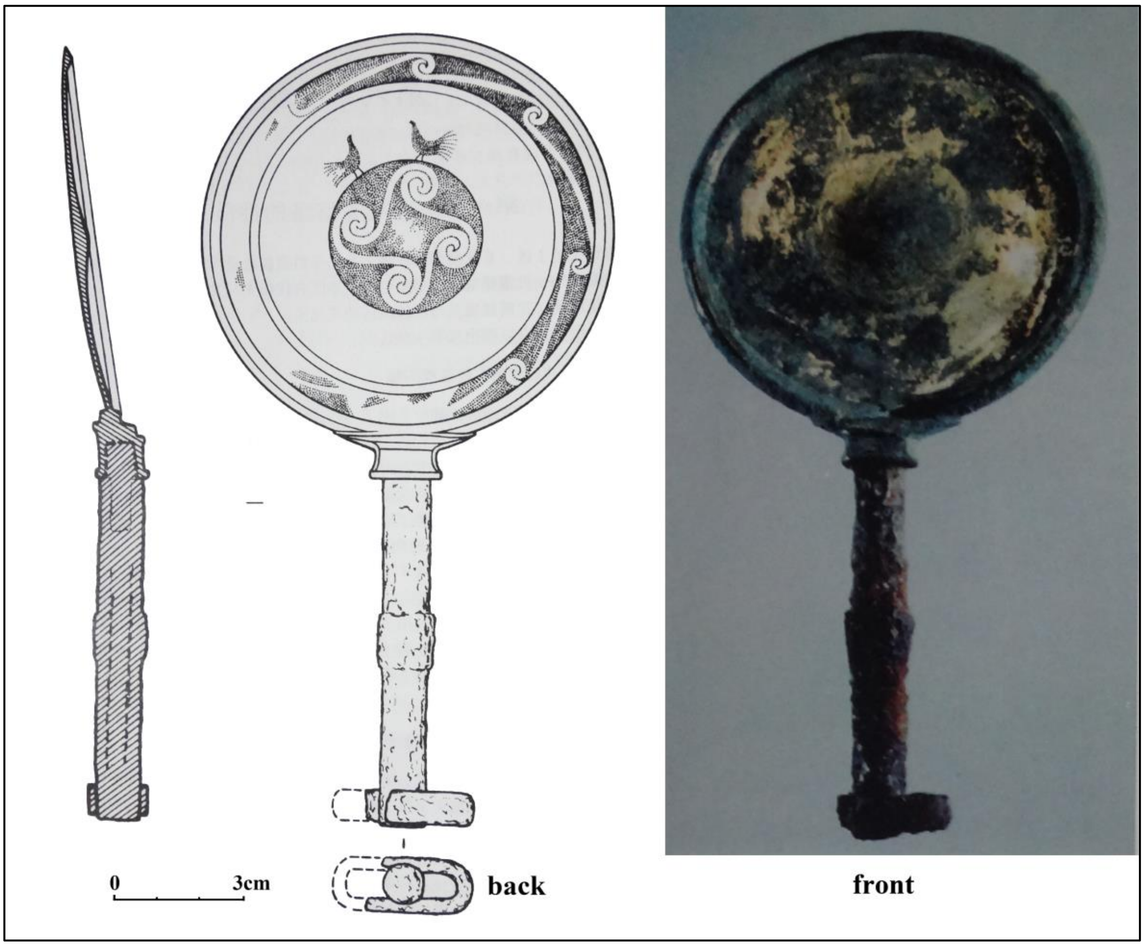


Fig. 4.3 Bronze mirror with iron handle (M203:2) excavated from Lasa Qugong, Xizang (source: ZGSHKXYKGYJS and XZZZQWWJ 1999a, fig.145, pl.4)

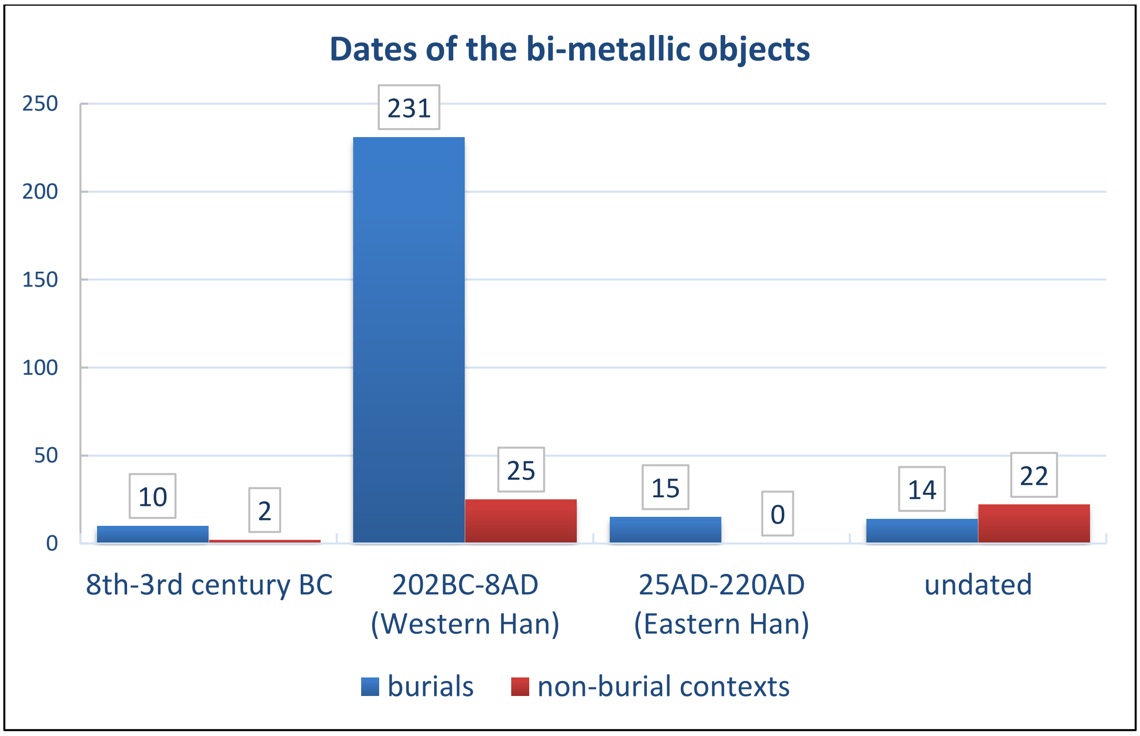


Fig. 4.4 Dates of the bi-metallic objects excavated from burials and non-burial contexts (source: author)

More than 85% of the excavated bi-metallic objects from the burials were weapons, and about 12% were tools. For those excavated from non-burial contexts, about 65% were weapons and 35% were tools (Table 4.2, Fig. 4.5).

Table 4.2 Types of bi-metallic objects excavated from burials and non-burial contexts

	burials	%	non-burial contexts	%	total	%
weapons	**230**	*85.2*	**32**	*65.3*	**262**	*82.1*
tools	**32**	*11.9*	**17**	*34.7*	**49**	*15.4*
domestic objects	**1**	*0.4*	**0**	*0.0*	**1**	*0.3*
unidentified	**7**	*2.6*	**0**	*0.0*	**7**	*2.2*
total	**270**	*84.6*	**49**	*15.4*	**319**	

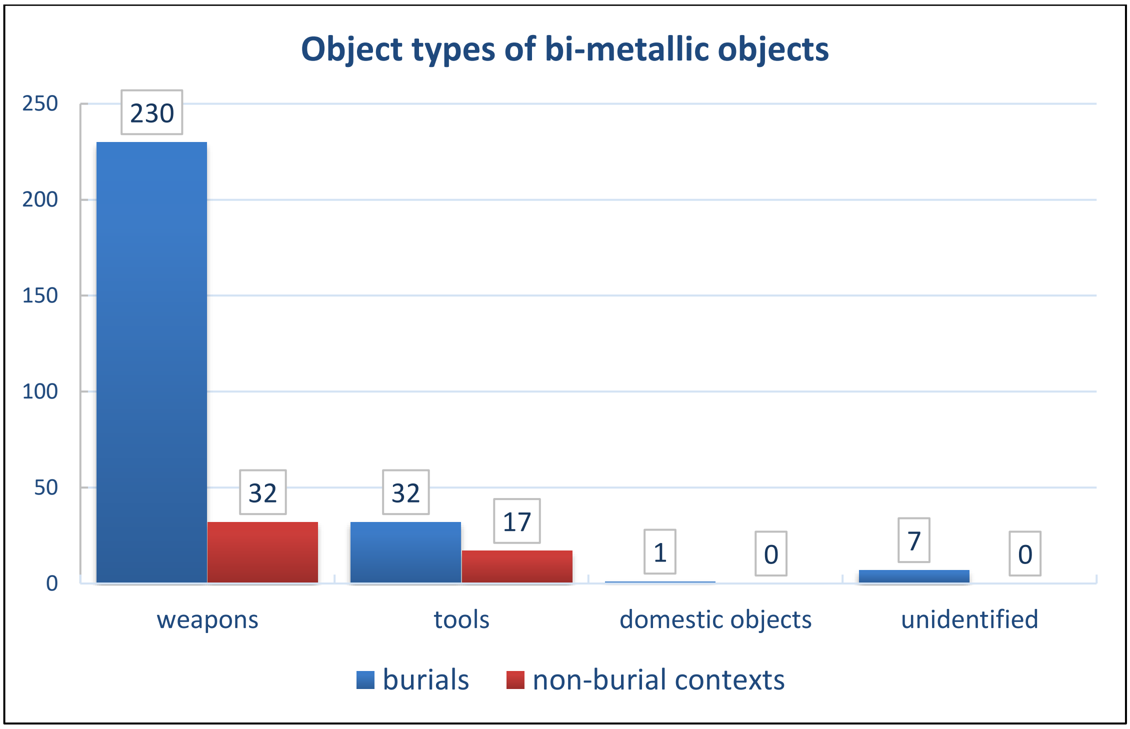


Fig. 4.5 Comparison of different type of bi-metallic objects excavated from burials and non-burial contexts (source: author)

Weapons

Weapons make up 82% of the database. The weapon types of the bi-metallic objects include a large number of iron swords with bronze guards or handles and iron spearheads with bronze sockets, and small numbers of iron dagger-axeheads with bronze sockets, iron halberdheads with bronze sockets, bronze arrowheads with iron body, and iron ferrules with bronze sockets (Table 4.3, Fig. 4.6, Fig. 4.7).

Table 4.3 Object type of the bi-metallic weapons

Weapons type	burials	%	non-burial contexts	%	total	%
iron ferrules with bronze sockets	**1**	*50.0*	**1**	*50.0*	**2**	*0.8*
iron halberdheads with bronze sockets	**2**	*50.0*	**2**	*50.0*	**4**	*1.5*
iron spearhead with bronze socket	**78**	*96.3*	**3**	*3.7*	**81**	*30.9*
iron swords with bronze guards or handles	**144**	*84.7*	**26**	*15.3*	**170**	*64.9*
bronze arrowheads with iron body	**2**	*100.0*	**0**	*0.0*	**2**	*0.8*
iron dagger-axeheads with bronze sockets	**3**	*100.0*	**0**	*0.0*	**3**	*1.1*
total	**230**	*87.8*	**32**	*12.2*	**262**	

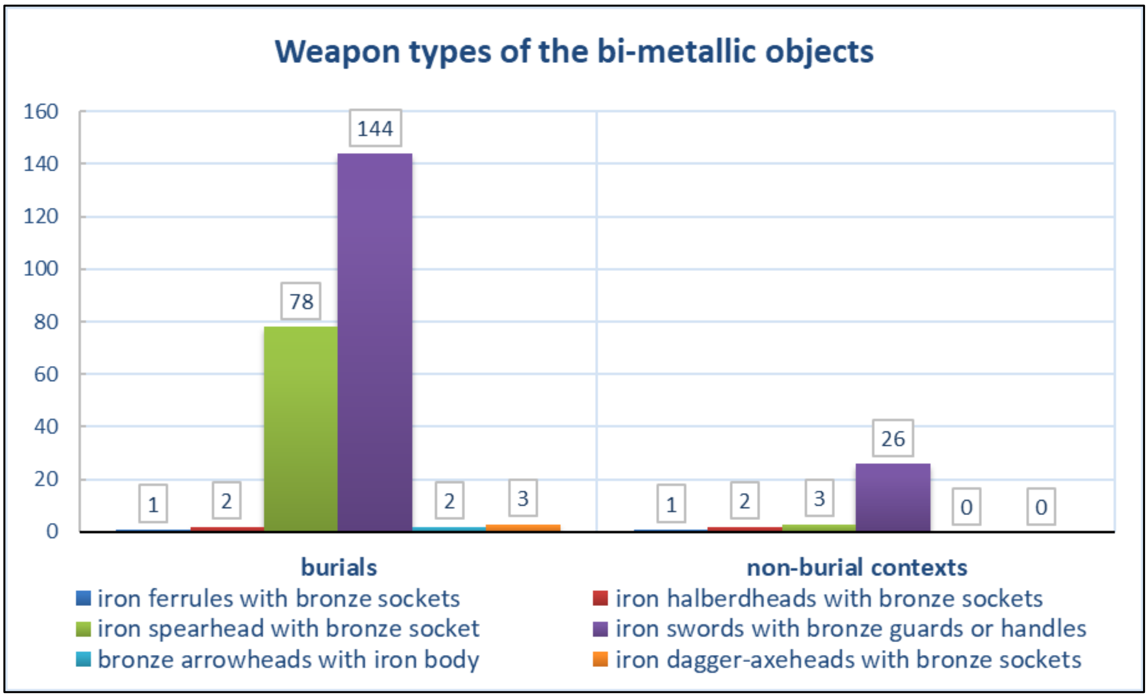


Fig. 4.6 Weapon types of the bi-metallic objects (source: author)

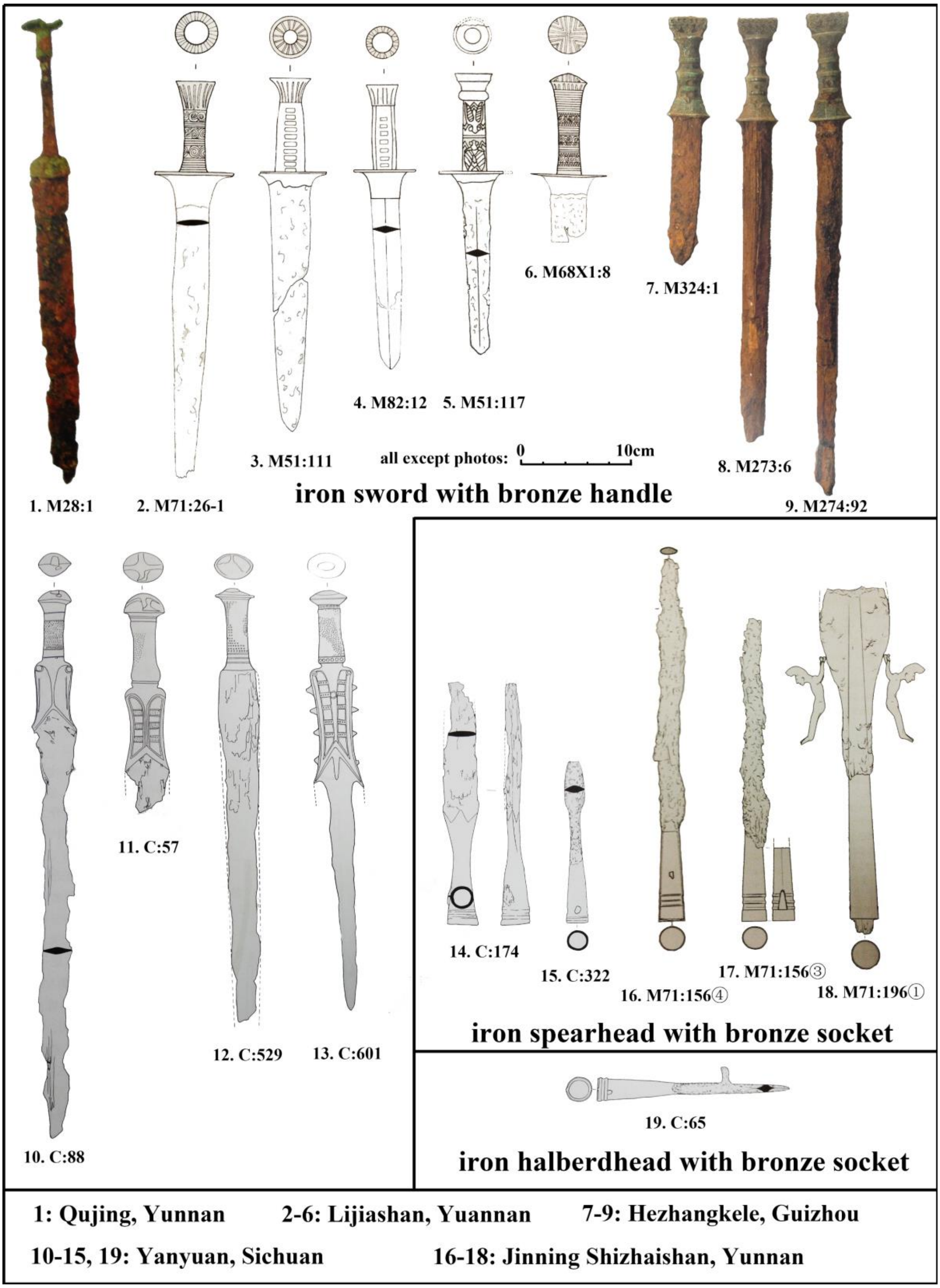


Fig. 4.7 Examples of bi-metallic weapons of Southwest China (source: see appendix C4)

Tools

Tools make up 15% of the total bi-metallic database. Most of the bi-metallic tools were excavated from Yunnan, and only a small number of iron knives with bronze handles were excavated from Sichuan. The tool types include iron axeheads with bronze body or sockets, iron blades with bronze handles or sockets, iron chisels with bronze sockets, and iron knives with bronze handles (Table 4.4, Fig. 4.8, Fig. 4.9).

Table 4.4 Object type of the bi-metallic tools

Tools type	burials	%	non-burial contexts	%	total	%
iron axeheads with bronze body or sockets	**12**	*100.0*	**0**	*0.0*	**12**	*24.5*
iron blades with bronze handles or sockets	**7**	*43.8*	**9**	*56.3*	**16**	*32.7*
iron chisels with bronze sockets	**10**	*100.0*	**0**	*0.0*	**10**	*20.4*
iron knives with bronze handles	**3**	*30.0*	**7**	*70.0*	**10**	*20.4*
iron sickleheads with bronze handles	**0**	*0.0*	**1**	*100.0*	**1**	*2.0*
total	**32**	*65.3*	**17**	*34.7*	**49**	

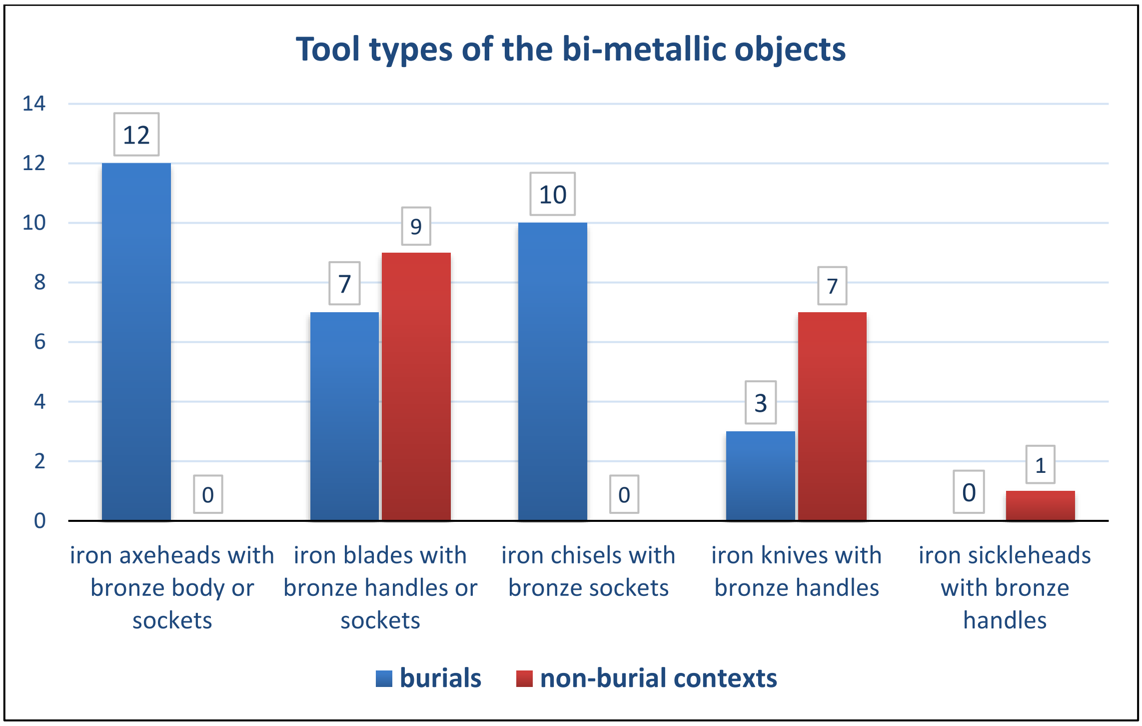


Fig. 4.8 Tool types of the bi-metallic objects (source: author)

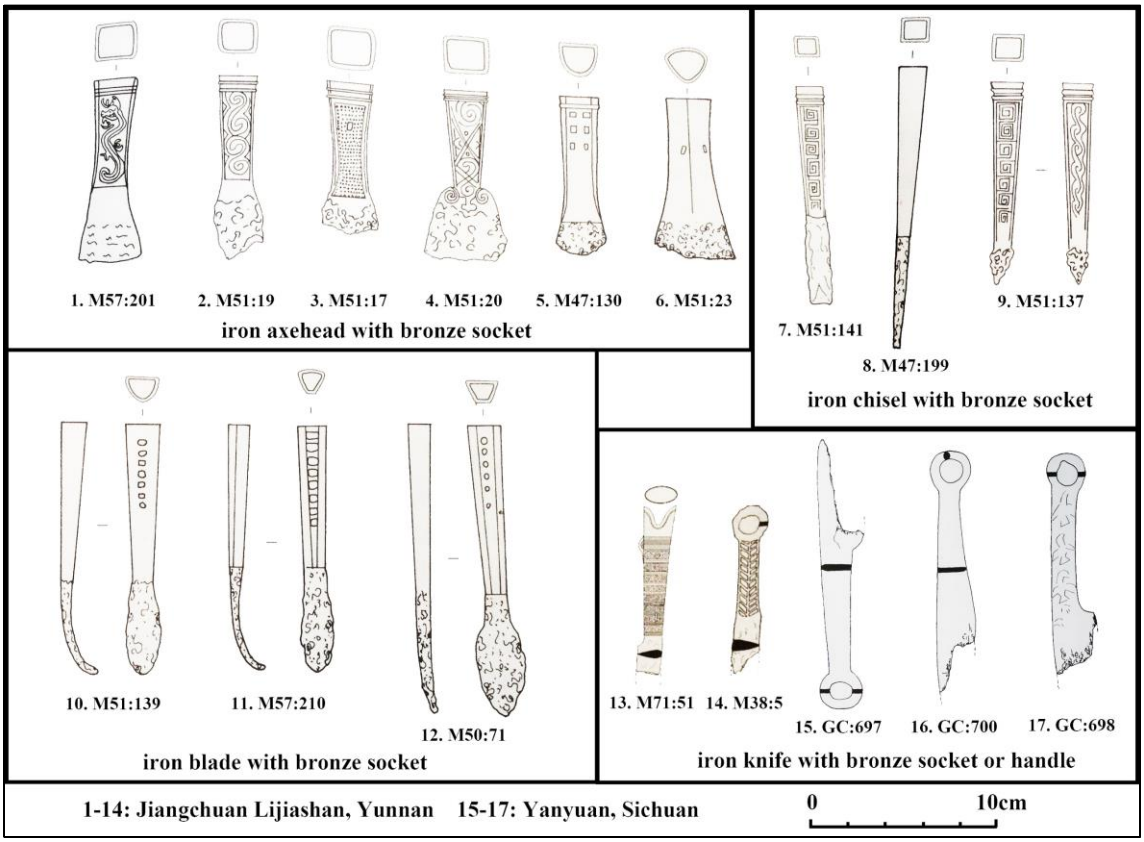


Fig. 4.9 Examples of bi-metallic tools of Southwest China (source: see appendix C4)

4.3.2 Iron objects

There are 1,612 entries of iron artefacts excavated from sites in Southwest China in the database, and more than 70% of them were excavated from burials (Fig. 4.10).

According to the database, 66% of the iron objects of Southwest China were excavated from Chongqing, 16% were excavated from Yunnan, 9% were excavated both from Sichuan and Guizhou, and only 0.68% were from Xizang (Fig. 4.11).

Based on the dates given in the published reports, the 1,612 iron objects entries were dated from the 8th century BC to the 19th century AD (Table 4.5, Fig. 4.12). Among those, over 59% were dated from the Western Han to the Eastern Han dynasties (202BC-220AD), and more than 90% were excavated from burials.

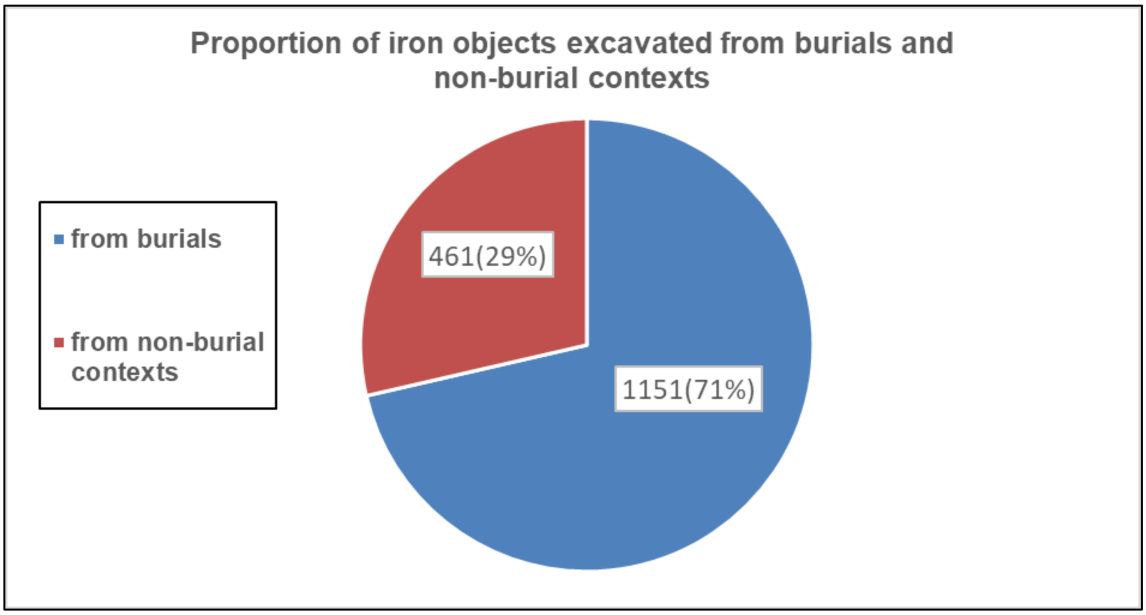


Fig. 4.10 Proportion of the iron objects excavated from burials and non-burial contexts (source: author)

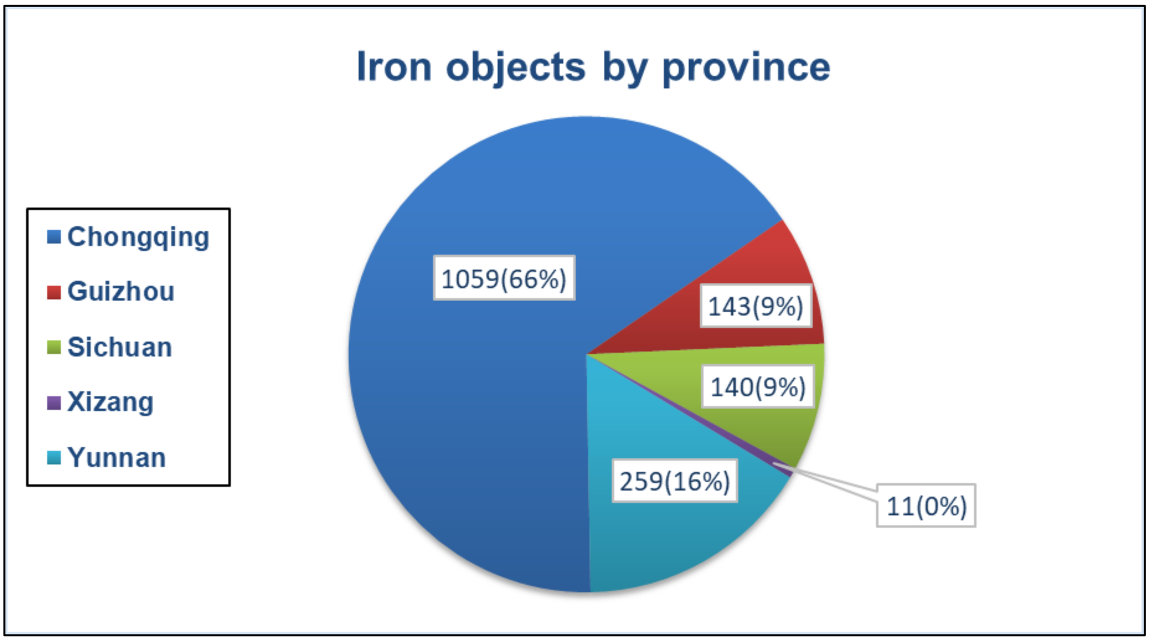


Fig. 4.11 Iron objects by province (source: author)

Tools (40%), weapons (25%) and domestic objects (14%) were the main types of iron objects. Most of the domestic objects (92%), accessories (86%) and weapons (69%) were excavated from burials. About 16% of the iron objects were unidentified types, and most of them were also found in burials (Table 4.6, Fig. 4.13).

Table 4.5 Dates of the iron objects excavated from burials and non-burial contexts

	burials	%	non-burial contexts	%	total	%
8th-3rd century BC	**61**	*43.3*	**80**	*56.7*	**141**	*8.7*
202BC to 8AD (Western Han)	**585**	*93.6*	**40**	*6.4*	**625**	*38.8*
25-220AD (Eastern Han)	**294**	*89.4*	**35**	*10.6*	**329**	*20.4*
221-960AD (Wei and Jin to the Five dynasties)	**119**	*47.0*	**134**	*53.0*	**253**	*15.7*
10th-19th century (Ming and Qing dynasty)	**42**	*30.0*	**98**	*70.0*	**140**	*8.7*
undated	**50**	*40.3*	**74**	*59.7*	**124**	*7.7*
total	**1151**	*71.4*	**461**	*28.6*	**1612**	

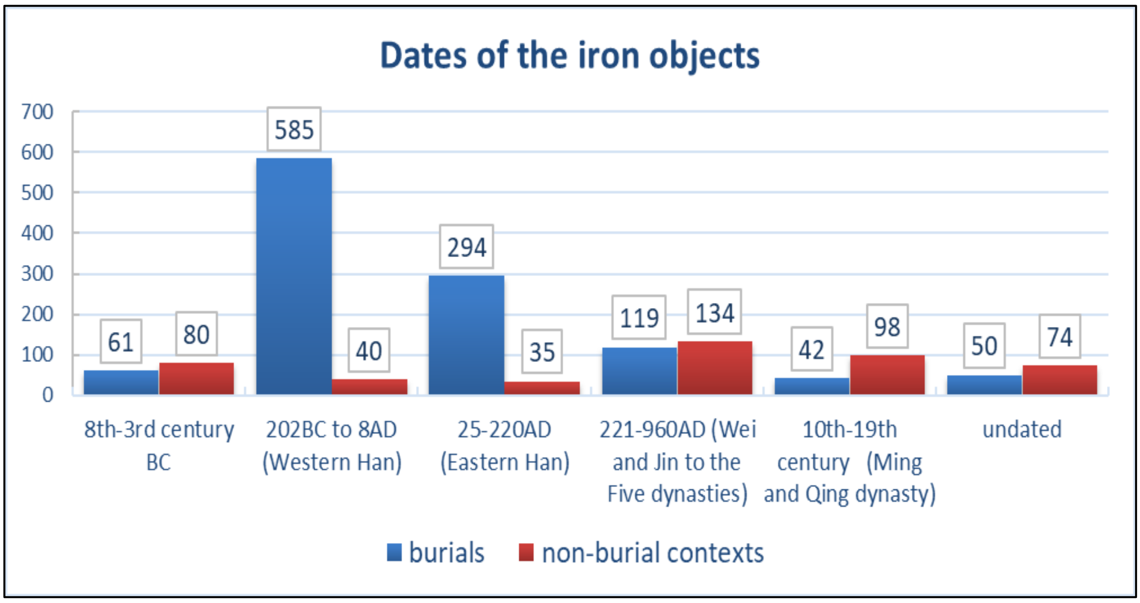


Fig. 4.12 Dates of the iron objects excavated from burials and non-burial contexts (source: author)

Table 4.6 Types of the iron objects excavated from burials and non-burial contexts

	burials	%	non-burial contexts	%	total	%
weapons	**275**	*68.6*	**126**	*31.4*	**401**	*24.9*
tools	**410**	*62.9*	**242**	*37.1*	**652**	*40.4*
domestic objects	**214**	*92.2*	**18**	*7.8*	**232**	*14.4*
accessories	**32**	*86.5*	**5**	*13.5*	**37**	*2.3*
others	**23**	*59.0*	**16**	*41.0*	**39**	*2.4*
unidentified	**197**	*78.5*	**54**	*21.5*	**251**	*15.6*
total	**1151**	*71.4*	**461**	*28.6*	**1612**	

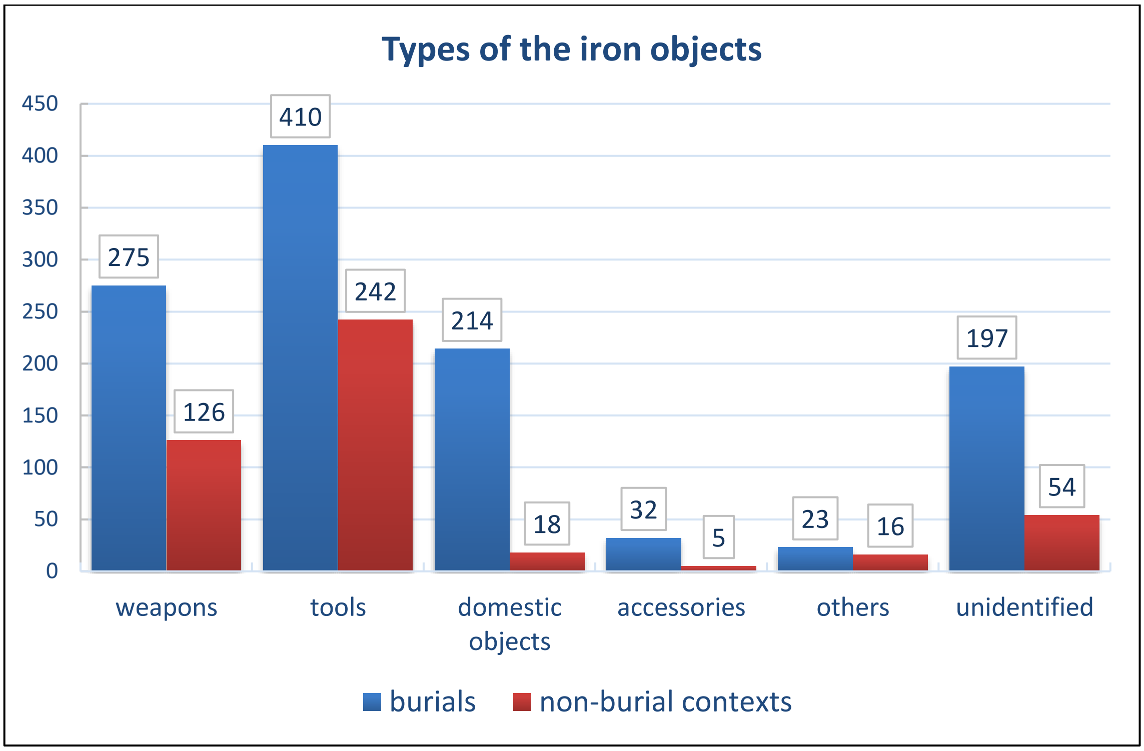


Fig. 4.13 Types of the iron objects excavated from burials and non-burial contexts (source: author)

Weapons

Weapons make up 25% of the total database. Over 65% of the excavated iron weapons were dated to the Han dynasty (202BC-220AD), and most of them (over 90%) were excavated from burials (Table 4.7, Fig. 4.14).

Table 4.7 Iron weapons by period from burials and non-burial contexts

Period	burials	%	non-burial contexts	%	total	%
8th-3rd century BC	**11**	*55.0*	**9**	*45.0*	**20**	*5.4*
202BC to 8AD (Western Han)	**149**	*93.7*	**10**	*6.3*	**159**	*42.9*
25-220AD (Eastern Han)	**73**	*90.1*	**8**	*9.9*	**81**	*21.8*
221-960AD (Wei and Jin to the Five dynasties)	**28**	*34.6*	**53**	*65.4*	**81**	*21.8*
10th-19th century (Ming and Qing dynasty)	**3**	*10.0*	**27**	*90.0*	**30**	*8.1*
total	**264**	*71.2*	**107**	*28.8*	**371**	

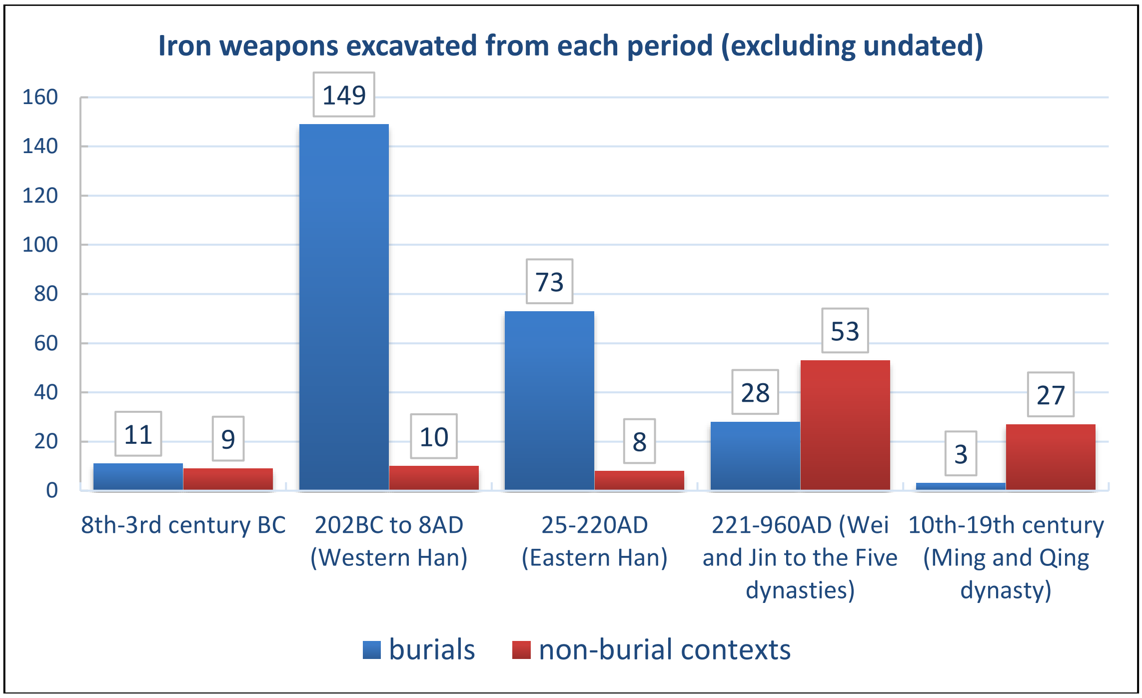


Fig. 4.14 Iron weapons from each period (source: author)

The most common types of weapons were sabres (37%), swords (21%), spearheads (15%), arrowheads (14%), and ring-pommeled sabres/swords (10%). There were also a small number of iron ferrules, daggers, halberdheads, broadaxheads, and armour lamella excavated. Most of the iron weapons were excavated from burials, except the arrowheads, armour lamella, sabres, and ferrules which were discovered equally or more often in non-burial contexts. The ring-pommeled sabres/swords, iron swords, and spearheads were the most popular iron weapon types of gravegoods (Table 4.8, Fig. 4.15).

Table 4.8 Object types of the iron weapons

Type of the iron weapons	burials	%	non-burial contexts	%	total	%
sabre	**88**	*59.5*	**60**	*40.5*	**148**	*36.9*
sword	**76**	*91.6*	**7**	*8.4*	**83**	*20.7*
spearhead	**50**	*83.3*	**10**	*16.7*	**60**	*15.0*
arrowhead	**15**	*27.3*	**40**	*72.7*	**55**	*13.7*
ring-pommeled sabre/sword	**37**	*94.9*	**2**	*5.1*	**39**	*9.7*
ferrule	**2**	*33.3*	**4**	*66.7*	**6**	*1.5*
armour lamella	**1**	*25.0*	**3**	*75.0*	**4**	*1.0*
halberdhead	**3**	*100.0*	**0**	*0.0*	**3**	*0.7*
broadaxhead	**2**	*100.0*	**0**	*0.0*	**2**	*0.5*
dagger	**1**	*100.0*	**0**	*0.0*	**1**	*0.2*
total	**275**	*68.6*	**126**	*31.4*	**401**	

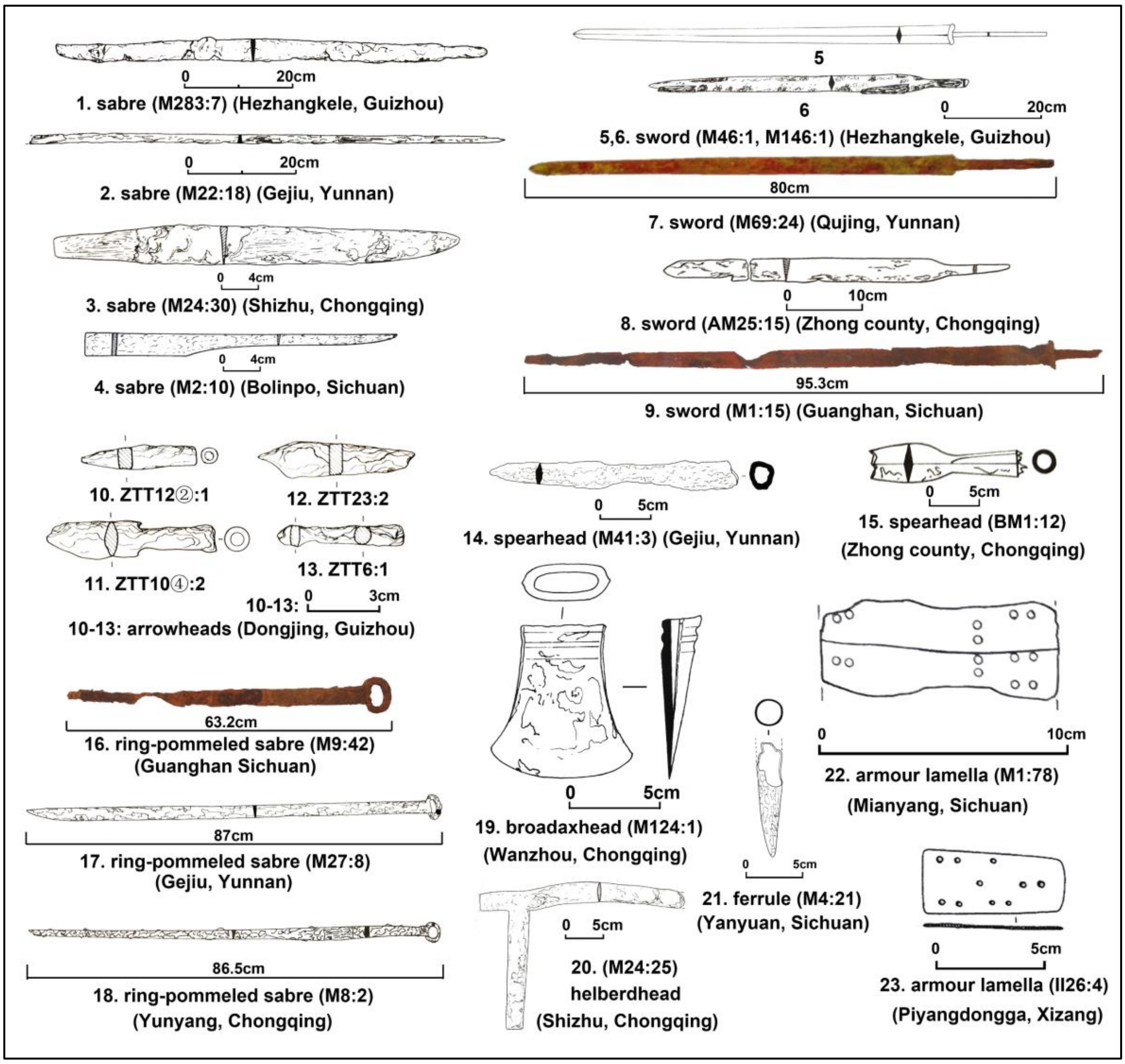


Fig. 4.15 Examples of the iron weapons excavated from Southwest China (source: see appendix C4)

Tools

Tools make up 40% of the total database. Over 70% of the excavated iron tools were dated before 220AD. The iron tools were more likely to be found in burials of the Han dynasty (Table 4.9, Fig. 4.16).

The main types of the excavated iron tools were ring-headed knives (13%), axeheads (13%), nails (12%), U-shaped implement caps (9%), chisels (8%), mattockheads (8%), and knives (5%, Table 4.10, Fig. 4.17).

The ring-headed knives, scissors, knives, curved iron blades, ploughshares and caps, and saws were mostly excavated from burials, which suggests the popular iron tool types of gravegoods.

Table 4.9 Iron tools by period from burials and non-burial contexts

Period	burials	%	non-burial contexts	%	total	%
8th-3rd century BC	**33**	*35.5*	**60**	*64.5*	**93**	*15.6*
202BC to 8AD (Western Han)	**213**	*90.3*	**23**	*9.7*	**236**	*39.7*
25-220AD (Eastern Han)	**78**	*82.1*	**17**	*17.9*	**95**	*16.0*
221-960AD (Wei and Jin to the Five dynasties)	**43**	*38.7*	**68**	*61.3*	**111**	*18.7*
10th-19th century (Ming and Qing dynasty)	**23**	*38.3*	**37**	*61.7*	**60**	*10.1*
total	**390**	*65.5*	**205**	*34.5*	**595**	

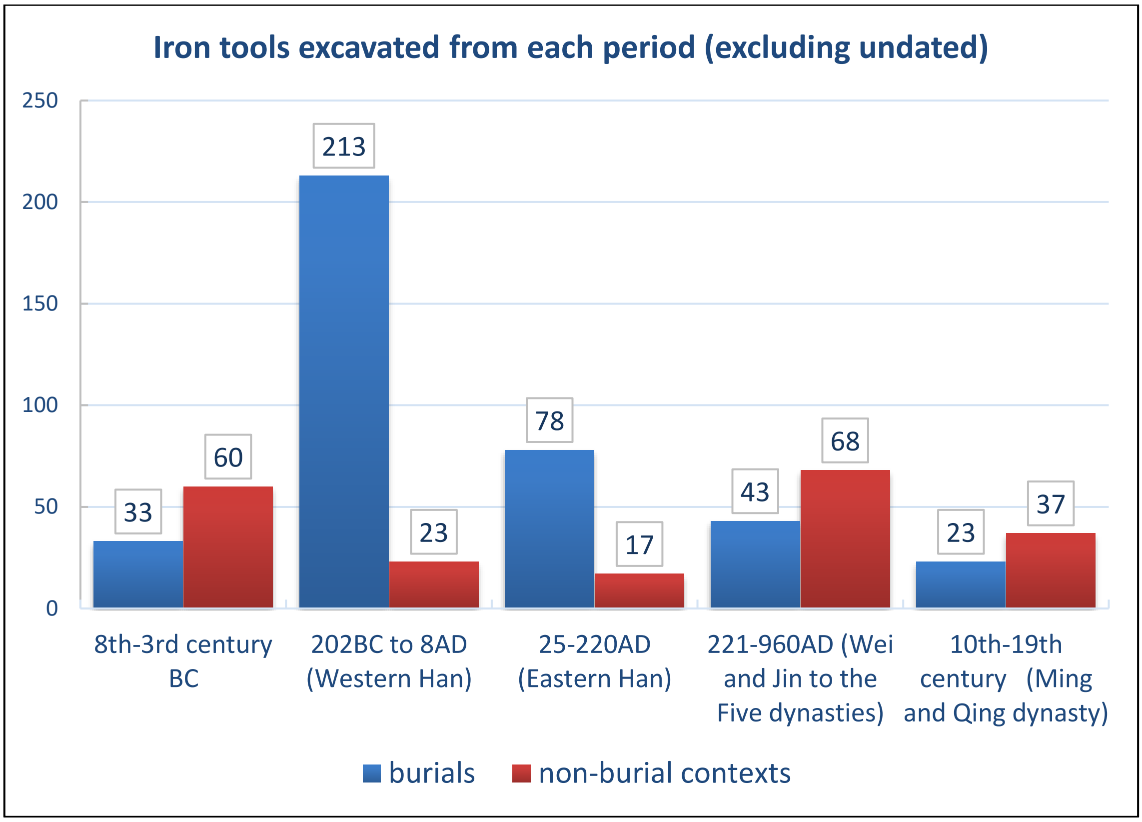


Fig. 4.16 Iron tools from each period (source: author)

Table 4.10 Object types of the iron tools

Type of the iron tools	burials	%	non-burial contexts	%	total	%
ring-headed iron knife	83	96.5	3	3.5	86	13.2
axehead	42	50.0	42	50.0	84	12.9
nail	45	58.4	32	41.6	77	11.8
U-shaped implement cap	27	45.8	32	54.2	59	9.0
chisel	24	49.0	25	51.0	49	7.5
mattockhead	28	57.1	21	42.9	49	7.5
knife	27	77.1	8	22.9	35	5.4
hoehead	13	48.1	14	51.9	27	4.1
sicklehead	14	56.0	11	44.0	25	3.8
adze	17	73.9	6	26.1	23	3.5
scissors	21	95.5	1	4.5	22	3.4
hook	5	27.8	13	72.2	18	2.8
shovelhead	9	56.3	7	43.8	16	2.5
ring	8	53.3	7	46.7	15	2.3
stick	9	75.0	3	25.0	12	1.8
curved iron blade	10	100.0	0	0.0	10	1.5
weight	5	71.4	2	28.6	7	1.1
ploughshare and cap	6	100.0	0	0.0	6	0.9
saw	5	100.0	0	0.0	5	0.8
fork	1	25.0	3	75.0	4	0.6
hammerhead	2	50.0	2	50.0	4	0.6
rake tooth	1	25.0	3	75.0	4	0.6
spinning wheel	3	75.0	1	25.0	4	0.6
plier	1	33.3	2	66.7	3	0.5
corner connect	2	100.0	0	0.0	2	0.3
fish hook	0	0.0	2	100.0	2	0.3
pickaxehead	0	0.0	1	100.0	1	0.2
condensation jar lid	0	0.0	1	100.0	1	0.2
needle	1	100.0	0	0.0	1	0.2
net weight	0	0.0	1	100.0	1	0.2
Total	409	62.7	243	37.3	652	

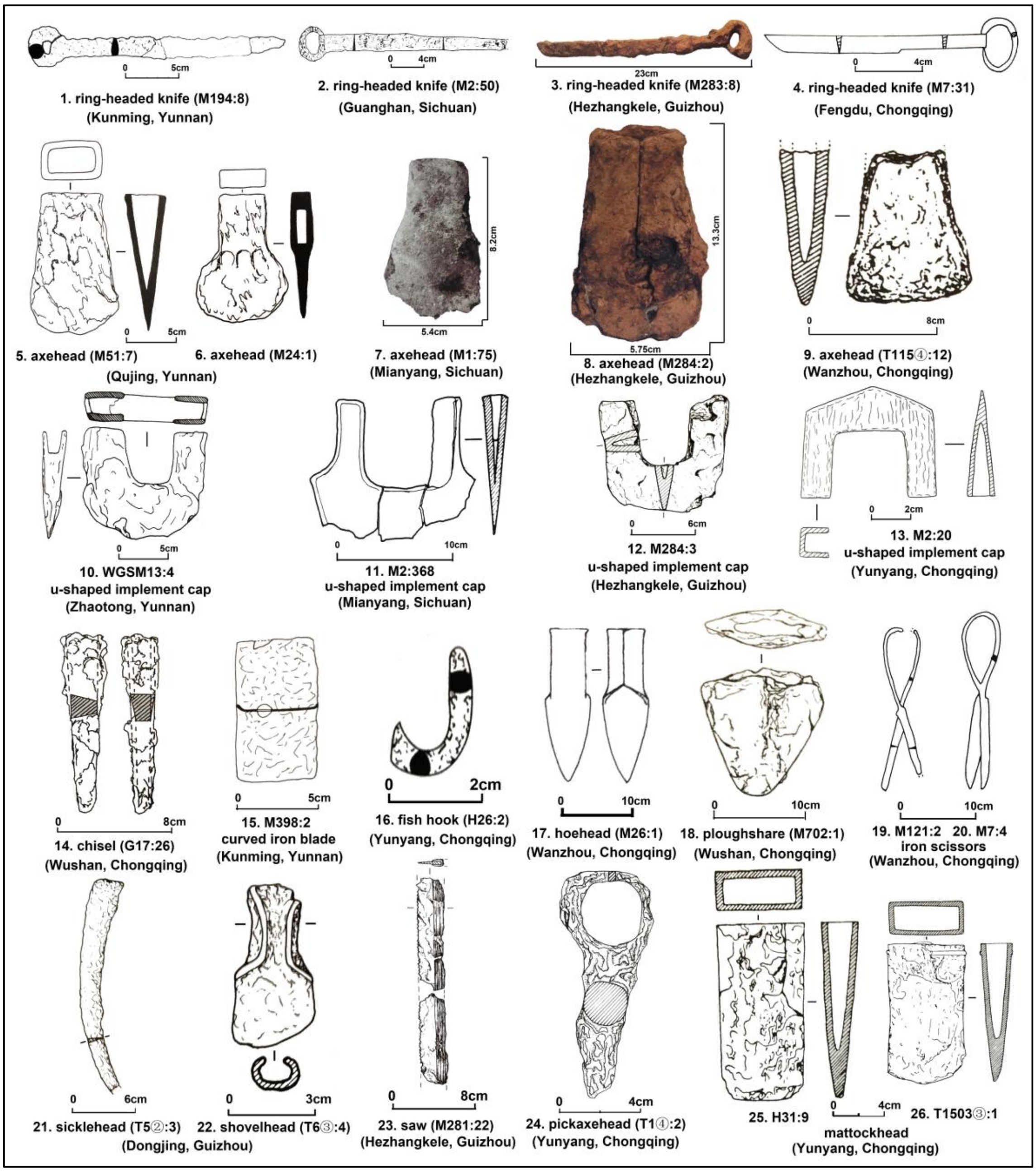


Fig. 4.17 Examples of the iron tools excavated from Southwest China (source: see appendix C4)

Domestic objects

Domestic objects make up 14% of the total database. Over 85% of the domestic objects were dated to the Han dynasty (202BC-220AD), and nearly all of them were excavated from burials (Table 4.11, Fig. 4.18).

Table 4.11 Domestic iron objects by period from burials and non-burial contexts

Period	burials	%	non-burial contexts	%	total	%
8th-3rd century BC	**3**	*75.0*	**1**	*25.0*	**4**	*1.8*
202BC to 8AD (Western Han)	**105**	*99.1*	**1**	*0.9*	**106**	*46.9*
25-220AD (Eastern Han)	**85**	*98.8*	**1**	*1.2*	**86**	*38.1*
221-960AD (Wei and Jin to the Five dynasties)	**13**	*72.2*	**5**	*27.8*	**18**	*8.0*
10th-19th century (Ming and Qing dynasty)	**4**	*33.3*	**8**	*66.7*	**12**	*5.3*
total	**210**	*92.9*	**16**	*7.1*	**226**	

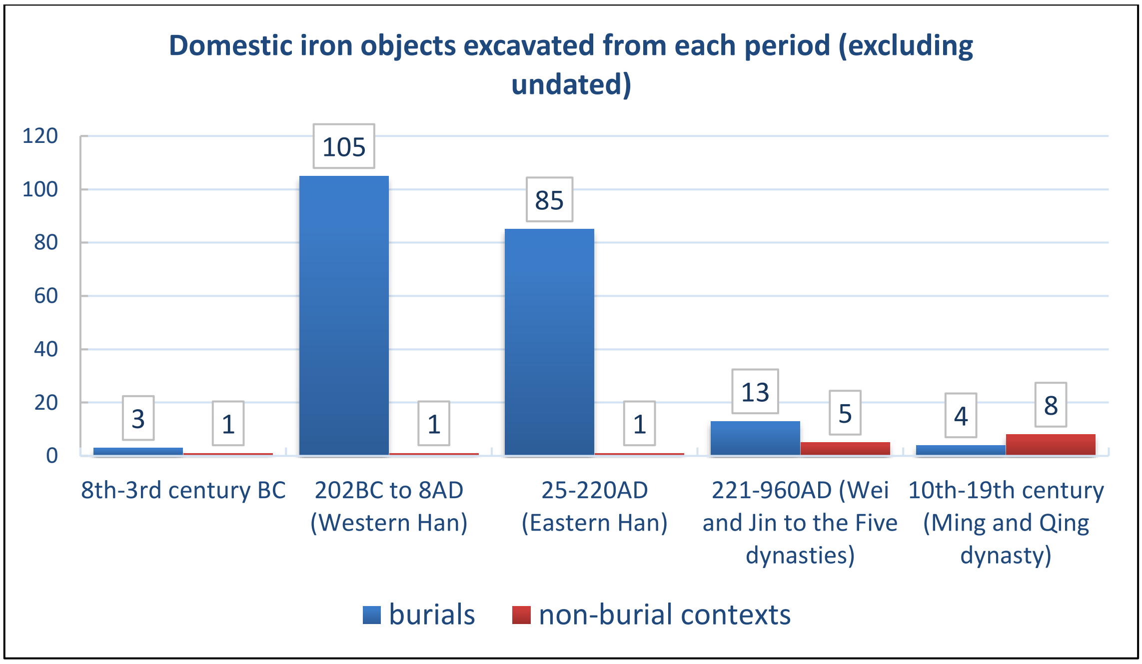


Fig. 4.18 Domestic iron objects from each period (source: author)

The main types of the excavated domestic iron objects were *fu*-pots (54%), stands (13%), *mou*-pots (6%), lamps (5%), and tri-pots (4%, Table 4.12, Fig. 4.19).

The iron *fu*-pot was a very popular cooking vessel in Southwest China, which is usually used together with an iron stand. It is clear that this assemblage was also popular as gravegoods in the Han dynasty.

Table 4.12 Object types of the domestic iron objects

Type of the domestic iron objects	burials	%	non-burial contexts	%	total	%
fu -pot	**122**	*96.8*	**4**	*3.2*	**126**	*54.3*
iron stand	**27**	*93.1*	**2**	*6.9*	**29**	*12.5*
iron *mou-* pot	**13**	*100.0*	**0**	*0.0*	**13**	*5.6*
lamp	**12**	*100.0*	**0**	*0.0*	**12**	*5.2*
tri-pot	**8**	*80.0*	**2**	*20.0*	**10**	*4.3*
spoon	**6**	*66.7*	**3**	*33.3*	**9**	*3.9*
object ear/handle/bottom	**5**	*55.6*	**4**	*44.4*	**9**	*3.9*
tri-pot with handle	**6**	*100.0*	**0**	*0.0*	**6**	*2.6*
ring	**5**	*100.0*	**0**	*0.0*	**5**	*2.2*
lock	**2**	*66.7*	**1**	*33.3*	**3**	*1.3*
E-shaped object lid	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
box	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
hearth	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
earpick	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
iron *jian* (jar)	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
knocker	**0**	*0.0*	**1**	*100.0*	**1**	*0.4*
mirror	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
tri-plate	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
iron wok	**0**	*0.0*	**1**	*100.0*	**1**	*0.4*
squared iron pot	**1**	*100.0*	**0**	*0.0*	**1**	*0.4*
total	**214**	*92.2*	**18**	*7.8*	**232**	

Fig. 4.19 Examples of the domestic iron objects excavated from Southwest China (source: see appendix C4)

Accessories

Accessories make up only 2.3% of the total database. There are a small number of iron accessories excavated, including belt hooks (70%), bracelets (22%), and hair clasps (8%), which were mostly excavated from burials (Table 4.13, Fig. 4.20).

Table 4.13 Object types of the iron accessories

Type of the iron accessories	burials	%	non-burial contexts	%	total	%
belt hook	22	*84.6*	4	*15.4*	26	*70.3*
bracelet	8	*100.0*	0	*0.0*	8	*21.6*
hair clasp	2	*66.7*	1	*33.3*	3	*8.1*
total	32	*86.5*	5	*13.5*	37	

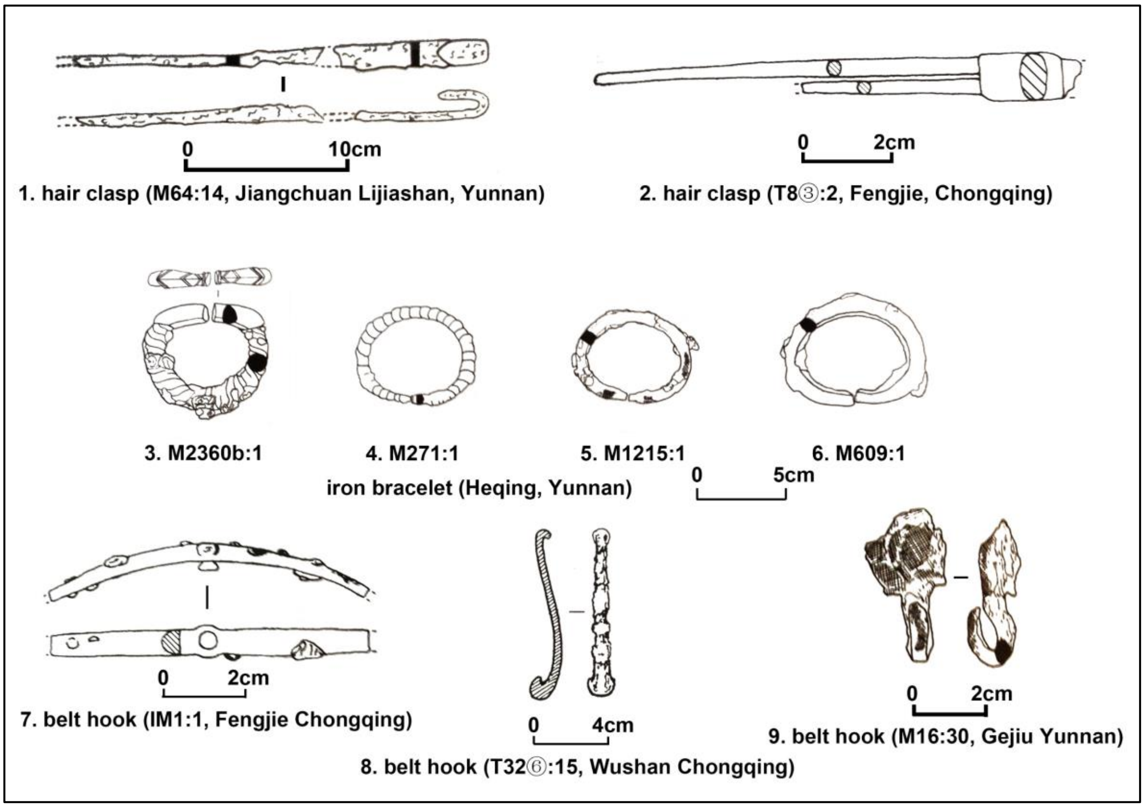


Fig. 4.20 Examples of the iron accessories excavated from Southwest China (source: see appendix C4)

Others

Others make up only 2.4% of the total database. Most of the excavated iron objects of the other types are iron coins, and a small number of horse accessories (Table 4.14, Fig. 4.21).

Table 4.14 Object types of the other objects

Type of the other excavated iron objects	burials	%	non-burial contexts	%	total	%
coin	**17**	*56.7*	**13**	*43.3*	**30**	*76.9*
horse accessories	**4**	*57.1*	**3**	*42.9*	**7**	*17.9*
iron ox	**1**	*100.0*	**0**	*0.0*	**1**	*2.6*
iron pig	**1**	*100.0*	**0**	*0.0*	**1**	*2.6*
total	**23**	*59.0*	**16**	*41.0*	**39**	

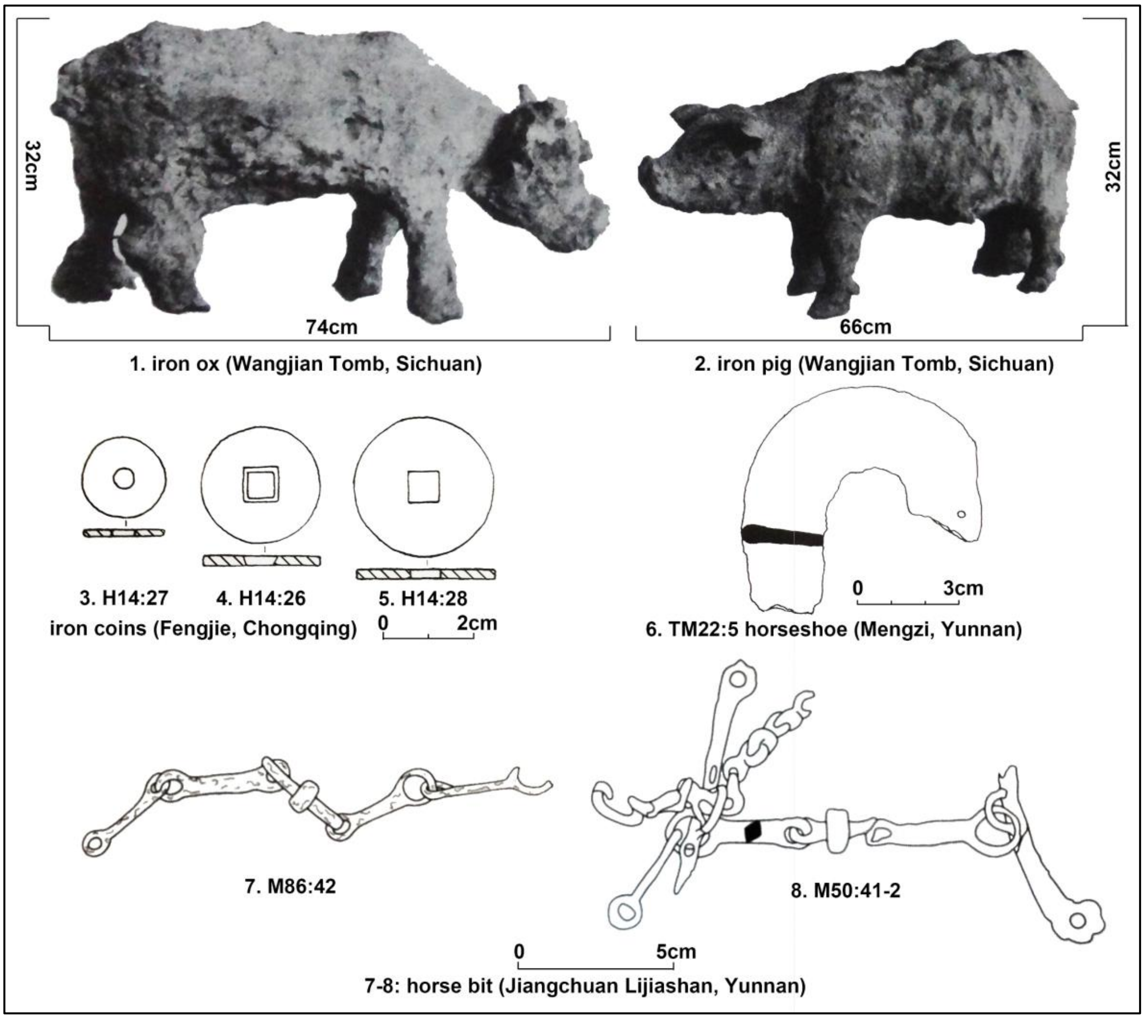


Fig. 4.21 Examples of the excavated iron objects of the other types (source: see appendix C4)

4.4 Summary

This section provides a general image of the bi-metallic and iron objects from excavations in Southwest China.

Bi-metallic objects

Most of the bi-metallic objects were discovered in Yunnan province (83%), and over 85% were excavated from burials. All of the excavated bi-metallic objects were dated to and before the Han dynasty (except 36 undated), of which over 94% were dated before 8AD (the end of the Western Han).

Weapons were the main type (84%) of bi-metallic objects. There were also some bi-metallic tools (16%), and one domestic object (bronze mirror with iron handle). Over 95% of the bi-metallic weapons are iron swords with bronze handles or guards (65%) and iron spearheads with bronze sockets (31%).

The main types of the bi-metallic tools were iron blades with bronze handles (33%), iron axeheads with bronze sockets (24%), iron chisels with bronze sockets (20%), and iron knives with bronze sockets (20%).

Iron objects

Of all periods, up to 71% of the iron objects were excavated from burials in Southwest China, and the other 29% were excavated from non-burial contexts.

Specifically, there is a total of 66% of the iron objects excavated in Chongqing; 9% excavated from the sites in Sichuan, which are mainly distributed in central, the east (near Chongqing), and the south (near Yunnan) of Sichuan; 9% excavated all from one site (Hezhangkele) in Guizhou, which is located at the intersection of Sichuan, Yunnan and Guizhou provinces; 9% excavated from the sites in Yunnan, which are mainly distributed in central Yunnan (Kunming, Jinning, and Jiangchuan); and less than 1% excavated from two sites in Xizang (Fig. 4.22).

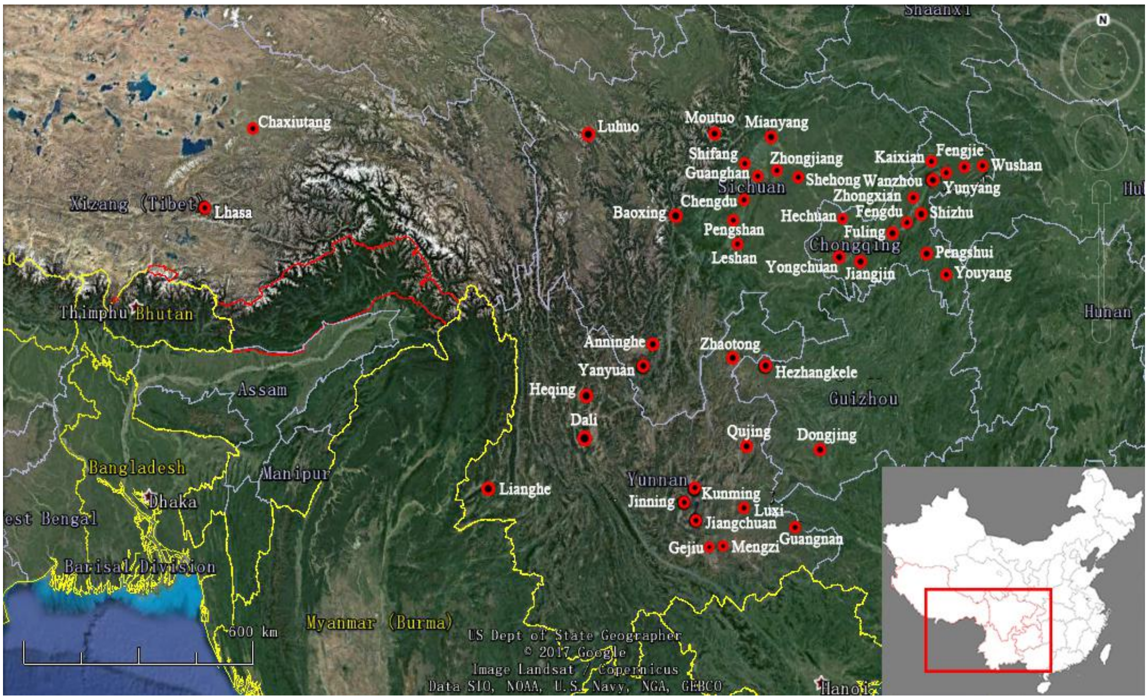


Fig. 4.22 Map showing the sites where iron objects were mainly excavated in SW China (source: Google Map)

About 9% of the iron objects are dated to the pre-Han dynasties (8^{th}-3^{rd} centuries BC), and the amounts increased rapidly to a total of 59.2% of iron objects dated to the Han dynasty (202BC-220AD). Among these, 38.8% of the objects are dated to the Western Han dynasty (202BC-8AD), and the amounts continuously decreased from the Eastern Han dynasty to the Ming and Qing dynasties.

Disregarding the unidentified objects, tools (48%) were the main type of the iron objects. There were 29% weapons and 17% domestic objects. Most of the iron tools, weapons and domestic objects were dated to the Han dynasty (202BC-220AD). The most commonly seen weapons were iron sabres, swords, spearheads, and arrowheads. The most commonly seen tools were ring-headed knives, axeheads, nails, and U-shaped implement caps. Nearly all of the domestic iron objects were excavated from burials. The *fu*-pot and its iron stand were the most commonly seen domestic object type.

Iron weapons, tools, and domestic objects largely appeared as gravegoods during the Han dynasty, especially the Western Han dynasty. Large amounts of these objects of this period were excavated, and over 90% of them were from burials.

According to my analysis, iron sabres are the most commonly seen weapons in Southwest China (36.9%). Swords, ring-pommeled sabres/swords, and spearheads were the typical gravegoods of iron weapons. There are also iron halberdheads and broadaxheads excavated from burials, but the amount is too few to be significant in statistics. Iron arrowheads and small amounts of ferrules and armour lamellas were more often discovered in non-burial contexts, suggesting possibility that the ferrules and the armour lamellas might be lost as missing parts for the original objects.

Ring-headed knives are the most typical gravegoods of the iron tools. They make up 13.2% of the total excavated iron tools, and 96.5% of them were from burials. Scissors, curved iron blades, ploughshares and caps, and saws were also found dominantly in burials, which might be an indication of the profession of the burial owners.

There is a total of 85% domestic objects dated to and before the Han dynasty. Nearly all of the iron domestic objects of all periods were excavated from burials. It showed that domestic objects as gravegoods might be a tradition of Southwest China. The *fu*-pot was the most popular cooking vessels in Southwest China during the Han dynasty. The *fu*-pot and its stand are also the most typical gravegoods of domestic objects (a total of 66.8%). The appearance of the *fu*-pot in burials may indicate a practice of providing foods for the burial owners in their afterlife.

There are not many discoveries of iron accessories, most of them are belt hooks, and most of those belt hooks were excavated from burials (84.6%). There were also two large size iron animal castings discovered from the mausoleum of Wangjian (847-918AD), Sichuan province.

4.5 Discussion

This section discusses the patterns revealed in analyzing the bronze and iron bi-metallic objects and iron objects in section 6.3. I will try to compare the situation of Southwest China to the Central Plains and northern China, and to study their relationships and connections. The bi-metallic and iron objects are discussed in separated sections.

4.5.1 Bi-metallic objects

Worldwide

There are some well-known bi-metallic artifacts discovered worldwide, for instance, an iron dagger with gold handle was discovered in a Hittite tomb dated 2500 BC in Alaca Höyük, Turkey (Murakami 2014). Chen Jianli *et al* (2012, 49) quoted two other bi-metallic objects from Tylecote (1992), one iron sword with gold handle in Tutankhamun's tomb dated to 1323 BC and one bronze spear with iron blade was discovered in Ugarit, Syria. All the iron used on these three weapons was identified as meteoritic iron because of the high content of nickel detected (Fig. 4.23).

Fig. 4.23 Iron dagger with gold handle from Alaca Höyük, Turkey (source: Murakami Y. 2014)

There are two bi-metallic objects excavated from Southeast Aisa. A bronze socket with iron blade spearhead and a bronze hilt with iron blade sword excavated from Dong Son, Vietnam (Higham 1996, 110-111; Janse 1958).

Central Plains and northern China

The discovery of the bi-metallic objects in the Central Plains and northern China could be divided into three stages. First stage, the Shang dynasty to the early Western Zhou dynasty (the 14th-10th centuries BC). The bi-metallic objects discovered from this stage were usually ritual weapons (*Yue* and *Ge*), the iron was meteoritic iron and only used on the cutting edges.

Second stage, the late Western Zhou dynasty to the early Warring States period (the 9^{th}-5^{th} centuries BC). The number of objects increased, and smelted iron was used. As well as ritual weapons, there were also bi-metallic tools.

Third stage, the late Warring States period to the Eastern Han dynasty (the 5^{th} century BC to the 2^{nd} century AD). The number of bi-metallic objects further increased, and varying types of weapons and tools were discovered. Iron was also used to make the feet of the domestic objects such as bronze *Ding* (tri-pot).

The earliest bi-metallic objects discovered so far in the Central Plains and northern China are two bronze *Yue* (broadaxhead) with iron blades, which were dated to the mid-Shang Dynasty (about 14^{th} century BC). One of them was from a burial excavated in 1972 at Taixicun, Gaocheng, Hebei province (Fig. 4.24). The burial was dated according to a total of twenty-seven excavated bronze, lithic and jade artifacts. A metallographic analysis of the corroded residue from its iron blade was carried out in 1976, which indicates that the iron was meteoritic iron. The conclusion was based on, 1) No large number of inclusions in artificial iron; 2) Nickel content detected was between 0.8-2.8%; 3) Cobalt content detected was over 0.4%. The meteoritic iron was first hammered into a blade less than 2 mm and then placed into a mould to cast the bronze body (Li Z. 1976, 31-32).

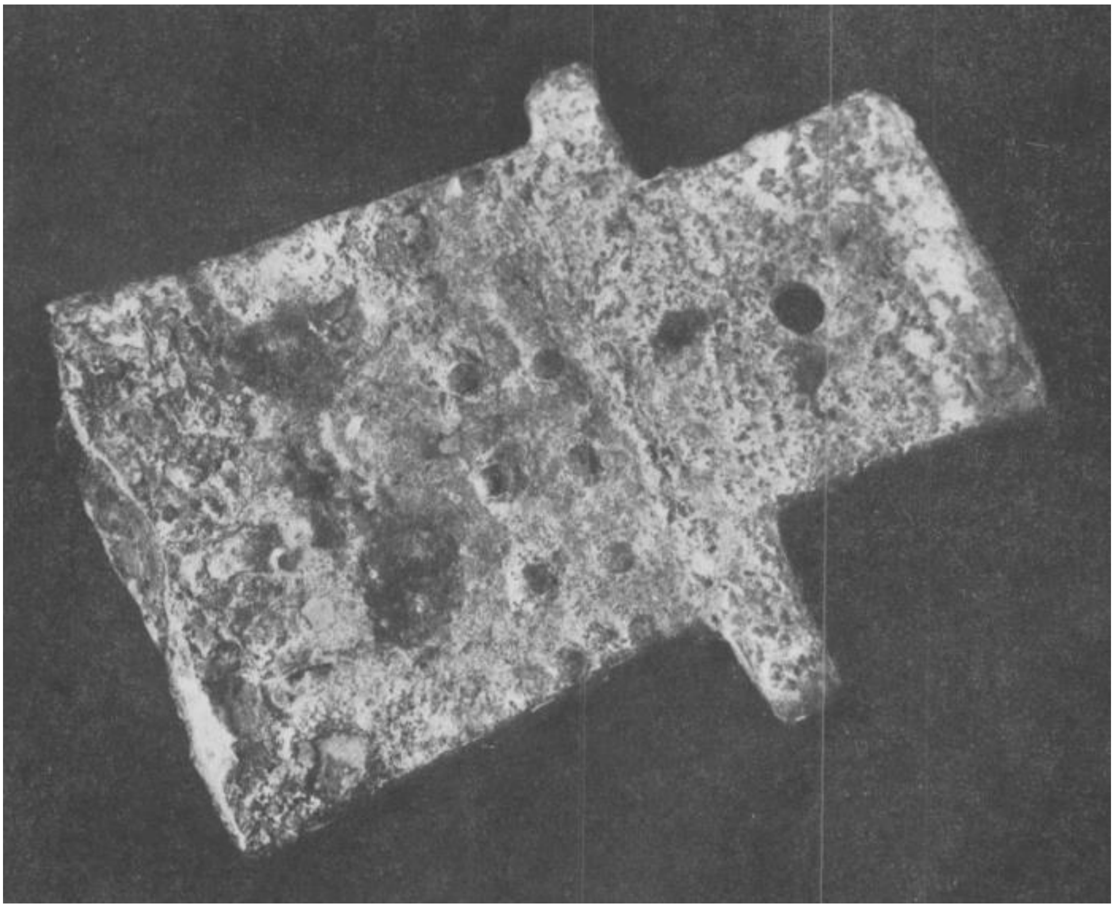


Fig. 4.24 Bronze *Yue* with iron blade from Taixicun, Hebei (source: Li Z. 1976, plate 1)

The other was from a burial excavated in 1975 at Liujiahe, Pinggu, Beijing. The dating was based on the other artifacts excavated from the burial. A metallographic analysis was carried out in 1990, and the sample was taken from the corroded part of the iron blade (Fig. 4.25). The results showed again that the iron was meteoritic iron because, 1) There are large amounts of nickel and 21 other rare elements such as cobalt, germanium and gallium seen in the ferrite matrix; and 2) Nine different spots were analyzed using electronic probe indicated a high variance (1.9-18.4%) in nickel content and a low variance (0.2-4.2%) in copper content (Zhang X. and Zhang 1990, 69-71).

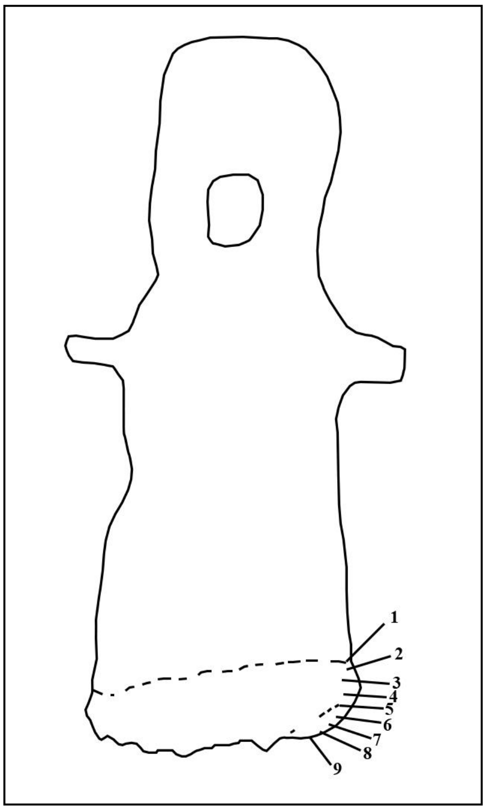


Fig. 4.25 Bronze *Yue* with iron blade from Liujiahe, Beijing showing the sampling spots of the electronic probe (reproduced from: Zhang and Zhang 1990, 69 fig.4)

Some other early bi-metallic objects discovered in the Central Plains and northern China are shown in Table 4.15.

Table 4.15 Bi-metallic artifacts in the Central Plains and northern China

No.	Location	Name	Date	Iron type	Reference
1	Taixicun, Gaocheng, Hebei	Bronze *Yue* (broadaxhead) with iron blade	14^{th} century BC	Meteoritic	(Li Z. 1976)
2	Liujiahe, Pinggu, Beijing	Bronze *Yue* with iron blade	14^{th} century BC	Meteoritic	(Zhang X. and Zhang 1990)
3	Xunxian, Henan	Bronze *Yue* with iron blade	10^{th} century BC	Meteoritic	(Gettens *et al* 1971)
4	Xunxian, Henan	Bronze *Ge* (dagger-axehead) with iron blade	10^{th} century BC	Meteoritic	
5	Sanmenxia, Henan	Bronze *Ge* with iron blade (M2009:703)	9^{th}-8^{th} centuries BC	Meteoritic	(Han R. *et al* 1999)
6	Sanmenxia, Henan	Iron *Ben* (adze) with bronze socket (M2009:720)	9^{th}-8^{th} centuries BC	Meteoritic	
7	Sanmenxia, Henan	Iron knife with bronze handle (M2009:732)	9^{th}-8^{th} centuries BC	Meteoritic	

No.	Location	Name	Date	Iron type	Reference
8	Sanmenxia, Henan	Iron sword with jade handle (M2001:393)	9th-8th centuries BC	Smelted	
9	Sanmenxia, Henan	Bronze *Ge* with iron blade (M2001:526)	9th-8th centuries BC	Smelted	
10	Sanmenxia, Henan	Iron spear with bronze socket (M2009:730)	9th-8th centuries BC	Smelted	
11	Jingjiazhuang, Lingtai, Gansu	Iron sword with bronze handle	8th-7th centuries BC	Smelted	(Liu Dezhan 1981)
12	Yimencun, Baoji, Shaanxi	Iron sword with gold handle	7th-6th centuries BC	Smelted	(Bai C. 1994)
13	Liangdaicun, Hancheng, Shaanxi	Bronze *Ge* with iron blade (M27:970)	8th-5th centuries BC	Smelted	(Chen J. *et al* 2009a)
14	Liangdaicun, Hancheng, Shaanxi	Iron knife with bronze handle (M27:391)	8th-5th centuries BC	Smelted	
15	Xiji, Ningxia	Iron sword with bronze handle	8th-5th centuries BC	Smelted	(Han R. and Ke 2007)
16	Guyuan, Ningxia	Iron sword with bronze handle	8th-5th centuries BC	Smelted	
17	Pengyang, Ningxia	Iron sword with bronze handle	8th-5th centuries BC	Smelted	
18	M2, Zhaoping, Lixian, Gansu	Iron sword with gold handle			(Lixian and Lixian 2004)

Southwest China

Very few metallographic analyses of bi-metallic objects excavated in Southwest China have been studied, and there is not yet meteoritic iron object discovered. In general, the dates of the bi-metallic objects discovered in Southwest China were relatively later than in the Central Plains and northern China. According to my database, most of the bi-metallic objects (over 95%) excavated in Southwest China were dated from the mid-Warring States period to the Western Han dynasty (c.350BC to 8AD). Only one bronze mirror with iron handle excavated from Lasa Qugong, Xizang, was dated to the 8th century BC.

Except one inlaid (gold) iron object, all of the other bi-metallic objects discovered in Southwest China were iron and bronze bi-metallic objects. It is an important gravegoods type since 85% of the bi-metallic objects were excavated from burials, and only 15% were discovered in non-burial contexts. It may indicate that bi-metallic objects in Southwest China are precious items, a symbol of status, which people would bring into their graves after death.

It is interesting that more than 83% of the bi-metallic objects were discovered in Yunnan province. There are 11% of the bi-metallic objects excavated in Sichuan province and most of them were excavated from Yanyuan county which is in the south of Sichuan and very close to Yunnan. Most of these objects are iron swords/knives with bronze handles, and only one iron halberdhead and one spearhead with bronze sockets which were both excavated from Yanyuan. Only 4% of the objects were excavated in Chongqing and 2% were excavated in Guizhou, and they are all iron swords with bronze handles/guards (Fig. 4.26).

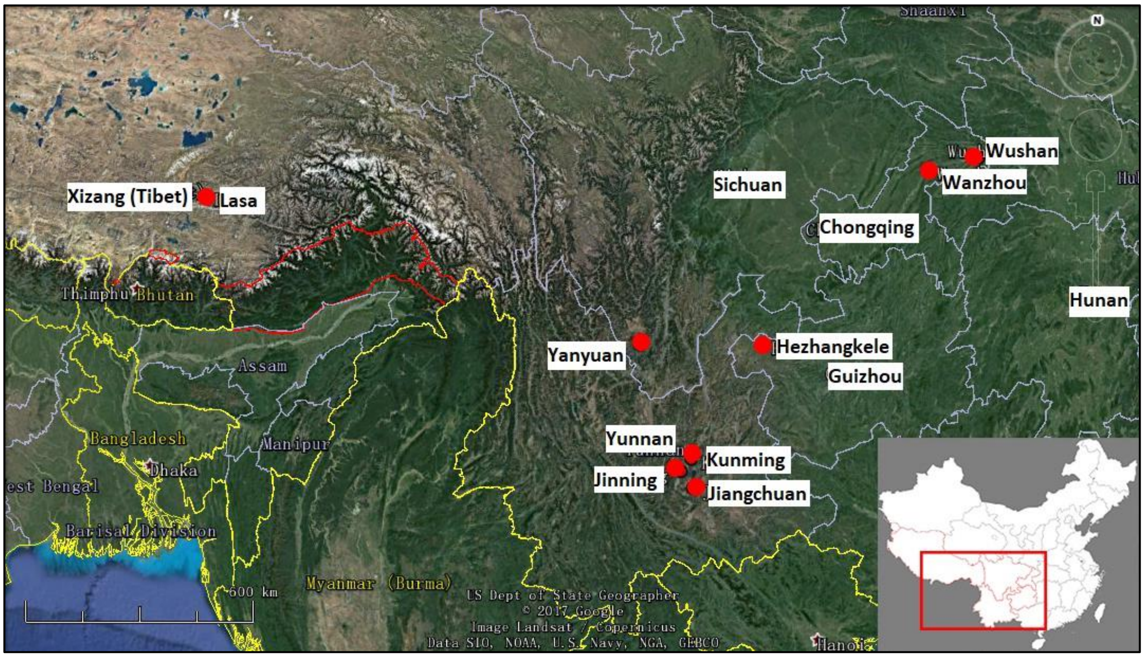


Fig. 4.26 Map showing the sites where bi-metallic objects were mainly excavated in SW China (source: Google Map)

There is a total of 263 entries of the bi-metallic objects excavated in Yunnan, and 253 of them were excavated from Jinning county, Jiangchuan county, and Kunming city (Fig. 6.26). The types of bi-metallic objects discovered in Yunnan include both weapons (81.4%) and tools (16.3%). The large amounts indicate that bi-metallic objects were mainly used within a 100km diameter area in central Yunnan. Weapons were the dominant type of bi-metallic objects excavated in Southwest China, but the discovery of tools may suggest that bi-metallic objects were not only intended as ritual objects but possibly also as functional objects.

However, the bi-metallic tools are mainly axeheads and knives, which could also be weapons, the ‘iron chisels with bronze sockets’ and ‘iron blades with bronze sockets’ also look like some kind of stabbing weapon such as spearhead (see Fig. 6.9:7-12). Whether the objects were actually being used and what technology was applied will require further studies.

The bronze mirror with iron handle excavated in Lasa is the earliest bi-metallic object discovered in Southwest China. The mirror is 0.3cm thick with a diameter of 9.3cm, the hollow iron handle is 9.4cm long with diameter of 1.4cm. The handle was made separately and attached to the mirror with a 10° angle. There are 8 continuous cloud patterns make up a circle on the back of the mirror and a couple of standing birds in the middle (Huo 1994, 650).

The most interesting part of this mirror to me is how the iron handle was made. There is one metallographic analysis of the mirror carried out in 1993-94 by Mei and Han, the results were published in the appendices of the excavation report in 1999 (ZGSHKXYKGYJS and XZZZQWWJ 1999a, 252-254). A small piece of corrosion on the iron handle’s surface was sampled for analyzing. The results showed small amounts of pearlite on a ferrite matrix with a carbon content of 0.1%-0.2% and some slag inclusions of iron oxide and silicate distributed in a direction (Fig. 4.27). Mei and Han (1999, 252) therefore conclude the iron handle was forged from smelted iron.

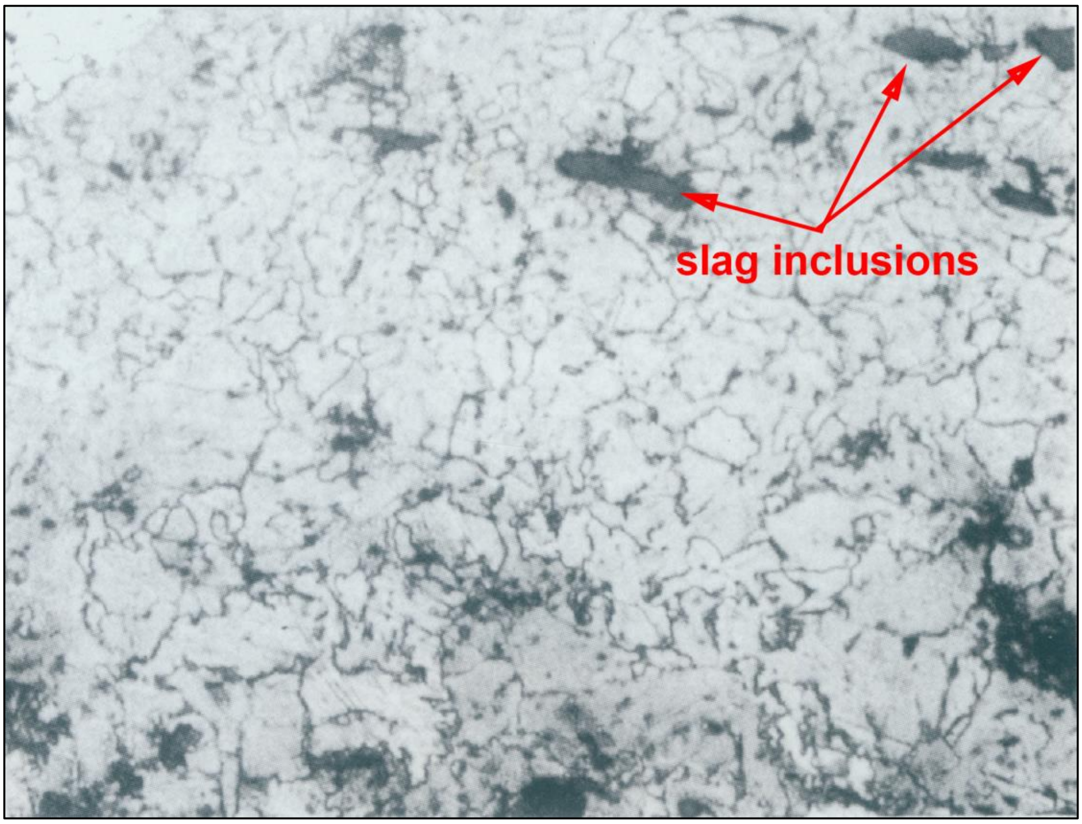


Fig. 4.27 Metallographic picture of the iron handle (scale: X156), Qugong, Lasa (ZGSHKXYKGYJS and XZZZQWWJ 1999a, pl.91-1)

Zhao Huimin (1994, 642, 648) believed that the style of mirror is closer to the northern area of South Asia and the discovery of the mirror is the evidence of the passage between Xizang and India via Nepal in ancient times. But Zhao concluded that the iron handle was cast without providing any explanation and support. Huo Wei (1994, 650; Huo 1997, 69) and Lu Hongliang (2009, 33) indicated that the mirror is very different than the traditional Chinese bronze mirror system, and probably related to the Scythian culture of Eurasia (8^{th} to 3^{rd} century BC). Tong Tao (2010) suggests the mirror belongs to the Dian culture based on its patterns and the popularity of bronze and iron bi-metallic objects in the Dian culture (Yunnan). However, if the mirror belongs to the Dian culture, it may suggest either the mirror was made locally in Yunnan and brought to Xizang, or the blacksmith who made the mirror came from Yunnan. Liao Xiaocen (2011, 99) concluded that forged iron objects discovered in Yunnan could be dated as early as the mid-late Warring States period (c.340-200BC), and there is no clear evidence that the objects were made locally. The date of the mirror is much earlier, it is the only domestic object and clearly different than the other bronze and iron bi-metallic objects excavated in Southwest China. Therefore, I believe that the mirror is more possible imported from the west and related to some Central Asia cultures.

Overall, limited research has been carried out on bi-metallic objects excavated in China. Some of them were metallographic studies and composition analyses (cf. Li Z. 1976; Zhang X. and Zhang 1990; Lian and Xiong 1995; He T. *et al* 2004; Chen J. *et al* 2009a; Li Xiaocen *et al* 2010; Li Yaoguang 2014a), and some discuss the production techniques and development of particular types such as iron swords with bronze (or jade) handles and bronze arrowheads with iron body (cf. Zhang Z. 1982; Song Z. 1997; Su and Yin 2005; Li S. 2006; Zhang H. a. 2012).

Some scholars have concluded that the technique of making the iron (both meteoritic and smelted) and bronze bi-metallic objects was to forge the iron blade first, put the finished blade into the ceramic mould, and then cast the remaining part with bronze (Li Z. 1976, 32; Chen J. *et al* 2009a, 1577). The similar shape and structure of the objects and the same production techniques showed that the meteoritic bronze and iron bi-metallic objects and the smelted bronze and iron bi-metallic objects were closely related. The difference is that meteoritic iron was very precious in the early stage (14th century BC) and used only on the cutting edge of ritual weapons, and smelted iron (still precious but not as meteoritic iron) was also applied on functional weapons (10th-5th centuries BC).

Notice that the iron blades (smelted) of the bi-metallic objects are usually discovered as steel (Li S. 2006, 92; Chen J. *et al* 2009a, 1580; Li Xiaocen *et al* 2010, 63). It may not be enough to say that when making those iron blades, the craftsman intended to carburize the blades for a better hardness, but it at least showed that there was a separated hearth fueled by charcoal applied for heat treatments as early as the 10th century BC.

According to my statistics, most of the bronze and iron bi-metallic objects of Southwest China are dated to the Western Han dynasty (2nd century BC). Most of bi-metallic objects are excavated in Yunnan, and iron swords with bronze guards or handles are the dominant type. Li Xiaocen (2010, 63) studied two of these swords and concluded that both swords have typical characteristics of the

Dian culture, and were possibly made locally or made for the Dian culture in some other place.

Song Zhimin (1997, 53) studied the iron sword with bronze handle and 'E'-shaped guard and indicated that this type of swords in Southwest China could only be dated from the late Warring States period to the Western Han dynasty (4^{th}-2^{nd} centuries BC), which is much later than the similar swords discovered in northern China. Based on the half-moon spreading passage of cultural exchange between northeast to Southwest China (proposed by Tong E. 1986) and through a systematic comparative study, Song therefore concluded that this type of bronze and iron swords originated in northern China and spread to Southwest China (Song Z. 1997, 57). I agree with Song's opinion, that the bi-metallic objects excavated from Sichuan and Chongqing were possibly spread here from the north via the interaction of cultural change. On the other hand, the bi-metallic weapons excavated in Guizhou have obvious local characteristics, and thus might be made locally.

No later than the Shang dynasty (c.1550-1050BC), the ancient Chinese had developed a very sophisticated piece-mould system of casting, understood the properties of metals, and used their knowledge in the alloying process. A prescriptive tin-bronze industry was highly developed at that time and was supported by patrons of the political and social elite (Linduff and Mei 2009, 268).

Following the bi-metallic objects themselves, I also would like to bring in some discussion about the craftsmen who were making the objects. All of the bronze and iron bi-metallic objects discovered so far shared a common characteristic in that the iron was forged and the bronze was cast. Smithing and founding are two separate technology systems that involve very different techniques. The craftsmen who were making the bronzes in ancient China have been a profession for a very long time. In the *Kao Gong Ji* (The Articifers' Record, in *Chou Li*, written in the Warring States period), it records that the national metal workers were divided into six categories as early as in the Spring and Autumn period (10^{th} century BC): 1) *'zhu shi'*, who were knife founders; 2) *'ye shi'*, who were arrowhead, dagger-axehead and halberdhead founders; 3) *'tao shi'*, who were sword founders; 4) *'fu shi'*, who were music instrument founders; 5) *'li shi'*, who were measuring vessel founders; and 6) *'duan shi'*, note that the original text about *'duan shi'* was not preserved, Zheng Xuan (127-200AD) annotated that *'duan shi'* referred to people in charge of making agricultural implements (Anonymous 1998, 263-266). Guo Moruo (1973, 203) indicated that *'duan shi'* is an official position, and '*duan*' also means 'forging'. He therefore concluded that the agricultural implements were forged with iron. There is nothing impossible about this, but there is no evidence for it, and I think the material referred here is more reasonable to be bronze than iron by the context of the text. However, the point is that this might be the earliest written evidence so far for 'smithing' in ancient China.

In ancient times, bronze was a very precious material and an important military resource. The exploitation and smelting were controlled by the government down the ages. To make the bi-metallic objects, it requires both founding technique of bronze and smithing technique of iron. There was insufficient supply of iron to make living as a blacksmith in the 10th century BC, and the smithing required to make the bi-metallic objects was very possibly done also by the bronze makers. However, although large amounts of bronze objects might be produced every year, only a small number of the most experienced smiths would have the chance to try to make bi-metallic objects. Therefore, the early bronze and iron bi-metallic objects were probably first made by the most experienced bronze makers, and some of these people or their descendants probably became the first professional blacksmiths when iron supply was sufficient. These skilled people were presumably concentrated in northern China during the 10th-5th centuries BC as this is where the early bi-metallic objects were excavated, and some of them were possibly introduced to the Dian (modern Yunnan) or sent to the Dian as political 'gift' during the 3rd-2nd centuries BC.

4.5.2 Iron objects

Apart from Southwest China

The earliest smelted iron in China is one iron bar and one unidentified corroded iron object excavated in Mogou, Gansu province, Northwest China. Two radio-carbon samples were taken from the human bones and the remaining wood in the socket of the bronze axe from burial M444, and the results were calibrated and dated to the 14th century BC (Chen J. *et al* 2012, 47). This is the only evidence of the use of smelted iron in China so far before the 11th century BC, and Chen Jianli *et al* (2012, 49) suggests that it would be appropriate to date the first use of iron in Xinjiang to the 9th century BC.

Bai Yunxiang (2003, 308; 2005, 41-43; 2006, 30) first suggested that there were two different systems of ancient Chinese iron objects: 1) the 'northwest system', of which the early iron objects excavated are from Xinjiang and nearby areas; and 2) the 'Central Plains system', of which the earliest iron objects have been excavated from western Henan and southern Shanxi, including the areas of the middle and lower reaches of the Yellow River and Yangtze River. Bai indicated that iron smelting technology in ancient China derived and developed separately in Xinjiang and the Central Plains.

Xinjiang is geographically located in Central Asia contiguous with West Asia. Large amounts of iron objects dated to the 10th century BC have been excavated in Xinjiang, and some of them have been dated as early as the 12th century BC or even earlier. However, no iron smelting sites before the 3rd century BC have been discovered so far in this area. Therefore, the early iron objects excavated in Xinjiang were very possibly introduced from West Asia, but it is still unclear whether the iron production technology was also introduced from the west (Bai Y. 2005, 42).

The excavated iron (smelted) and bronze bi-metallic objects from Sanmenxia, Henan province (Table 4.15:8-10) may indicate that the iron smelting technology of the Central Plains could be dated as early as the 9th-8th century BC, and the technology possibly originated in western Henan, southern Shanxi, and the middle of Shaanxi provinces, which was the political, economic, and cultural centre of the Western Zhou dynasty (Bai Y. 2005, 43). Smelted iron used on the cutting edges of these bi-metallic objects showed that the technology applied was from the bloomery process (Yang K. 1982, 2-5). Bai Yunxiang (2005, 43) pointed out that large amounts of iron of the Western Zhou and Spring and Autumn period (11th-5th centuries BC) were excavated in the Central Plains areas, the similar structures and decorations of these iron objects (such as swords, dagger-axes, spears, knives, and adzes) and the local bronzes of the same period showed that the iron objects were made locally. On the other hand, the earliest cast iron object was excavated from Qucun, Shanxi province, and is dated to the 8th-7th centuries BC (Han R. 2000, 1180). Han Rubin (2000, 15) pointed out that the uneven distribution and development of iron and steel production technology of ancient China suggests that bronze objects were replaced by iron objects firstly in the Central Plains area and gradually elsewhere of China from the 5th century BC to the 2nd-3rd centuries AD.

The discovery of excavated iron objects in China could be divided into three stages. The first stage is the Western Zhou to the Spring and Autumn period (11th-5th centuries BC). Before the discovery of the unidentified iron objects in Mogou, the earliest smelted iron object in China is the iron sword with bronze handle excavated from a noble tomb of Guo state in Sanmenxia, Henan province. The iron blade of the sword was identified as bloomery iron and the object is dated to the second half of the 9th century BC (Anonymous 1990). Wang Wei (1999, 37) concluded that the iron objects before the mid-Spring and Autumn period (first half of the 6th century BC) were mostly excavated from Gansu and Shaanxi provinces, and the iron objects of the late-Spring and Autumn period were mostly excavated in the Yangtze River areas. Wang also pointed out that bloomery smelting emerged in the Central Plains should be no later than the late-Western Zhou, and there were small numbers of cast iron tools of the Spring and Autumn period.

The second stage is the Warring States period (475-221BC). The iron smelting and iron production technology developed quickly and spread widely during this stage. More than ten iron smelting sites of this stage were discovered and excavated (Li J. 1994a). Compare to the first stage, the numbers and object types increased significantly, and the iron objects were widely distributed during the mid to late-Warring States period.

The third stage is the Qin and Han dynasties (221BC-220AD). In this stage, a total of 49 *Tieguan* (government controlled offices responsible for iron smelting and production activities) were set up all over China, and the central government of the Han had established a monopoly in iron and salt production by 117BC. Iron smelting and production technology and the number of iron objects were further developed and increased significantly. Bronze weapons and tools were replaced by iron objects.

Table 4.16 is the iron tools, weapons and domestic objects before the Qin and Han dynasties (before 221BC) excavated in Inner Mongolia, Liaoning, Guangxi, Henan, Shanxi, Hunan, and Guangdong provinces (Fig. 4.28). In general, 52.5% of the excavated iron objects were weapons, which indicated that iron production was mainly applied for military purpose in China before the Qin and Han dynasties.

Table 4.16 Statistics of iron objects before the Qin and Han dynasties excavated in China

Province	Tools	%	Weapons	%	Domestic objects	%	Total	%	Source
Inner Mongolia	**14**	*1.3*	**1004**	*92.6*	**66**	*6.1*	**1084**	*28.9*	(Duan 2001, 114)
Liaoning	**119**	*16.4*	**602**	*82.9*	**5**	*0.7*	**726**	*19.4*	
Guangxi	**180**	*90.5*	**13**	*6.5*	**6**	*3.0*	**199**	*5.3*	
Henan	**174**	*45.1*	**119**	*30.8*	**93**	*24.1*	**386**	*10.3*	
Shanxi	**72**	*9.7*	**79**	*10.6*	**593**	*79.7*	**744**	*19.8*	
Hunan	**98**	*56.0*	**62**	*35.4*	**15**	*8.6*	**175**	*4.7*	
Guangdong	**35**	*8.0*	**92**	*21.1*	**310**	*70.9*	**437**	*11.7*	(Yang S. 1977, 97)
total	**692**	*18.4*	**1971**	*52.5*	**1088**	*29.0*	**3751**		

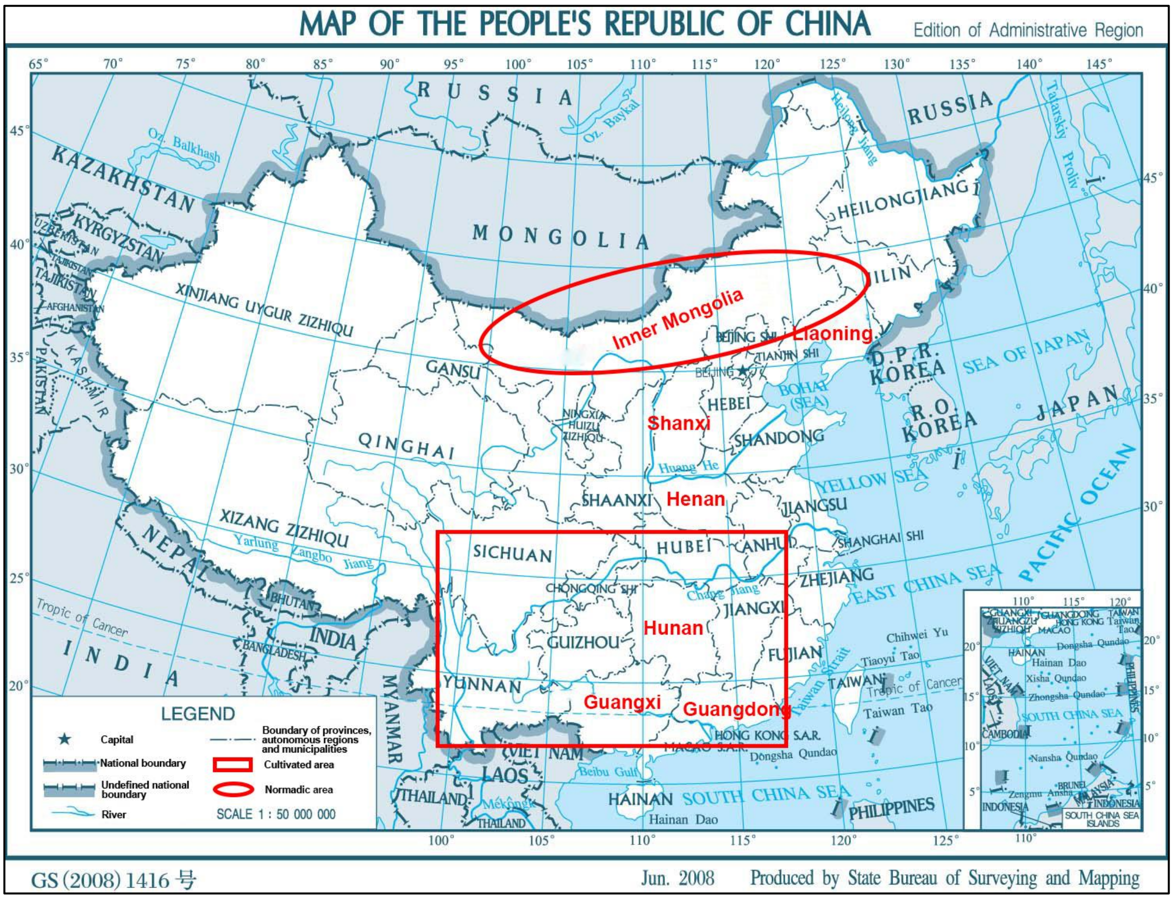


Fig. 4.28 Map of China showing the areas where iron objects of pre-Qin and Han dynasties were excavated (source: State Bureau of Surveying and Mapping of China)

However, the different proportions in each area show a difference between nomadic areas (such as Inner Mongolia and Liaoning) and cultivated areas (such as Guangxi and Hunan), and between the Central Plains (Henan and Shanxi) and the frontier areas (Inner Mongolia and Liaoning). There are many more weapons from the nomadic and frontier areas, and more tools and domestic objects from the cultivated areas and the Central Plains.

According to Wang Wei (1999, 368-372) and Bai Yunxiang (2010, 612, 617-618), the most commonly seen iron weapons before 200AD include swords, sabres, spearheads, dagger-axeheads, dagger-spearheads, halberdheads, arrowheads, and armour. The most common iron tools include mattockheads, shovelheads, U-shaped implement caps, ploughshares and ploughshare caps, sickles, axeheads, chisels, ring-headed knives, knives, saws, adzes, hammerheads, and pliers. The most common domestic objects include *ding* (tri-pots), *fu*-pots, *mou*-pots, and iron stands. There are also large amounts of structural parts and accessories of horses and chariots and small amounts of iron coins. The large quantities of excavated objects and increased diversity of object types indicate that the iron smelting and iron production technology developed quickly and spread widely during this period.

Southwest China

Previous studies of the iron smelting technology in Southwest China are mostly focused on the areas of Yunnan and Guizhou Plateau, and there is no consensus opinion. Li Jiarui (1962, 34; 1964, 208) believes the use of iron objects in Yunnan starts in the Western Han, and that the iron was imported from Sichuan, with Yunnan starting to make its own iron objects from the Eastern Han. Lin Sheng (1963, 201) believes that Yunnan's iron smelting and production started in the period of Emperor *Wu* (156-87BC) of the Western Han while Tong Enzheng (1964, 205) believes that the *Dian* people of Yunnan started using iron objects in the Western Han dynasty and had already mastered smithing techniques, but that iron smelting only started in the Eastern Han dynasty. Song Shikun (1984, 271; 1992, 245) believes that the use of iron objects in central Yunnan and western Guizhou started in the late Warring States period, and that people mastered iron production technology during the late Warring States period and the Qin and Han dynasties but not smelting technology. Finally, Zhang Zengqi (1982, 61) believes the use of iron objects in Yunnan could be dated from the late of Spring and Autumn period to the early of Warring States period (8^{th}-5^{th} centuries BC).

From the more recent fieldwork of iron smelting sites in Southwest China reported in this study (section 3.5 and 3.6), iron smelting sites are concentratedly distributed in the Chengdu Plain, and smelting technology in Southwest China possibly started after Qin's conquest of Ba and Shu (316BC). The iron produced was probably traded from modern Sichuan to modern Yunnan as raw material, but it was family-based activity and comparatively small-scaled. The government controlled large-scaled iron smelting industry was introduced and started in the early Western Han dynasty. However, the primary function of smelting in the Chengdu Plain was to produce iron ingots, and there is still a lack of evidence for forging or casting of iron. On the other hand, smithing techniques were possibly introduced to Yunnan during the 3rd-2nd centuries BC, and the technology was probably a new branch and separated from bronze making.

Overall, there are not many iron objects before the Qin and Han dynasties excavated in Southwest China (Table 4.17). However, there is significant increase in both object quantities and types during the Han dynasty (Table 4.18), and most of the tools, weapons and domestic objects are the same or similar types as those discovered in the Central Plains. It suggests that the use and the spread of iron production in Southwest China was influenced by the Central Plains to a great extent in the Qin and Han dynasties.

Although there is not enough information for iron objects before the Han dynasty for each province, the overall proportion indicates that the use of iron tools was wider than weapons and domestic objects in Southwest China before the Han dynasty (Table 4.17). This may suggest that the main economic livelihood of SW China was agriculture. This situation is possibly related to the Qin's conquest of Ba and Shu (316BC). Qin developed irrigation systems and agriculture in the areas of Ba and Shu as economic support for the later big goal of conquering the other six states of the ancient China (230-221BC).

Table 4.17 Statistics of iron objects before the Qin and Han dynasties excavated in Southwest China (source: author)

Province	Tools	%	Weapons	%	Domestic objects	%	Total	%
Sichuan	**3**	*100.0*	**0**	*0.0*	**0**	*0.0*	**3**	*2.6*
Guizhou	**20**	*80.0*	**5**	*20.0*	**0**	*0.0*	**25**	*21.6*
Yunnan	**8**	*80.0*	**2**	*20.0*	**0**	*0.0*	**10**	*8.6*
Chongqing	**62**	*79.5*	**13**	*16.7*	**3**	*3.8*	**78**	*67.2*
total	**93**	*80.2*	**20**	*17.2*	**3**	*2.6*	**116**	

More than 65% of the identifiable iron objects of the Han dynasty (202BC-220AD) in Southwest China were excavated in Chongqing, which maybe because Chongqing is closer to the Central Plains. There are more iron tools excavated in all of the provinces except Yunnan, which might be evidence to show that Southwest China was a cultivated region during the Han dynasty. The higher proportion of iron weapons from Yunnan is possibly because the region is the most southwesterly and distant from political and social stability. By the same measure, the high proportion of domestic objects from Chongqing may indicate a safer and more stable society in an area closer to the centre of power during the Han dynasty (Table 4.18).

Table 4.18 Statistics of iron objects of Han dynasty excavated in Southwest China (source: author)

Province	Tools	%	Weapons	%	Domestic objects	%	Total	%
Sichuan	**52**	*53.6*	**26**	*26.8*	**19**	*19.6*	**97**	*12.7*
Guizhou	**25**	*62.5*	**8**	*20.0*	**7**	*17.5*	**40**	*5.2*
Yunnan	**46**	*37.1*	**73**	*58.9*	**5**	*4.0*	**124**	*16.3*
Chongqing	**208**	*41.4*	**133**	*26.5*	**161**	*32.1*	**502**	*65.8*
total	**331**	*43.4*	**240**	*31.5*	**192**	*25.2*	**763**	

Noticeable, there are much less horse decoration and structural parts of chariots excavated in Southwest China than the Central Plains. This is probably because chariots were a very important military source and also a symbol of status, which was usually produced and managed by the central government during and before the Han dynasty.

The distribution of the excavated iron objects (Fig. 4.22) showed that iron objects were more widespread in Chongqing than other provinces of Southwest China, especially in the northeast of Chongqing which is closer to Shaanxi province. It perhaps suggests that the northeast of Chongqing was largely influenced by the Central Plains. The concentrated distribution of iron objects in Yunnan and Guizhou may suggest that those areas were the economic and cultural centres of the ancient time further southwest.

The increasing distribution of the iron objects during the Han dynasty indicates that iron making technology and use were developed rapidly in Southwest China. Decreasing distribution since the end of the Eastern Han dynasty is possibly indirect evidence of the development of an iron recycling technique or population decreases and reduced political control.

Compared to the Central Plains and northern areas of China, there is a larger proportion of iron tools/implements excavated in Southwest China, and some of the object types such as pickaxehead (appendix C4; section 4.3.2, Fig. 4.17:24; section 5.3, SK0057 and 58) are not often seen in other areas. This reinforces the suggestion that the economic formation of society in Southwest China was primarily agricultural. On the other hand, the number of horse accessories and structural components of chariots excavated in the Central Plains exceed those discovered in Southwest China. This probably reflects that the level of economic development of the Central Plains was much higher than Southwest China.

There are two iron animal castings dated to 847-918AD discovered in Chengdu, Sichuan. Both were discovered beside the coffin bed of the mausoleum of Wangjian, the first king of Qianshu (one of the kingdoms during the Five dynasties). The iron ox is 74cm long, 32cm high, and weighed 60kg. The iron pig is 66cm long and 32cm high. This was the only evidence of large iron casting in Southwest China before the discovery of the bridge piers in Guanghan, Sichuan, which indicated Sichuan was capable of casting big iron objects at least by 96BC (Li Yingfu *et al* 2016).

The survey of iron objects from excavations in Southwest China described in this chapter has helped to reveal significant patterns in the development of ferrous metallurgy both through time and as an indicator of socio-cultural conditions. Important evidence regarding the prevalence of a bi-metallic tradition in Yunnan has been revealed and inferences have been made about the spread of iron production from the Central Plains during the Qin and Han period. The next chapter will look more closely through metallographic analysis at the technologies in use in Southwest China.

Chapter 5: Metallographic study of objects from Lijiaba and Qiaogoutou

5.1 Introduction

The aim of this chapter is through metallographic study of the excavated iron objects to characterise the range of technologies used.

Both the Lijiaba and Qiaogoutou sites were excavated by the Sichuan University, and the excavated iron objects were sent to the lab of the archaeology department for analysis. A total of 66 metallographic samples of these objects from both sites were prepared and analysed by the author.

Most of the metallographic samples were collected from the Lijiaba site, Yunyang county, Chongqing municipality, and some from the cemetery site at Qiaogoutou, Yibin city, Sichuan province. There was one iron nail sample (SK0065) collected from Xuxiebian (section 5.5.2) which was fully corroded and had no metal remaining. The results help us to understand the material that was used to produce these iron objects and some of the techniques applied either in the forging or casting processes of their manufacture. The results are discussed by different site.

The techminology that will be included in this chapter are introduced as follow. When iron has been melted and poured into a mould it solidifies as either white or grey cast iron. **White cast iron** (Fig. 5.1:a) is extremely hard and cannot be filed or chiseled. The carbon in white cast iron is in chemical combination with iron in cementite (iron carbide, Fe_3C). A white cast iron with 4% carbon is 60% cementite. Cementite is extremely hard, harder than quartz, and this is why white cast iron is so hard. **Grey cast iron** (Fig. 5.1:b) is soft, and can be filed and chiseled. The carbon is in the form of microscopic graphite flakes, and it is these which cause a fractured surface to appear grey. Graphite is very light (2.2g/cm^3 vs 7.9g/cm^3 for iron), and a grey cast iron with 4% carbon by weight has up to 13% graphite by volume. Graphite comes close to being the softest mineral known, and in comparison with iron it has no strength at all. The microscopic flakes act therefore as empty internal cracks in the iron. It is these cracks which make grey cast iron brittle, and they also cause the iron to spall when it is filed or chiseled (Wagner 1993, 214-215).

When a lower carbon content is required, the white cast iron is decarburized using any of a number of different possibilities. Annealing processes decarburize iron objects or iron ingots in the solid state, and under different conditions it could produce **decarburized steel/wrought iron** and **malleable cast iron** (Fig. 5.1:c).

Wagner defines '**malleable cast iron**' as subjecting a casting to a lengthy heat treatment to significantly improve its mechanical properties. Decarburization and graphitization are two quite different processes used to bring about this effect. **Decarburization** occurs if the furnace atmosphere during the anneal is slightly oxidizing. The carbon in the iron is burned away at the surface (Fig. 5.1:f). In the course of a few days all or most of the carbon in the casting can diffuse to the surface and be burned away, leaving a decarburized iron casting whose carbon content corresponds to that of steel or even wrought iron (Fig. 5.1:e). **Graphitization** describes the situation when cementite (iron carbide, Fe_3C) in the iron decomposes and precipitates as graphite ($Fe_3C \rightarrow 3Fe+C$). The microscopic graphite 'nodules' precipitated in this process normally have a much more rounded shape than the flakes in grey cast iron (Fig. 5.1:c). Graphitized white cast iron is therefore much more tough than grey cast iron (Wagner 1993, 222). In modern practice heat treatment is typically for a period of a day or two at a temperature in the range 900-1,000°C. The purpose may be a tougher casting, or one with a soft and easily machinable surface, or a combination of both (Wagner 1993, 212). If the primary effect of the heat treatment is to decarburize the casting, the product is called **whiteheart malleable cast iron**. If the primary effect is graphitization, the product is called **blackheart malleable cast iron** (Wagner 1993, 223).

Malleable cast iron was widely used in China as early as the fourth century BC. It was used both for implements and for decorative objects. Until recently the latest malleable cast iron objects known in China were from the fourth century AD, and Chinese historians believed that the technique dropped out of use and was forgotten by the Tang dynasty (7th to 10th centuries AD) (Hua 1982, 17-19).

The **fining process** involved liquifying cast iron in a fining hearth and removing carbon from the molten cast iron through oxidation (Pigott 1999, 186-187). It produces different quality of steels and wrought iron in a small furnace, usually a bowl-shaped furnace in the Han dynasty, and possibly square furnace in the Ming dynasty (14^{th} to 17^{th} centuries AD) (Song Y. 1933, 98). Percy (1864, 579) applied the word fining to the operation of converting cast into malleable iron by the specific process, or series of processes, now to be considered, *i.e.* in a hearth or open fire, urged by a blast of air with charcoal as the fuel. The products obtained from the fining process are called **fined iron** (Fig. 5.1:d) in this thesis.

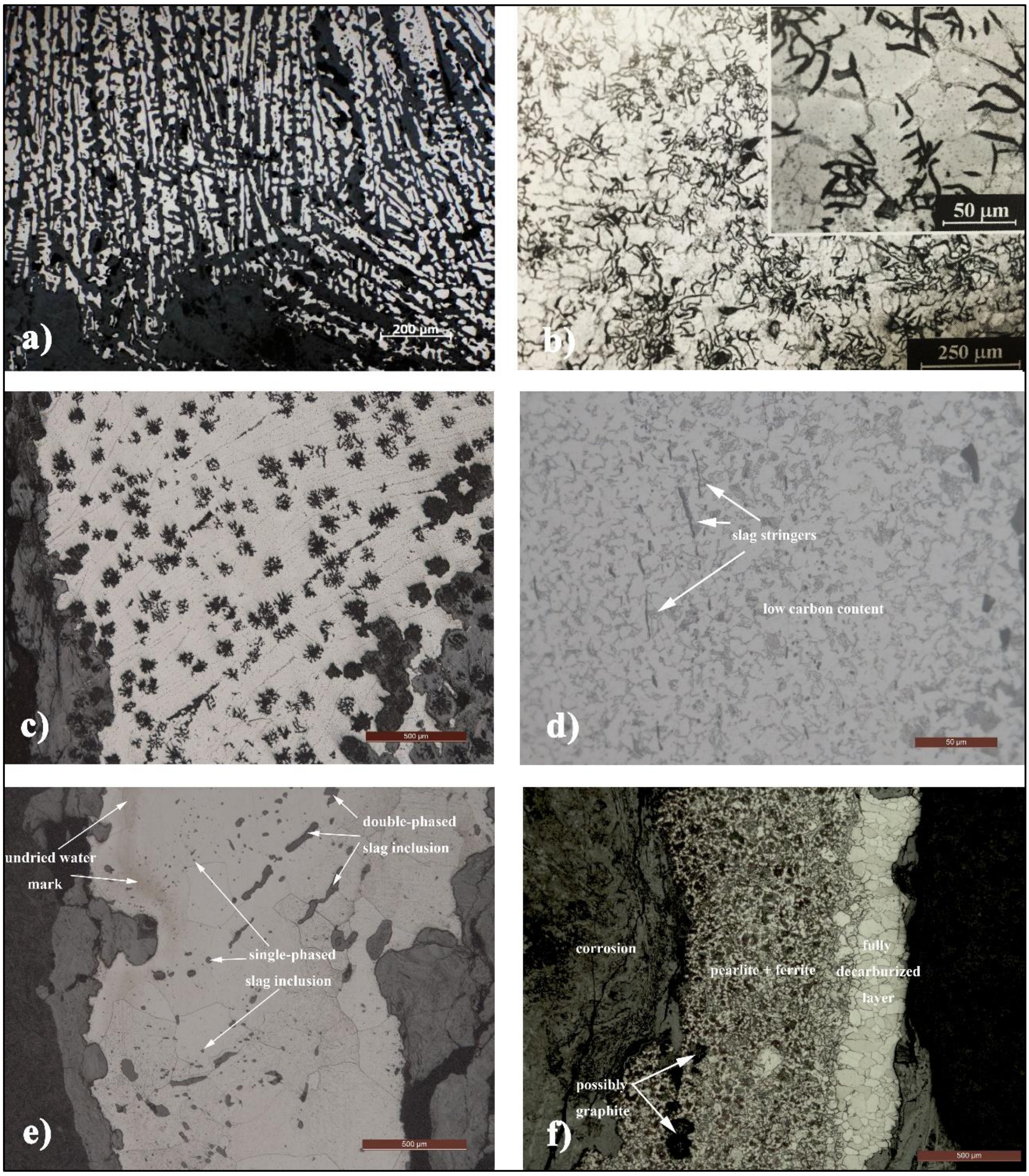


Fig. 5.1 Examples of mentioned microstructures
a) white cast iron, b) grey cast iron, graphite flakes, graphitization, c) malleable cast iron, cotton-like graphite, graphitization, d) fined iron, single-phased slag inclusions, e) wrought iron, double-phased slag inclusions, f) fully decarburized layer (source: a. after Yang Sheng, b. after Kahanov *et al* 2012, 105, c-f. author)

Noticeably, some Chinese scholars translated fined iron as 'puddled steel' (such as in Liu Haifeng *et al* 2014). It is possibly because the traditional Chinese term for the fining process described here is '*chao gang*', where '*chao*' is literally 'stir-frying' (Chang K.-C. 1977a, 358-359) and '*gang*' is steel. However, the English word '**puddling**' is specifically referring to pig iron conversion to wrought iron in a reverberatory furnace fueled with coal or coke (Wagner 1993, 276). The **puddling process** consists essentially in stirring pig iron molten on the bed of a reverberatory furnace, heated by flame, until it becomes converted into malleable iron, through the decarburizing action of the oxygen of the air circulating through such a furnace. Thus all contact between the metal and solid fuel is avoided, and the necessity of blowing machinery is dispensed with (Percy 1864, 627). In this thesis, fined iron refers to pig iron that was decarburized in the liquid state and urged by a blast of air with charcoal as the fuel.

5.2 Methodology

There were 66 metallographic samples taken from 42 excavated iron objects (one slag sample) prepared and analysed (Table 5.1). The 'Lab No.' in table 7.1 is not consecutive because it refers to the total sample number assessed in the archaeometallurgy laboratory of Sichuan University. Photos and diagrams were taken and drawn before cutting the objects. Handheld mini-type grinder was used to cut the samples, the resin blade is 23mm in diameter and 0.7mm in thickness. The samples were usually taken by making two cuts inward to meet at the central rib area and sometimes a cross section was taken when the sample was either small or too fragment. The samples were compression mounted at 30±5Mpa and 130±5°C, ground and polished. The polished sections were examined using a Leica CM6000M optical microscope before and after etching with 2% nital.

When I got an easier access to an SEM-EDS analysis in 2017, three samples from Qiaogoutou (SK0072, 73, and 74) were firstly analysed by using a Zeiss EVO18 scanning electron microscope equipped with an Oxford X-MaxN50mm2

EDS system at the Jinsha Museum in Chengdu, China, and the acceleration voltage was set to 20kV. The SEM-EDS analysis for the Lijiaba samples was not included in this thesis but will be carried out in the future.

The results of the examinations were recorded on the ‘Recording Sheet of Metallographic Samples’ manually first and then typed and saved electronically. Each of the recordings include the sample details, sampling spot, observations under different magnifications and a preliminary interpretation. The original recordings can be found in Appendix C.

A thin layer of vaseline was painted on each sample surface after examination, and the samples were put into small boxes separately and stored in a dry cabinet set to 30% RH to prevent corrosion as much as we can.

The assessment of microstructures was first taught and instructed by Dr. Donald B. Wagner from the Nordic Institute of Asian Studies, University of Copenhagen, Denmark, and then self-studied from published metallographic studies and textbooks of material sciences. The microstructures in this thesis were compared with other published Chinese metallographic studies, and most of results were consulted with Dr. Wagner.

Some of the samples from Lijiaba (section 2.2.3) were collected from the surface corrosion of the iron objects (such as SK0003). It was an attempt to find out whether the corrosion could provide any useful information about the material, however for most of the results showed negative.

Most of the iron objects from Qiaogoutou were badly corroded, the densities of these iron objects were very low. Two cuts were made on two of these low-density objects (an axehead and a spearhead) but it turned out there was no metal remaining (SK0066-69), thus we stopped cutting these low-density objects. Fortunately, in three higher density objects, were found to have enough metal remaining for metallographic examination.

Table 5.1 List of the metallographic samples

Lab No.	Site	Context	Object type	Sampling Spot
SK0001	Lijiaba	02YLIF12:1	mattockhead	cutting edge
SK0002	Lijiaba	02YLDT0514-0615③:1	mattockhead	socket
SK0003	Lijiaba	02YLIDT0409⑩:1(sample1)	axehead	corrosion
SK0004	Lijiaba	02YLIAT0709-0810⑮:3	iron knife	cross section (end)
SK0005	Lijiaba	02YLIAT0208④:1	iron sabre	body
SK0006	Lijiaba	02YLIAT0207⑧:1	arrowhead	body
SK0008	Lijiaba	02YLIF12:2	mattockhead	socket
SK0010	Lijiaba	02YLIAT0511⑮:2	iron knife?	Body
SK0011	Lijiaba	01YLIIBT1510-1611②b:2	axehead	cutting edge
SK0012	Lijiaba	02YLIAT0207⑧:6(A)	ring-headed iron knife	cross section (ring head)
SK0013	Lijiaba	02YLIAT0207⑧:6(B)	ring-headed iron knife	cross section (body)
SK0014	Lijiaba	02YLIAT0511⑮:15(sample1)	mattockhead	corrosion
SK0015	Lijiaba	02YLIAT0511⑮:15(sample2)	mattockhead	cutting edge
SK0017	Lijiaba	02YLIAT0511⑮:10(sample2)	arrowhead	corrosion
SK0018	Lijiaba	02YLIAT0511⑮:10(sample3)	arrowhead	body
SK0019	Lijiaba	02YLIDT0712-0813③:1(sample1)	iron knife	cutting edge (corroded)
SK0020	Lijiaba	02YLIDT0712-0813③:1(sample2)	iron knife	back
SK0021	Lijiaba	02YLIAT0511⑮:4(sample1)	axehead	cutting edge
SK0022	Lijiaba	02IF16:2	iron knife	cutting edge
SK0024	Lijiaba	02YLIAT0608⑪:1(A)	undefined object	section (horizontal)
SK0025	Lijiaba	02YLIAT0608⑪:1(B)	undefined object	section (vertical)
SK0028	Lijiaba	02YLIDT0315-0416③:1	mattockhead	socket
SK0029	Lijiaba	02YLDT0512-0613③:2(sample1)	iron sabre	cutting edge
SK0030	Lijiaba	02YLDT0512-0613③:2(sample2)	iron sabre	back
SK0031	Lijiaba	02YLVH:1(sample1)	chisel	point
SK0032	Lijiaba	02YLVH:1(sample2)	chisel	end
SK0033	Lijiaba	02YLVH:1(sample3)	chisel	corrosion
SK0034	Lijiaba	02YLDT0512-0613③:2(sample3)	iron sabre	corrosion
SK0035	Lijiaba	02YLIDT0409⑩:1(sample2)	axehead	cutting edge
SK0036	Lijiaba	02YLIAT0511⑮:4(sample2)	axehead	socket
SK0038	Lijiaba	03YLIVM14:89	shovelhead	cutting edge

Lab No.	Site	Context	Object type	Sampling Spot
SK0039	Lijiaba	03YLIVM14:89	shovelhead	socket
SK0040	Lijiaba	00YLIBT2219⑥:3	mattockhead	cutting edge
SK0041	Lijiaba	00YLIBT2219⑥:3	mattockhead	corrosion
SK0042	Lijiaba	03YLIVM6:8	ring-headed iron knife	back
SK0043	Lijiaba	03YLIVM6:8	ring-headed iron knife	cutting edge
SK0044	Lijiaba	03YLIVM6:8	ring-headed iron knife	ring head
SK0045	Lijiaba	03YLIIIM15:20	ring-headed iron knife	back
SK0046	Lijiaba	03YLIIIM15:20	ring-headed iron knife	cutting edge
SK0047	Lijiaba	03YLIVM6:38	belt hook	cross section (middle)
SK0048	Lijiaba	03YLIVM10:5	iron sabre	back
SK0049	Lijiaba	03YLIVM10:5	iron sabre	cutting edge
SK0050	Lijiaba	00YLIBT2219⑥:2	axehead	cutting edge
SK0051	Lijiaba	00YLIBT2219⑥:2	axehead	socket
SK0052	Lijiaba	03YLIVM3:9	belt hook	cross section (hook)
SK0053	Lijiaba	00YLIBT2014⑤:8	mattockhead	cutting edge
SK0054	Lijiaba	00YLIBT2014⑤:8	mattockhead	socket
SK0055	Lijiaba	97BT0205⑩	iron ring	cross section
SK0056	Lijiaba	03YLIVM6:34	belt hook	hook side
SK0057	Lijiaba	00YLIBT1612④:2	pickaxehead	point
SK0058	Lijiaba	00YLIBT1612④:2	pickaxehead	socket
SK0059	Lijiaba	00YLIBT2014⑥(⑧):5	mattockhead	cutting edge
SK0060	Lijiaba	00YLIBT2014⑥(⑧):5	mattockhead	socket
SK0061	Lijiaba	03YLIVM6:6	belt hook	body
SK0062	Lijiaba	00YLIBT2520⑥:2	axehead	cutting edge
SK0063	Lijiaba	00YLIBT2520⑥:2	axehead	socket
SK0064	Lijiaba	01YLIIBT1515⑤a:3	undefined object	cross section (end)
SK0065	Xuxiebian	2011PSXT01②	nail	cross section
SK0066	Qiaogoutou	2011PQM3:11	axehead	socket
SK0067	Qiaogoutou	2011PQM3:11	axehead	cutting edge
SK0068	Qiaogoutou	2011PQM15:1(sample1)	spearhead	body section
SK0069	Qiaogoutou	2011PQM15:1(sample2)	spearhead	body section
SK0072	Qiaogoutou	2011PQM13:4	sword	section
SK0073	Qiaogoutou	2011PQM23:9	axehead	cutting edge
SK0074	Qiaogoutou	2011PQM22:1	U-shaped implement cap	socket
CD	Lijiaba	02YLIAT0111-0212⑩:3	axehead	socket
			Total samples:	**66**

Lab No.	Site	Context	Object type	Sampling Spot
			Total objects:	**42**

5.3 Iron objects excavated from the Lijiaba site

5.3.1 Introduction

As introduced in section 2.2.3, the Lijiaba site is a Ba culture site which could be dated from the Shang dynasty to the Han dynasty (c.1,700BC-200AD). The site is located on the terrace of Pengxi River (a tributary of the Long River) in Yunyang county, Chongqing municipality (Fig. 5.2). The Lijiaba site was first discovered in 1987, the archaeological survey and excavation were carried out by Sichuan University from 1993-2003. There were three annual excavation reports of 1997 (Luo E. 2002), 1999 (Zhou Kelin *et al* 2011a; Huang Wei *et al* 2011) and 2000 (He Y. *et al* 2016) published until 2017. The whole site is about 120,000m^2, with a core area of about 30,000m^2 (Zhou Kelin *et al* 2011a, 369, 424). There is a cemetery of about 10,000m^2 located in the eastern part of the site (area II), where more than 320 burials of the Ba culture were densely distributed and 44 of them were dated to the Warring States Period (476-221BC).

There are 13 iron objects (appendix C) in the three published annual reports, and 37 more iron objects were excavated from 2001-2003 not yet published. Among these 50 iron objects, 35 were excavated from non-burial contexts (Table 5.2, Fig. 5.3) and the other 15 were excavated from burials (Table 5.3, Fig. 5.4). The categories of the objects included weapons, tools, accessories, domestic objects and unidentified objects.

All 50 iron objects were investigated by the author except one axehead (02YLIAT0111-0212⑩:3) which was analysed by Yang Sheng from the Chengdu Archaeological Institute. All of the iron objects were cleaned and well recorded before sampling. Diagrams were drawn for most of the objects except the too fragmentary ones. The diagrams can be found in appendix C. There were 58 samples taken from 36 objects. There were 8 objects of unidentified type, and only one sample was taken from one of these unidentified objects (SK0011).

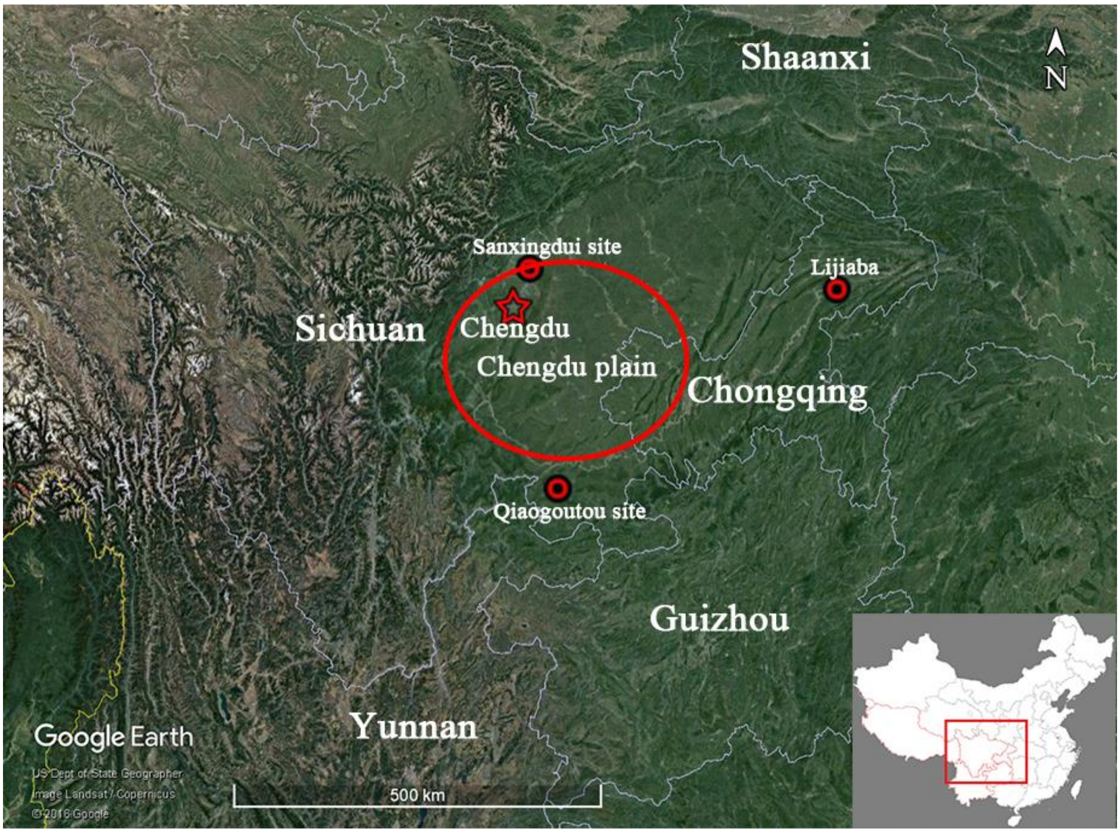


Fig. 5.2 Map showing the location of Lijiaba and Qiaogoutou (base map: Google Earth)

Table 5.2 Iron objects excavated from different contexts at Lijiaba

Category	Type	Count	Percentage
Domestic objects	object ear (handle)	1	*3%*
Weapons	sabre	1	*9%*
	arrowhead	2	
Tools	axehead	7	*71%*
	chisel	1	
	mattockhead	8	
	nail	1	
	knife	6	
	ring-headed knife	1	
	pickaxehead	1	
Others	unidentified	6	*17%*
	Total	**35**	

Table 5.3 Iron objects excavated from burials at Lijiaba

Category	Type	Count	Percentage
Domestic objects	*mou*-pot (caldron)	1	*7%*
Weapons	sword	1	*27%*
	sabre	3	
Tools	shovelhead	1	*33%*
	mattockhead	1	
	ring headed iron knife	3	
Accessories	belt hook	4	*27%*

Others	unidentified	1	*6%*
	Total	**15**	

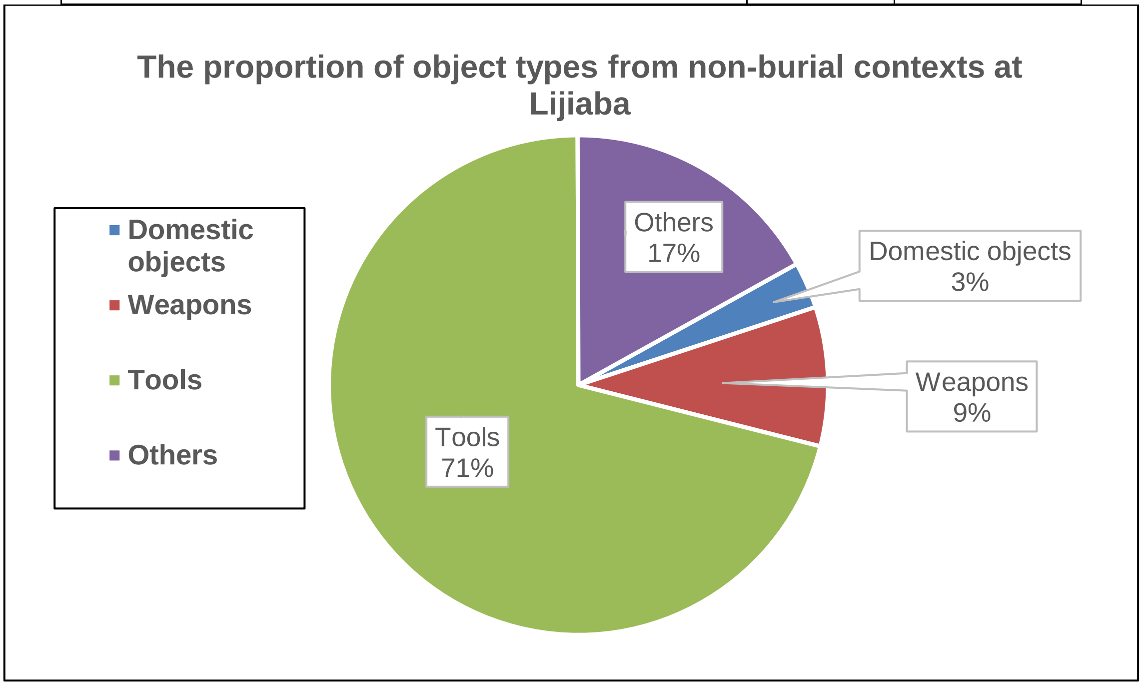


Fig. 5.3 Proportion of object types from non-burial contexts at Lijiaba

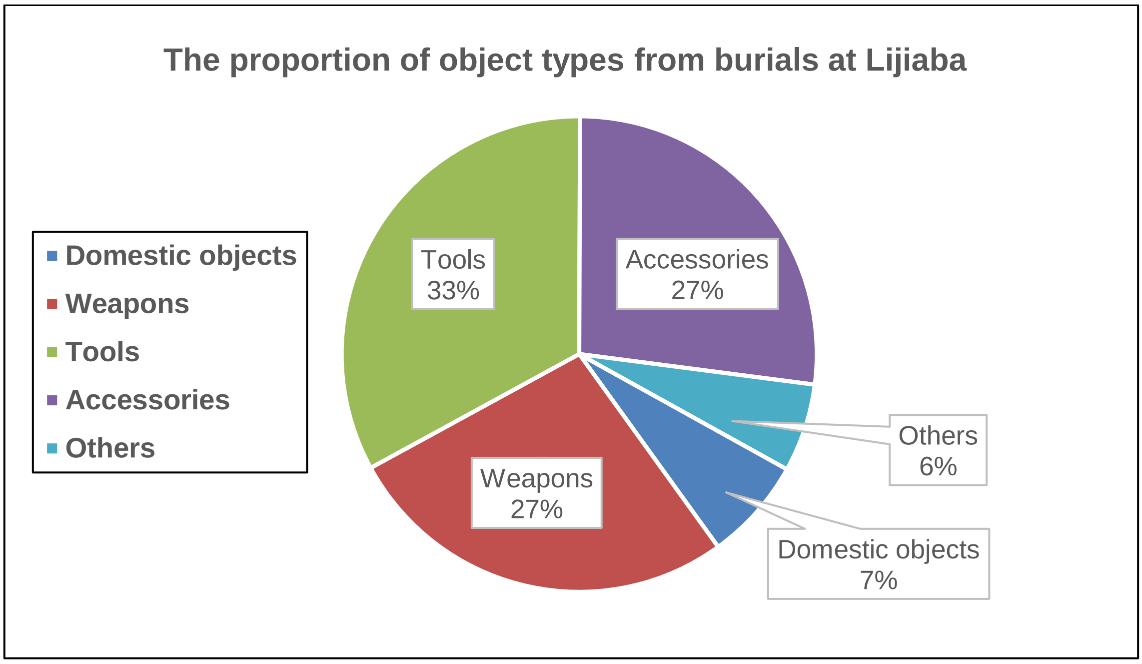


Fig. 5.4 Proportion of object types from burials at Lijiaba

5.3.2 Dating

There are no published radiocarbon dating results for the Lijiaba site. The dating of the site is based on the excavated pottery. In the published annual reports, the main remains of the Lijiaba site were dated to the mid-late Western Zhou (c.922-771BC) to the late Warring States and early Western Han dynasty (c.260-200BC). The dating of the pottery assemblages can be found in the reports and will not be discussed in detail here.

The iron objects from the burials excavated in 1997 and 1999 were dated to the late Warring States period (c.260-221BC, Luo E. 2002, 29; Huang Wei *et al* 2011, 478). The iron objects excavated from the non-burial contexts in 2000 were dated to the Han and Tang dynasties (He Y. *et al* 2016, 10). The objects excavated from 2001-2003 do not yet have published dates, and the excavator suggested to date the objects from the contexts to the Han and Tang dynasties (Table 5.4).

Table 5.4 List of excavated iron objects from Lijiaba

No.	Sample No.	Type	Category	Context No.	Burial	Date
1	SK0001	mattockhead	T	02YLIF12:1	N	Han & Tang*
2	SK0002	mattockhead	T	02YLIDT0514-0615③:1	N	‘’
3	SK0003, 35	axehead	T	02YLIDT0409⑩:1	N	‘’
4	SK0004	iron knife	T	02YLIAT0709-0810⑮:3	N	‘’
5	SK0005	iron knife	T	02YLIAT0208④:1	N	‘’
6	SK0006	arrowhead	W	02YLIAT0207⑧:1	N	‘’
7	SK0008	axehead	T	02YLIF12:2	N	‘’
8	SK0010	iron knife	T	02YLIAT0511⑮:2	N	‘’
9	SK0011	axehead	U	01YLIIBT1510-1611②b:2	N	‘’
10	SK0012, 13	ring-headed iron knife	T	02YLIAT0207⑧:6	N	‘’
11	SK0014, 15	mattockhead	T	02YLIAT0511⑮:15	N	‘’
12	SK0017, 18	arrowhead	W	02YLIAT0511⑮:10	N	‘’
13	SK0019, 20	iron knife	T	02YLIDT0712-0813③:1	N	‘’
14	SK0021, 36	axehead	T	02YLIAT0511⑮:4	N	‘’
15	SK0022	iron knife	T	02IF16:2	N	‘’
16	SK0024, 25	iron knife	T	02YLIAT0507-0608⑪:1	N	‘’
17	SK0028	mattockhead	T	02YLIDT0315-0416③:1	N	‘’
18	SK0029, 30, 34	iron sabre	W	02YLDIT0512-0613③:2	N	‘’
19	SK0031, 32, 33	chisel	T	02YLVH:1	N	‘’
20	SK0038, 39	shovelhead	T	03YLIVM14:89	Y	‘’

No.	Sample No.	Type	Category	Context No.	Burial	Date
21	SK0040, 41	mattockhead	T	00YLIBT2219⑥:3	N	Han & Tang
22	SK0042, 43, 44	ring-headed iron knife	T	03YLIVM6:8	Y	Han & Tang*
23	SK0045, 46	iron knife	T	03YLIIIM15:20	Y	‘’
24	SK0047	belt hook	A	03YLIVM6:38	Y	‘’
25	SK0048, 49	iron sabre	W	03YLIVM10:5	Y	‘’
26	SK0050, 51	axehead	T	00YLIBT2219⑥:2	N	Han & Tang
27	SK0052	belt hook	A	03YLIVM3:9	Y	Han & Tang*
28	SK0053, 54	mattockhead	T	00YLIBT2014⑤:8	N	Han & Tang
29	SK0055	iron object ear	D	97BT0205⑩	N	late WS to early Han
30	SK0056	belt hook	A	03YLIVM6:34	Y	Han & Tang*
31	SK0057, 58	pickaxehead	T	00YLIBT1612④:2	N	Han & Tang
32	SK0059, 60	mattockhead	T	00YLIBT2014⑥(⑧):5	N	‘’
33	SK0061	belt hook	A	03YLIVM6:6	Y	Han & Tang*
34	SK0062, 63	axehead	T	00YLIBT2520⑥:2	N	Han & Tang
35	SK0064	nail	T	01YLIIBT1515⑤a:3	N	Han & Tang*
36	/	unidentified object	U	03YLIVM14:38	Y	‘’
37	/	unidentified object	U	02YLIH9:1	N	‘’
38	/	unidentified object	U	02YLIH9:2	N	‘’
39	/	unidentified object	U	02YLIAT0905-1006⑯:1	N	‘’
40	/	unidentified object	U	02YLIAT0905⑬:2	N	‘’
41	/	unidentified object	U	02YLIAT0905⑬:1	N	‘’
42	/	unidentified object	U	02IAT0408⑥	N	‘’
43	/	axehead	T	01YLF12:4	N	‘’
44	/	mou (caldron)	D	99IIM22:4	Y	late WS
45	/	sword	W	99IIM22:5	Y	‘’
46	/	ring-headed iron knife	T	99IIM22:6	Y	‘’
47	/	iron sabre	W	99IIM38:4	Y	‘’
48	/	iron sabre	W	97M53:8	Y	‘’
49	/	mattockhead	T	97M27:2	Y	‘’
50	CD	axehead	T	02YLIAT0111-0212⑩:3	N	Han & Tang*

* the dating was suggested by the excavator (He Yuanhong) of 2001-2003.

5.3.3 Results

SK0001

Sample: cut from cutting edge of an iron *Jue* (mattockhead, Fig. 5.5).

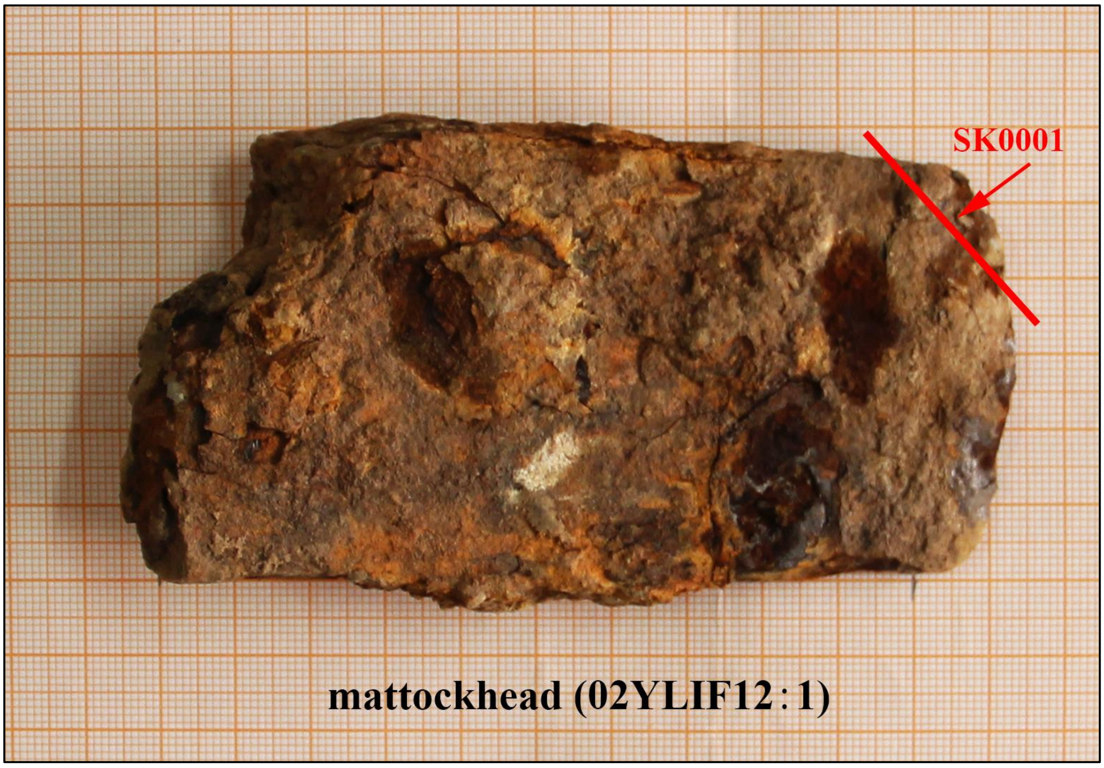


Fig. 5.5 Mattockhead (02YLIF12:1) showing the sampling spot of SK0001 (source: author)

Unetched*:* corroded on the surface with some metal remaining in the centre. Large amount of small black dots and a crack are in the unetched section. There are no slag inclusions (Fig. 5.6).

Etched*:* at low magnification, etching revealed a varying carbon content of the sample, with large size of cementite distributed in the middle of the sample, and pearlite and small size of irregular shaped cementite on the sides (Fig. 5.7). At a higher magnification, it can be seen that the cementite in the middle is distributed on a ferrite matrix and some small granular pearlite. The size of the cementite get smaller, and the amount of pearlite increases towards to the object surface. The shape of the pearlite is more lamellar (Fig. 5.8).

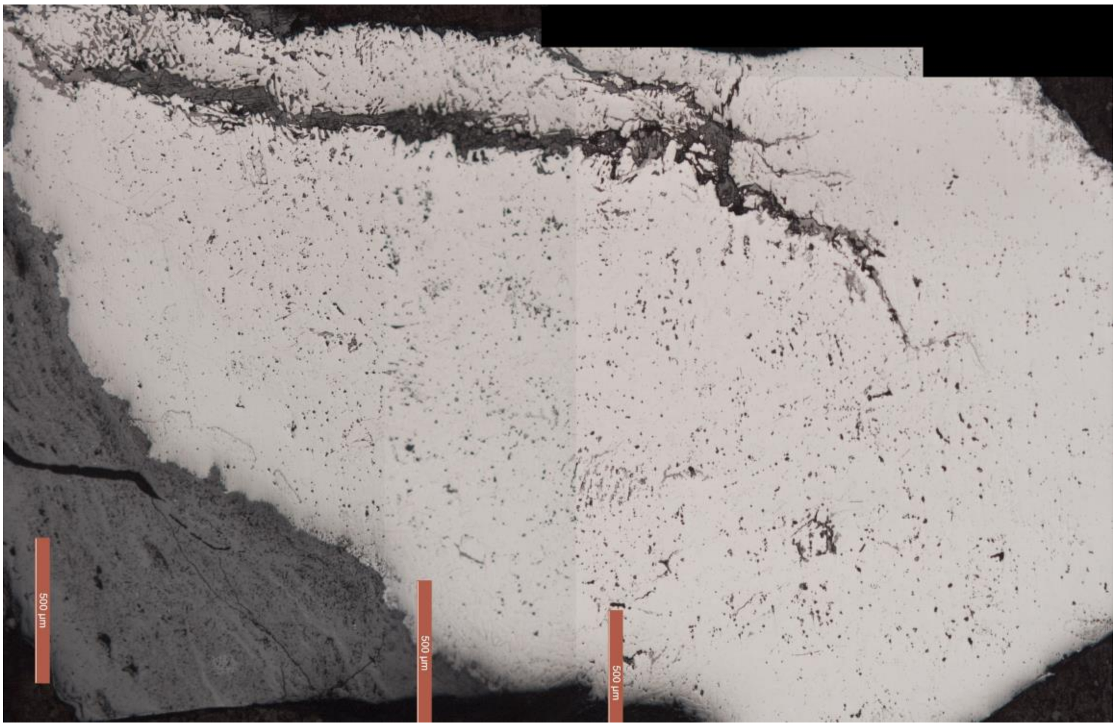


Fig. 5.6 Montage of the section from SK0001. Unetched, scale bar 500µm (source: author)

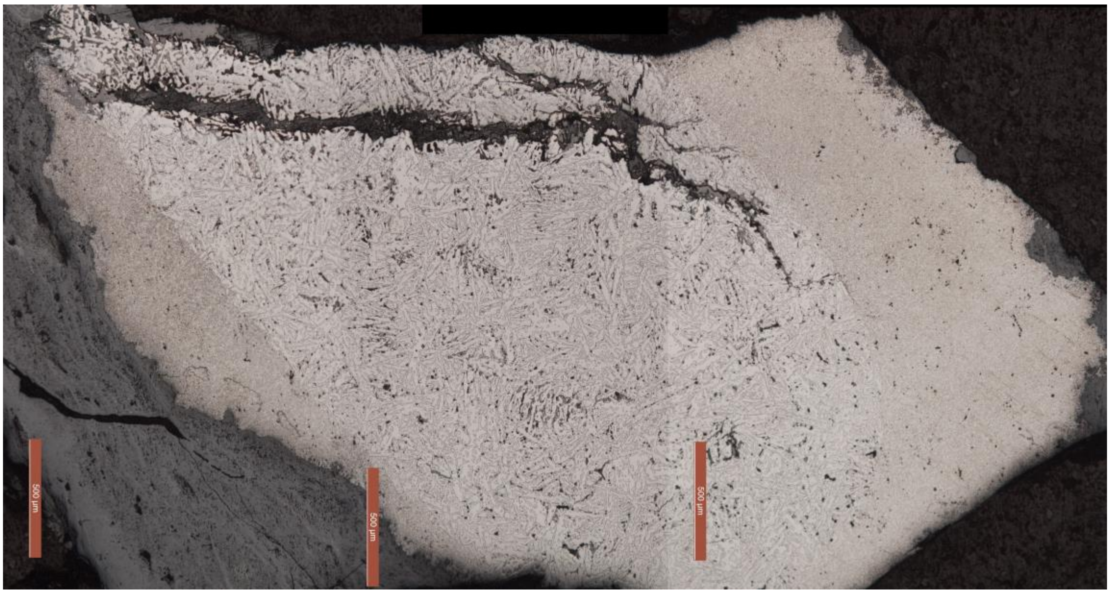


Fig. 5.7 Montage of the section from SK0001 showing the difference of carbon content in different areas of the object. Etch 2% nital, scale x37.5 (source: author)

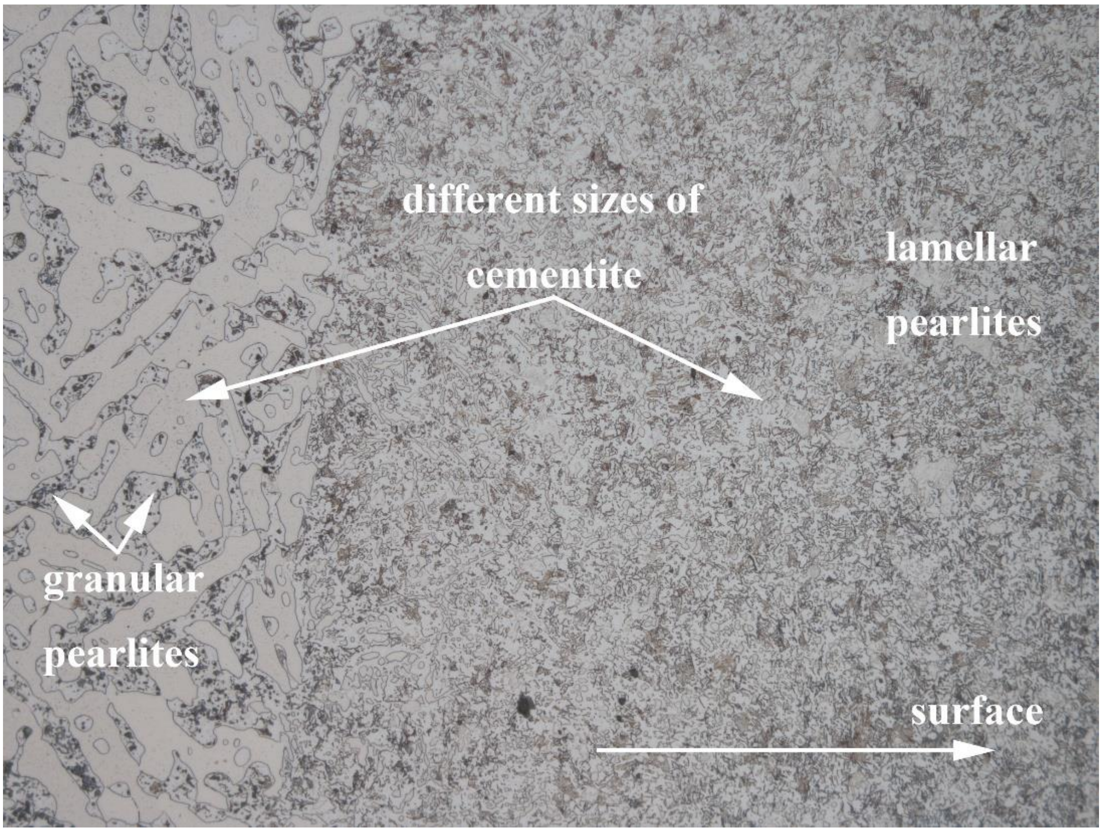


Fig. 5.8 Section from SK0001 showing the different sizes of cementite and different shapes of pearlite in the middle and the side areas. Etch 2% nital, scale x150 (source: author)

***Initial interpretation**:* the mattockhead was probably cast in white cast iron first, and then decarburized incompletely, which explains why there is still cementite of large amounts in the middle and small amount near the surface.

SK0002

***Sample**:* cut from socket end of an iron mattockhead (Fig. 5.9). The sample was prepared in 2014, and re-polished in 2016.

***Unetched**:* slightly corroded on the surface with some metal remaining in the centre. The dark grey phase is corrosion, and the light grey phase is possibly new corrosion due to the imperfections in sample preparing. The black phase in granular and star shapes is possibly graphite. There are no slag inclusions (Fig. 5.10).

Etched: at low magnification, etching revealed a very fine pearlite matrix. The grain sizes are small and even. The carbon content is about 0.6% ~ 0.7%, and ferrite distributed like a net on grain boundaries. The shape of the pearlite cannot be identified at this magnification level (Fig. 5.11). The shape of the pearlite is lamellar at a higher magnification (Fig. 5.12).

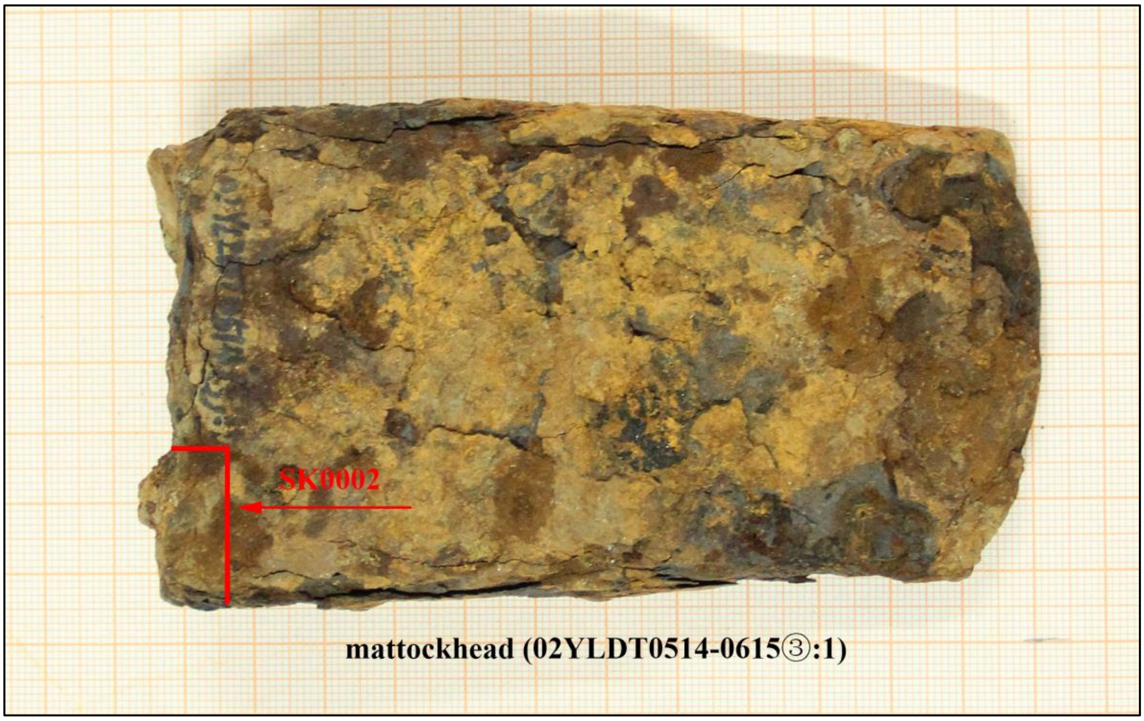


Fig. 5.9 Mattockhead (02YLDT0514-0615③:1) showing the sampling spot of SK0002 (source: author)

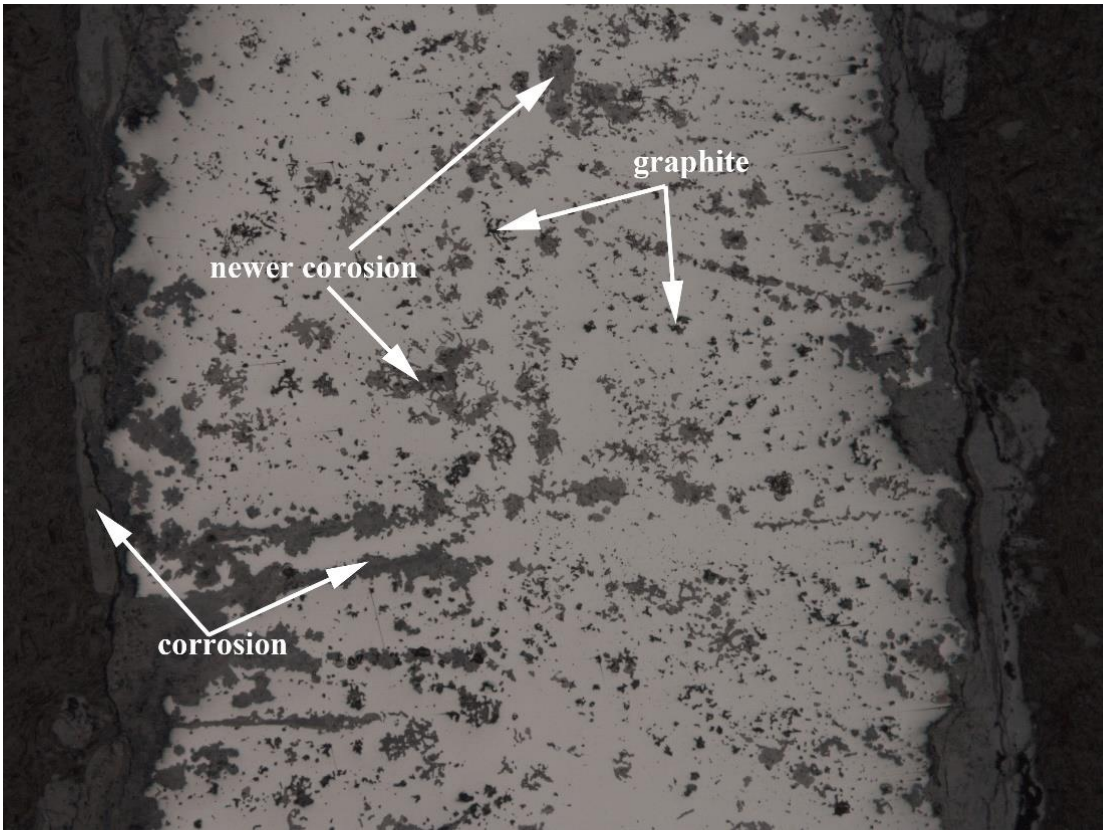


Fig. 5.10 Section from SK0002 showing different corrosions and graphite. Unetched, scale x37.5 (source: author)

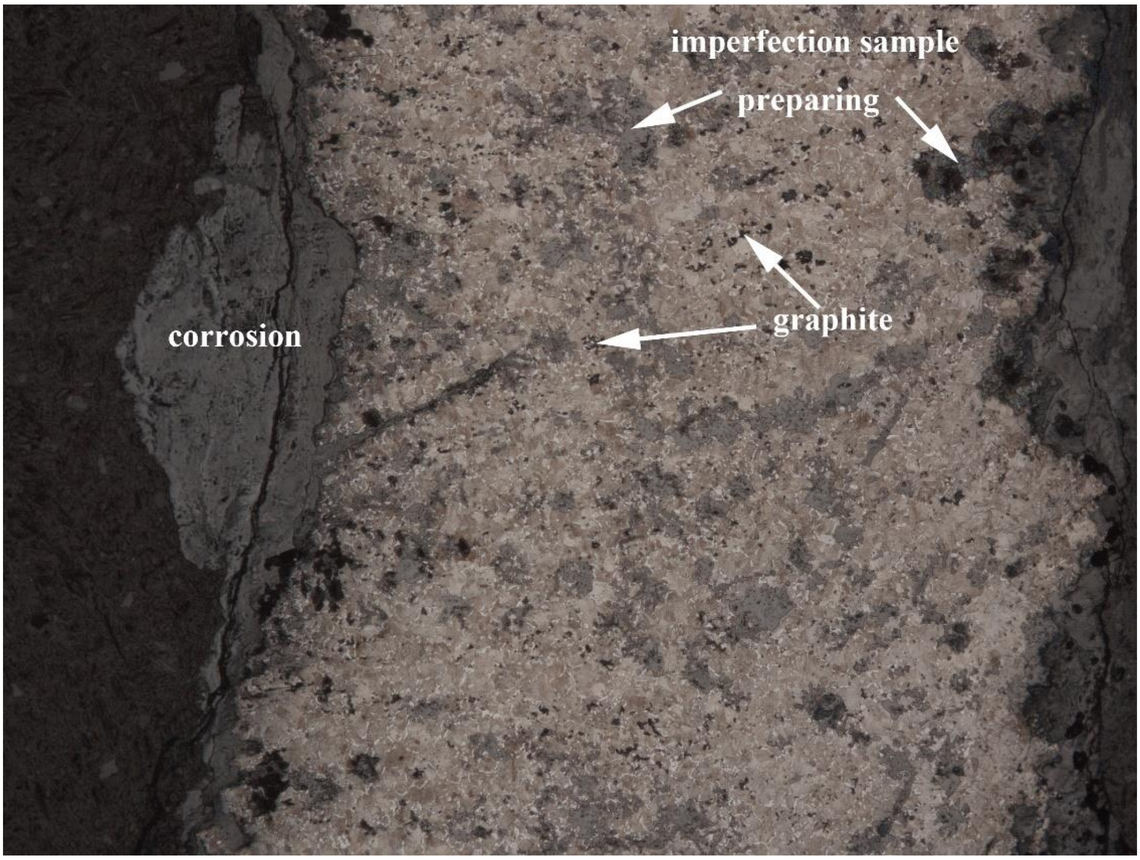


Fig. 5.11 Section from SK0002 showing the fine pearlite matrix and indicating the graphite and imperfection of sample preparing. Etch 2% nital, scale x37.5 (source: author)

Fig. 5.12 Section from SK0002 showing lamellar pearlite. Etch 2% nital, scale x375 (source: author)

Initial interpretation*:* the socket part of the mattockhead was made from hypo-eutectoid steel, with a carbon content of c.0.6-0.7%. The graphite-like structures indicate the object was possibly annealed for graphitization.

SK0003 and SK0035

Sample*:* SK0003 was collected from the corrosion which fell off from an iron axehead (02YLIDT0409⑩:1) surface (Fig. 5.13). SK0035 was cut from the cutting edge of the same object (Fig. 5.13).

Unetched*:* SK0003 is fully corroded and no metallographic structures can be identified from the section (Fig. 5.14). SK0035 is badly corroded on the surface but has some metal remaining in the centre. There are both single and double-phased slag inclusions. The single-phased slag inclusions are in the form of stringers and chains, and the double-phased slag inclusions are irregular and look like crack (Fig. 5.15).

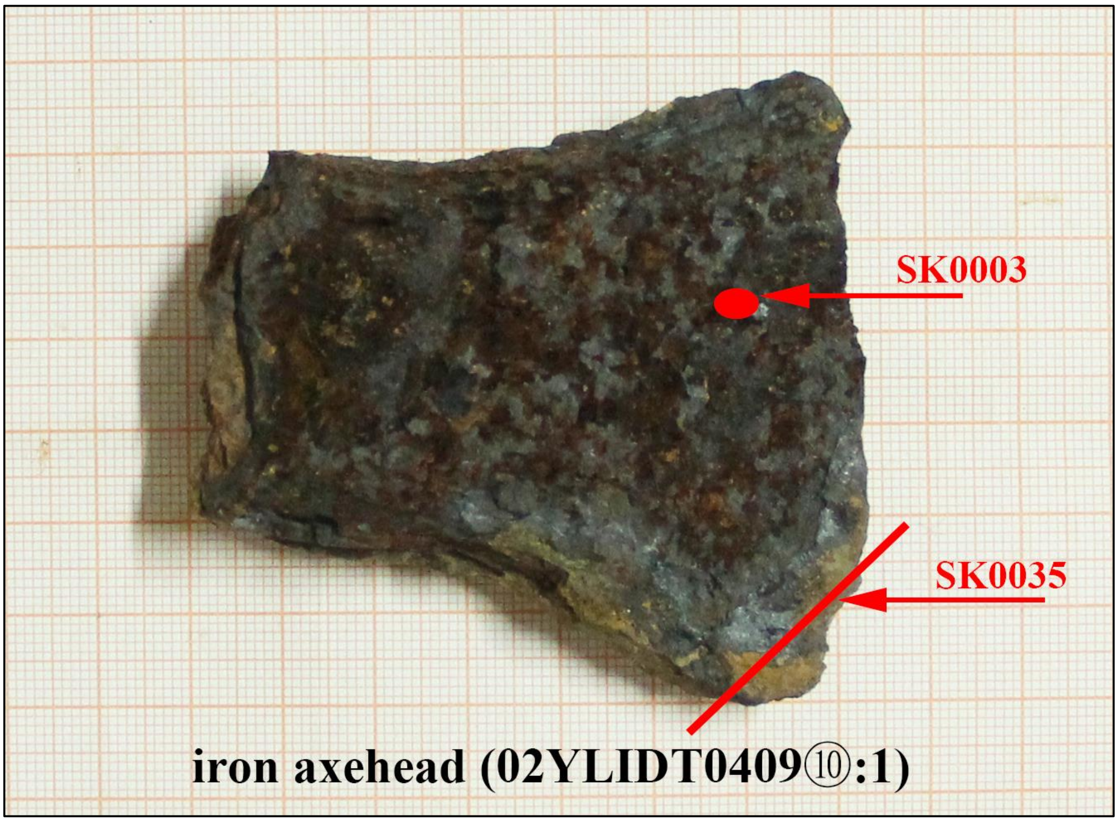


Fig. 5.13 Axehead (02YLIDT0409⑩:1) showing the sampling spot of SK0003 and SK0035 (source: author)

Fig. 5.14 Section from SK0003 showing the corrosion. Etch 2% nital, scale x37.5 (source: author)

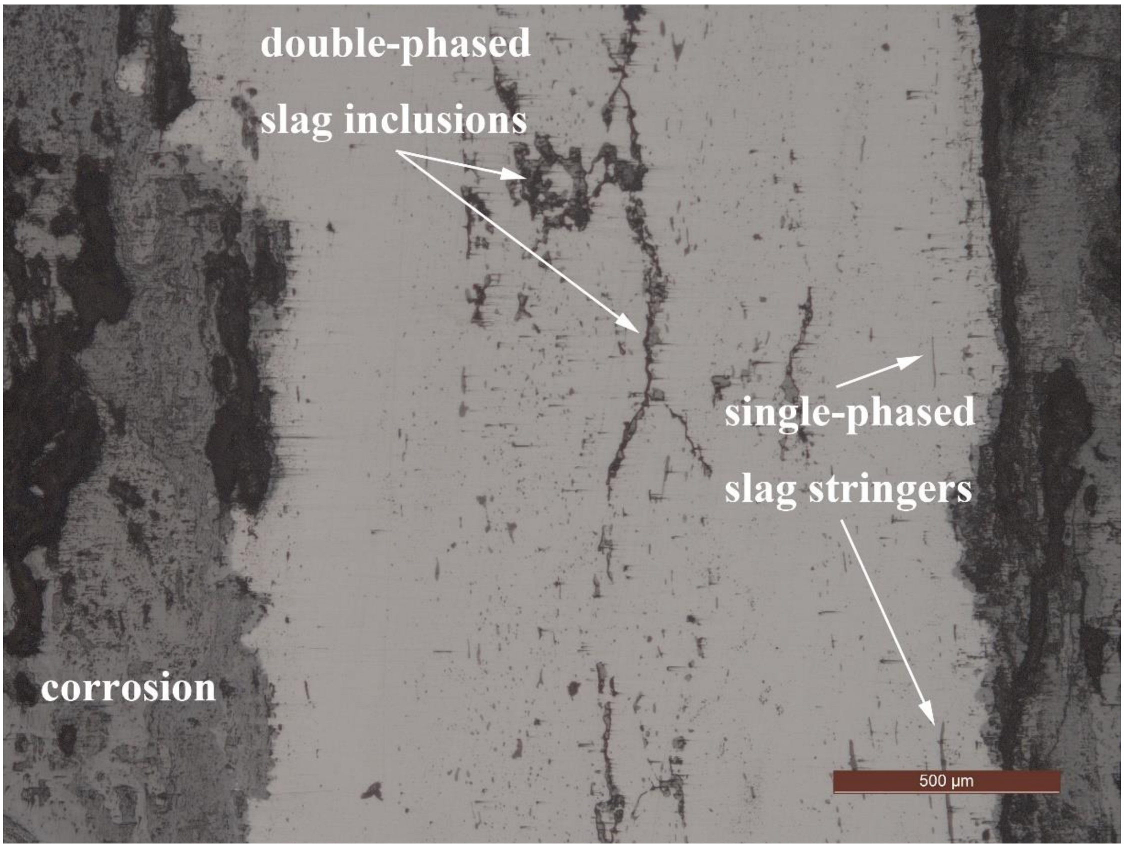


Fig. 5.15 Section from SK0035 showing both single and double-phased slag inclusions. Unetched, scale bar 500µm (source: author)

Etched: at low magnification of SK0035, etching revealed varying carbon content in multiple layers, including nearly pure ferrite in the middle area and ferrite and pearlite on the sides near the surface. There are low carbon layers and high carbon layers distributed alternately between the centre and the surface. The grain size in the middle is large and very small on the surfaces. The grain boundaries are not clear in the low carbon areas (Fig. 5.16). At a higher magnification, there are needle-like ferrite structures extending inwards from the grain boundaries, indicating a Widmanstätten structure. The distance between the pearlite is very small, and the shape of the pearlite is still unidentified. The carbon content varies from 0.1 to 0.5%, and closer to the object surface the higher the carbon content is. There is less than 0.1% carbon in the low carbon layers (Fig. 5.17).

Initial interpretation*:* the object was forged probably from a fined iron or bloomery iron, and was possibly carburized.

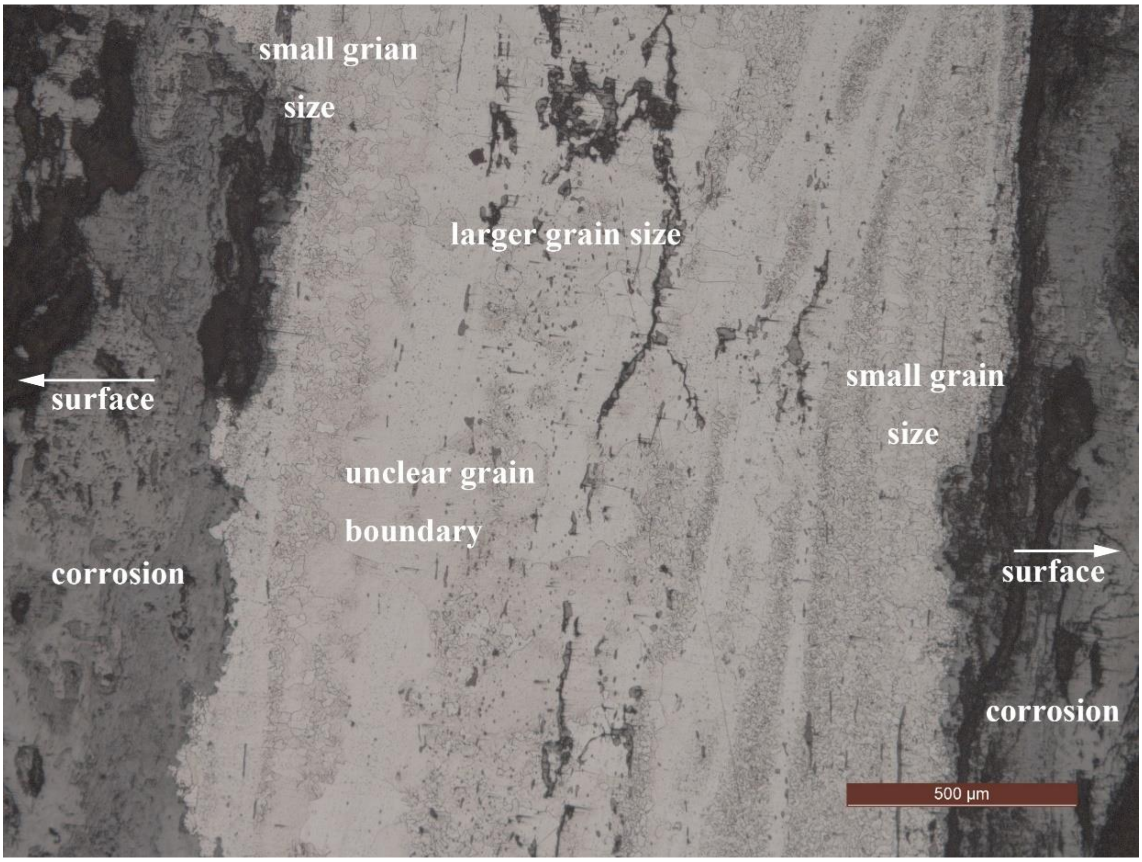


Fig. 5.16 Section from SK0035 showing different carbon content and grain sizes in different layers. Etch 2% nital, scale bar 500µm (source: author)

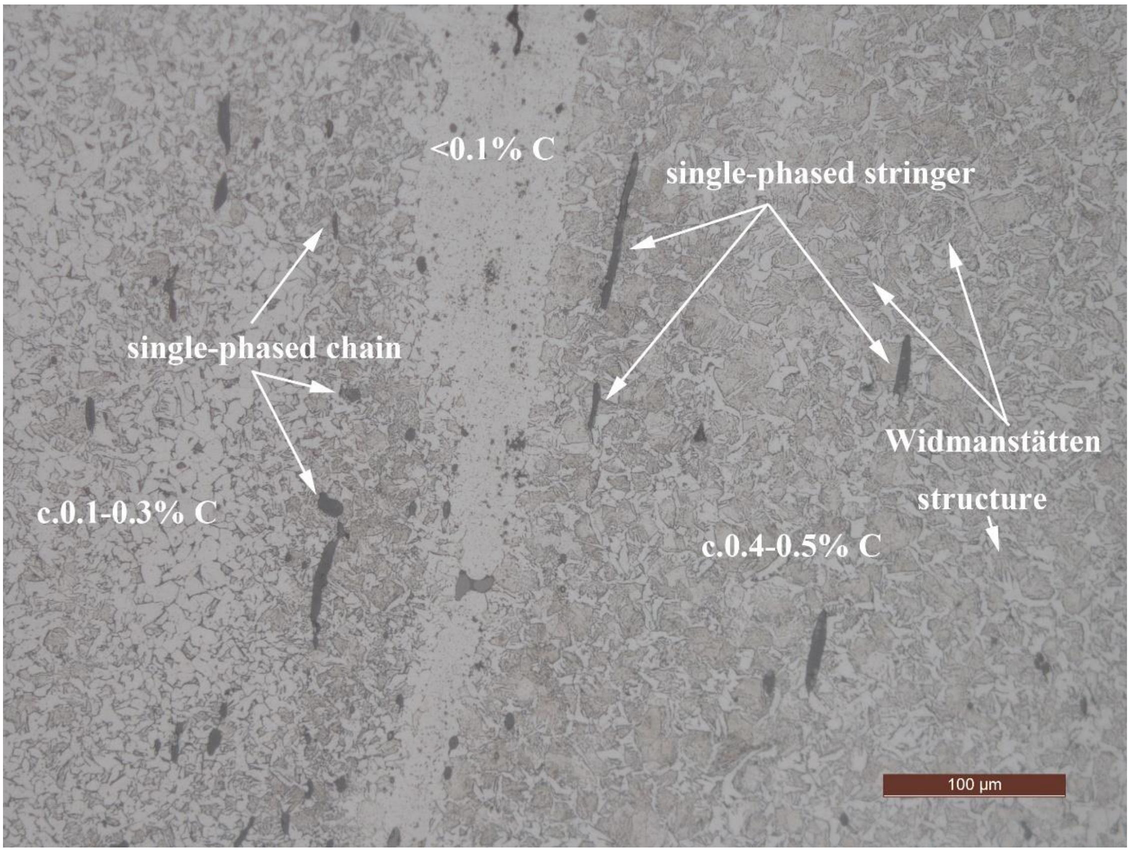


Fig. 5.17 Section from SK0035 showing different carbon content and indicating a Widmanstätten structure. Etch 2% nital, scale bar 100μm (source: author)

SK0004

***Sample**:* the cross section cut from the tang end of an iron knife (Fig. 5.18).

Fig. 5.18 Iron knife (02YLIAT0709-0810⑮:3) showing the sampling spot of SK0004 (source: author)

***Unetched**:* the sample is badly corroded on the surface with some metal remaining in the centre. There are some cotton-like graphite nodules in the middle and no slag inclusions (Fig. 5.19).

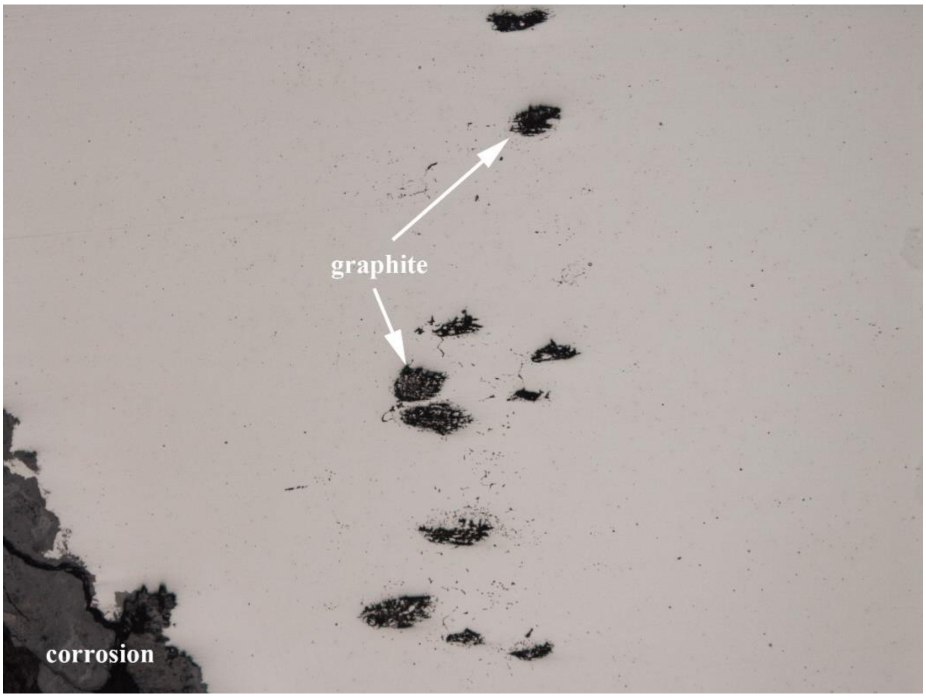


Fig. 5.19 Section from SK0004 showing the metal and the graphite. Unetched, scale x37.5 (source: author)

***Etched**:* at low magnification, etching revealed a fine pearlite matrix with small grain size. There is a small amount of ferrite on the edge of the sample (Fig. 5.20).

At a higher magnification, some of the pearlite is lamellar, and there are large amounts of small size cementite (Fig. 5.21).

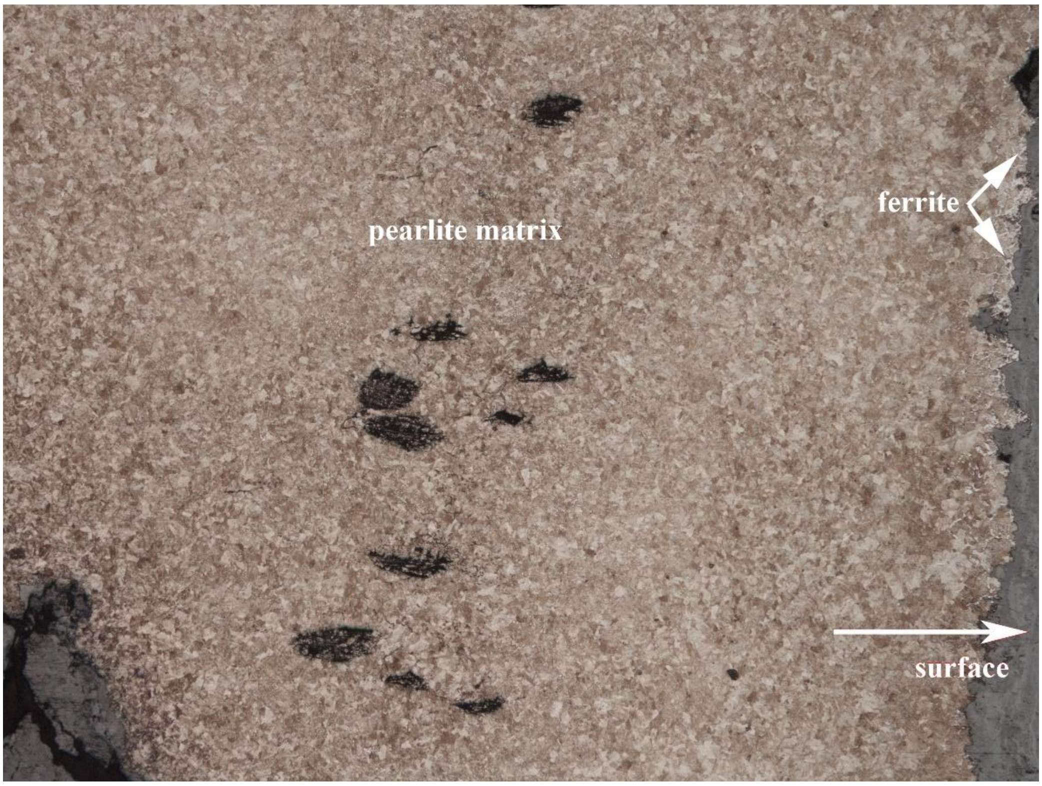


Fig. 5.20 Section from SK0004 showing a pearlite matrix, the cotton-like graphite, and the ferrite. Etch 2% nital, scale x37.5 (source: author)

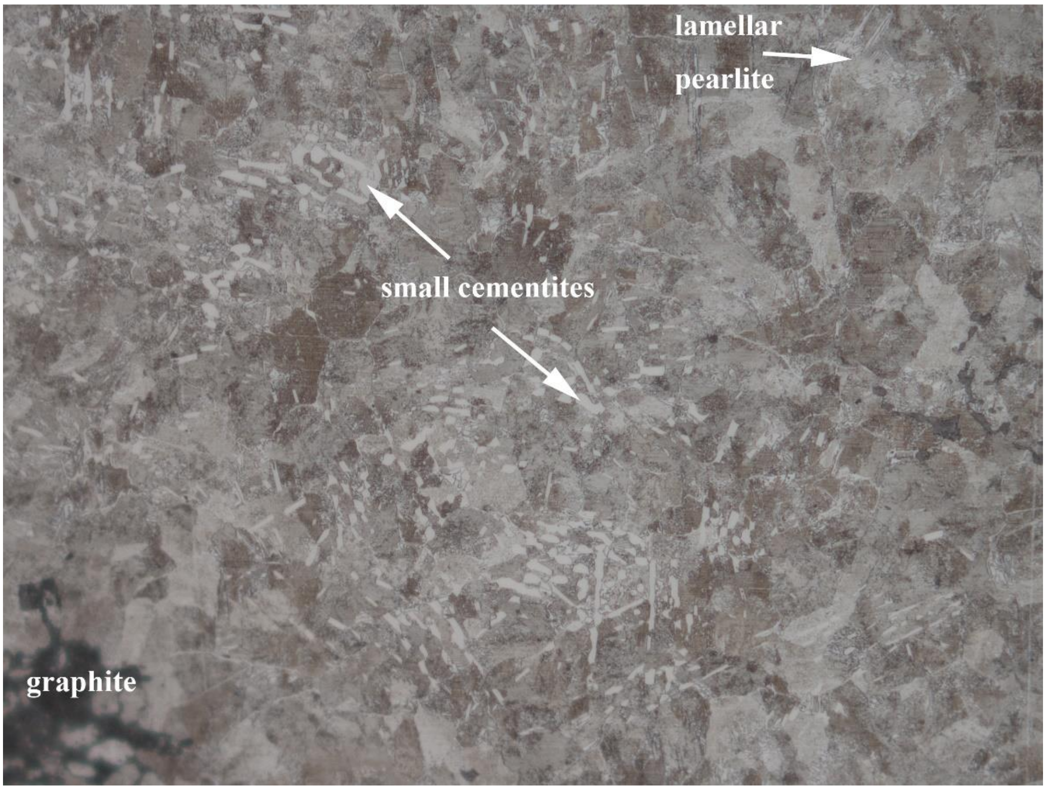


Fig. 5.21 Section from SK0004 showing lamellar pearlite and small cementite. Etch 2% nital, scale x300 (source: author)

***Initial interpretation**:* the iron knife was cast in white cast iron first and annealed for decarburization and graphitization. However, the annealing process was insufficient which there is still small size cementite. This material is called mottled cast iron, in which the carbon in the object are both in cementite and graphite forms.

SK0005

Sample: cut from the cutting edge of a broken iron sabre (Fig. 5.22).

Fig. 5.22 Iron sabre (02YLIAT0208④:1) showing the sampling spot of SK0005 (source: author)

***Unetched**:* the sabre is badly corroded on the surface with some metal remaining in the centre. There are large amounts of slag inclusions in stringers and chains aligned with long axis of blade and indicate direction of forging (Fig. 5.23)

Fig. 5.23 Section from SK0005 showing the slag inclusions. Unetched, scale bar 500μm (source: author)

Etched: at low magnification, etching revealed a ferrite matrix with an uneven grain sizes. The grain boundaries are clearly seen, and some of the grains are slightly elongated. There is an uneven response to etching was visible throughout the section, which is defined as 'ghost' structure indicating dissolved phosphorus (Lang 2014, 12). The slag inclusions on the sides are smaller than those in the middle (Fig. 5.24). At a higher magnification, it shows clearly that all of the slag inclusions are double-phased slag inclusions (Fig. 5.25).

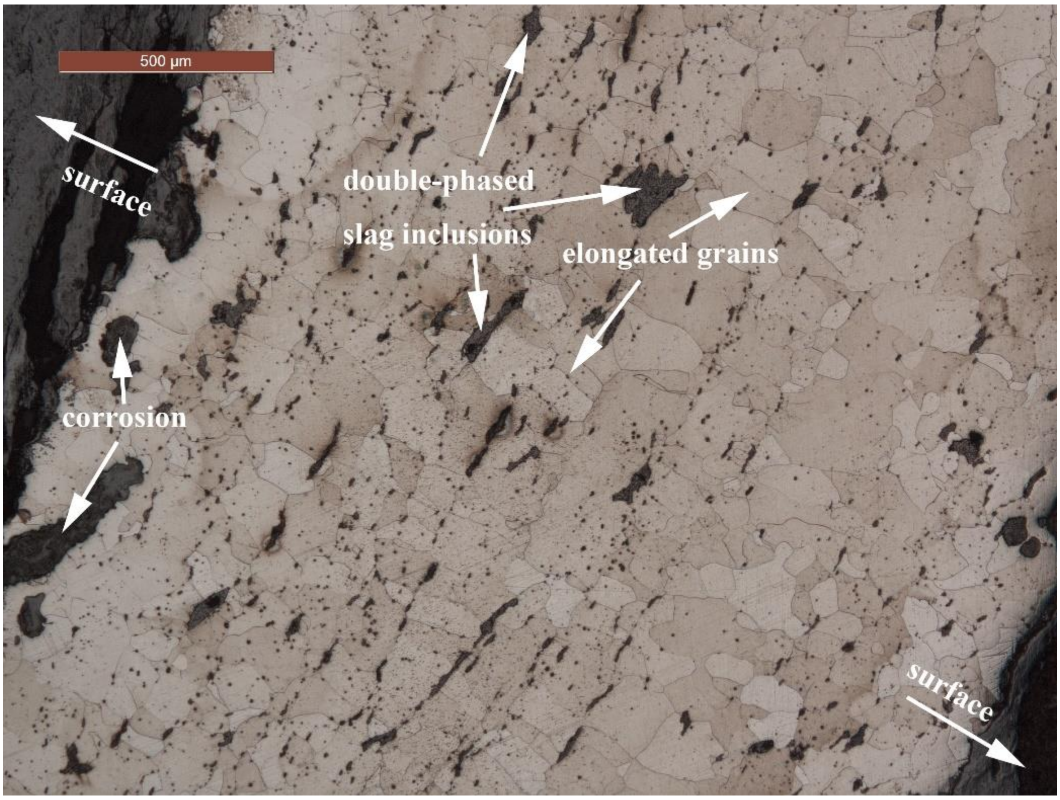


Fig. 5.24 Section from SK0005 showing a ferrite matrix and the slag inclusions. Etch 2% nital, scale bar 500µm (source: author)

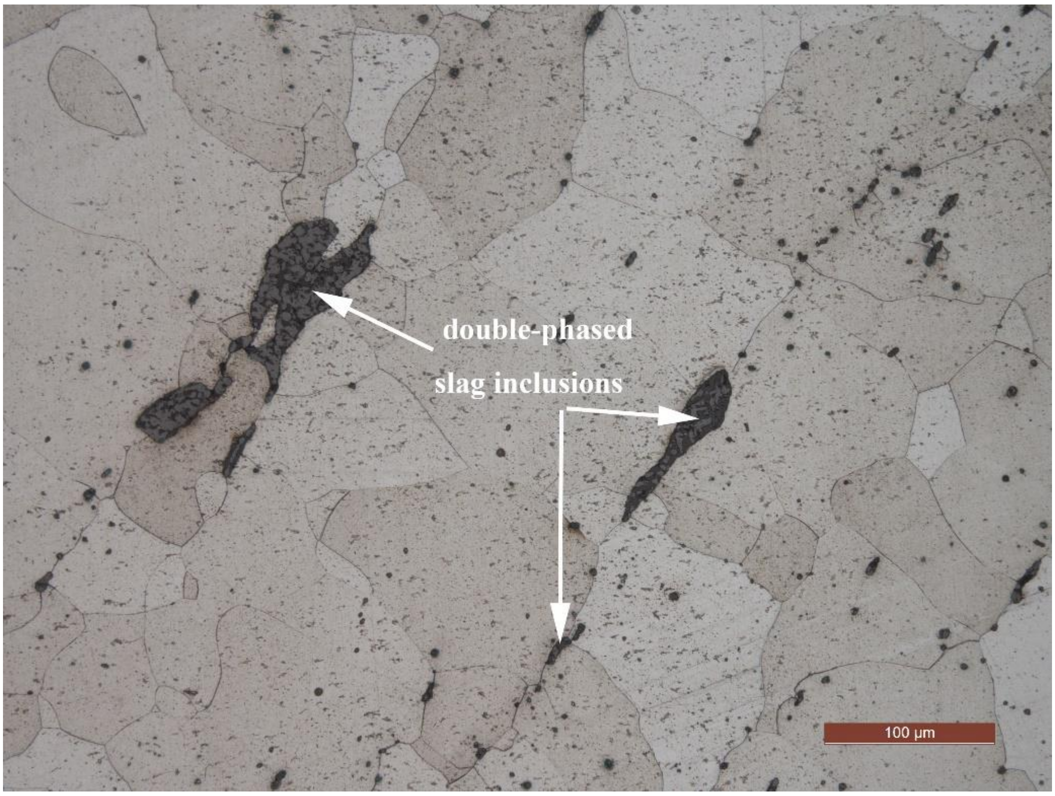


Fig. 5.25 Section from SK0005 showing the double-phased slag inclusions. Etch 2% nital, scale bar 100µm (source: author)

Initial interpretation*:* the iron sabre was forged from bloomery iron or fined iron.

SK0006

Sample*:* cut from the tang end of an iron arrowhead (Fig. 5.26).

Fig. 5.26 Iron arrowhead (02YLIAT0207⑧:1) showing the sampling spot of SK0006 (source: author)

Unetched*:* the sample is corroded on the surface with some metal remaining in the centre. There are large amounts of small black dots (Fig. 5.27).

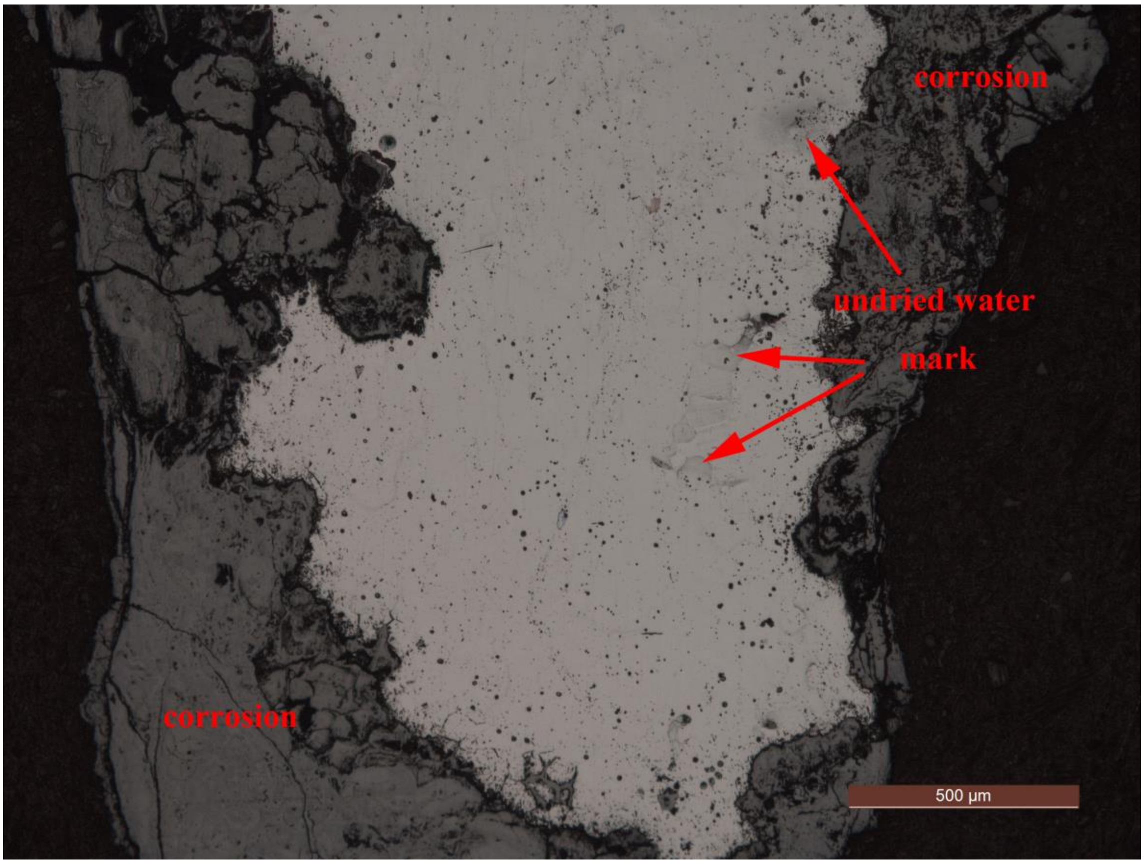


Fig. 5.27 Section from SK0006. Unetched, scale bar 500μm (source: author)

***Etched**:* at low magnification, etching revealed a ferrite matrix with small and even grain size, and the grain boundaries are clearly seen. There is a slightly uneven response to etching visible throughout the section possibly indicating dissolved phosphorus (Fig. 5.28). At a higher magnification, the small black dots are mostly angular and look like impurities probably from the sample preparation (Fig. 5.29).

***Initial interpretation**:* there is no evidence of forging, the arrowhead was probably cast first and then fully decarburized.

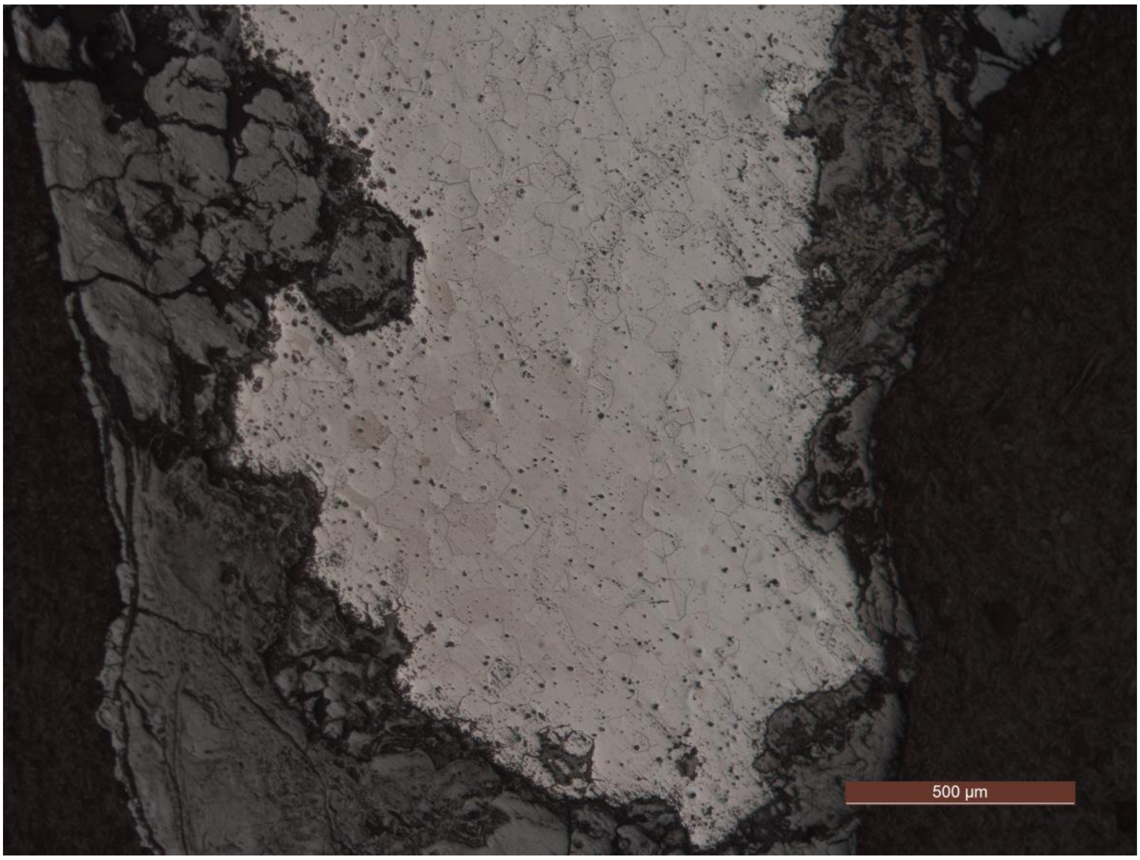


Fig. 5.28 Section from SK0006 showing a ferrite matrix with small and even grain size. Etch 2% nital, scale bar 500µm (source: author)

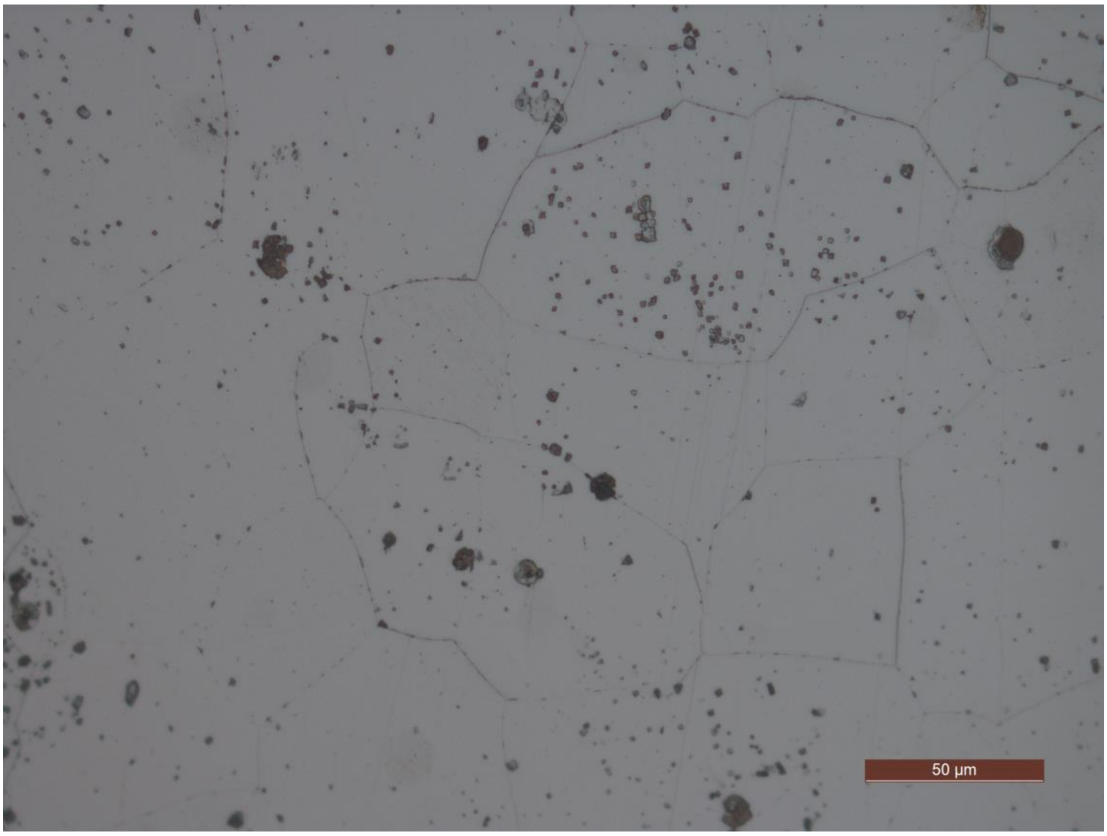


Fig. 5.29 Section from SK0006 showing the angular impurities. Etch 2% nital, scale bar 50µm (source: author)

SK0008

Sample: cut from the socket part of an iron mattockhead (Fig. 5.30).

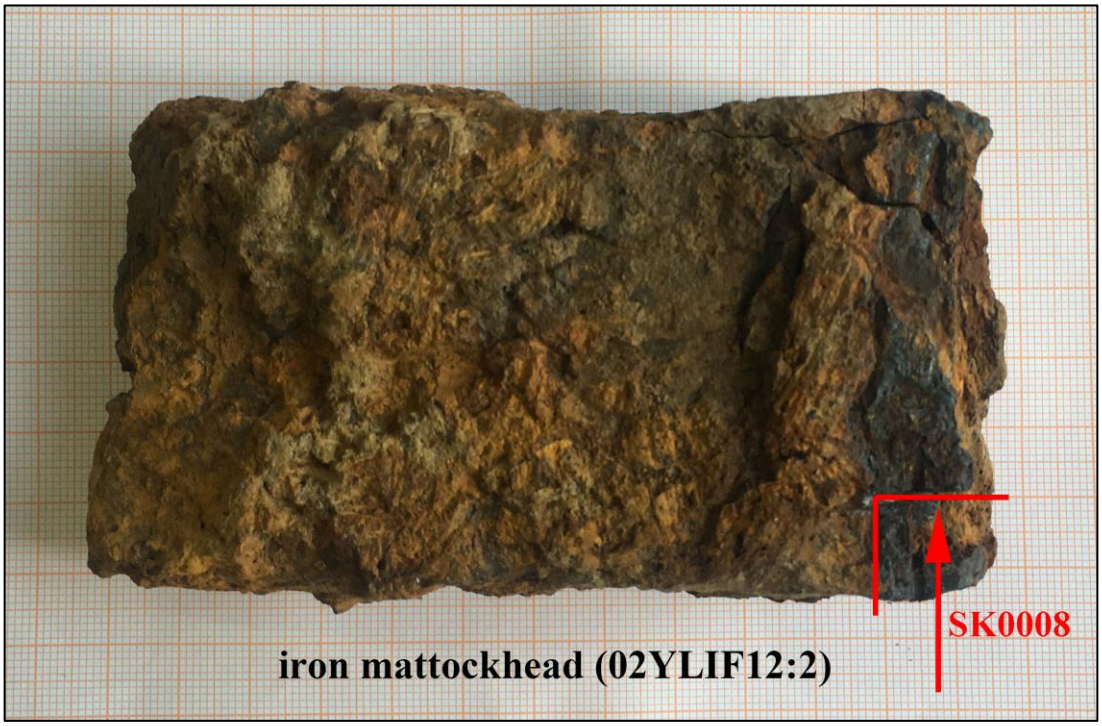


Fig. 5.30 Iron mattockhead (02YLIF12:2) showing the sampling spot of SK0008 (source: author)

Unetched*:* the sample is corroded on the surface with some metal remaining in the centre. There are large amounts of black cotton-like graphite nodules, and no slag inclusions (Fig. 5.31).

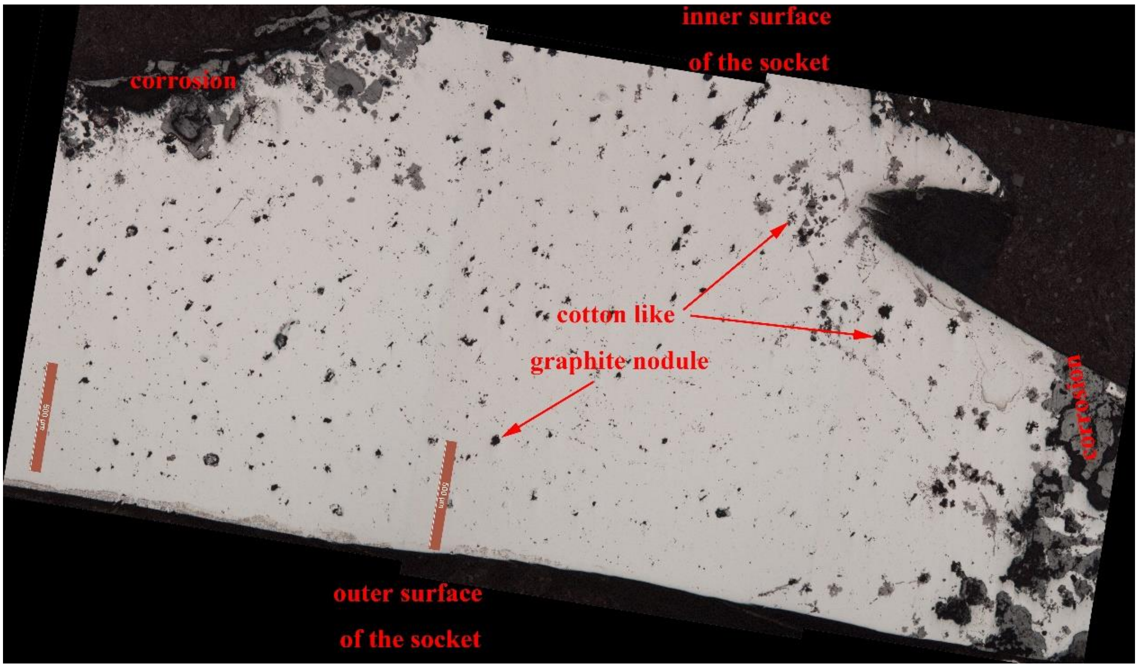


Fig. 5.31 Montage of the section from SK0008. Unetched, scale bar 500µm (source: author)

Etched*:* at low magnification, etching revealed a ferrite and pearlite matrix. The grain boundaries are clear for the pearlite and unclear for the ferrite. The pearlite is concentrated in the middle of the sample. The areas close to each surface are nearly fully decarburized to pure ferrite with unclear grain boundaries. The cotton-like graphite nodules are throughout the etched section (Fig. 5.32). At a higher magnification, the shape of the pearlite is visible in lamellar (Fig. 5.33).

Initial interpretation*:* there are no slag inclusions in the sample section, the object was cast probably in white cast iron first, and then annealed for decarburization and graphitization. This material is known as ferrite and pearlite matrix malleable cast iron.

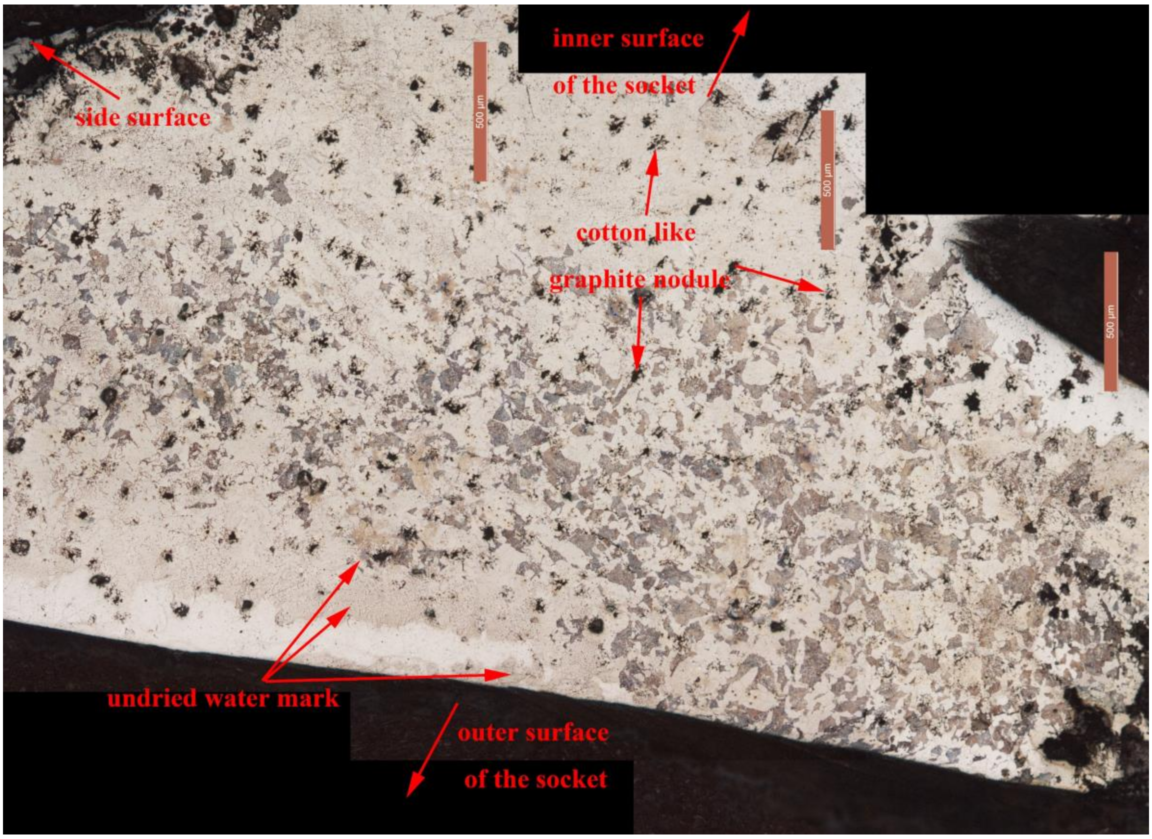


Fig. 5.32 Montage of the section from SK0008 showing the ferrite, pearlite, and graphite. Etch 2% nital, scale bar 500µm (source: author)

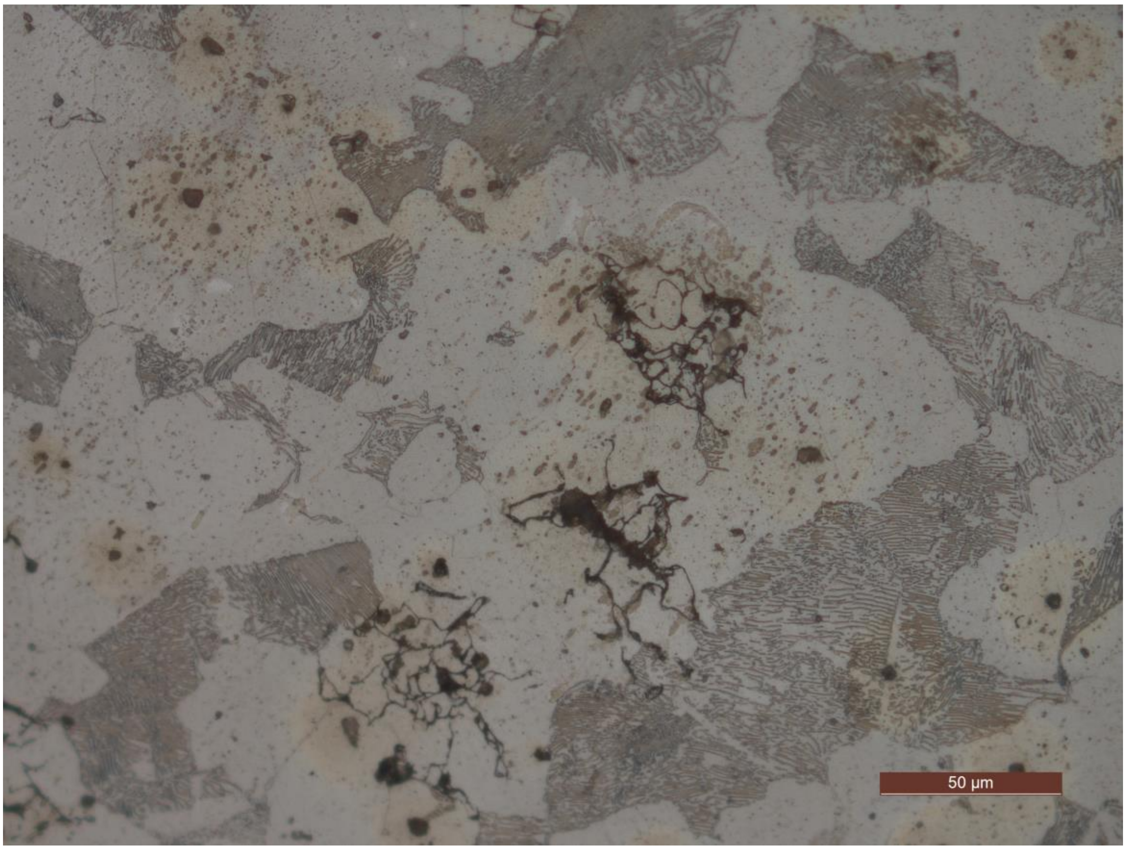


Fig. 5.33 Section from SK0008 showing the lamellar pearlite and the cotton-like graphite nodules. Etch 2% nital, scale bar 50µm (source: author)

SK0010

***Sample**:* the cross section cut from the tang end of an iron knife (Fig. 5.34).

Fig. 5.34 Iron knife (02YLIAT0511⑮:2) showing the sampling spot of SK0010 (source: author)

***Unetched**:* the sample is corroded on the surface with some metal remaining in the centre. There are large amounts of slag stringers (Fig. 5.35).

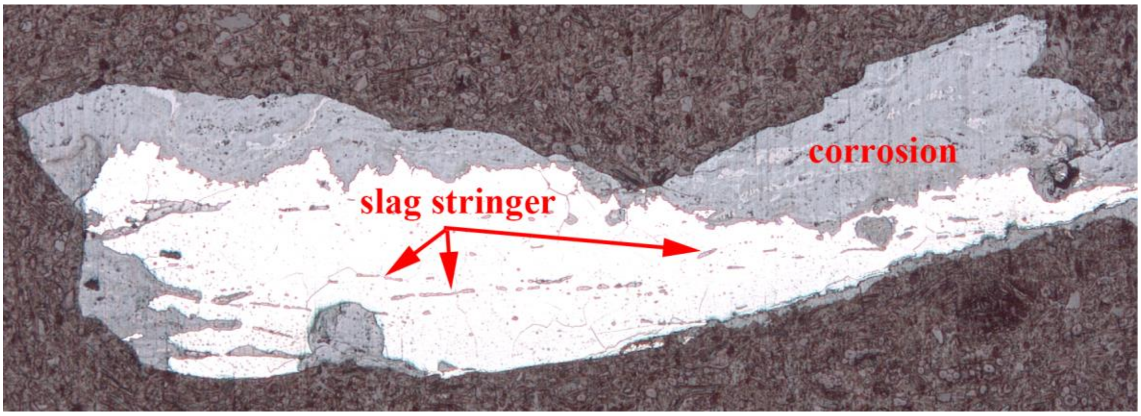


Fig. 5.35 Section from SK0010. Unetched, scale x37.5 (source: author)

***Etched**:* at low magnification, etching revealed a ferrite matrix with even grain size, and the grain boundaries are clearly seen. There is a slightly uneven response to etching was visible throughout the section indicating dissolved phosphorus (Fig. 5.36). At a higher magnification, it can be identified that the slag stringers are double-phased slag inclusions (Fig. 5.37).

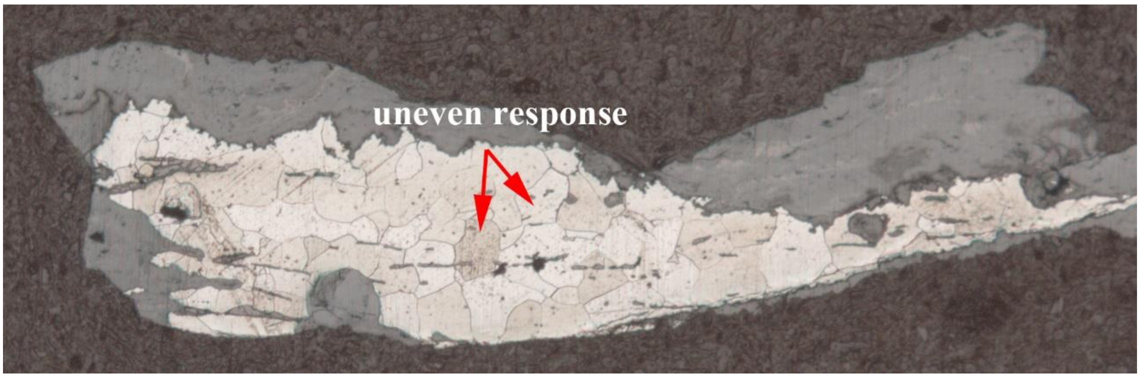


Fig. 5.36 Section from SK0010 showing a ferrite matrix and slag stringers. Etch 2% nital, scale x37.5 (source: author)

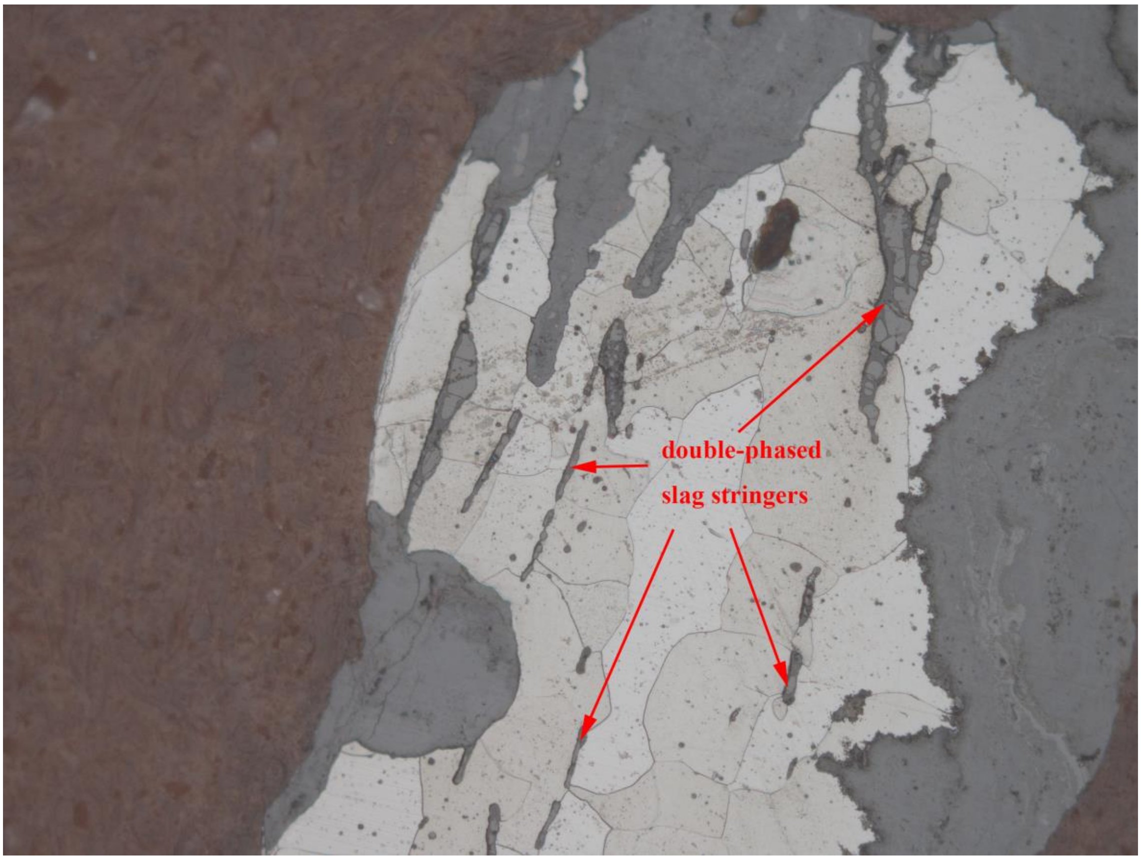


Fig. 5.37 Section from SK0010 showing the double-phased slag stringers. Etch 2% nital, scale x150 (source: author)

Initial interpretation*:* the iron knife was forged either from fined iron or bloomery iron.

SK0011

Sample*:* cut from the cutting edge of an iron axehead (Fig. 5.38). There are some possible hammer scale scars on the surface.

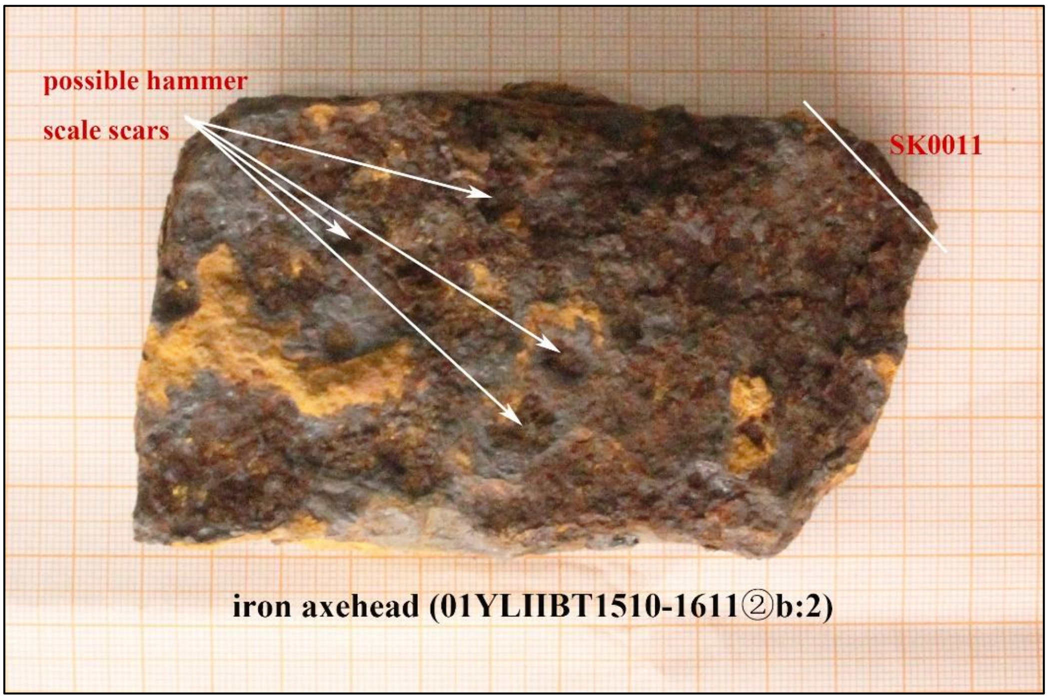


Fig. 5.38 Iron axehead (01YLIIBT1510-1611②b:2) showing the sampling spot of SK0011 (source: author)

Unetched: the sample is corroded on the surface with some metal remaining in the centre. There are large amounts of irregular and small rounded slag inclusions distributed in chains (Fig. 5.39).

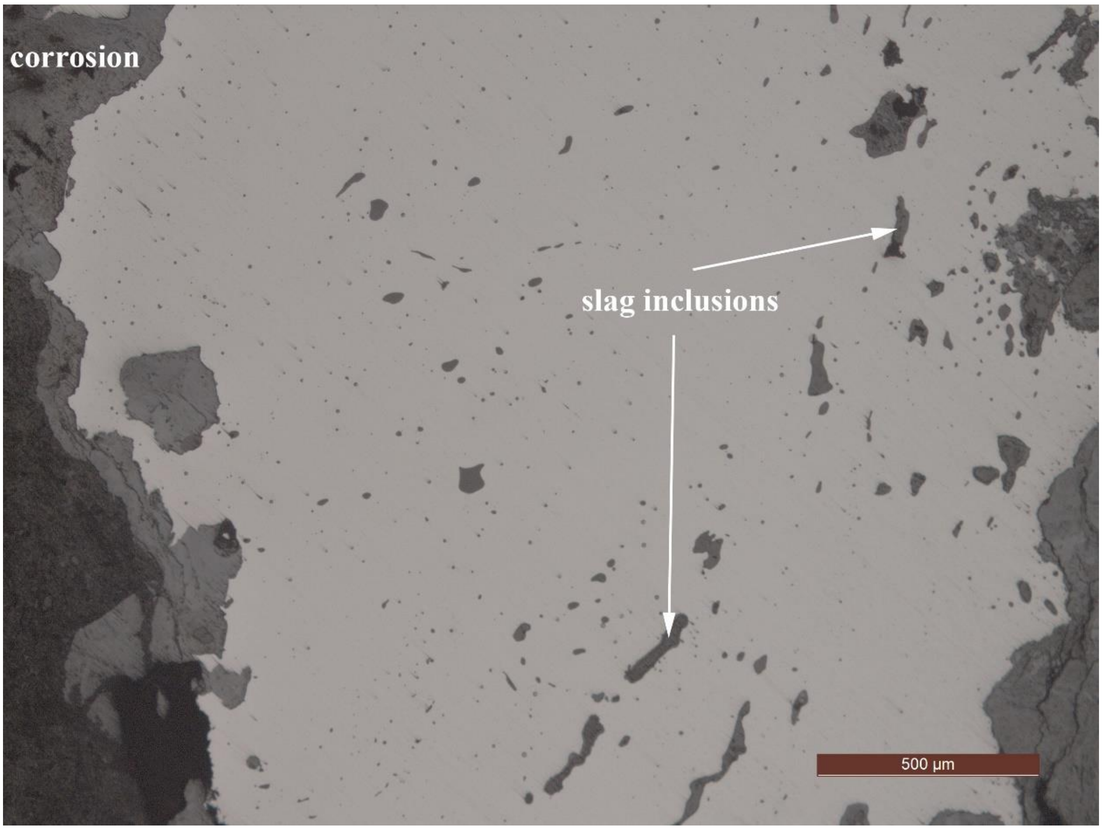


Fig. 5.39 Section from SK0011. Unetched, scale bar 500μm (source: author)

***Etched**:* at a low magnification, etching revealed a ferrite matrix with large grain size, and the grain boundaries are clear. There are both single and double-phased slag inclusions distributed in chains (Fig. 5.40).

***Initial interpretation**:* the object was forged either from fined iron or bloomery iron. It looks like an unfinished iron axehead or a primary billet by its figure and the hammering scale on its surface. The slag inclusions were probably stringers in the vertical section. The reason why that they are roughly distributed and looked unworked here is because the sample was cut in a 45 degree.

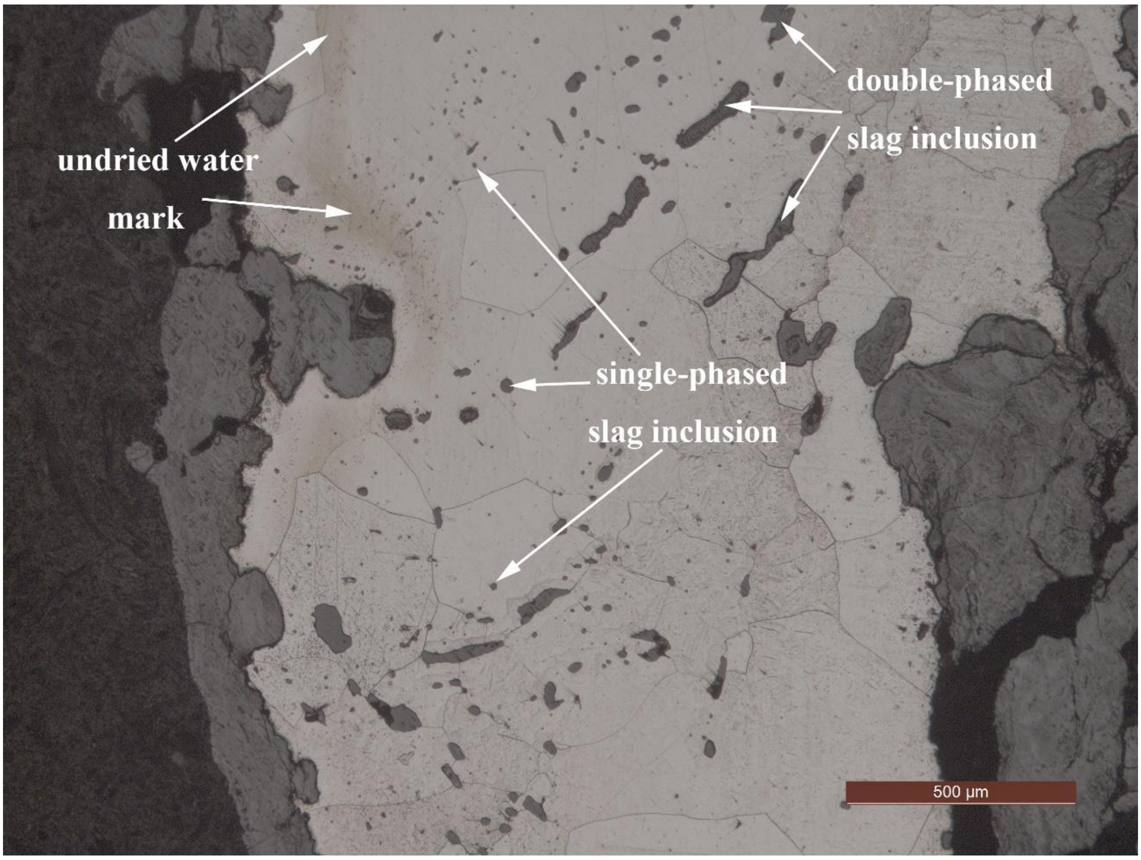


Fig. 5.40 Section from SK0011 showing the ferrite matrix and slag inclusions. Etch 2% nital, scale bar 500μm (source: author)

SK0012 and SK0013

***Sample**:* SK0012 is the cross section cut from the ring head of an iron ring-headed knife (Fig. 5.41).

Fig. 5.41 Ring-headed iron knife (02YLIAT0207⑧:6) showing the sampling spot of SK0012 and SK0013 (source: author)

Unetched: SK0012 is corroded on the surface with some metal remaining in the centre. There are large amounts of small slag inclusions distributed in chains and slightly curved (Fig. 5.42).

Fig. 5.42 Section from SK0012. Unetched, scale bar 500µm (source: author)

Etched: at low magnification, etching revealed a pearlite and ferrite matrix with small grain size. The slag inclusions are single-phased slag inclusions. The carbon content is c.0.3-0.5% (Fig. 5.43).

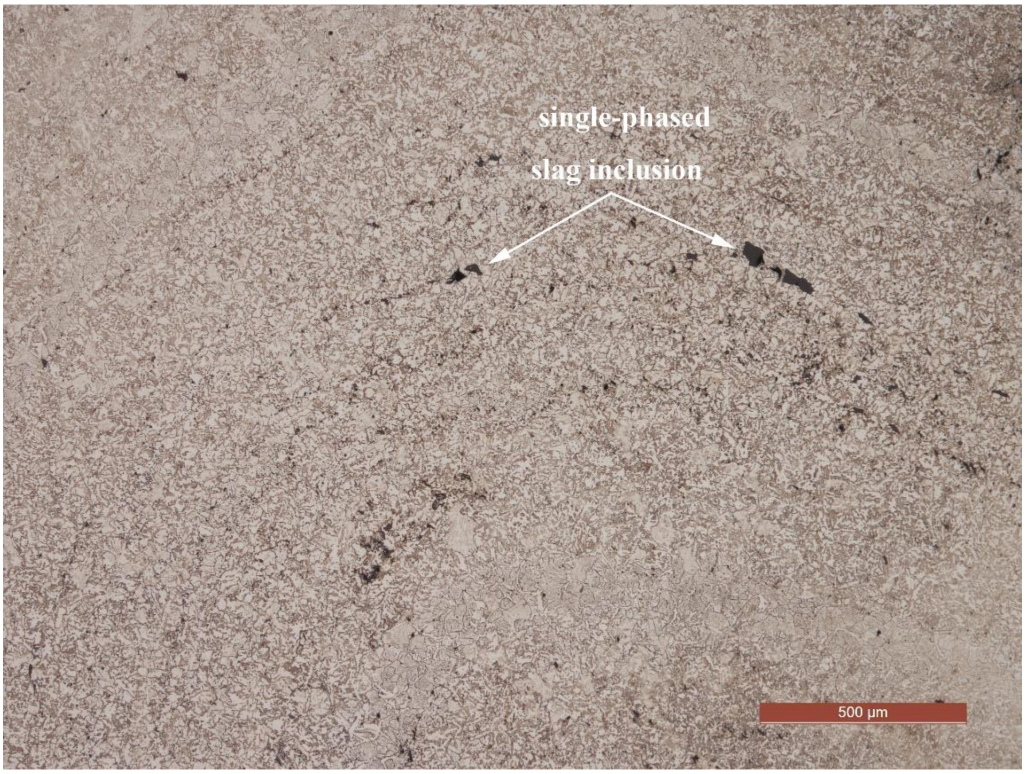


Fig. 5.43 Section from SK0012 showing the pearlite and ferrite matrix. Etch 2% nital, scale bar 500µm (source: author)

Sample: SK0013 is the cross section cut from the body of the same object (Fig. 5.41).

***Unetched**:* SK0013 is corroded on the surface with some metal remaining in the centre. There are some small slag inclusions (Fig. 5.44).

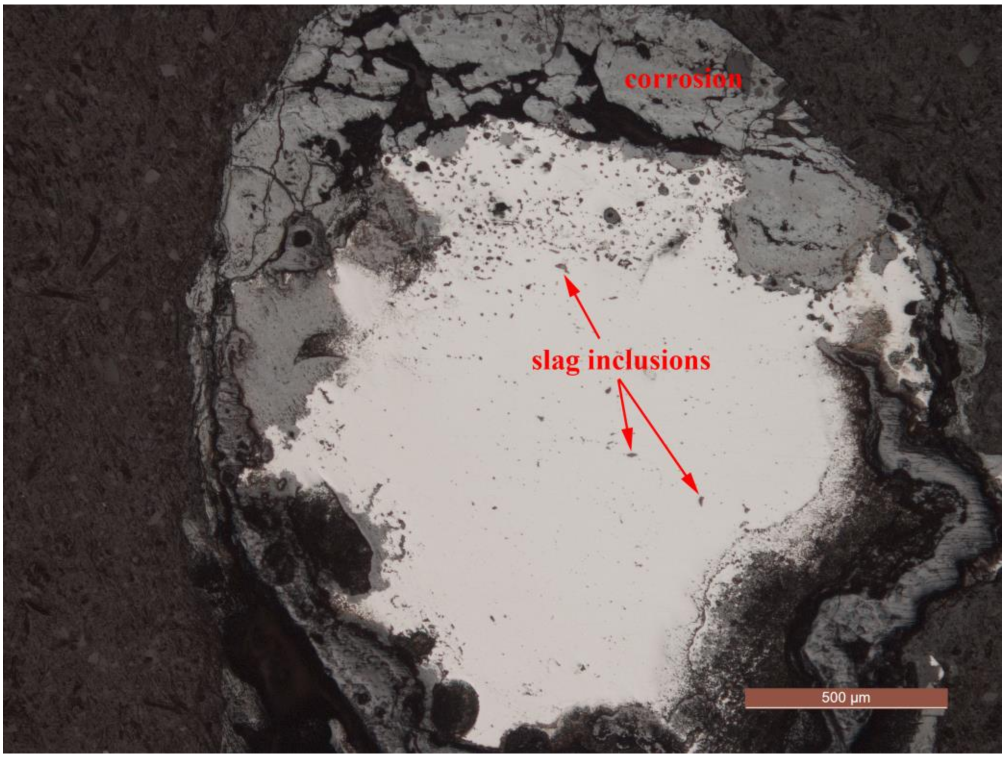


Fig. 5.44 Section from SK0013. Unetched, scale bar 500μm (source: author)

Etched*:* at low magnification, etching revealed a ferrite and pearlite matrix with unclear grain boundaries. The upper part of the sample is almost pure ferrite, which is the back side of the knife. The amount of pearlite is increasing downwards to the cutting edge of the knife. The highest carbon content is at the cutting edge which is c.0.5-0.6%. The slag inclusions are single-phased and very small, and it is probably because they are in cross section (Fig. 5.45).

Initial interpretation*:* in summary of these two samples, the ring-headed iron knife was made from fined iron or bloomery iron, and the cutting edge was carburized for a better hardness.

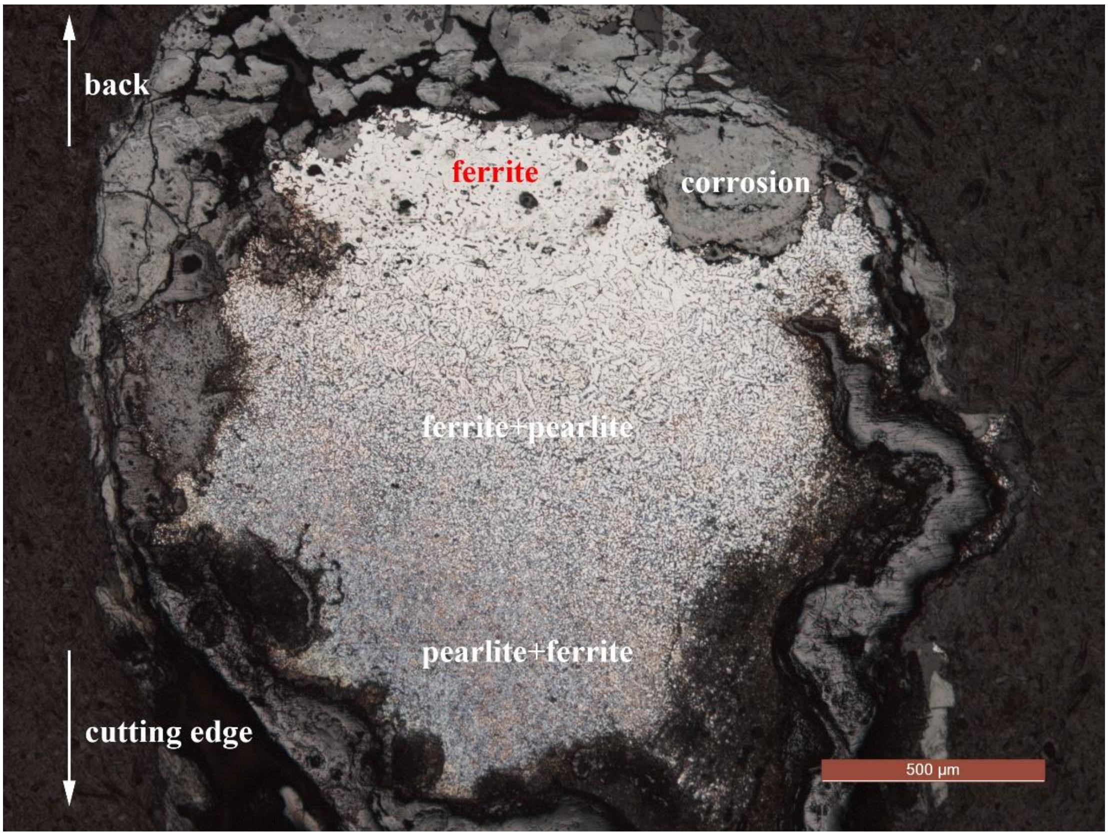


Fig. 5.45 Section from SK0013 showing the increasing pearlite toward to the cutting edge. Etch 2% nital, scale bar 500µm (source: author)

SK0014 and SK0015

***Sample**:* SK0014 is collected from a small part which fell off from an iron mattockhead (Fig. 5.46). SK0015 is cut from the cutting edge of the same object (Fig. 5.46).

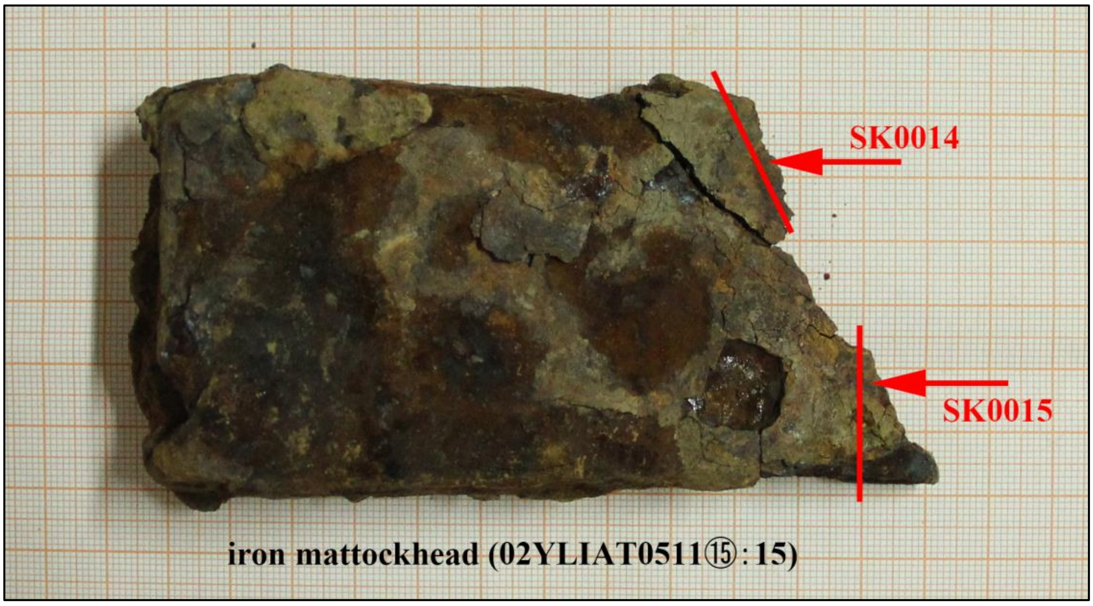


Fig. 5.46 Iron mattockhead (02YLIAT0511⑮:15) showing the sampling spot of SK0014 and SK0015 (source: author)

Unetched: SK0014 is fully corroded and no metallographic structures can be identified from the section (Fig. 5.47). SK0015 is badly corroded and only a little metal remaining in the centre. Both samples were cut and prepared in 2014 and re-polished in 2016. The re-polishing did not go too deep because it was concerned that there was not much metal left over, which there are some newer corrosion visible throughout the section.

Fig. 5.47 Section from SK0014. Etch 2% nital, scale x37.5 (source: author)

Etched: at low magnification of SK0015, etching revealed an unclear grain boundaries. There is some dendritic cementite form of ledeburite structure in the middle of the top area in Fig. 5.48, which is the core of the mattockhead's cutting edge. The cementite was started forming into lamellar pearlite toward the object surface. There are no slag inclusions.

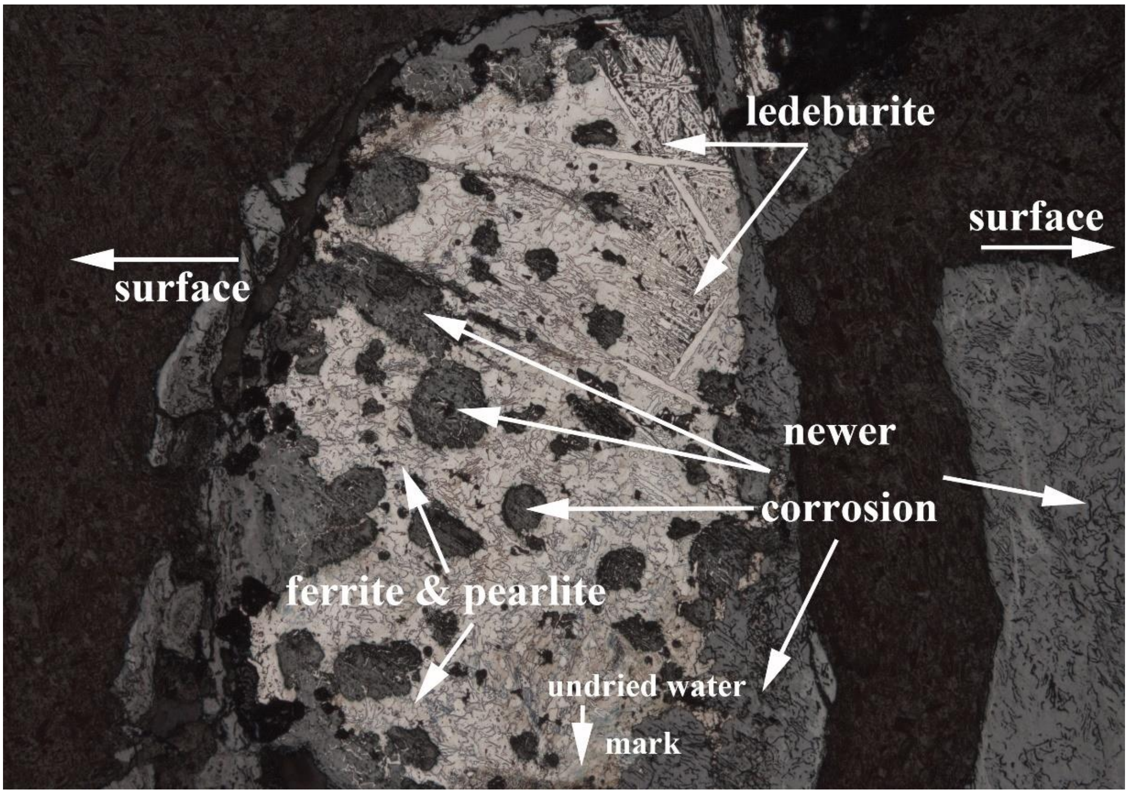


Fig. 5.48 Section from SK0015. Etch 2% nital, scale x37.5 (source: author)

Initial interpretation*:* the iron mattockhead was probably cast in white cast iron first and annealed for decarburization.

SK0017 and SK0018

Sample: SK0017 is cut from the tang end of an iron arrowhead (Fig. 5.49). Sample SK0018 is a further cut from the same object (Fig. 5.49).

Fig. 5.49 Iron arrowhead (02YLIAT0511⑮:10) showing the sampling spot of SK0017 and SK0018 (source: author)

Unetched*:* SK0017 is fully corroded and no metallographic structures can be identified from the section (Fig. 5.50). SK0018 is corroded on the surface with some metal remaining in the centre. There are large amounts of small black dots throughout the section (Fig. 5.51).

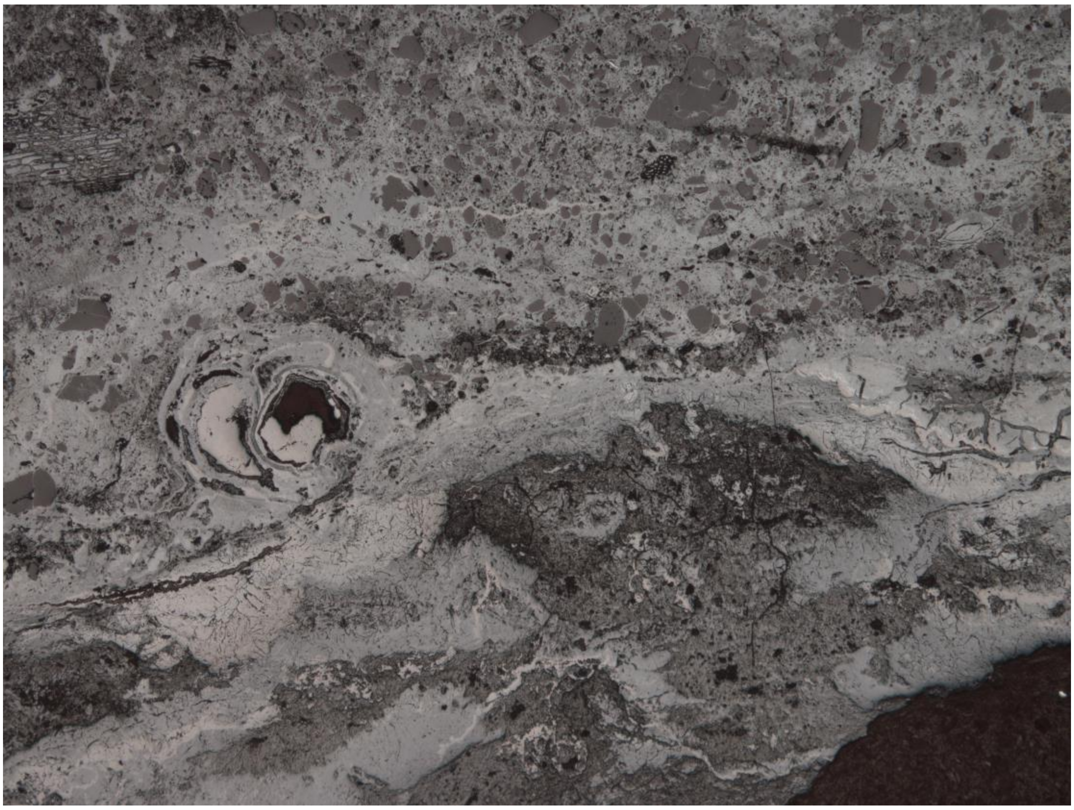


Fig. 5.50 Section from SK0017. Unetched, scale x37.5 (source: author)

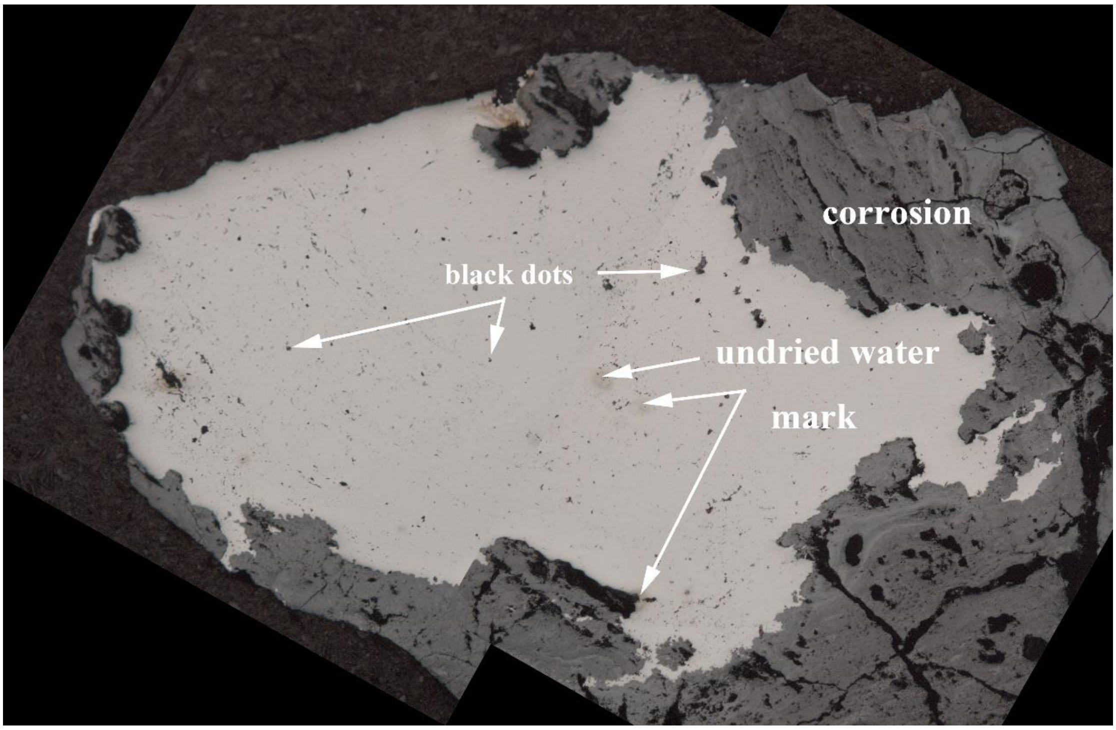


Fig. 5.51 Montage of the section from SK0018. Unetched, scale x37.5 (source: author)

Etched: at low magnification of SK0018, etching revealed a pearlite matrix with some ferrite network. Some of the larger black dots seen in the unetched section remained after etching (Fig. 5.52). At a higher magnification, the black dots are transparent, which indicates they are possibly corrosion or dirt. There are no obvious slag inclusions (Fig. 5.53).

Initial interpretation*:* the object was possibly an iron arrowhead or an iron nail. There is no evidence of forging, the object was probably decarburized from white cast iron, with a carbon content of c.0.5-0.6%.

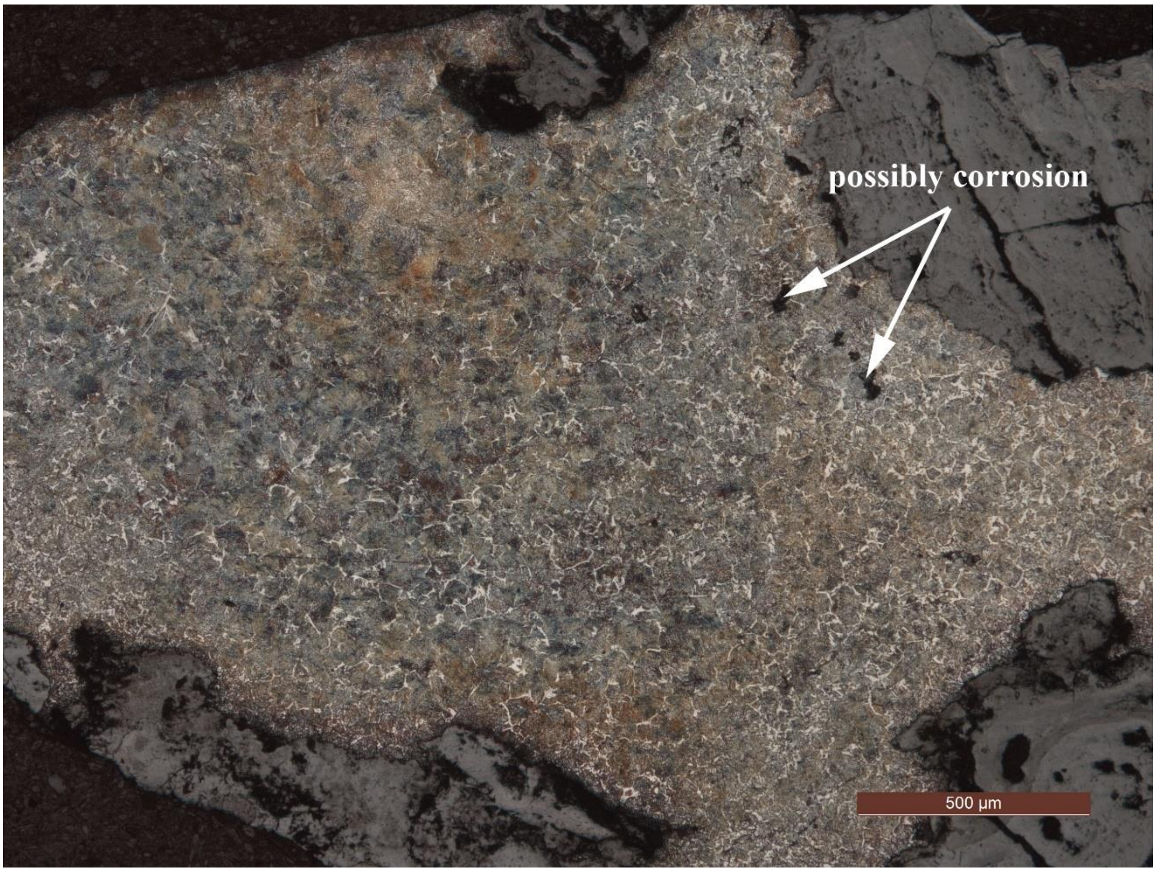


Fig. 5.52 Section from SK0018. Etch 2% nital, scale bar 500μm (source: author)

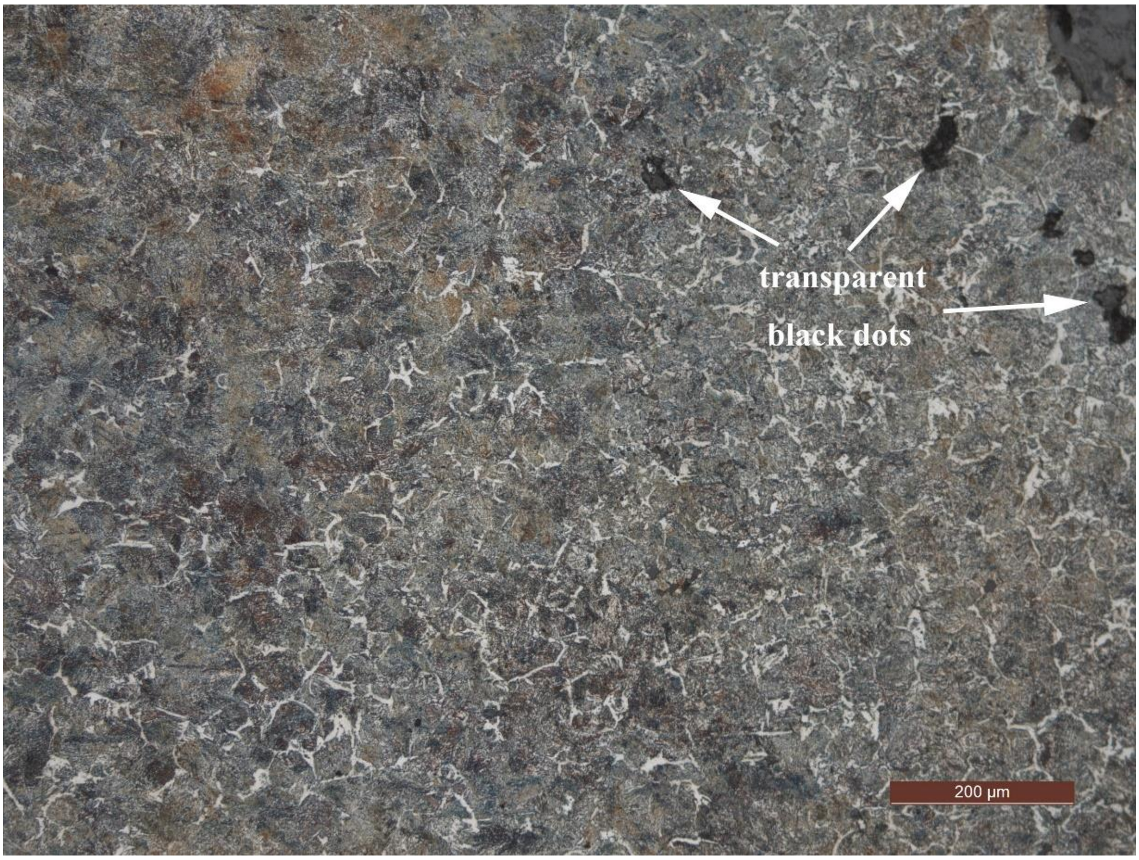


Fig. 5.53 Section from SK0018 showing the transparent black dots. Etch 2% nital, scale bar 200µm (source: author)

SK0019 and SK0020

***Sample**:* SK0019 is cut from the cutting edge of an iron knife (Fig. 5.54). SK0020 is cut from the ridge of the same iron knife (Fig. 5.54).

Fig. 5.54 Iron knife (02YLIDT0712-0813③:1) showing the sampling spot of SK0019 and SK0020 (source: author)

***Unetched**:* SK0019 is fully corroded and no metallographic structures can be identified from the section (Fig. 5.55). SK0020 is corroded on the surfaces of the sides and ridge. There is some metal remaining in the core. There are small amounts of graphite-like nodules, some linear corrosion, and some scratches from improper sample preparation (Fig. 5.56).

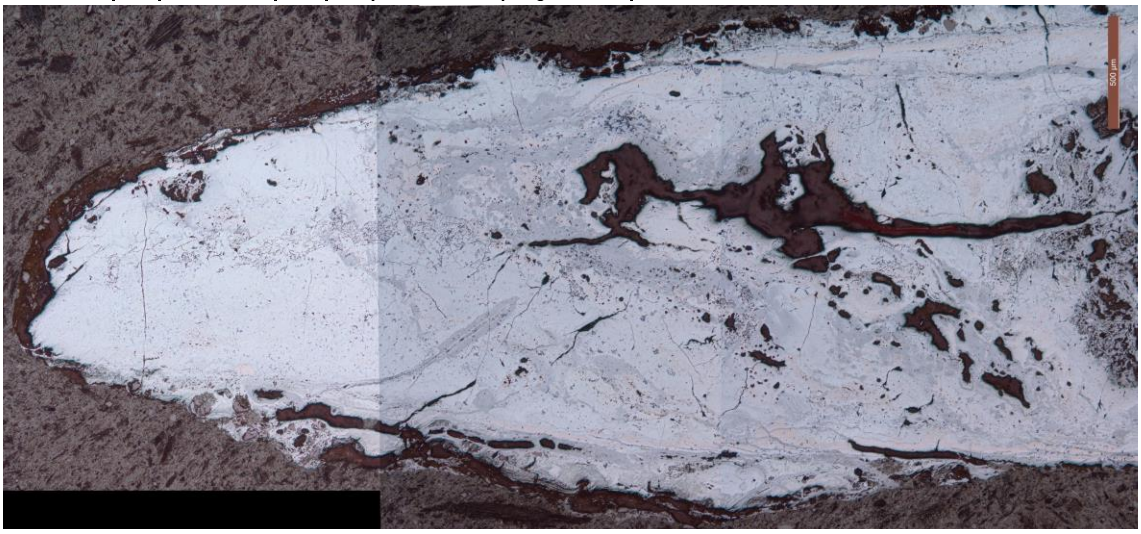


Fig. 5.55 Montage of section from SK0019. Etch 2% nital, scale bar 500µm (source: author)

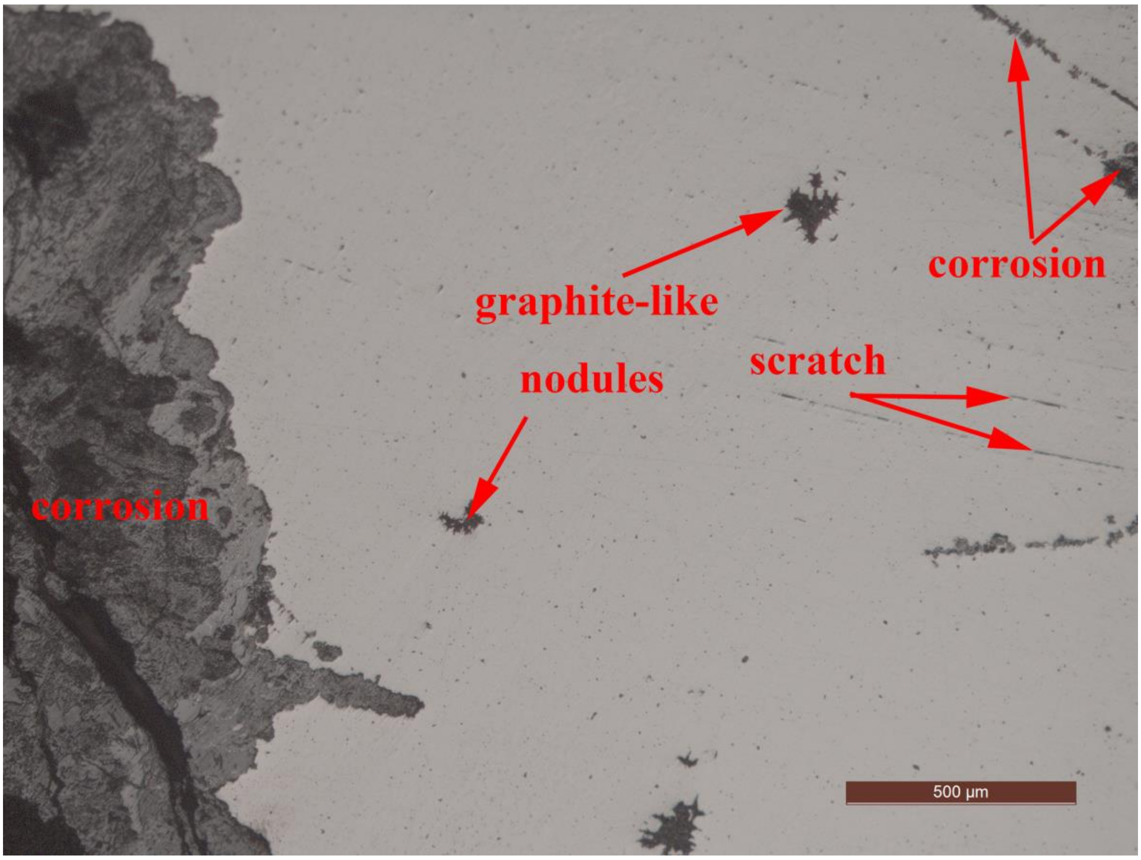


Fig. 5.56 Section from SK0020. Unetched, scale bar 500µm (source: author)

***Etched**:* at low magnification of SK0020, etching revealed a pearlite and ferrite matrix with unclear grain boundaries. There is some dendritic cementite in the core of the sample. The amount of pearlite decreases toward the ridge side, and there is a layer with large amounts of ferrite and very little pearlite near the surface of the knife ridge. Some graphite nodules are near the core of the sample. There are no obvious slag inclusions (Fig. 5.57). At a higher magnification, the shape of the pearlite is lamellar (Fig. 5.58).

***Initial interpretation**:* the object was probably cast in white cast iron first, and then annealed for decarburization and graphitization. The remaining cementite and graphite indicate the material is mottled cast iron.

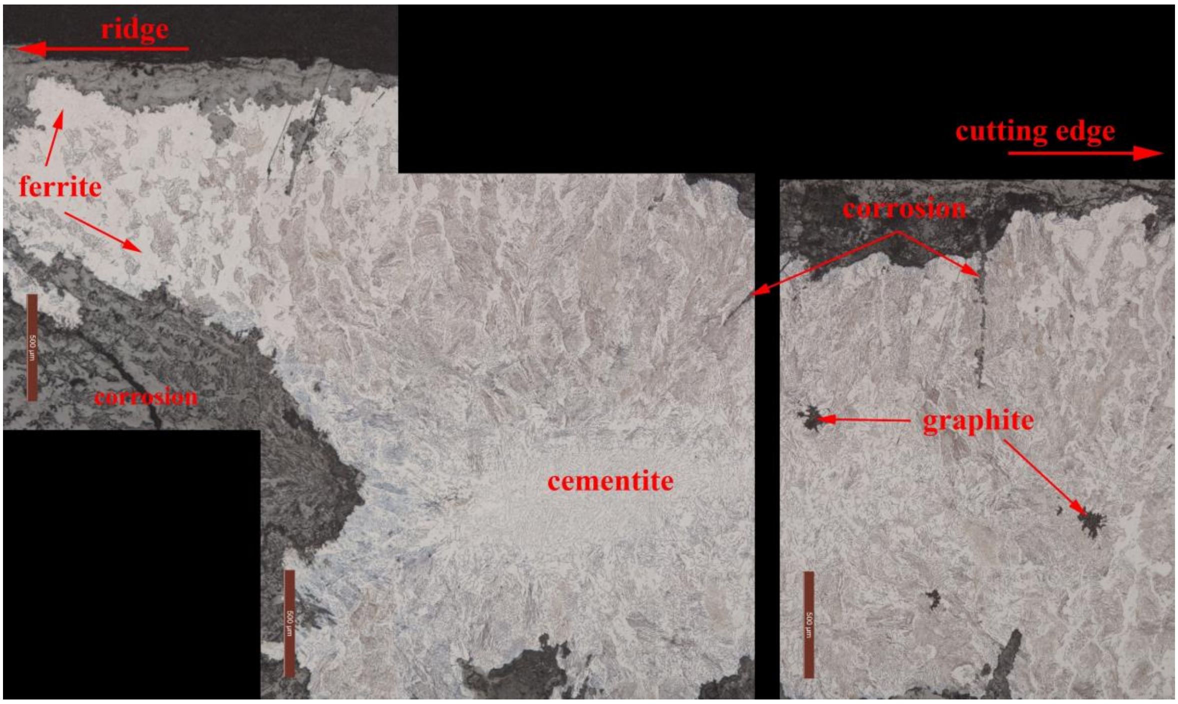


Fig. 5.57 Montage of section from SK0020. Etch 2% nital, scale bar 500μm (source: author)

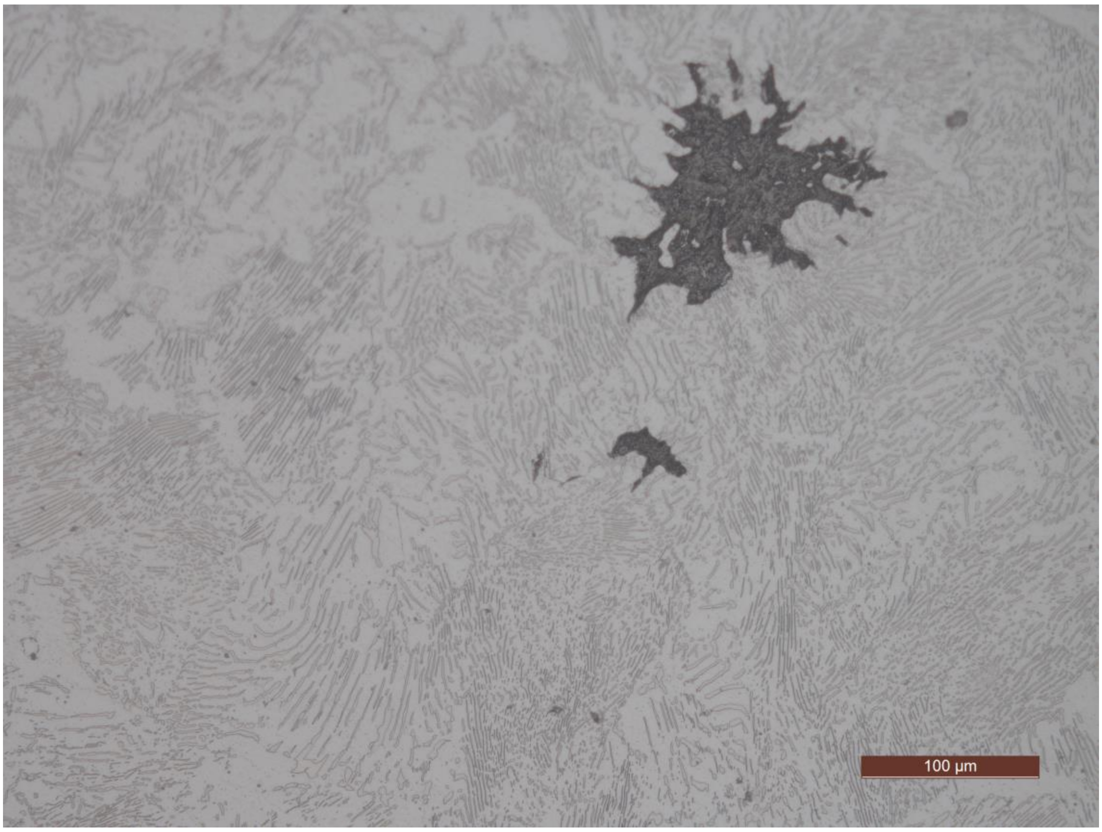


Fig. 5.58 Section from SK0020 showing the lamellar pearlite and the graphite. Etch 2% nital, scale bar 100µm (source: author)

SK0021 and SK0036

***Sample**:* SK0021 is cut from the cutting edge of an iron axehead (Fig. 5.59).

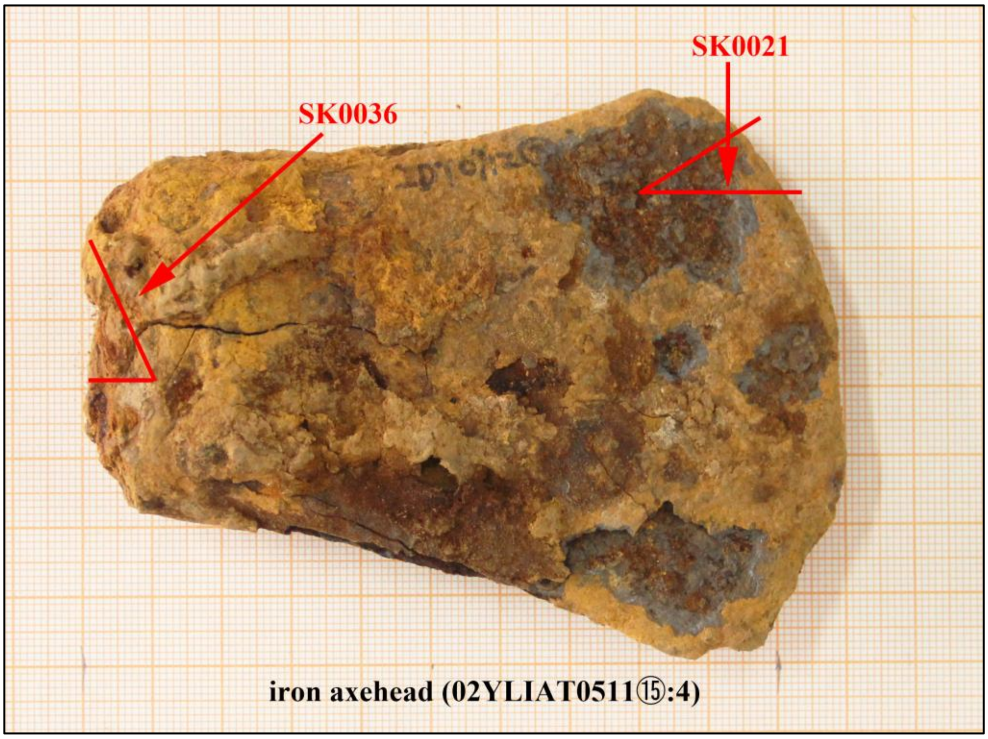


Fig. 5.59 Iron axehead (02YLIAT0511⑮:4) showing the sampling spot of SK0021 and SK0036 (source: author)

***Unetched**:* SK0021 is slightly corroded on the surface with some metal remaining in the centre. There are large amounts of star-like graphite nodules (Fig. 5.60).

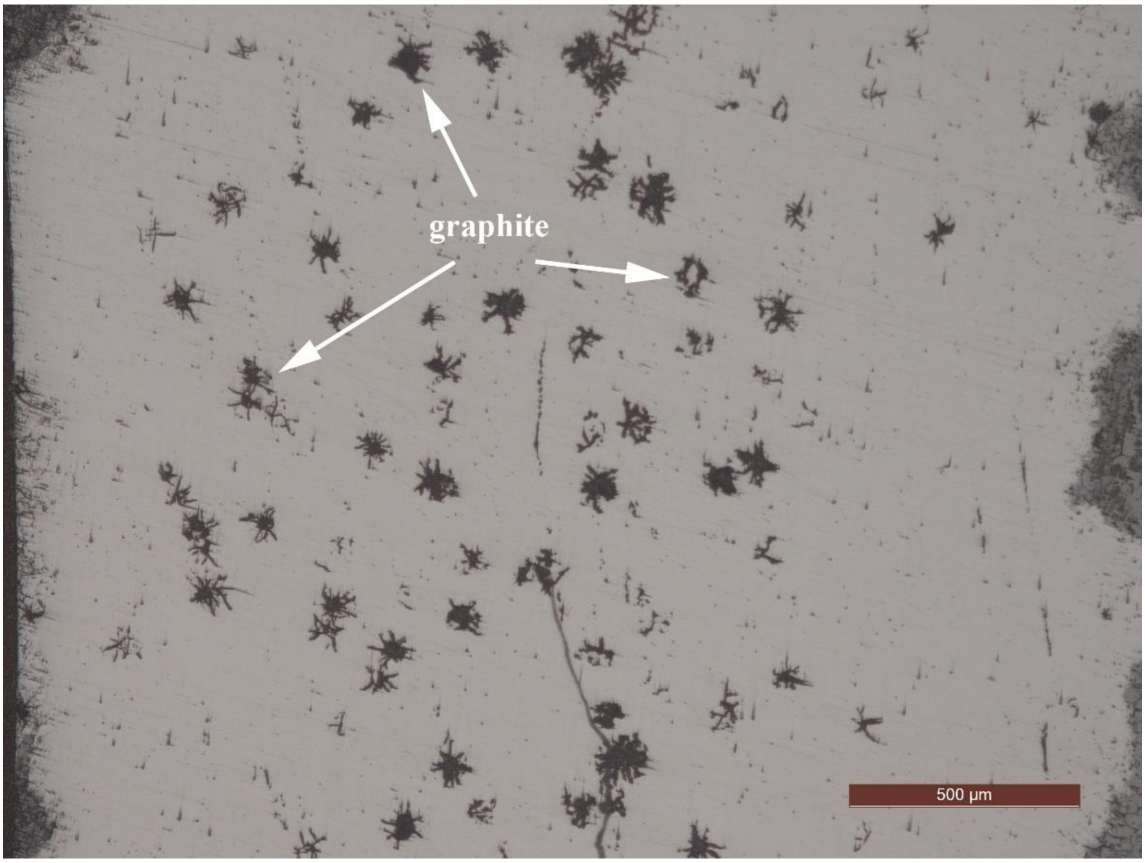


Fig. 5.60 Section from SK0021. Unetched, scale bar 500μm (source: author)

***Etched**:* at low magnification of SK0021, etching revealed a pearlite and ferrite matrix with small grain size. The grain boundaries are clear at both sides and unclear in the core. There are more ferrite grains at both sides, and more pearlite in the core. There are some possible slag inclusions in the etched section (Fig. 5.61). There is another sample of the cutting edge of the same object prepared in 2014. The details of the sample preparation were not well recorded, but it shows there is a fully decarburized layer of ferrite, in which the grain size is bigger and slightly elongated (Fig. 5.62).

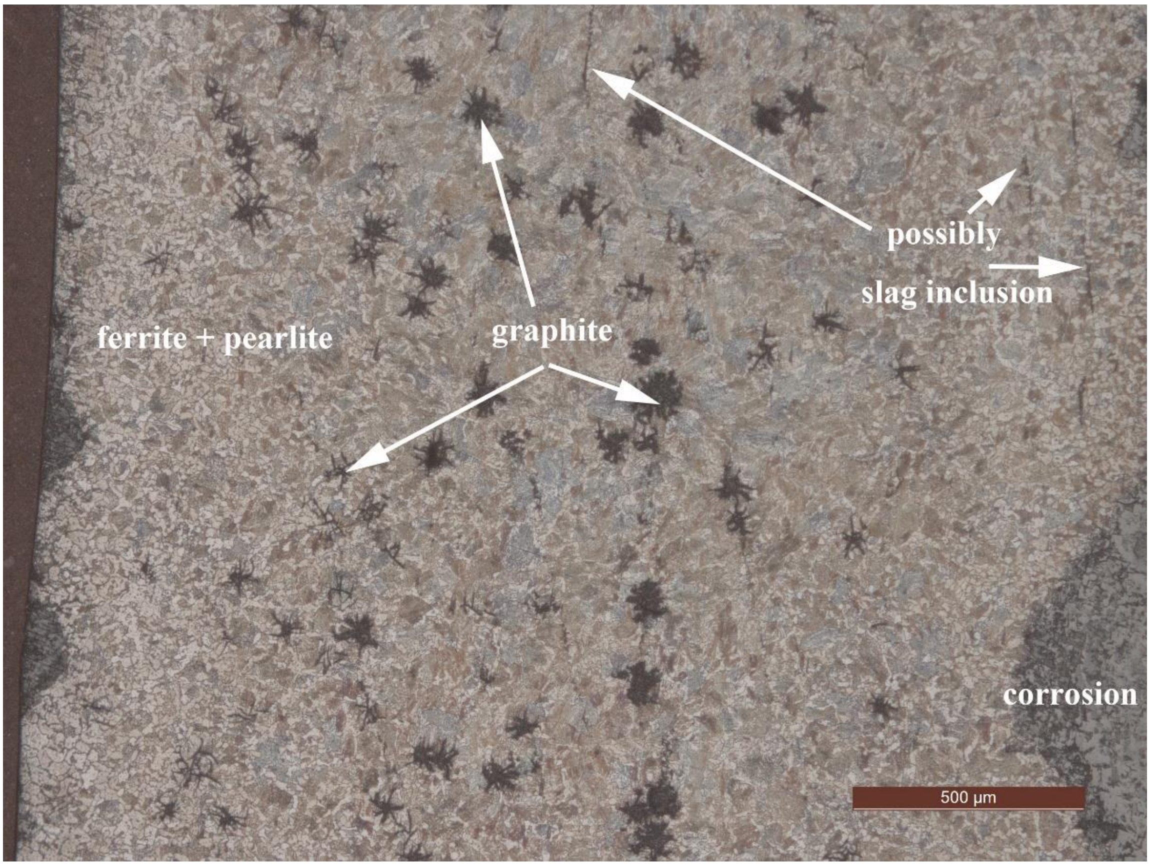


Fig. 5.61 Section from SK0021. Etch 2% nital, scale bar 500μm (source: author)

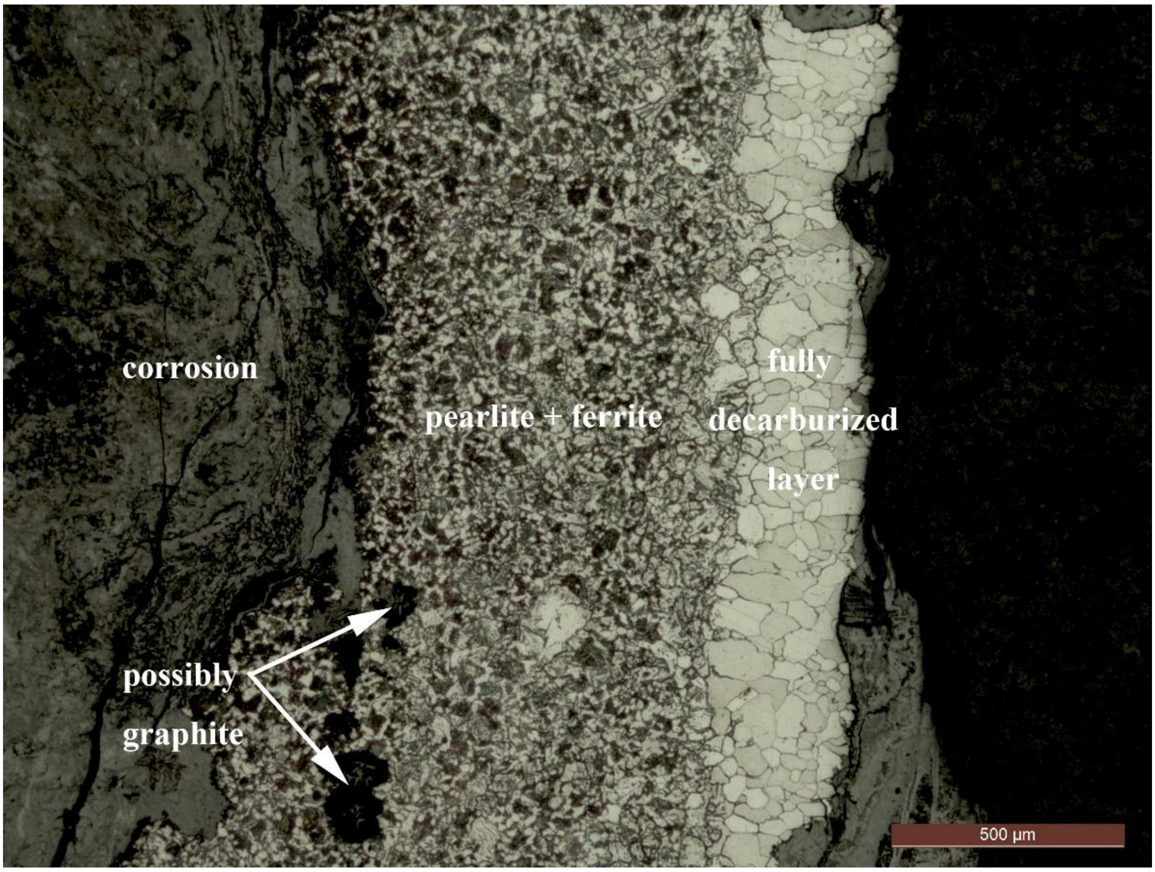


Fig. 5.62 Section from the cutting edge of the same object prepared in 2014. Etch 2% nital, scale bar 500μm (source: author)

***Sample**:* SK0036 is cut from the socket of the same iron axehead (Fig. 5.59).

***Unetched**:* SK0036 is corroded on the surface with some metal remaining in the centre. There are small amounts of star-like graphite (Fig. 5.63).

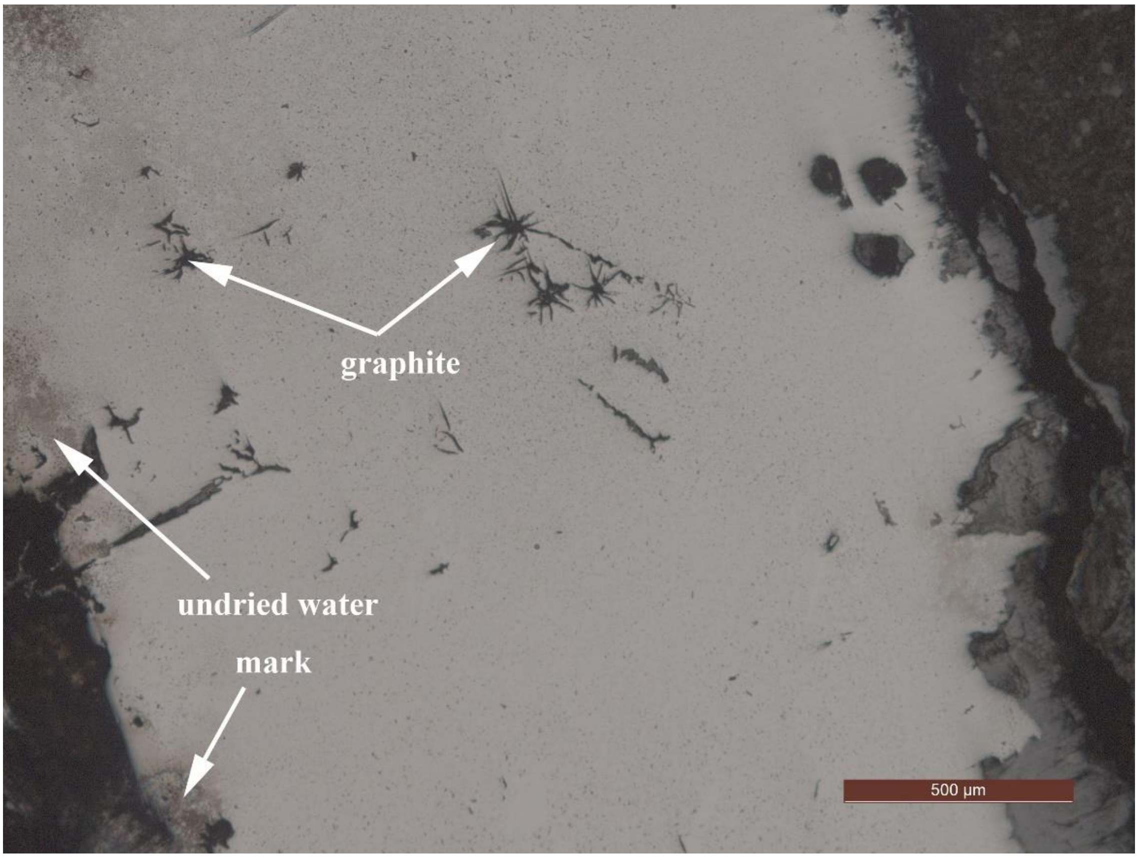


Fig. 5.63 Section from SK0036. Unetched, scale bar 500μm (source: author)

***Etched**:* at low magnification of SK0036, etching revealed a pearlite and ferrite matrix with a fully decarburized layer of ferrite grains at the surface. The grain sizes are small and even. The pearlite is unevenly distributed in the core, with a carbon content of c.0.1-0.4%. There is no obvious evidence of slag inclusions (Fig. 5.64).

***Initial interpretation**:* in summary of these two samples, the iron axehead was probably cast in white cast iron first, and then annealed for decarburization and graphitization. The graphitization was completed which there are large amounts of graphite and no remaining cementite. The decarburization formed a fully decarburized layer at the surface. The material is pearlite and ferrite matrix malleable cast iron.

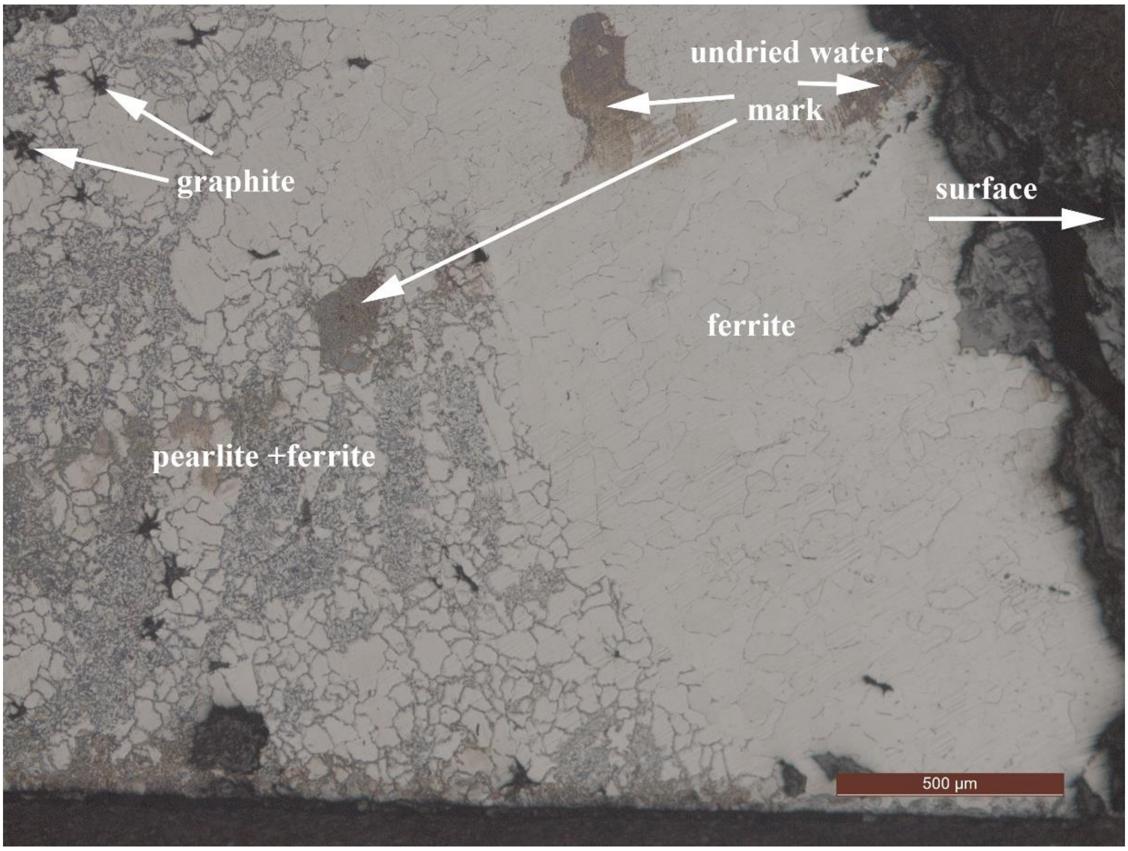


Fig. 5.64 Section from SK0036. Etch 2% nital, scale bar 500µm (source: author)

SK0022

Sample*:* cut from the cutting edge of an iron knife (Fig. 5.65).

Fig. 5.65 Iron knife (02IF16:2) showing the sampling spot of SK0022 (source: author)

Unetched*:* the sample is corroded on the surface with some metal remaining in the centre. There are large amounts of very small black dots which disappeared in re-polishing (Fig. 5.66).

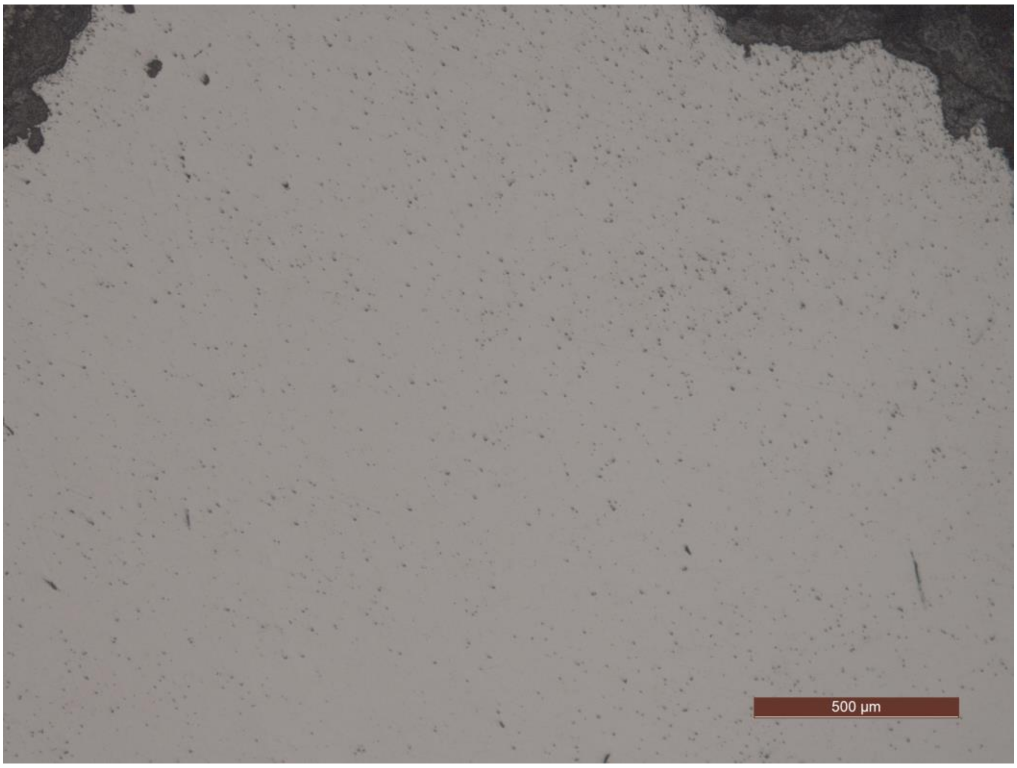


Fig. 5.66 Section from SK0022. Unetched, scale bar 500μm (source: author)

Etched: at low magnification, etching revealed a ferrite and pearlite matrix with very small grain size. The ferrite and pearlite are evenly distributed, and the carbon content is c.0.2-0.3%. There is no obvious evidence of slag inclusions (Fig. 5.67).

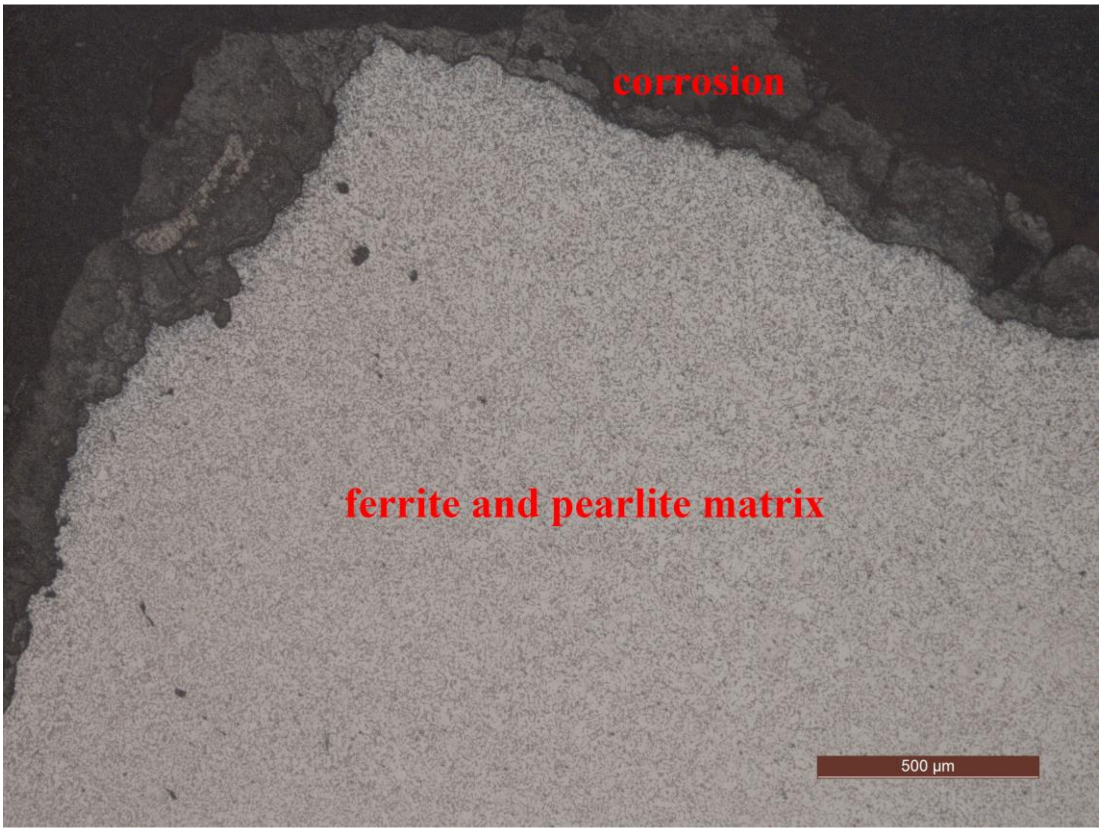


Fig. 5.67 Section from SK0022. Etch 2% nital, scale bar 500µm (source: author)

Initial interpretation: the object was cast in white cast iron and decarburized to c.0.2-0.3% carbon content hypo-eutectoid steel.

SK0024 and SK0025

Sample: SK0024 is the cross section (horizontal) of an iron knife (Fig. 5.68).

Fig. 5.68 Iron knife? (02YLIAT0507-0608⑪:1) showing the sampling spot of SK0024 and SK0025 (source: author)

Unetched: SK0024 is corroded on the surface with some metal remaining in the centre. There are large amounts of slag strings (Fig. 5.69).

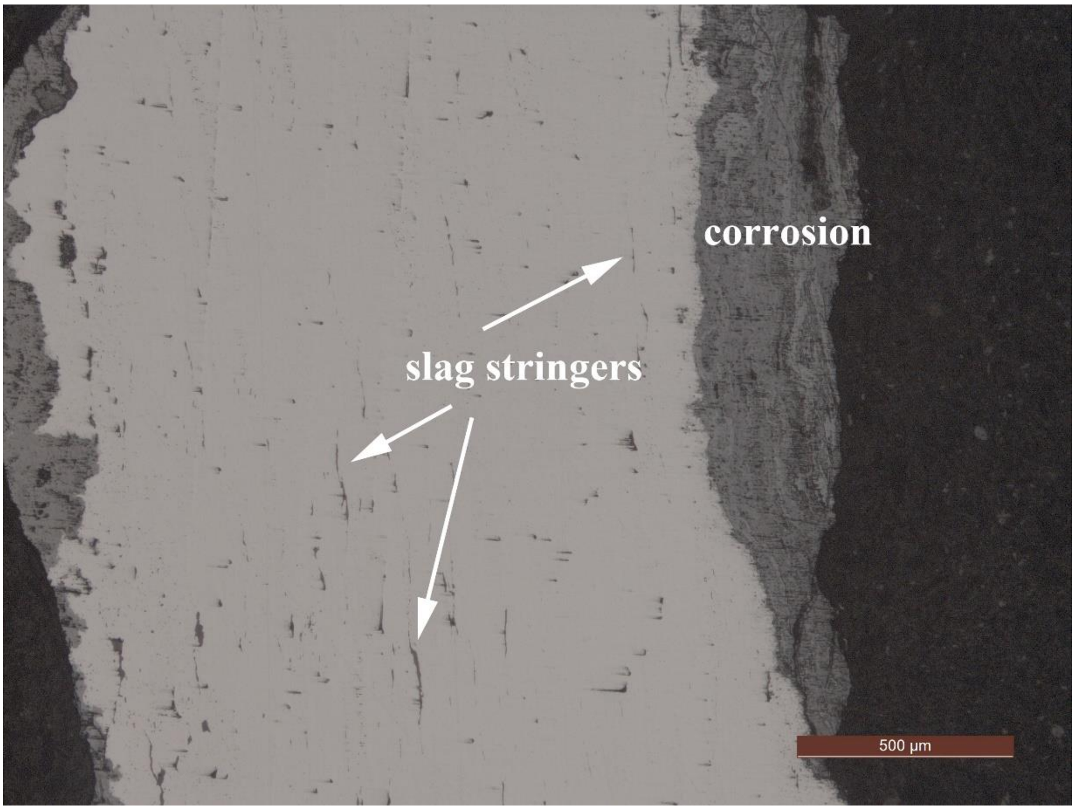


Fig. 5.69 Section from SK0024. Unetched, scale bar 500µm (source: author)

Etched: at low magnification of SK0024, etching revealed a pearlite and ferrite matrix with an unclear grain size and boundaries. The pearlite is unevenly distributed, and there is more pearlite at the sides and less in the core. There are needle-like ferrite structures extend inwards from the grain boundaries in the core area, indicating a Widmanstätten structure (Fig. 5.70). At a higher magnification, the slag stringers are single-phased slag inclusions, and the shape of the pearlite is unclear (Fig. 5.71).

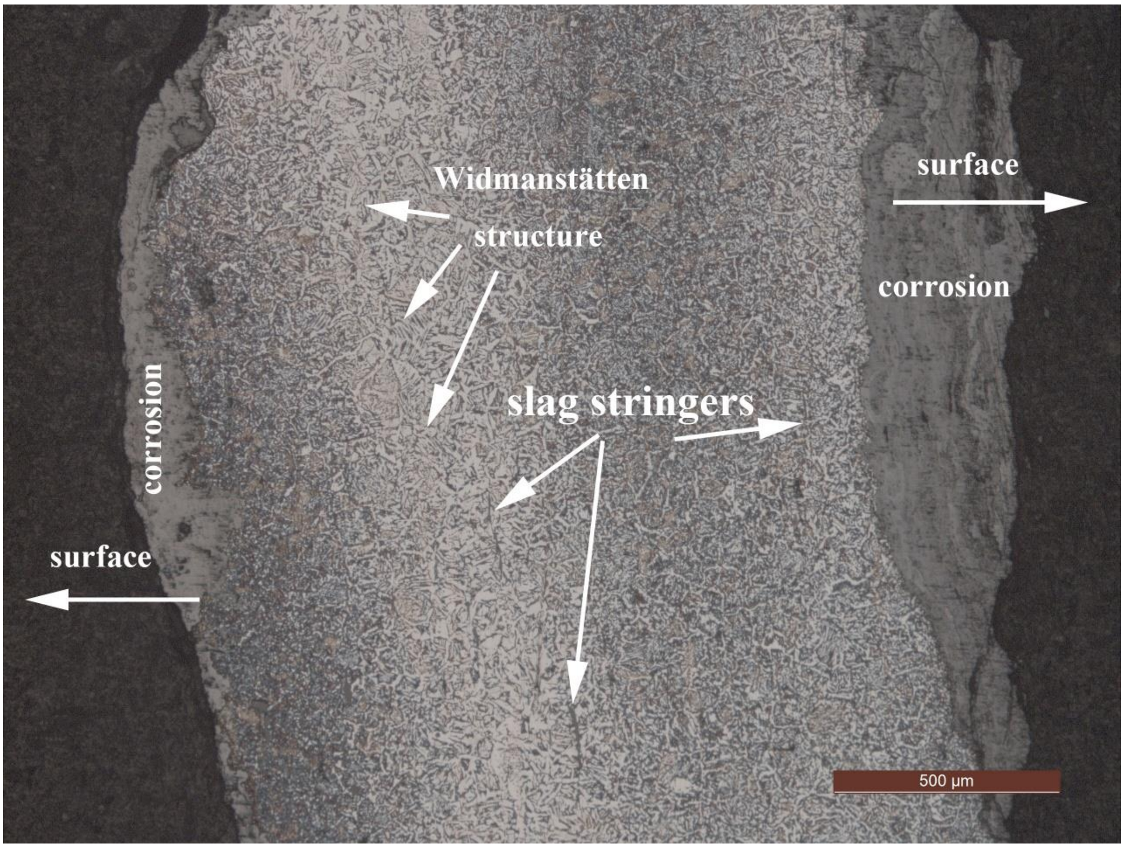


Fig. 5.70 Section from SK0024. Etch 2% nital, scale bar 500μm (source: author)

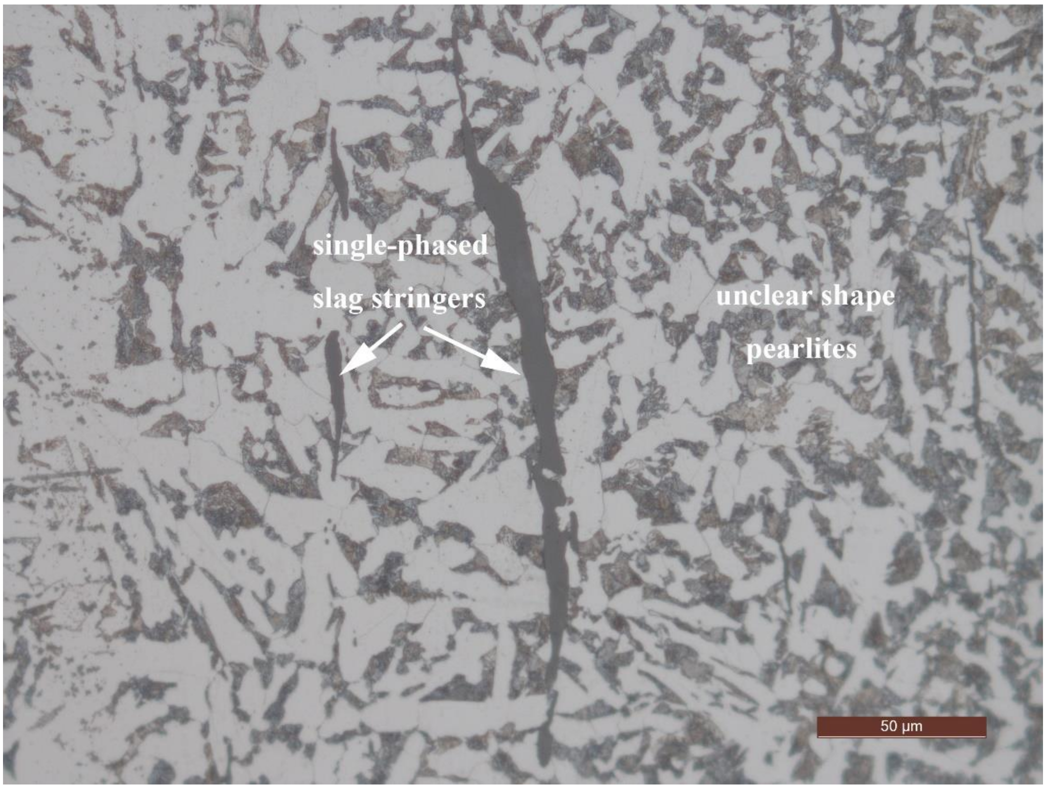


Fig. 5.71 Section from SK0024. Etch 2% nital, scale bar 50μm (source: author)

Sample: SK0025 is the cross section (vertical) of the same object (Fig. 5.68).

Unetched: SK0025 is corroded on the surface with some metal remaining in the centre. In the unetched section, there are large amounts of slag stringers (Fig. 5.72).

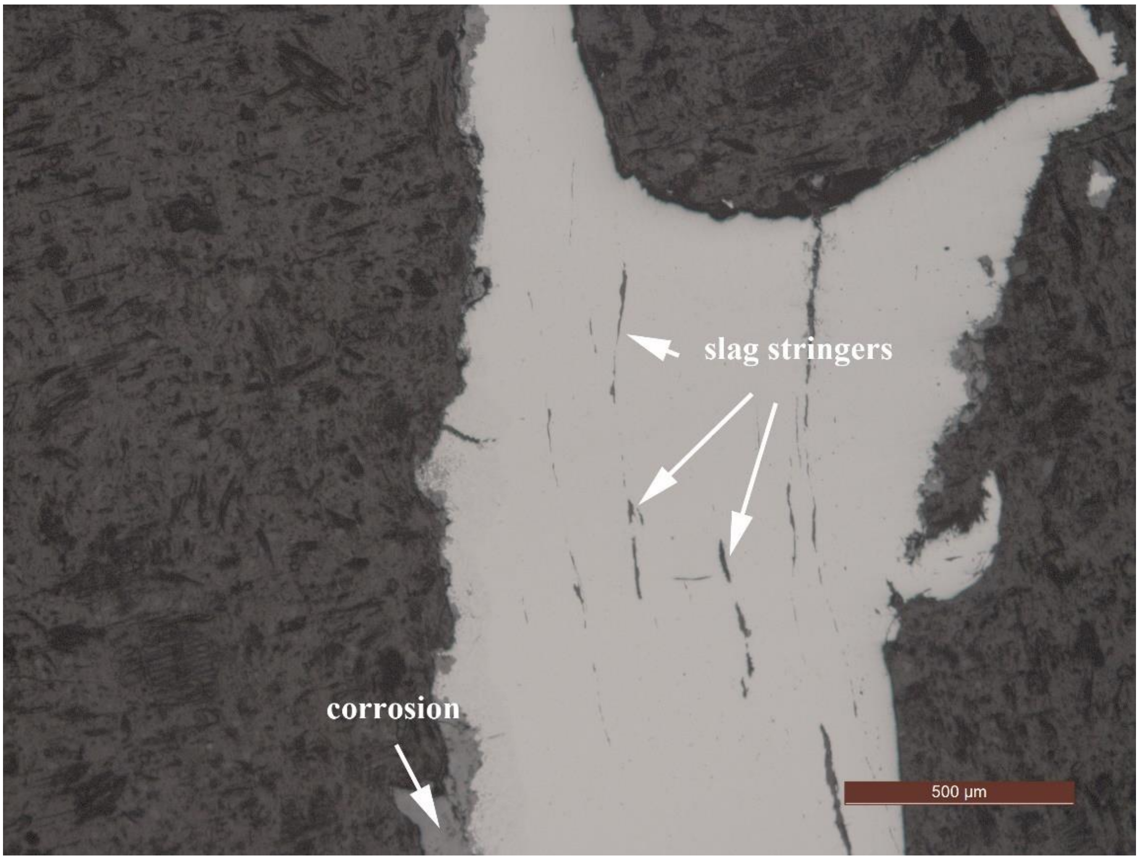


Fig. 5.72 Section from SK0025. Unetched, scale bar 500μm (source: author)

Etched: the metallographic structure of sample SK0025 is similar to SK0024. At low magnification, etching revealed a pearlite and ferrite matrix with small grain size. The pearlite close to the surface is much more than in the core. There are also needle-like ferrite structures extend inwards from the grain boundaries in the core area, indicating a Widmanstätten structure (Fig. 5.73).

Initial interpretation: in summary of these two samples, there is a lower carbon content in the core of the object and higher at the surface. The iron knife was probably forged from fined iron or bloomery iron, with a carbon content in the core of c.0.1-0.3% and c.0.3-0.6% at the surface.

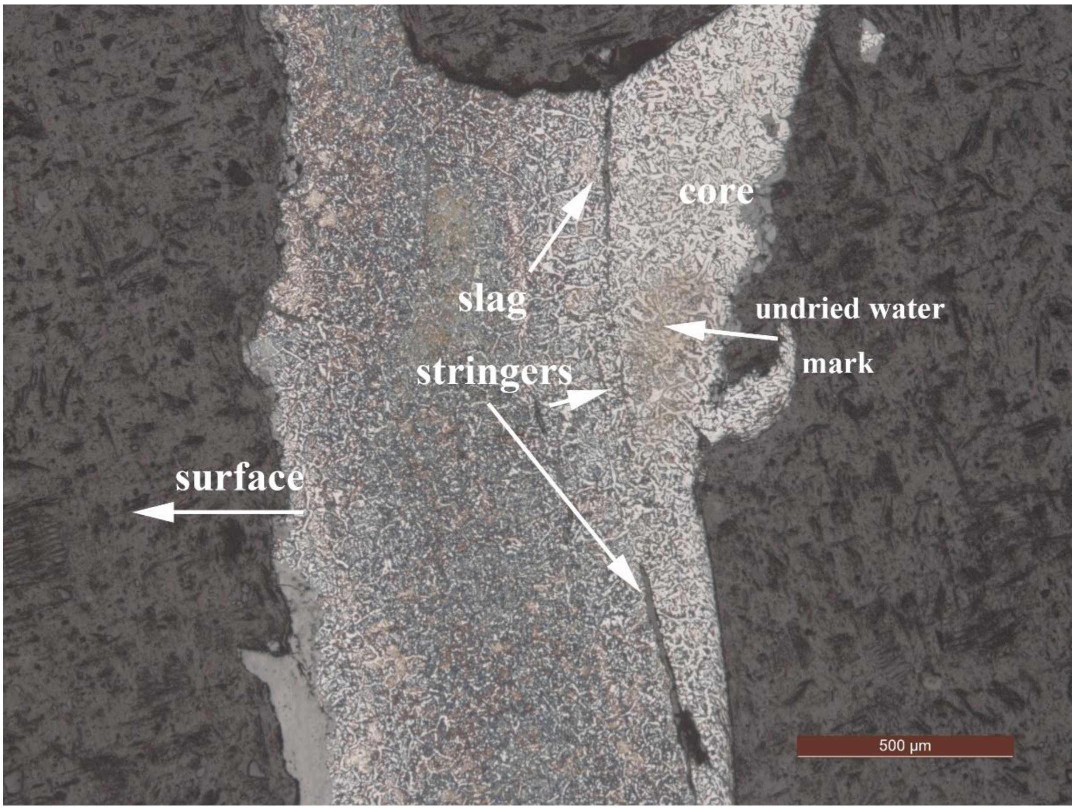


Fig. 5.73 Section from SK0025. Etch 2% nital, scale bar 500μm (source: author)

SK0028

Sample: cut from the socket part of an iron mattockhead (Fig. 5.74).

Unetched: the sample is corroded on the surface with some metal remaining in the centre. In the unetched section, there are some circular black dots which might be graphite, and large amounts of very small impurities throughout the section (Fig. 5.75).

Fig. 5.74 Iron mattockhead (02YLIDT0315-0416③:1) showing the sampling spot of SK0028 (source: author)

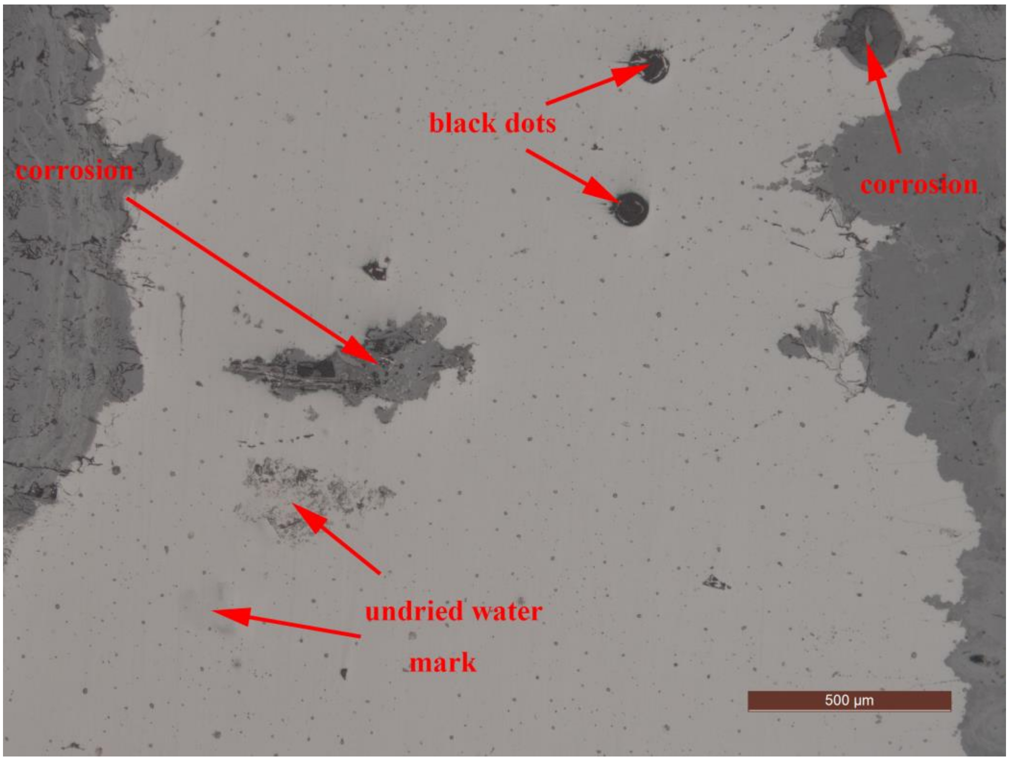


Fig. 5.75 Section from SK0028. Unetched, scale bar 500µm (source: author)

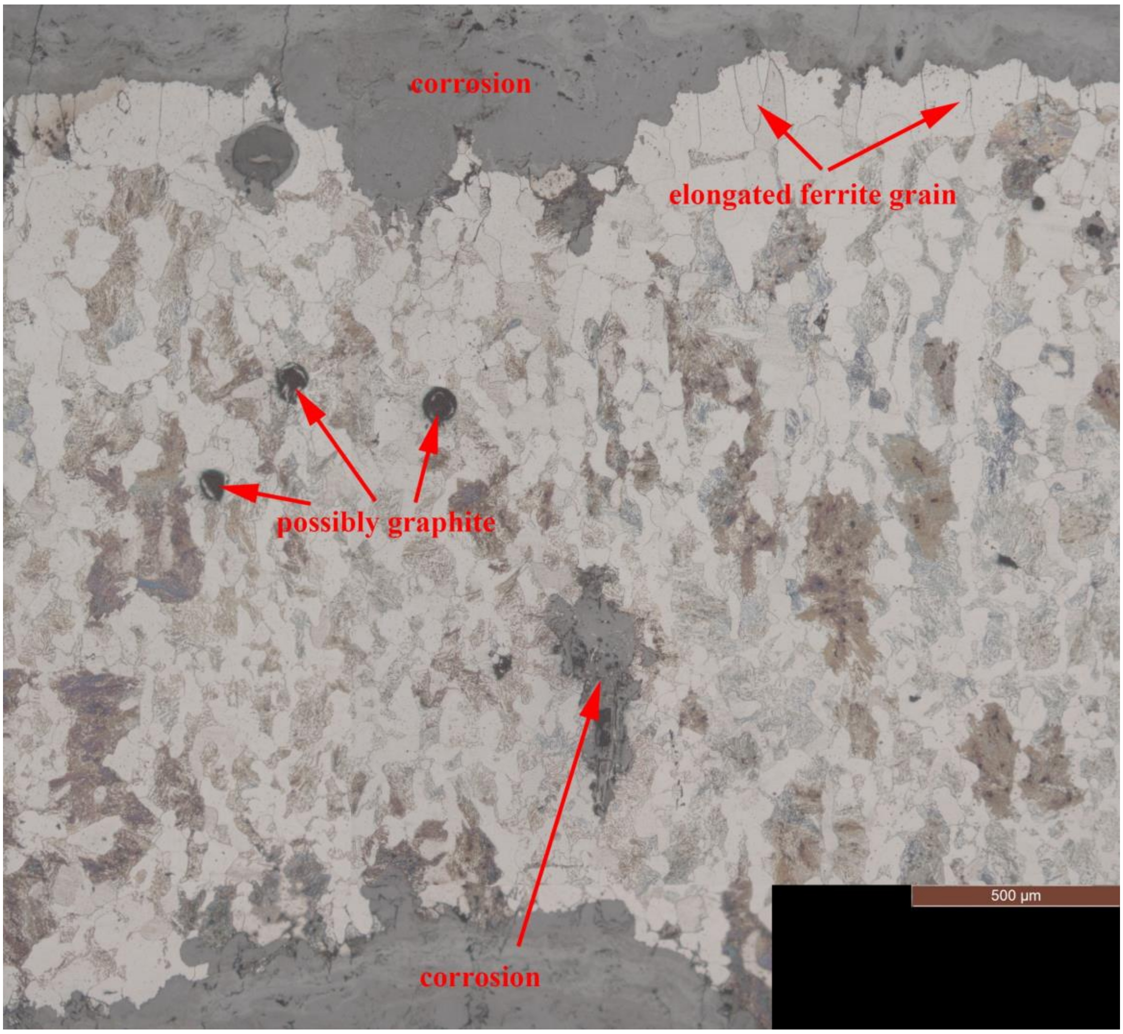


Fig. 5.76 Montage of section from SK0028. Etch 2% nital, scale bar 500µm (source: author)

Etched: at low magnification, etching revealed a pearlite and ferrite matrix with small grain size. There is a fully decarburized layer of ferrite grains at the surface. The grains are elongated, especially at the decarburized layer at the surface. The pearlite is lamellar, and the impurities disappeared after etching. The small black dots are likely to be spheroidized graphite. There is no obvious evidence of slag inclusions (Fig. 5.76).

Initial interpretation: the object was cast probably in white cast iron first, and then decarburized and graphitized. The material is pearlite and ferrite matrix malleable cast iron, and there is a fully decarburized layer at the object surface.

SK0029, SK0030 and SK0034

Sample: SK0029 is cut from the cutting edge of an iron sabre (Fig. 5.77).

Unetched: SK0029 is corroded on the surface with some metal remaining in the centre. There are some slag inclusions in stringers and chains (Fig. 5.78).

Fig. 5.77 Iron sabre (02YLDIT0512-0613③:2) showing the sampling spot of SK0029, SK0030, and SK0034 (source: author)

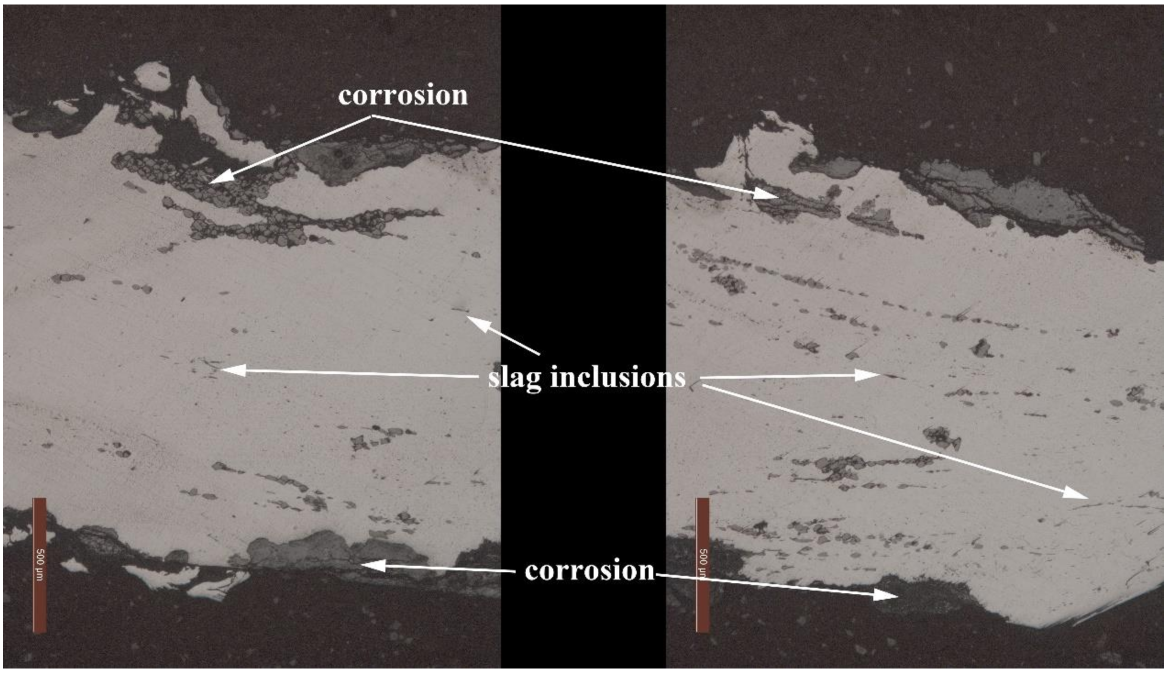


Fig. 5.78 Montage of section from SK0029. Unetched, scale bar 500μm (source: author)

Etched: at low magnification of SK0029, etching revealed a ferrite matrix with small grain size. The carbon content at the surface of cutting edge is much higher than elsewhere, which the highest area is c.0.6-0.77%. The grain sizes are bigger at the surface towards the core. Some of the bigger grey colour phase are corrosions due to an imperfect sample preparation. The slag stringers are single-phased slag inclusions (Fig. 5.79).

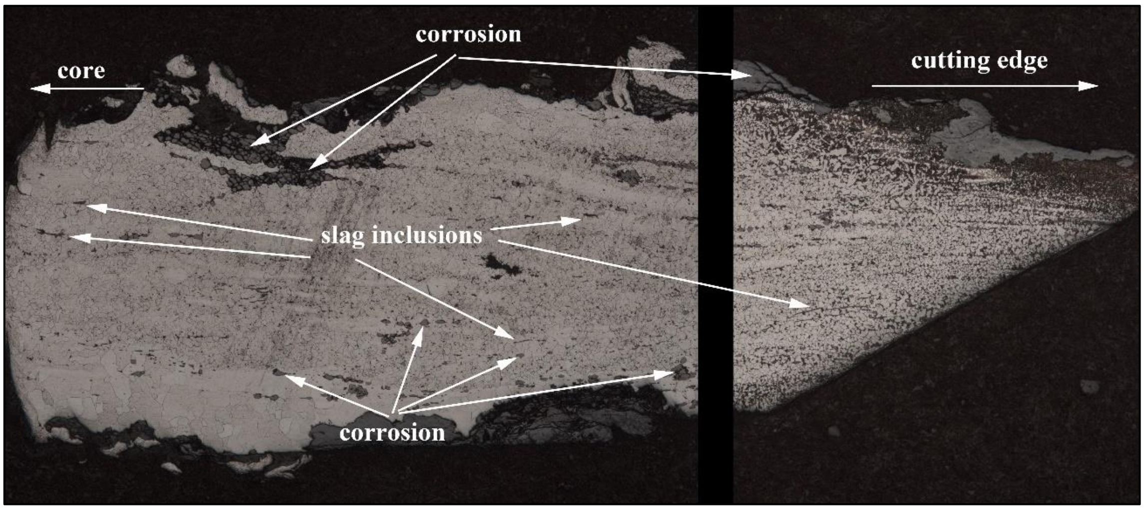


Fig. 5.79 Montage of section from SK0029. Etch 2% nital, scale x37.5 (source: author)

Sample: SK0030 is cut from the ridge of the same iron sabre (Fig. 5.77).

Unetched: SK0030 is slightly corroded on the surface and the metal remaining in the centre. In the unetched section, there are large amounts of double-phased slag inclusions (Fig. 5.80).

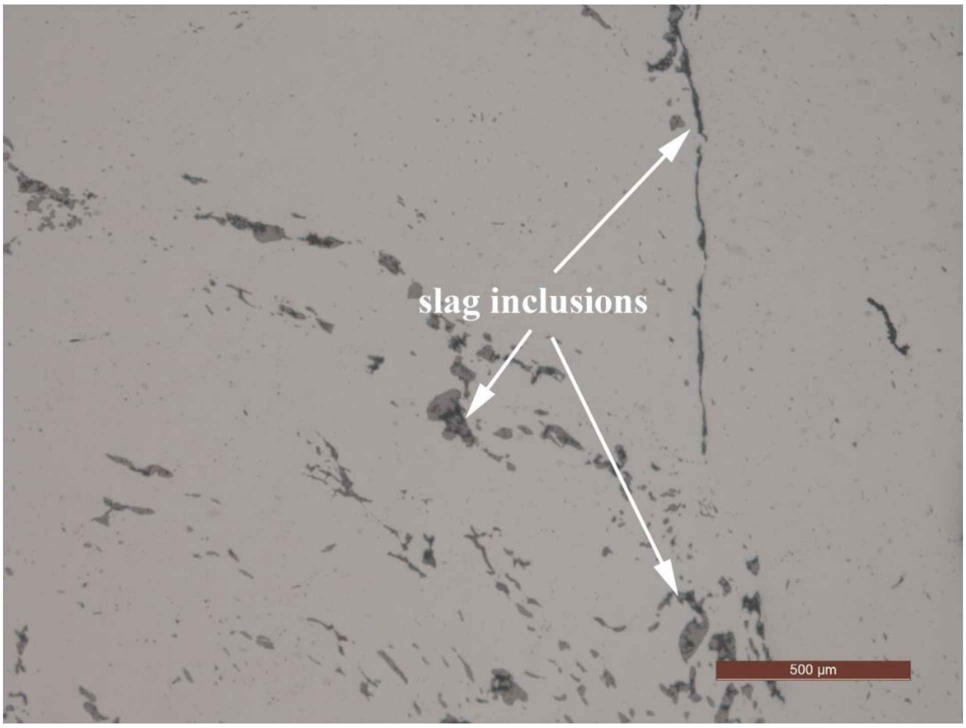


Fig. 5.80 Section from SK0030. Unetched, scale bar 500μm (source: author)

Etched: at low magnification of SK0030, etching revealed a ferrite matrix with uneven grain sizes. The grain size is very small and there is some carbon on the grain boundaries in the bottom left area of the etched section, which is near the core of the object. The grain sizes are much bigger elsewhere. There are large amounts of randomly distributed slag inclusions with irregular shapes throughout the section (Fig. 5.81).

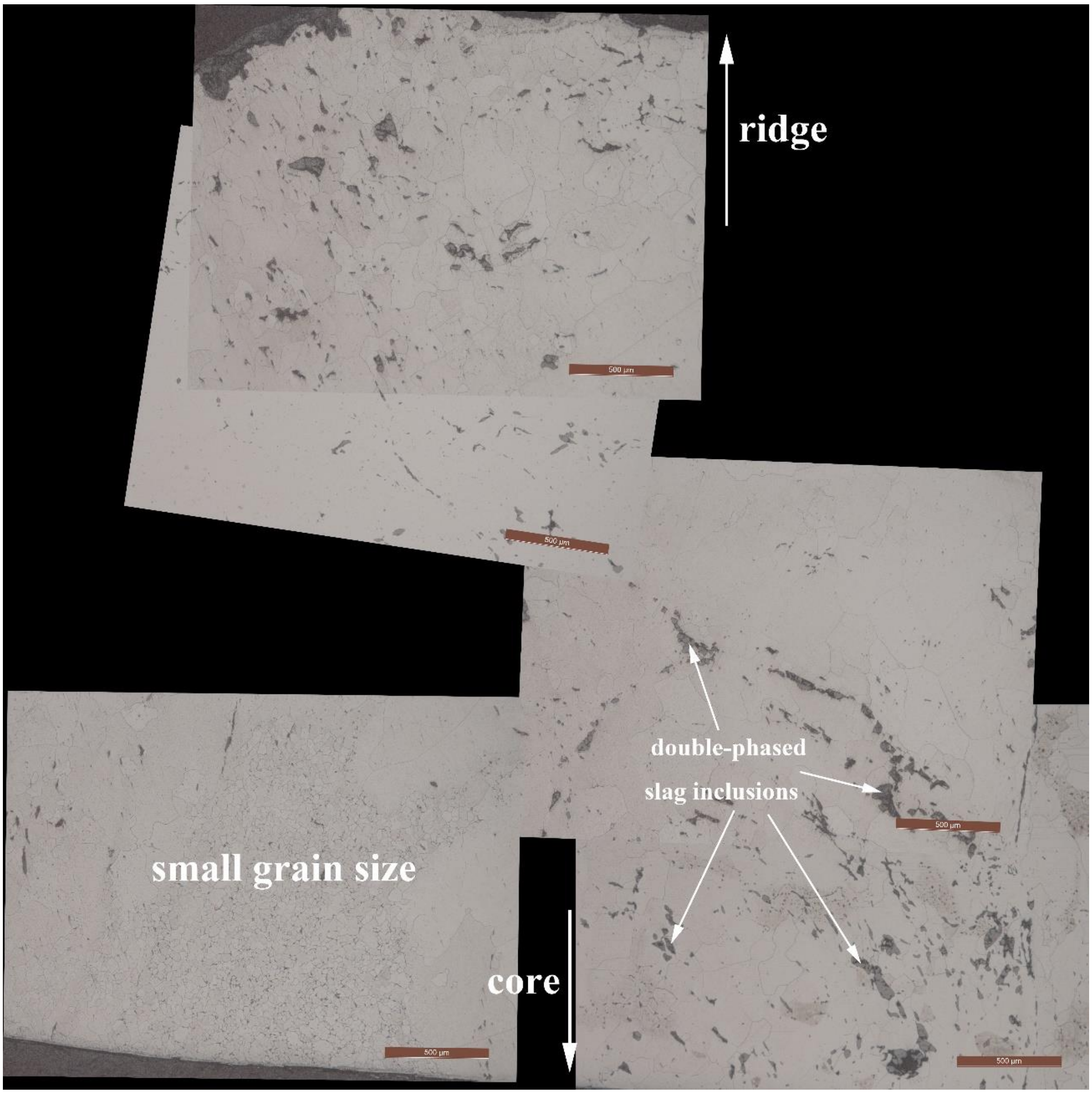


Fig. 5.81 Montage of section from SK0030. Etch 2% nital, scale bar 500μm (source: author)

Sample: SK0034 is collected from the corrosion which fell off from the sabre (Fig. 5.77).

Unetched: SK0034 is fully corroded which no metallographic structures can be identified from the section.

Initial interpretation: in summary of the sample SK0029 and SK0030, the iron sabre was forged from bloomery iron or fined iron, and carburized on the cutting edge.

SK0031, SK0032 and SK0033

Sample: SK0031 is cut from the cutting edge of an iron chisel (Fig. 5.82).

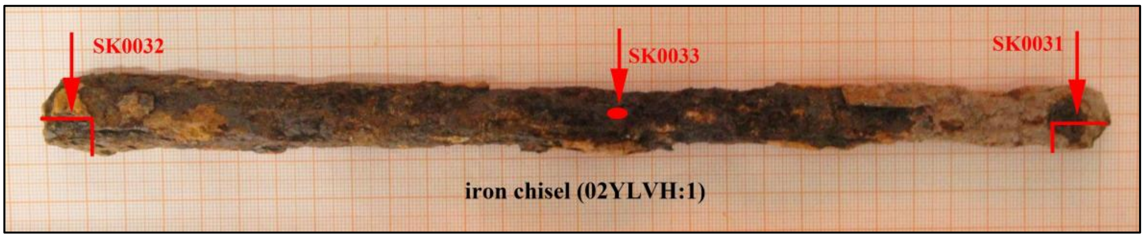


Fig. 5.82 Iron chisel (02YLVH:1) showing the sampling spot of SK0031, SK0032, and SK0033 (source: author)

Unetched: SK0031 is corroded on the surface with some metal remaining in the centre. There are large amounts slag stringers and a 0.02mm banding throughout the section (Fig. 5.83).

Fig. 5.83 Section from SK0031. Unetched, scale bar 500μm (source: author)

Etched: at low magnification of SK0031, etching revealed a different carbon content distribution in layers. On the left of the banding, the carbon content is as low as c.0.1% in the middle, and as high as c.0.77% at the sides. On the right of the banding, the carbon content is c.0.02-0.3%. The slag inclusions are both single and double-phased (Fig. 5.84).

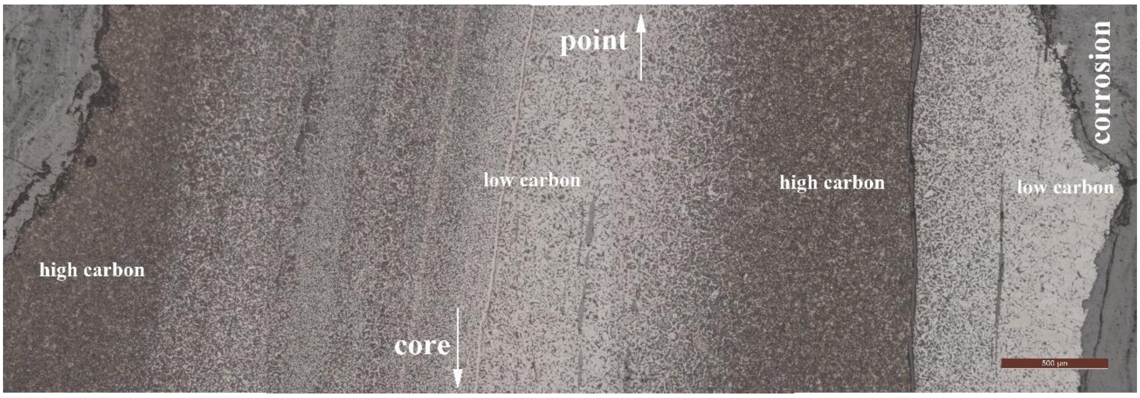


Fig. 5.84 Montage of section from SK0031. Etch 2% nital, scale bar 500μm (source: author)

Sample: SK0032 is cut from the tang end of the same chisel (Fig. 5.82).

Unetched: SK0032 is corroded on the surface with some metal remaining in the centre. There are large amounts of irregular single-phased slag inclusions (Fig. 5.85).

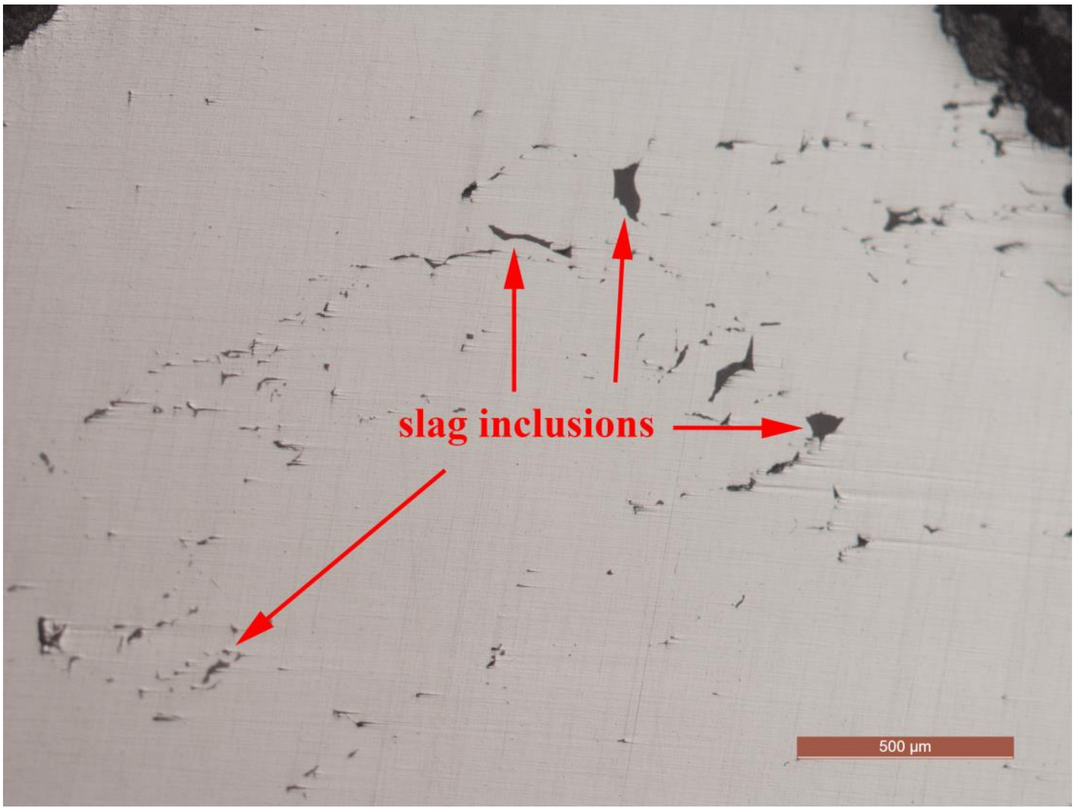


Fig. 5.85 Section from SK0032. Unetched, scale bar 500μm (source: author)

Etched: at low magnification of SK0032, etching revealed a fine pearlite matrix with small grain size and very little ferrite. The carbon content is c.0.6-0.7% (Fig. 5.86).

Sample: SK0033 is collected from the corrosion which fell off from the chisel (Fig. 5.82).

Unetched: SK0033 is fully corroded which no metallographic structures can be identified from the section.

Initial interpretation: in summary of the sample SK0031 and SK0032, the iron chisel was forged from fined iron or bloomery iron. The blacksmith was likely to started with a wrought iron bar of very low carbon content, and then carburized the finished object to c.0.6-0.7% carbon content. The banding shows that the cutting edge of the object was probably broken and being repaired with a small piece of low carbon iron.

Fig. 5.86 Section from SK0032. Etch 2% nital, scale x37.5 (source: author)

SK0038 and SK0039

Sample: SK0038 is cut from the cutting edge of an iron shovelhead (Fig. 5.87).

Unetched: SK0038 is corroded on the surface with some metal remaining in the centre. There are large amounts of slag stringers evenly distributed parallel to the object surface (Fig. 5.88).

Fig. 5.87 Iron shovelhead (03YLIVM14:89) showing the sampling spot of SK0038 and SK0039 (source: author)

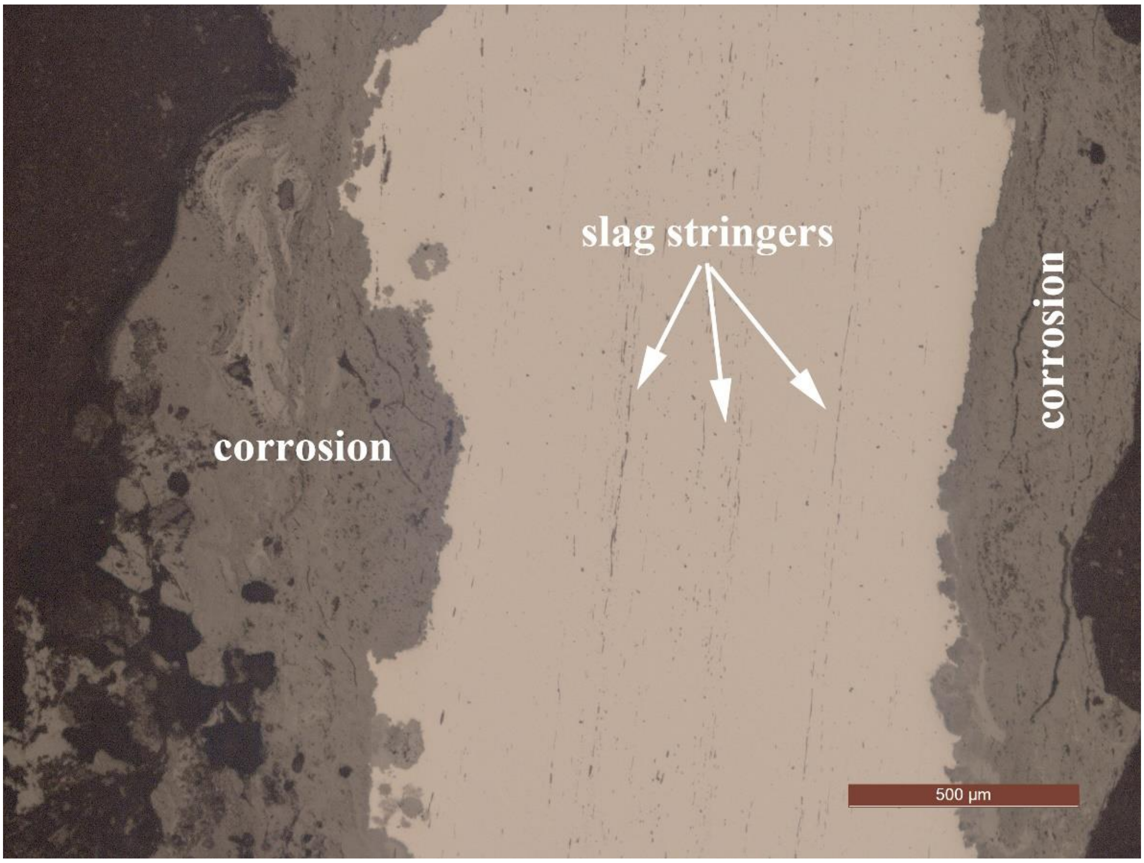


Fig. 5.88 Section from SK0038. Unetched, scale bar 500µm (source: author)

At low magnification, etching revealed a ferrite matrix with unclear grain boundaries and large amounts of very small dots (Fig. 5.89). At a higher magnification, the small dots look like spheroidized pearlite and the slag stringers are single-phased slag inclusions (Fig. 5.90).

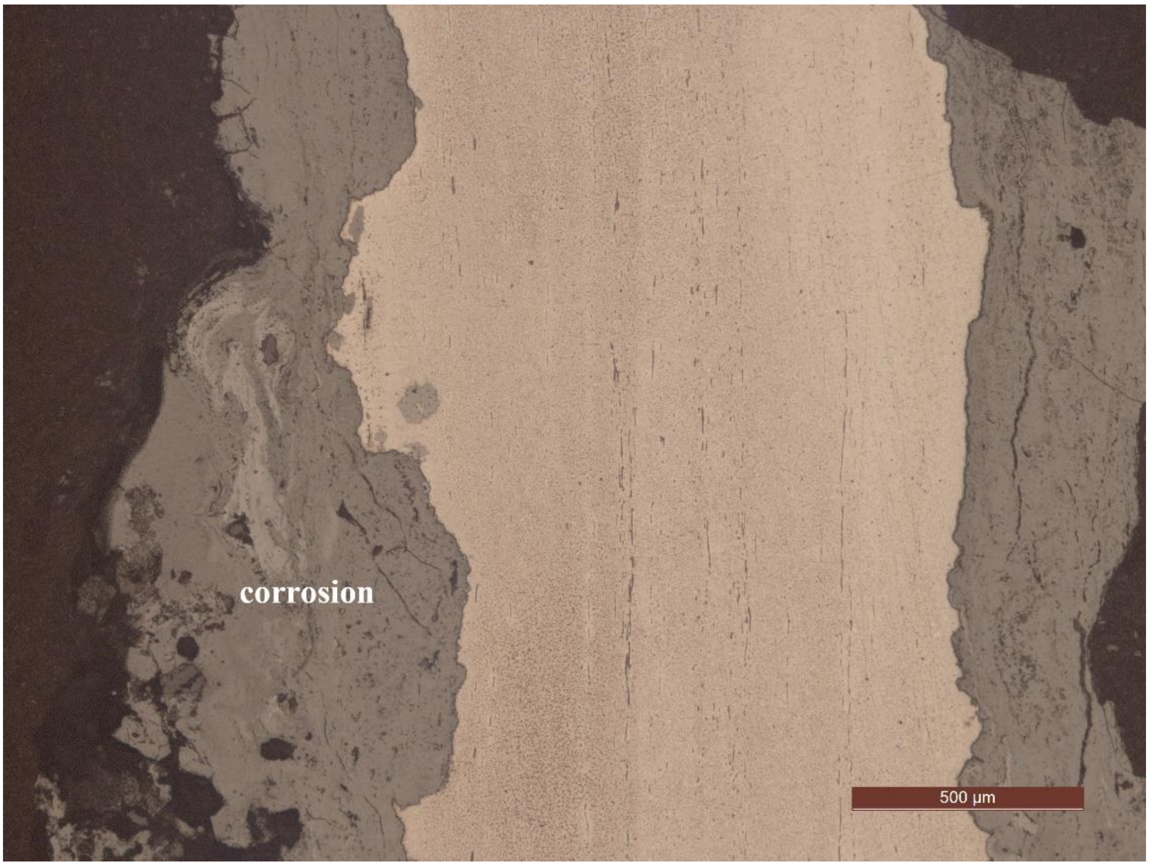


Fig. 5.89 Section from SK0038. Etch 2% nital, scale bar 500μm (source: author)

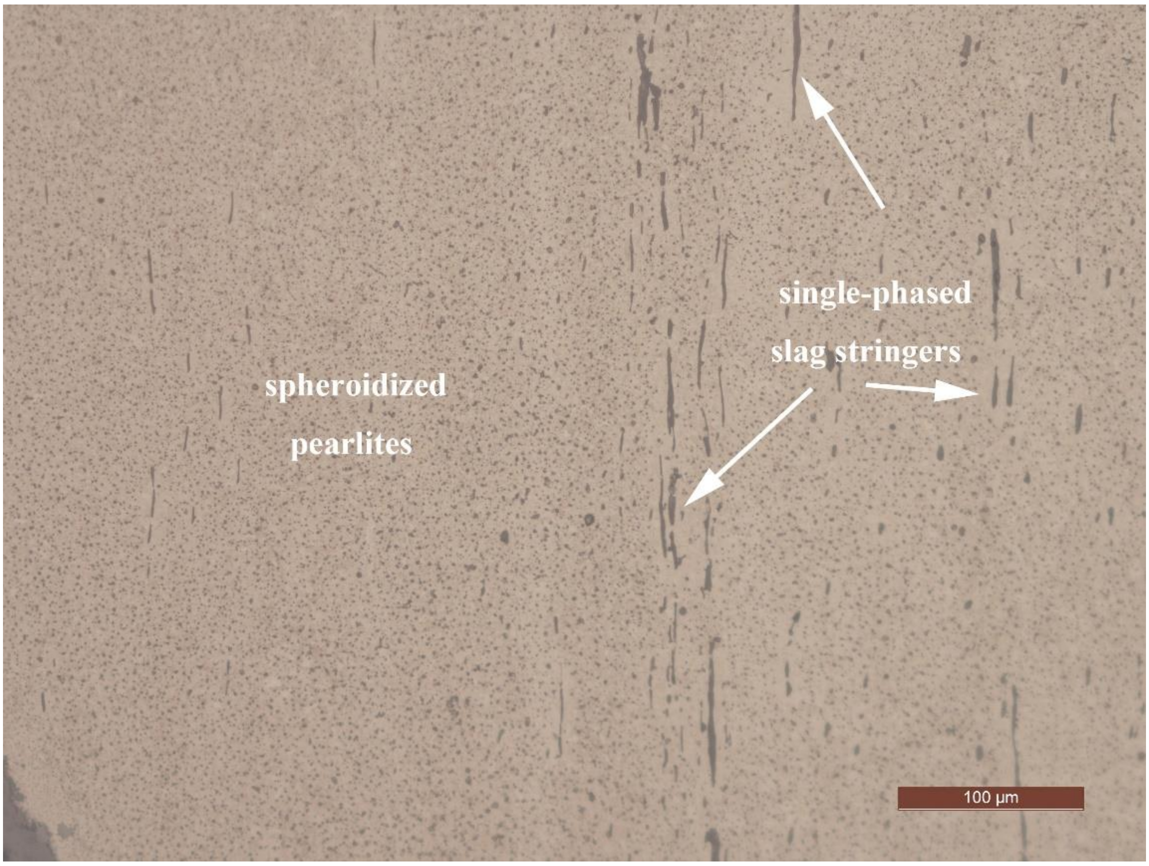


Fig. 5.90 Section from SK0038. Etch 2% nital, scale bar 100μm (source: author)

Sample: SK0039 is cut from the socket of the same iron shovelhead (Fig. 5.87).

Unetched: SK0039 is corroded on the surface with some metal remaining in the centre. In the unetched section, there are large amounts of single-phased slag stringers (Fig. 5.91).

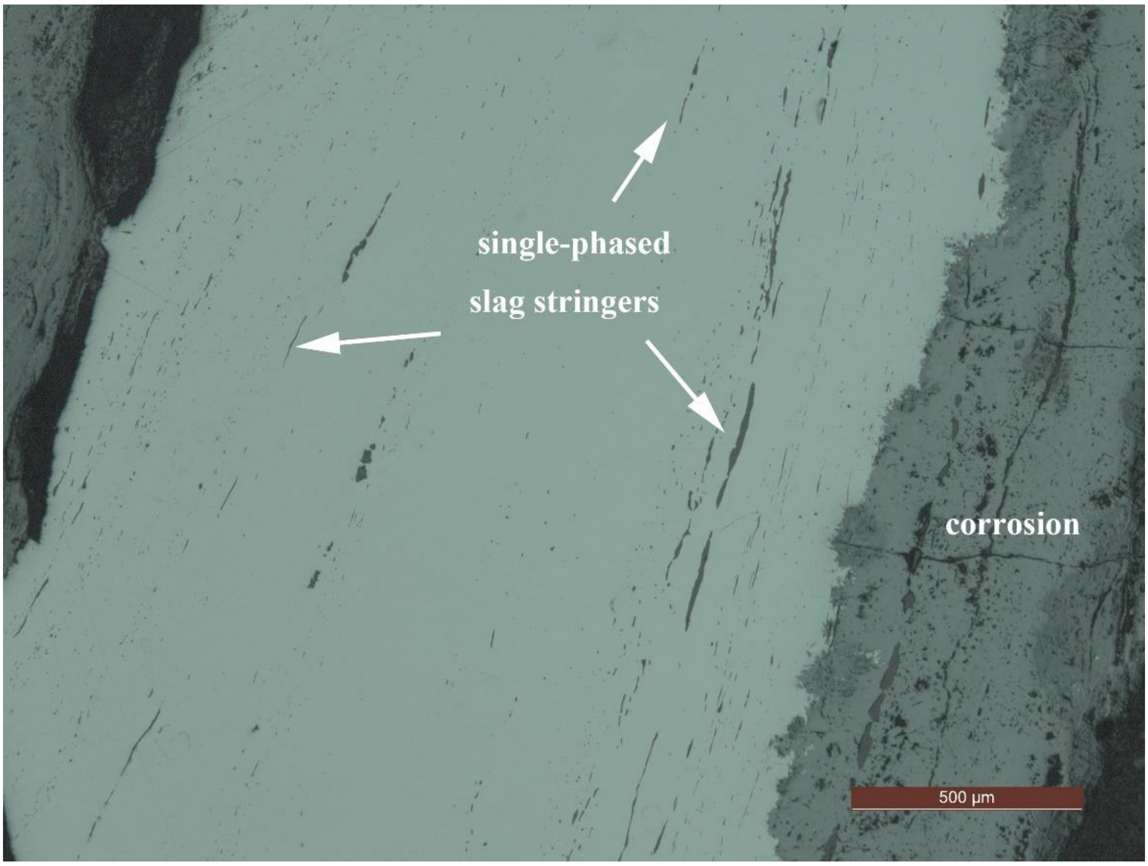


Fig. 5.91 Section from SK0039. Unetched, scale bar 500μm (source: author)

Etched: at a low magnification of SK0039, etching revealed a pearlite and ferrite matrix with small grain size and clear grain boundaries. There is more pearlite with bigger grain size in the middle than the sides. The carbon content is c.0.1-0.5%. There are needle-like ferrite structures extend inwards from the grain boundaries throughout the section, indicating a Widmanstätten structure (Fig. 5.92).

Initial interpretation: in summary of the sample SK0038 and SK0039, the iron shovelhead was forged from fined iron or bloomery iron with low carbon content, both the spheroidized pearlite at the cutting edge and the Widmanstätten structure at the socket might indicated that the temperature in the forging process was probably too high.

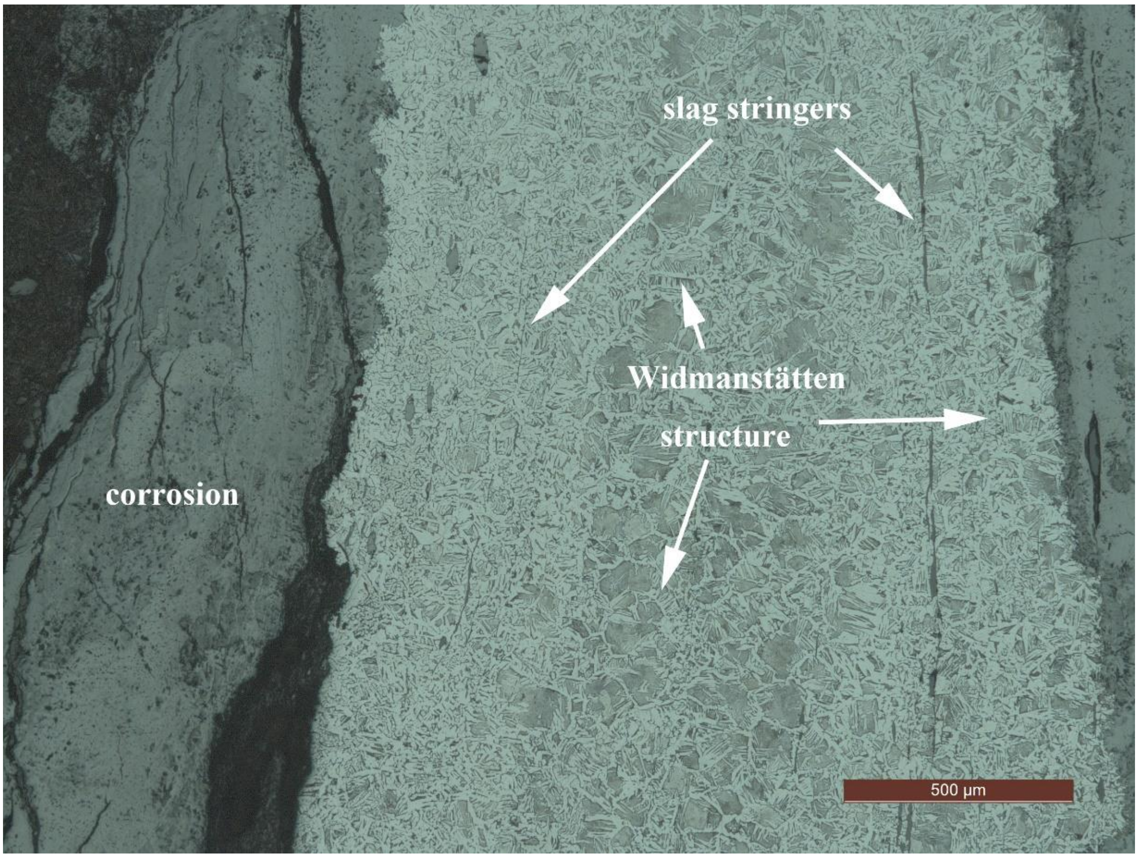


Fig. 5.92 Section from SK0039. Etch 2% nital, scale bar 500µm (source: author)

SK0040 and SK0041

Sample: SK0040 is cut from the cutting edge of an iron mattockhead (Fig. 5.93).

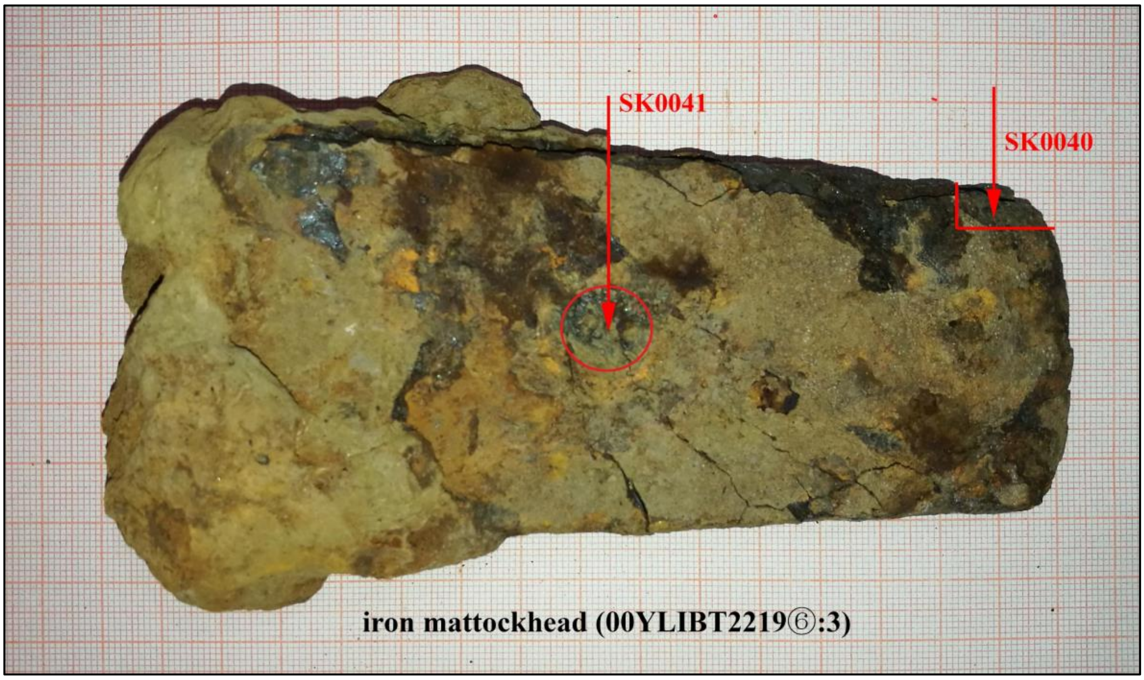


Fig. 5.93 Iron mattockhead (00YLIBT2219⑥:3) showing the sampling spot of SK0040 and SK0041 (source: author)

Unetched: SK0040 is corroded on the surface with some metal remaining in the centre. In the unetched section, some dendritic structures are visible in the corroded area (Fig. 5.94).

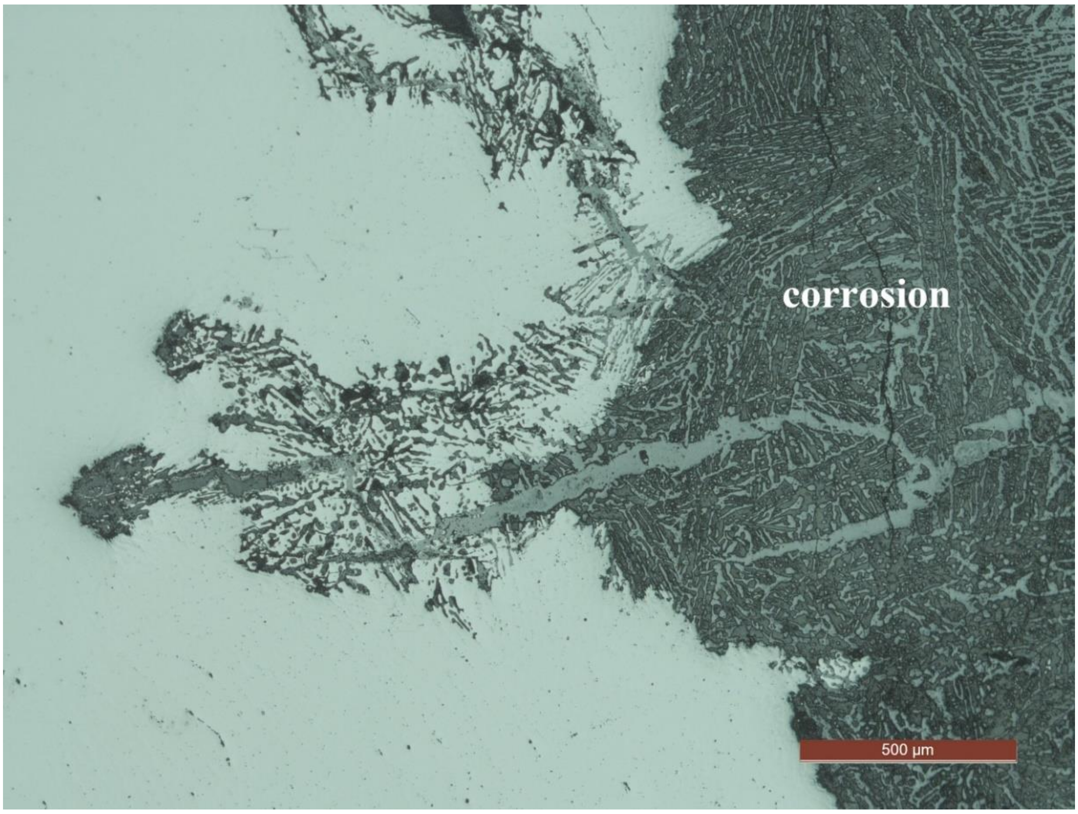


Fig. 5.94 Section from SK0040. Unetched, scale bar 500μm (source: author)

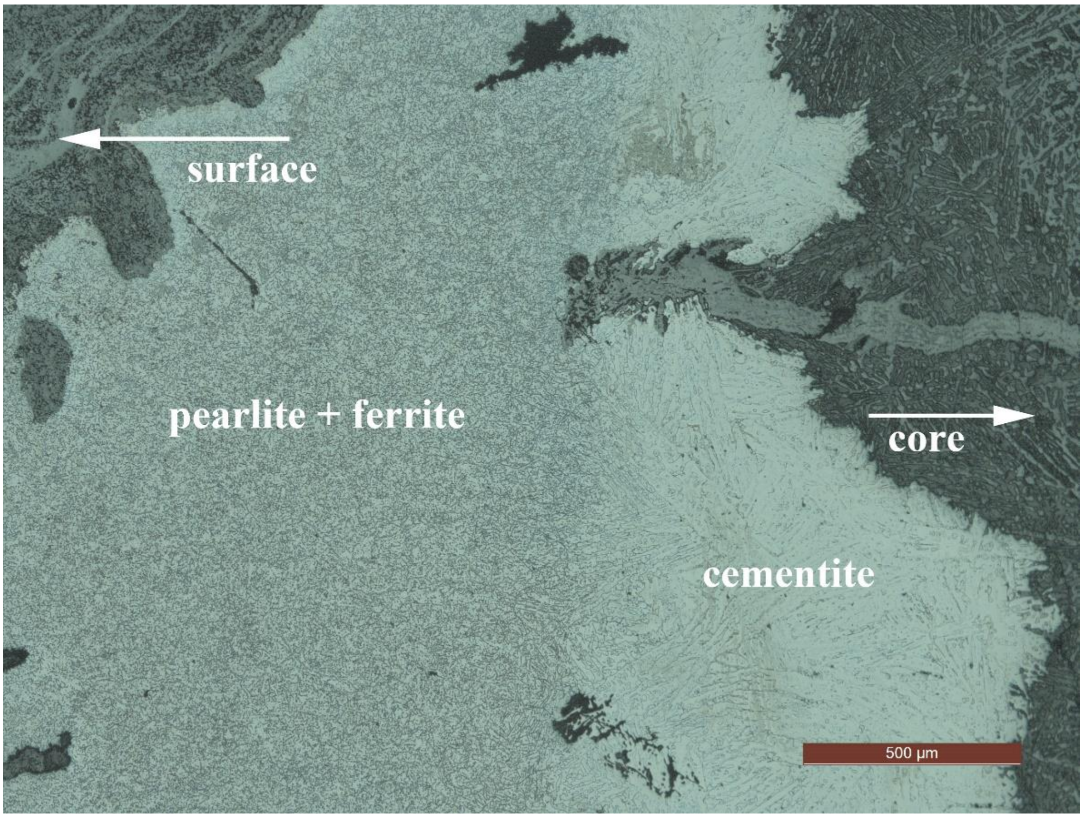


Fig. 5.95 Section from SK0040. Etch 2% nital, scale bar 500μm (source: author)

Etched: at low magnification of SK0040, etching revealed a pearlite and ferrite matrix near the surface area and dendritic cementite in the core area. The grain boundaries are not clear, and there is no obvious evidence of slag inclusions (Fig. 5.95). At a higher magnification, the pearlite is spheroidized (Fig. 5.96).

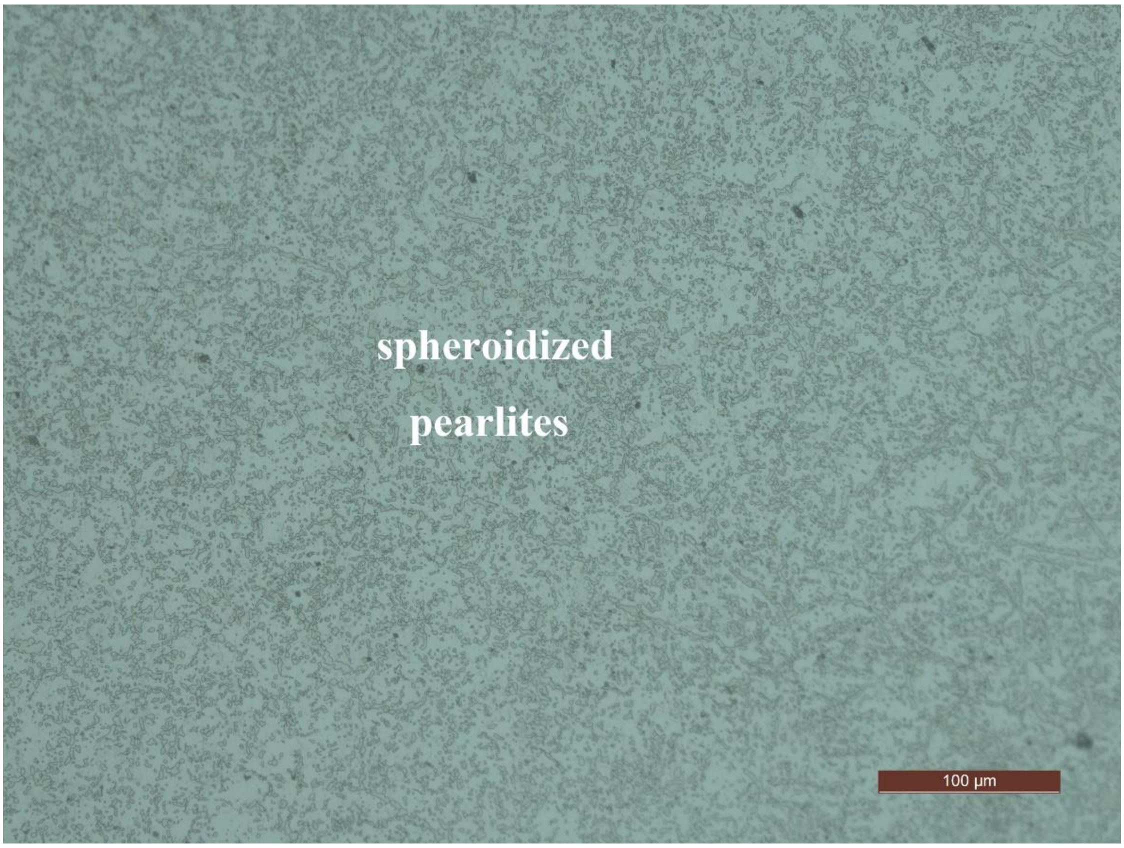


Fig. 5.96 Section from SK0040. Etch 2% nital, scale bar 100µm (source: author)

Sample: SK0041 is collected from the corrosion which fell off from the mattockhead (Fig. 5.93).

Unetched: SK0041 is fully corroded which no metallographic structures can be identified from the section.

Initial interpretation: the object was cast in white cast iron first, and the surface was then being decarburized.

SK0042, SK0043 and SK0044

Sample: SK0042 is cut from the ridge of an iron ring-headed knife (Fig. 5.97).

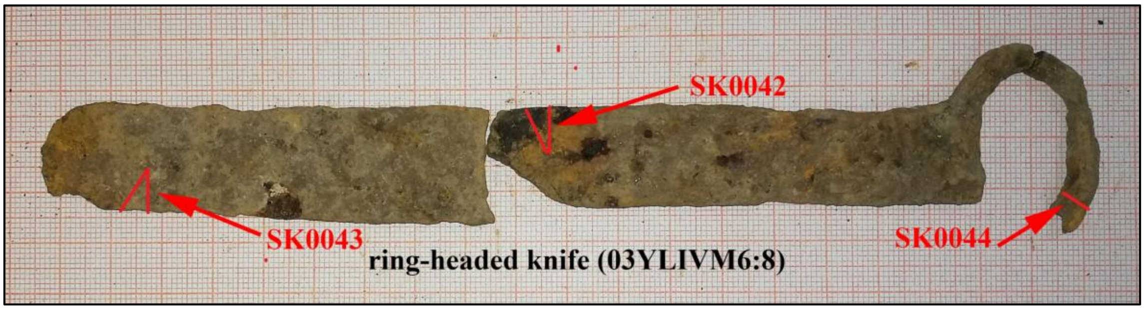


Fig. 5.97 Iron ring-headed knife (03YLIVM6:8) showing the sampling spot of SK0042, SK0043 and SK0044 (source: author)

Unetched: SK0042 is corroded on the surface with some metal remaining in the centre (Fig. 5.98).

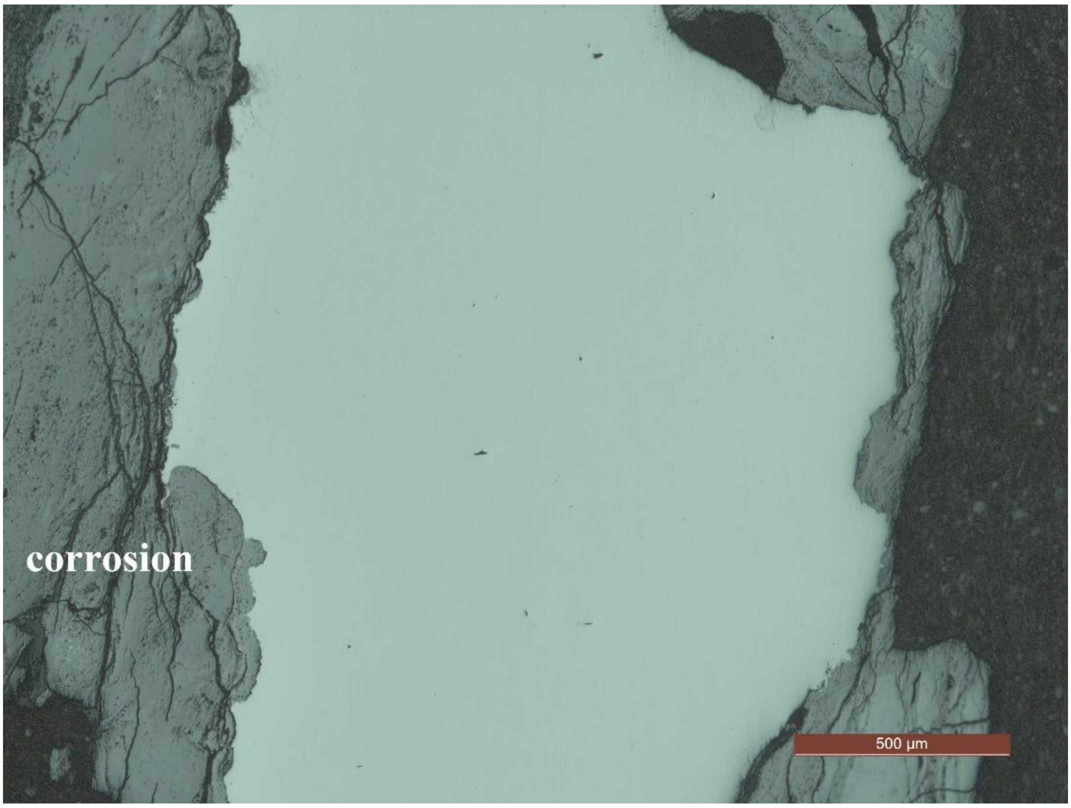


Fig. 5.98 Section from SK0042. Unetched, scale bar 500μm (source: author)

Etched: at low magnification of SK0042, etching revealed a ferrite and pearlite matrix with very small grain size and clear grain boundaries. The carbon content is c.0.1-0.2%. There is no obvious evidence of slag inclusions (Fig. 5.99).

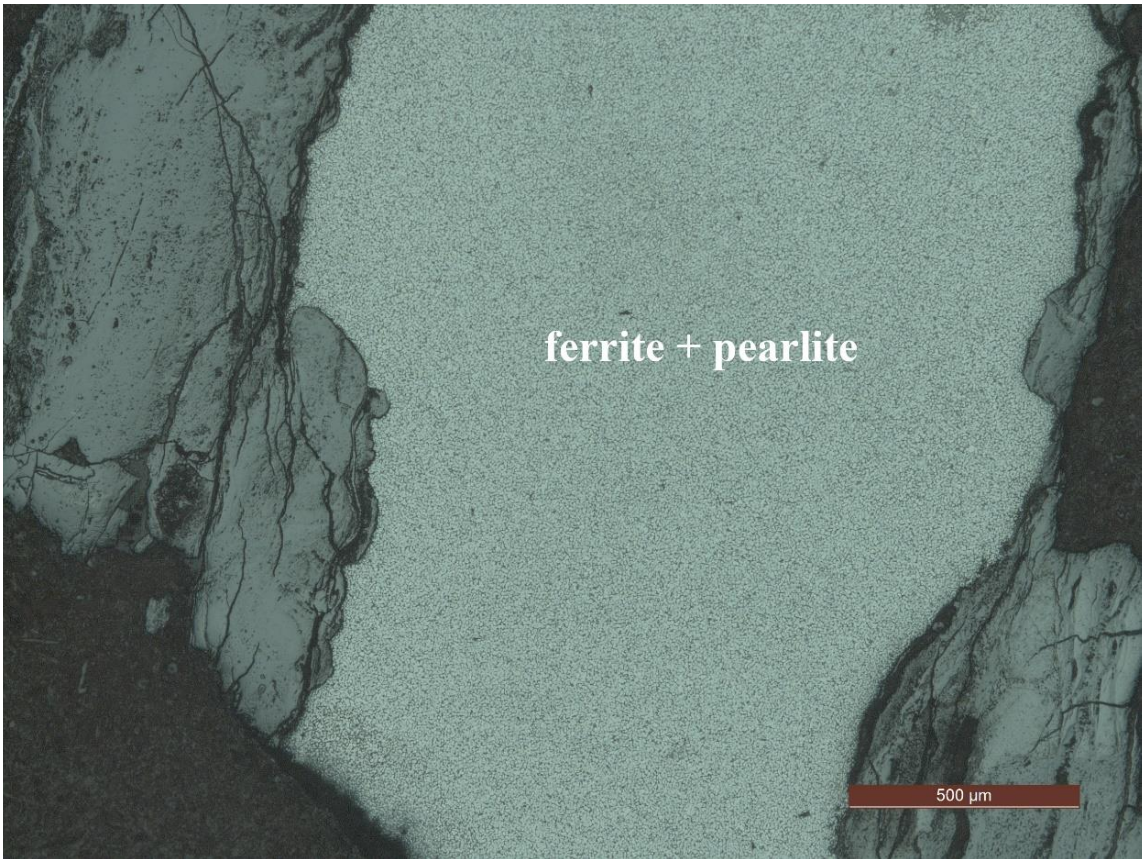


Fig. 5.99 Section from SK0042. Etch 2% nital, scale bar 500μm (source: author)

Sample: SK0043 is cut from the cutting edge of the same knife (Fig. 5.97).

Unetched: SK0043 is corroded on the surface with some metal remaining in the centre. There are some small dots of impurities throughout the section (Fig. 5.100).

Etched: at low magnification of SK0043, etching revealed a pearlite and ferrite matrix with very small grain size and clear grain boundaries. The carbon content is c.0-3-0.5%. There is no obvious evidence of slag inclusions (Fig. 5.101). At a higher magnification, there are some needle-like ferrite structures extend inwards from the grain boundaries throughout the section, which may indicate a Widmanstätten structure (Fig. 5.102)

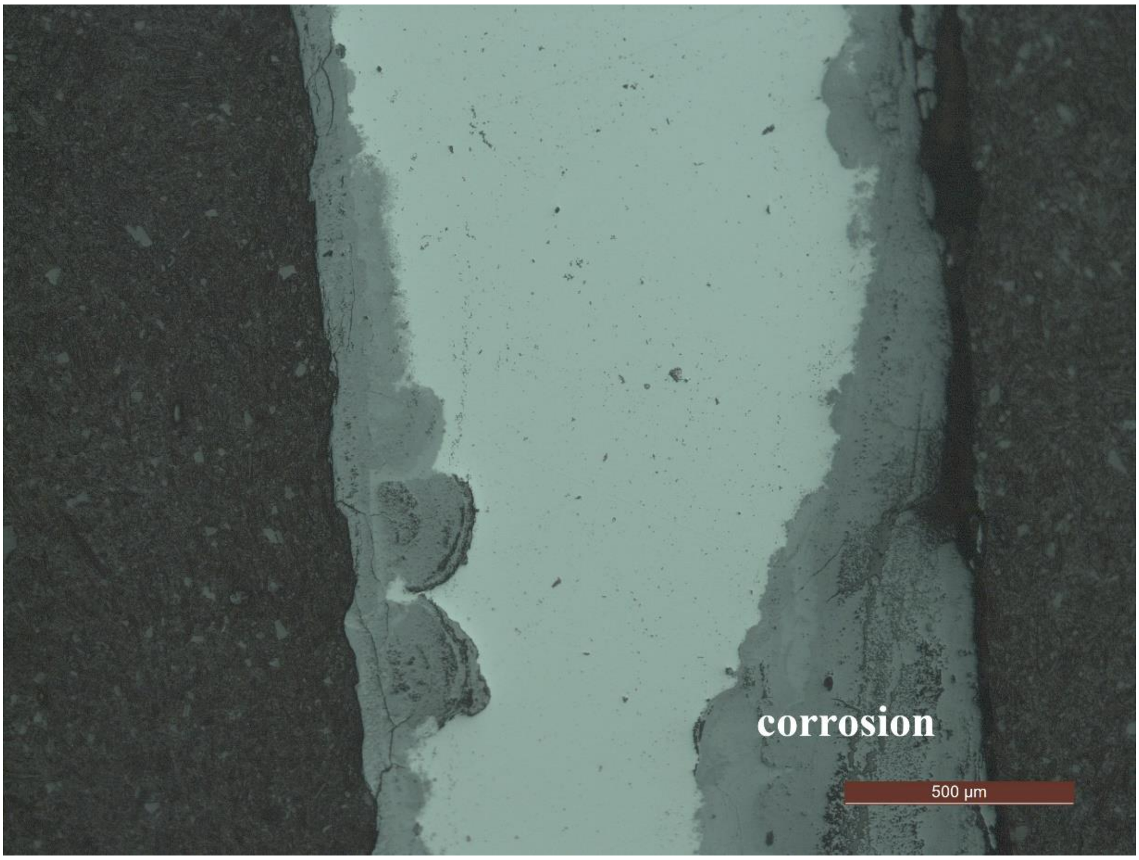


Fig. 5.100 Section from SK0043. Unetched, scale bar 500μm (source: author)

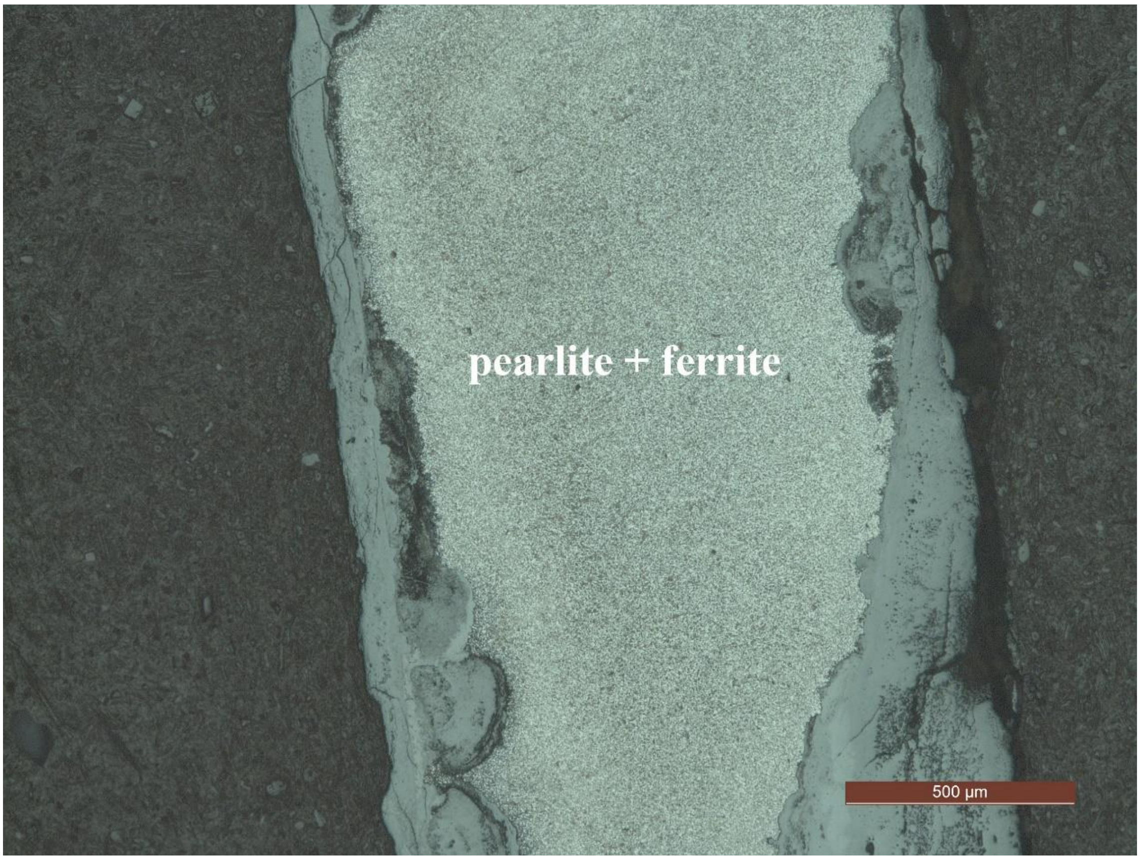


Fig. 5.101 Section from SK0043. Etch 2% nital, scale bar 500μm (source: author)

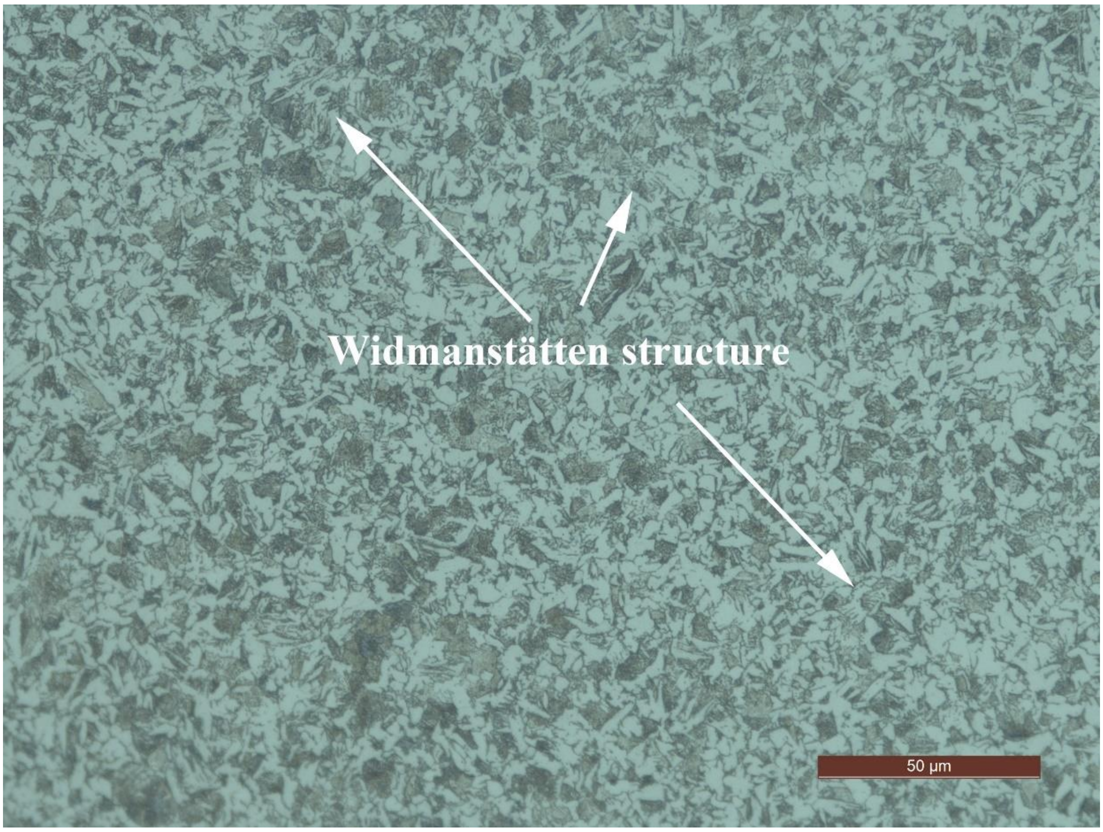


Fig. 5.102 Section from SK0043. Etch 2% nital, scale bar 50μm (source: author)

Sample: SK0044 is the cross section of the ring-head of the same knife (Fig. 5.97).

Unetched: SK0044 is badly corroded with some metal remaining in the centre (Fig. 5.103).

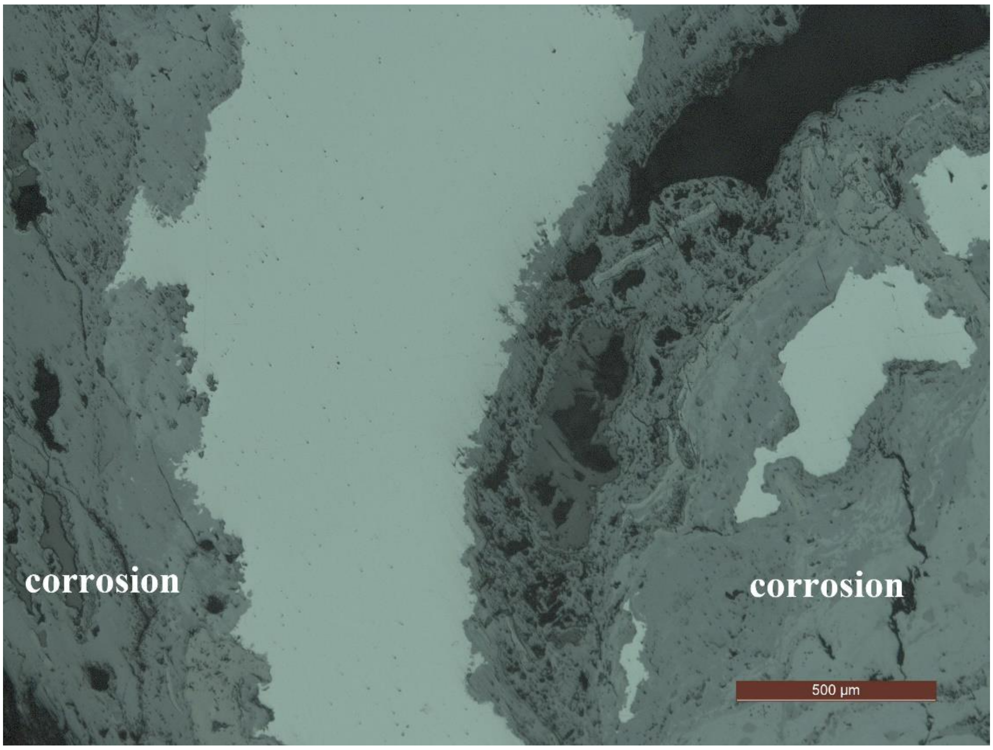


Fig. 5.103 Section from SK0044. Unetched, scale bar 500µm (source: author)

Etched: at low magnification of SK0044, etching revealed a ferrite matrix with uneven grain size and clear grain boundaries. There is a low occurrence of carbon distributed along with grain boundaries of the smaller ferrite grains (Fig. 5.104).

Initial interpretation: in summary of the sample SK0042, SK0043 and SK0044, the iron ring-headed knife was probably cast in white cast iron first, and then decarburized to a different extent of different parts. According to these samples, the carbon content at the ridge of the knife is c.0.2% and c.0.3-0.5% at the cutting edge, and the ring-head was fully decarburized.

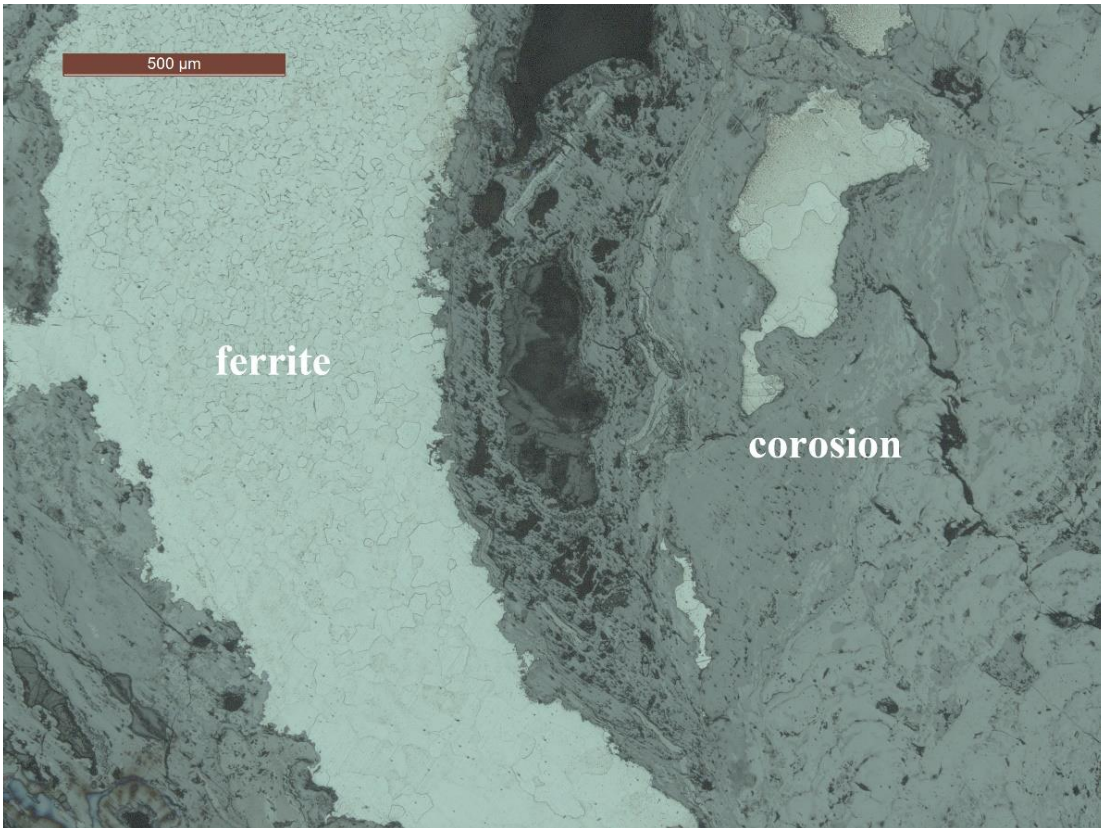


Fig. 5.104 Section from SK0044. Etch 2% nital, scale bar 500µm (source: author)

SK0045 and SK0046

Sample: SK0045 is cut from the ridge of an iron ring-headed knife (Fig. 5.105).

Fig. 5.105 Iron ring-headed knife (03YLIIIM15:20) showing the sampling spot of SK0045 and SK0046 (source: author)

Unetched: SK0045 is slightly corroded with some metal remaining in the centre (Fig. 5.106).

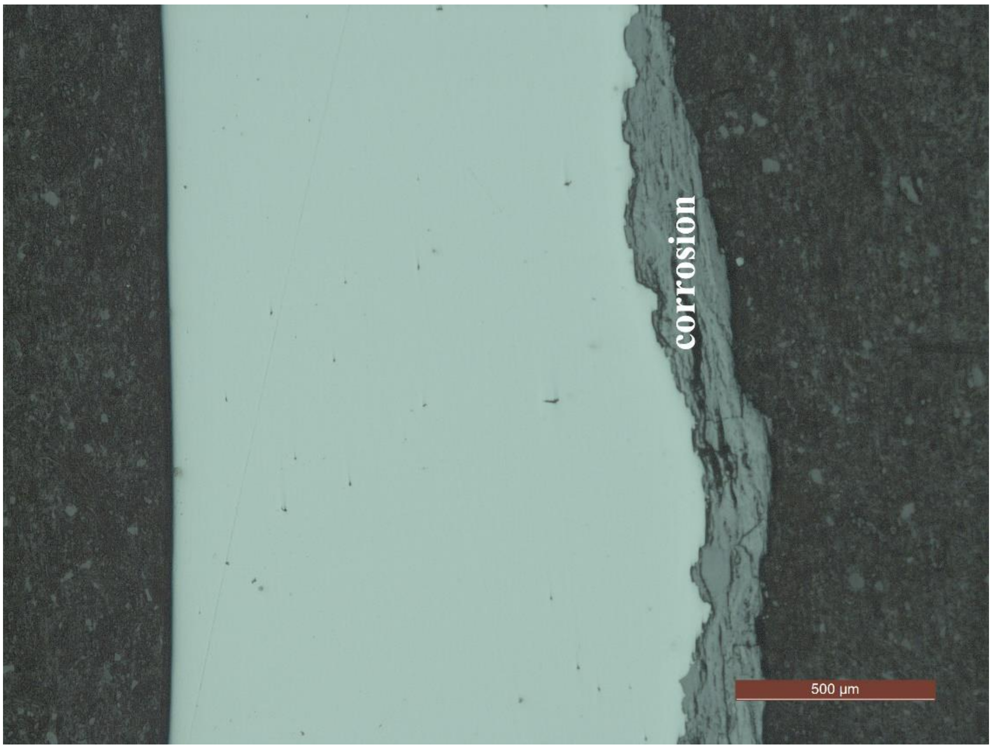


Fig. 5.106 Section from SK0045. Unetched, scale bar 500μm (source: author)

Etched: at low magnification of SK0045, etching revealed a pearlite and ferrite matrix with very small grain size and clear grain boundaries. The carbon content is c.0.5-0.6%, and there is no obvious evidence of slag inclusions (Fig. 5.107).

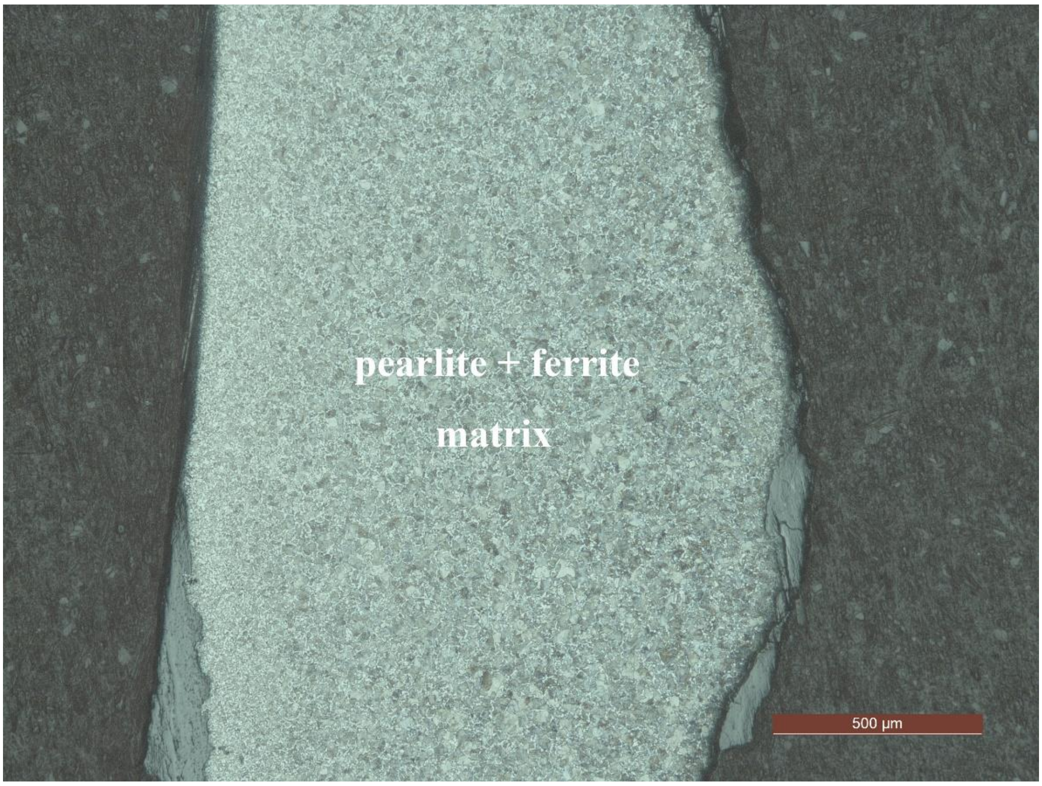


Fig. 5.107 Section from SK0045. Etch 2% nital, scale bar 500μm (source: author)

Sample: SK0046 is cut from the cutting edge of the same knife (Fig. 5.105).

Unetched: SK0046 is badly corroded on the surface with some metal remaining in the centre (Fig. 5.108).

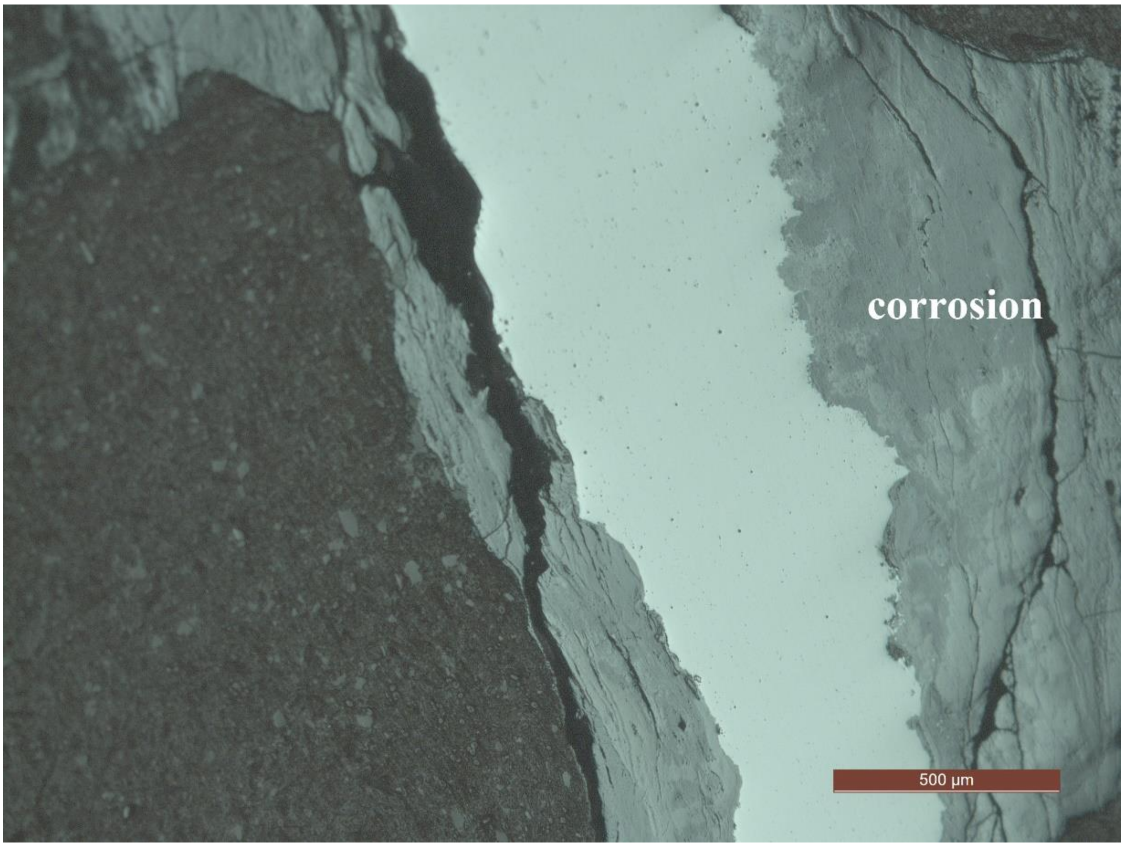


Fig. 5.108 Section from SK0046. Unetched, scale bar 500μm (source: author)

Etched: at low magnification of SK0046, etching revealed a pearlite and ferrite matrix with very small grain size and clear grain boundaries. The carbon content is c.0.6-0.7% at the cutting edge which is slightly higher than in the core. There is no obvious evidence of slag inclusions (Fig. 5.109).

Initial interpretation: in summary of the sample SK0045 and SK0046, the iron ring-headed knife was probably cast in white cast iron first, and then annealed for decarburization. According to the samples, the carbon content at the ridge of the knife is c. 0.5-0.6% and 0.6-0.7% at the cutting edge.

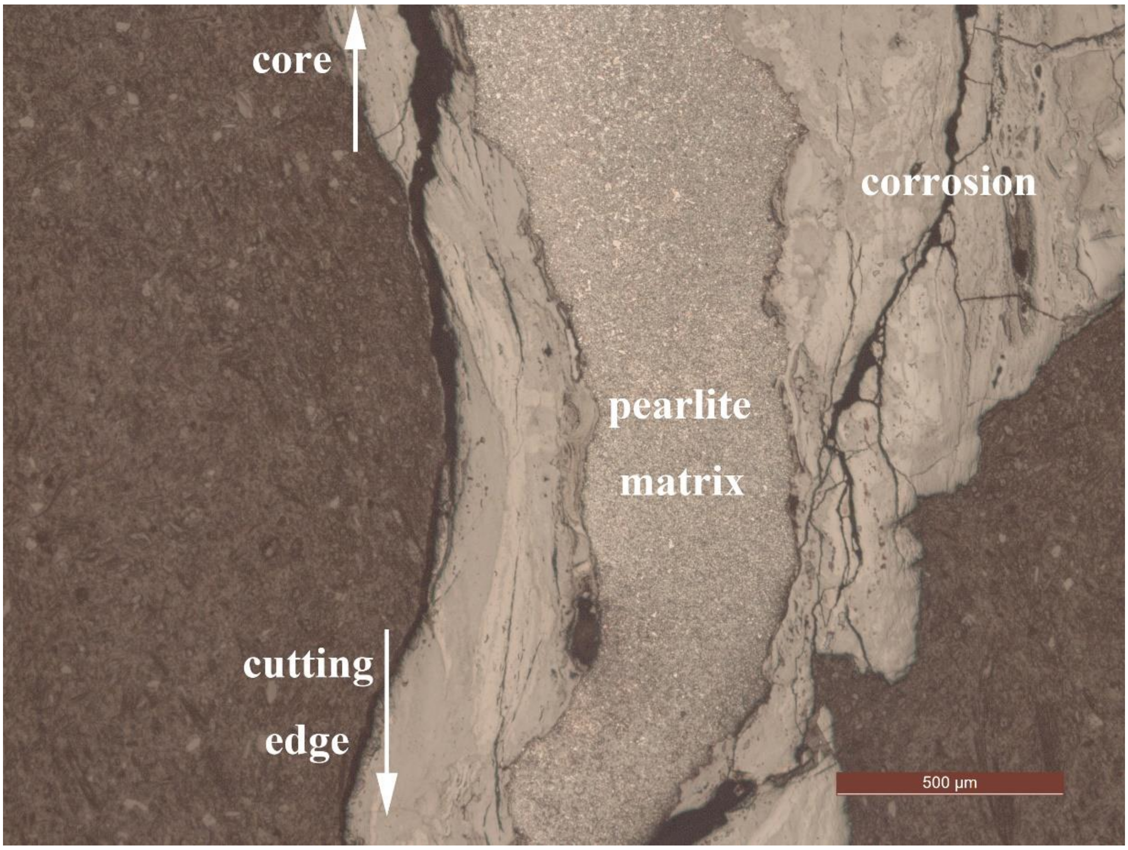


Fig. 5.109 Section from SK0046. Etch 2% nital, scale bar 500µm (source: author)

SK0047

Sample: the cross section of an iron belt hook (Fig. 5.110).

Fig. 5.110 Iron belt hook (03YLIVM6:38) showing the sampling spot of SK0047 (source: author)

Unetched: the sample is corroded on the surface with some metal remaining in the centre. There are some slightly deformed slag inclusions distributed in chains (Fig. 5.111).

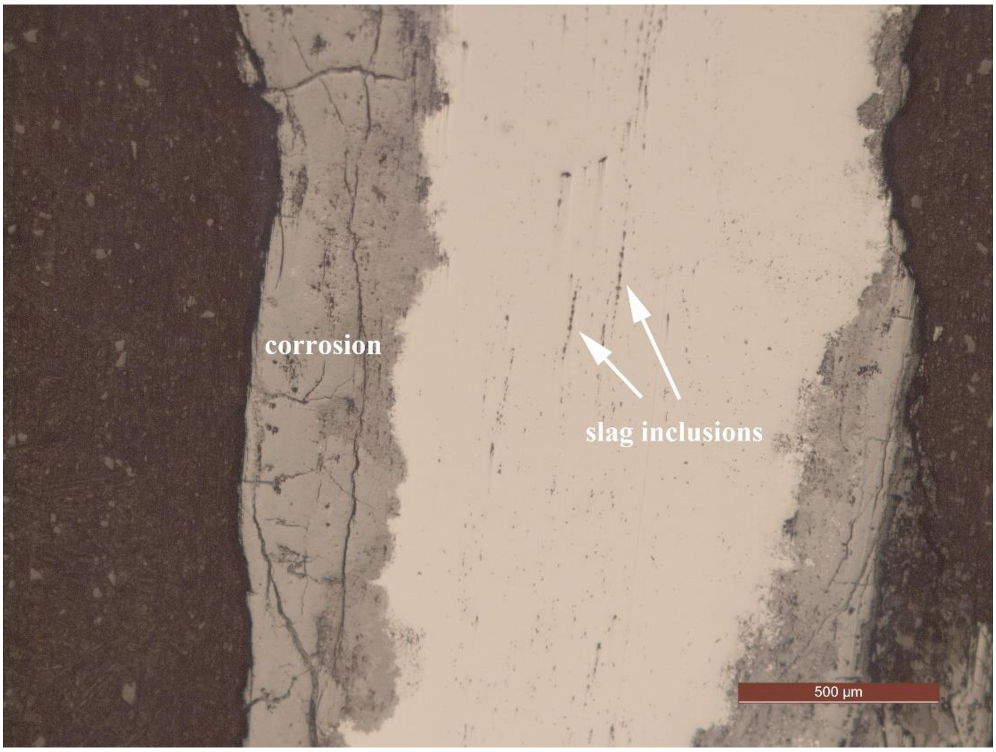


Fig. 5.111 Section from SK0047. Unetched, scale bar 500μm (source: author)

Etched: at low magnification, etching revealed a pearlite and ferrite matrix with uneven grain sizes and unclear grain boundaries. The carbon content is different in layers, which at the lower areas is c.0.1-0.2% and c.0.4-0.5% at the higher areas (Fig. 5.112). At a higher magnification, it can be seen that the slag inclusions are single-phased (Fig. 5.113).

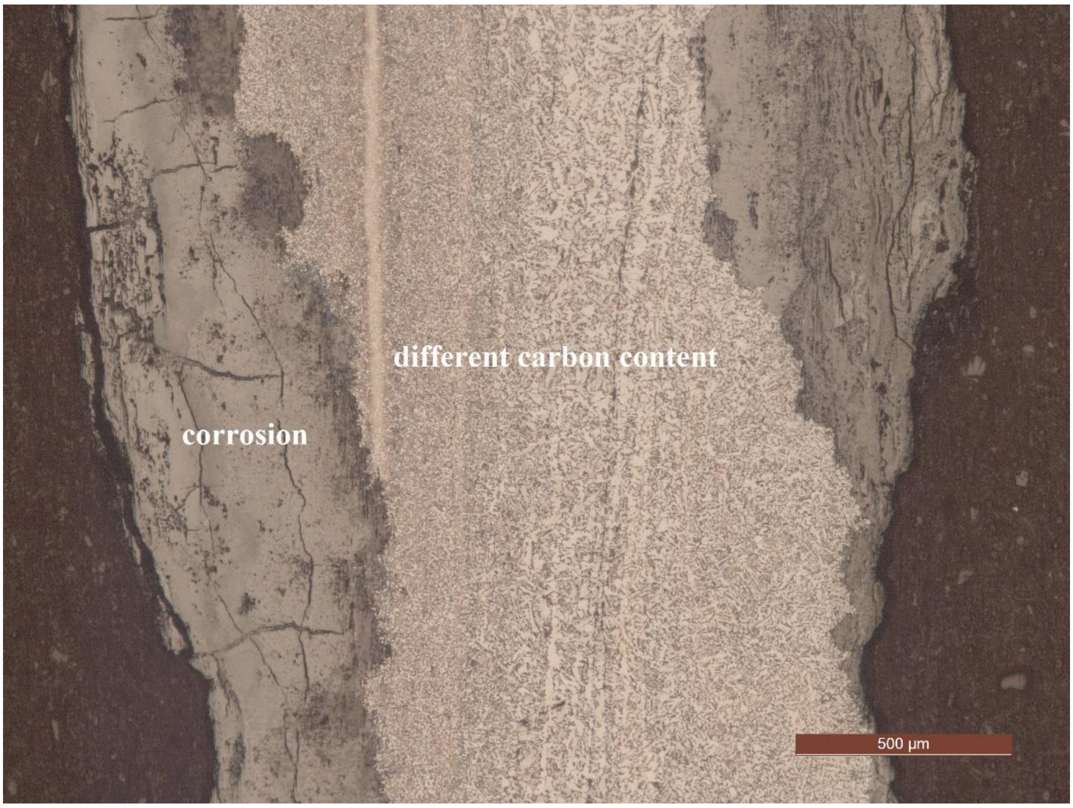


Fig. 5.112 Section from SK0047. Etch 2% nital, scale bar 500µm (source: author)

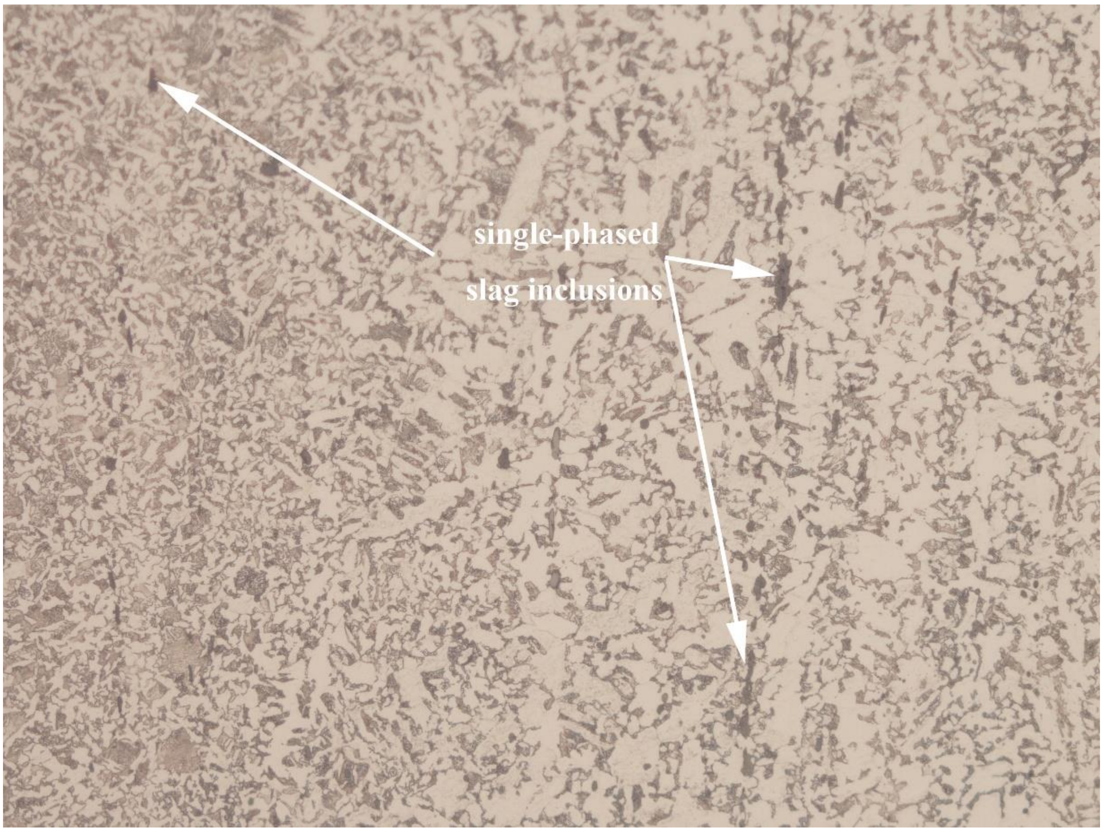


Fig. 5.113 Section from SK0047. Etch 2% nital, scale x150 (source: author)

Initial interpretation: the belt hook was probably forged from fined iron or bloomery iron. The distribution of the carbon content is uneven from c.0.1-0.5%. It is more likely that the material used was fined iron because large amounts of this daily live accessories were discovered at the site.

SK0048 and SK0049

Sample: SK0048 is cut from the ridge of an iron sabre (Fig. 5.114).

Fig. 5.114 Iron sabre (03YLIVM10:5) showing the sampling spot of SK0048 and SK0049 (source: author)

Unetched: SK0048 is badly corroded with some metal remaining in the centre. There are some slag stringers (Fig. 5.115).

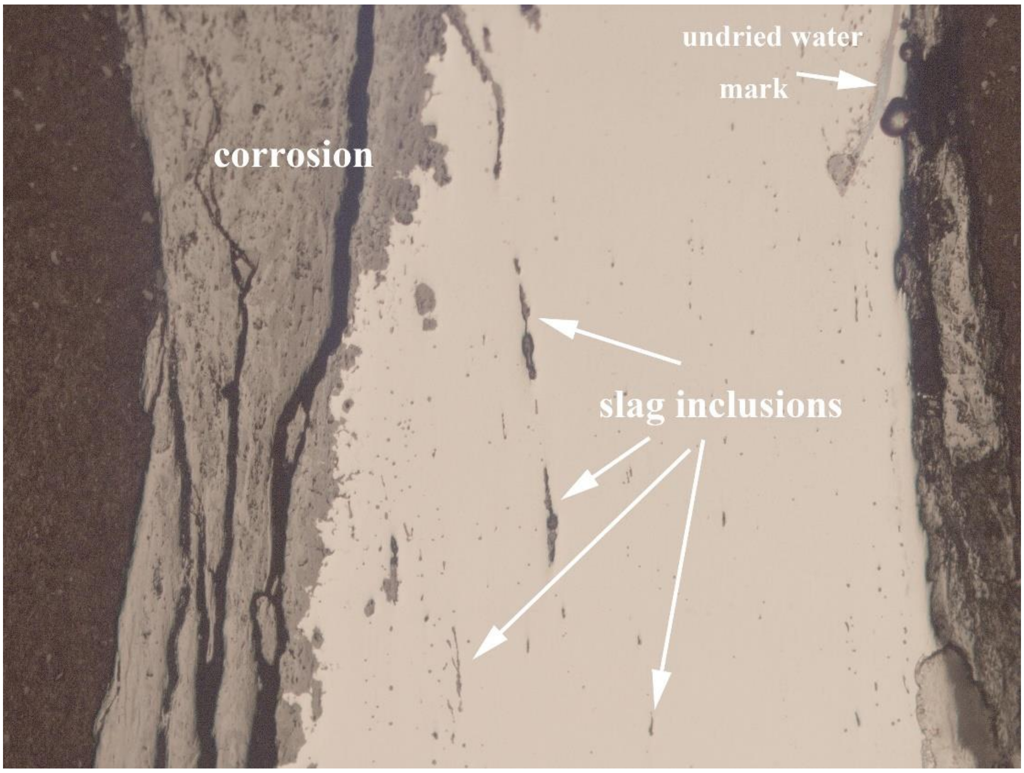


Fig. 5.115 Section from SK0048. Unetched, scale x37.5 (source: author)

Etched: at low magnification of SK0048, etching revealed a ferrite matrix with small grain size and clear grain boundaries. There is a low occurrence of carbon distributed along with grain boundaries. There are both single and double-phased slag inclusions, which the single-phased slag stringers are smaller than the double-phased slag inclusions. The carbon content is less than 0.1% (Fig. 5.116).

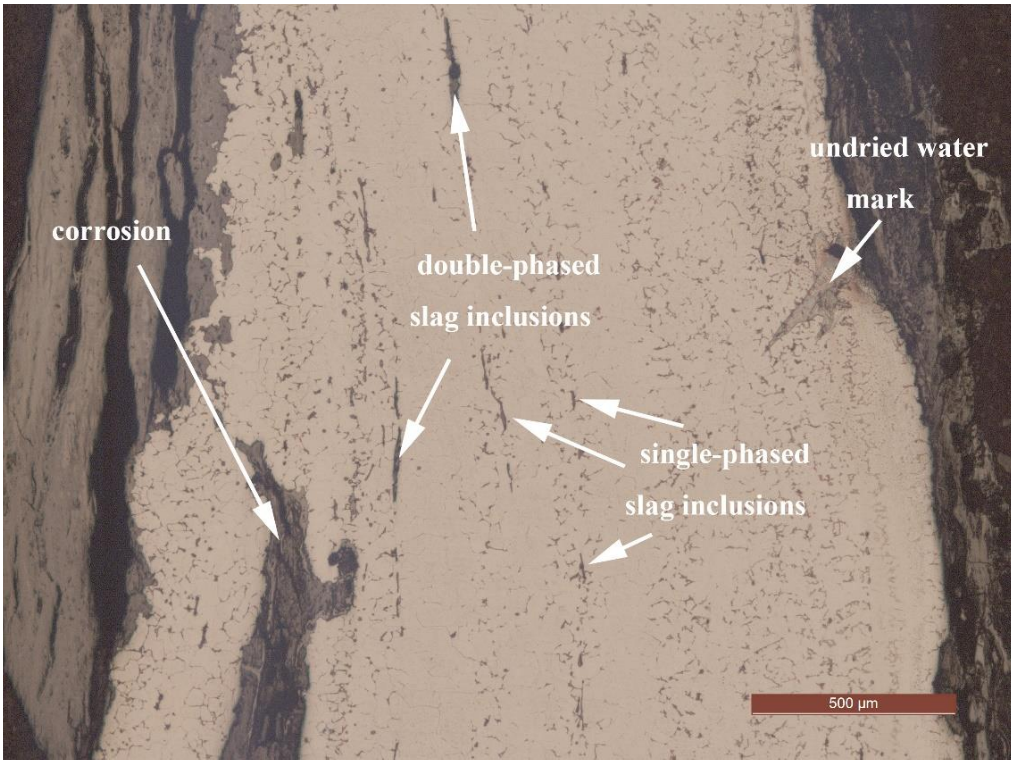


Fig. 5.116 Section from SK0048. Etch 2% nital, scale bar 500μm (source: author)

Sample: SK0049 is cut from the cutting edge of the same sabre (Fig. 5.114).

Unetched: SK0049 is badly corroded on the surface with some metal remaining in the centre. There are large amounts of slag stringers and chains (Fig. 5.117).

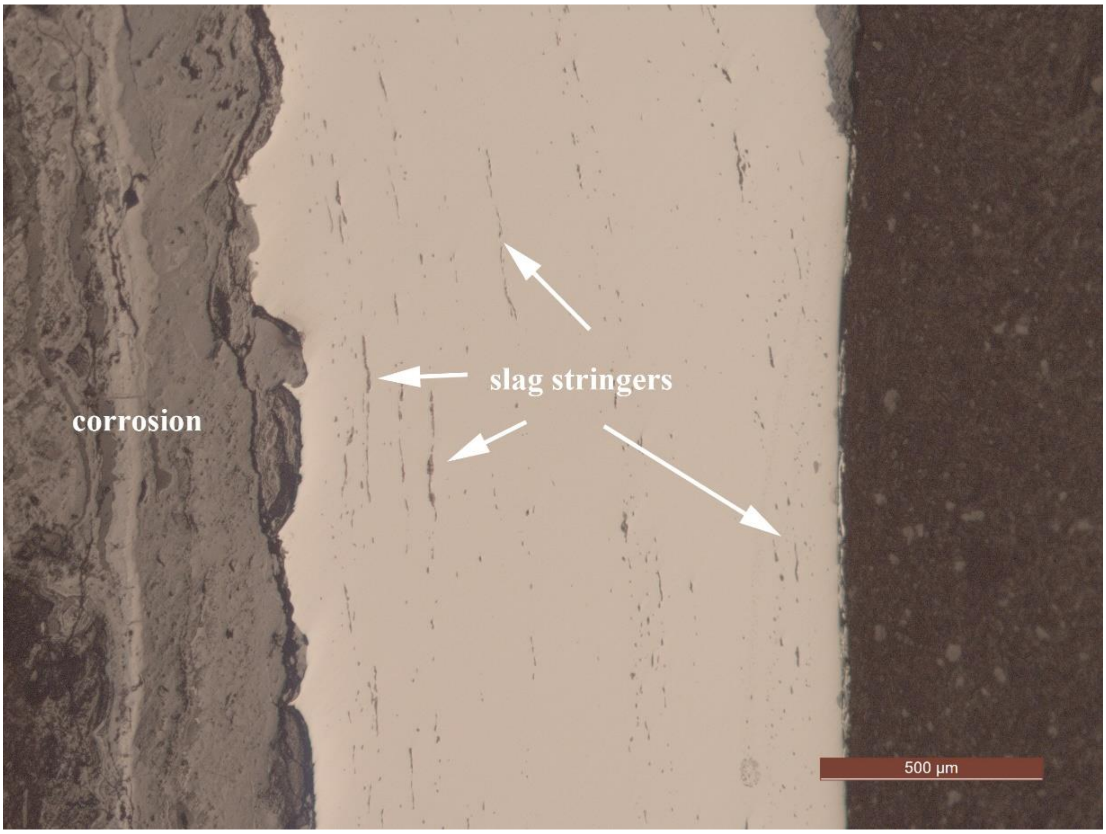


Fig. 5.117 Section from SK0049. Unetched, scale bar 500µm (source: author)

Etched: at low magnification of SK0049, etching revealed a ferrite matrix with large grains size and clear grain boundaries. The slag stringers and chains are distributed in multiple layers. The grain size is bigger in the middle than at the sides (Fig. 5.118). At a higher magnification, the slag inclusions are both single and double-phased. There is a low occurrence of carbon distributed along with grain boundaries (Fig. 5.119).

Initial interpretation: in summary of the sample SK0048 and SK0049, the object was forged either from fined iron or bloomery iron. The overall carbon content is very low, which is less than 0.1% at the ridge of the sabre and almost pure ferrite at cutting edge.

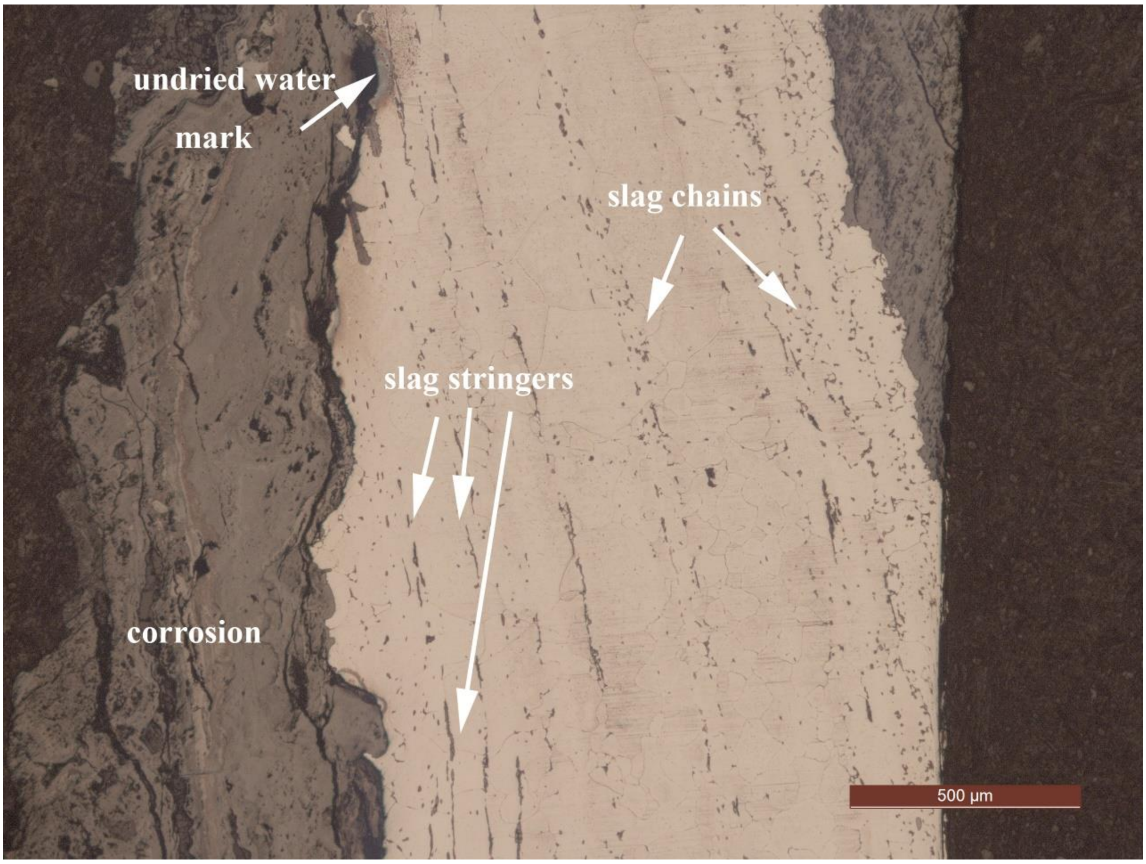


Fig. 5.118 Section from SK0049. Etch 2% nital, scale bar 500μm (source: author)

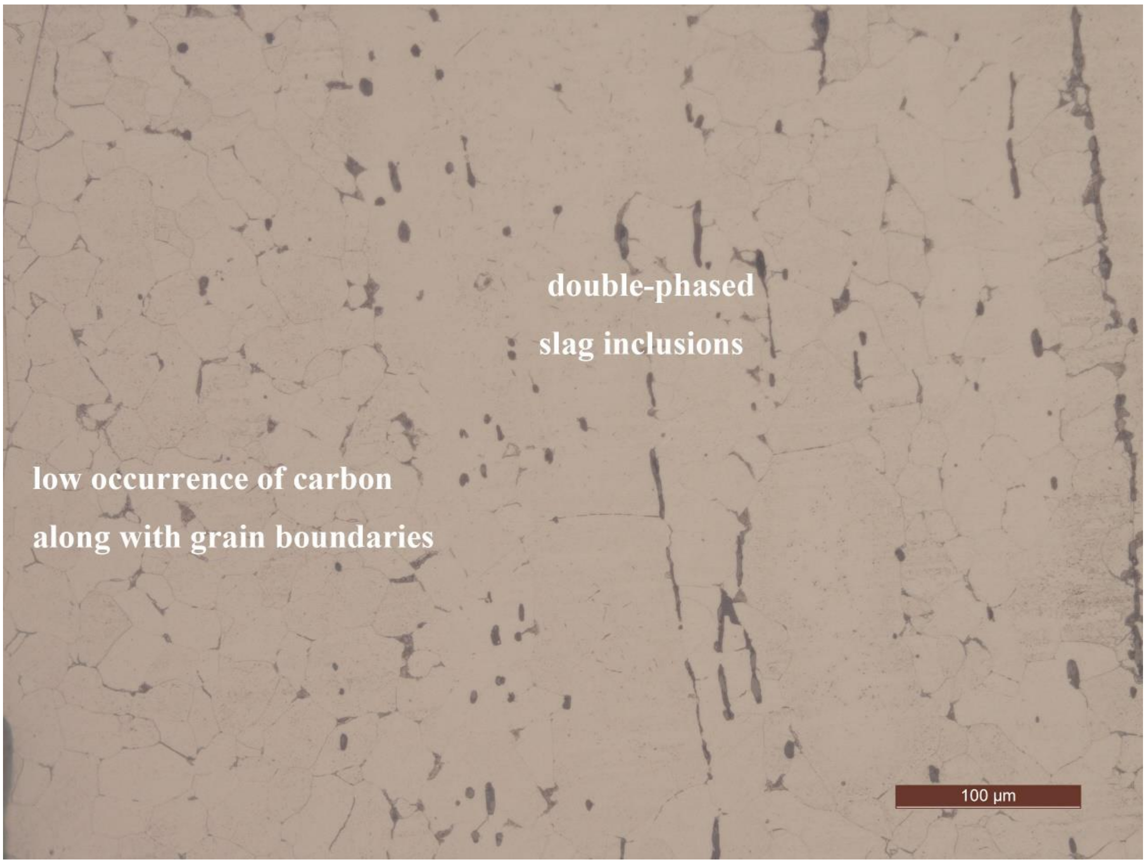


Fig. 5.119 Section from SK0049. Etch 2% nital, scale bar 100μm (source: author)

SK0050 and SK0051

Sample: SK0050 is cut from the cutting edge of an iron axehead, and sample SK0051 is cut from the socket of the same axehead (Fig. 5.120).

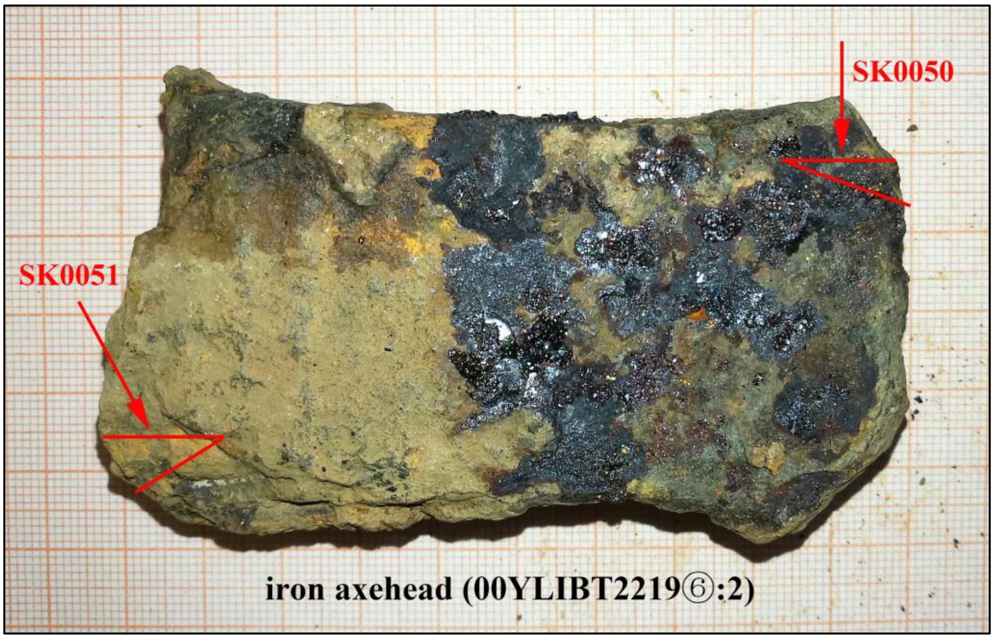


Fig. 5.120 Iron axehead (00YLIBT2219⑥:2) showing the sampling spot of SK0050 and SK0051 (source: author)

Unetched: both samples are almost fully corroded, there are no significant changes before and after etching. Little structures can still be identified from the corroded section (Fig. 5.121).

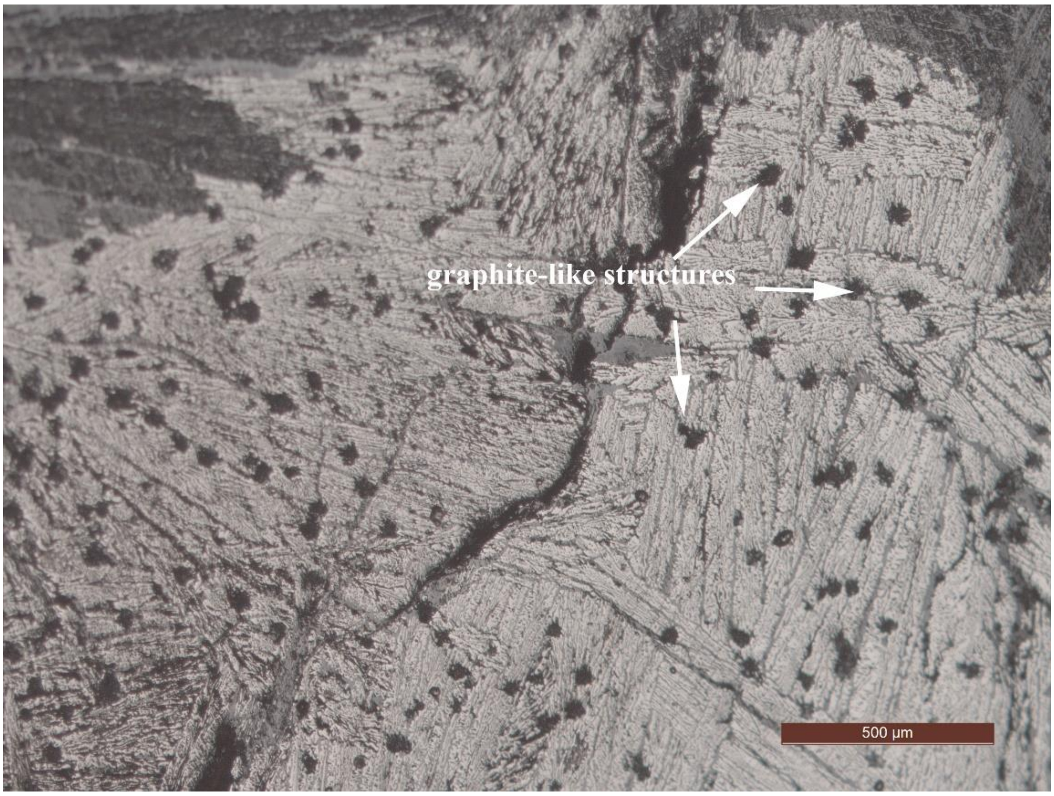


Fig. 5.121 Section from SK0050. Etch 2% nital, scale bar 500µm (source: author)

Etched: at low magnification of sample SK0050, there are large amounts of graphite-like structures throughout the section. The dendritic structures look like ledeburite (Fig. 5.121). At a higher magnification, there are some lamellar pearlite-like structures visible in the corroded area (Fig. 5.122). At low magnification of sample SK0051, although it is almost fully corroded but it can be seen that the structures are possibly similar to SK0001, which there was ledeburite in the middle and pearlite at the sides (Fig. 5.123).

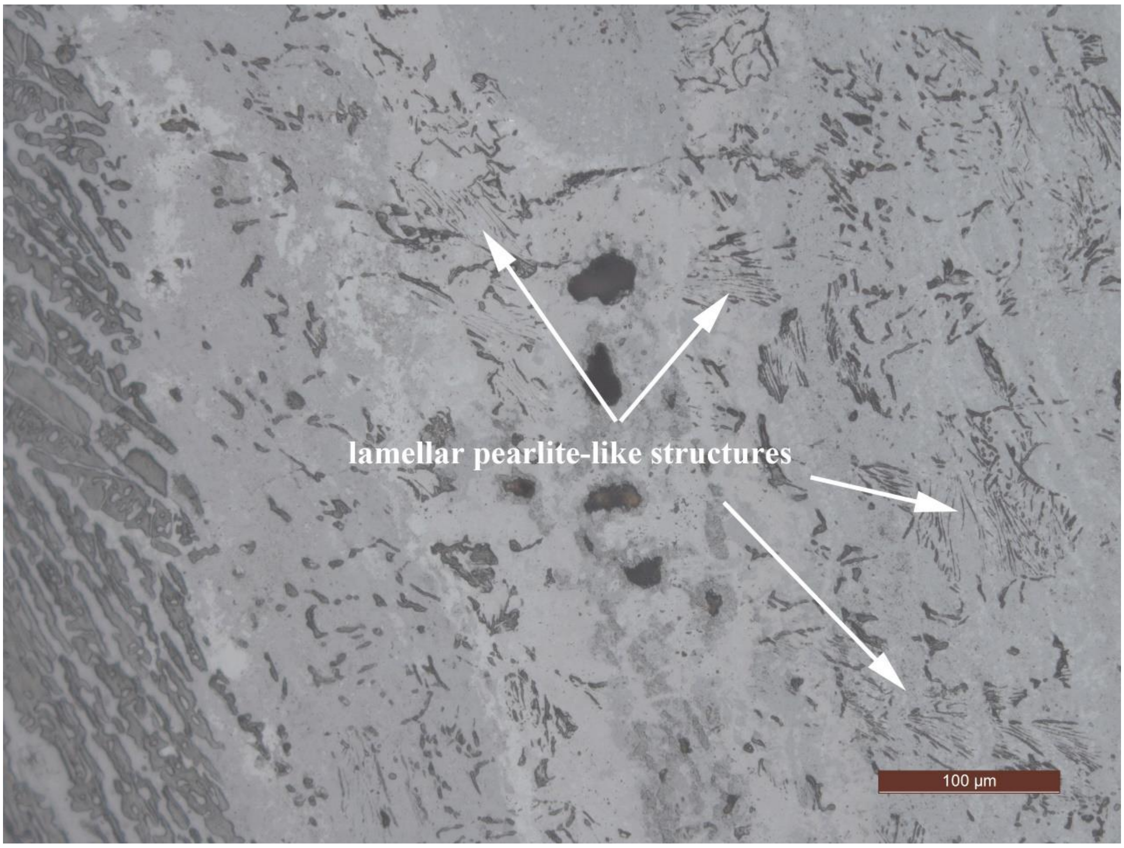


Fig. 5.122 Section from SK0050. Etch 2% nital, scale bar 100μm (source: author)

Initial interpretation: the object was probably cast in white cast iron, and then decarburized incompletely which the cementite started to form pearlite at the surface and ledeburite were left in the core. There might be graphitization happened at the cutting edge.

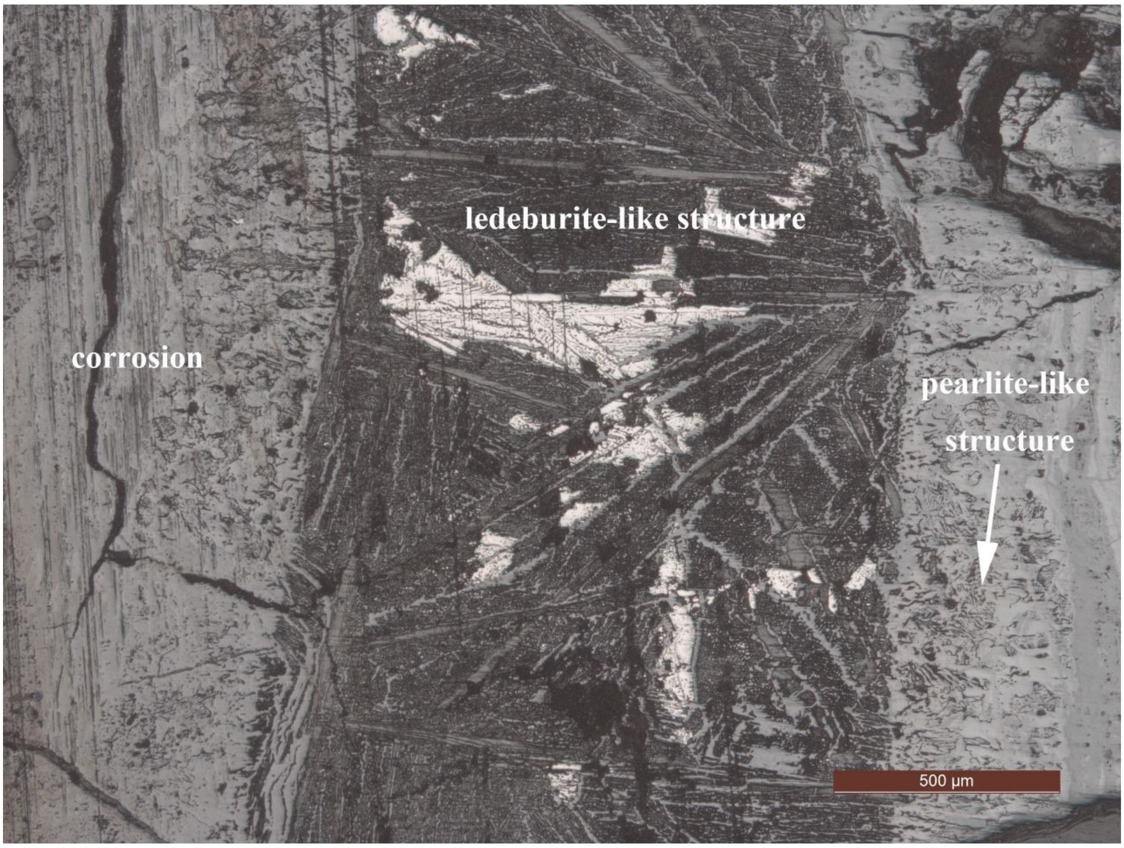


Fig. 5.123 Section from SK0051. Etch 2% nital, scale bar 500µm (source: author)

SK0052

Sample: the cross section of an iron belt hook (Fig. 5.124).

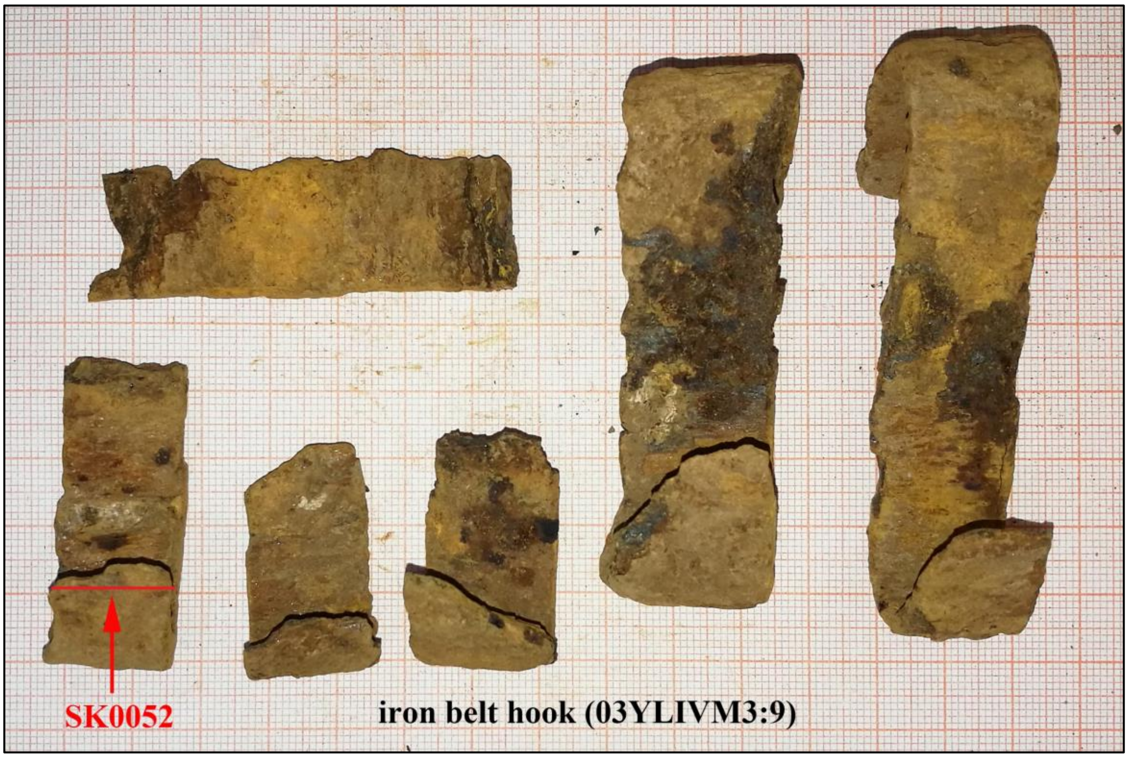


Fig. 5.124 Iron belt hook (03YLIVM3:9) showing the sampling spot of SK0052 (source: author)

Unetched: the sample is badly corroded with some metal remaining in the centre (Fig. 5.125).

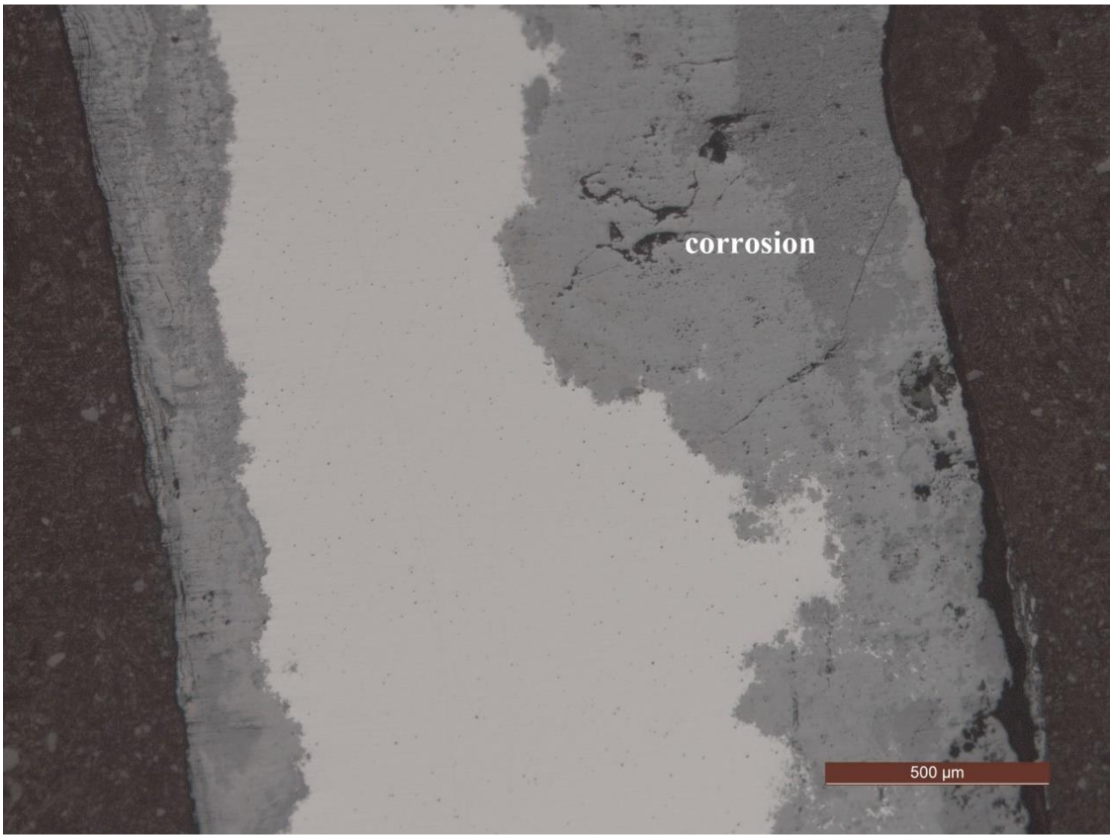


Fig. 5.125 Section from SK0052. Unetched, scale bar 500µm (source: author)

Fig. 5.126 Section from SK0052. Etch 2% nital, scale bar 500μm (source: author)

Etched: at low magnification, etching revealed a ferrite matrix with very small grain size and clear grain boundaries. There is a low occurrence of carbon distributed along with grain boundaries. The carbon content is c.0.1%. There is no obvious evidence of slag inclusions (Fig. 5.126).

Initial interpretation: the belt hook was cast and decarburized to c.0.1% carbon content.

SK0053 and SK0054

Sample: SK0053 is cut from the cutting edge of an iron mattockhead and sample SK0054 is cut from the socket of the same mattockhead (Fig. 5.127).

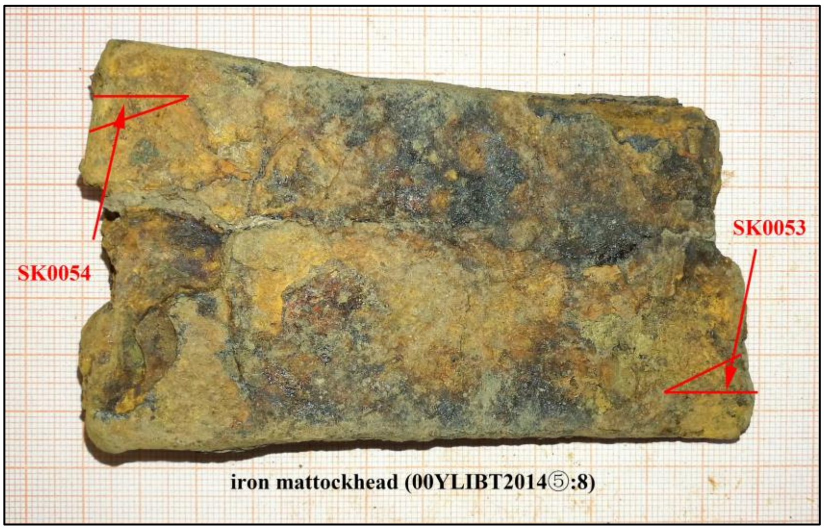


Fig. 5.127 Iron mattockhead (00YLIBT2014⑤:8) showing the sampling spot of SK0053 and SK0054 (source: author)

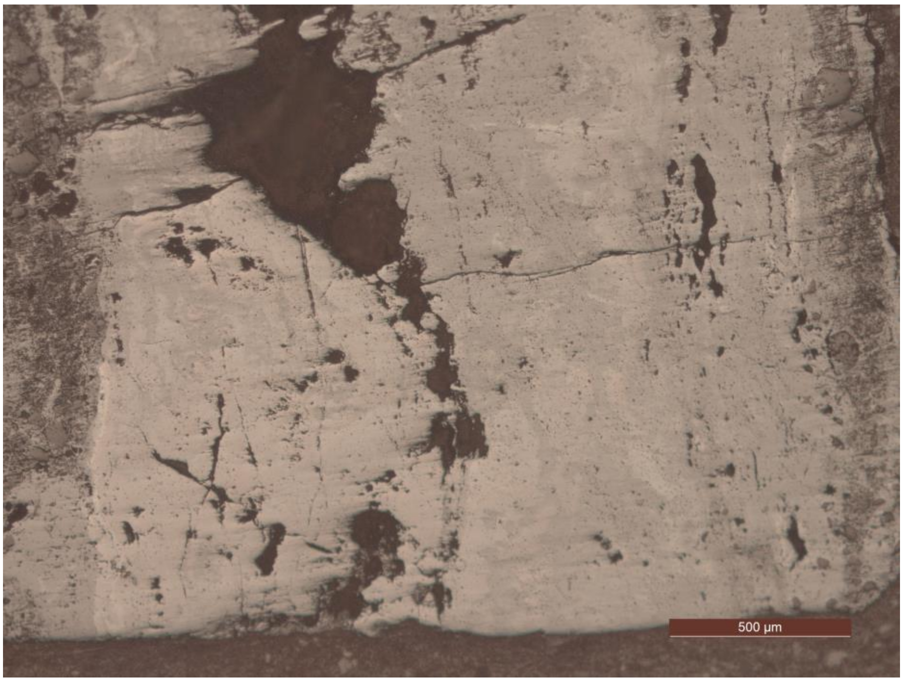


Fig. 5.128 Section from SK0053. Etch 2% nital, scale bar 500µm (source: author)

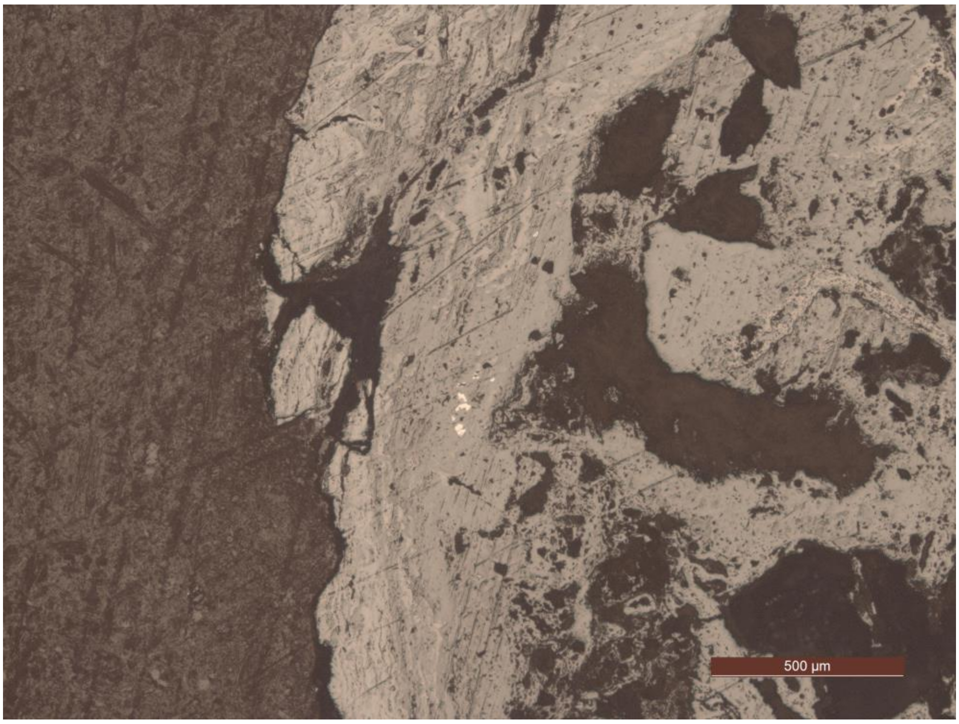


Fig. 5.129 Section from SK0054. Etch 2% nital, scale bar 500μm (source: author)

Initial interpretation: both samples are fully corroded which no metallographic structures can be identified from neither the unetched nor the etched sections (Fig. 5.128, Fig. 5.129).

SK0055

Sample: the cross section of an iron object ear (handle) (Fig. 5.130).

Fig. 5.130 Iron object ear (97BT0205⑩) showing the sampling spot of SK0055 (source: author)

Unetched: the sample is slightly corroded with some metal remaining in the centre. There are large amounts of very small slag inclusions distributed in curved chains (Fig. 5.131).

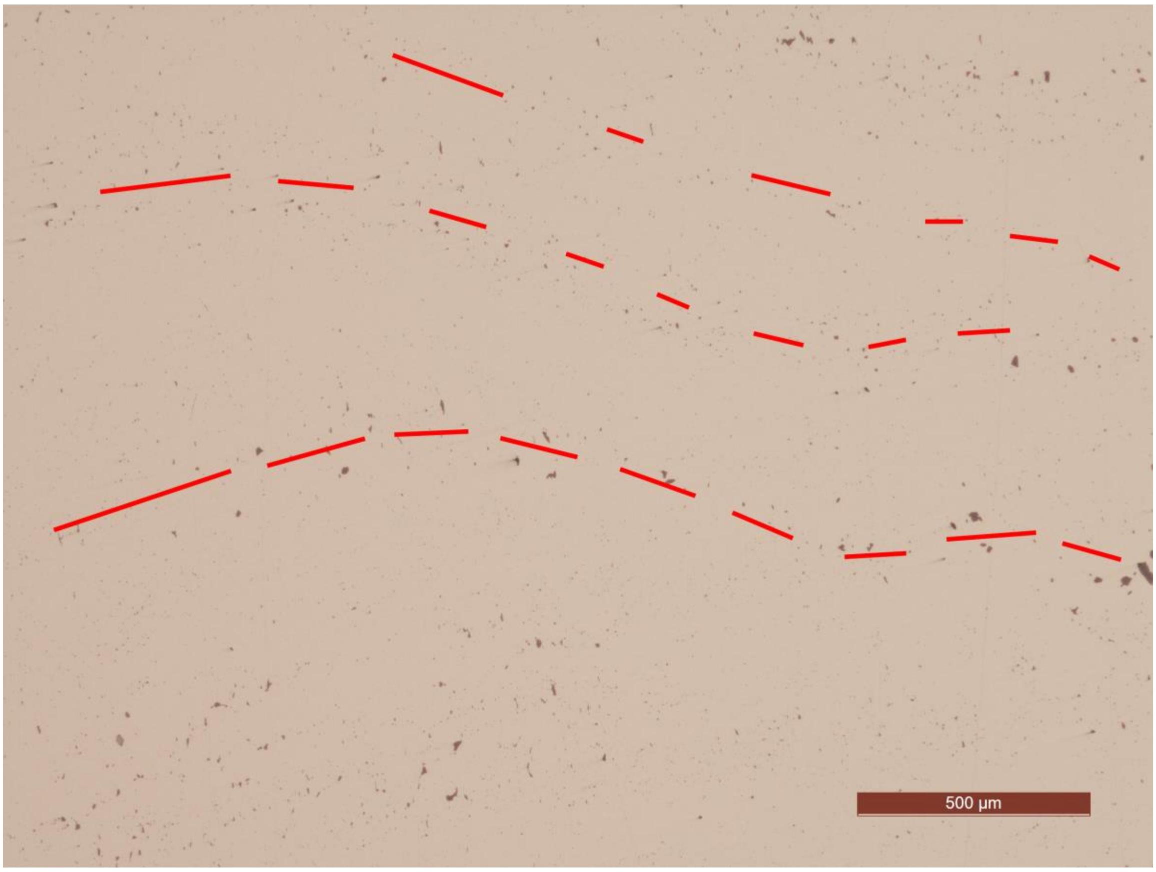


Fig. 5.131 Section from SK0055. Unetched, scale bar 500µm (source: author)

Etched: at low magnification, etching revealed a pearlite and ferrite matrix with very small grain size and clear grain boundaries. The carbon content differs from 0.4-0.6% in different layers. The slag inclusions are very small and not clearly shown in the light field (Fig. 5.132). In the dark field at a higher magnification, the slag inclusions are visible. Some of the slag inclusions are in stringers and some are less deformed nodules (Fig. 5.133).

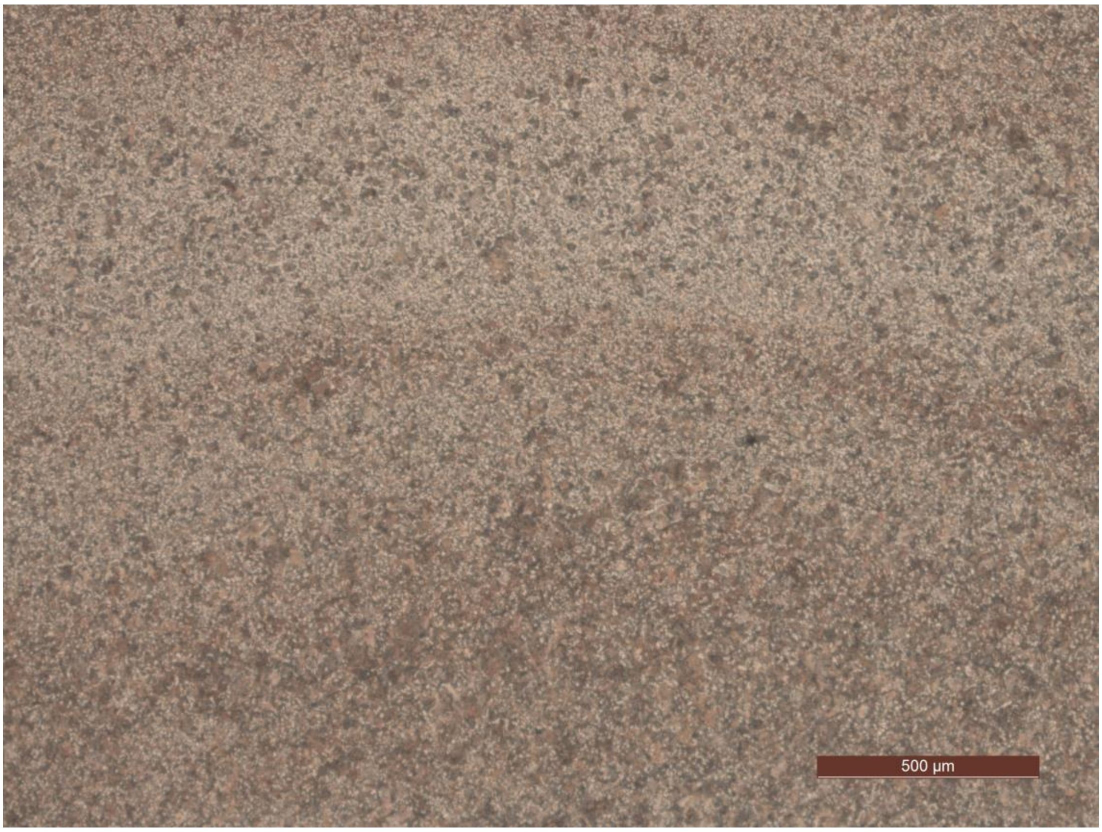


Fig. 5.132 Section from SK0055. Etch 2% nital, scale bar 500μm (source: author)

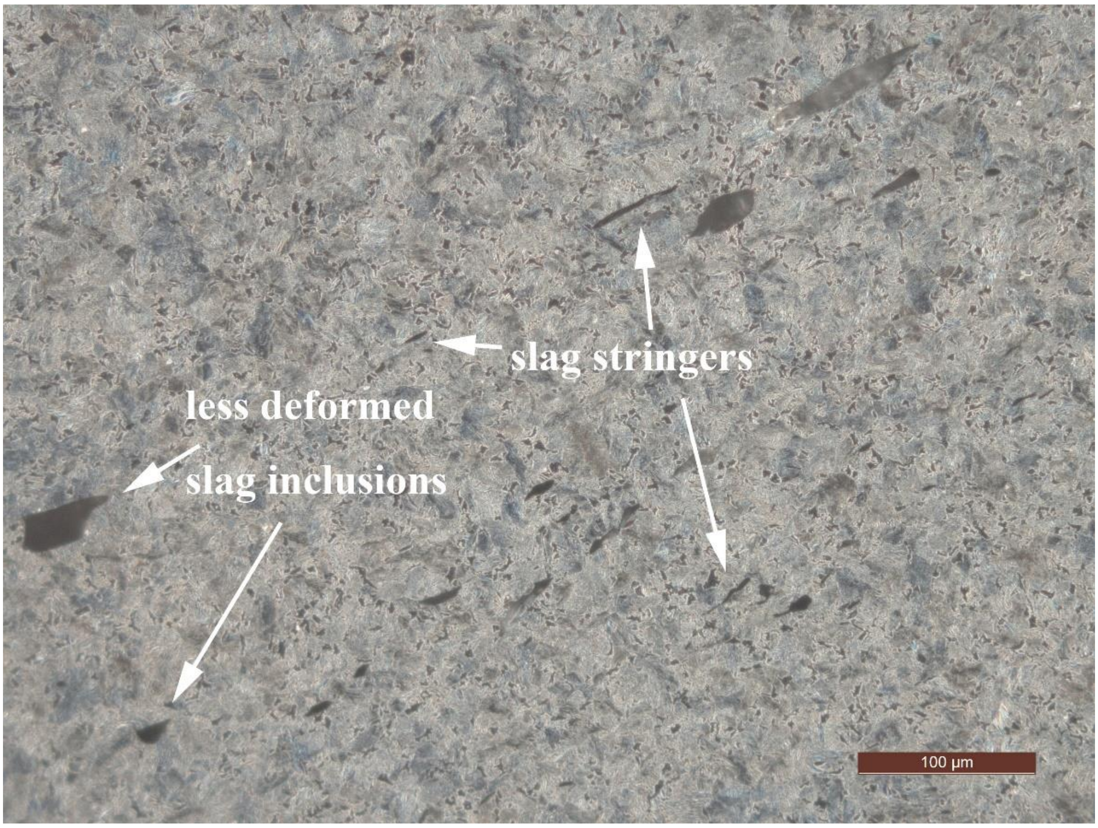


Fig. 5.133 Section from SK0055. Dark field, etch 2% nital, scale bar 100μm (source: author)

Initial interpretation: the iron object ear was probably forged from fined iron or bloomery iron.

SK0056

Sample: the cross section of an iron belt hook (Fig. 5.134).

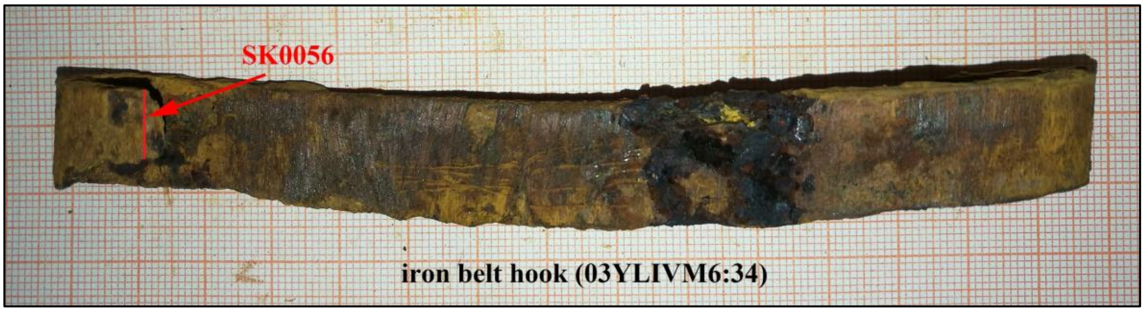


Fig. 5.134 Iron belt hook (03YLIVM6:34) showing the sampling spot of SK0056 (source: author)

Unetched: the sample is corroded on the surface with some metal remaining in the centre. There are large amounts of very small slag inclusions distributed in chains (Fig. 5.135).

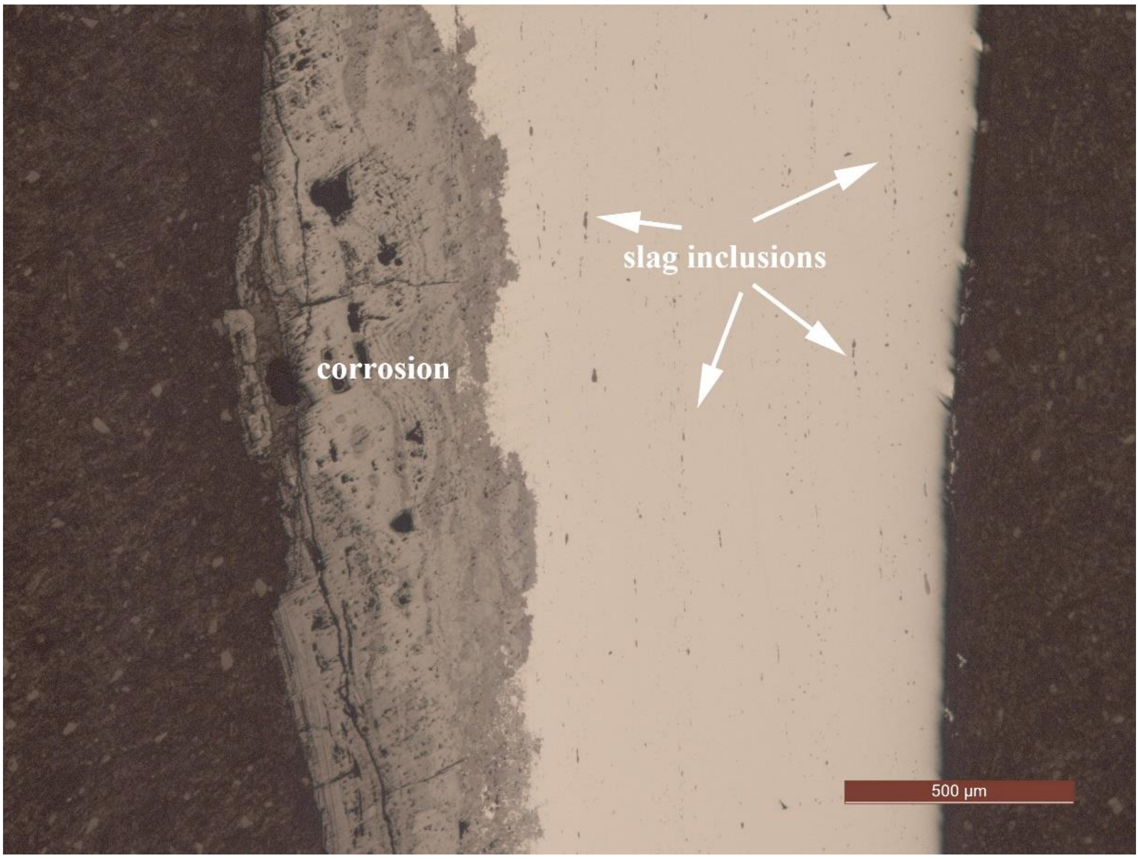


Fig. 5.135 Section from SK0056. Unetched, scale bar 500µm (source: author)

Etched: at low magnification, etching revealed a pearlite and ferrite matrix with small grain size and clear grain boundaries. The carbon content is c.0.2-0.5%, which there are less carbon content at the surface than in the core. There is a slightly segregation of pearlite in the core, which the sizes of the pearlite grains are bigger than elsewhere throughout the section (Fig. 5.136).

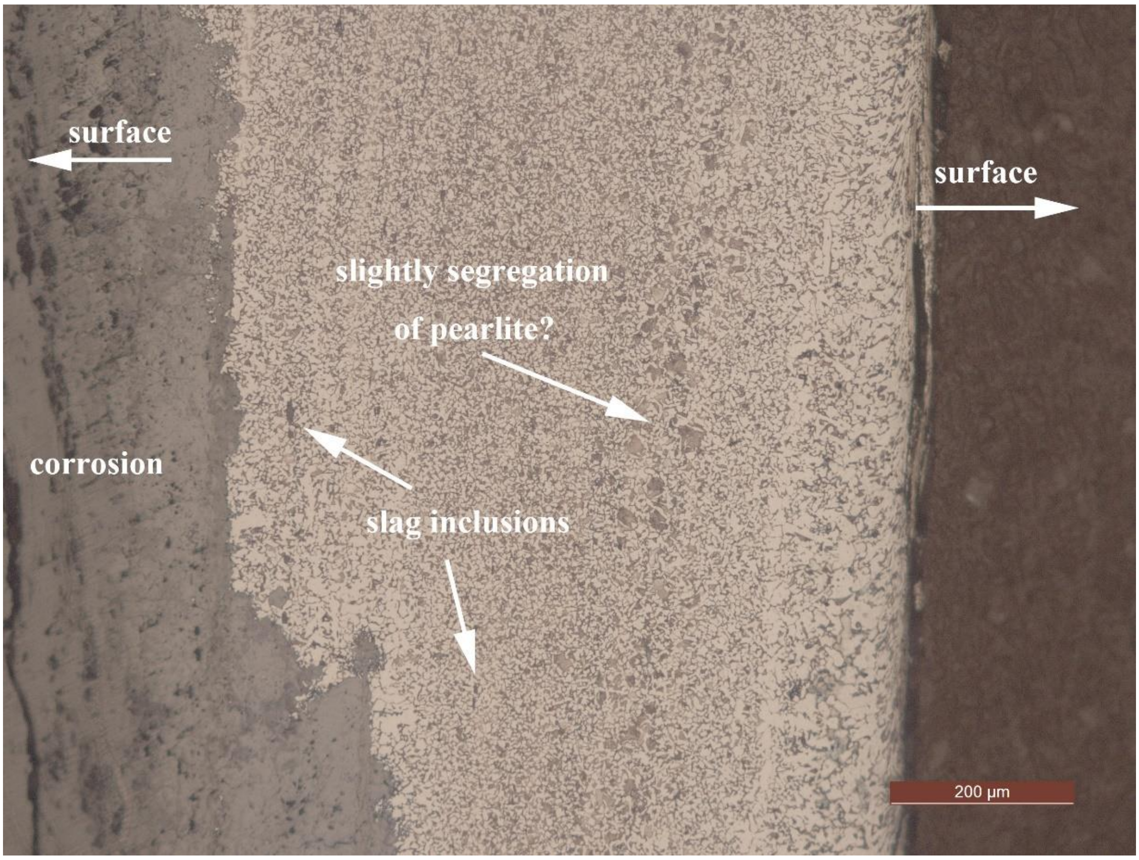


Fig. 5.136 Section from SK0056. Etch 2% nital, scale bar 200μm (source: author)

Initial interpretation: the iron belt hook was probably forged from fined iron or bloomery iron.

SK0057 and SK0058

Sample: SK0057 is cut the peak of an iron pickaxehead (Fig. 5.137).

Unetched: SK0057 is slightly corroded on the surface and the metal remaining in the centre. There are large amounts of small slag inclusions distributed randomly (Fig. 5.138).

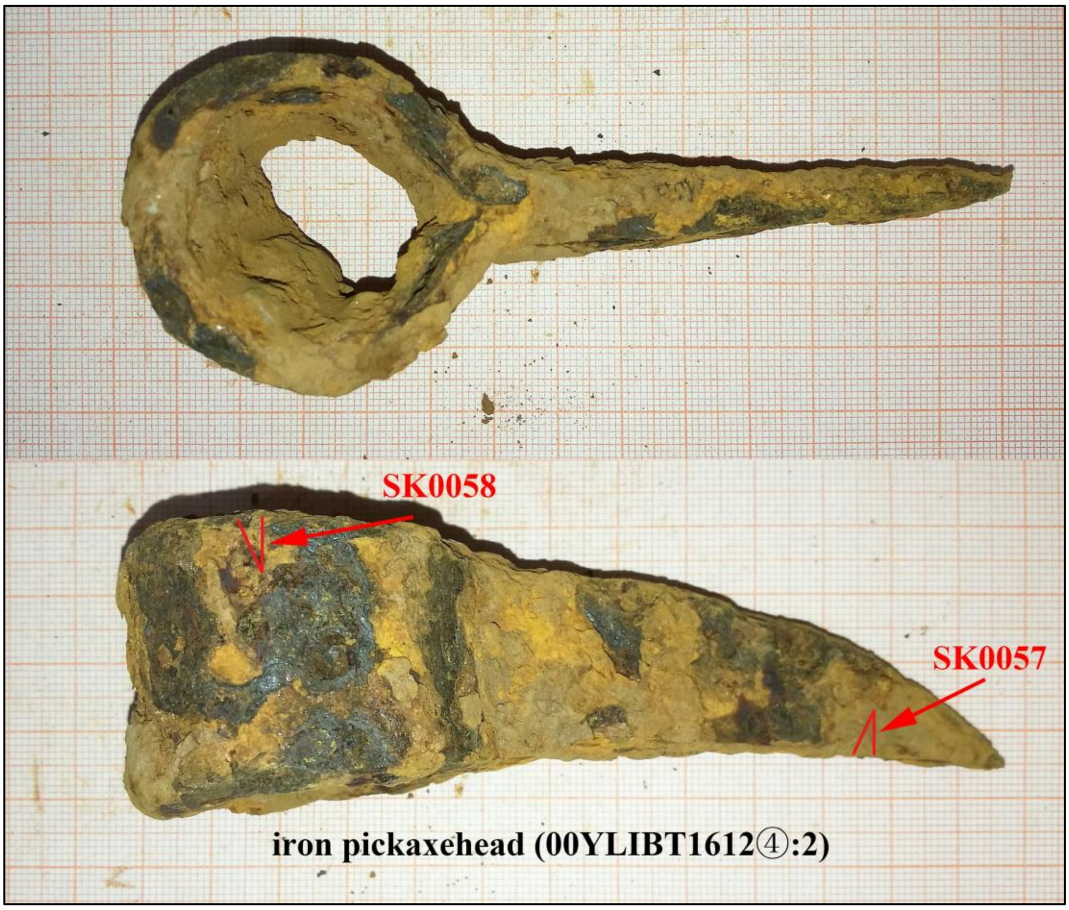


Fig. 5.137 Iron pickaxehead (00YLIBT1612④:2) showing the sampling spot of SK0057 and SK0058 (source: author)

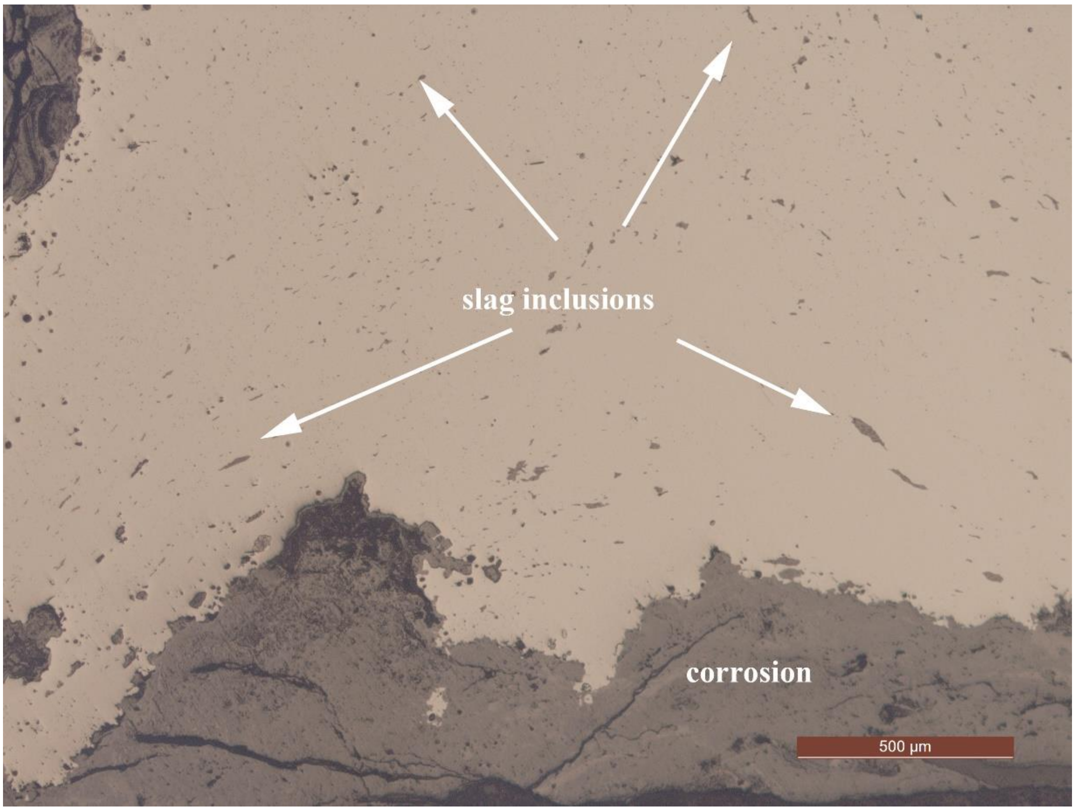


Fig. 5.138 Section from SK0057. Unetched, scale bar 500μm (source: author)

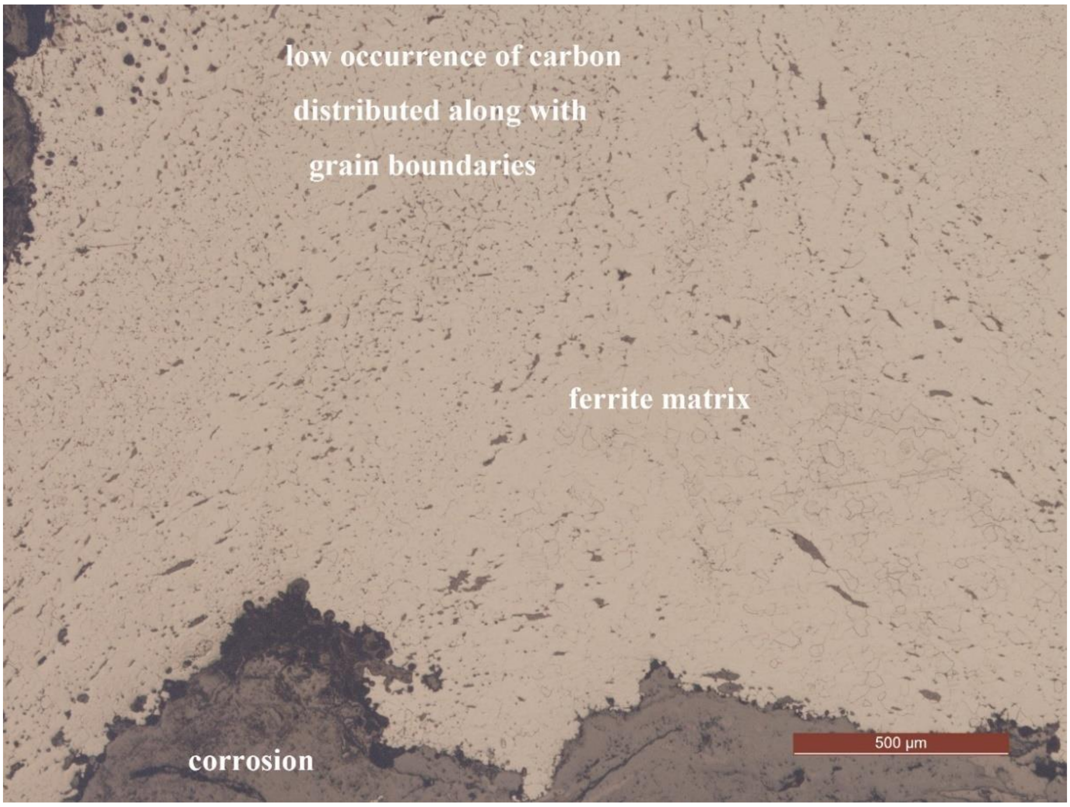


Fig. 5.139 Section from SK0057. Etch 2% nital, scale bar 500μm (source: author)

Etched: at low magnification of SK0057, etching revealed a ferrite matrix with small grain size (Fig. 5.139). There is a low occurrence of carbon distributed along with grain boundaries, which could be seen clearly at a higher magnification (Fig. 5.140).

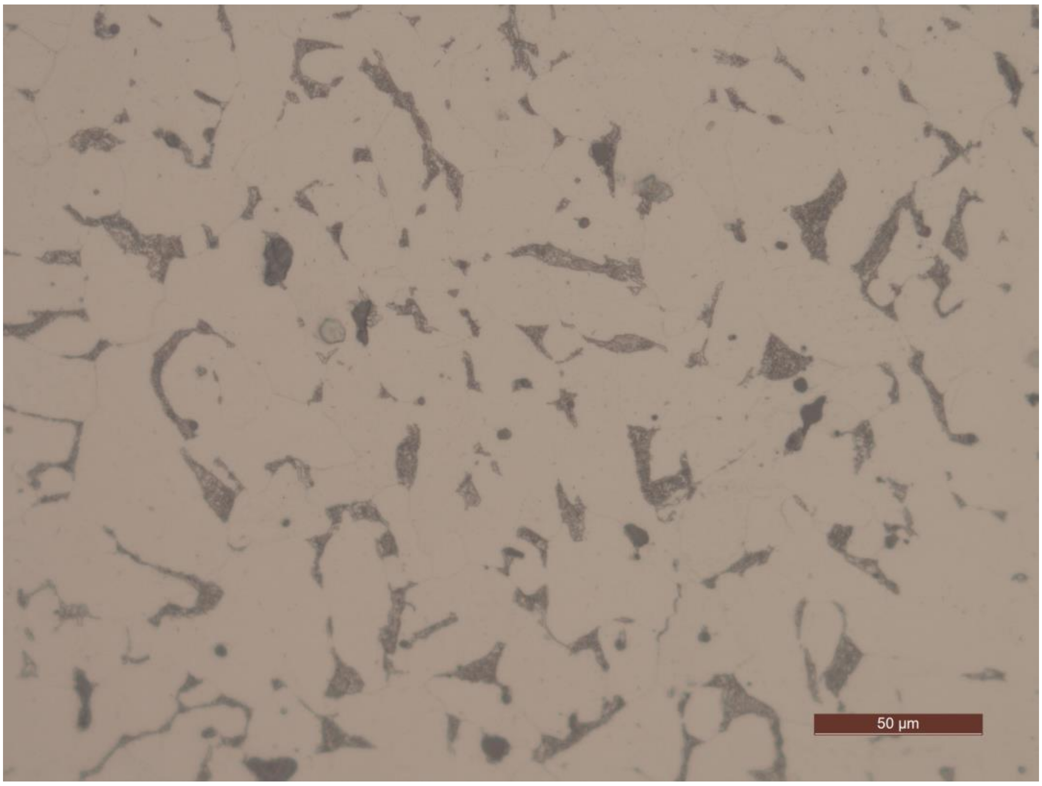


Fig. 5.140 Section from SK0057. Etch 2% nital, scale bar 50μm (source: author)

Sample: SK0058 is cut from the socket of the same pickaxehead (Fig. 5.137).

Unetched: SK0058 is slightly corroded and the metal remaining in the centre. There are large amounts of slag stringers distributed in one direction and slightly curved (Fig. 5.141).

Etched: at low magnification of SK0058, etching revealed a ferrite matrix with small grain size (Fig. 5.142). There is a low occurrence of carbon distributed along with grain boundaries, which could be seen clearly at a higher magnification (Fig. 5.143). The slag inclusions are double-phased.

Initial interpretation: in summary of the sample SK0057 and SK0058, the iron pickaxehead was probably forged from fined iron or bloomery iron.

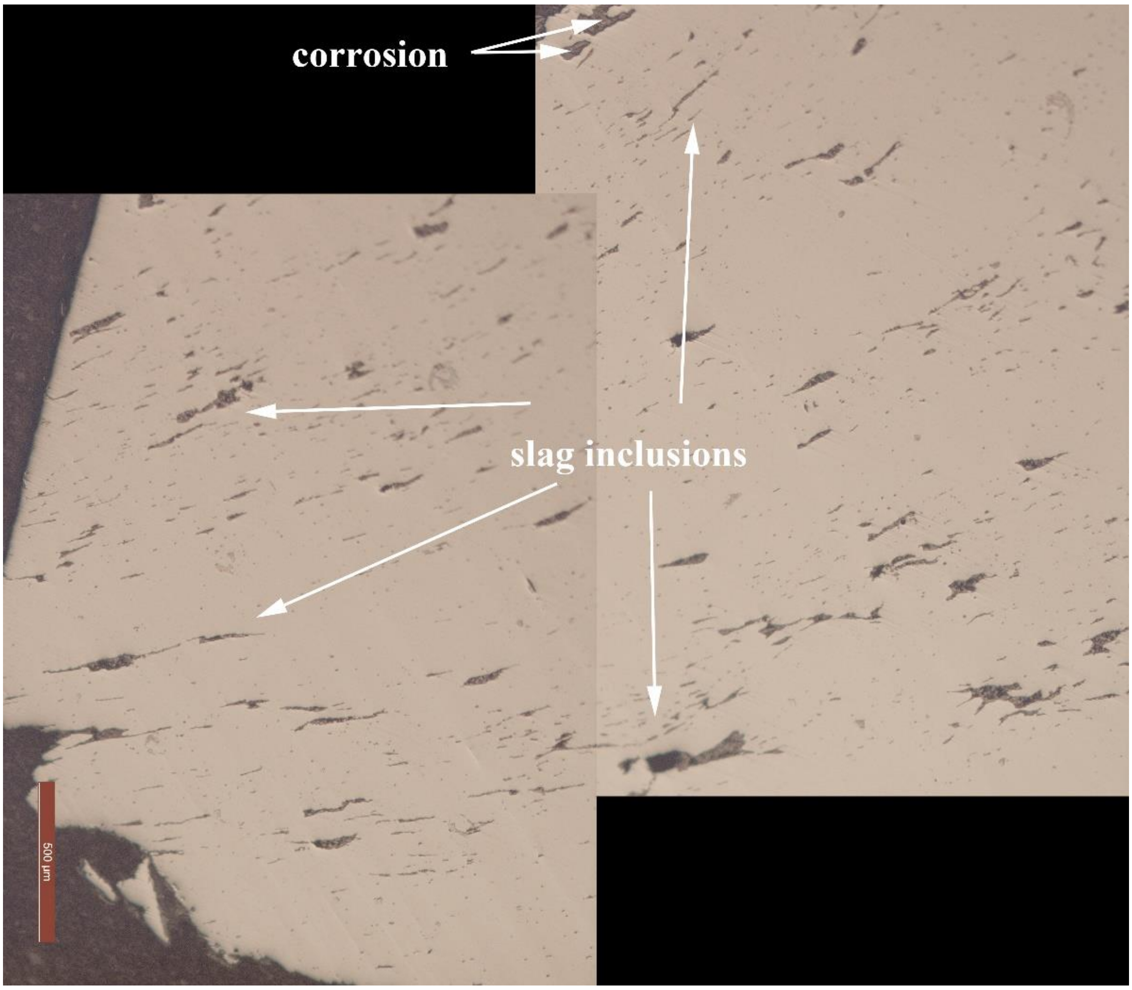


Fig. 5.141 Montage of the section from SK0058. Unetched, scale bar 500µm (source: author)

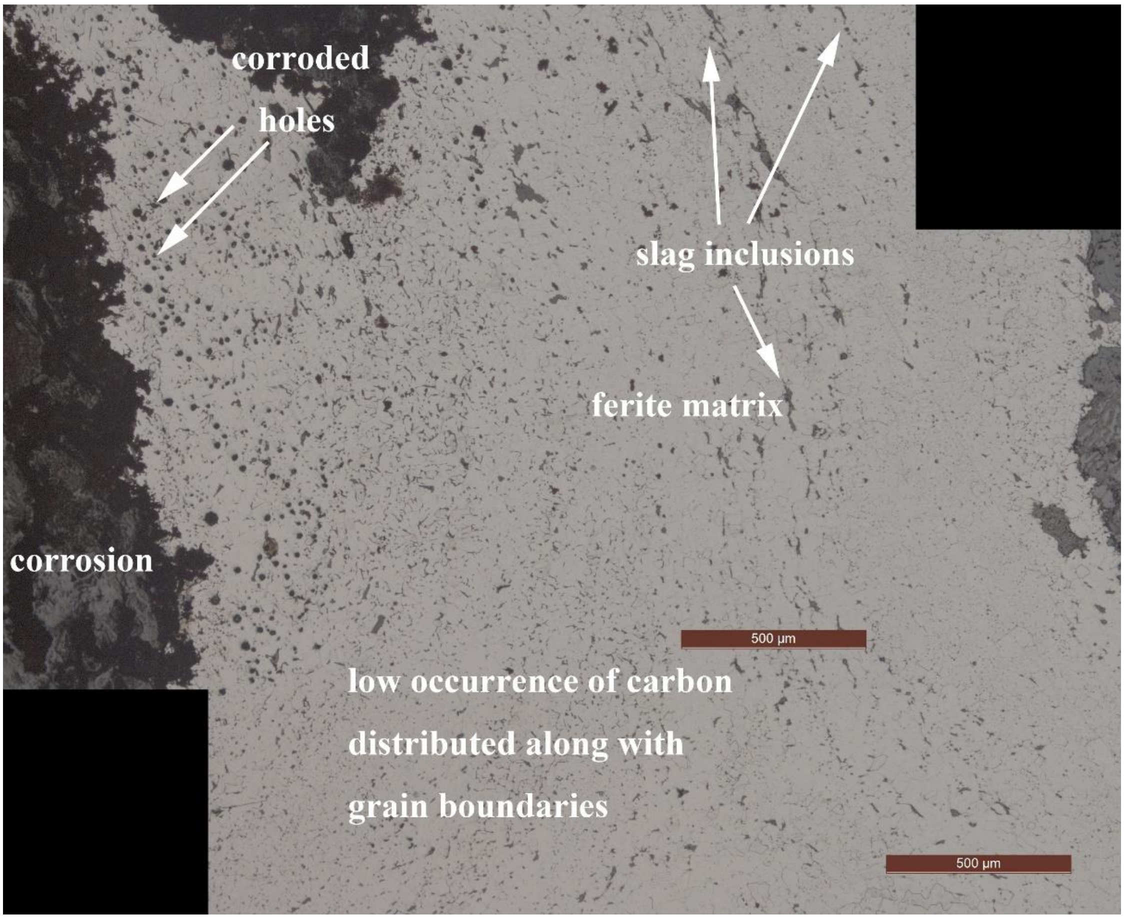


Fig. 5.142 Montage of the section from SK0058. Etch 2% nital, scale bar 500μm (source: author)

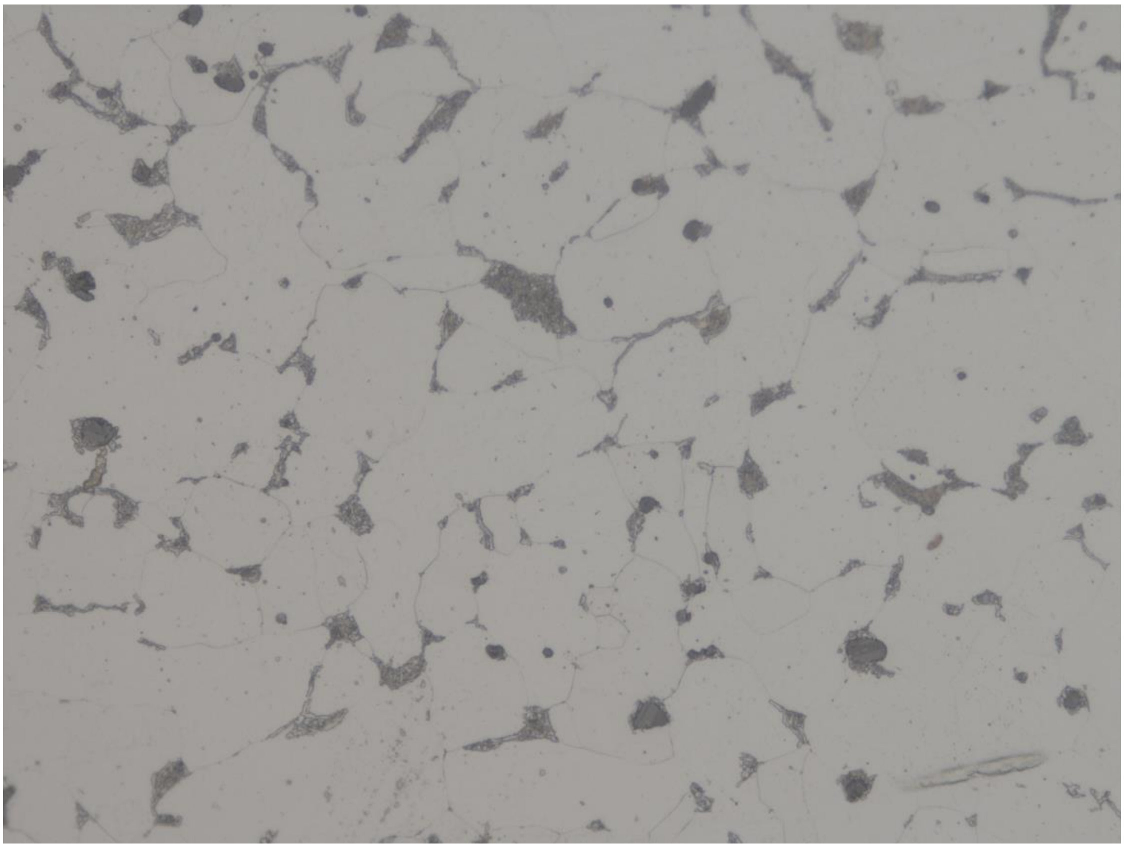


Fig. 5.143 Section from SK0058. Etch 2% nital, scale x375 (source: author)

SK0059 and SK0060

Sample: SK0059 is cut from the cutting edge of an iron mattockhead (Fig. 5.144).

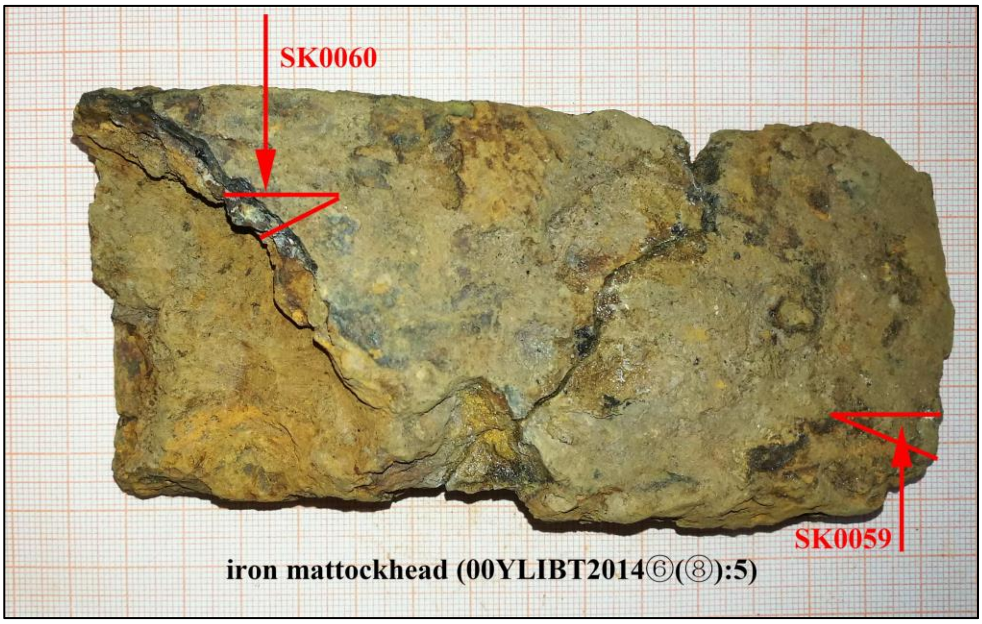


Fig. 5.144 Iron mattockhead (00YLIBT2014⑥(⑧):5) showing the sampling spot of SK0059 and SK0060 (source: author)

Unetched: SK0059 is badly corroded and there are no significant changes before and after etching. There are some structures can still be identified. Large amounts of graphite-like nodules are visible throughout the section (Fig. 5.145). There are some lamellar pearlite-like structures visible at a higher magnification (Fig. 5.146).

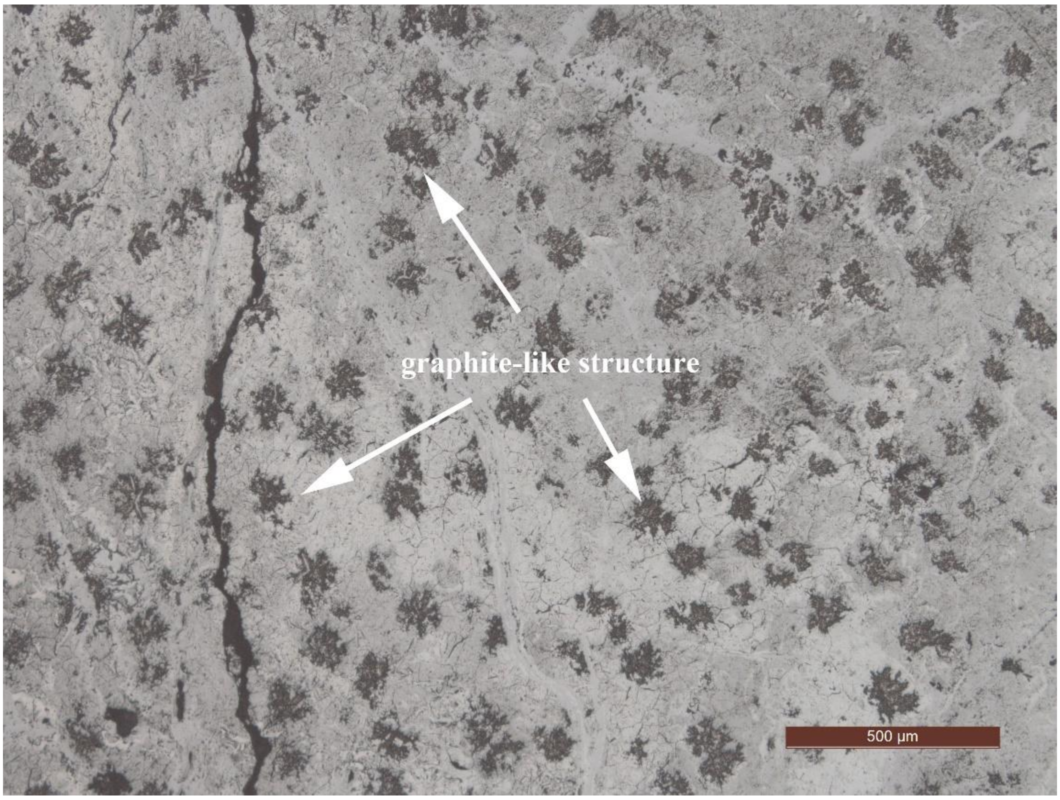


Fig. 5.145 Section from SK0059. Etch 2% nital, scale bar 500μm (source: author)

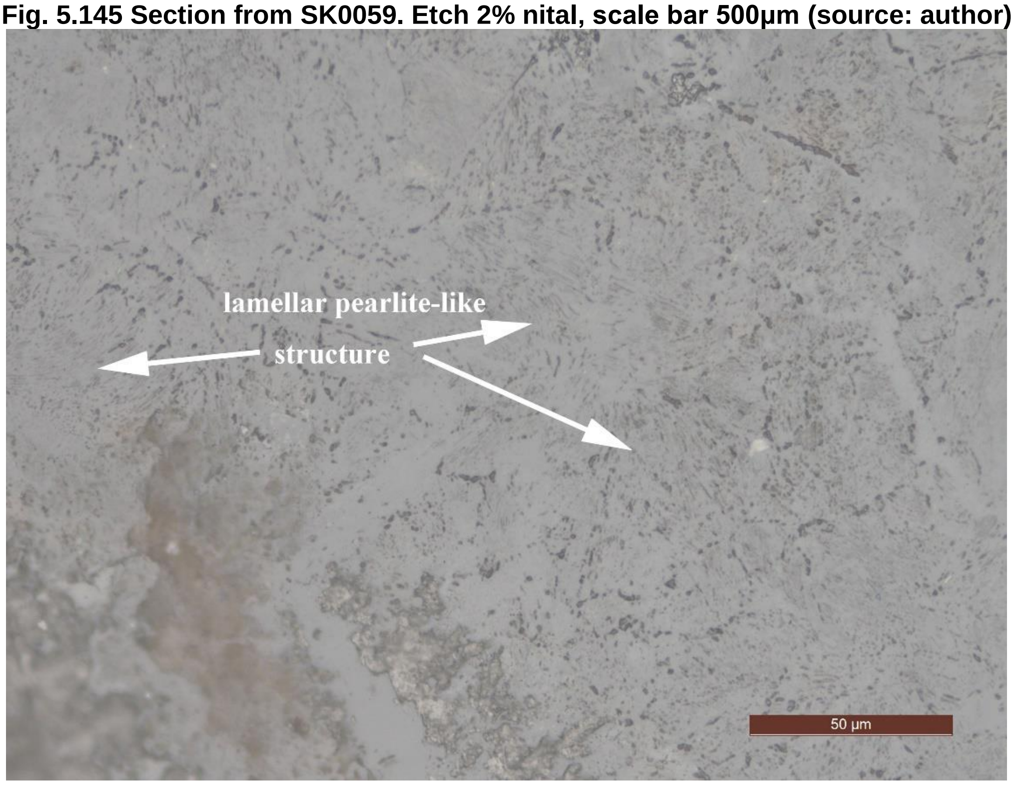


Fig. 5.146 Section from SK0059. Etch 2% nital, scale bar 50μm (source: author)

Sample: SK0060 is cut from the socket of the same mattockhead (Fig. 5.144).

Unetched: SK0060 is fully corroded which no metallographic structures can be identified from the section (Fig. 5.147).

Initial interpretation: in summary of the two samples, the iron mattockhead was probably cast in white cast iron first, and then annealed to malleable cast iron.

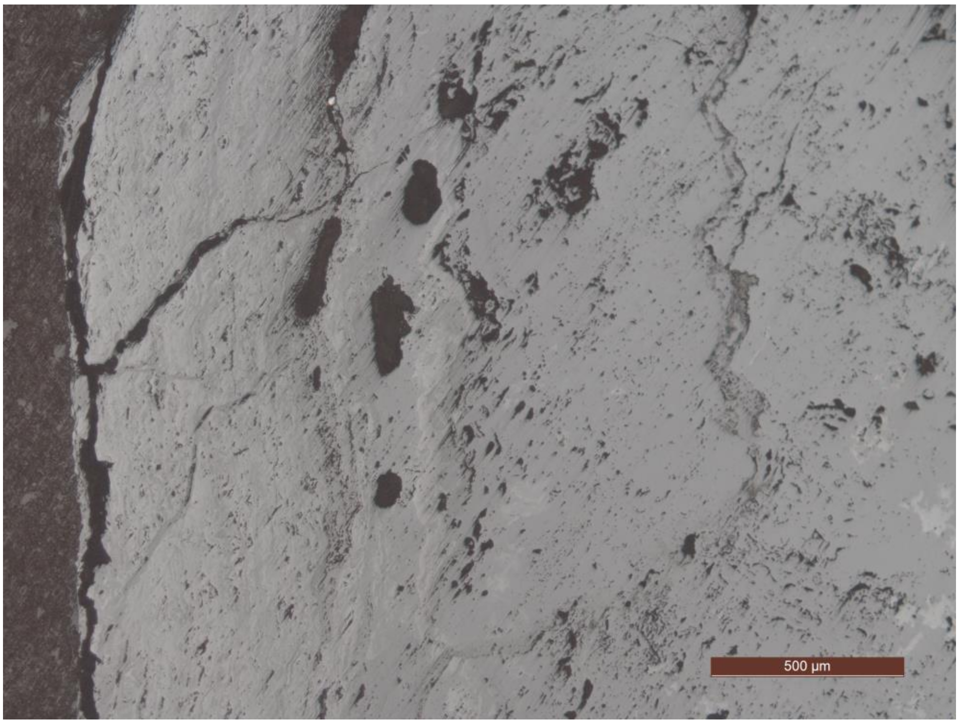


Fig. 5.147 Section from SK0060. Etch 2% nital, scale bar 500μm (source: author)

SK0061

Sample: the cross section of an iron belt hook (Fig. 5.148).

Fig. 5.148 Iron belt hook (03YLIVM6:6) showing the sampling spot of SK0061 (source: author)

Unetched: the sample is corroded on the surface with some metal remaining in the centre. There are some big slag inclusions and many small slag stringers (Fig. 5.149).

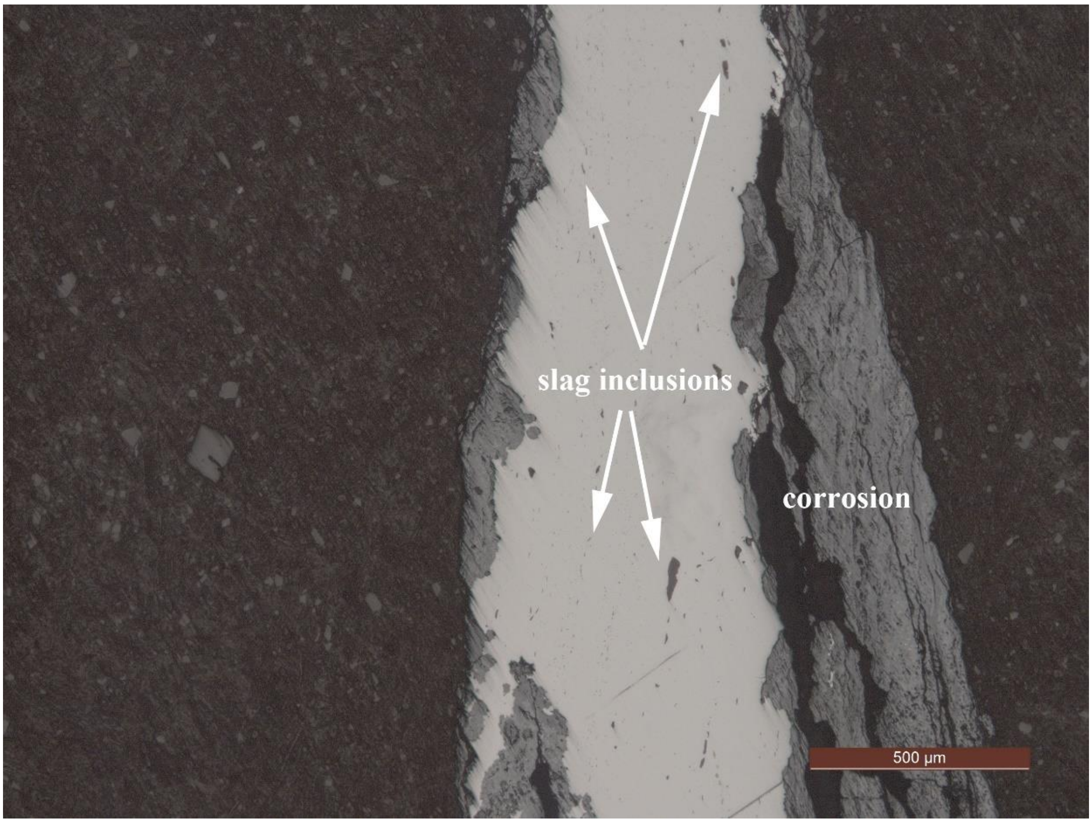


Fig. 5.149 Section from SK0061. Unetched, scale bar 500µm (source: author)

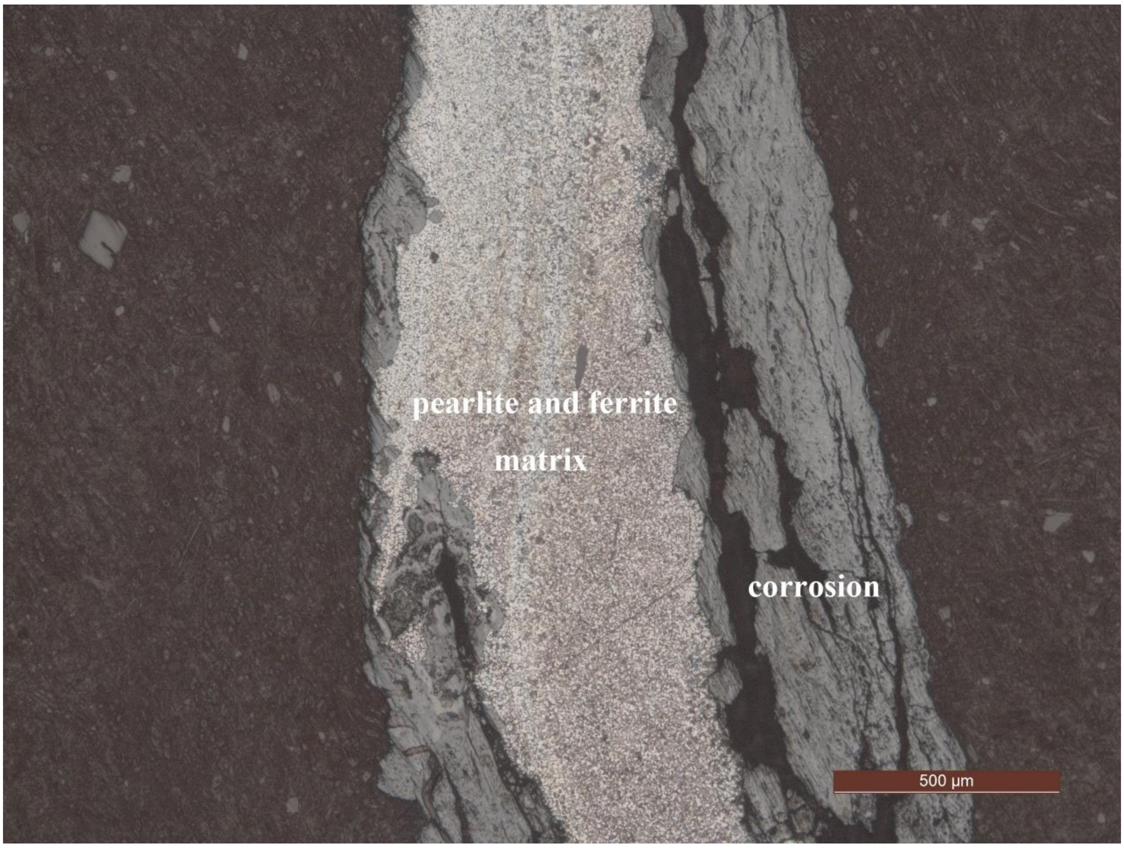


Fig. 5.150 Section from SK0061. Etch 2% nital, scale bar 500μm (source: author)

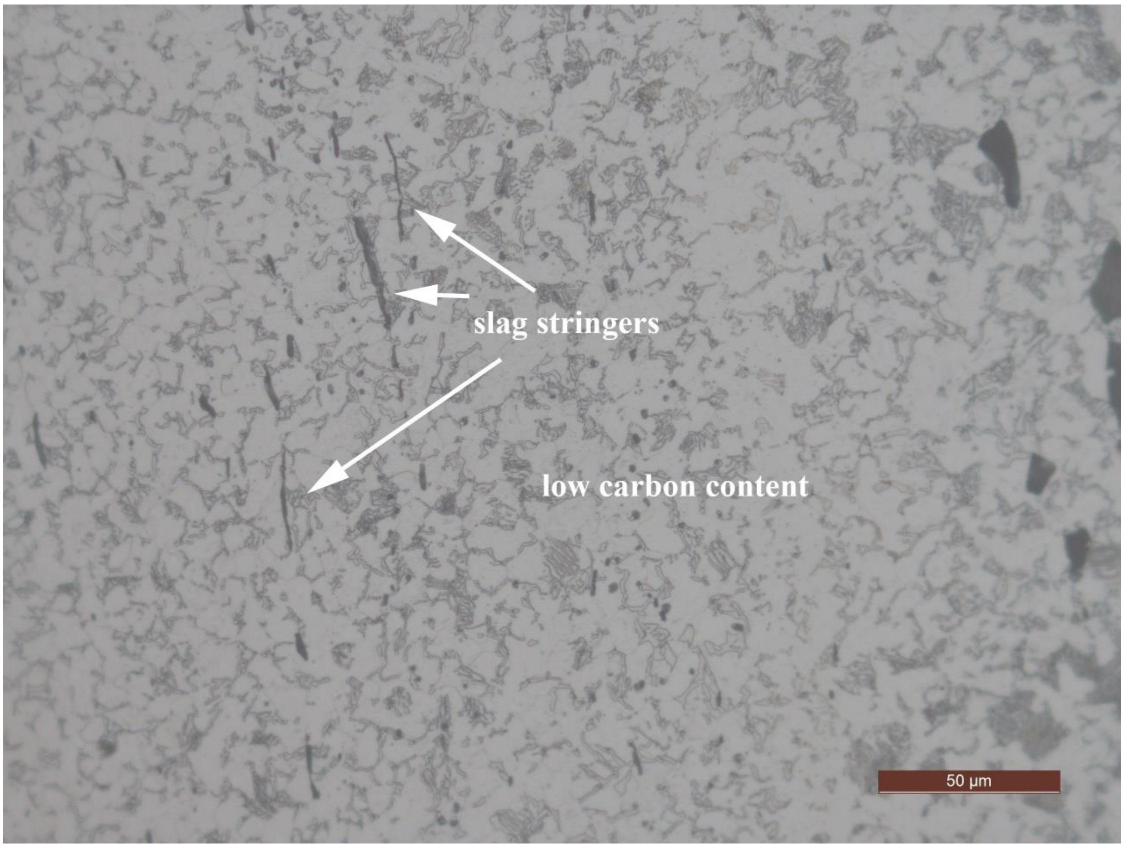


Fig. 5.151 Section from SK0061. Etch 2% nital, scale bar 50μm (source: author)

Etched: at low magnification, etching revealed a pearlite and ferrite matrix with very small grain size and clear grain boundaries. The carbon content is uneven throughout the section, which is higher in the core and lower at the surface (Fig. 5.150). At a higher magnification, the slag inclusions are in stringers and the carbon content in the low area is c.0.2% (Fig. 5.151).

Initial interpretation: the iron belt hook was probably forged from fined iron or bloomery iron, with a carbon content of c.0.2-0.4% throughout the section.

SK0062 and SK0063

Sample: SK0062 is cut from the cutting edge of an iron axehead (Fig. 5.152).

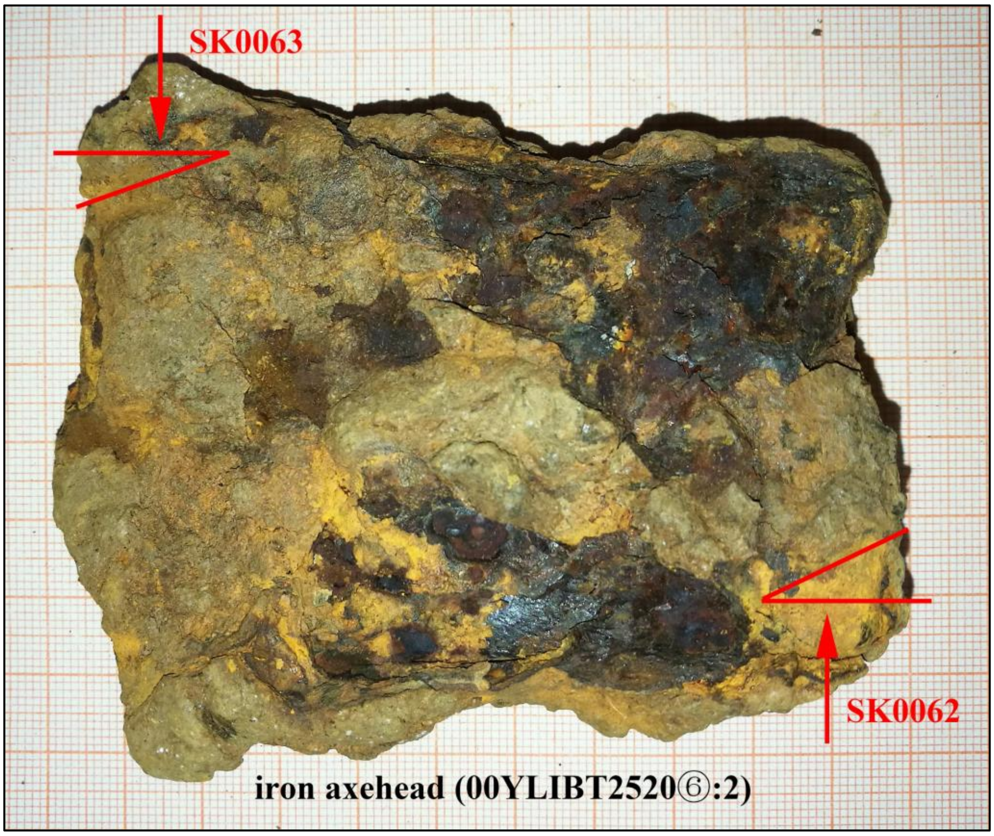


Fig. 5.152 Iron axehead (00YLIBT2520⑥:2) showing the sampling spot of SK0062 and SK0063 (source: author)

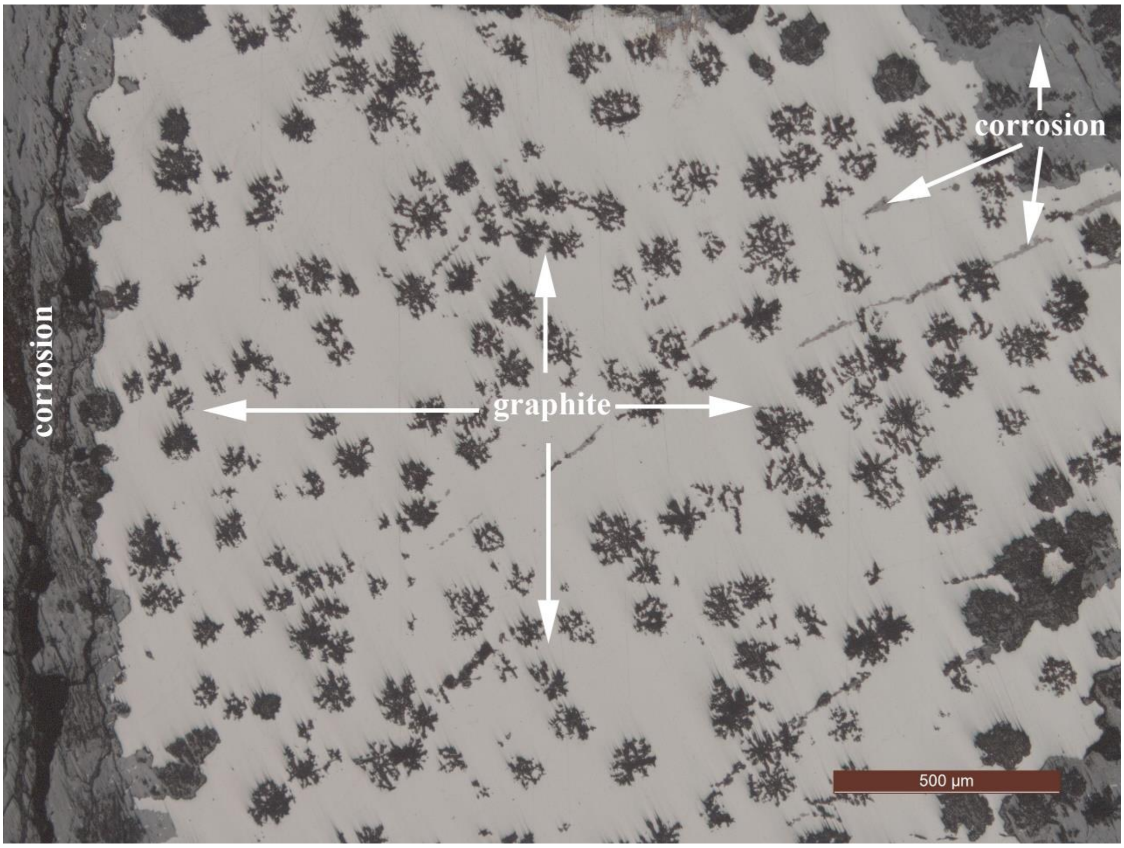


Fig. 5.153 Section from SK0062. Unetched, scale bar 500μm (source: author)

Unetched: SK0062 is badly corroded with some metal remaining in the centre. There are large amounts of graphite nodules throughout the section (Fig. 5.153).

Etched: at low magnification of SK0062, etching revealed a ferrite matrix with unclear grain boundaries and size. There are large amounts of linear structures visible throughout the section. There is no obvious evidence of slag inclusions (Fig. 5.154). At a higher magnification, these linear structures are mostly cementite. There is also some lamellar pearlite (Fig. 5.155).

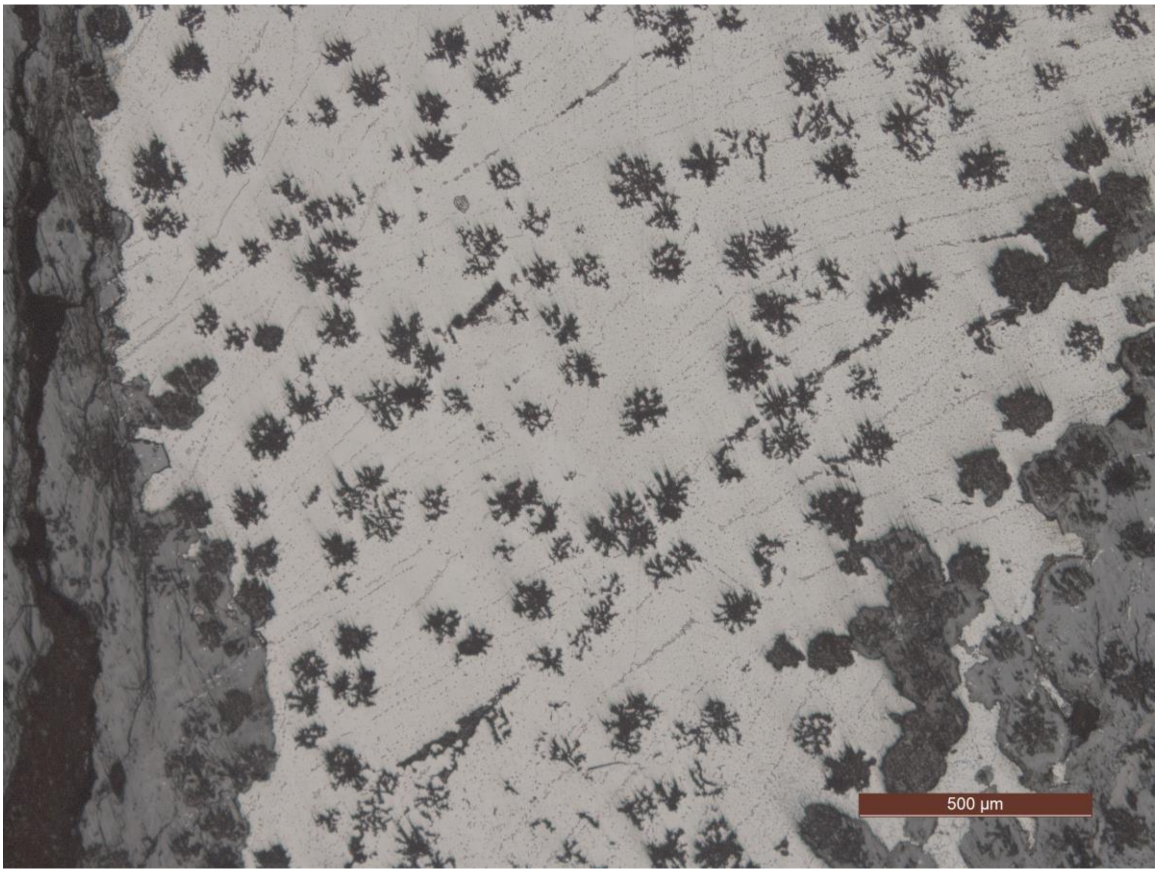


Fig. 5.154 Section from SK0062. Etch 2% nital, scale bar 500μm (source: author)

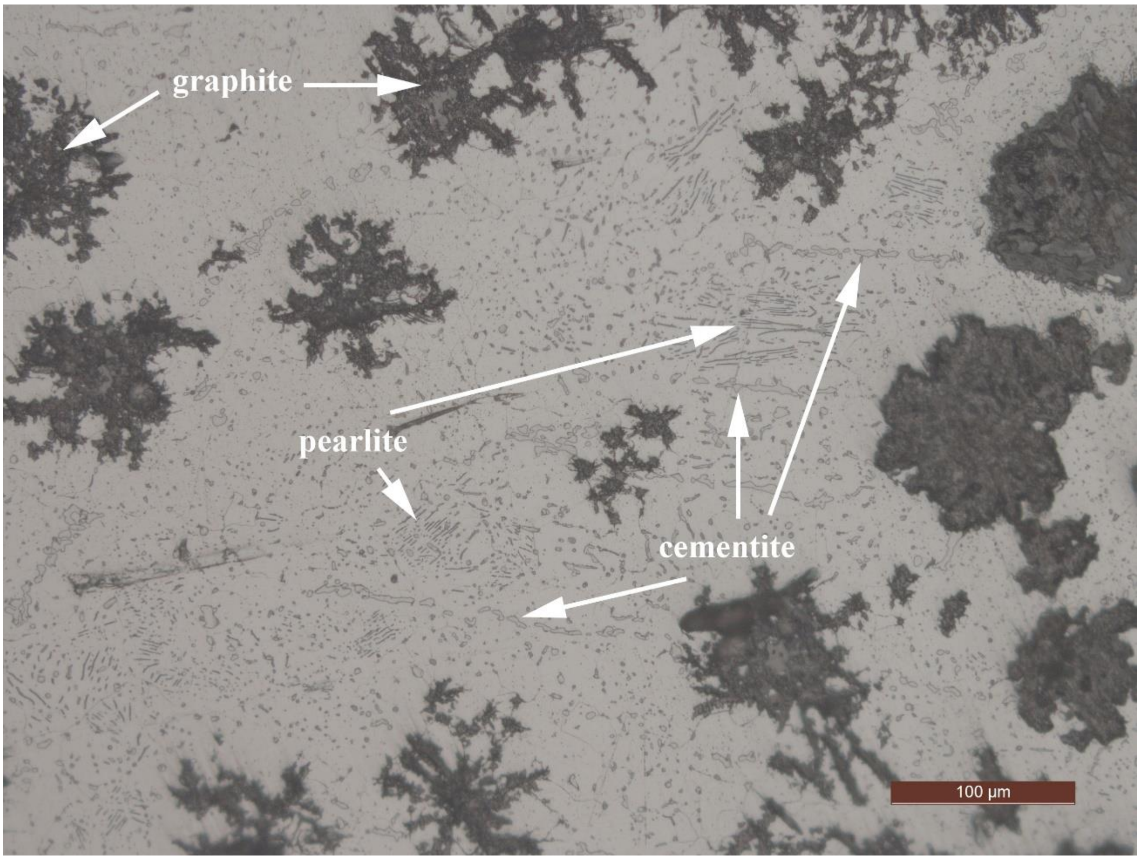


Fig. 5.155 Section from SK0062. Etch 2% nital, scale bar 100μm (source: author)

Sample: SK0063 is cut from the socket of the same axehead (Fig. 5.152).

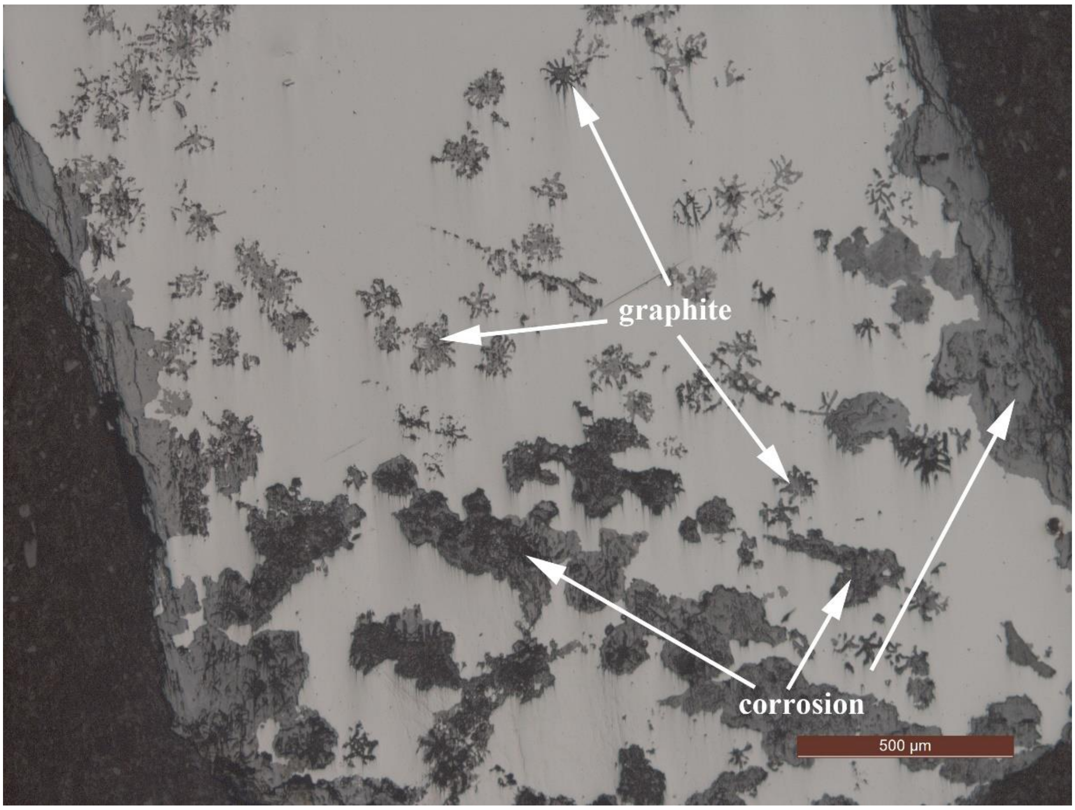


Fig. 5.156 Section from SK0063. Unetched, scale bar 500μm (source: author)

Unetched: SK0063 is badly corroded with some metal remaining in the centre. In the unetched section, there are large amounts of graphite nodules and some of them are corroded (Fig. 5.156).

Etched: at low magnification of SK0063, etching revealed a ferrite matrix with uneven grain size and clear grain boundaries. There is no obvious evidence of slag inclusions (Fig. 5.157).

Initial interpretation: in summary of the sample SK0062 and SK0063, the iron axehead was probably cast in white cast iron first, and then annealed for decarburization and graphitization. There is some small cementite remained in the cutting edge area but not in the socket area. The material is ferrite matrix malleable cast iron.

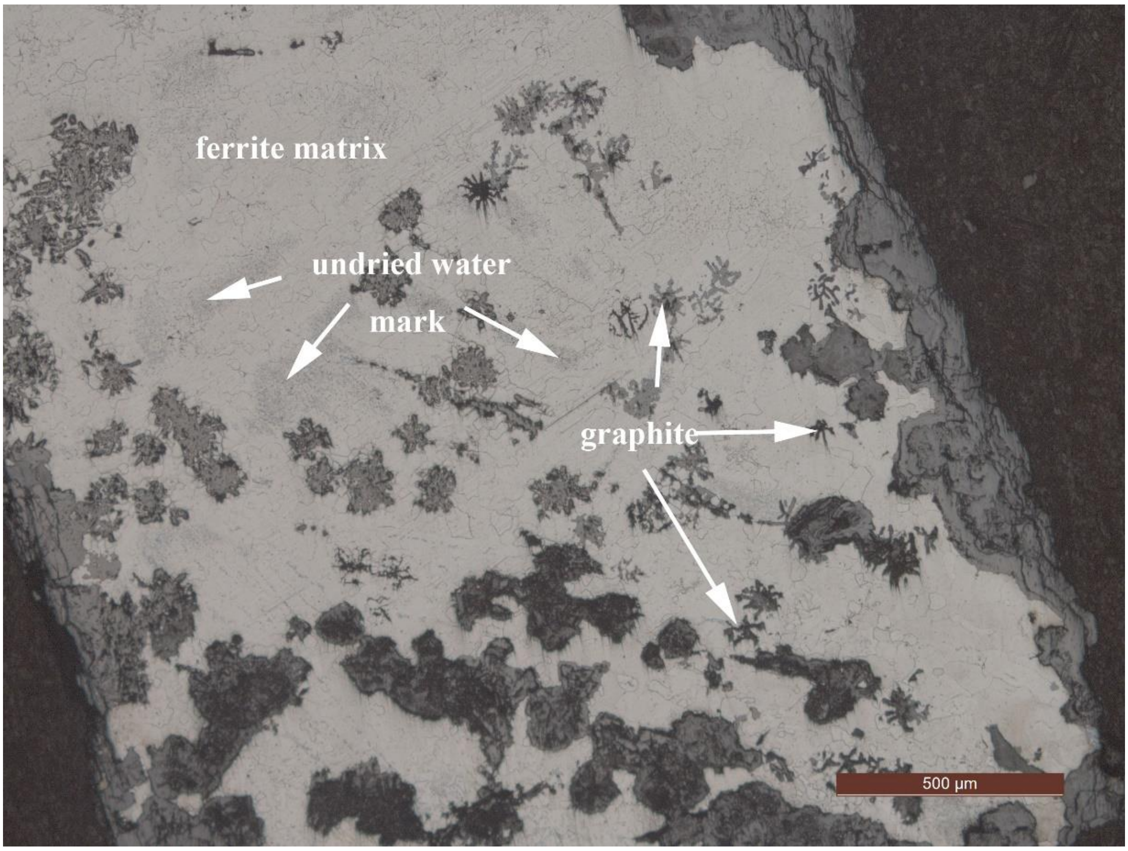


Fig. 5.157 Section from SK0063. Etch 2% nital, scale bar 500μm (source: author)

SK0064

Sample: the cross section of an iron nail (Fig. 5.158).

Fig. 5.158 Iron nail (01YLIIBT1515⑤a:3) showing the sampling spot of SK0064 (source: author)

Unetched: the sample is badly corroded on the surface with some metal remaining in the centre. There are large amounts of very small slag inclusions distributed in chains (Fig. 5.159)

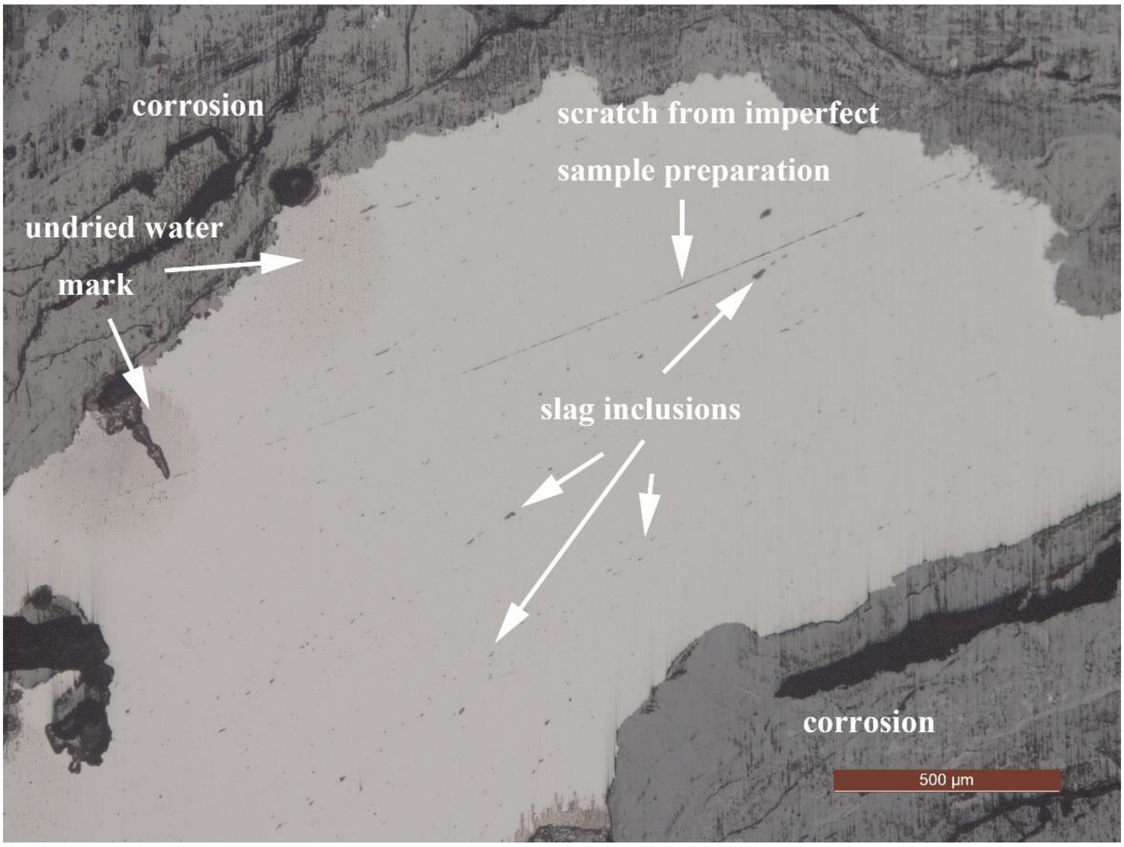


Fig. 5.159 Section from SK0064. Unetched, scale bar 500µm (source: author)

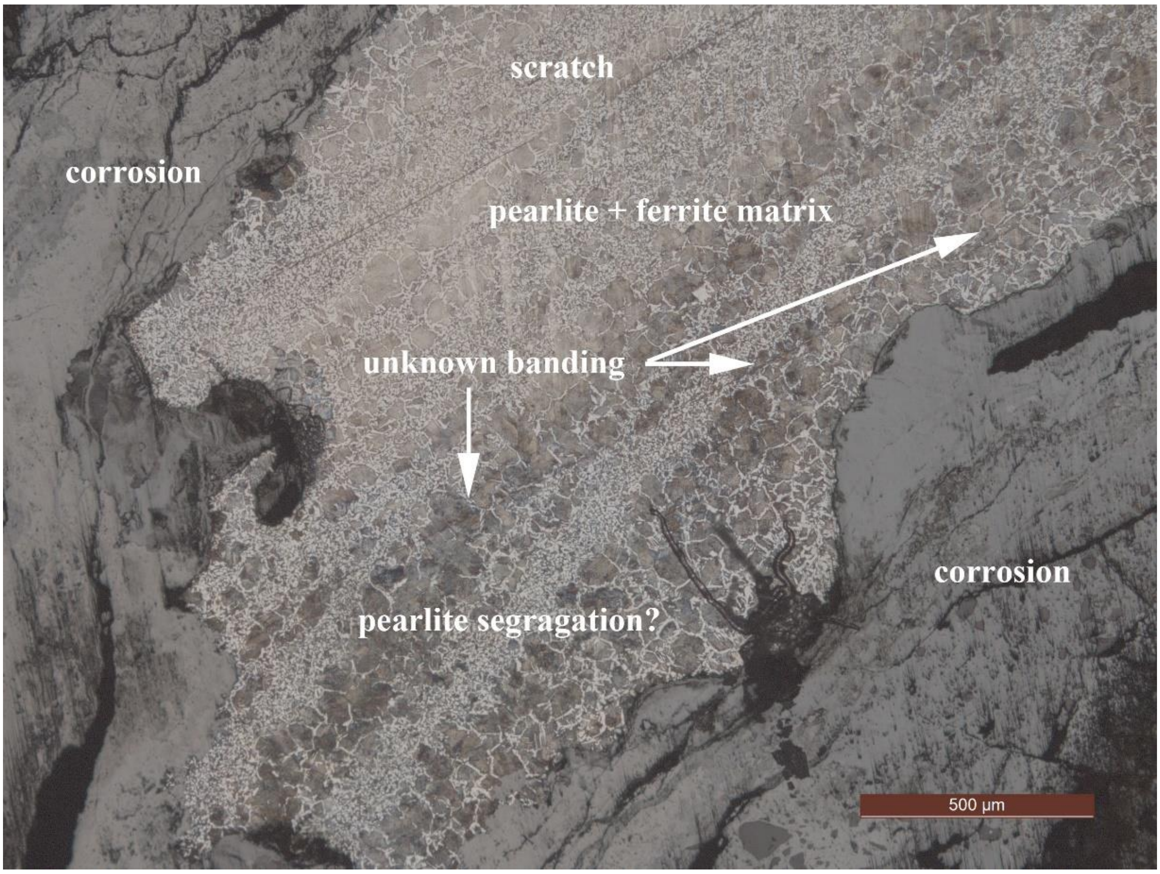


Fig. 5.160 Section from SK0064. Etch 2% nital, scale bar 500µm (source: author)

Etched: at low magnification, etching revealed a pearlite and ferrite matrix with uneven grain size and clear grain boundaries. The carbon content is c.0.4-0.6% and there is a slightly pearlite segregation throughout the section. There is an unknown thin banding in the middle of the sample which was not visible before etching (Fig. 5.160).

Initial interpretation: the iron nail was probably forged from fined iron or bloomery iron.

CD

Sample: cut from the socket of an iron axehead (Fig. 5.161).

Fig. 5.161 Iron axehead (02YLIAT0111-0212⑩:3) showing the sampling spot of CD (source: Yang Sheng)

Etched: the sample is etched by 4% nital, and there are no significant changes before and after etching. There are dendritic ledeburites visible throughout the section (Fig. 5.162).

Initial interpretation: the iron axehead was cast in white cast iron.

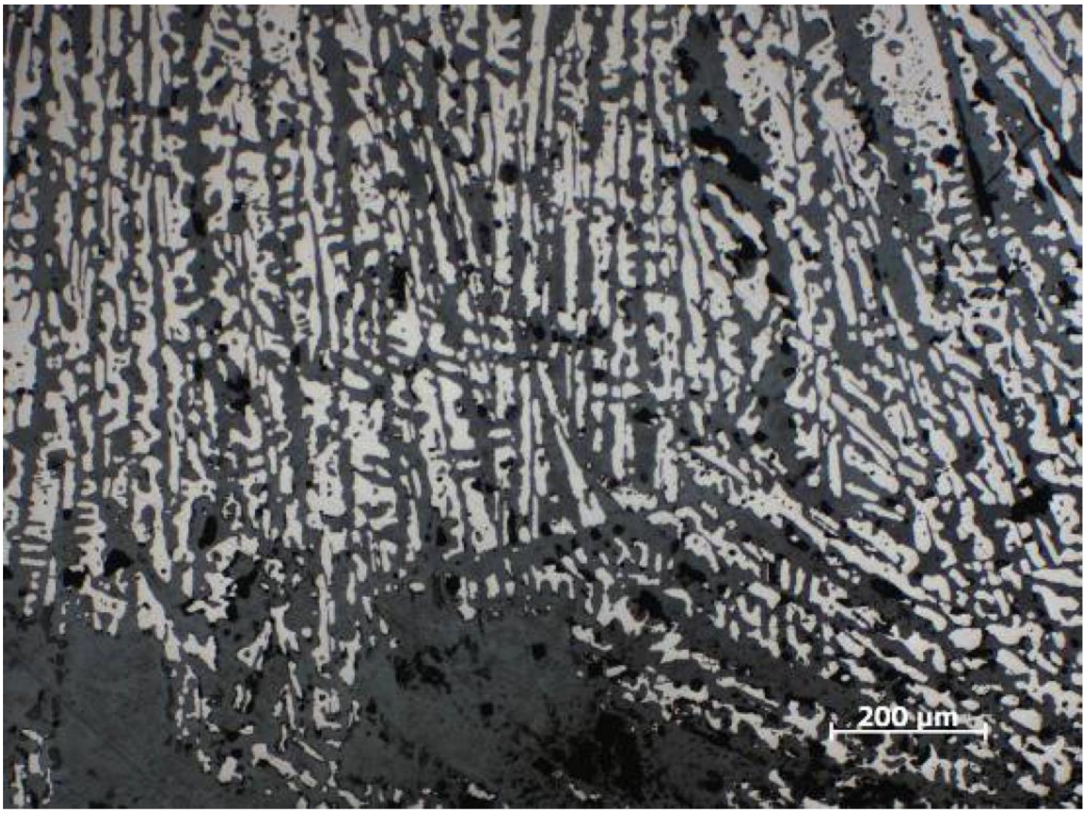


Fig. 5.162 Section from CD. Unetched, scale bar 200µm (source: Yang Sheng)

5.4 Iron objects excavated from the Qiaogoutou site

5.4.1 Introduction

The Qiaogoutou site is located in Yibin city, Sichuan province, China (Fig. 5.2). It is on the banks of the upper Yangtze River, about 290km southeast from Chengdu. The site was discovered by the Sichuan Provincial Cultural Relics and Archaeology Research Institute during fieldwork associated with the construction project of the Xiangjiaba dam in 2006, 2007 and 2009 (Liu Zhiyan 2012). Part of the site, a total area of 2,650m^2 cemetery, was excavated by the Sichuan University in 2011. The site was long occupied from the Neolithic to the Qing dynasty (1644-1912AD), and the primary remains are from the Warring States period (475-221BC) to the Qin and Han dynasties (221BC-220AD). There are 20 pit burials dating from the late Warring States to the early Han dynasty (c.300-140BC) which contained gravegoods consisting of assemblages of pottery, bronze and iron objects.

5.4.2 Dating

A total of 52 iron objects were excavated from 17 burials, including categories of domestic objects, weapons, tools, accessories and some unidentified (Table 5.5, Fig. 5.163). Dating was based on the typical local ceramic assemblage and excavated bronze coins which were retrieved from almost every burial. All the bronze coins were *Banliang* coins of the Qin state. '*Banliang*', a weight unit of 8g, these typical coins were circulated in the Qin state between 336-206BC. The ceramics were dated as early as the late Warring States period to the mid-Western Han dynasty (400-140BC, Liu B. 2013, 35-37). Bronze coins were discovered in every burial in which iron objects were excavated. Therefore, the iron objects excavated from Qiaogoutou could be dated to 336-140BC.

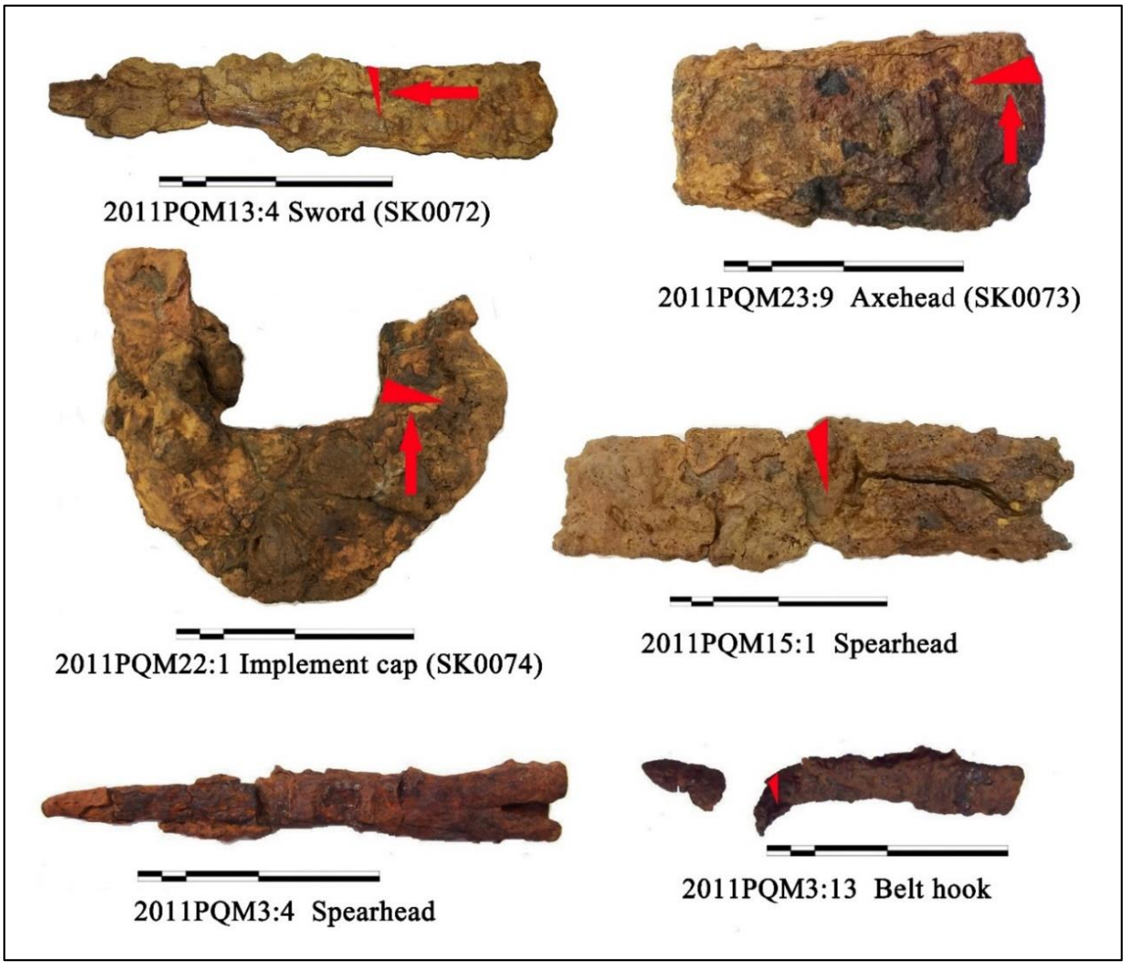


Fig. 5.163 Examples of iron objects from Qiaogoutou cemetery showing cutting spots (source: author)

Table 5.5 Iron objects excavated from Qiaogoutou

Category	Type	Count	Percentage
Domestic objects	*mou*-pot (caldron)	2	4%
Weapons	sword	10	27%
	spearhead	4	
Tools	axehead	12	46%
	implement cap	8	
	sicklehead	2	
	knife	2	
Accessories	belt hook	1	2%
Others	unidentified	11	21%
	Total	**52**	

Table 5.6 Sample analysis details from Qiaogoutou

Artifact No	Type	Laboratory No	Metallographic analysis	SEM-EDS
2011PQM15:1	spearhead	-	NO	NO
2011PQM3:13	belt hook	-	NO	NO
2011PQM13:4	sword	SK0072	YES	YES
2011PQM23:9	axehead	SK0073	YES	YES
2011PQM22:1	U-shaped implement cap	SK0074	YES	YES

5.4.3 Results

SK0072

Sample: cut from the cross section of an iron sword (Fig. 5.163).

Unetched: the sample is almost fully corroded with very little metal remaining in the core (about 0.6cm wide and 0.1-0.2cm thick). Some slag inclusions, single-phased, could be seen in the unetched section. Most were seen as narrow stringers aligned in a direction parallel to the surfaces (Fig. 5.164).

Etched: at low magnification, etching revealed a ferrite matrix with small grain size, and some light precipitates within the ferrite grains. The grain boundaries are faint, and a slightly uneven response to etching was visible throughout the section (Fig. 5.165). It is of low carbon content, 0.1%, with grain boundary cementite and a little pearlite (Fig. 5.166). Grain sizes and orientation are even and give no obvious clues of working deformation.

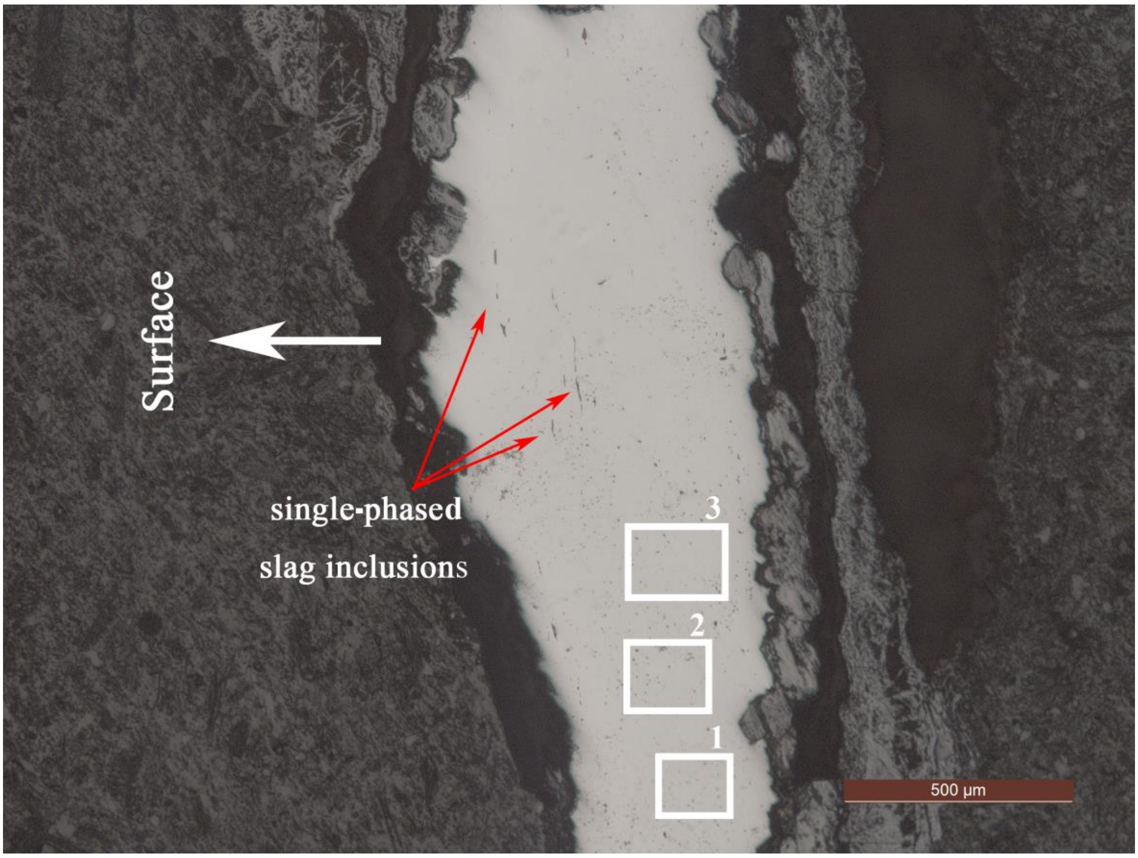


Fig. 5.164 Microsection from SK0072 showing the remaining metal and the distribution of the inclusions, and areas for composition analyses. Unetched. Scale bar 500µm (source: author)

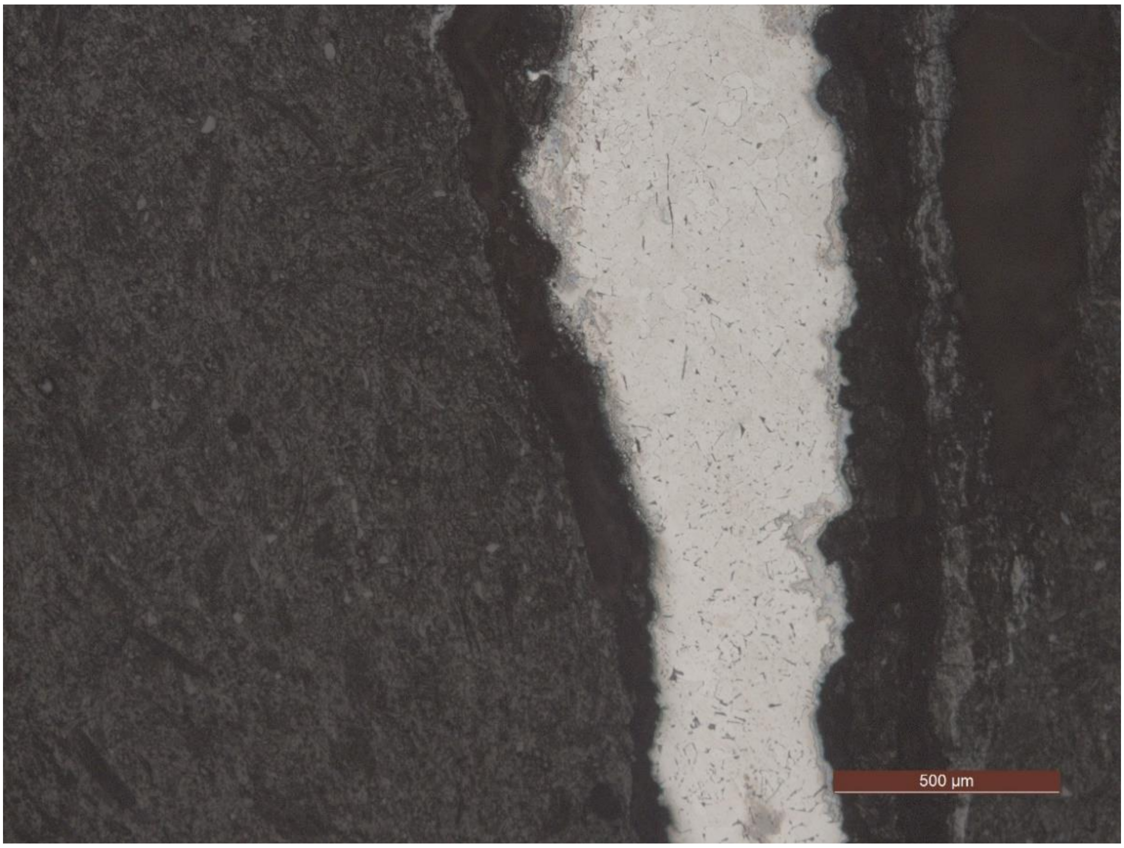


Fig. 5.165 Microsection from SK0072. Small grains, not very clear grain boundaries. Ferrite with a slightly uneven response, indicating phosphorus, grain boundary pearlite and stringers. Etch 2% nital (source: author)

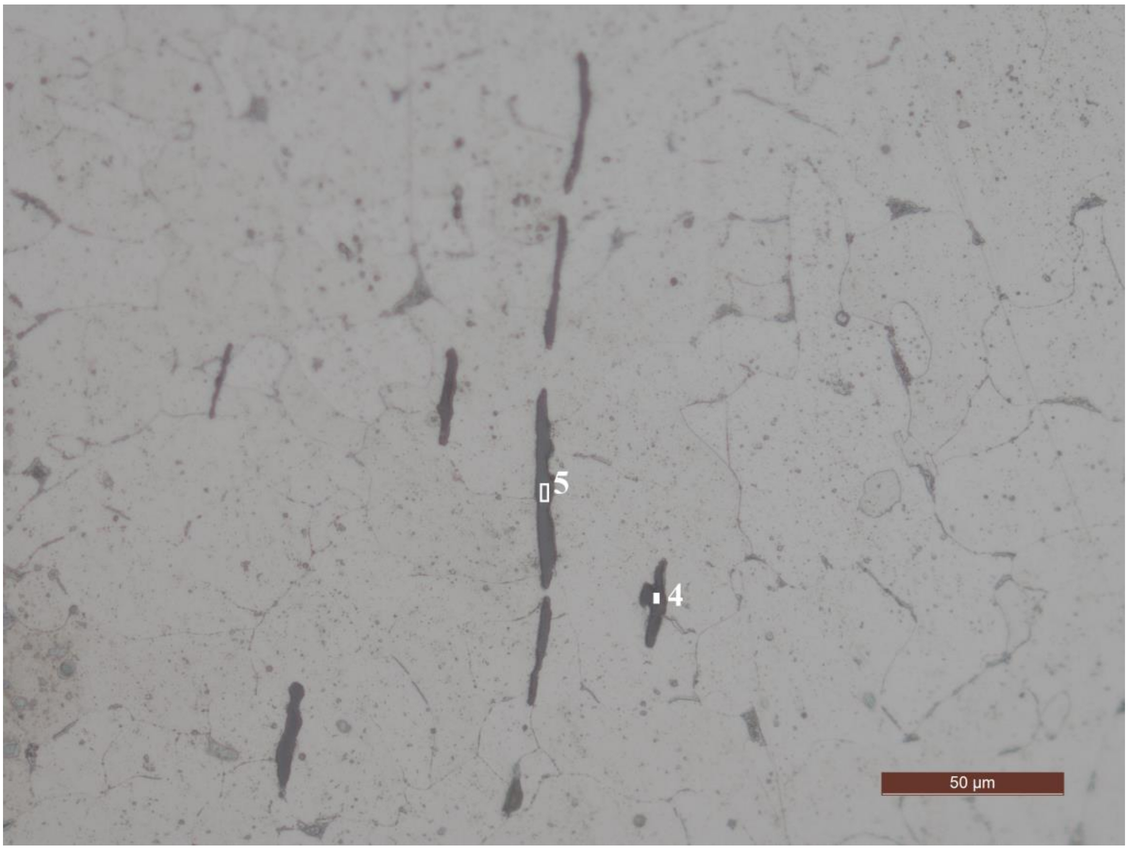


Fig. 5.166 Microsection from SK0072 showing the distribution of the stringers and low occurrence of carbon distributed along with grain boundaries, and areas for composition analyses. Etch 2% nital (source: author)

SK0073

Sample: cut from the cutting edge of an iron axehead (Fig. 5.163).

Unetched: one side of the sample shows a band of corrosion within the remaining metal. The corrosion is dark and light grey in colour. Both single and double-phased slag inclusions could be seen before etching (Fig. 5.167). The single-phased slag inclusions are relatively small, elongated, and distributed in groups parallel to the surface. The double-phased slag inclusions are larger, mainly elongated with some irregular exceptions, and also distributed parallel to the surface. The double-phased slag inclusions have dark and light grey phases which could be identified as an iron silicate (fayalitic) matrix with wüstite dendrites (Fig. 5.169).

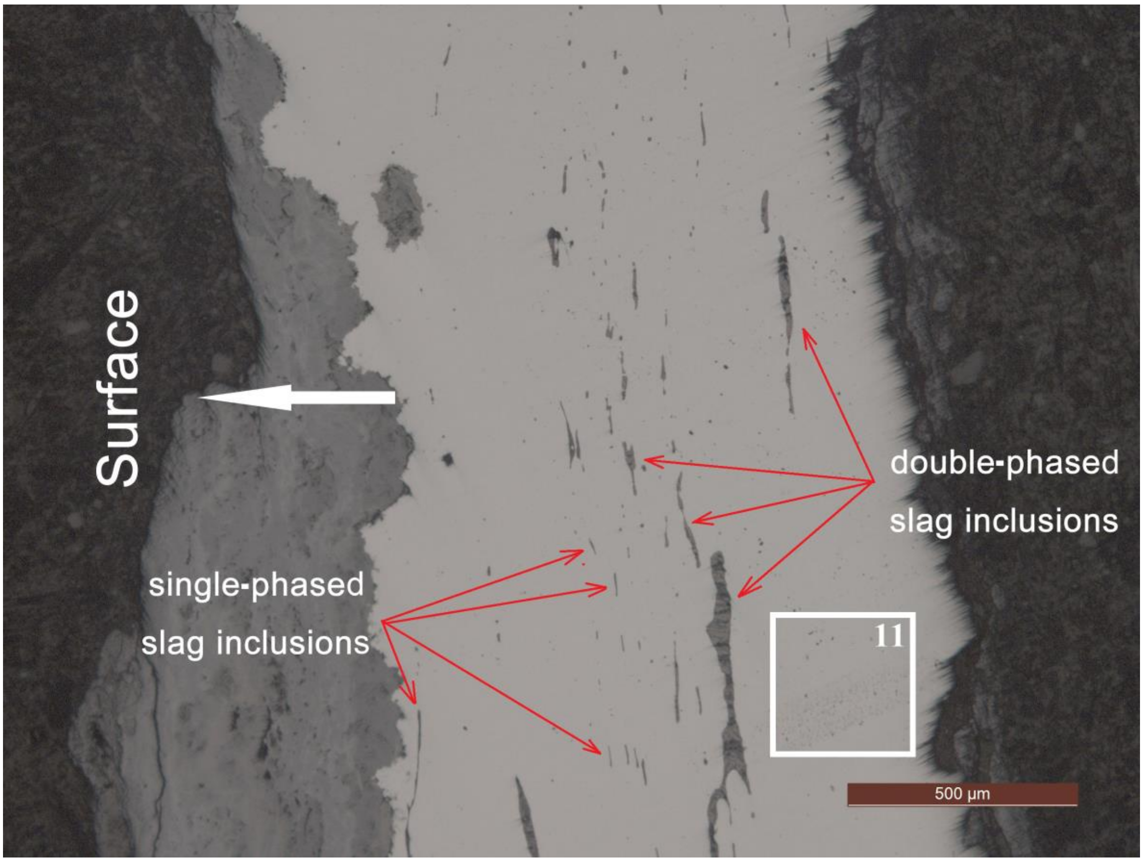


Fig. 5.167 Microsection from SK0073 showing the remaining metal, the distribution of the inclusions, and area for composition analysis. Unetched. Scale bar 500μm (source: author)

Etched: at low magnification, etching revealed a fine pearlite matrix. The structure near the tip area is pure pearlite. Ferrite started forming on the edge of the grain boundaries beyond the tip area. The amount of ferrite increased from the tip to the middle and from one surface to the other surface of the axehead. The carbon content is c.0.2%-0.4% in the top right corner in Fig. 5.168. Needle-like ferrite structures extend inwards from the grain boundaries, indicating a Widmanstätten structure. The grains are equiaxed without distortion (Fig. 5.169).

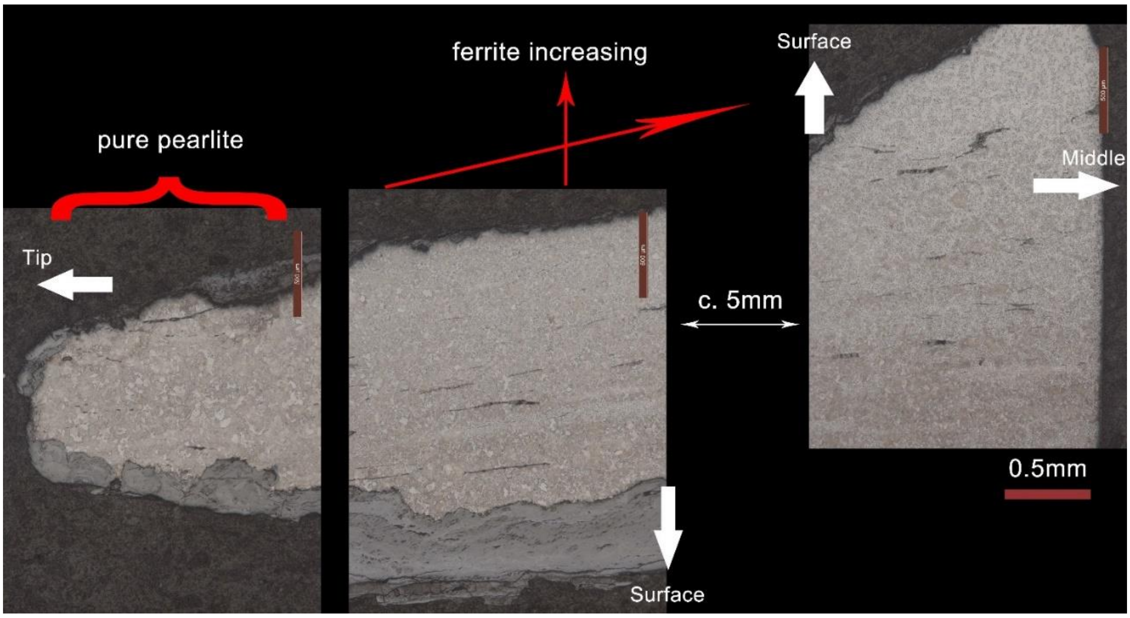


Fig. 5.168 Montage of the section from SK0073 showing the difference of carbon content in different areas of the object. Etch 2% nital (source: author)

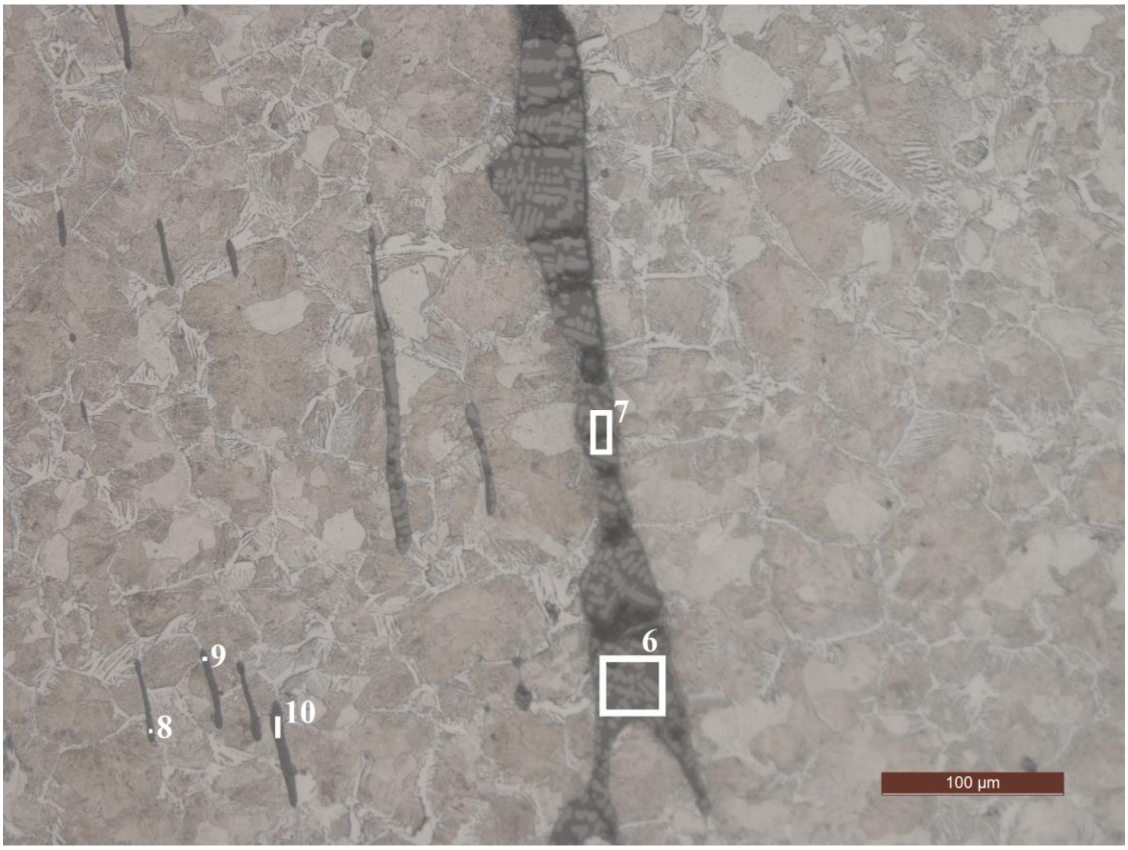


Fig. 5.169 Microsection from SK0073 showing the ferrite and pearlite matrix, the distribution of the inclusions, a Widmanstätten precipitation of ferrite into pearlite containing grains, and areas for composition analyses. Etch 2% nital (source: author)

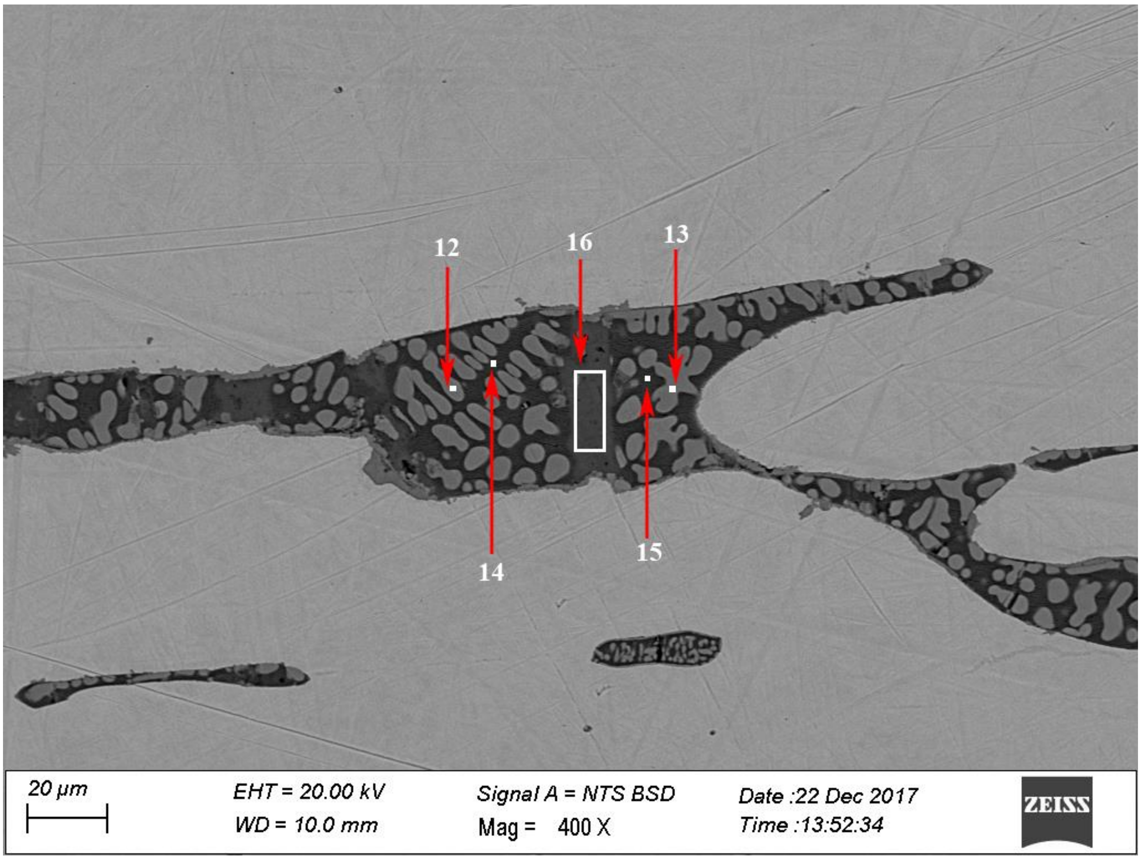


Fig. 5.170 SK0073 showing the double-phased slag inclusions and areas for composition analyses (source: author)

SK0074

Sample: cut from the edge of a U-shaped iron implement cap (Fig. 5.163).

Unetched: the sample is badly corroded with very little metal left in the centre.

Etched: at low magnification, etching revealed a ferrite matrix and clear grain structure with different size grains. The rust in the middle of the sample was from imperfect drying during sample preparation. There were no visible slag inclusions or grain distortion that might indicate forging. There are some graphite-like structures throughout the section (Fig. 5.171).

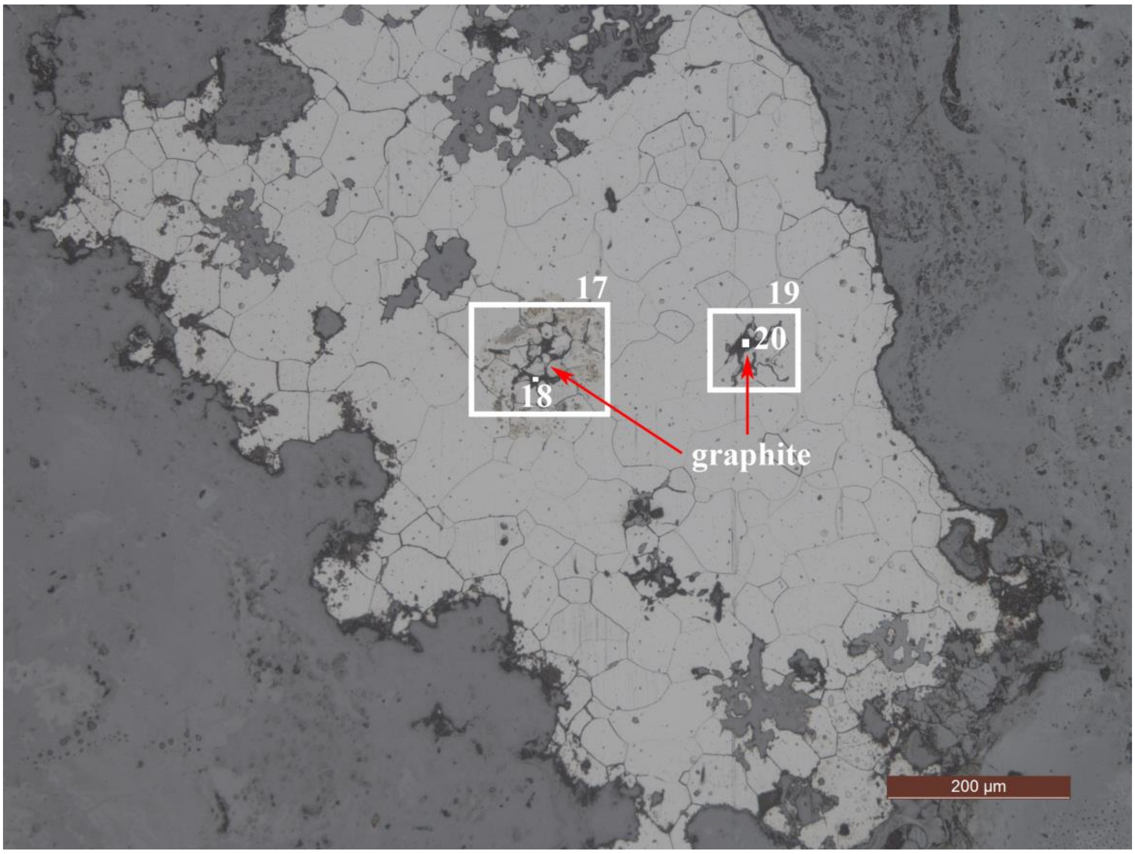


Fig. 5.171 Microsection from SK0074 showing the ferrite matrix, clear grain crystal in different sizes, and areas for composition analyses. Etch 2% nital (source: author)

Table 5.7 Result of chemical compositions (normalized wt%)

Sample no.	Analysis no.	C	O	Na	Mg	Al	Si	P	Cl	K	Ca	Ti	Mn	Fe
SK0072	1	3.3	-	-	-	-	-	-	-	-	-	-	-	96.7
	2	3.8	-	-	-	-	0.5	-	-	-	-	-	-	95.7
	3	3.8	-	-	-	-	-	-	-	-	-	-	-	96.3
	4	5.6	24.3	0.5	1.8	3.1	16.9	-	-	1.7	6.0	0.6	2.3	37.3
	5	4.3	41.0	-	1.0	2.2	22.9	0.1	-	2.3	5.0	0.4	2.9	17.3
SK0073	6	12.8	25.3	-	-	1.0	5.2	0.5	0.4	0.6	1.1	-	-	53.1
	7	23.0	22.5	-	0.4	1.0	4.9	0.6	0.1	0.7	1.1	-	-	45.9
	8	27.4	26.2	-	0.7	1.3	8.1	1.3	-	1.7	5.1	-	1.0	27.3
	9	36.6	24.1	-	0.5	1.3	7.9	1.3	-	2.1	4.2	-	0.8	21.3
	10	26.2	23.9	-	0.6	1.6	8.6	1.3	-	2.0	6.2	0.2	1.0	28.6
	11	4.1	-	-	-	-	-	-	-	-	-	-	-	95.9
	12	5.0	23.2	-	-	0.5	2.2	0.3	-	-	0.4	-	-	68.3
	13	9.3	24.6	-	0.6	1.3	6.8	0.7	-	0.5	1.1	-	-	55.2
	14	11.1	31.6	-	0.6	2.0	11.9	1.3	-	1.5	2.8	-	-	37.2
	15	11.4	29.9	-	0.7	2.0	10.6	1.3	-	1.2	2.4	-	-	40.5
	16	5.3	32.8	-	-	-	-	-	5.0	-	-	-	-	56.9
SK0074	17	5.0	-	-	-	-	0.4	0.4	-	-	-	-	-	94.2
	18	29.0	9.8	-	-	-	0.5	0.3	-	-	0.2	-	-	60.2
	19	6.6	-	-	-	-	0.3	0.5	-	-	-	-	-	92.7
	20	60.3	18.8	-	-	-	0.6	0.1	-	-	0.6	-	-	19.6

Notes: '-' means below detection limit.

5.5 Discussion

This section reviewed the previous metallographic studies of iron objects excavated from Southwest China and discussed the metallographic results of the iron objects excavated from Lijiaba, Chongqing, and Qiaogoutou, Sichuan.

Previous work:

Up to now, there have been very few metallurgical studies of excavated iron objects from Southwest China. Li Xiaocen (2011) analyzed some iron objects from Yunnan, and the results show that there were both forged and cast iron in use. The forged iron objects appeared no later than the mid-late Warring States period (c.340-200BC), and both the quantity and type of the iron objects are few and include iron bracelet, iron knife, iron sword (bronze handle) and iron chisel (bronze socket) indicating iron may have been regarded as a precious material at the time. In addition, hypo-eutectoid steel objects were also in use. However, according to Li Xiaocen, there is no evidence of iron smelting activities in ancient Yunnan before the mid-Western Han dynasty (c.140-50BC), and the iron objects and primary material were possibly imported from Sichuan or further afield. Iron was widely applied in the making of tools and weapons in ancient Yunnan during the mid-late Western Han dynasty (c.140BC-9AD). Many puddled steel, quenched steel and cast iron objects were discovered in burials indicating a big improvement of iron making technology (Li Xiaocen 2011, 99).

Chen Jianli *et al* (2008a, 195-206) analyzed 11 iron objects, one of which was a bi-metallic iron sword with bronze handle, excavated from Kele, Guizhou province. The objects are dated from the late Warring States period to the early Han dynasty (300-150BC). The result shows that the objects were both forged and cast, and the materials and included white cast iron (decarburized to steel and wrought iron), malleable cast iron, bloomery iron, and fined iron. They concluded that iron production technology of Kele, Guizhou, derived from the Central Plains technology system (Chen Jianli *et al* 2008a, 206).

Li Yingfu *et al* (2016) analyzed a bridge pier weighing 1.38 tons and dated 96BC, discovered in Guanghan, Sichuan. The metallographic results show the artefact is grey-cast iron, and nearby were found fragments of the mould in which it was cast. It is direct evidence indicating that the ancient Sichuan was capable of casting big iron objects at least by 96BC.

Lijiaba

A summary of the metallographic analysis undertaken for this research of the 58 samples from 36 iron objects excavated from Lijiaba is given in the table below.

Table 5.8 Summary of metallographic analysis of the iron objects excavated from Lijiaba

Laboratory No.	Artefact	Sampling spot	Phases	Material and techniques
SK0001	mattockhead	cutting edge	ferrite, pearlite, cementite	cast, white cast iron, decarburized incompletely
SK0002	mattockhead	socket	ferrite, pearlite	cast, decarburized, hypo-eutectoid steel, graphitized
SK0003	axehead	corrosion	corrosion	-
SK0035		cutting edge	ferrite, pearlite	forged, fined iron or bloomery iron, possibly carburized
SK0004	knife	cross section (tang end)	ferrite, pearlite, cementite, graphite	cast, decarburized and graphitized, mottled cast iron
SK0005	sabre	cutting edge	ferrite	forged, bloomery iron or fined iron
SK0006	arrowhead	cross section (tang end)	ferrite	cast and fully decarburized
SK0008	mattockhead	socket	ferrite, pearlite, graphite	cast, ferrite and pearlite matrix malleable cast iron, decarburized and graphitized
SK0010	knife	cross section (tang end)	ferrite	forged, fined iron or bloomery iron
SK0011	axehead	cutting edge	ferrite	forged, fined iron or bloomery iron

Laboratory No.	Artefact	Sampling spot	Phases	Material and techniques
SK0012	ring-headed knife	cross section (ring head)	ferrite, pearlite	forged, fined iron or bloomery iron, carburized on cutting edge
SK0013		cross section (body)	ferrite, pearlite	
SK0014	mattockhead	corrosion	corrosion	-
SK0015		cutting edge	ferrite, pearlite, ledeburite	white cast iron, annealed for decarburization
SK0017	arrowhead or nail	cross section (tang end)	corrosion	-
SK0018		cross section (tang end)	ferrite, pearlite	cast, decarburized from white cast iron
SK0019	knife	cutting edge	corrosion	-
SK0020		ridge	ferrite, pearlite, cementite, graphite	cast, decarburized and graphitized, mottled cast iron
SK0021	axehead	cutting edge	ferrite, pearlite, graphite	cast, ferrite and pearlite matrix malleable cast iron, decarburized and graphitized
SK0036		socket	ferrite, pearlite, graphite	
SK0022	knife	cutting edge	ferrite, pearlite	cast, decarburized, hypo-eutectoid steel
SK0024	knife?	cross section (horizontal)	ferrite, pearlite	forged, fined iron or bloomery iron, hypo-eutectoid steel
SK0025		cross section (vertical)	ferrite, pearlite	
SK0028	mattockhead	socket	ferrite, pearlite, graphite	cast, pearlite and ferrite matrix malleable cast iron, decarburized and graphitized
SK0029	sabre	cutting edge	ferrite, pearlite	forged, bloomery iron or fined iron, carburized on the cutting edge
SK0030		ridge	ferrite, pearlite	
SK0034		corrosion	corrosion	-
SK0031	chisel	cutting edge	ferrite, pearlite	forged, fined iron or bloomery iron, carburized and probably being repaired
SK0032		tang end	ferrite, pearlite	
SK0033		corrosion	corrosion	-
SK0038	shovelhead	cutting edge	ferrite, pearlite	forged, fined iron or bloomery iron
SK0039		socket	ferrite, pearlite	
SK0040	mattockhead	cutting edge	ferrite, pearlite, cementite	cast, decarburized from white cast iron
SK0041		corrosion	corrosion	-
SK0042	ring-headed knife	ridge	ferrite, pearlite	cast, decarburized from white cast iron, different extent of decarburization
SK0043		cutting edge	ferrite, pearlite	
SK0044		ring-head	ferrite	
SK0045	ring-headed knife	ridge	ferrite, pearlite	cast, decarburized from white cast iron, different extent of decarburization
SK0046		cutting edge	ferrite, pearlite	
SK0047	belt hook	cross section	ferrite, pearlite	forged, fined iron or bloomery iron
SK0048	sabre	ridge	ferrite, pearlite	forged, fined iron or bloomery iron
SK0049		cutting edge	ferrite, very little pearlite	
SK0050	axehead	cutting edge	ledeburite, pearlite, graphite	cast, white cast iron, decarburized at the surface, possibly graphitized at the cutting edge
SK0051		socket	ledeburite, pearlite	

<table>
<tr><th>Laboratory No.</th><th>Artefact</th><th>Sampling spot</th><th>Phases</th><th>Material and techniques</th></tr>
<tr><td>SK0052</td><td>belt hook</td><td>cross section</td><td>ferrite, pearlite</td><td>cast, decarburized from white cast iron</td></tr>
<tr><td>SK0053</td><td rowspan="2">mattockhead</td><td>cutting edge (corroded)</td><td>corrosion</td><td rowspan="2">-</td></tr>
<tr><td>SK0054</td><td>socket (corroded)</td><td>corrosion</td></tr>
<tr><td>SK0055</td><td>object ear/handle</td><td>cross section</td><td>ferrite, pearlite</td><td>forged, fined iron or bloomery iron</td></tr>
<tr><td>SK0056</td><td>belt hook</td><td>cross section</td><td>ferrite, pearlite</td><td>forged, fined iron or bloomery iron</td></tr>
<tr><td>SK0057</td><td rowspan="2">pickaxehead</td><td>near the peak</td><td>ferrite, pearlite</td><td rowspan="2">forged, fined iron or bloomery iron</td></tr>
<tr><td>SK0058</td><td>socket</td><td>ferrite, pearlite</td></tr>
<tr><td>SK0059</td><td rowspan="2">mattockhead</td><td>cutting edge (corroded)</td><td>pearlite? Graphite?</td><td rowspan="2">possibly malleable cast iron</td></tr>
<tr><td>SK0060</td><td>socket (corroded)</td><td>corrosion</td></tr>
<tr><td>SK0061</td><td>belt hook</td><td>cross section</td><td>ferrite, pearlite</td><td>forged, fined iron or bloomery iron</td></tr>
<tr><td>SK0062</td><td rowspan="2">axehead</td><td>cutting edge</td><td>ferrite, graphite, cementite, pearlite</td><td rowspan="2">cast, decarburized and graphitized, ferrite matrix malleable cast iron</td></tr>
<tr><td>SK0063</td><td>socket</td><td>ferrite, graphite</td></tr>
<tr><td>SK0064</td><td>nail</td><td>cross section</td><td>ferrite, pearlite</td><td>forged, fined iron or bloomery iron</td></tr>
<tr><td>CD</td><td>axehead</td><td>socket</td><td>ledeburite</td><td>cast, white cast iron</td></tr>
<tr><td colspan="2">Total sample:</td><td colspan="3">58</td></tr>
<tr><td colspan="2">Total object:</td><td colspan="3">36</td></tr>
</table>

***Weapons*:**

There is one arrowhead (SK0006) excavated from non-burial contexts, which was cast and fully decarburized. Another object (SK0017) from the non-burial context which was reported as an arrowhead but actually looks like an iron nail (Fig. 5.49). The object was fully corroded, and no useful information was obtained from the metallographic sample. In the literature, there are metallographic analyses of 12 other arrowheads excavated from Shaanxi (appendix **C5:44-46**, Du and Han 1983, 225) and Hebei provinces (**C5:99**, **101**, **115-118**, **134-135** and **149**, Liu Haifeng *et al* 2013, 136-138). All of the arrowheads are dated to the Han dynasty (202BC-220AD) except **C5:149** which is dated to the 13th/14th centuries AD. Only one of them (**C5:135**) was made from decarburized wrought iron from white cast iron, and all others were made from fined iron with 0-0.9% carbon content. Some of the arrowheads (**C5:46**, **101**, **116**, **118** and **134**) are recorded as forged because there are slag stringers but no pictures are provided. The production technique of SK0006 is the same as **C5:135** excavated from Xi'an, Shaanxi, which shows arrowheads might be also cast in white cast iron and then being decarburized. However, this conclusion may not be representative since both arrowheads are the only example in their region.

There are three iron sabres, two (SK0005; SK0029, 30 and 34) were excavated from non-burial contexts, and the third (SK0048-49) was from burial No.10 of 2003. All were forged from fined iron or bloomery iron, and one cutting edge (SK0029) was carburized. To compare, there are metallographic analyses of three other sabres excavated from Beijing (appendix **C5:20**,Yang J. *et al* 2014, 180), Shaanxi (**C5:49**, Du and Han 1983, 225), and Jiangsu (**C5:70**, Chen J. and Han 1999, 80). The sabre excavated in Beijing is dated to the Northern dynasty (386-581AD), and the other two are dated to the Western Han dynasty (202BC-20AD). **C5:20** and **49** were made from fined iron, and **C5:70** was folded and forged from fined iron and carburized steel from bloomery iron. The carbon contents of **C5:49** and **C5:70** are 0.9% and 0.5-0.6%. The carbon contents are different in layers (similar to SK0048) and there is a segregation of phosphorous in **C5:70** (similar to SK0005). In general, the production techniques and material used for iron sabres excavated at Lijiaba are similar to those excavated in other regions of China.

***Tools*:**

There are six axeheads (one fully corroded, SK0003) from non-burial contexts were analysed. Four of the axeheads were cast in white cast iron and most of them were annealed either for decarburization or graphitization, or both. The other sample (SK0011) has an unfinished shape that looks like an axehead (Fig. 5.38) but is possibly a primary billet which was forged from fined iron. In the literature, there are analyses of four other axeheads excavated in Liaoning (appendix **C5:6** and **7**, Chen J. *et al* 2001, 71-72) and Fujian provinces (**C5:12** and **13**, Chen J. *et al* 2008b, 89, 93 fig.2). The axeheads excavated in Liaoning are dated to the $3^{rd}/4^{th}$ centuries AD, and the axeheads excavated in Fujian are dated to the $-4^{th}/-2^{nd}$ centuries BC. All four axeheads were made from decarburized steel from white cast iron with carbon contents of 0.2-0.4%. **C5:12** and **13** are recorded as forged, with small amounts of single-phased inclusions seen in both samples but no clear pictures are provided. On the other hand, **C5:13** is said to be forged from two pieces of decarburized steel from white cast iron, and the socket area was pure ferrite. The material used for the iron axeheads excavated from Lijiaba is similar to those excavated from Liaoning and Fujian, and they were both forged (SK0003 and 35) and cast. The difference is that graphitization is found in most of the axeheads excavated at Lijiaba (SK0021, 36, 50, 51, 62 and 63).

There were five knives (one fully corroded, SK0019) excavated from non-burial contexts. The iron knives were either forged from fined iron (or bloomery iron) or cast in white cast iron and annealed either for decarburization or graphitization, or both. For comparison, there are metallographic analyses of ten other iron knives excavated from Shaanxi (appendix **C5:40**, Lin Y. *et al* 2015, 98, 101 fig.2.14), Hebei (**C5:104**, **120-124**, and **133**, Liu Haifeng *et al* 2013, 136-137), and Guizhou provinces (**C5:175** and **178**, GZSWWKGYJS 2008, 197-198). These knives are dated from the late Warring States period to the Han dynasty (300BC-220AD). Except **C5:104** which is fully corroded, most of the knives are made with decarburized steels from white cast iron with varying carbon content from 0.1-1.8%., and one knife (**C5:175**) is dated to the 300-221BC, which is said to be forged from two pieces of different materials, one bloomery iron and one decarburized steel. Martensite is found at the cutting edge of **C5:121** and **C5:124**. One of the knives (**C5:124**) is said to be forged in which slag stringers were discovered and recorded, but it is very difficult to identify from the picture provided (Liu Haifeng *et al* 2013, 140 fig.7). The recorded object type could be inaccurate sometimes when the iron objects are badly corroded. According the appearance of the objects and their metallographic results, two knives analysed in this study (SK0004; SK0019 and 20) are similar to those excavated in the Central Plains; two (SK0010; SK0024-25) are possibly forged iron sheets; SK0022 looks like an awl or chisel rather than a knife.

There are three ring-headed knives in this study, which two (SK0042-44; SK0045-46) were excavated from burial No.6 and No.15 of 2003, and the other (SK0012-13) was excavated from non-burial contexts in 2002. The two from the burials were cast in white cast iron and decarburized to 0.2-0.7% carbon content steels, and there are Widmanstätten structures visible in sample SK0043. The object from non-burial contexts was forged from fined iron or bloomery iron and its cutting edge was carburized. From the structures of one of the ring-headed knives (SK0042-44), the ring head of the knife was decarburized heavier than the body. There are five other analyses of ring-headed knives excavated from Shaanxi (appendix **C5:28**, Lin Y. *et al* 2015, 97, 99 fig.2.1), Hebei (**C5:105**, Liu Haifeng *et al* 2013, 136), and Guizhou provinces (**C5:173**, **174** and **180**, GZSWWKGYJS 2008, 197-198). The knives are dated from the late Warring States period to the Han dynasty (300BC-220AD) and were made with decarburized steels from white cast iron with a different carbon content of 0.3-0.7%. One of the knives (**C5:174**) is said to be forged from two pieces of decarburized steels. There are Widmanstätten structures recorded in most of samples. The forged ring-headed knife studied here (SK0012-13) is similar to one of the knives excavated from Guizhou, and the production techniques of the other two knives excavated at Lijiaba were similar as the knives excavated from the Central Plains.

There are eight mattockheads in this study (one fully corroded, SK0053-54) excavated from different contexts. All of them were made from material decarburized from white cast iron, and graphitization is found in half of the samples (such as SK0002 and 08). For comparison, there are analyses of 16 other mattockheads excavated in Hebei (appendix **C5:92**, **96**, **111** and **143**, Liu Haifeng *et al* 2013, 136-137; **C5:171**, Anonymous 1975, 243), Jilin (**C5:153-155** and **157-163**, Liu W. and Chen 2014, 388), and Guizhou provinces (**C5:179**, GZSWWKGYJS 2008, 197). Among these mattockheads, **C5:111** is dated to the mid-late Western Han (150BC-20AD) and **C5:143** is dated to the Tang and Song dynasties (7^{th}-13^{th} centuries AD), and all others are dated from the late Warring States period to the early Han dynasty (300-150BC). Most of the mattockheads were cast, the materials used were decarburized from white cast iron with varying carbon contents of 0-1.4%, and graphitization was found in samples **C5:159** and **160**. Two of the mattockheads (**C5:163** and **171**) were not decarburized and **C5:92** was made from mottled iron. The production techniques and material used for the iron mattockheads excavated at Lijiaba are basically the same as the those excavated in Hebei, Jilin, and Guizhou provinces.

The chisel (SK0031-32) was excavated from non-burial context, and was forged from fined iron or bloomery iron and the working edge was carburized. The object was probably broken and repaired with a small piece of low carbon iron. From elsewhere in China, there are analyses of seven other chisels excavated in Jiangsu (appendix **C5:79**, **80**, **85**, **88**, **90** and **91**, Chen J. and Han 1999, 85-86, 88 fig.11-12) and Hebei provinces (**C5:125**, Liu Haifeng *et al* 2013, 137, 140 fig.8, 141 fig.9). All of the chisels are dated to the Western Han dynasty (202BC-20AD). The chisels excavated in Jiangsu were all folded and forged from fined iron or decarburized steel from white cast iron except **C5:79**, and some of chisels were partially quenched (**C5:80**, **85**, **90** and **91**). The chisel excavated in Hebei was considered possibly made from perfusing steel which is a mixture of liquid cast iron and heated low carbon steel/wrought iron. The production technique and the material used for the chisel excavated at Lijiaba (SK0031-32) is similar to most of the chisels excavated in Jiangsu.

The shovelhead (SK0038-39) was excavated from burial No.14 of 2003, and the object was forged from fined iron or bloomery iron. For comparison, there is an analysis of three iron objects which recorded as shovelheads excavated at Dongheishan site, Hebei province (Liu Haifeng *et al* 2013, 136-137), but according to the sketches in the original reports (Shi L. *et al* 2014, 35 fig.18:9, 61 fig.35:4, 156 fig.87:5), those objects are actually mattockheads (see mattockheads above). There is one object with only the socket part remaining excavated from Guizhou, which looks like a shovelhead (**C5:181**, GZSWWKGYJS 2008, 19, 198). The result shows that the object was forged from decarburized steel from white cast iron and is similar to the shovelhead excavated at Lijiaba.

The pickaxehead (SK0057-58) in my study was excavated from non-burial context, and the object was forged from fined iron or bloomery iron. There are no metallographic studies of other excavated iron pickaxeheads in the literature.

The nail (SK0064) was excavated from non-burial context and was forged from fined iron. There are examples of analyses of four other iron nails excavated from Hebei province (appendix **C5:102**, **103**, **150** and **152**, Liu Haifeng *et al* 2013, 136, 138). **C5:102** and **103** are dated to the early Western Han (202-150BC), and **C5:150** and **152** are dated to the 13th/19th centuries AD. The two nails of the Western Han dynasty were made from steel/wrought iron decarburized from white cast iron with carbon contents of 0-0.5%. The production technique of the iron nail excavated at Lijiaba seems to be different than the two excavated in Hebei of the Western Han dynasty. However, this is the only sample we have examined so far and the figure of the object also looks like an arrowhead (Fig. 5.158).

***Accessories*:**

There are four belt hooks excavated from 2 burials. Three of them (SK0047, 56 and 61) were excavated from burial No.6 of 2003. The other (SK0052) was actually at least 4 belt hooks excavated from burial No.3 of 2003, but they all shared one artefact number and only one sample was collected. For comparison, there are analyses of five other belt hooks excavated in Shaanxi (appendix **C5:62-68**, Guo Meiling *et al* 2014, 116, 118 fig.5-7) and Hebei provinces (**C5:144**, Liu Haifeng *et al* 2013, 137). The belt hooks excavated from Shaanxi are dated to the Warring States period (476-300BC), and were all cast in hypoeutectic white cast iron and were decarburized. The one excavated in Hebei is dated to the $7^{th}/13^{th}$ centuries AD, and was cast in white cast iron. The belt hooks excavated at Lijiaba are slightly later than those excavated in Shaanxi province, and they were not only cast in white cast iron and decarburized (SK0052) but also forged from fined iron or bloomery iron (SK0047, 56 and 61).

***Domestic object*:**

There is one object ear/handle (SK0055) excavated from non-burial context, and the object ear was forged from fined iron or bloomery iron. There are no metallographic studies of other excavated iron object handles in the literature from China.

Noticeably, there is no evidence of iron smelting or production sites near Lijiaba. The iron objects excavated at Lijiaba were likely to be imported from the Central Plains. However, the iron pickaxehead and the forged iron belt hooks, differ from the object type and production techniques from the Central Plains, might be an evidence to show that there was also local iron making activities.

As shown in the chart (Fig. 5.172), among these 36 objects, 19 were cast, 16 were forged, and one was totally corroded. Both the forged and the cast iron objects were relatively evenly applied at the Lijiaba site. The totally corroded sample (SK0053-54) was cut from a mattockhead. The other 7 mattockheads in this study were all cast from white cast iron (some were decarburized and graphitized), and this one could be very possible the same.

Almost all of the cast objects were iron tools, the reason is probably because the tools such as mattockheads and axeheads needed a better toughness in their applications. The cast weapon was an arrowhead (SK0006), and the other 'arrowhead' (SK0017-18) is redefined as an iron nail. Among these cast objects, decarburization was found on 18 of the objects and graphitization was discovered on 9 of the objects. There is a fully decarburized layer at the surface on some of the cast objects (SK0001, 21, 36, and 40) indicating the objects were cast first and decarburized in solid-state. Only one axehead (CD) was discovered as pure white cast iron without decarburization and graphitization. These excavated objects are dated from the Han (more probable) to Tang dynasty, and the annealing techniques applied are similar to the Central Plains technology system of the pre-Han period (Chen J. *et al* 2008a, 195; Yang J. *et al* 2014, 183). The related technology system of Lijiaba and the Central Plains may indicate that the iron production technology of Lijiaba was introduced from the Central Plains.

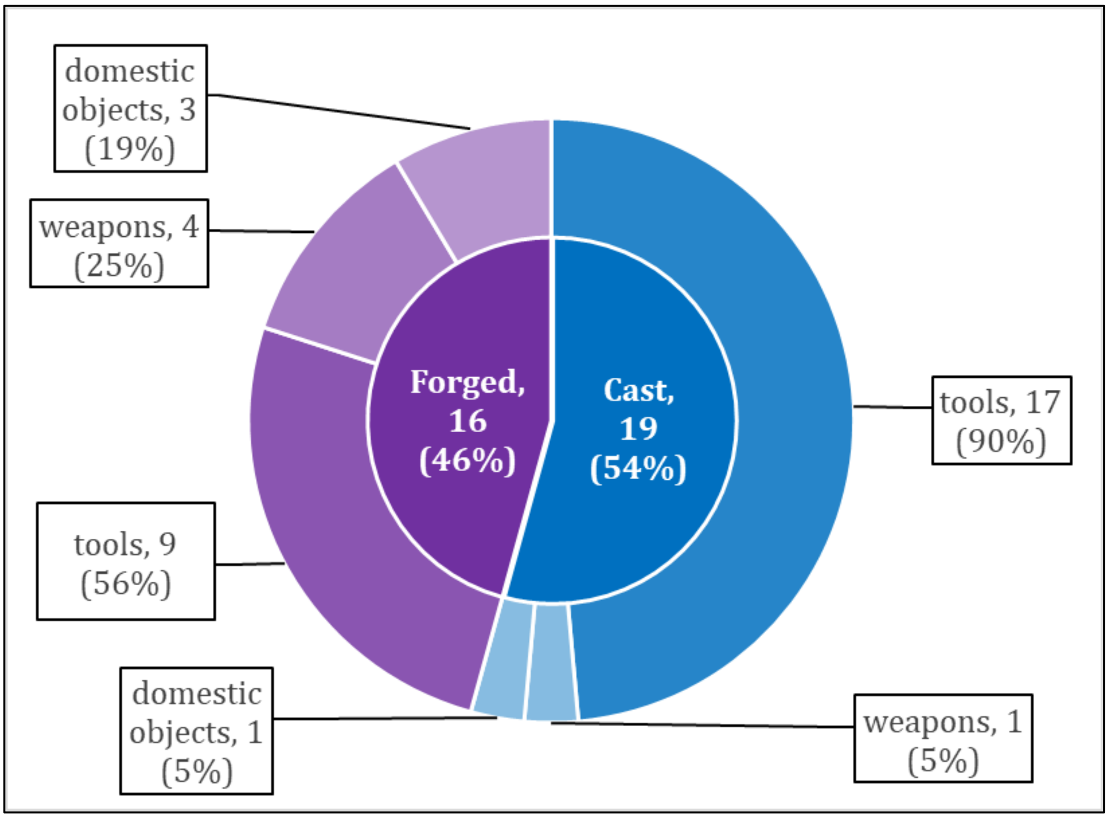


Fig. 5.172 Proportion of the object types of both forged and cast iron objects from Lijiaba (source: author)

Carburization was found at the surfaces of five forged iron objects. Most of the carburization was discovered on the cutting edges of the objects. For example, the cutting edge of an iron sabre (SK0029) has a carbon content of c.0.6-0.77%, and at its ridge it revealed a ferrite matrix with uneven gain sizes (SK0030). It shows that the ancient workers already had a good understanding of carbon to the change of property of the iron, and they were capable to apply the technique well in their iron making activities.

It is interesting that wrought iron tools were found in Sichuan. Wagner (1993, 2007) has pointed out in his works that in early times in China, weapons were wrought and tools were cast, and that this began to change in the Tang dynasty (618-907AD). There are some exceptions, for example, an iron scythe-blade from a Han tomb excavated in Mianyang (near Chengdu), Sichuan province (Wagner 1993, 212), these 9 iron tools excavated from Lijiaba (Fig. 5.172), and the iron axehead (SK0073) from Qiaogoutou were all wrought iron tools. These exceptions might be helpful in studying the differences in policy and management of the central government and the frontier areas relating to iron production technology. Note that the burials of the Lijiaba site are dated from the Han to the Tang dynasties according to the pottery assemblage, the wrought iron tools could be an indication of the changing situation of the production techniques of iron tools in this area. However, a more reliable and precise dating process such as radio-carbon dating of the burials would be helpful in discussing this changing situation.

All of the 16 forged objects were made from either bloomery iron or fined iron. Some scholars believe that slag inclusions can be used to identify the material is either bloomery iron or fined iron (Chen and Han 2007, 37; Liu 2014, 60). Some western scholars believe that the slag inclusions tell only the technical skill level of the blacksmith (such as Wagner). Chen and Han’s method may not yet be a sufficient way to identify bloomery iron and fined iron. One counter example of the Qiaogoutou sample (SK0073) is discussed in the following section. Yang Ju *et al* (2014, 182-186) suggested that the high content of calcium and phosphorus could be an evidence of distinguishing fined iron from bloomery iron. However, this method is not quite convincible because the scanned areas of their compositional analysis were not clearly demonstrated and there are no comparison group of bloomery irons. Rostoker and Dvorak (1990, 153) indicated that the slag associated with production is trapped in the metal and can be used to differentiate the production methods, which the puddled wrought irons have the purest slags, the bloomery irons have much less pure slags, and finery slags seem to be intermediate. But it could be very difficult to decided (on the basis of the slag composition) whether the wrought iron was made by the bloomery or finery process. These are the reasons that no decision was made yet for the wrought iron objects from Lijiaba were either bloomery iron or fined iron.

Although it is very possible that bloomery process was once existed and developed independently in ancient China (Bai Y. 2005, 42), but there is still lack of direct evidence of bloomery smelting in ancient China. According to the situation of Lijiaba and other excavated iron objects of ancient China, wrought iron was widely applied in making tools, weapons, and domestic objects. Considering the limited supply of wrought iron from the bloomery process and the large demand of the ancient Chinese society, and the situation that blast furnaces and refining furnaces usually discovered together at the ancient Chinese iron smelting sites, the bloomery process was probably superceded by the finery process quickly as early as the late Warring States period to the Western Han dynasty (3^{rd}-2^{nd} centuries BC). A further study of compositional analysis of the slag inclusions in the forged iron objects of Lijiaba will be carried out. But until then, we may not be able to distinguish the two processes even that many of these objects seem very possible to be made from fined iron.

In addition, most of the present compositional studies of the slag inclusions are trying to distinguish the processes from the productions. However, a better way would be to do more experimental smelting of both bloomery and finery processes, and to analyze the wrought iron obtained from both processes.

Qiaogoutou

A summary of the metallographic analysis of the three samples is given in the table below.

Table 5.9 Summary of metallographic analysis of the iron objects excavated from Qiaogoutou

Artifact No	Laboratory No	Phases	Carbon	Material and techniques
2011PQM13:4	SK0072	ferrite	some carbon on grain boundary	wrought iron, solid-state decarburized, forged, annealed
2011PQM23:9	SK0073	ferrite, pearlite	decreasing from tip to middle, and one surface to the other. Low to 0.2-0.4%, and high to 0.6-0.77%	wrought iron, hypo-eutectoid steel, forged
2011PQM22:1	SK0074	ferrite	some graphite	whiteheart malleable cast iron

The slag inclusions in SK0072 (sword) are fewer and smaller than the slag inclusions in SK0073 (axehead). The acicular phases in the ferrite grains are either carbides, nitrides or carbide-nitrides (Scott 2013, 167). The carbon content is very low in SK0072, less than 0.1%. The single-phased slag stringers and undistorted grains in SK0072 suggests that the object was forged and annealed from wrought iron. When making iron swords, the blacksmiths of ancient China probably started with wrought iron, and carburized the sword during the forging process. In ancient China, wrought iron could have been produced in a number of different ways – by a bloomery process, a crucible process, by the fining of pig iron from a blast furnace, or by solid-state decarburization of pig iron from a blast furnace (Wagner 1993, 288). There is still insufficient evidence of a crucible process for iron smelting in China before 200AD (Zhou W. *et al* 2016, 363), and we might expect more and larger slag inclusions if the wrought iron was from a bloomery process. It is possible to produce wrought iron by fining pig iron from a blast furnace although the primary purpose of this process was to produce steel of varying carbon content. In addition, the high silica single-phased slag inclusions may indicate the wrought iron used to forge this sword was probably from solid-state decarburization of pig iron, and the iron was cast into a plate or rod and annealed in an oxidizing atmosphere, decarburizing it in the solid state.

The slag stringers and the decreasing pearlite from the tip to the middle of SK0073 suggest that the object was forged from wrought iron and then carburized to a medium-high carbon steel. As mentioned before, some scholars believe slag inclusions can be used to identify the material is either bloomery iron or fined iron (Chen and Han 2007, 37; Liu 2014, 60). According to their definition and the SEM-EDS result of SK0073 (Table 5.7, analysis no.6-16), the material could be identified as bloomery iron because the clear eutectoid phase-separated microstructure as in bloomery iron's high Fe and low Si double-phased inclusions (Fig. 5.170), however, it could also be identified as fined iron (or puddled steel as defined by Liu 2014) because there are also many single-phased inclusions (Fig. 5.169). Therefore, in this case this method may not yet be a sufficient way to identify bloomery iron and fined iron.

There is only very little metal left in the centre of SK0074 (U-shaped implement cap). No conclusive evidence of either forging or casting was discovered. However, this type of implement is usually believed to be cast rather than forged in ancient China. The SEM-EDS result indicated that the graphite-like structures are very possibly graphite (Table 5.7, analysis no.17-20). The artefact was possibly made from whiteheart malleable cast iron, being cast in white cast iron and then decarburized in the solid-state. A small amount of pearlite and more graphite could be expected in a larger sample.

Metallographic studies of iron objects dating to the 5th century BC or earlier have concluded that the blades of iron swords (with bronze or jade handles) were made from carburized bloomery iron with a carbon content up to 0.5% (Han R. 1998, 92). Other metallographic studies of iron swords, axeheads, and U-shaped implement caps from the 4th century BC to the 4th century AD can be find in appendix C5. From the descriptions, the materials used to make these iron swords were hypo-eutectoid steel with carbon content usually higher near the surface from 0.3% to 0.8% and lower in the core from 0.1% to 0.3%, and sometimes quenched. The axeheads were made of decarburized steel from white cast iron with a carbon content between 0.2% to 0.4%, and the earlier two (4th-2nd century BC) were forged and the later (200-350AD) were cast (see axeheads of Lijiaba). The U-shaped implement caps were made of varied materials including white cast iron, decarburized steel from white cast iron, and malleable cast iron.

The Qiaogoutou site is located in the south of Sichuan province close to Yunnan province. The iron objects analyzed here were dated to the late Warring States period and early Western Han dynasty (336-140BC). The metallographic characteristics of these objects are similar to the ones discovered in Yunnan of the same period, but in larger quantity and more types including weapons, tools and domestic objects. However, it is still too early for conclusions to be drawn about the iron production technology of this area until more samples can be studied. On the other hand, it is worth mentioning that these artefacts were all excavated from cemetery contexts, which could not be fully representative of daily use situations. In addition, there is so far no evidence of iron smelting in this area. To address the question whether they were made locally or imported from other places will require more samples to be studied in the future.

Chapter 6: Conclusions

In these conclusions I will briefly review the main findings of the three major areas of work undertaken in this thesis: the site-based fieldwork (chapter 3), the survey of published objects (chapter 4), and the metallographic analysis of objects from Lijiaba and Qiaogoutou (chapter 5). From this it will be possible to assess the extent to which the data has addressed the original research questions of the thesis.

Iron smelting sites and iron smelting technology

Based on the archaeological surveys of iron smelting sites carried out in Southwest China (chapter 3), the origin of iron smelting in Southwest China has been traced to the 4th-3rd centuries BC, which suggests it is closely related to the control and exploitation of the mineral resources in Southwest China by the central government during the Qin and Han dynasties.

Most of the recorded iron smelting sites are located in the Chengdu Plain, and the early iron smelting sites are all situated in the intersection area of modern Pujiang and Qionglai counties. The reasons for this situation are that, on the one hand, Chengdu Plain was recorded as an important area of abundant iron ore resource and early iron smelting activities in multiple ancient texts (section 2.1.5), and on the other hand, most archaeological fieldwork has been carried out on the Chengdu Plain and much less in other provinces.

The earliest written evidence that the iron smelting technology was brought to Southwest China is recorded in *Shi Ji* ('Records of the historian'). The ancestors of the Zhuo family were deported from Zhao (a state which included parts of modern Shanxi, Shaanxi, and Hebei) to Shu when Qin conquered Zhao (228-222 BC), and the Zhuo family became rich with an ironworks. In the *Hua Yang Guo Zhi*, iron smelting could be traced to about 316BC when the Qin state conquered Ba (modern Chongqing) and Shu (modern Sichuan) and deported people from Qin to the conquered territories (Chang Q. 2009, 128). The iron produced was probably traded to modern Yunnan as raw material, but it was family-based and comparatively small-scaled. The government controlled large-scaled iron smelting industry was introduced and started in the early of Western Han dynasty

(202-150BC), and iron production offices (*TieGuan*) were set up in the Shu county. The earliest archaeological evidence of iron smelting in Southwest China is the Tieniucun sites which is dated as early as the early of 2nd century BC (section 3.5.3). On the other hand, smithing techniques were introduced to Yunnan during the 3rd-2nd centuries BC, and the technology was probably a new branch and separated from bronze making.

Based on the field evidence examined for this thesis, the iron smelting sites excavated in Southwest China were all pig iron smelting sites, and refining process was discovered at Tieniucun (section 3.5.3) and Xuxiebian (section 3.5.2). It may suggest that the primary function of iron smelting in the Chengdu Plain is to produce cast iron ingots and fined iron. There is still a lack of evidence of forging or casting of iron at or near the iron smelting sites, and there is no direct evidence of bloomery smelting in Southwest China.

For smelting, iron ores were selected, crushed, and roasted before charging into the furnaces. The ores were discovered to be crushed into 2-6cm sizes at Gushishan, Xuxiebian, Tieniucun, and Chadiping (a bigger group of 5-12cm are discovered at Chadiping, section 3.5.5). The iron ores used at Tieniucun were magnetite and hematite with an iron content possibly higher than 60-70%.

The fuel used in iron smelting activities in Southwest China was charcoal, and there is no evidence of coal or coke used in Southwest China. Since the Han dynasty (202BC-220AD), as the improvement in development of blast furnace, the scale of the iron smelting and production became very large, requiring a large and reliable supply of charcoal. Therefore, most of the smelting locations at the time were chosen in deep mountains, one of the reasons was there were plenty of forest and space to make charcoal onsite. The Tieniucun iron smelting site is one of the examples. The site is about 60km away from the ancient Chengdu city, and would possibly take two or more days to travel in the ancient time. According to the charcoal analysis of Tieniucun (section 3.5.3), varied tree species were used in the smelting and the charcoal was usually made near the smelting sites. Unlike some iron smelting sites where a limited tree species are used to make charcoal, the variety of tree species chosen at Tieniucun might also indicate a large smelting scale.

There are two cases of discovery of slags on site. One case is the Xuxiebian iron smelting site (section 3.5.2), where large amounts of slags were discovered indicating that the slags and other wastes from the smelting were discarded together on the lower side of the site. The other case is the Tieniucun iron smelting site (section 3.5.3), where few slags were discovered. However, large amounts of abraded slags were found at a village less than 1km from Tieniucun, which suggests that the slags produced at Tieniucun were possibly transported to nearby regions for road paving. In addition, the discovery of refining slags directly from the bowl furnace at Xuxiebian indicated the function of the bowl furnaces were for refining.

Furnace and furnace structures

The furnaces discovered in Southwest China are blast furnaces for pig iron smelting and bowl-shaped furnaces for refining process. The blast furnaces were cylindrical with an inner diameter of about 1m (about 0.5m at furnace mouth), probably 3-4m high, usually constructed with furnaces bricks, which is the reason why the furnace could be built big (furnace L1 at Gushishan, section 3.5.1). The furnace bricks are either made with sandstone, limestone, or clay. Small stones and charcoal were usually mixed into the clay when making clay bricks, and sometimes also small crushed slags. This mixed clay was also used to make both interior linings and exterior coverings. The furnace linings and coverings were usually 10-20cm thick. The furnace is usually bellowed from one side and tapped from another side. According to the location and topography of the sites, manpower was likely to be the bellowing method and no evidence of waterpower or animal power was discovered (section 3.5.4).

To build the refining furnace, the first step was to dig a bowl-shaped pit in the ground, and the earthen walls are then tamped hard. The second step was to use a mixture of clay, river sand and straw (or other organic fibres) to strengthen the interior surface. The third step was to build a circular or rectangular shaped furnace wall above the ground with clay or stone bricks and set up the bellow on one side and connect the tuyeres to the centre of the furnace. The final step was to cover more than half of the furnace top with clay or stone plate. There were two gaps (10-15cm) on both of the northern furnace wall of furnaces L1 and L2 excavated at Xuxiebian (section 3.5.2), which suggests that the refining furnace is probably bellowed from the top.

Iron production and labor identity

Unlike other iron smelting sites in China, there are no ceramic or iron moulds discovered in Southwest China. The production from iron smelting sites in Southwest China was probably only pig iron ingots. The only function of the iron smelting sites in Southwest China is to turn the iron ores into pig iron ingots, the ingots would then be transported to areas with stronger control by the central government in the Central Plains, where they were then cast into different objects. Even though we do not have direct archaeological evidence yet, but according to the locations of the discovered iron smelting sites in Sichuan, it suggests a high possibility that the labourers used in the iron smelting industry in Southwest China were exils and prisoners other than freeman (section 3.5.3). In which case the opportunity of making contact with iron weapons and implements would be strictly prevented. The risk of transporting primary material is clearly much lower than transporting iron weapons and implements.

In addition, the names of the *TieGuan* (iron production offices) were sometimes found cast onto iron implements but it is rare to see the name of the *TieGuan* of Southwest China. The only examples were all discovered in Yunnan province. Three iron mattockheads were excavated at Shimenkan, Zhaotong in 1936, in which four characters, ‘*Shu Jun Qian Wan*’ (‘*Shu Jun*’ means the ancient Shu county, ‘*Qian Wan*’ could be an approximate number or a place name) were cast (edited by Long and Lu 2007, vol.82). Another iron mattockhead was excavated in a Han tomb at Ludian in 1954, ‘*Shu Jun Cheng Du*’ (meaning Chengdu city of Shu county) was cast onto the object (Li J. 1962, 33). This indicates there were interactions between Shu (modern Sichuan) and Dian (modern Yunnan) during the Han dynasty, and it also suggests that the implements were probably cast in or near ancient Chengdu but not at the iron smelting sites in Qionglai and Pujiang. Unfortunately, there are still a lack of evidence of casting moulds and iron foundries sites around Chengdu.

Bi-metallic and iron objects

According to my statistics (section 4.3.1), most of the bronze and iron bi-metallic objects of Southwest China are dated to the Western Han dynasty (2nd century BC). Most of bi-metallic objects are excavated in Yunnan, and iron swords with bronze guards or handles are the dominant type. To make the bi-metallic objects, it requires both founding technique of bronze and smithing technique of iron. The early bronze and iron bi-metallic objects were probably first made by the most experienced bronze makers, and some of these people or their descendants probably became the first professional blacksmiths when iron supply was sufficient. These skilled people were presumably concentrated in northern China during the 10th-5th centuries BC as this is where the early bi-metallic objects were excavated, and some of them were possibly introduced to the Dian (modern Yunnan) or sent to the Dian as political ‘gift’ during the 3rd-2nd centuries BC (section 4.5.1).

There are not many iron objects before the Qin and Han dynasties excavated in Southwest China, but there is significant increase in both object quantities and types during the Han dynasty (section 4.3.2). In my discussion of the iron objects (section 4.5.2), it shows that the use and the spread of iron production in Southwest China was influenced by the Central Plains to a great extent in the Qin and Han dynasties. The overall proportion of iron tools, weapons, and domestic objects in Southwest China before the Han dynasty suggest that the main economic livelihood of SW China was agriculture. The bridge piers excavated in Sanxingdui suggest that Sichuan was capable of casting big iron objects as early as the mid-Western Han dynasty.

The higher proportion of iron weapons from Yunnan is possibly because the region is the most southwesterly and distant from political and social stability. By the same measure, the high proportion of domestic objects from Chongqing may indicate a safer and more stable society in an area closer to the centre of power during the Han dynasty. The concentrated distribution of iron objects in Yunnan and Guizhou may suggest that those areas were the economic and cultural centres of the ancient time further southwest.

The increasing distribution of the iron objects during the Han dynasty indicates that iron making technology was developed rapidly in Southwest China. Decreasing distribution since the end of the Eastern Han dynasty is possibly indirect evidence of the development of an iron recycling technique or a population decreases and a reduced political control.

Metallurgical studies

The iron objects excavated from Lijiaba and Qiaogoutou are abundant both in quantity and type (chapter 5). Multiple samples from weapons, wood working tools, and agricultural implements were assessed and analysed. The analyses provide valuable data for the study of iron making and smelting technology of Southwest China. According to the metallographic results, during the Warring States period and the Western Han dynasty, the primary use of iron at Qiaogoutou is forged wrought iron objects, and there is also evidence of cementation, annealing and decarburization (section 5.4). The production technology applied to the iron objects excavated at Lijiaba were more complicated (section 5.3) and include both casting and forging as well as hardening (carburization) and softening processes (decarburization and graphitization).

Future work

Archaeometallurgy is a recent discipline in Southwest China, many smelting related remains (especially bowl-shaped furnaces) were interpreted as pottery kilns or cooking hearths in the past. With the exception of Sichuan province, there is still a lack of direct archaeological evidence of iron smelting sites in Southwest China. However, archaeometallurgy has increasingly become a topic of interest in recent years with a greater amount of metallurgical surveys and metallographic studies being carried out in this area.

In reference to chapter 3 and 5, the general situation of iron production technology of Sichuan and Chongqing is relatively clear, however, the compositional analyses of the slag inclusions of the Lijiaba samples are yet to be studied. It may help to provide a better understanding of the iron production technologies employed in Chongqing. Further analysis of more metallographic samples from more sites should be studied in the future to provide greater understanding of local iron production technologies.

Field surveys need to be continued in Yunnan and Guizhou, as it is likely that more iron smelting sites are yet to be found. Archaeological excavations are planned to study the iron smelting technology of Yunnan and Guizhou as well as to investigate nearby settlement sites. Experimental smelting based on the discoveries from Sichuan and Chongqing is planned to further understand the processes of ancient smelting in the region. In addition, the scientific analysis of the experimental materials will provide a useful comparison to those conducted on the archaeological finds.

In reference to chapter 4, the bi-metallic and iron production techonologies in Yunnan were likely introduced from the Central Plains via Sichuan. There is also evidence of bi-metallic (section 4.5.1.) and iron objects in Southeast Asia (Higham 1996). Previous research has demonstrated close connections between Yunnan and Southeast Asia in the past, especially the Dian culture in Yunnan and the Dong Son culture in Vietnam (Chang K.-C. 1977b; Murowchick 1989; Tessitore 1990; Higham 1996; Yao A. 2010). Whether these connections also involved the sharing or transmission of iron production technologies still needs to be ascertained. Future comparisons of archaeological sites and artefacts from both regions may help to further understand the dynamics of past inter-regional contacts, including the trade in iron and possible transmissions of technologies.

Bibliography

Abbreviations

Abbreviation	Chinese	English
ABZZQZZZZWWGLS	阿坝藏族羌族自治州文物管理所	Bureau of Cultural Relics of Aba Prefecture
CD(S)WWKGYJS	成都文物考古研究所	Chengdu Institute of Cultural Relics and Archaeology
CQSWWJ	重庆市文物局	Bureau of Culture Relics of Chongqing
CQSWWKGS	重庆市文物考古所	Chongqing Institute of Cultural Relics and Archaeology
CQSYMJ	重庆市移民局	Bureau of Immigration of Chongqing
CQWHYCBHZX	重庆文化遗产保护中心	Chongqing Cultural Heritage Protection Center
DLBZZZZWWGLS	大理白族自治州文物管理所	Bureau of Cultural Relics of Dali Prefecture
DLSBWG	大理市博物馆	Dali City Museum
DYSWWKGYJS	德阳市文物考古研究所	Deyang Institute of Cultural Relics and Archaeology
DZSWWGLS	达州市文物管理所	Bureau of Cultural Relics of Dazhou City
GDQBWG	官渡区博物馆	Guandu District Museum
GHSWWBHGLS	广汉市文物保护管理所	Bureau of Cultural Relics of Guanghan City
GJSBWG	个旧市博物馆	Gejiu City Museum
GJWWJSXGCWWB HLDXZHBGZZ	国家文物局三峡工程文物保护领导小组湖北工作站	Hubei Workstation of the Three Gorge Project of the State Administration of Cultural Heritage of China
GZSBWG	贵州省博物馆	Guizhou Provincial Museum
GZSWWKGYJS	贵州省文物考古研究所	Guizhou Provincial Institute of Cultural Relics and Archaeology
HBSWWYJS	河北省文物研究所	Hebei Provincial Institute of Cultura Relics
HHZWWGLS	红河州文物管理所	Bureau of Cultural Relics of Honghe Prefecture
HQXWWGLS	鹤庆县文物管理所	Bureau of Cultural Relics of Heqing County
JCXWHJ	江川县文化局	Bureau of Culture of Jiangchuan County
JNXWWGLS	晋宁县文物管理所	Bureau of Cultural Relics of Jinning County
KMSBWG	昆明市博物馆	Kunming City Museum

Abbreviation	Chinese	English
LSYZZZZBWG	凉山彝族自治州博物馆	Liangshan Museum
MXQZBWG	茂县羌族博物馆	Maoxian Museum
MYBWG	绵阳博物馆	Mianyang Museum
NJBWY	南京博物馆	Nanjing Museum
SBCK	四部丛刊	A series of books edited and published by the Shangwu Yinshuguan during 1922 to 1937.
SCDX	四川大学	Sichuan University
SCSBWG	四川省博物馆	Sichuan Provincial Museum
SCSWWKGYJY	四川省文物考古研究院	Sichuan Provincial Cultural Relics and Archaeology Research Institute
SFSBWG	什邡市博物馆	Shifang City Museum
SHXWWGLS	射洪县文物管理所	Bureau of Cultural Relics of Shehong County
SNSCBWG	遂宁宋瓷博物馆	Suining Song Porcelain Meseum
STXWWGLS	三台县文物管理所	Bureau of Cultural Relics of Santai County
SXSKGYJS	陕西省考古研究所	Shaanxi Provincial Institute of Cultural Relics and Archaeology
WSZWWGLS	文山州文物管理所	Bureau of Cultural Relics of Wenshan Prefecture
XCSWWGLS	西昌市文物管理所	Bureau of Cultural Relics of Xichang City
XHXWWGLS	宣汉县文物管理所	Bureau of Cultural Relics of Xuanhan County
XZWWGLWYH	西藏文物管理委员会	Bureau of Cultural Relics of Xizang
XZZZQWWJ	西藏自治区文物局	Bureau of Cultural Relics of Xizang
YNSBWG	云南省博物馆	Yunnan Provincial Museum
YNSWWKGYJS	云南省文物考古研究所	Yunnan Provincial Institute of Cultural Relics and Archaeology
YXSWWGLS	玉溪市文物管理所	Bureau of Cultural Relics of Yuxi City
ZGDBKQSZBWH	中国大百科全书总编委会	Editorial Board of Encyclopedia of China
ZGSHKXYKGYJS	中国社会科学院考古研究所	Chinese Academy of Social Sciences Archaeology Institute
ZJXWWBHGLS	中江县文物保护管理所	Bureau of Cultural Relics of Zhongjiang County

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Early Use and Production Technologies of Iron in Southwest China
(Appendices)

Volume 2 of 2

Submitted by YU NIU LI to the University of Exeter

as a thesis for the degree of

Doctor of Philosophy in Archaeology

In March 2018

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ……………………………………………………………………..

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Appendix A

1. Technological classification scheme of slags

SLAG

Class		Type		Sub-type	
Symbol	**Description**	**Symbol**	**Description**	**Symbol**	**Description**
S	Slag	***i***	Tap slag	***a***	Upper surface and base present (cake)
				b	Individual tendril
				c	Fragment –undiagnostic
		ii	Furnace slag	***d***	Plano-convex base
				e	Uncertain base
		iii	Refining slag	***f***	Fragment –undiagnostic

VARIANTS AND DESCRIPTORS FOR SLAG

Variant		Descriptors		
Symbol	**Description**	**symbol**	**description**	
A	Shape	1	Plano-concave	
		2	Plano	
		3	Plano-convex	
		4	Convex	

Variant		**Descriptors**		
Symbol	**Description**	**symbol**	**description**	
		5	Concave-convex	
		6	Amorphous	
		7	Hollow rod	
		8	Single rod	
		9	Multiple rods	
B	Overall Size	1	Very large (>20cm)	
		2	Large (15-20cm)	
		3	Moderate (10-15cm)	
		4	Small (5-10cm)	
		5	Very small (<5cm)	
		6	Complete	
C	Thickness	1	Very thick (>6cm)	
		2	Thick (4-6cm)	
		3	Moderate (2-4cm)	
		4	Small (1-2cm)	
		5	Very small (<1cm)	
D	Density	1	High	
		2	Moderate	
		3	Low	
		4	Very low	
E	Porosity proportion	1	Very high (>60%)	
		2	High (40-60%)	
		3	Moderate (20-40%)	

Variant		**Descriptors**		
Symbol	**Description**	**symbol**	**description**	
		4	Low (20%)	
		5	Very low (<5%)	
		6	Unclear	
		7	No	
F	Porosity size	1	Large (>10mm)	
		2	Moderate (2-10mm)	
		3	Small (1-2mm)	
		4	Very small (<1mm)	
G	Porosity shape	1	Network	
		2	Elongated	
		3	Spherical	
		4	Broken – random	
		5	Mixed spherical – elongated – all sizes	
H	Surface texture	1	Smooth	
		2	Ropey	
		3	Smooth with broken bubbles	
		4	Small tendrils	
		5	Globular projections	
		6	Rough	
		7	Broken	
		8	Crystalline	
		9	Duck’s foot morphology	
		10	Splash marks	

Variant		Descriptors		
Symbol	**Description**	**symbol**	**description**	
		11	Abraded	
I	colour	1	Black	
		2	Grey	
		3	Red	
		4	Brown	
		5	Purple	
		6	Grayish-blue	
		7	Yellow-orange	
		8	Metallic	
		9	Glassy green	
		10	Glassy black	
J	Surface impressions	1	Charcoal	
		2	Soil-geological	
		3	Toolmarks	
		4	Tuyeres – furnace wall refractory	
		5	Stone	
K	Underside texture	1	Smooth	
		2	Rippled – tendrils	
		3	Rough	
		4	Undulated	
		5	Geological – furnace material	
		6	broken	
L	Underside impressions	1	Charcoal	

Variant		Descriptors		
Symbol	**Description**	**symbol**	**description**	
		2	Soil – geological	
		3	Toolmarks	
		4	Tuyeres – furnace wall refractory	
		5	Slag	
M	Inclusions	1	Furnace wall – tuyere refractory	
		2	Charcoal	
		3	Geological – soil	
		4	Bloom – iron	
N	magnetism	1	High	
		2	Moderate	
		3	Low	
		4	Non-magnetic	
		5	Partially – isolated areas	
O	Viscosity	1	High	
		2	Moderate	
		3	Low	
		4	Unclear	
P	Multiple flow episodes	1	Yes	
		2	No	
		3	Unclear	
Q	Degree of fracture	1	Total – all surfaces	
		2	Partial – all edges	
		3	Minor – some old fractures – uncertain	

Variant		Descriptors		
Symbol	**Description**	**symbol**	**description**	
		4	Complete – edges intact	
		5	Abraded	

2. Recording sheet of metallographic samples

Recording Sheet of Metallographic Samples

<table>
<tr><th>Date</th><th>Artifact No.</th><th>Lab No.</th><th>Type</th><th>Site</th><th>Artifact date</th><th>Processor</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5"></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6"></td></tr>
<tr><td>Etch</td><td colspan="6"></td></tr>
<tr><td>After etching</td><td colspan="6"></td></tr>
<tr><td>Conclusion</td><td colspan="6"></td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Appendix B

1. Blast furnace of Han dynasty (202BC-220AD) discovered in China

Province	**Region**	**Site**	**No.**	**Shape**	**Dimensions (cm)**				**Date**	**Reference**
					Length	Width	inner diameter	remaining height		
Henan	Gongxian	Tieshenggou	L1	rectangular	133		62-80		c.150BC-50AD	(Zhao and Zhao 1962); (Zhao *et al.* 1985)
Henan	Gongxian	Tieshenggou	L2	circular			115		c.150BC-50AD	
Henan	Gongxian	Tieshenggou	L3	rectangular	130		100		c.150BC-50AD	
Henan	Gongxian	Tieshenggou	L5	circular			200	110	c.150BC-50AD	
Henan	Gongxian	Tieshenggou	L6	circular			165		c.150BC-50AD	
Henan	Gongxian	Tieshenggou	L16	circular			200		c.150BC-50AD	
Henan	Gongxian	Tieshenggou	L18	circular			108		c.150BC-50AD	
Henan	Gongxian	Tieshenggou	L19	circular			200	150	c.150BC-50AD	
Henan	Guxing		L1	elliptic	400	270		54	c.150BC-50AD	(ZZSBWG 1978)
Henan	Guxing		L2	elliptic	920	260-375			c.150BC-50AD	
Henan	Lushan	Wangchenggang	L1	elliptic					c.150BC-50AD	(Liu and Zhao 2002)
Henan	Linru	Xiadian		circular			200		c.200BC-200AD	(Ni 1960)
Shaanxi	Xi'an	Hanchang'ancheng		circular			90	10-12	c.150BC-9AD	(Li Y. *et al.* 1995)
Jiangsu	Liguoyi	Location 3		rectangular	470		380		c.9AD-200AD	(Li Z. 1960)

2. Smelting furnace of Han dynasty (202BC-220AD) discovered in China

Province	Region	Site	No.	Shape	Dimensions (cm)			Date	Source
					Diameter	inner diameter	remaining height		
Henan	Gongxian	Tieshenggou	L4	circular		101	120	c.150BC-50AD	(Zhao and Zhao 1962); (Zhao *et al.* 1985)
Henan	Dengfeng	Gaocheng	L5	circular		115		c.200BC-200AD	(An and Li 1992)
Henan	Dengfeng	Gaocheng	L4					c.200BC-200AD	
Shaanxi	Xi'an	Hanchang'ancheng		circular		90	10-20	c.150BC-9AD	(Li Y. *et al.* 1995)
Henan	Nanyang	Wafangzhuang	L20	circular				c.200BC-9AD	(Li J. 1991)
Henan	Nanyang	Wafangzhuang	L21	circular				c.200BC-9AD	
Henan	Nanyang	Wafangzhuang	L31	circular				c.200BC-9AD	
Henan	Nanyang	Wafangzhuang	L32	circular				c.200BC-9AD	
Henan	Nanyang	Wafangzhuang	L2	elliptic	190-240	190-240		c.50BC-200AD	
Henan	Nanyang	Wafangzhuang	L4	circular	270-350	200		c.50BC-200AD	
Henan	Nanyang	Wafangzhuang	L6	circular	350-420	108-114		c.50BC-200AD	
Henan	Nanyang	Wafangzhuang	L7		250-280	250-280		c.50BC-200AD	
Henan	Nanyang	Wafangzhuang	L11	irregular	200-310	15-60		c.50BC-200AD	

3. Furnace bricks of Han dynasty (202BC-220AD) discovered in China

<table>
<tr><th rowspan="2">Province</th><th rowspan="2">Region</th><th rowspan="2">Site</th><th rowspan="2">No.</th><th rowspan="2">L</th><th rowspan="2">W</th><th rowspan="2">T</th><th rowspan="2">Arc length</th><th colspan="2">Predict Diameter</th><th rowspan="2">Ave.</th><th rowspan="2">Date</th><th rowspan="2">Source</th></tr>
<tr><th>Inner</th><th>Outer</th></tr>
<tr><td>Sichuan</td><td>Pujiang</td><td>Tieniucun</td><td>10PXTH2③Ⅰ:4</td><td></td><td></td><td>6.3</td><td>19</td><td>101</td><td></td><td rowspan="3">82</td><td rowspan="3">c.100BC -220AD</td><td rowspan="3"></td></tr>
<tr><td>Sichuan</td><td>Pujiang</td><td>Tieniucun</td><td>10PXTH2⑦:20</td><td></td><td></td><td>7.5</td><td>26.5</td><td>62</td><td></td></tr>
<tr><td>Sichuan</td><td>Pujiang</td><td>Tieniucun</td><td>10PXTH2⑤:66</td><td></td><td></td><td>6.2</td><td>23.2</td><td>169</td><td></td></tr>
<tr><td>Henan</td><td>Guxing</td><td></td><td></td><td></td><td></td><td>8</td><td>35</td><td>160</td><td></td><td>155</td><td>c.100BC -220AD</td><td>(ZZSBWG 1978)</td></tr>
<tr><td>Henan</td><td>Gongxian</td><td>Tieshenggou</td><td>C35</td><td></td><td></td><td></td><td>30</td><td>85</td><td></td><td rowspan="3">100</td><td rowspan="3">c.100BC -9AD</td><td rowspan="3">(Zhao and Zhao 1962);
(Zhao et al. 1985)</td></tr>
<tr><td>Henan</td><td>Gongxian</td><td>Tieshenggou</td><td>C36</td><td></td><td></td><td>9.5</td><td>31</td><td>99</td><td>118</td></tr>
<tr><td>Henan</td><td>Gongxian</td><td>Tieshenggou</td><td>C37</td><td></td><td></td><td>9</td><td>31.5</td><td>115</td><td>133</td></tr>
<tr><td>Henan</td><td>Anyang</td><td>Dongye</td><td></td><td>14.5</td><td>10.5</td><td>8.5</td><td>12</td><td>88-109</td><td></td><td></td><td>202BC-220AD</td><td>(Li J. 1992)</td></tr>
<tr><td>Henan</td><td>Xin'an</td><td>Shanggudengcun</td><td>H1:16</td><td></td><td></td><td></td><td>36</td><td>98.6</td><td></td><td></td><td>c.50BC-220AD</td><td>(Huang and Dang 1988)</td></tr>
<tr><td>Henan</td><td>Nanyang</td><td>Wafangzhuang</td><td>T42①A:161</td><td>45</td><td>45</td><td>11.1</td><td>45</td><td>110</td><td>136</td><td>129.9</td><td rowspan="2">c.50BC-220AD</td><td rowspan="2">(Li J. 1991)</td></tr>
<tr><td>Henan</td><td>Nanyang</td><td>Wafangzhuang</td><td>T2①A:169</td><td>40</td><td>22</td><td>12.5</td><td>40</td><td>149.6</td><td>174.6</td><td>149</td></tr>
</table>

Province	Region	Site	No.	L	W	T	Arc length	Predict Diameter		Ave.	Date	Source
								Inner	Outer			
Henan	Nanyang	Wafangzhuang	T3①A:187	49	24	8	38	124	140			
Henan	Nanyang	Wafangzhuang	T3①A:189	38	25	7	33	116	130			
Henan	Nanyang	Wafangzhuang	T38①A:50	29	23	10	24	145	155			
Henan	Nanyang	Wafangzhuang	T42①A:133	28	17	9	28	140	158			
Henan	Nanyang	Wafangzhuang	T42①A:167	20	70	11	20	93	119			
Henan	Nanyang	Wafangzhuang	T18①A:32	46	26	13	40	142	166.4			
Henan	Nanyang	Wafangzhuang	T32①A:52	30	24	8	26	168	184			
Henan	Nanyang	Wafangzhuang	T2①A:170	49	46	13.4	40	126	152			
Henan	Nanyang	Wafangzhuang	T1①A:305	23	23	12	22.5	92	116			
Henan	Nanyang	Wafangzhuang	T1①A:306	26	25	8.5	24	126	143			
Henan	Nanyang	Wafangzhuang	H1:14	27	17	4	27	158	164			

4. Information of the iron smelting related sites in Southwest China

*E=elevation; TA=total area; DOD=depth of deposit; BS=burned soil; ISG=iron slag; IS=iron sand; IO=iron ore; FL=furnace lining; C=charcoal; F=presence of furnace.

No.	Site	E (m)	TA (m²)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
1	Gushishan															
2	Xuxiebian															
3	Tieniucun															
4	Shazitang															
5	Tonggucun Jigongshan	531.0	7700	40	60	Han	c.200 BC to 200AD	y	y	n	n	n	n	n		
6	Tonggucun Group 7	543.5	500			Song	960-1279AD	y	y	n	n	y	n	n		
7	Tonggucun Group 6	545.7	5000			Song	960-1279AD	n	y	y	n	y	n	n		
8	Tonggucun Shaziping	538.6	6075	70	90	Song	960-1279AD	y	y	n	n	n	y	n		
9	Qingshancun	528.0	1710	40	50	Song	960-1279AD	n	y	n	n	y	y	y	There used to have a broken furnace which is about 2.1 m wide, horseshoe shape, and constructed from bricks that is 0.27 m long and 0.6 m thick.	

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
10	Liufenyuan	523.0	814	50	50	Song	960-1279AD	n	y	n	n	n	y	n		
11	Shengchashequ Gaoluchong	641.6	1000			Song	960-1279AD	n	y	y	n	n	n	y	One broken furnace is remaining, which is 1.6 m high and 1.7 m wide.	
12	Shazitian	582.0	2000	30	50	Ming-Qing	14th to 19th century	n	n	n	n	n	n	y	One broken furnace was discovered. The furnace belly is about 1.8 m in diameter. Stone and pebble were used around the furnace for strengthen purpose.	No cultural relics were discovered at the site. The site might be date to Ming or Qing dynasties (14th to 19th century) based on the way the furnace was built.
13	Shuangliucun	473.6	1334			Song-Ming	10th to 17th centuries	n	y	y	n	y	n	n		
14	Manancun Gaolushan	511.1	3335	30	50	Song	960-1279AD	n	y	y	n	y	n	y	One furnace is found in a comparatively good condition on the top of the hill. The furnace is 1.4 m high remaining. The furnace wall is about 0.6 m thick and is built from structured stones.	The red iron sand is discovered in a 10 m2 area near the furnace and is about 0.5 to 1 m thick. The slag deposit is about 0.3 to 0.5 m thick distributing in an area of 1,500 m2 at the bottom of the hill.

No.	Site	E (m)	TA (m²)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
15	Bajiaojingcun	585.0	10000	60	60		955-1127 AD	y	y	n	y	n	y	y	Furnaces ruins were recorded in the earlier survey, but not found in the survey in 2007.	By the augering result, the site is about 0.6 m in depth, where charcoal ash and iron ore were discovered at the 0.25 m level, and slag was discovered at the 0.55 m level. On the east of the site, there is a small hill which is already being developed as farmland, but slag, burned soil, charcoal ash, broken tile and pottery can be easily found on the ground. The slag deposit of this area is about 5 m in depth, the slag is over thousands tons. The slag is used to build road now.
16	Miaofengcun	557.6	68	400	400	Song	960-1279AD	y	y	n	n	y	y	n		
17	Pengheshequ Tiekuangshan	572.8	3035	200	200	Song	960-1279AD	y	y	n	n	y	n	n		

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
18	Lupingcun	595.8	1200	150	150	Song	960-1279AD	y	n	y	n	n	n	n		
19	Liudalin	599.4	6670	300	300	Song	960-1279AD	y	n	y	n	n	n	n		
20	Guanqiaocun	602.2	1800	150	150	Song	960-1279AD	y	n	y	n	y	y	n		
21	Guanqiaocun Group 3	601.3	1200			Song	960-1279AD	y	y	n	y	y	n	y	One furnace was found in the earlier survey, but not seen in the survey in 2007.	
22	Shazidi	575.8	6670	200	200	Song	960-1279AD	y	n	y	n	y	n	n		
23	Shixiangzi	576.8	4000			Song	960-1279AD	y	n	y	n	n	n	n		
24	Shihuiqiao	584.2	6700	400	400	Song	960-1279AD	y	n	y	n	n	n	n		
25	Wangjiashan	576.3	1500	200	200	Song	960-1279AD	y	n	y	n	y	n	n		
26	Yangfenyuan	592.5	1800	200	200	Song	960-1279AD	y	y	y	n	n	n	n		
27	Gaolushan	582.5	8000	300	300	Song	960-1279AD	n	y	y	n	y	n	n		
28	Sanhechang	590.0	3035	50	50	Song	960-1279AD	y	y	y	n	y	n	n		

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
29	Yulongcun Group 1	558.5	5000	30	40	Song	960-1279AD	n	n	n	n	n	n	n		
30	Datiancun Gaoluchong	556.3	2500	60	70	Song	960-1279AD	n	n	n	n	y	n	n		
31	Datiancun Douyan	575.4	2500	60	70	Ming	1368 – 1644 AD	y	y	y	n	y	n	n		
32	Wufenyuan	558.7	1500	60	70	Song	960-1279AD	n	n	n	n	n	n	n		
33	Futiancun	558.3	1140	50	70	Song	960-1279AD	y	y	n	n	y	n	n		
34	Futiancun Group 15	542.8	700			Song	960-1279AD	n	y	n	n	y	n	n		
35	Shiqiaocun Group 8	538.9	1500	10	30	Song	960-1279AD	y	y	y	n	n	n	n		
36	Shiqiaocun Group 12	532.9	1000	60	70	Song	960-1279AD	n	y	y	n	y	n	n		
37	Yucaicun Group 7	553.2	400	20	30	Song	960-1279AD	n	y	n	n	y	n	n		
38	Shazidang	550.3	3335	20	30	Song	960-1279AD	n	y	n	n	y	n	y	One broken furnace and an ancient mine were discovered in 2007. The remaining height of the furnace is 2.2 m and the inner diameter is about 1.4 m.	

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
															The furnace was constructed from refractory brick which has a dimension of 0.5 m long, 0.33 m wide, and 0.14 m thick.	
39	Shaduizi	550.0	2700	70	90	Song-Ming	10th to 17th centuries	y	y	n	n	y	y	y	Two pieces of furnace base were discovered, the larger one is 0.4 m long, 0.38 m wide, and 0.23 m thick.	
40	Guihuacun Group 1 A		2400	30	40	Song	960-1279AD	n	n	n	n	y	y	n		
	Guihuacun Group 1 B		875	50	60	Song	960-1279AD	n	n	n	n	y	y	n		
	Guihuacun Group 1 C		1000	60	70	Song	960-1279AD	n	n	n	n	y	y	n		
41	Dacaocun Group 11 Luochang	532.7	1000			Song	960-1279AD	y	y	n	n	y	y	n		
42	Dacaocun Group 11 Youyugou	527.9	600			Song	960-1279AD	n	y	n	n	n	y	n		
43	Dacaocun Group 12	539.4	800			Song	960-1279AD	y	y	n	n	y	y	n		

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
44	Dacaocun Group 6	507.4	1200			Song	960-1279AD	n	y	n	n	y	n	n		
45	Dacaocun Group 1	524.9	800	60	160	Song	960-1279AD	y	y	n	n	y	n	y	One broken furnace was discovered in the earlier survey, which was recorded as 1.4 m high and the furnace wall was 0.65 m thick. The furnace was cylindrical and was constructed from refractory bricks.	In the mountain on the east of the site, there are five mines of total area about 300 m2. The deepest part of the mine is about 3.7 m
46	Dacaocun Group 9	527.1	700			Song	960-1279AD	y	y	n	n	y	n	n		
47	Dacaocun Group 13	531.9	1300	300	300	Song	960-1279AD	y	y	n	n	y	n	n		
48	Dacaocun Group 14 Shazidi	532.9	5000	40	40	Tang-Song	7th to 13th century	n	y	n	n	y	n	n		There is a small hill piled up with slag and furnace lining, which is about 150 m^2 and 2 m higher than the surface level
49	Tiexicun Group 1	531.4	2700			Song	960-1279AD	y	y	n	n	y	n	n		
50	Longtoucun	514.6	1340	100	100	Song	960-1279AD	n	y	n	n	y	n	n		

No.	Site	E (m)	TA (m²)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
51	Dengganping	534.6	740	100	100	Song	960-1279AD	y	y	n	n	y	y	n		
52	Liuhechang					Qing	1893 AD									A trench was discovered connected to a coal mine. The remaining of the trench is 19.1 m long, and 0.25 m wide and deep. The trench was used to transport coal. On the wall inside the mine, it carved ‘the 19th year of the Guangxu of Qing dynasty (1893 AD)’.
53	Dangoucun Group 11	511.8	2000	100	100	Song	960-1279AD	n	y	y	n	n	n	n		The local people used the slag to build the border of the fields.
54	Pangoucun Group 1	539.6	5000	70	80	Song	960-1279AD	y	y	n	n	n	n	n		
55	Pangoucun Group 4	531.7	600			Song	960-1279AD	n	y	n	n	y	n	n		
56	Shizicun	561.4	2100	40	50	Song	960-1279AD	n	y	y	n	n	n	n		
57	Shizicun Group 1	557.2	900	20	30	Song	960-1279AD	n	y	y	n	y	n	y	One broken furnace was discovered, which has a	

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
															remaining height and width of 1.9 and 0.5 m.	
58	Tiquancun Group 4					Song	960-1279AD	n	y	n	n	y	n	y	The remaining height of the furnace is 2 m and the diameter of the belly is 3.5 m. The furnace was constructed with refractory brick and red sand stone, half part of the furnace wall was still remained.	The site is consisted with 1 broken furnace, 5 slag pile, and 5 mines. Furnace lining and slag can be found around the furnace. Slag pile A is 44 m long and 40 m wide. Slag pile B is 20 m long and 8 m wide. Slag pile C is 7 m long and 5 m wide. Slag pile D is 7 m long and 5 m wide. Slag pile E is 42 m long and 40 m wide.
59	Tiquancun Group 5 Shazidun	566.5	630	200	200	Song	960-1279AD	y	y	n	n	y	n	n		
60	Tiquancun Group 5 Shazidi	556.8	600			Song	960-1279AD	n	y	n	n	n	n	n		
61	Honglucun Honggaolu	589.7	600			Song	960-1279AD	n	y	n	n	n	y	y	Two furnace bases were discovered 7 m away from each other. Furnace A is 1 m	

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
															long and 0.35 m wide, and furnace B is 1.2 m long and 0.5 m wide.	
62	Honglucun Gaolushang	553.5	5000	200	200	Song	960-1279AD	y	y	n	n	n	n	n		
63	Gaoluzui	561.1	1800			Song	960-1279AD	y	y	n	n	y	y	y	One broken furnace was discovered in 1987, which has a remaining height of 2.2 m, diameter of 2 m, and 0.45 m thick of the furnace wall. Now destroyed.	
64	Shaziwan	588.5	2600			Ming	1368 – 1644 AD	n	y	y	n	y	n	n		
65	Gaolubang	581.0	1000			Song	960-1279AD	n	y	n	n	y	y	n		
66	Shuangshuijingcun Shaluzui	536.4	900	200	200	Song	960-1279AD	n	y	n	n	n	y	n		
67	Shaloucun	611.1	12000	200	200	Yuan	1271 – 1368 AD	n	y	y	n	y	n	n		
68	Huatouzui	607.6	910	300	300	Yuan	1271 – 1368 AD	n	n	y	n	n	y	n		

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
69	Kuangkengshan	638.5	60000	200	200	Song	960-1279AD	n	n	y	n	n	n	n		The iron sand deposit is about 2 m thick and 0.5 m from the surface, which is distributing in an area of 25,000 m2. There are hundreds of mine holes on the site. Most of them have rounded shape, and a diameter from 2 to 5 m and a depth from 1 to 2 m. The largest mine hole is 30 m long and 20 m wide. One kiln was discovered, which has a diameter of 1.9 m and 1.6 m deep.
70	Jianwan	626.3	1000	200	200	Song	960-1279AD	y	y	n	n	n	n	n		
71	Wanghe	630.7	600			Song	960-1279AD	n	y	n	n	y	y			
72	Tieshiba	590.0	57500													
73	Tieshidui		1500			Song	960-1279AD	y	y	n	n	y	n	n		One kiln was discovered.

No.	Site	E (m)	TA (m^2)	DOD (cm)		Date (by recorder)	Appro. Date	BS	ISG	IS	IO	FL	C	F	Furnace info	Note
74	Tiechangchong		4000			Tang-Song	7th to 13th century	y	y	n	n	y	n	n		
75	Chadiping	355.0														

5. Metallographic studies of iron swords, axeheads, and U-shaped implement caps in China, from the 4th century BC to the 4th century AD

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion	Source
1	7117	M374:15	cutting edge	sword	200-350AD	Liaoning (northeast)	pure pearlite in the cutting edge area, 0.8% carbon; core area about 0.3% carbon with a Widmanstätten structure; slag stringers, carburized on the edge.	fined steel, forged	(Chen *et al.* 2001)
2	7118	M218:10	cutting edge	sword	200-350AD	Liaoning (northeast)	uneven carbon content distribution, higher on the edge with a Widmanstätten structure, 0.3% carbon, carburized. Core area is ferrite and small amount of pearlite on the grain boundaries, 0.1% carbon, single and sub-double phases inclusion stringers mostly in the core area.	fined steel, forged	
3	7119	M309:13	cutting edge	sword	200-350AD	Liaoning (northeast)	uneven carbon content distribution, higher side is ferrite+pearlite on the grain boundaries, 0.1% carbon, lower side is ferrite, single phase inclusion stringers.	fined steel, cold forging	
4	7112	M4:46	cutting edge	axehead	200-350AD	Liaoning (northeast)	even carbon distribution, pearlite+ferrite, 0.4% carbon, few inclusions.	decarburized steel from white cast iron	
5	7131	M205:11	cutting edge	axehead	200-350AD	Liaoning (northeast)	ferrite+pearlite, pearlite precipitated on the ferritic grain boundaries, 0.2% carbon, very few inclusions, shrinkage cavities or gas hole in casting.	decarburized steel from white cast iron, cast	

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion	Source
6	7134	M20:4	cutting edge	U-shaped implement cap	200-350AD	Liaoning (northeast)	white cast iron, casting flaws.	white cast iron	
7	FWC01	③:18		U-shaped implement cap	-4th/-2nd century	Fujian (southeast coast)	badly corroded, trace of white cast iron structure in the corrosion.	white cast iron	(Chen *et al.* 2008)
8	FWC02	T13II③:4		U-shaped implement cap	-4th/-2nd century	Fujian (southeast coast)	badly corroded, little metal left, which is pearlite with 0.8% carbon content, no inclusion.	decarburized steel from white cast iron, forged	
9	FWC03			U-shaped implement cap	-4th/-2nd century	Fujian (southeast coast)	pearlite+ferrite matrix with graphite.	malleable cast iron	
10	FWC05	T287 ③:39		axehead	-4th/-2nd century	Fujian (southeast coast)	ferrite, grain size grade 5, some carbides precipitated in the ferritic grains, few single phase inclusions.	decarburized steel from white cast iron, forged	
11	FWC06	T287 ③:34		axehead	-4th/-2nd century	Fujian (southeast coast)	ferrite+pearlite in the cutting edge area, 0.2% carbon, few single phase inclusions. Ferrite in the socket area, grain size grade 5.	two pieces of decarburized steel from white cast iron, forged	
12	FWC16	T8III③:1		sword	-4th/-2nd century	Fujian (southeast coast)	martensite, some bandings caused by trace element, single phase inclusion stringers.	fined steel, forged	

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion	Source
13	FWC17			sword	-4th/-2nd century	Fujian (southeast coast)	uneven structure, 3-5 layers of differnet carbon content, Widmanstätten structure in high carbon content area, 0.7% carbon with some spheridized pearlite, ferrite+pearlite in lower carbon content areas, 0.4% carbon, some single phase inclusion stringers.	fined steel, forged	
14	1:4249	Tomb of Liusheng	body?	sword	165-113BC	Hebei (Central Plain)	5 layers for the central ridge, and 4 layers in the blade areas. Higher carbon layer about 0.6-0.7% carbon, and lower carbon layers about 0.3% carbon. Martensite on the cutting edge. 'carbon-free bainite' (lower bainite) on the surface.	carburized steel from bloomery iron, quenched	(Yu and Qian 2011)
15	1:5105	Tomb of Liusheng	section	sword	165-113BC	Hebei (Central Plain)	lower carbon content layer about 0.1-0.2%, higher carbon content layer about 0.5-0.6%, surface carburized, higher than 0.6% carbon, martensite observed. Layers are thin due to the repeatedly forging process. Inclusion size is small, the biggest is 0.05-0.1mm.	carburized steel from bloomery iron, partially quenched	
16	HXS-4	M37:4	broken section	sword	202BC-20AD	Henan (Central Plain)	trace of forging, indistinct pearlite, forged from eutectoid steel.	decarburized steel from white cast iron, forged	(Rong *et al.* 2013)

* these were translated directly from the descriptions in Chinese

Appendix C

1. Details of the slag (s) samples collected from the excavated sites (referring to appendix A1)

'S no.'= sampel number; 'F no.'= file number; 'R'= recorder; 'C'= class; 'T'= type; 'Sub T'= sub-type; 'TQ'= total quantity; 'A'= shape; 'D'= density; 'E'= porosity proportion; 'F'= porosity size; 'G'= porosity shape; 'H'= surface texture; 'I'= colour; 'J'= surface impressions; 'K'= underside texture; 'L'= underside impressions; 'M'= inclusions; 'N'= magnetism; 'O'= viscosity; 'P'= multiple flow episodes; 'Q'= degree of fracture.

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	2	2010	Tieshiba	T5	LYN	s	i	a	1	1	13.0	11.5	6.5	1	5	2	2,3	2	2		4		2	4	2	1	3
2	2	2010	Tieshiba	T5	LYN	s	i	a	1	1	15.0	11.0	6.0	2	2	1	4	3	2		3	2	3	4	3	1	3
3	2	2010	Tieshiba	T5	LYN	s	i	c	1	6	10.0	9.0	6.0	2	3	2	3	6	2,4	2	3	2		5	4	2	3
4	2	2010	Tieshiba	T5	LYN	s	i	a	2	1	8.0	6.5	3.5	2	3	2	2,3	6	2	2	3	2	3	4	4	3	2
5	2	2010	Tieshiba	T5	LYN	s	ii	f	2	6	4.5	3.5	3.0	2	3	3	2,3	6	2,4					2	4		1
6	3	2010	Tieshiba	T5	LYN	s	i	c	1	2	7.0	4.5	4.0	2	3	2	2	3	2	2	4			4	2	2	2
7	3	2010	Tieshiba	T5	LYN	s	i	c	1	2	6.0	3.5	1.0	2	3	2	2	3	2	2	4			4	2	2	2
8	3	2010	Tieshiba	T5	LYN	s	i	c	1	2	7.0	4.5	1.0	2	3	2	2	3	2	2	4			4	2	2	2
9	3	2010	Tieshiba	T5	LYN	s	i	c	1	2	4.5	4.0	1.5	2	3	2	2	3	2	2	4			4	2	2	2
10	8	2011	Xuxiebian	TG1:④	LYN	s			1		2.5	0.5	0.5														
11	9	2007	Xuxiebian	TG2:②	LYN	s	i	c	1	2	4.0	3.0	2.0	2	3	2	2,3	1	2		4	2		4	3	2	2
12	10	2007	Gushishan	ground collection	LYN	s	i	c	2	6	6.0	4.5	3.0	3	3	2	3	6	2,4		3			4	4	3	3
13	10	2007	Gushishan	ground collection	LYN	s	ii	f	2		3.5	2.5	2.5	3	3	2	3	6	2,4,7				2	2	4		3

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
14	11	2011	Xuxiebian	TG2:①	LYN	s	i	c	4	2	5.5	4.0	1.0	2	4	3	3	1	2		4			4	2	2	3
15	11	2011	Xuxiebian	TG2:①	LYN	s	iii	a	1	1	9.0	6.5	3.5	3	3	2	3	6	1	1	3	1	3	4	4	2	2
16	11	2011	Xuxiebian	TG2:①	LYN	s	i	c	3	6	7.5	3.5	3.5	2	3	2	3	1	2					5	2	2	3
17	11	2011	Xuxiebian	TG2:①	LYN				1																		
18	13	2011	Xuxiebian	L2	LYN	s			1		11.0	11.0	8.0														
19	14	2011	Xuxiebian	TG1:③	LYN	s			1		12.0	11.0	5.5														
20	15	2011	Xuxiebian	T01·①	LYN	s			2		5.5	5.0	2.5														
21	15	2011	Xuxiebian	T01·①	LYN	s	i	c	1	6				4				6	1					4			
22	17	2011	Xuxiebian	H1·①	LYN	s	iii	a	9	6				3	3	2	3	6	1	1	3	1	3	4	4	2	2
23	20	2009	Shazitang		LYN	s	ii	f	2	6	8.5	4.0	4.0	2	3	2	2,3	6	2,4				2	2	4		2
24	22	2007	Pangoucun G1		LYN	s	i	a	1	8	12.0	6.5	6.5	2	3	2	2,3	3	2,4	2				3	3	2	4
25	26	2011	Xuxiebian	H1·①	LYN	s	iii	c	21	6				3	2	2	2,3	6	1,2				2	4	4	2	2
26	27	2011	Xuxiebian	TG2:L3	LYN	s			1		10.0	9.0	3.0														
27	27	2011	Xuxiebian	TG2:L3	LYN	s	i	c	1	6	5.0	5.0	4.0	2	3	2	3	1	2					3	2	2	3
28	27	2011	Xuxiebian	TG2:L3	LYN	s	i	c	1	6	7.5	7.5	5.0	2	3	2	3	1	2					3	2	2	3
29	27	2011	Xuxiebian	TG2:L3	LYN	s	i	c	1	6	8.0	5.0	3.5	2	3	2	3	1	2					3	2	2	3
30	27	2011	Xuxiebian	TG2:L3	LYN	s	i	c	1	6	6.0	4.0	2.5	2	3	2	3	1	2					3	2	2	3
31	27	2011	Xuxiebian	TG2:L3	LYN	s	i	c	1	6	8.0	4.5	4.0	2	3	2	3	1	2					3	2	2	3
32	27	2011	Xuxiebian	TG2:L3	LYN	s	i	c	8	6				2	3	2	3	1	2					3	2	2	3
33	27	2011	Xuxiebian	TG2:L3	LYN	s	iii	c	1	6	8.0	5.0	4.0	2	3	2	3	1	2,4					5	2	2	3

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
34	27	2011	Xuxiebian	TG2:L3	LYN	s	iii	c	1	6	5.0	4.0	3.5	2	3	2	3	1	2,4					5	2	2	3
35	27	2011	Xuxiebian	TG2:L3	LYN	s	iii	c	4	6				2	3	2	3	1	2,4					5	2	2	3
36	28	2006	Honggaolu		LYN	s	i	c	2	6	3.5	2.5	2.0	4	2	2	3	6					3	4	4	2	3
37	31	2006	Tonggucun		LYN	s	i	a	1	6	8.0	8.0	7.0	2	3	2	3	1,11	2		3			4	1	2	3
38	31	2006	Tonggucun		LYN	s	i	a	1	2	6.0	4.5	2.0	2	3	2	3	2	2		3			4	2	2	
39	31	2006	Tonggucun		LYN	s	ii	f	1	6	10.5	6.0	3.0	2	3	3	3	6	1,2,4				3	2	4		3
40	31	2006	Tonggucun		LYN	s	ii	f	7	6																	
41	32	2007	Shiqiaocun G8		LYN	s	ii	f	1	6	6.5	5.0	3.0	2	3	3	3	6	1				2	3	4		3
42	32	2007	Shiqiaocun G8		LYN	s			1		10.0	8.0	5.5														
43	32	2007	Shiqiaocun G8		LYN	s			1		7.0	6.5	5.0														
44	34	2006	Honglucun		LYN	s	i	c	1	8	5.0	4.0	4.0	3	3	3	3	1	2					4	2	2	2
45	34	2006	Honglucun		LYN	s	ii	f	1	6	8.5	6.0	3.0	2	3	2	3	6	2,4				2	2	4		3
46	34	2006	Honglucun		LYN	s	ii	f	1		11.0	7.5	6.0	2	2	2	2,3	6	1,3,4,8				2,3	4	4		3
47	34	2006	Honglucun		LYN	s	ii	f	1		3.5	3.0	2.5	2	2	2	2,3	6	1,3,4,8				2,3	4	4		3

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
48	34	2006	Honglucun		LYN	s	ii	f	2					2	2	2	2,3	6	1,3, 4,8				2 , 3	4	4		3
49	34	2006	Honglucun		LYN	s	ii	f	1	6				2	3	3	3	6	1				2	3	4		3
50	34	2006	Honglucun		LYN	s	ii	f	4	6				2	3	3	3	6	1				2	3	4		3
51	34	2006	Honglucun		LYN	s	ii	f	3	6				2	3	3	3	6	1				2	3	4		3
52	43	2010	Tieshiba		LYN	s	i	c	1	6	4.0	2.5	1.0	2	4	3	3	1	2		4			4	2	2	2
53	43	2010	Tieshiba		LYN	s	i	c	1	6	3.0	2.0	1.0	2	4	3	3	1	2		4			4	2	2	2
54	43	2010	Tieshiba		LYN	s	i	c	4	6				2	4	3	3	1	2		4			4	2	2	2
55	43	2010	Tieshiba		LYN	s	i	c	2	6	2.5	2.5	1.0	3	2	2	3	6	2,4		3			4	4	2	2
56	44	2011	Xuxiebian	T1②	LYN	s	i	c	2	6	3.5	3.0	2.0	4	2	2	3	6	1,2, 4		3			4	4	2	2
57	47	2011	Xuxiebian	T2·H1	LYN	s	i	c	15	6				3	2	2	3	6	1,2				2	4	4	2	2
58	49	2011	Xuxiebian	TG1②	LYN	s	i	c	2	6	5.0	3.5	3.0	2	3	2	3	6	1,2		3	2		4	4	2	2
59	56	2007	Gushishan		LYN	s			1		26.0	19.0	17.0														
60	57	2006	Liudalin		LYN	s			1																		
61	57	2006	Liudalin		LYN	s			1																		
62	57	2006	Liudalin		LYN	s			1																		
63	57	2006	Liudalin		LYN	s			1		15.0	11.0	7.0														
64	58	2006	Bajiaojingcun		LYN	s			1		14.0	10.0	7.0														

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
65	60	2006	Bajiaojingcun		LYN	s			1		6.0	4.5	4.0														
66	60	2006	Bajiaojingcun		LYN	s	i	c	1	6	5.5	5.0	1.0	2	3	3	2	1	2				3	4	2	3	2
67	60	2006	Bajiaojingcun		LYN	s			1		18.0	13.0	8.0														
68	60	2006	Bajiaojingcun		LYN	s	i	a	1	1	18.0	13.0	8.0	3	3	2	3	3	1,2	1,2	3	1,2	2	4	2	1	3
69	64		Gaoluchong		LYN	s			1		11.0	9.0	5.0														
70	64		Gaoluchong		LYN	s			1		10.0	6.5	4.0														
71	65	2006	Qingshancun		LYN	s	i	a	5					2	3	2	2,3		2					4	2	3	2
72	65	2006	Qingshancun		LYN	s	i	c	1	6	19.0	9.0	8.0	3	3	2	3	3	1,2	1,2	3	1,2	2	4	2	1	3
73	65	2006	Qingshancun		LYN	s	i	c	1	6	10.0	6.5	5.0	3	3	2	3	3	1,2	1,2	3	1,2	2	4	2	1	3
74	65	2006	Qingshancun		LYN	s	i	c	4	6	3.0	2.5	2.5	3	3	2	3	3	1,2	1,2	3	1,2	2	4	2	1	3
75	66	2007	Tieniucun		LYN	s	ii	f	1	8	9.0	4.0	3.5	2	4	3	3	11	1,4				3	2	4		3
76	66	2007	Tieniucun		LYN	s	i	c	1	6	12.0	5.5	3.5	2	3	3	3	6,11	1,4	1,2	3	2		5	2	1	3

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
77	66	2007	Tieniucun		LYN	s	i	c	1	6	8.5	7.0	5.0	2	3	3	3	6,11	1,4	1,2	3	2		5	2	1	3
78	66	2007	Tieniucun		LYN	s	i	c	2	6				2	3	3	3	6,11	1,4	1,2	3	2		5	2	1	3
79	68	2007	Gushishan		LYN	s	ii	f	1	6	11.0	9.0	6.5	1	4	3	3	6	2,4	1	3	1		2	4		3
80	70	2006	Shaziwan		LYN	s	ii	f	1	6	6.0	5.5	5.0	2	3	2	3	6,11	1,2				2	5	4		2
81	70	2006	Shaziwan		LYN	s	ii	f	1	6	5.0	4.0	4.0	2	3	2	3	6,11	1,2				2	5	4		2
82	70	2006	Shaziwan		LYN	s	ii	f	1	6	3.0	2.0	1.0	2	3	2	3	6,11	1,2				2	5	4		2
83	70	2006	Shaziwan		LYN	s	ii	f	4	6				2	3	2	3	6,11	1,2				2	5	4		2
84	71	2011	Xuxiebian	TG2:L2	LYN	s			1		11.5	7.5	6.5														
85	71	2011	Xuxiebian	TG2:L2	LYN	s	iii	f	2	6	9.0	8.5	5.0	2	4	3	3	6	2					5			3
86	71	2011	Xuxiebian	TG2:L2	LYN	s	iii	f	1	6	5.5	5.0	3.5	2	4	3	3	6	2					5			3
87	71	2011	Xuxiebian	TG2:L2	LYN	s	iii	f	2	6	3.5	3.0	2.0	2	4	3	3	6	2					5			3
88	71	2011	Xuxiebian	TG2:L2	LYN	s	iii	f	1	6	6.0	4.0	2.0	2	6			6	2,4	1				2	3		
89	71	2011	Xuxiebian	TG2:L2	LYN	s	iii	f	1	6	5.0	3.0	2.5	2	6			6	2,4	1				2	3		
90	71	2011	Xuxiebian	TG2:L2	LYN	s	iii	f	2	6				2	6			6	2,4	1				2	3		
91	76	2011	Xuxiebian	ground collection	LYN	s	iii	f	1																		
92	77	2010	Tieshiba	T5	LYN	s	i	a	1	1	16.0	14.0	9.0	1	5	2	2,3	6	2,4	2	3	2		4	2	1	3
93	78	2011	Xuxiebian	T01①	LYN	s	i	c	1	6	6.0	4.5	3.0	3	2	2	3	6	1,4				2	4	2		
94	78	2011	Xuxiebian	T01①	LYN	s	i	c	1	6	5.0	3.5	3.0	3	2	2	3	6	1,4				2	4	2		
95	78	2011	Xuxiebian	T01①	LYN	s	i	c	1	6	3.5	2.5	2.0	3	2	2	3	6	1,4				2	4	2		
96	78	2011	Xuxiebian	T01①	LYN	s	i	c	1	6	4.0	2.5	2.0	3	2	2	3	6	1,4				2	4	2		

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
97	78	2011	Xuxiebian	T01①	LYN	s	i	c	17	6				3	2	2	3	6	1,4				2	4	2		
98	83	2010	Tieshiba	location 10	LYN	s	i	c	2	6	3.0	3.0	2.0	2	5	3	3	1	2		4			4	2	3	2
99	83	2010	Tieshiba	location 10	LYN	s	ii	f	2	6	2.0	1.5	1.0	2	3	3	3	11	1,4					2			1
100	85	2010	Tieshiba	location 6	LYN	s	i	c	1	6	2.0	2.0	2.0	2	5	3	3	1	2					4	2	1	2
101	86	2010	Tieshiba	location 33	LYN	s	i	c	1	2	6.0	4.0	2.5	2	4	2	2,3	2	2		3			4	2	1	2
102	87	2010	Tieshiba	location 17	LYN	s	i	c	1	2	5.0	4.0	2.0	2	3	2	3	6	2		4			4	4	1	2
103	97	2007	Gushishan	TG1③:1	LYN	s	i	c	1	6	5.0	3.5	3.0	3	2	2	3	6	2,4				2	4			2
104	98	2011	Xuxiebian	TG2②	LYN	s	i	c	4	6				2	3	2	3	7			6			4	4	3	1
105	98	2011	Xuxiebian	TG2②	LYN	s			1																		
106	103	2011	Xuxiebian	L1	LYN	s			1																		
107	105	2007	Mafucun	T2	LYN	s	i	c																			
108	106	2010	Tieshiba	T5	LYN	s	i	a	1	2	9.5	7.5	2.0	2	4	2	2	2	2		4			4	2	1	2
109	106	2010	Tieshiba	T5	LYN	s	i	a	1	2	9.0	5.5	3.0	2	4	2	2	2	2		4			4	2	1	2
110	106	2010	Tieshiba	T5	LYN	s	i	a	2	2				2	4	2	2	2	2		4			4	2	1	2
111	107	2011	Gaolushan		LYN	s			1																		
112	108	2007	Tieniucun		LYN	s	i	a	1	2	8.0	7.0	3.0	1	5	4	3	2	2		3	2		4	2	1	3
113	108	2007	Tieniucun		LYN	s			1		5.5	5.5	4.0														
114	108	2007	Tieniucun		LYN	s			1																		
115	110	2010	Tieshiba	T5	LYN	s			1																		
116	115	2014	Yindongzi	ground collection	LYN	s	i	c	1	6	3.0	1.5	1.5	2	4	2	3	2	2,5		4			4	2	3	2

S no.	F no.	Year	Site	Context level	R	C	T	Sub T	T Q	A	L (cm)	W (cm)	H (cm)	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
117	119	2014	Chadiping	L1	LYN	s			1		4.0	3.5	2.0														
118	119	2014	Chadiping	L1	LYN				1																		
119	122	2014	Chadiping	L6	LYN				1		11.0	9.0	9.0														
120	123	2014	Chadiping	L9	LYN	s	i	c	1	6	4.0	3.0	3.0	3	2	2	3	6	1,2,4	1	3	1		4			2
121	123	2014	Chadiping	L9	LYN	s	i	c	1	6	4.5	4.5	4.0	3	2	2	3	6	1,2,4	1	3	1		4			2
122	123	2014	Chadiping	L9	LYN	s	i	c	4	6				3	2	2	3	6	1,2,4	1	3	1		4			2
123		2007	Gushishan	TG2③:3		s	i																				
124		2007	Gushishan	TG1③:8		s	i		1		31.3	15.5	6.7														
125		2007	Gushishan	TG1③:9		s	i		1		28.0	19.5	10.0														
126		2007	Gushishan	TG1③:20		s	i		1		7.3	6.4	5.2														
127		2007	Gushishan	TG1③:10		s	i		1		8.0	5.5	3.2														
128		2007	Gushishan	TG1③:28		s	i		1		16.5	14.0	10.0														
129		2007	Gushishan	TG1③:16		s	i		1		8.7	6.2	4.0														
130		2014	Chadiping	SGC1		s	i	a	1	2	23.0	20.0	5.0	2	4	2	3	3	2,4		4	1			1	3	4

2. Details of the furnace lining (FL), furnace brick (FB), flux (F), and ore (O) samples collected from the excavated sites

'S no.'= sampel number; 'F no.'= file number; 'R'= recorder; 'C'= class; 'TQ'= total quantity; 'T'= type.

S no.	F No.	Year	Site	Context/level	R	C	TQ	T	L (cm)	W (cm)	H (cm)	Description
1		2007	Gushishan	TG1③:12		O	1		6.0	5.5	2.7	
2		2007	Gushishan	TG1③:14		O	1		5.0	4.0	3.1	
3		2007	Gushishan	TG1③:13		O	1		5.4	3.1	3.0	
4		2007	Gushishan	TG1③:24		O	1		6.3	2.8	2.0	
5		2007	Gushishan	TG1③:17		O	1		11.5	8.8	5.5	
6		2007	Gushishan	ground collection 1	LYN	O	1		6.5	5.0	4.0	
7	1	2011	Xuxiebian	TG1②	LYN	F	2		11.0	13.0		
8	1	2011	Xuxiebian	TG1②	LYN	F						
9	4	2011	Xuxiebian	TG1③	LYN	F	3		8.0	4.5	4.5	covered with black slags. Greyish white, non-magnetic.
10	4	2011	Xuxiebian	TG1③	LYN	F	1		12	9	5	dark grey outside, red and orange inside. One surface is slightly vitrified.
11	6	2011	Xuxiebian	TG2:L3	LYN	FB	1	S	11	11.5	8	high density, fine fabric, orange colour with some red, very few adhering slag, very tight structure. The temperature is not very high, possibly used to block the tapping hole.
12	7	2011	Xuxiebian	TG1·⑤	LYN	FB	1	C	15	14	5	one surface is covered with a thin layer of slag, and the other surface is smooth. Clay made, fine fabric, partially magnetic.

S no.	F No.	Year	Site	Context/level	R	C	TQ	T	L (cm)	W (cm)	H (cm)	Description
13	7	2011	Xuxiebian	TG1·⑤	LYN	FB	1	L	6	6	4.5	most of the surfaces are covered with highly vitrified slags. The thickest part is about 1cm. Black and dark grey on the surface. Look like rock from the core.
14	7	2011	Xuxiebian	TG1·⑤	LYN	F	2					nodular adhering slag instead of a thin layer, non-magnetic. Limestone.
15	9	2011	Xuxiebian	TG2·②	LYN	O	4		5			grey, melting surface, moderate porosity proportion with sizes 1-2mm. Strong magnetic.
16	9	2011	Xuxiebian	TG2·②	LYN	O	5		3			grey, melting surface, moderate porosity proportion with sizes 1-2mm. Strong magnetic.
17	9	2011	Xuxiebian	TG2·②	LYN	O	2					red colour, seems like being roasted, non-magnetic, lots of impurities. Possibly the discarded material after ore sellection and roasting.
18	16	2011	Xuxiebian	T02·H1③	LYN	O	1		7.5	7.5	6	roasted iron ore, partially magnetic. Redish and greyish brown colours.
19	16	2011	Xuxiebian	T02·H1③	LYN	O	1		6	5.5	4	roasted iron ore, partially magnetic. Redish and greyish brown colours.
20	17	2011	Xuxiebian	H1·①	LYN	O	1		6.5	6.5	4	burned, non-magnetic.
21	17	2011	Xuxiebian	H1·①	LYN	O	1		2.5	2.5	1.5	burned, non-magnetic.
22	25	2011	Xuxiebian	TG1·②:1	LYN	FB	1	C	16	13	13	clay made, one surface is flat, burned with network cracks, very tight structure. Yellow and orange colours, high density, fine fabric with tiny stone particle inclusions.

S no.	F No.	Year	Site	Context/level	R	C	TQ	T	L (cm)	W (cm)	H (cm)	Description
23	29	2011	Xuxiebian	TG1⑦	LYN	FB	1	R				burned, slightly curved, red colour on the surface with purple in some areas, grey colour on the section. From its colour and density, it might be iron ore before processing or the big iron rich rocks are also used to make furnace bricks.
24	33	2011	Xuxiebian	H1③:FB2	LYN	FB	1	S	16	14.5	12	sandstone, burned, red colour, high density, 'U' shaped in section, tool marks on the flat surface. There is a triangular slag adhering to the curved surface, black colour and non-magnetic. The colours on the section are in different layers as red, dark red, greyish white, and yellow. The shaped is clearly man-made. It is possibly used to block the tapping hole, the adhering slag side is close to inner side of the furnace.
25	33	2011	Xuxiebian	H1③:FB1	LYN	FB	1	L	17	16	9.5	limestone, all covered with slags except the section, the adhering slags are black and coarse with inclusions of charcoal and tiny stones. White colour on the section. The thickest part of the slag erosion is about 1cm.
26	33	2011	Xuxiebian	H1③	LYN	FB	1	L			5	broken, the original height can be predicted as 5cm. A very thin layer of slag is covered all over the brick except the section. Limestone, the section is white colour.
27	35	2011	Xuxiebian	T01②:1	LYN	FB	1	C	11	7.5	3.5	intact height, clay made, neatly done, dark grey both on the surface and section. Fine fabric with tiny stones and or organic fibres. Possibly refractory brick particularly made.
28	38	2011	Xuxiebian	T01·H2:5	LYN	FB	1	C				similar to File 35. Surface is less smooth.
29	40	2011	Xuxiebian	T01·H2:1	LYN	FB	1	C				similar to File 35.

S no.	F No.	Year	Site	Context/level	R	C	TQ	T	L (cm)	W (cm)	H (cm)	Description
30	41	2011	Xuxiebian	H4	LYN	FB	1	C	6.5	5.5	4	clay made with inclusions of small stones and organic fibres, yellow colour, one flat surface.
31	44	2011	Xuxiebian	T1②	LYN	FB	4	C			3.5	similar to File 35.
32	45	2011	Xuxiebian	H1③	LYN	FB	1	C	12	7.5	4	similar to other FL found at Xuxiebian, irregular shape, probably unfinished.
33	45	2011	Xuxiebian	H1③	LYN	FB	1	L	8.5	5	3	limestone, white in the core and slightly red on the surface. A very thin layer of slightly vitrified slags. Some nodular adhering slags. Trapezoid shape in section.
34	45	2011	Xuxiebian	H1③	LYN	FB	1	C	13.5	12	8	a clay made furnace brick with lots of adhering clays, non-magnetic. Possibly furnace brick with furnace lining.
35	46	2011	Xuxiebian	TG1⑧	LYN	FB	1	C	8	7.5	3	slightly curved, orange colour in section, one side highly vitrified. Clay made, fine fabric.
36	47	2011	Xuxiebian	T2·H1	LYN	O	2		3			grey colour with orange in some areas, burned, some magnetic, small circular porosities, like the ones got from the experiment at Exeter U. low temperature in short time, crushed and roasted.
37	50	2011	Xuxiebian	H1③	LYN	FB	1	S	21	16	12	sandstone, trapezoid shape in section, slightly curved at the top, the sides are flat as being processed particularly. One small slag is adhering to one side, moderate magnetic. Yellow colour overall. Some scratch marks on the surface.
38	51	2011	Xuxiebian	TG1②:FB7	LYN	FB	1	L	19.5	14.5	9	covered with slag, 25x18x10.5cm, limestone brick, greyish white colour inside, the surface of the brick is eroded about 2mm. The brick is broken into two pieces from the middle. One side is eroded badly.

S no.	F No.	Year	Site	Context/level	R	C	TQ	T	L (cm)	W (cm)	H (cm)	Description
39	52	2007	Xuxiebian	ground collection	LYN	FB	12	L				similar to File 4 and 51. all are limestone covered with a thin layer of slag.
40	53	2011	Xuxiebian	H1③	LYN	FB	4	S			10	broken, the original heights are predicted to 10cm, sandstones, orange colour, a thin layer of slightly vitrified slag. Particularly made.
41	54	2011	Xuxiebian	L1	LYN	FB	1	S	13	12	12	similar to File 33-1, sandstone, orange colour, intact height of 12cm and width 12cm, 'U' shaped in section, two sides flat, possibly used for block the block the tapping hole.
42	54	2011	Xuxiebian	L1	LYN	FB	1	S	11	14	12	similar to File 33-1, sandstone, orange colour, intact height of 12cm and width 14cm, 'U' shaped in section, two sides flat, possibly used for block the block the tapping hole.
43	55	2011	Xuxiebian	TG1:FB1	LYN	FB	1	S	14.5	10	10	similar to File 33 and 54. sandstone, yellow colour, 'U' shaped in section, one half of the brick is covered with a very thin layer of black and highly vitrified slag, and the other side is clean. Possibly used for block the tapping hole.
44	63	2007	Xuxiebian	L1	LYN	FB	3	S			8	sandstone, orange colour, grey colour nodular adhering slag, the section of the slag is black and high and large porosity proportion and size, non-magnetic.
45	72	2011	Xuxiebian	TG1②	LYN	FB	1	S	16	20	4.5	sandstone, burned red, neatly done, intact width and thickness, a thin layer of burned clay with network cracks, indicating mixed clay was used as an adhesive in building the furnace. An adhering slag of 4x3x1cm with moderate magnetic.

S no.	F No.	Year	Site	Context/level	R	C	TQ	T	L (cm)	W (cm)	H (cm)	Description
46	74	2011	Xuxiebian	H2:6	LYN	FB	1	C	18	11	4.5	clay made with inclusions of small stones and organic fibres, fine fabric, high density, grey colour, intact, similar to File 35. Particularly made.
47	75	2011	Xuxiebian	H1①	LYN	FB	14	C				similar to File 35 and 74. fragmental, clay made with inclusions of small stones and organic fibres, fine fabric, higg density, 7 dark grey colour and 7 orange colour, abraded on the surfaces.
48	75	2011	Xuxiebian	H1①	LYN	FB	3	S				fragmental, sandstone, covered with slightly vitrified black and grey slags, non-magnetic, particularly made, similar to File 53.
49	78	2011	Xuxiebian	T01①	LYN	O	2		4			burned red, both about 4cm size.
50	93	2007	Xuxiebian	L1	LYN	FB	1	S	18	11	11.5	similar to File 33, 54, 55. sandstone, burned red, flat top and curved bottom, 'U' shaped in section. Intact width and height of 11cm and 11.5cm.
51	95	2011	Xuxiebian	H2:8	LYN	FB	2	C			3.5	fragmental with intact height of 3.5cm, clay made with a large amount inclusions of small stones, fine fabric, greyish yellow colour.
52	100	2011	Xuxiebian	T02·H1③	LYN	FB	1	S	7	6.5	5	fragmental, sandstone, yellow colour, similar to File 53.
53	100	2011	Xuxiebian	T02·H1③	LYN	FB	1	C	11	8	8	fragmental, only one surface left, dary grey colour, the remaining surface is flat, clay made with inclusions of small stones and organic fibers, particularly made, similar to File 35.
54	100	2011	Xuxiebian	T02·H1③:FL1	LYN	FL	1					burned clay with a small amount inclusions of charcoal debris, different colours, very tight structure, dark red in section. Possibly particular made refractory furnace lining.

S no.	F No.	Year	Site	Context/level	R	C	TQ	T	L (cm)	W (cm)	H (cm)	Description
55	100	2011	Xuxiebian	T02·H1③:FL2	LYN	FL	1					burned clay, high density, yellow colour with red in some areas, very tight structure, some tamped marks. Possibly strengthened ground before building the furnace.
56	102	2011	Xuxiebian	T1③	LYN	FB	1	C	6	6	3.5	greyish white colour, clay made with inclusions of tiny stones, fine fabric.

3. Details of the pottery and porcelain samples collected from the excavated sites

No.	Artifact No.	Site	Material	Type	Colour	Description
1	07PGSTG4②:1	Gushishan	pottery	jar	grey	contracted mouth, fat lip, wovon texture on the interior surface. Mouth diameter 24cm, remaining height 3cm.
2	07PGSTG1①:6	Gushishan	pottery	bowl	light grey	sandy clay, rounded lip, slightly flared mouth, rounded belly. Mouth diameter 21cm, remaining height 5cm.
3	07PGSTG1②:6	Gushishan	pottery	jug	light grey	sandy clay, straight mouth, fat and rounded lip. Remaining height 1.9cm.
4	07PGSTG1 ②:16	Gushishan	pottery	basin	red and brown	red body and brown coating, slightly contracted mouth, rounded lip and belly, a stripe texture at the connection of the should and belly. Mouth diameter 36cm, remaining height 5cm.
5	07PGSTG1③:5	Gushishan	pottery	sherd	black	fragment, 2.2x1.9x0.2cm.
6	07PGSTG4②:2	Gushishan	pottery	sherd	black	fragment, near the object bottom, 4.7x3.6x0.6cm.
7	07PGSTG1②:1	Gushishan	pottery	sherd	black	fragment, 3.0x2.2x0.8cm.
8	07PGSTG1②:5	Gushishan	porcelain	bowl	brown	red body and brown coating, flared mouth, rounded belly. Mouth diameter 17cm, remaining height 2cm.
9	07PGSTG3①:3	Gushishan	porcelain	bowl	greyish white	slightly contracted mouth, rounded belly, cracking texture on the surface. Mouth diameter 18cm, remaining height 2cm.
10	07PGSTG3①:1	Gushishan	porcelain	vase	grey	wide flared mouth, mouth diameter 11, and remaining height 1.5cm.
11	07PGSTG3①:2	Gushishan	porcelain	vase	cyan	wide flared mouth, cracking texture on the surface, mouth diameter 12, and remaining height 2cm.
12	11PSXH1③:1	Xuxiebian	pottery	bowl	redish brown	brown coating, contracted mouth, rounded lip, remaining height 7.2cm, and 0.4cm thickness.
13	11PSXTG1④:7	Xuxiebian	pottery	urn	greyish brown	brown coating, remaining height 11.4cm, thickness 1-1.5cm,

No.	Artifact No.	Site	Material	Type	Colour	Description
14	11PSXTG1④:1	Xuxiebian	pottery	urn	greyish brown	brown coating, remaining height 15cm, and 1.4cm thickness.
15	11PSXTG1④:11	Xuxiebian	pottery	vat	greyish brown	brown coating, slightly contracted mouth, square lip, contracted belly, remaining height 8cm, and 1.6cm thickness.
16	11PSXTG1④:9	Xuxiebian	pottery	vat	greyish brown	brown coating, rounded lip, sloped shoulder, remaining height 11cm, and 0.8cm thickness.
17	11T2②:3	Xuxiebian	pottery			
18	11PSXTG1④:2	Xuxiebian	pottery			
19	11PSXTG1④:3	Xuxiebian	pottery			
20	11PSXTG1④:5	Xuxiebian	pottery			
21	11PSXTG1④:6	Xuxiebian	pottery			
22	07PSXC:1	Xuxiebian	pottery	object bottom	grey	clay made, some sand particles and water mark on the surface, bottom diameter 22cm, and remaining height 3.9cm.
23	11T3②:1	Xuxiebian	pottery	basin		
24	07PSXC:2	Xuxiebian	pottery	sherd	grey	plain, remaining length 4.6, width 2.5-5.5, thickness 0.5cm.
25	07PSXH1:1	Xuxiebian	pottery	sherd	grey	brown coating, contracted mouth, rounded lip, curved shoulder and belly. Mouth diameter 34cm and remaining height 4.5cm.
26	07PSXTG2①:1	Xuxiebian	pottery	sherd	grey	plain, clay made, remaining height 4.6, width 3.6, and thickness 0.5cm.
27	07PSXC:3	Xuxiebian	porcelain	basin	greyish brown	contracted mouth, angular shoulder, straight belly, mouth diameter 37.5cm, and remaining height 6cm. Proded design on the belly.
28	07PSXTG2③:1	Xuxiebian	porcelain	urn	greyish brown	contracted mouth, angular shoulder, straight belly, mouth diameter 46cm, and remaining height 4.6cm. Ripple design on the shoulder and belly.

No.	Artifact No.	Site	Material	Type	Colour	Description
29	11TG1⑤:3	Xuxiebian	porcelain			
30	11TG1④:1	Xuxiebian	porcelain	jar		
31	07PSXTG1②:4	Xuxiebian	porcelain	object bottom	brown	bottom diameter 4.2cm, and remaining height 0.5cm.
32	07PSXTG1②:3	Xuxiebian	porcelain	object bottom	brown	bottom diameter 5.1cm, and remaining height 0.5cm.
33	11PSXH4:1	Xuxiebian	porcelain	object bottom		remaining height 2.8, thickness 1cm.
34	07PSXTG1②:2	Xuxiebian	porcelain	sherd	blue and white	flared mouth, pointed lip, sloped belly, mouth diameter 13, and remaining height 2.8cm. Proded design on the belly.
35	07PSXTG1②:1	Xuxiebian	porcelain	spout	greyish brown	mouth diameter 1.2cm and remaining height 10.2cm.
36	11PSXT3②:1	Xuxiebian	porcelain	sherd		
37	11PSXT3②:3	Xuxiebian	porcelain	sherd		
38	11PSXT3②:2	Xuxiebian	porcelain	sherd		
39	11PSXT3②:4	Xuxiebian	porcelain	sherd		
40	11PSXT1①:3	Xuxiebian	porcelain	sherd		
41	11PSXT1①:1	Xuxiebian	porcelain	sherd		
42	11PSXT1①:2	Xuxiebian	porcelain	sherd		
43	11PSXTG1③:1	Xuxiebian	porcelain	object ear		remaining height 10, width 6, and thickness 2.2cm.

4. List of the excavated iron objects of Southwest China

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1	ring-pommeled iron sword	2	W	Fengdu Ranjialukou	Chongqing		N	N	25-220AD (Eastern Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	45
2	iron nail	6	T	Fengdu Caofanggou	Chongqing		N	N	25-220AD (Eastern Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	55
3	iron knife	1	U	Fengdu Caofanggou	Chongqing		N	N	25-220AD (Eastern Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	55
4	iron hoehead	1	T	Yunyang	Chongqing	95IT3④a:1	N	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	86
5	ring-headed iron knife	1	U	Yunyang	Chongqing	94IT3④:2	N	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	86
6	iron sabre	1	W	Yunyang	Chongqing	94IT2④a:4	N	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	86
7	iron axehead	1	T	Yunyang	Chongqing	94IIT3⑤:11	N	Y	8th-3rd century BC	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	117
8	iron nail	1	T	Yunyang	Chongqing		N	N	221-960AD (Wei and Jin to the Five dynasties)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	132
9	iron sabre	1	W	Yunyang	Chongqing	T2④:5	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	137
10	iron fork	1	T	Wushan	Chongqing	M38:7	Y	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	549
11	iron knife	1	T	Wushan	Chongqing	M38:8	Y	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	549
12	iron *mou*	1/2	D	Wushan	Chongqing	M32:4	Y	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	549
13	iron saw	1	T	Wushan	Chongqing	M38:5	Y	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	549
14	iron sword	1	W	Wushan	Chongqing	M39:1	Y	Y	202BC to 8AD (Western Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	549
15	iron object	1	U	Fengjie	Chongqing	M1:2	Y	N	25-220AD (Eastern Han)	(GJWWJSXGCWWBHLDXZHBGZZ 2000)	572
16	iron *fu*-pot	1	D	Fengjie	Chongqing	M188:39	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2013)	69
17	iron stand	1	D	Fengjie	Chongqing	M218:30	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2013)	69
18	iron stand	1	D	Fengjie	Chongqing	M188:39	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2013)	69
19	iron nail	20	T	Fengjie	Chongqing	M104:7	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2013)	97
20	iron belt hook	2	A	Fengjie	Chongqing	M26	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2013)	299
21	iron coin	15	O	Fengjie	Chongqing	M92	Y	N		(CQSWWJ and CQSYMJ 2013)	299
22	iron nail	580	T	Fengjie	Chongqing		N	N		(CQSWWJ and CQSYMJ 2013)	299
23	iron nail	18	T	Fengjie	Chongqing		N	N		(CQSWWJ and CQSYMJ 2013)	299

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
24	iron ring	1	T	Fengjie	Chongqing	M175	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2013)	299
25	iron sheet	1	U	Fengjie	Chongqing	M94	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2013)	299
26	iron sheet	1	U	Fengjie	Chongqing	M1	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2013)	299
27	iron sabre	1	W	Fengjie	Chongqing	2000IM1041:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	109
28	iron plate	1	U	Fengjie	Chongqing	2001IM1006:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	129
29	iron plate	1	U	Fengjie	Chongqing	2001IM1010:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	129
30	iron nail	1	T	Fengjie	Chongqing	2000IM1005:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	156
31	iron coin	numerous	O	Fengjie	Chongqing	2000IM1020	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	160
32	iron coin	121	O	Fengjie	Chongqing	2000IM1047	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	170
33	iron coin	1	O	Fengjie	Chongqing	2000IM1065	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	174
34	iron coin	6	O	Fengjie	Chongqing	2000IM1074	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	179
35	iron belt hook	1	A	Fengjie	Chongqing	2001IM1001:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	186
36	iron weight	1	T	Fengjie	Chongqing	2001IM1001:5	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	186
37	iron belt hook	1/4	A	Fengjie	Chongqing	2001IM1001:4	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	187
38	iron coin	1	O	Fengjie	Chongqing	2001IM1013	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	188
39	iron coin	13	O	Fengjie	Chongqing	2001IM1014	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	190
40	iron coin	6	O	Fengjie	Chongqing	2001IM3001	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	201
41	iron coin	14	O	Fengjie	Chongqing	2001IM5011	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	225
42	iron plate	1	U	Fengjie	Chongqing	2001IM5011:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	225
43	corner connect	2	T	Fengjie	Chongqing	2001IM5004	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	232
44	iron coin	1	O	Fengjie	Chongqing	2001IM5001	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	232
45	iron coin		O	Fengjie	Chongqing	2001IM5002	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	232
46	iron spoon	1	D	Fengjie	Chongqing	2001IM5002	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	232
47	iron coin	3	O	Fengjie	Chongqing	2001IM5009	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	236

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
48	iron coin	2	O	Fengjie	Chongqing	2001IM5010	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	240
49	iron axehead	1	T	Fengjie	Chongqing	2001IT4002⑤:1	N	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	280
50	iron hoehead	1	T	Fengjie	Chongqing	2001IT4004③:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010d)	280
51	iron tri-pot	1	D	Fengjie	Chongqing	2001IF4:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010d)	288
52	iron mattockhead	1	T	Fengjie	Chongqing	T5005④:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	66
53	unidentified	1/2	U	Fengjie	Chongqing	T314④:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	66
54	iron sabre	1	W	Fengjie	Chongqing	T5008⑥:5	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	66
55	iron belt hook	1	A	Fengjie	Chongqing	IM1:1	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	85
56	iron mattockhead	1	T	Fengjie	Chongqing	IIT6④:6	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	85
57	iron sicklehead	1	T	Fengjie	Chongqing	IM3:1	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	85
58	unidentified	8	U	Fengjie	Chongqing		N	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	85
59	iron sabre	1	W	Fengjie	Chongqing	IIT6④:8	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	85
60	iron sabre	1	W	Fengjie	Chongqing	IIT4④:14	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010e)	85
61	iron mattockhead	1/13	T	Fengjie	Chongqing	G1:9	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	96
62	u-shaped implement cap	1/2	T	Fengjie	Chongqing	G1:10	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	98
63	iron chisel	1	T	Fengjie	Chongqing	G302:10	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	99
64	iron coin	1	O	Fengjie	Chongqing	T301③:3	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	99
65	iron nail	1/6	T	Fengjie	Chongqing	T7③:8	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	99
66	unidentified	1/2	U	Fengjie	Chongqing	G1:33	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	99
67	unidentified	21	U	Fengjie	Chongqing		N	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	99
68	iron sabre	1	W	Fengjie	Chongqing	H301:4	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010e)	99
69	iron sabre	1	W	Fengjie	Chongqing	T307④:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010e)	110
70	iron hair clasp	1	A	Fengjie	Chongqing	T8③:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010e)	111
71	iron coin	1	O	Fengjie	Chongqing	H14:27	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010e)	111

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
72	iron coin	1	O	Fengjie	Chongqing	H14:26	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010e)	111
73	iron coin	1	O	Fengjie	Chongqing	H14:28	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010e)	111
74	iron mattockhead	1	T	Wanzhou	Chongqing	M154:8	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006a)	47
75	iron broadaxhead	1	W	Wanzhou	Chongqing	M124:1	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006a)	47
76	iron *fu*-pot	1/10	D	Wanzhou	Chongqing	M40:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006a)	127
77	iron *fu*-pot	2/10	D	Wanzhou	Chongqing	M44:15	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	127
78	iron *fu*-pot	3/10	D	Wanzhou	Chongqing	M1:11	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	127
79	iron *fu*-pot	4/10	D	Wanzhou	Chongqing	M28:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	127
80	iron *fu*-pot	5/10	D	Wanzhou	Chongqing	M32:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	127
81	iron *fu*-pot	6/10	D	Wanzhou	Chongqing	M134:13	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	127
82	iron *fu*-pot	7/10	D	Wanzhou	Chongqing	M37:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	127
83	iron *fu*-pot	8/10	D	Wanzhou	Chongqing	M150:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	127
84	iron scissors	1	T	Wanzhou	Chongqing	M7:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	129
85	iron scissors	1	T	Wanzhou	Chongqing	M121:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	129
86	object handle	1/4	D	Wanzhou	Chongqing	M1:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	129
87	ring-headed iron knife	2/6	U	Wanzhou	Chongqing	M43:10	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	129
88	iron halberdhead	1	W	Wanzhou	Chongqing	M143:12	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	129
89	iron sabre	1/6	W	Wanzhou	Chongqing	M143:18	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	129
90	iron sabre	3/6	W	Wanzhou	Chongqing	M148:35	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	129
91	iron spinning wheel	1	T	Wanzhou	Chongqing	M7:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	130
92	iron belt hook	1	A	Wanzhou	Chongqing	M10:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	131
93	iron stand	1	D	Wanzhou	Chongqing	M130:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	131
94	u-shaped implement cap	1	T	Wanzhou	Chongqing	M150:55	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006a)	131
95	iron *fu*-pot	1	D	Wanzhou	Chongqing	M35:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
96	iron hammerhead	1	T	Wanzhou	Chongqing	M57:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169
97	iron scissors	1/4	T	Wanzhou	Chongqing	M38:28	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169
98	iron scissors	3/4	T	Wanzhou	Chongqing	M64:18	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169
99	iron scissors	2/4	T	Wanzhou	Chongqing	M2:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169
100	iron tri-pot with handle	1	D	Wanzhou	Chongqing	M64:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169
101	iron sabre	1	W	Wanzhou	Chongqing	M38:31	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169
102	iron sabre	1	W	Wanzhou	Chongqing	M112:12	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006a)	169
103	iron sabre	1	W	Yunyang	Chongqing	2001YSBI T1204 ⑥:5	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	185
104	iron axehead	1	T	Yunyang	Chongqing	2001YSC IIIJ1:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	186
105	iron spoon	1	D	Yunyang	Chongqing	2001YSC IT0904 ⑤:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	186
106	horseshoe	1	O	Yunyang	Chongqing	2001YSC IT0604 ④:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	212
107	iron ring	1	T	Yunyang	Chongqing	2001YSBI VM4:3	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	212
108	iron ring	1	T	Yunyang	Chongqing	2001YSBI VM4:2	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	212
109	iron ring	1	T	Yunyang	Chongqing	2001YSBI VM2:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	212
110	iron sabre	1	W	Yunyang	Chongqing	2001YSC IT1205 ⑤:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	212
111	iron sabre	1	W	Yunyang	Chongqing	2001YSA T1204 ②:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	212
112	iron sabre	1	W	Yunyang	Chongqing	2001YSC IVT1104 ③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	212
113	iron nail	1	T	Yunyang	Chongqing	2001YSC IT0805 ⑤:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	213
114	iron spearhead	1	W	Yunyang	Chongqing	2001YSC IT0805 ③:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2008a)	213
115	ring-headed iron knife	1	T	Yunyang	Chongqing	03YGZM 1:87	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	33
116	iron *fu*-pot	1	D	Yunyang	Chongqing	03YGZM 10:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2011)	72
117	iron object	1/2	U	Yunyang	Chongqing	03YGZM 14:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2011)	84
118	ring-headed iron knife	1	T	Yunyang	Chongqing	03YGZM 15:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	98

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
119	iron nail	1	T	Yunyang	Chongqing	03YGZM 19	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	107
120	iron *fu*-pot	1	D	Yunyang	Chongqing	03YGZM 19:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	108
121	iron axehead	1	T	Yunyang	Chongqing	03YGZM 20:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	109
122	ring-headed iron knife	1	T	Yunyang	Chongqing	04YGZM 1:79	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	163
123	ring-headed iron knife	1	T	Yunyang	Chongqing	04YGZM 1:112	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	163
124	iron *fu*-pot	1	D	Yunyang	Chongqing	04YGZM 3:29	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	173
125	iron construction implement	1	U	Yunyang	Chongqing	04YGZM 9:61	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2011)	209
126	iron sabre	1	W	Zhong County	Chongqing	ZXM29:1 1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	12
127	iron tri-pot	1	D	Zhong County	Chongqing	ZXM30:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	13
128	iron sabre	1	W	Zhong County	Chongqing	ZXM30:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	13
129	iron tri-pot with handle	1	D	Zhong County	Chongqing	ZXM30:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	15
130	iron sabre	1	W	Zhong County	Chongqing	ZTAM3:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	38
131	iron sabre	1	W	Zhong County	Chongqing	ZTAM3:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	38
132	iron sword	1	W	Zhong County	Chongqing	ZTAM3:4	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	38
133	iron knife	1	T	Zhong County	Chongqing	ZTAM5:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	43
134	iron sabre	1	W	Zhong County	Chongqing	ZTAM6:1 8	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	50
135	iron sabre	1	W	Zhong County	Chongqing	ZTAM6:2 2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	50
136	iron tri-pot with handle	1	D	Zhong County	Chongqing	ZTAM18: 1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	73
137	iron *fu*-pot	1	D	Zhong County	Chongqing	ZTBM1:4 2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	86
138	iron sabre	1	W	Zhong County	Chongqing	ZTBM1:1 1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	86
139	iron sabre	1	W	Zhong County	Chongqing	ZTBM1:2 8	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	86
140	iron sabre	1	W	Zhong County	Chongqing	ZTBM3:2 3	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	97
141	iron sabre	1	W	Zhong County	Chongqing	ZTBM3:4 0	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	97
142	iron sabre	1	W	Zhong County	Chongqing	ZTBM3:3 2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	97

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
143	iron arrowhead	1	W	Zhong County	Chongqing	ZTBM3:24	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	98
144	iron sword	1	W	Zhong County	Chongqing	ZTBM3:22	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	98
145	iron sword	1	W	Zhong County	Chongqing	ZTBM3:17	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	98
146	ring-headed iron knife	1	U	Zhong County	Chongqing	ZTBM8:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	114
147	iron sabre	1	W	Zhong County	Chongqing	ZTBM10:26	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	123
148	iron sabre	1	W	Zhong County	Chongqing	ZTBM13:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2008b)	132
149	iron tri-pot with handle	1	D	Zhong County	Chongqing	ZTBM17:6	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	147
150	iron *fu*-pot	1	D	Zhong County	Chongqing	ZHM2:12	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2008b)	168
151	iron axehead	1	T	Yunyang	Chongqing	IAT0701(23)B:52	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2001)	228
152	iron bottom	1	D	Yunyang	Chongqing	IAT0701(23):53	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2001)	228
153	iron belt hook	1	A	Yunyang	Chongqing	IBT0703(20):68	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
154	iron axehead	1	T	Yunyang	Chongqing	IBT0704(19):15	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
155	iron axehead	1	T	Yunyang	Chongqing	IBT0704(21):6	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
156	iron axehead	1	T	Yunyang	Chongqing	IBT0705(21):22	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
157	iron knife	1	T	Yunyang	Chongqing	IBT0605(21):4	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
158	iron nail	1	T	Yunyang	Chongqing	IBT0704(21)A:7	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
159	u-shaped implement cap	1	T	Yunyang	Chongqing	IAT0701(20):36	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
160	iron sabre	1/3	W	Yunyang	Chongqing	IBT0703(21)C:67	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
161	iron sabre	2/3	W	Yunyang	Chongqing	IBT0704(19):14	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	237
162	iron adze	1	T	Yunyang	Chongqing	M27:2	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2001)	281
163	iron knife	1	T	Yunyang	Chongqing	M53:8	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2001)	281
164	iron axehead	1	T	Yunyang	Chongqing	IBT0907⑨:19	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2001)	322
165	iron rake tooth	1	T	Yunyang	Chongqing	IBT0703⑧:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2001)	322
166	iron rake tooth	1	T	Yunyang	Chongqing	IBT0804⑨:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2001)	322

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
167	unidentified	1	U	Yunyang	Chongqing	IBT0705⑨:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2001)	322
168	iron object	1	U	Wanzhou	Chongqing	BT5③:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2001)	415
169	iron object	1	U	Wanzhou	Chongqing	BT5③:2	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2001)	416
170	iron *fu*-pot	1	D	Wanzhou	Chongqing	M1:1	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	433
171	iron sabre	1	W	Wanzhou	Chongqing	M3:26	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	433
172	ring-headed iron knife	1	T	Wanzhou	Chongqing	M1:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	457
173	iron object	1	U	Wanzhou	Chongqing		N	N		(CQSWWJ and CQSYMJ 2001)	457
174	ring-headed iron knife	1	U	Wanzhou	Chongqing	M1:5	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	467
175	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M1:3	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	467
176	iron arrowhead	1	W	Wanzhou	Chongqing	T1②:12	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2001)	499
177	iron *fu*-pot	1	D	Wanzhou	Chongqing	M1	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	506
178	iron *fu*-pot	1	D	Wanzhou	Chongqing	M5	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2001)	516
179	iron nail	1	T	Wanzhou	Chongqing	M3:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2001)	536
180	iron nail	1	T	Wanzhou	Chongqing	M9:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2001)	537
181	iron nail	1	T	Wanzhou	Chongqing	M6:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2001)	539
182	iron nail	1	T	Wanzhou	Chongqing	M9:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2001)	539
183	iron nail	1	T	Wanzhou	Chongqing	M8:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2001)	539
184	iron hoehead	1	T	Zhong County	Chongqing	DT0403(12)A:1	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2001)	607
185	ring-headed iron knife	1/2	T	Fengdu Huinan	Chongqing	M7:31	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2001)	709
186	iron ploughshare cap	1	T	Wushan	Chongqing	M702:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	77
187	iron *fu*-pot	1	D	Wushan	Chongqing	M703:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	80
188	iron stick	1	T	Wushan	Chongqing	M703:16	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	80
189	iron earpick	1	D	Wushan	Chongqing	M705:40	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	87
190	ring-headed iron knife	1	U	Wushan	Chongqing	M707:31	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	99

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
191	iron mattockhead	1/2	T	Wushan	Chongqing	G4:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	111
192	u-shaped implement cap	1/2	T	Wushan	Chongqing	T10③:2	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	111
193	iron arrowhead	1	W	Wushan	Chongqing	T18③:3	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	111
194	iron tri-pot	1	D	Wushan	Chongqing	M43:2	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	121
195	iron *mou*	1	D	Wushan	Chongqing	M54:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	124
196	iron sword with bronze guard	1	W	Wushan	Chongqing	M49:11	Y	Y	Western Han	(CQSWWJ and CQSYMJ 2003)	124
197	iron sword with bronze guard	1/3	W	Wushan	Chongqing	M3:9	Y	Y	Eastern Han(late)	(CQSWWJ and CQSYMJ 2003)	166
198	iron sabre	1	W	Wushan	Chongqing	M3:7	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	166
199	iron spearhead	1	W	Wushan	Chongqing	M5:15	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	166
200	iron mattockhead	1	T	Wushan	Chongqing	T510⑥:6	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	194
201	iron sabre	1	W	Wushan	Chongqing	T403⑤:4	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	201
202	iron chisel	1	T	Wushan	Chongqing	T402⑤:9	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	202
203	iron hoehead	1	T	Wushan	Chongqing	T511④:9	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	202
204	iron mattockhead	1	T	Wushan	Chongqing	H5:1	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	202
205	u-shaped implement cap	1	T	Wushan	Chongqing	T511④:1	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	202
206	iron sabre	1	W	Wushan	Chongqing	T510⑤:2	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	202
207	iron nail	1	T	Wushan	Chongqing	M11:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	223
208	ring-headed iron knife	1	U	Wushan	Chongqing	M18:39	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	223
209	ring-headed iron knife	1	U	Wushan	Chongqing	M19:31	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	223
210	iron nail	1/7	T	Wushan	Chongqing	M6:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	226
211	iron nail	2/7	T	Wushan	Chongqing	M2:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	226
212	iron object	1	U	Fengjie	Chongqing		N	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	247
213	iron belt hook	1	A	Fengjie	Chongqing		N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	270
214	iron adze	1	T	Fengjie	Chongqing	M24:1	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	282

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
215	iron adze	1	T	Fengjie	Chongqing	M48:6	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	283
216	iron sword	1	W	Fengjie	Chongqing	M27:7	Y	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	283
217	iron *fu*-pot	1	D	Fengjie	Chongqing	M26:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	285
218	iron *fu*-pot	1	D	Fengjie	Chongqing	M12:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	293
219	iron scissors	1	T	Fengjie	Chongqing	M2:4	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	293
220	iron sabre	1	W	Fengjie	Chongqing	M12:4	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	293
221	iron nail	1/2	T	Fengjie	Chongqing	M50:7	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	297
222	iron axehead	1/3	T	Yunyang	Chongqing	IDT0811⑤:2	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	332
223	iron axehead	1	T	Yunyang	Chongqing	IBT2216(11):1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	343
224	iron sicklehead	1	T	Yunyang	Chongqing	IF1:5	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	343
225	iron object	1	U	Yunyang	Chongqing	M12:11	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	385
226	iron stick	1	T	Yunyang	Chongqing	FG1:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	435
227	iron arrowhead	1	W	Yunyang	Chongqing	IT03⑦:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	435
228	iron axehead	1/3	T	Yunyang	Chongqing	AT01⑤:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
229	iron axehead	2/3	T	Yunyang	Chongqing	HH2:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
230	iron chisel	1/2	T	Yunyang	Chongqing	AT04⑤:8	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
231	iron hook	1/2	T	Yunyang	Chongqing	AT07⑤:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
232	iron nail	1/7	T	Yunyang	Chongqing	CT02④:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
233	iron stick	1/3	T	Yunyang	Chongqing	AT03⑤:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
234	unidentified	1	U	Yunyang	Chongqing	IT03④:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
235	iron arrowhead	1/4	W	Yunyang	Chongqing	AT04④:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
236	iron arrowhead	1/7	W	Yunyang	Chongqing	CT01④:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
237	iron sabre	1/6	W	Yunyang	Chongqing	AT07⑤:3	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
238	iron sabre	2/6	W	Yunyang	Chongqing	AT04⑤:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
239	iron sabre	3/6	W	Yunyang	Chongqing	ET01⑤:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
240	iron spearhead	1	W	Yunyang	Chongqing	AT06⑤:5	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	445
241	iron nail	1	T	Yunyang	Chongqing	ET02③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	451
242	iron arrowhead	1/4	W	Yunyang	Chongqing	ET03③:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	451
243	iron sabre	1/2	W	Yunyang	Chongqing	BT04③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	451
244	iron object	1	U	Wanzhou	Chongqing	AT12①:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	555
245	iron *fu*-pot	1	D	Wanzhou	Chongqing	M26	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	564
246	iron *fu*-pot	2	D	Wanzhou	Chongqing	M27	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	569
247	iron sword	1	W	Zhong County	Chongqing	BM2:5	Y	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2003)	699
248	unidentified	1	U	Zhong County	Chongqing	BM17:2	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	704
249	iron rod	1	U	Zhong County	Chongqing	BM10:13	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	707
250	iron object	3	U	Zhong County	Chongqing		N	N		(CQSWWJ and CQSYMJ 2003)	707
251	iron sword	1	W	Zhong County	Chongqing	BM10:41	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	707
252	iron *fu*-pot	1	D	Zhong County	Chongqing	AM3:36	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	712
253	iron *fu*-pot	1	D	Zhong County	Chongqing	BM22:77	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	718
254	unidentified	3	U	Zhong County	Chongqing		N	N		(CQSWWJ and CQSYMJ 2003)	718
255	iron sword	1	W	Zhong County	Chongqing	BM22:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2003)	718
256	iron object	1	U	Zhong County	Chongqing	DM2:40	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	723
257	iron nail	1/59	T	Zhong County	Chongqing	BM7:7	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	725
258	iron coin	190	O	Zhong County	Chongqing		N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	726
259	iron coin	1	O	Zhong County	Chongqing	BM13:11	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	729
260	iron nail	1/21	T	Zhong County	Chongqing	BM13:12	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2003)	729
261	iron sword with bronze guard	1	W	Fengdu Huinan	Chongqing	M13:9	Y	Y	Western Han(late)	(CQSWWJ and CQSYMJ 2003)	806
262	iron sword	3	W	Fengdu Huinan	Chongqing		N	N		(CQSWWJ and CQSYMJ 2003)	806

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
263	iron hoehead	1	T	Fengdu Huinan	Chongqing	M27:11	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	807
264	iron scissors	1/2	T	Fengdu Huinan	Chongqing	M27:20	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	807
265	ring-headed iron knife	1	U	Fengdu Huinan	Chongqing	M13:27	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	807
266	iron knife	3	U	Fengdu Huinan	Chongqing		N	N		(CQSWWJ and CQSYMJ 2003)	807
267	iron halberdhead	1	W	Fengdu Huinan	Chongqing	M27:27	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	807
268	iron sabre	5	W	Fengdu Huinan	Chongqing		N	N		(CQSWWJ and CQSYMJ 2003)	807
269	ring-pommeled iron sword	1	W	Fengdu Huinan	Chongqing	M27:24	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2003)	807
270	ring-headed iron knife	2/3	T	Fuling	Chongqing	M6:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	891
271	ring-headed iron knife	1/3	T	Fuling	Chongqing	M2:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	891
272	u-shaped implement cap	1	T	Fuling	Chongqing	M5:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	892
273	u-shaped implement cap	1	T	Fuling	Chongqing	M2:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2003)	892
274	iron bar	3	U	Wushan	Chongqing		N	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	6
275	u-shaped implement cap	1/4	T	Wushan	Chongqing	T44③:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	6
276	u-shaped implement cap	2/4	T	Wushan	Chongqing	T33③:7	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	6
277	iron mattockhead	1/5	T	Wushan	Chongqing	H23:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	16
278	iron mattockhead	2/5	T	Wushan	Chongqing	Y2:4	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	16
279	iron hoehead	1	T	Wushan	Chongqing	G12:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	17
280	unidentified	10	U	Wushan	Chongqing		N	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	17
281	iron arrowhead	1	W	Wushan	Chongqing		N	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	17
282	u-shaped implement cap	1/9	T	Wushan	Chongqing	H23:5	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	17
283	iron hook	1	T	Wushan	Chongqing	T908⑪:2	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	38
284	iron sabre	1/2	W	Wushan	Chongqing	T810(12):8	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	38
285	u-shaped implement cap	1	T	Wushan	Chongqing	T1110(13):3	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	39
286	iron sword	1/2	W	Wushan	Chongqing	T908(11):1	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	39

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
287	iron mattockhead	1	T	Wushan	Chongqing	T808(10):1	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
288	iron ring	1	T	Wushan	Chongqing	T809(10):5	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
289	iron bar	1	U	Wushan	Chongqing	T604⑨:2	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
290	iron construction implement	1	U	Wushan	Chongqing	F4:14	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
291	iron arrowhead	1	W	Wushan	Chongqing	T714⑥:3	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
292	iron arrowhead	1	W	Wushan	Chongqing	T1009(11):4	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
293	u-shaped implement cap	1	T	Wushan	Chongqing	T605⑧:1	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
294	u-shaped implement cap	1	T	Wushan	Chongqing	T711(10):14	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
295	iron sabre	1	W	Wushan	Chongqing	T809(10):4	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
296	iron spearhead	1	W	Wushan	Chongqing	T608⑧:3	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	57
297	u-shaped implement cap	1	T	Wushan	Chongqing	TG801-3⑤:4	N	Y		(CQSWWJ and CQSYMJ 2006b)	142
298	iron hearth	1	D	Fengjie	Chongqing	IIM1:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	165
299	iron nail	1	T	Fengjie	Chongqing		N	N		(CQSWWJ and CQSYMJ 2006b)	166
300	unidentified	1	U	Fengjie	Chongqing		N	N		(CQSWWJ and CQSYMJ 2006b)	166
301	ring-pommeled iron sword	1	W	Fengjie	Chongqing	IIM2:22	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	166
302	iron mattockhead	1	T	Fengjie	Chongqing	H2:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	185
303	iron shovelhead	1	T	Fengjie	Chongqing	H1:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	185
304	iron coin	1	O	Fengjie	Chongqing	T6:10	N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	214
305	iron coin	1	O	Fengjie	Chongqing	T5:9	N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	214
306	ring-headed iron knife	1	T	Fengjie	Chongqing	T7③:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	214
307	iron knife	1	U	Fengjie	Chongqing	T7:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	214
308	iron arrowhead	1/4	W	Fengjie	Chongqing	T5:13	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	214
309	iron axehead	1	T	Fengjie	Chongqing	T7:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	217
310	iron sicklehead	1	T	Fengjie	Chongqing	T5:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	217

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
311	iron ferrule	1	W	Fengjie	Chongqing	F2:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	217
312	iron ferrule	1	W	Fengjie	Chongqing	F2:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	217
313	corner connect	1/4	T	Fengjie	Chongqing	M3:8	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	225
314	iron coin	82	O	Fengjie	Chongqing	M	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	225
315	iron nail	numerous	T	Fengjie	Chongqing	M	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	225
316	iron nail	1/2	T	Fengjie	Chongqing	M3:3	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	225
317	iron belt hook	1	A	Wanzhou	Chongqing	M2:1	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	272
318	iron object	1	U	Wanzhou	Chongqing	M2:2	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	272
319	iron object	1	U	Wanzhou	Chongqing	M2:29	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	272
320	iron coin	1/5	O	Wanzhou	Chongqing	M9:11	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	287
321	iron pipe?	1	U	Wanzhou	Chongqing	M9:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	287
322	iron chisel	1	T	Wanzhou	Chongqing	M3:30	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	325
323	iron sword	1	W	Wanzhou	Chongqing	M4:9	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	333
324	iron *fu*-pot	1	D	Wanzhou	Chongqing	M4:49	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	336
325	iron ring	1	T	Wanzhou	Chongqing	M4:44	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	336
326	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M6:43	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	344
327	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M7:36	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	348
328	iron *fu*-pot	1	D	Wanzhou	Chongqing	M14:7	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	362
329	ring-headed iron knife	1	T	Wanzhou	Chongqing	M14:34	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	365
330	iron *fu*-pot	1	D	Wanzhou	Chongqing	M19:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	368
331	iron hoehead	1	T	Wanzhou	Chongqing	M26:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	371
332	iron axehead	1	T	Wanzhou	Chongqing	M26:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	373
333	iron *fu*-pot	1	D	Wanzhou	Chongqing	M26:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	373
334	iron *fu*-pot	1	D	Wanzhou	Chongqing	M26:16	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	373

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
335	ring-headed iron knife	1	T	Wanzhou	Chongqing	M26:18	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	373
336	u-shaped implement cap	1	T	Wanzhou	Chongqing	M26:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	373
337	iron sabre	1	W	Wanzhou	Chongqing	M3:6	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	379
338	iron scissors	1	T	Wanzhou	Chongqing	M8:20	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	383
339	iron sword with bronze guard	1	W	Wanzhou	Chongqing	99CWWA IT2⑤:1	N	Y	Han Dynasty	(CQSWWJ and CQSYMJ 2006b)	460
340	iron nail	1	T	Wanzhou	Chongqing	99CWWA IIT3⑤:1	N	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	461
341	iron stand	1	D	Wanzhou	Chongqing		N	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	466
342	u-shaped implement cap	1	T	Wanzhou	Chongqing	99CWW M1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	466
343	iron knife	1	T	Wanzhou	Chongqing	99CWWA IT10③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2006b)	474
344	iron axehead	1	T	Wanzhou	Chongqing	T115 ④:12	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	514
345	u-shaped implement cap	1	T	Wanzhou	Chongqing	T107 ④:13	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2006b)	514
346	iron ball	1	U	Fengdu	Chongqing	T1018 ③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	678
347	iron object	1	U	Fengdu	Chongqing		N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2006b)	678
348	ring-headed iron knife	1	U	Fengdu Dujiabao	Chongqing	M14:13	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2006b)	698
349	iron *mou*	1	D	Fuling	Chongqing	M15:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2006b)	772
350	iron knife	4	U	Fuling	Chongqing	M	Y	N		(CQSWWJ and CQSYMJ 2006b)	772
351	u-shaped implement cap	1	T	Wushan	Chongqing	T86③:9	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	8
352	iron mattockhead	1	T	Wushan	Chongqing	G19:11	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	9
353	iron axehead	1	T	Wushan	Chongqing	G17:23	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	15
354	iron chisel	1	T	Wushan	Chongqing	G17:26	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	15
355	iron knife	1	T	Wushan	Chongqing	H34:15	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	15
356	iron mattockhead	1	T	Wushan	Chongqing	G17:25	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	15
357	iron mattockhead	1	T	Wushan	Chongqing	G14:14	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	15
358	u-shaped implement cap	1	T	Wushan	Chongqing	G17:17	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	15

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
359	iron chisel	1	T	Wushan	Chongqing	M4:7	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	22
360	iron sabre	1	W	Wushan	Chongqing	M4:6	Y	N	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	22
361	iron sicklehead	1/2	T	Wushan	Chongqing	T514M4:3	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	45
362	u-shaped implement cap	1	T	Wushan	Chongqing	T508②:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	46
363	iron sabre	1	W	Wushan	Chongqing	BT4:4	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	66
364	iron mattockhead	1	T	Wushan	Chongqing	ET4:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	71
365	iron coin	1	O	Wushan	Chongqing	CT8:5	N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	77
366	iron belt hook	1	A	Wushan	Chongqing	T32⑥:15	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	120
367	iron axehead	1	T	Wushan	Chongqing	T32⑥:13	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	120
368	iron hoehead	1	T	Wushan	Chongqing	T31⑥:13	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	120
369	ring-headed iron knife	1	T	Wushan	Chongqing	T30⑥:6	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	120
370	u-shaped implement cap	1	T	Wushan	Chongqing	T30⑥:5	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	120
371	u-shaped implement cap	1	T	Wushan	Chongqing	T29⑥:5	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	120
372	ring-headed iron knife	1/2	U	Wushan	Chongqing	IM5:11	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	143
373	iron sword	1/2	W	Wushan	Chongqing	IIIM8:75	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	143
374	iron hair clasp	1	A	Wushan	Chongqing	M3:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	151
375	iron knife	1	T	Wushan	Chongqing	M3:9	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	151
376	object ear	1	D	Wushan	Chongqing	M3:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	151
377	iron sheet	1	U	Wushan	Chongqing	M3:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	151
378	iron nail	5	T	Wushan	Chongqing	M1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	155
379	iron sabre	1	W	Wushan	Chongqing	M1:35	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	156
380	iron sabre	1	W	Wushan	Chongqing	M1:36	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	156
381	iron scissors	1	T	Wushan	Chongqing	M5:7	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	171
382	iron nail	47	T	Wushan	Chongqing		N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	173

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
383	ring-headed iron knife	1	U	Wushan	Chongqing	M8:64	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	199
384	ring-headed iron knife	1	U	Wushan	Chongqing	M13:4	Y	Y		(CQSWWJ and CQSYMJ 2007b)	199
385	iron sword with bronze guard	1	W	Wushan	Chongqing	M13:3	Y	Y		(CQSWWJ and CQSYMJ 2007b)	199
386	iron adze	1	T	Wushan	Chongqing	T1736 ⑤:4	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
387	iron adze	1	T	Wushan	Chongqing	H37:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
388	iron adze	1	T	Wushan	Chongqing	H37:2	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
389	iron axehead	1	T	Wushan	Chongqing	T1637 ⑧:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
390	iron axehead	1	T	Wushan	Chongqing	T1740 ⑧:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
391	iron axehead	1	T	Wushan	Chongqing	G6:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
392	u-shaped implement cap	1/6	T	Wushan	Chongqing	H37:3	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
393	u-shaped implement cap	2/6	T	Wushan	Chongqing	G6:2	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
394	u-shaped implement cap	3/6	T	Wushan	Chongqing	T1842 ⑧:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	228
395	iron adze	1	T	Wushan	Chongqing	T1637 ⑦:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	235
396	iron axehead	1	T	Wushan	Chongqing	T1740 ⑦:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	235
397	u-shaped implement cap	1/3	T	Wushan	Chongqing	T1443 ⑥:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	235
398	iron sword	1	W	Wushan	Chongqing	T1538 ⑦:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	240
399	iron mattockhead	1/3	T	Wushan	Chongqing	M26:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	289
400	iron tri-pot	1	D	Wushan	Chongqing	M24:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	289
401	iron sabre	1	W	Wushan	Chongqing	M38:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	289
402	iron sword	1	W	Wushan	Chongqing	M45:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	289
403	iron nail	numerous	T	Wushan	Chongqing	M	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	292
404	iron sword	1	W	Wushan	Chongqing	M5:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	318
405	iron sword	1	W	Wushan	Chongqing	M18:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	322
406	iron spoon	1	D	Wushan	Chongqing	AH1:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	366

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
407	iron *mou*	1	D	Wushan	Chongqing	M9:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	415
408	iron spoon	1	D	Wushan	Chongqing	M8:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	416
409	iron weight	1	T	Wushan	Chongqing	M2:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	416
410	iron ring	1	T	Fengjie	Chongqing	T2203 ③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	501
411	u-shaped implement cap	1/2	T	Fengjie	Chongqing	C:001	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	501
412	iron nail	numerous	T	Fengjie	Chongqing	M	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	543
413	iron sabre	1	W	Fengjie	Chongqing	M1041:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	543
414	iron chisel	1	T	Fengjie	Chongqing	H205:15	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
415	iron box	1/2	D	Fengjie	Chongqing	M225:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
416	iron nail	numerous	T	Fengjie	Chongqing	M	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
417	iron rake tooth	1	T	Fengjie	Chongqing	M244:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
418	iron ring	1	T	Fengjie	Chongqing	T302②:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
419	iron wok	1/2	D	Fengjie	Chongqing	H205:18	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
420	object ear	1	D	Fengjie	Chongqing	H205:16	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
421	iron decoration	1/8	U	Fengjie	Chongqing	M224:18	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
422	iron ferrule	1	W	Fengjie	Chongqing	M301:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	609
423	iron *mou*	1	D	Fengjie	Chongqing	IM14:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007b)	619
424	iron construction implement	1/3	U	Fengjie	Chongqing	IIM25:7-1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	619
425	iron construction implement	2/3	U	Fengjie	Chongqing	IIM25:7-2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	619
426	iron arrowhead	1	W	Fengjie	Chongqing	IIM25:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	619
427	iron coin	26	O	Fengjie	Chongqing	M	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	622
428	iron weight	1	T	Fengjie	Chongqing	IIM10:3	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007b)	629
429	iron mattockhead	1	T	Fengjie	Chongqing	T5005 ④:1	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	639
430	iron sabre	1	W	Fengjie	Chongqing	T5008 ⑥:5	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	639

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
431	iron mattockhead	1/3	T	Yunyang	Chongqing	CT1503 ③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	658
432	iron mattockhead	2/3	T	Yunyang	Chongqing	CH31:9	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	658
433	iron sabre	1	W	Yunyang	Chongqing	BH1:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	658
434	iron sabre	1	W	Yunyang	Chongqing	BM1:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007b)	658
435	iron hoehead	1	T	Yunyang	Chongqing	ET1208 ⑤:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	659
436	iron arrowhead	1	W	Yunyang	Chongqing	ET1209 ⑤:3	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	659
437	iron arrowhead	1	W	Yunyang	Chongqing	ET1208 ⑤:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007b)	659
438	ring-headed iron knife	1	U	Kai County	Chongqing	M9:3	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007b)	677
439	iron chisel	1	T	Wanzhou	Chongqing	M7:26	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007c)	725
440	iron *fu*-pot	1	D	Wanzhou	Chongqing	M5:45	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	796
441	iron object	2	U	Wanzhou	Chongqing	M6	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007c)	804
442	iron sabre	1	W	Wanzhou	Chongqing	M9:23	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007c)	804
443	iron *fu*-pot	1	D	Wanzhou	Chongqing	M2:26	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	821
444	iron axehead	1/2	T	Zhong County	Chongqing	AM25:29	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	861
445	iron axehead	1/3	T	Zhong County	Chongqing	AM8:20	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	861
446	iron chisel	1/2	T	Zhong County	Chongqing	AM25:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	861
447	iron chisel	1	T	Zhong County	Chongqing	AM5:24	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	861
448	iron mattockhead	1/8	T	Zhong County	Chongqing	AM25:19	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	861
449	iron mattockhead	2/8	T	Zhong County	Chongqing	AM13:35	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	861
450	ring-headed iron knife	1/3	T	Zhong County	Chongqing	AM5:30	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	861
451	ring-headed iron knife	2/3	T	Zhong County	Chongqing	AM5:28	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	861
452	iron knife	7	U	Zhong County	Chongqing		N	N		(CQSWWJ and CQSYMJ 2007c)	861
453	iron spearhead	1	W	Zhong County	Chongqing	AM25:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	861
454	iron spearhead	1	W	Zhong County	Chongqing	AM25:37	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	861

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
455	iron hoehead	1/2	T	Zhong County	Chongqing	AM25:17	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	862
456	iron shovelhead	1	T	Zhong County	Chongqing	AM9:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	862
457	unidentified	1	U	Zhong County	Chongqing	BM6:4	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007c)	862
458	u-shaped implement cap	1	T	Zhong County	Chongqing	AM3:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	862
459	iron sword with bronze guard	1	W	Zhong County	Chongqing	AM5:29	Y	Y	Eastern Han(early)(mid)	(CQSWWJ and CQSYMJ 2007c)	862
460	iron sword	1	W	Zhong County	Chongqing	AM25:15	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	862
461	iron *fu*-pot	1	D	Zhong County	Chongqing	AM5:3	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	864
462	iron *fu*-pot	1	D	Zhong County	Chongqing	AM6:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	864
463	iron sicklehead	1	T	Zhong County	Chongqing	AM4:35	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	864
464	unidentified	1/4	U	Zhong County	Chongqing	AM25:35	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007c)	864
465	iron sabre	1	W	Zhong County	Chongqing		N	N		(CQSWWJ and CQSYMJ 2007c)	901
466	ring-headed iron knife	1	T	Zhong County	Chongqing	M1:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	1045
467	iron *fu*-pot	1	D	Fengdu Shanghezui	Chongqing	M1:10	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007c)	1060
468	iron nail	1	T	Fuling	Chongqing	H39:30	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007c)	1106
469	iron nail	1	T	Fuling	Chongqing	M6:4	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007c)	1106
470	iron hoehead	1	T	Fuling	Chongqing	IVT0206⑥:4	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007c)	1124
471	iron hook	1	T	Fuling	Chongqing	IVT0803③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007c)	1136
472	iron decoration	1	U	Fuling	Chongqing	IVT1103②:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007c)	1136
473	ring-headed iron knife	1	T	Fuling	Chongqing	M4:19	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	1144
474	iron spearhead	1	W	Fuling	Chongqing	M12:18	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	1158
475	iron decoration	1	U	Fuling	Chongqing	M14:8	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007c)	1167
476	u-shaped implement cap	1	T	Wushan	Chongqing	IM7fills:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	12
477	iron arrowhead	1	W	Wushan	Chongqing	IIT61③a:2	N	Y		(CQSWWJ and CQSYMJ 2007d)	13
478	iron arrowhead	1	W	Wushan	Chongqing	IIT61③a:1	N	Y		(CQSWWJ and CQSYMJ 2007d)	13

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
479	iron *fu*-pot	1	D	Wushan	Chongqing	IIM6	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	22
480	iron *fu*-pot	1	D	Wushan	Chongqing	IIM7:23	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	25
481	unidentified	1	U	Wushan	Chongqing	IIM7:9	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	25
482	iron scissors	1	T	Wushan	Chongqing	IIM5:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	30
483	iron axehead	1	T	Wushan	Chongqing	G2:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	67
484	iron arrowhead	1	W	Wushan	Chongqing	T303②:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	67
485	iron sabre	1	W	Wushan	Chongqing	H9:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	67
486	iron sabre	1	W	Wushan	Chongqing		N	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	67
487	iron spearhead	1	W	Wushan	Chongqing	H9:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	67
488	iron hammerhead	1	T	Wushan	Chongqing	T418②:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	69
489	iron nail	6	T	Wushan	Chongqing	M12	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	85
490	iron weight	1	T	Wushan	Chongqing	TG6⑥:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	85
491	iron axehead	1	T	Wushan	Chongqing	T1348 ⑦:10	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007d)	106
492	iron axehead	1	T	Wushan	Chongqing	T1348 ⑦:9	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007d)	106
493	u-shaped implement cap	1/3	T	Wushan	Chongqing	T1350 ⑥:6	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007d)	106
494	u-shaped implement cap	1/4	T	Wushan	Chongqing	H31:5	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	124
495	iron axehead	1	T	Wushan	Chongqing	T1632 ④:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	129
496	iron chisel	1	T	Wushan	Chongqing	T1546 ④:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	129
497	iron sabre	1	W	Wushan	Chongqing	T1251 ④:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	129
498	iron tri-pot	1	D	Wushan	Chongqing	IIM5:25	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	173
499	ring-pommeled iron sword	1	U	Wushan	Chongqing	IIIM4:8	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	173
500	iron sword with bronze guard	1/3	W	Wushan	Chongqing	IIM5:24	Y	N	8 to 23 AD	(CQSWWJ and CQSYMJ 2007d)	173
501	iron sword with bronze guard	2/3	W	Wushan	Chongqing	IIM9:20	Y	N	Eastern Han(mid-late)	(CQSWWJ and CQSYMJ 2007d)	173
502	iron sword	1	W	Wushan	Chongqing	IIM4:34	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	173

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
503	iron mattockhead	1	T	Wushan	Chongqing	IIM4:26	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	174
504	iron nail	1/4	T	Wushan	Chongqing	IVM3:2	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	174
505	iron hoehead	1	T	Wushan	Chongqing	M16:14	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	236
506	iron *mou*	1	D	Wushan	Chongqing	M10:17	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
507	iron *mou*	1	D	Wushan	Chongqing	M11:7	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
508	iron nail	1	T	Wushan	Chongqing	M15:62	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
509	iron tri-pot	1	D	Wushan	Chongqing	M4:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
510	ring-headed iron knife	1	T	Wushan	Chongqing	M13:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
511	ring-headed iron knife	1	T	Wushan	Chongqing	M15:60	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
512	iron knife	1	U	Wushan	Chongqing	M15:61	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
513	iron sword	1	W	Wushan	Chongqing	M15:59	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	236
514	ring-pommeled iron sword	1	W	Wushan	Chongqing	M3:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	236
515	iron hoehead	1	T	Wushan	Chongqing	BH36:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	280
516	iron weight	1/2	T	Wushan	Chongqing	BT1809 ④:6	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	280
517	iron sabre	1	W	Wushan	Chongqing	BH11:5	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	280
518	ring-headed iron knife	1	T	Wushan	Chongqing	M66:22	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	307
519	ring-headed iron knife	1	T	Wushan	Chongqing	M59:8	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	307
520	iron chisel	1	T	Fengjie	Chongqing	G302:10	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	330
521	iron coin	1	O	Fengjie	Chongqing	T301③:3	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	330
522	iron mattockhead	1	T	Fengjie	Chongqing	T307 ④:24	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	330
523	u-shaped implement cap	1/3	T	Fengjie	Chongqing	G302:4	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	330
524	unidentified	numerous	U	Fengjie	Chongqing		N	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	330
525	iron sabre	1	W	Fengjie	Chongqing	H301:4	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	330
526	iron sabre	1	W	Fengjie	Chongqing	T307④:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	331

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
527	iron hook	1	T	Fengjie	Chongqing	T119③:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	365
528	iron spoon	1	D	Fengjie	Chongqing	T106③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	365
529	iron sheet	1	U	Fengjie	Chongqing	H4:8	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	366
530	iron axehead	1	T	Fengjie	Chongqing	T4002 ⑤:1	N	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	401
531	iron hoehead	1	T	Fengjie	Chongqing	T4004 ③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	401
532	iron tri-pot	1	D	Fengjie	Chongqing	F4:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	408
533	iron *fu*-pot	1	D	Fengjie	Chongqing	M4009:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	417
534	iron stand	1	D	Fengjie	Chongqing	M4009	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	417
535	iron mattockhead	1	T	Fengjie	Chongqing	M4013:6	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	428
536	iron scissors	1	T	Fengjie	Chongqing	M5012:3	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	433
537	iron nail	1	T	Fengjie	Chongqing	M1005:3	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	438
538	iron belt hook	1	A	Fengjie	Chongqing	IM1001:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	440
539	iron belt hook	1/4	A	Fengjie	Chongqing	IM1001:4	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	441
540	iron weight	1	T	Fengjie	Chongqing	IM1001:5	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	441
541	iron object	8	U	Fengjie	Chongqing	M	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	521
542	iron sword handle	1	W	Fengjie	Chongqing	M5:6	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007d)	546
543	ring-headed iron knife	1	T	Fengjie	Chongqing	M2:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	549
544	iron sabre	1	W	Fengjie	Chongqing	M3:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	549
545	iron sabre	1	W	Fengjie	Chongqing	M3:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	550
546	iron stand	1	D	Fengjie	Chongqing	M4:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	557
547	iron pickaxehead	1	T	Yunyang	Chongqing	IIT1④:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007d)	580
548	iron *fu*-pot	1	D	Yunyang	Chongqing	M17:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	595
549	iron arrowhead	1	W	Yunyang	Chongqing	T1437② F:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	605
550	iron *fu*-pot	1/3	D	Yunyang	Chongqing	M12:69	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007d)	673

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
551	ring-headed iron knife	1/10	T	Yunyang	Chongqing	M24:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	673
552	ring-headed iron knife	2/10	T	Yunyang	Chongqing	M3:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	673
553	iron arrowhead	1	W	Yunyang	Chongqing	M2:130	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	673
554	iron arrowhead	1	W	Yunyang	Chongqing	M2:129	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	673
555	iron sword	1/5	W	Yunyang	Chongqing	M7:22	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	673
556	ring-pommeled iron sword	1	W	Yunyang	Chongqing	M2:52	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007d)	673
557	iron axehead	1	T	Yunyang	Chongqing	M42:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007d)	676
558	iron axehead	1	T	Shizhu	Chongqing	T0209 ②:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1455
559	iron coin	1	O	Shizhu	Chongqing	T0306 ③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1455
560	iron axehead	2/3	T	Shizhu	Chongqing	IM11:13	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
561	iron axehead	1/3	T	Shizhu	Chongqing	IM6:27	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
562	iron shovelhead	1/2	T	Shizhu	Chongqing	IM6:28	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
563	ring-headed iron knife	4/7	T	Shizhu	Chongqing	IM6:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
564	ring-headed iron knife	1/7	T	Shizhu	Chongqing	IM1:3	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1515
565	ring-headed iron knife	5/7	T	Shizhu	Chongqing	IIM2:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1515
566	u-shaped implement cap	1/2	T	Shizhu	Chongqing	IM6:29	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
567	ring-headed iron knife	2/7	U	Shizhu	Chongqing	IM11:18	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
568	ring-headed iron knife	3/7	U	Shizhu	Chongqing	IM6:32	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
569	iron sabre	1	W	Shizhu	Chongqing	IVM1:67	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
570	iron sabre	1	W	Shizhu	Chongqing	IIM1:20	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1515
571	iron sword	1	W	Shizhu	Chongqing	IM11:19	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1515
572	iron *fu*-pot	1/6	D	Shizhu	Chongqing	M11:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1517
573	iron sabre	1	W	Shizhu	Chongqing	IM5:17	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1524
574	iron spearhead	1	W	Shizhu	Chongqing	IM5:16	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1524

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
575	iron stand	1	D	Zhong County	Chongqing	M1:11	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1560
576	iron axehead	1	T	Zhong County	Chongqing	M1:33	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1561
577	iron sicklehead	1	T	Zhong County	Chongqing	M1:35	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1561
578	iron sword	1	W	Zhong County	Chongqing	M5:67	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1563
579	iron *fu*-pot	1	D	Zhong County	Chongqing	M1:7	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1596
580	ring-headed iron knife	1/4	U	Zhong County	Chongqing	M1Disturbed:20	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1596
581	ring-headed iron knife	2/4	U	Zhong County	Chongqing	M1Disturbed:15	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1596
582	iron spearhead	1/2	W	Zhong County	Chongqing	M1:9	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1596
583	iron spearhead	2/2	W	Zhong County	Chongqing	M1:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1596
584	ring-pommeled iron sword	1/3	W	Zhong County	Chongqing	M1Disturbed:21	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1596
585	ring-pommeled iron sword	2/3	W	Zhong County	Chongqing	M1Disturbed:22	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1596
586	iron hoehead	1/2	T	Zhong County	Chongqing	M1:14	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1598
587	iron hoehead	2/2	T	Zhong County	Chongqing	M1:29	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1598
588	u-shaped implement cap	1	T	Zhong County	Chongqing	M1:13	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1598
589	iron object	1	U	Zhong County	Chongqing	M	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1606
590	iron sabre	1/2	W	Fengdu Shidiba	Chongqing	T1334③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1625
591	iron sabre	2/2	W	Fengdu Shidiba	Chongqing	T1133③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1625
592	iron chisel	1	T	Fengdu Huangliuzui	Chongqing	IIT6⑥:1	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1640
593	iron shovelhead	1	T	Fengdu Huangliuzui	Chongqing	IVM1:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1640
594	iron sabre	1	W	Fengdu Huangliuzui	Chongqing	IVM2:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1640
595	iron sabre	1	W	Fengdu Huangliuzui	Chongqing	IVM1:13	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1640
596	iron sabre	1	W	Fengdu Huangyanzui	Chongqing	T0102③:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1661
597	iron nail	1	T	Fengdu Tangfang	Chongqing	G1:18	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1691
598	iron object	1	U	Fengdu Tangfang	Chongqing	T305③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1691

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
599	iron arrowhead	1/2	W	Fengdu Tangfang	Chongqing	G1:14	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1691
600	iron arrowhead	2/2	W	Fengdu Tangfang	Chongqing	G1:19	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1691
601	circular iron object	1	U	Fengdu	Chongqing	Y2:12	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1703
602	iron object	1	U	Fengdu Puzihe	Chongqing	T56③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1758
603	iron coin	1	O	Fengdu Puzihe	Chongqing	T67③:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1759
604	iron object	1	U	Fengdu Puzihe	Chongqing	T57③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1759
605	iron object	1	U	Fengdu Puzihe	Chongqing	T57②:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1767
606	iron object	1	U	Fengdu Puzihe	Chongqing	T67②:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1767
607	iron spearhead	1	W	Fengdu Puzihe	Chongqing	H9:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	1767
608	iron scissors	1/2	T	Fengdu Caofanggou	Chongqing	M1:11	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1789
609	iron scissors	2/2	T	Fengdu Caofanggou	Chongqing	M1:12	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1789
610	iron spinning wheel	1	T	Fengdu Caofanggou	Chongqing	M1:4	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1789
611	iron arrowhead	1	W	Fengdu Caofanggou	Chongqing	M1:16	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1789
612	iron sabre	1/2	W	Fengdu Caofanggou	Chongqing	M1:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1789
613	iron sabre	2/2	W	Fengdu Caofanggou	Chongqing	M1:17	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1789
614	iron scissors	1	T	Fengdu Caofanggou	Chongqing	M3:33	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1795
615	unidentified	1	U	Fengdu Caofanggou	Chongqing	M3:29	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1795
616	iron sabre	1	W	Fengdu Caofanggou	Chongqing	M3:27	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007e)	1795
617	ring-headed iron knife	1	U	Fengdu Maojiabao	Chongqing	M4:23	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	1918
618	iron *fu*-pot	1	D	Fuling	Chongqing	M32:2	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007e)	1976
619	u-shaped implement cap	1	T	Fuling	Chongqing	M28:11	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007e)	1976
620	iron knife	1	U	Fuling	Chongqing	M73:4	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007e)	1976
621	iron coin	1	O	Fuling	Chongqing	B1T3232 ④:6	N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	2004
622	iron nail	1	T	Fuling	Chongqing	M11	Y	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007e)	2038

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
623	iron sword	1	W	Fuling	Chongqing	M8:16	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007e)	2038
624	ring-headed iron knife	1	T	Wanzhou	Chongqing	M33:2	Y	Y		(CQSWWJ and CQSYMJ 2007a)	744
625	ring-headed iron knife	1	T	Wanzhou	Chongqing	M35:31	Y	Y		(CQSWWJ and CQSYMJ 2007a)	746
626	iron sabre	1	W	Wanzhou	Chongqing	M35:17	Y	Y		(CQSWWJ and CQSYMJ 2007a)	746
627	iron *fu*-pot	1	D	Wanzhou	Chongqing	M38:9	Y	Y		(CQSWWJ and CQSYMJ 2007a)	757
628	iron *fu*-pot	1	D	Wanzhou	Chongqing	M38:91	Y	Y		(CQSWWJ and CQSYMJ 2007a)	757
629	ring-headed iron knife	1	T	Wanzhou	Chongqing	M38:18	Y	Y		(CQSWWJ and CQSYMJ 2007a)	757
630	ring-headed iron knife	1	T	Wanzhou	Chongqing	M38:24	Y	Y		(CQSWWJ and CQSYMJ 2007a)	757
631	iron nail	2	T	Wanzhou	Chongqing	M40	Y	N		(CQSWWJ and CQSYMJ 2007a)	759
632	u-shaped implement cap	1	T	Wanzhou	Chongqing	M43:5	Y	Y		(CQSWWJ and CQSYMJ 2007a)	760
633	ring-headed iron knife	1	T	Wanzhou	Chongqing	M44:26	Y	Y		(CQSWWJ and CQSYMJ 2007a)	763
634	iron sabre	1	W	Wanzhou	Chongqing	M44:24	Y	Y		(CQSWWJ and CQSYMJ 2007a)	763
635	iron axehead	1	T	Wanzhou	Chongqing	M45:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	764
636	iron *fu*-pot	1	D	Wanzhou	Chongqing	M45:16	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	764
637	iron *fu*-pot	1	D	Wanzhou	Chongqing	M45:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	764
638	ring-headed iron knife	1	T	Wanzhou	Chongqing	M45:18	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	764
639	u-shaped implement cap	1	T	Wanzhou	Chongqing	M45:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	764
640	iron hoehead	1	T	Wanzhou	Chongqing	M45:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	765
641	iron stand	2	D	Wanzhou	Chongqing	M09	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	777
642	iron *fu*-pot	1	D	Wanzhou	Chongqing	M12:38	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	790
643	iron *fu*-pot	1	D	Wanzhou	Chongqing	M12:39	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	790
644	iron *fu*-pot	1	D	Wanzhou	Chongqing	M14:3	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	803
645	iron *fu*-pot	1	D	Wanzhou	Chongqing	M15	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	803
646	iron spearhead	1	W	Wanzhou	Chongqing	T1②:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007a)	851

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
647	iron nail	1/2	T	Wanzhou	Chongqing	M8:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	872
648	iron sword	1	W	Wanzhou	Chongqing	M8:13	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	872
649	ring-pommeled iron sword	1/4	W	Wanzhou	Chongqing	M6:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	876
650	iron *fu*-pot	1/2	D	Wanzhou	Chongqing	M2:122	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	884
651	iron mattockhead	1	T	Wanzhou	Chongqing	M2:54	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	885
652	iron sabre	6	W	Wanzhou	Chongqing	M2	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	885
653	iron sword	1/5	W	Wanzhou	Chongqing	M2:33	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	885
654	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M2:36	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	885
655	iron mattockhead	1	T	Wanzhou	Chongqing	M7:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	912
656	iron sabre	1	W	Wanzhou	Chongqing	M7:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	912
657	iron hook	1	T	Wanzhou	Chongqing	M4:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	913
658	iron *fu*-pot	1	D	Wanzhou	Chongqing	M3:7	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	916
659	ring-headed iron knife	1	T	Wanzhou	Chongqing	M1:11	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	925
660	iron sword	1	W	Wanzhou	Chongqing	M1:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	925
661	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M1:7	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	925
662	iron knife	1	T	Wanzhou	Chongqing	M2:3	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	931
663	iron sabre	1	W	Wanzhou	Chongqing	M2:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	931
664	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M2:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	931
665	iron *fu*-pot	1/2	D	Wanzhou	Chongqing		N	N		(CQSWWJ and CQSYMJ 2007a)	960
666	iron scissors	1	T	Wanzhou	Chongqing	M18:6	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	960
667	iron knife	1/3	U	Wanzhou	Chongqing	M18:5	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	960
668	iron spearhead	1	W	Wanzhou	Chongqing	M16:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	960
669	ring-headed iron knife	1	T	Wanzhou	Chongqing	M3:36	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	977
670	iron *fu*-pot	1	D	Wanzhou	Chongqing	M10:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	997

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
671	iron *fu*-pot	1	D	Wanzhou	Chongqing	M18:69	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	997
672	iron ring	1	D	Wanzhou	Chongqing	M18:57	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	997
673	iron tri-pot	1	D	Wanzhou	Chongqing	M18:19	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	997
674	iron tri-pot	1	D	Wanzhou	Chongqing	M18:80	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	997
675	ring-headed iron knife	1	T	Wanzhou	Chongqing	M2:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	999
676	iron sword	3	W	Wanzhou	Chongqing	M	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	999
677	iron hoehead	1	T	Wanzhou	Chongqing	M2:20	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1000
678	ring-headed iron knife	1	T	Wanzhou	Chongqing	M8:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1000
679	iron sabre	1	W	Wanzhou	Chongqing	M10:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1000
680	iron axehead	1	T	Wanzhou	Chongqing	M8:5a	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1001
681	iron hoehead	1	T	Wanzhou	Chongqing	M8:5b	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1001
682	iron sheet	1	U	Wanzhou	Chongqing	M8:5c	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1001
683	iron *fu*-pot	1	D	Wanzhou	Chongqing	M4:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1185
684	iron *fu*-pot	1	D	Wanzhou	Chongqing	M7:25	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1185
685	iron mattockhead	1	T	Wanzhou	Chongqing	M5:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1185
686	iron mattockhead	1	T	Wanzhou	Chongqing	M6:10-2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1185
687	iron axehead	1	T	Wanzhou	Chongqing	M6:10-1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1186
688	iron chisel	1	T	Wanzhou	Chongqing	M6:13-2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1186
689	iron ring	1	T	Wanzhou	Chongqing	M7:16	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1186
690	ring-headed iron knife	1	U	Wanzhou	Chongqing	M6:13-1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1186
691	iron sabre	1/4	W	Wanzhou	Chongqing	M7:26	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1186
692	iron *fu*-pot	1	D	Wanzhou	Chongqing	M22:9	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1202
693	iron *fu*-pot	1	D	Wanzhou	Chongqing	M4:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
694	iron *fu*-pot	1	D	Wanzhou	Chongqing	M4:27	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
695	iron hook	1	T	Wanzhou	Chongqing	M4:71	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
696	iron stand	1	D	Wanzhou	Chongqing	M4:59	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
697	ring-headed iron knife	1	T	Wanzhou	Chongqing	M4:60	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
698	ring-headed iron knife	1	T	Wanzhou	Chongqing	M4:70	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
699	iron object	1	U	Wanzhou	Chongqing	M4:82	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
700	iron sabre	1	W	Wanzhou	Chongqing	M4:79	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
701	iron sabre	1	W	Wanzhou	Chongqing	M4:83	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
702	iron sabre	1	W	Wanzhou	Chongqing	M4:84	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
703	iron sabre	1	W	Wanzhou	Chongqing		N	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
704	iron sword	1	W	Wanzhou	Chongqing	M4:22	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
705	iron sword	1	W	Wanzhou	Chongqing	M4:34	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1208
706	iron stick	1	T	Wanzhou	Chongqing	M26:13	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1216
707	ring-headed iron knife	1	T	Wanzhou	Chongqing	M26:15	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1216
708	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M26:14	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1216
709	iron *fu*-pot	1	D	Wanzhou	Chongqing	M26:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1217
710	ring-headed iron knife	1	U	Wanzhou	Chongqing	M26:19	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1217
711	ring-headed iron knife	1	U	Wanzhou	Chongqing	M26:20	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1217
712	iron *fu*-pot	1	D	Wanzhou	Chongqing	M36:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1219
713	iron *fu*-pot	1	D	Wanzhou	Chongqing	M36:9	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1219
714	ring-headed iron knife	1	T	Wanzhou	Chongqing	M36:13	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1219
715	iron *fu*-pot	1	D	Wanzhou	Chongqing	M1:15	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1224
716	ring-headed iron knife	1	T	Wanzhou	Chongqing	M6:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1224
717	iron sabre	2	W	Wanzhou	Chongqing	M1	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1224
718	iron sabre	1	W	Wanzhou	Chongqing	M9:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1227

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
719	ring-headed iron knife	1	T	Wanzhou	Chongqing	M18:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1229
720	ring-headed iron knife	1	T	Wanzhou	Chongqing	M18:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1229
721	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M23:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1235
722	iron belt hook	1	A	Wanzhou	Chongqing	M24:41	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
723	iron belt hook	1	A	Wanzhou	Chongqing	M24:63	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
724	iron belt hook	1	A	Wanzhou	Chongqing	M24:74	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
725	iron *fu*-pot	1	D	Wanzhou	Chongqing	M24:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
726	iron *fu*-pot	1	D	Wanzhou	Chongqing	M24:39	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
727	iron nail	1	T	Wanzhou	Chongqing	M24:80	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
728	iron nail	1	T	Wanzhou	Chongqing	M24	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
729	iron stand	1	D	Wanzhou	Chongqing	M24:85	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
730	iron stick	1	T	Wanzhou	Chongqing	M24:91	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1242
731	iron sword with bronze guard	1	W	Wanzhou	Chongqing	M24:30	Y	Y	Eastern Han	(CQSWWJ and CQSYMJ 2007a)	1242
732	iron sword with bronze guard	1	W	Wanzhou	Chongqing	M24:55	Y	Y	Eastern Han	(CQSWWJ and CQSYMJ 2007a)	1242
733	iron sword with bronze guard	1	W	Wanzhou	Chongqing	M24:76	Y	Y	Eastern Han	(CQSWWJ and CQSYMJ 2007a)	1242
734	ring-headed iron knife	1	U	Wanzhou	Chongqing	M24:56	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1243
735	ring-headed iron knife	1	U	Wanzhou	Chongqing	M24:77	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1243
736	ring-headed iron knife	1	U	Wanzhou	Chongqing	M24:84	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1243
737	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M24:94	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1243
738	ring-headed iron knife	1	U	Wanzhou	Chongqing	M39:21	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1255
739	iron sabre	1	W	Wanzhou	Chongqing	M39:29	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1255
740	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M39:30	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1255
741	iron knife	1	T	Wanzhou	Chongqing	M14:8	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2007a)	1264
742	iron sabre	1	W	Wanzhou	Chongqing	M3:13	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1287

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
743	iron *fu*-pot	1	D	Wanzhou	Chongqing	M5:13	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1288
744	iron *fu*-pot	1	D	Wanzhou	Chongqing	M9:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1291
745	iron stand	1	D	Wanzhou	Chongqing	M9	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1291
746	iron *jian*	1	D	Wanzhou	Chongqing	M9:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1292
747	iron sabre	1	W	Wanzhou	Chongqing	M13:3	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1292
748	iron chisel	1	T	Wanzhou	Chongqing	M7:12	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	1296
749	iron *fu*-pot	1	D	Wanzhou	Chongqing	M8:29	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1319
750	ring-headed iron knife	1	T	Wanzhou	Chongqing	M2:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1319
751	u-shaped implement cap	1	T	Wanzhou	Chongqing	collected	N	Y		(CQSWWJ and CQSYMJ 2007a)	1319
752	ring-headed iron knife	1	U	Wanzhou	Chongqing	M	Y	N		(CQSWWJ and CQSYMJ 2007a)	1319
753	ring-headed iron knife	1	U	Wanzhou	Chongqing	M	Y	N		(CQSWWJ and CQSYMJ 2007a)	1319
754	iron *fu*-pot	1	D	Wanzhou	Chongqing	M10:10	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1331
755	object handle	1	D	Wanzhou	Chongqing	M1:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1331
756	iron scissors	1	T	Wanzhou	Chongqing	M7:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1333
757	iron spinning wheel	1	T	Wanzhou	Chongqing	M7:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1335
758	iron belt hook	1	A	Wanzhou	Chongqing	M10:16	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1340
759	iron sabre	1	W	Wanzhou	Chongqing	M21:1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1345
760	iron scissors	1	T	Wanzhou	Chongqing	M2:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2007a)	1347
761	iron *fu*-pot	1	D	Wanzhou	Chongqing	M1:22	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1356
762	iron stand	1	D	Wanzhou	Chongqing	M1:34	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1356
763	iron *fu*-pot	1	D	Wanzhou	Chongqing	M2:8	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1362
764	ring-headed iron knife	1	U	Wanzhou	Chongqing	M2:2	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1362
765	iron *fu*-pot	1	D	Wanzhou	Chongqing	M3:6	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1364
766	iron sword with bronze guard	1	W	Wanzhou	Chongqing	M4:7	Y	Y	Western Han(late)	(CQSWWJ and CQSYMJ 2007a)	1373

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
767	iron *fu*-pot	1	D	Wanzhou	Chongqing	M4:59	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1374
768	iron *fu*-pot	1	D	Wanzhou	Chongqing	M4:63	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1374
769	iron hook	1	T	Wanzhou	Chongqing	M4:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1374
770	ring-headed iron knife	1	U	Wanzhou	Chongqing	M4:8	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1374
771	iron *fu*-pot	1	D	Wanzhou	Chongqing	M5:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1382
772	iron stand	1	D	Wanzhou	Chongqing	M5	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1382
773	ring-headed iron knife	1	T	Wanzhou	Chongqing	M5:13	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1382
774	ring-headed iron knife	1	T	Wanzhou	Chongqing	M5:52	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1382
775	iron *fu*-pot	1	D	Wanzhou	Chongqing	M6:40	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1389
776	ring-headed iron knife	1	T	Wanzhou	Chongqing	M6:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2007a)	1389
777	iron *fu*-pot	1	D	Wanzhou	Chongqing	M7:19	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1394
778	iron stand	1	D	Wanzhou	Chongqing	M7:20	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1394
779	iron object	1	U	Wanzhou	Chongqing	M7:6	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2007a)	1394
780	iron sword with bronze guard	1	W	Wanzhou	Chongqing	M9:20	Y	Y	Western Han(mid)	(CQSWWJ and CQSYMJ 2007a)	1398
781	ring-headed iron knife	1	U	Kai County	Chongqing	M56:4	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007a)	1430
782	ring-headed iron knife	1	U	Kai County	Chongqing	M85:4	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007a)	1442
783	iron *fu*-pot	1	D	Kai County	Chongqing	M93:1	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2007a)	1444
784	iron *mou*	1	D	Wushan	Chongqing	M91:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	101
785	ring-headed iron knife	1/2	T	Wushan	Chongqing	M81:35	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	101
786	ring-headed iron knife	2/2	U	Wushan	Chongqing	M77:4	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	101
787	iron adze	1/2	T	Wushan	Chongqing	H101①:5	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
788	iron axehead	1/10	T	Wushan	Chongqing	H101 ②:13	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
789	iron axehead	2/10	T	Wushan	Chongqing	H101 ①:12	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
790	iron axehead	3/10	T	Wushan	Chongqing	H101 ②:19	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
791	iron axehead	4/10	T	Wushan	Chongqing	H101①:9	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
792	iron axehead	5/10	T	Wushan	Chongqing	H101①:8	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
793	iron axehead	6/10	T	Wushan	Chongqing	H84:11	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
794	iron chisel	1	T	Wushan	Chongqing	H76:2	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
795	u-shaped implement cap	1/10	T	Wushan	Chongqing	H101 ①:11	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
796	u-shaped implement cap	2/10	T	Wushan	Chongqing	H101 ②:15	N	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	132
797	iron axehead	1	T	Wushan	Chongqing	T1939 ⑤:1	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	140
798	u-shaped implement cap	1/3	T	Wushan	Chongqing	H84:5	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	140
799	iron sabre	1	W	Wushan	Chongqing	H115②:1	N	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	140
800	iron *fu*-pot	1	D	Fengjie	Chongqing	H101:1	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	159
801	iron belt hook	1/3	A	Fengjie	Chongqing	M102:9	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	160
802	iron belt hook	2/3	A	Fengjie	Chongqing	M102:10	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	160
803	iron belt hook	3/3	A	Fengjie	Chongqing	M102:11	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	160
804	iron nail	1/2	T	Fengjie	Chongqing	M102:12	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	160
805	iron nail	2/2	T	Fengjie	Chongqing	M102:13	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	160
806	iron nail	1/4	T	Fengjie	Chongqing	T203③:1	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	162
807	iron ring	1	T	Fengjie	Chongqing	T125①:1	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	162
808	unidentified	1/4	U	Fengjie	Chongqing	T125①:4	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	162
809	unidentified	2/4	U	Fengjie	Chongqing	T130②:1	N	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	162
810	unidentified	3/4	U	Fengjie	Chongqing	T114①:1	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	162
811	unidentified	4/4	U	Fengjie	Chongqing	T125①:3	N	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	162
812	iron nail	1	T	Fengjie	Chongqing	M2:9	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	187
813	iron nail	1/5	T	Fengjie	Chongqing	T35①:1	N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010a)	189
814	iron *fu*-pot	1	D	Fengjie	Chongqing	M3:30	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	204

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
815	iron lamp	1	D	Fengjie	Chongqing	M3:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	204
816	iron nail	1/3	T	Fengjie	Chongqing	M3:33-1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	206
817	iron *mou*	1	D	Fengjie	Chongqing	M4:03	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	227
818	object handle	1	D	Fengjie	Chongqing	M1:04	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	227
819	iron sabre	1	W	Fengjie	Chongqing	M1:09	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	227
820	iron *fu*-pot	1	D	Fengjie	Chongqing	H6:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010a)	253
821	iron sicklehead	1	T	Fengjie	Chongqing	H10:10	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010a)	253
822	iron arrowhead	1/18	W	Yunyang	Chongqing	02YJAT0 809③:5	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	281
823	iron arrowhead	2/18	W	Yunyang	Chongqing	02YJAT0 708③:20	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	281
824	iron chisel	1	T	Yunyang	Chongqing	02YJAT0 708③:11	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
825	iron fish hook	1	T	Yunyang	Chongqing	02YJAT0 602③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
826	iron arrowhead	3/18	W	Yunyang	Chongqing	02YJAT0 602③:17	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
827	iron arrowhead	4/18	W	Yunyang	Chongqing	02YJAT0 809④:24	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
828	iron arrowhead	5/18	W	Yunyang	Chongqing	02YJAT0 710④:3	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
829	iron arrowhead	6/18	W	Yunyang	Chongqing	02YJAT0 810②:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
830	iron sabre	1/4	W	Yunyang	Chongqing	02YJAT0 601③:7	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
831	ring-pommeled iron sword	1	W	Yunyang	Chongqing	02YJAT0 810②:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	283
832	iron fork	1	T	Yunyang	Chongqing	02YJAT0 708③:13	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	285
833	iron hoehead	1	T	Yunyang	Chongqing	02YJAT0 610③:15	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	285
834	iron lock	1	D	Yunyang	Chongqing	02YJAT0 810②:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	285
835	iron mattockhead	1	T	Yunyang	Chongqing	02YJAT0 601③:15	N	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	285
836	iron sicklehead	1	T	Yunyang	Chongqing	02YJAT0 708③:23	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	285
837	u-shaped implement cap	1	T	Yunyang	Chongqing	02YJAT0 708③:22	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	285
838	iron spearhead	1	W	Yunyang	Chongqing	02YJAT0 601③:12	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	285

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
839	iron arrowhead	1	W	Yunyang	Chongqing	T2909②:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010a)	316
840	ring-headed iron knife	1	T	Yunyang	Chongqing	M10:47	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	327
841	iron belt hook	8	A	Yunyang	Chongqing	M11	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	331
842	iron *fu*-pot	1	D	Yunyang	Chongqing	M11:21	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	331
843	iron knife	1	U	Yunyang	Chongqing	M11	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	331
844	u-shaped implement cap	1	T	Yunyang	Chongqing	M2:20	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	352
845	ring-headed iron knife	1/2	U	Yunyang	Chongqing	M81:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	398
846	iron sicklehead	1	T	Yunyang	Chongqing	M60:5	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	404
847	ring-headed iron knife	1/3	T	Yunyang	Chongqing	M66:8	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	404
848	ring-pommeled iron sword	1/2	W	Yunyang	Chongqing	M58:5	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	404
849	ring-pommeled iron sword	2/2	W	Yunyang	Chongqing	M56:6	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	404
850	ring-headed iron knife	1	U	Yunyang	Chongqing	M4:19	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	418
851	ring-pommeled iron sword	1	W	Yunyang	Chongqing	M8:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	424
852	iron mirror	1	D	Yunyang	Chongqing	M3:64	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	452
853	iron knife	1	T	Yunyang	Chongqing	M3:18	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	452
854	iron scissors	1/2	T	Yunyang	Chongqing	M3:51	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	452
855	object handle	1	D	Yunyang	Chongqing	M3:107	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	452
856	iron bar	1/2	U	Yunyang	Chongqing	M3:17	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	452
857	E-shaped object lid	1/3	D	Yunyang	Chongqing	M5:20	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	458
858	iron hook	1	T	Yunyang	Chongqing	M5:9	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	458
859	iron nail	1/3	T	Yunyang	Chongqing	M5:14-1	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	458
860	unidentified	1	U	Yunyang	Chongqing	M5:42	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	458
861	ring-pommeled iron sword	1	W	Yunyang	Chongqing	M5:21	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	458
862	iron nail	1	T	Yunyang	Chongqing	M5:10	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	460

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
863	iron bar	1	U	Yunyang	Chongqing	M5:43	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	460
864	iron belt hook	1	A	Yunyang	Chongqing	M16:31	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	484
865	iron sabre	1	W	Yunyang	Chongqing	M30:15	Y	Y	8th-3rd century BC	(CQSWWJ and CQSYMJ 2010a)	484
866	iron arrowhead	1	W	Wanzhou	Chongqing	T131⑧:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	546
867	iron *fu*-pot	1/2	D	Wanzhou	Chongqing	M1:14	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	618
868	iron *fu*-pot	2/2	D	Wanzhou	Chongqing	M4:48	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	619
869	iron tri-pot with handle	1	D	Wanzhou	Chongqing	M12:10	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	619
870	ring-headed iron knife	1/2	T	Wanzhou	Chongqing	M4:83	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	619
871	ring-headed iron knife	1/3	T	Wanzhou	Chongqing	M4:12	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	619
872	iron sword	1/2	W	Wanzhou	Chongqing	M4:13	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	619
873	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M4:11	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	619
874	ring-headed iron knife	1	T	Wanzhou	Chongqing	M10:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	625
875	iron axehead	1	T	Wanzhou	Chongqing	M10:7	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	626
876	iron sabre	1	W	Wanzhou	Chongqing	M10:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	626
877	iron *fu*-pot	1	D	Wanzhou	Chongqing	M10:26	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	627
878	ring-headed iron knife	1	T	Wanzhou	Chongqing	M11:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	633
879	iron *fu*-pot	1	D	Wanzhou	Chongqing	M11:14	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	635
880	iron spoon	1	D	Wanzhou	Chongqing	M11:24	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	637
881	ring-headed iron knife	1	U	Wanzhou	Chongqing	M12:5	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	637
882	iron *fu*-pot	1	D	Wanzhou	Chongqing	M12:72	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	646
883	iron stand	1	D	Wanzhou	Chongqing	M12:73	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	646
884	ring-headed iron knife	1	T	Wanzhou	Chongqing	M12:81	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	646
885	iron object	1	U	Wanzhou	Chongqing	M12:76	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	646
886	iron object	1	U	Wanzhou	Chongqing	M12:78	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	646

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
887	iron *fu*-pot	1	D	Wanzhou	Chongqing	M13:16	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	648
888	ring-headed iron knife	1	T	Wanzhou	Chongqing	M14:38	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	656
889	iron object	1	U	Wanzhou	Chongqing	M14:35	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	656
890	iron object	1	U	Wanzhou	Chongqing	M14:36	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	656
891	iron *fu*-pot	1	D	Wanzhou	Chongqing	M14:62	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	661
892	ring-headed iron knife	1	T	Wanzhou	Chongqing	M14:74	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	661
893	iron stand	1	D	Wanzhou	Chongqing	M14:95	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	663
894	iron object	1	U	Wanzhou	Chongqing	M14:79	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	663
895	iron object	1	U	Wanzhou	Chongqing	M14:80	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	663
896	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M14:82	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	663
897	iron *fu*-pot	1	D	Wanzhou	Chongqing	M15:15	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	668
898	iron *fu*-pot	1	D	Wanzhou	Chongqing	2001WW HIIM2:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	676
899	iron *fu*-pot	1	D	Wanzhou	Chongqing	2001WW HIIM3:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	677
900	iron spoon	1	D	Wanzhou	Chongqing	2001WW HIIM2:9	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	677
901	iron stand	1	D	Wanzhou	Chongqing	2001WW HIIM3:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	678
902	iron *fu*-pot	1	D	Wanzhou	Chongqing	2002WW HIIM6:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	682
903	iron *fu*-pot	1	D	Wanzhou	Chongqing	2002WW HIIM9:27	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010a)	687
904	iron *fu*-pot	1	D	Wanzhou	Chongqing	2002WW HIVM1:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	694
905	iron lamp	1	D	Wanzhou	Chongqing	2002WW HIVM1:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	694
906	iron stand	1	D	Wanzhou	Chongqing	2002WW HIVM1:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	694
907	iron *fu*-pot	1	D	Wanzhou	Chongqing	2002WW HIVM5:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	701
908	iron axehead	1	T	Wanzhou	Chongqing	2002WW HIVM7:7	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	703
909	iron hoehead	1	T	Wanzhou	Chongqing	2002WW HIVM7:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	703
910	iron *mou*	1	D	Wanzhou	Chongqing	2002WW HIVM7:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	703

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
911	iron chisel	1	T	Wanzhou	Chongqing	2002WW HIVM7:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	705
912	iron object	1	U	Wanzhou	Chongqing	2001WW HIM1:27	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010a)	715
913	u-shaped implement cap	1	T	Wanzhou	Chongqing	M16:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	743
914	iron *fu*-pot	1	D	Wanzhou	Chongqing	M15:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	750
915	iron stand	1	D	Wanzhou	Chongqing	M15	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010a)	750
916	iron fork	1	T	Yunyang	Chongqing	T5a⑤:5	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010b)	1513
917	iron stand	1	D	Yunyang	Chongqing	T28④:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010b)	1513
918	iron belt hook	1/4	A	Yunyang	Chongqing	M5:14	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010b)	1546
919	iron belt hook	2/4	A	Yunyang	Chongqing	M2:64	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010b)	1546
920	iron stand	1	D	Yunyang	Chongqing	M7:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010b)	1546
921	ring-headed iron knife	1	T	Yunyang	Chongqing	M5:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010b)	1546
922	iron *fu*-pot	1	D	Wanzhou	Chongqing	M	Y	N		(CQSWWJ and CQSYMJ 2010b)	1742
923	ring-headed iron knife	1/2	T	Wanzhou	Chongqing	M11:28	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010b)	1742
924	iron *fu*-pot	1	D	Wanzhou	Chongqing	M21:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	849
925	iron *fu*-pot	1	D	Wanzhou	Chongqing	M23:16	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	849
926	ring-headed iron knife	1	U	Wanzhou	Chongqing	M23:15	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	852
927	iron sword	1	W	Wanzhou	Chongqing	M19:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	855
928	iron axehead	1	T	Wanzhou	Chongqing	M17:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	860
929	iron mattockhead	1	T	Wanzhou	Chongqing	M17:21	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	860
930	iron sabre	1	W	Wanzhou	Chongqing	M17:16	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	860
931	iron sword	1	W	Wanzhou	Chongqing	M20:55	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	863
932	ring-pommeled iron sword	1	W	Wanzhou	Chongqing	M20:53	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	863
933	iron sabre	1	W	Wanzhou	Chongqing	M13:22	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	872
934	iron *fu*-pot	1	D	Wanzhou	Chongqing	M14	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	875

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
935	iron hook	1	T	Wanzhou	Chongqing	M14:18	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	875
936	ring-headed iron knife	1/2	U	Wanzhou	Chongqing	M14:29	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	875
937	ring-headed iron knife	1	U	Wanzhou	Chongqing	M16:8	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	877
938	ring-headed iron knife	1/3	U	Wanzhou	Chongqing	M12:17	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	882
939	iron sword	1	W	Wanzhou	Chongqing	M12:10	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	882
940	u-shaped implement cap	1	T	Shizhu	Chongqing	M19:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	913
941	iron axehead	1	T	Shizhu	Chongqing	M19:20	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	914
942	iron shovelhead	1	T	Shizhu	Chongqing	M19:19	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	914
943	iron *fu*-pot	1	D	Shizhu	Chongqing	M20:53	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	918
944	iron sword	1	W	Shizhu	Chongqing	M20:6	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	918
945	iron object	1	U	Shizhu	Chongqing	M20:11	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	919
946	ring-pommeled iron sword	1/2	W	Shizhu	Chongqing	M20:15	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	919
947	iron axehead	1/2	T	Shizhu	Chongqing	M22:48	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	927
948	iron axehead	2/2	T	Shizhu	Chongqing	M22:49	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	927
949	iron tri-plate	1	D	Shizhu	Chongqing	M22:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	927
950	ring-headed iron knife	1	T	Shizhu	Chongqing	M22:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	927
951	unidentified	1	U	Shizhu	Chongqing	M23:18	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	931
952	ring-pommeled iron sword	1	W	Shizhu	Chongqing	M23:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	931
953	iron axehead	1	T	Shizhu	Chongqing	M24:27	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	936
954	iron shovelhead	1	T	Shizhu	Chongqing	M24:29	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	936
955	u-shaped implement cap	1	T	Shizhu	Chongqing	M24:26	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	936
956	iron halberdhead	1	W	Shizhu	Chongqing	M24:25	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	936
957	iron sabre	1/2	W	Shizhu	Chongqing	M24:16	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	936
958	iron sabre	2/2	W	Shizhu	Chongqing	M24:30	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	936

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
959	iron axehead	1/2	T	Shizhu	Chongqing	M25:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	940
960	iron saw	1	T	Shizhu	Chongqing	M25:25	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	940
961	u-shaped implement cap	1	T	Shizhu	Chongqing	M25:24	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	940
962	iron sabre	1	W	Shizhu	Chongqing	M25:21	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	940
963	iron object	1	U	Shizhu	Chongqing	M25:rob hole-5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	943
964	ring-headed iron knife	1	U	Shizhu	Chongqing	M26:40	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	947
965	iron sword	1	W	Zhong County	Chongqing	M12:5	Y	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	975
966	iron stand	1	D	Zhong County	Chongqing	BM5:11	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
967	iron saw	1	T	Zhong County	Chongqing	BM1:8	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
968	iron weight	1	T	Zhong County	Chongqing	BM1:10	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
969	ring-headed iron knife	1/3	T	Zhong County	Chongqing	BM1:19	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
970	u-shaped implement cap	1/3	T	Zhong County	Chongqing	BM5:41	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
971	u-shaped implement cap	2/3	T	Zhong County	Chongqing	BM4:1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
972	u-shaped implement cap	3/3	T	Zhong County	Chongqing	BM4:3	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
973	iron rod	1	U	Zhong County	Chongqing	BM4:14	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
974	iron spearhead	1/2	W	Zhong County	Chongqing	BM1:12	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
975	iron spearhead	2/2	W	Zhong County	Chongqing	BM4:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
976	iron sword	1	W	Zhong County	Chongqing	BM1:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1016
977	iron *fu*-pot	1/4	D	Zhong County	Chongqing	BM3:9	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
978	iron *fu*-pot	2/4	D	Zhong County	Chongqing	BM1:38	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
979	iron hoehead	1/3	T	Zhong County	Chongqing	BM4:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
980	iron hoehead	2/3	T	Zhong County	Chongqing	BM5:40	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
981	iron hoehead	3/3	T	Zhong County	Chongqing	BM7:2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
982	iron mattockhead	1/5	T	Zhong County	Chongqing	BM4:19	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
983	iron mattockhead	2/5	T	Zhong County	Chongqing	BM1:17	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
984	iron mattockhead	3/5	T	Zhong County	Chongqing	BM5:42	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
985	iron mattockhead	4/5	T	Zhong County	Chongqing	BM4:20	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
986	iron mattockhead	5/5	T	Zhong County	Chongqing	BM7:5	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
987	iron stand	1	D	Zhong County	Chongqing	BM3:17	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
988	ring-headed iron knife	2/3	T	Zhong County	Chongqing	BM3:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
989	ring-headed iron knife	3/3	T	Zhong County	Chongqing	BM8:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
990	iron sabre	1/2	W	Zhong County	Chongqing	BM7:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
991	iron sabre	2/2	W	Zhong County	Chongqing	BM8:9	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1019
992	iron *fu*-pot	3/4	D	Zhong County	Chongqing	BM5:16-2	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1021
993	iron *fu*-pot	4/4	D	Zhong County	Chongqing	BM8:7	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1021
994	iron stand	1	D	Zhong County	Chongqing	BM5:16-1	Y	Y	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1021
995	iron *fu*-pot	1	D	Zhong County	Chongqing	M1:2	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1038
996	iron sabre	1	W	Zhong County	Chongqing	M1:30	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1038
997	iron coin	13	O	Fengdu Maliuzui	Chongqing		N	N	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1082
998	iron scissors	1	T	Fengdu Maliuzui	Chongqing	IT305③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010c)	1083
999	iron sabre	1/3	W	Fengdu Maliuzui	Chongqing	IH1:3	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010c)	1083
1000	iron sabre	2/3	W	Fengdu Maliuzui	Chongqing	IH1:4	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010c)	1083
1001	iron sabre	3/3	W	Fengdu Maliuzui	Chongqing	IH1:5	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010c)	1083
1002	iron nail	numerous	T	Fengdu	Chongqing	M	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1106
1003	iron sicklehead	1	T	Fengdu	Chongqing	IIT0405 ③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010c)	1119
1004	iron spearhead	1	W	Fengdu	Chongqing	IIT0403 ③:1	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWJ and CQSYMJ 2010c)	1119
1005	iron sabre	1	W	Fengdu Dawan	Chongqing	M7:2	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1137
1006	iron object	1	U	Fuling	Chongqing	M2:22	Y	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1335

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1007	iron chisel	3/3	T	Yunyang	Chongqing	AT2④:13	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1008	iron chisel	1/3	T	Yunyang	Chongqing	CH5:27	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1399
1009	iron chisel	2/3	T	Yunyang	Chongqing	CH5:77	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1399
1010	iron mattockhead	1/2	T	Yunyang	Chongqing	CG3:10	N	Y		(CQSWWJ and CQSYMJ 2010c)	1399
1011	iron mattockhead	2/2	T	Yunyang	Chongqing	CT10⑤:6	N	Y		(CQSWWJ and CQSYMJ 2010c)	1399
1012	iron nail	1	T	Yunyang	Chongqing		N	N		(CQSWWJ and CQSYMJ 2010c)	1399
1013	iron ring	1	T	Yunyang	Chongqing	AT1⑤:15	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1399
1014	iron arrowhead	1/6	W	Yunyang	Chongqing	AT1③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1015	iron arrowhead	2/6	W	Yunyang	Chongqing	AT1④:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1016	iron arrowhead	3/6	W	Yunyang	Chongqing	SG2③:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1017	iron arrowhead	4/6	W	Yunyang	Chongqing	AT2④:11	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1018	iron arrowhead	5/6	W	Yunyang	Chongqing	SG2③:8	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1019	iron arrowhead	6/6	W	Yunyang	Chongqing	SG2②:7	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1020	iron sabre	2/2	W	Yunyang	Chongqing	AT1③:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWJ and CQSYMJ 2010c)	1399
1021	iron sabre	1/2	W	Yunyang	Chongqing	CH5:39	N	Y	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1399
1022	iron *fu*-pot	1	D	Zhong County	Chongqing	BM24:22	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1446
1023	iron object	1	U	Zhong County	Chongqing	BM24:29	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1446
1024	iron *fu*-pot	1	D	Zhong County	Chongqing	CM16:26	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1450
1025	iron sabre	1	W	Zhong County	Chongqing	CM16:24	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1450
1026	iron *fu*-pot	1	D	Zhong County	Chongqing	CM11:21	Y	N	202BC to 8AD (Western Han)	(CQSWWJ and CQSYMJ 2010c)	1453
1027	iron *fu*-pot	1	D	Zhong County	Chongqing	CM14:14	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1458
1028	iron sabre	1	W	Zhong County	Chongqing	CM14:31	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1458
1029	iron *fu*-pot	1	D	Zhong County	Chongqing	CM7:60	Y	N	25-220AD (Eastern Han)	(CQSWWJ and CQSYMJ 2010c)	1466
1030	iron sword with bronze guard	1	W	Zhong County	Chongqing	CM7:47	Y	Y	Eastern Han	(CQSWWJ and CQSYMJ 2010c)	1466

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1031	iron spinning wheel	1	T	Youyang	Chongqing	H41:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWKGS et al. 2009)	241
1032	iron axehead	1	T	Youyang	Chongqing	T33⑥:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWKGS et al. 2009)	242
1033	iron hook	1/4	T	Youyang	Chongqing	T52①:2	N	Y		(CQSWWKGS et al. 2009)	242
1034	iron hook	2/4	T	Youyang	Chongqing	T49②:1	N	Y		(CQSWWKGS et al. 2009)	242
1035	iron hook	3/4	T	Youyang	Chongqing	T11②:3	N	Y		(CQSWWKGS et al. 2009)	242
1036	iron nail	1	T	Youyang	Chongqing	T11②:2	N	Y		(CQSWWKGS et al. 2009)	242
1037	iron nail	1	T	Youyang	Chongqing	T49②:2	N	Y		(CQSWWKGS et al. 2009)	242
1038	iron nail	1	T	Youyang	Chongqing	T30②:2	N	Y		(CQSWWKGS et al. 2009)	242
1039	iron nail	1	T	Youyang	Chongqing	T52①:1	N	Y		(CQSWWKGS et al. 2009)	242
1040	iron nail	1	T	Youyang	Chongqing	T52③:1	N	Y	8th-3rd century BC	(CQSWWKGS et al. 2009)	242
1041	iron sicklehead	1	T	Youyang	Chongqing	G7:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWKGS et al. 2009)	242
1042	iron sicklehead	1	T	Youyang	Chongqing	T4②:2	N	Y		(CQSWWKGS et al. 2009)	242
1043	iron *fu*-pot	1	D	Youyang	Chongqing	IIH1:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWKGS et al. 2009)	243
1044	unidentified	1	U	Youyang	Chongqing	IIT6③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWKGS et al. 2009)	243
1045	unidentified	1	U	Youyang	Chongqing	T30②:1	N	Y		(CQSWWKGS et al. 2009)	243
1046	iron sabre	1	W	Youyang	Chongqing	H75:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWKGS et al. 2009)	243
1047	iron sword	1	W	Youyang	Chongqing	H75:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(CQSWWKGS et al. 2009)	243
1048	iron fish hook	1	T	Youyang	Chongqing	H26:2	N	Y	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2011)	231
1049	iron sabre	1	W	Youyang	Chongqing	G8:10	N	Y	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2011)	242
1050	u-shaped implement cap	1	T	Youyang	Chongqing	T4③:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWKGS and CQWHYCBHZX 2011)	384
1051	iron hoehead	1	T	Pengshui	Chongqing	G1①:3	N	Y	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2011)	391
1052	iron knife	1	U	Youyang	Chongqing	05YQM1:3	Y	N	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2011)	408
1053	iron knife	1	U	Youyang	Chongqing	05YQM2:6	Y	Y	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2011)	411
1054	iron object	1	U	Youyang	Chongqing	05YQM2:9	Y	N	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2011)	411

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1055	iron hoehead	1	T	Youyang	Chongqing	IIIT0803 ④:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWKGS and CQWHYCBHZX 2011)	435
1056	condensation jar lid	1/3	T	Youyang	Chongqing	T1②:2	N	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWKGS and CQWHYCBHZX 2011)	444
1057	iron sword	1	W	Hechuan	Chongqing	WM6:39	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	42
1058	iron axehead	1	T	Fengdu Yinbingdadao	Chongqing		N	N		(CQSWWKGS and CQWHYCBHZX 2010)	74
1059	iron *fu*-pot	1	D	Fengdu Yinbingdadao	Chongqing	M2:27	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	74
1060	iron knife	1	U	Fengdu Yinbingdadao	Chongqing		N	N		(CQSWWKGS and CQWHYCBHZX 2010)	74
1061	iron object	2	U	Fengdu Yinbingdadao	Chongqing		N	N		(CQSWWKGS and CQWHYCBHZX 2010)	74
1062	iron broadaxhead	1	W	Fengdu Yinbingdadao	Chongqing	M2:33	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	74
1063	iron *fu*-pot	1	D	Yunyang	Chongqing	M1:26	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	105
1064	ring-headed iron knife	1	T	Yunyang	Chongqing	M1:24	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	105
1065	iron sword	1	W	Yunyang	Chongqing	M1:1	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	105
1066	ring-headed iron knife	1	T	Yunyang	Chongqing	M4:32	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	127
1067	iron *fu*-pot	1	D	Yunyang	Chongqing	M5:28	Y	Y	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2010)	141
1068	iron *fu*-pot	1	D	Yunyang	Chongqing	M5:4	Y	Y	202BC to 8AD (Western Han)	(CQSWWKGS and CQWHYCBHZX 2010)	141
1069	iron sabre	1	W	Yunyang	Chongqing	M11:29	Y	Y	25-220AD (Eastern Han)	(CQSWWKGS and CQWHYCBHZX 2010)	159
1070	iron ring	1/6	T	Jiangjin	Chongqing	M1-2:3	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWKGS and CQWHYCBHZX 2010)	190
1071	iron ring	2/6	T	Jiangjin	Chongqing	M1-1:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(CQSWWKGS and CQWHYCBHZX 2010)	190
1072	iron nail	2	T	Yongchuan	Chongqing		N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWKGS and CQWHYCBHZX 2010)	260
1073	iron nail	1	T	Yongchuan	Chongqing		N	N	10th-19th century (Ming and Qing dynasty)	(CQSWWKGS and CQWHYCBHZX 2010)	263
1074	iron hook	1/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT14 ③:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	97
1075	iron arrowhead	3/5	W	Dongjing Tianjiaojiao	Guizhou	05ZTT10 ④:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	97
1076	iron arrowhead	5/5	W	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	97
1077	iron arrowhead	1/5	W	Dongjing Tianjiaojiao	Guizhou	05ZTT6:1	N	Y		(GZSWWKGYJS 2012)	97
1078	iron arrowhead	2/5	W	Dongjing Tianjiaojiao	Guizhou	05ZTT23:2	N	Y		(GZSWWKGYJS 2012)	97

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1079	iron arrowhead	4/5	W	Dongjing Tianjiaojiao	Guizhou	05ZTT12 ②:1	N	Y		(GZSWWKGYJS 2012)	97
1080	iron hook	3/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT10: 1	N	Y		(GZSWWKGYJS 2012)	98
1081	iron hook	2/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT11 ③:3	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	98
1082	iron hook	4/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT23 ③:8	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	98
1083	iron hook	5/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT22 ③:19	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	98
1084	iron sabre	1/29	W	Dongjing Tianjiaojiao	Guizhou	05ZTT22 ③:10	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	98
1085	iron sabre	2/29	W	Dongjing Tianjiaojiao	Guizhou	05ZTT5 ③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	98
1086	iron axehead	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTY1:4	N	Y		(GZSWWKGYJS 2012)	99
1087	iron knife	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ②:2	N	Y		(GZSWWKGYJS 2012)	99
1088	iron knife	1/2	T	Dongjing Tianjiaojiao	Guizhou	05ZTT22 ③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	99
1089	iron nail	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTT16 ④:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	99
1090	iron sabre	4/29	W	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ④:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	99
1091	iron sabre	1	W	Dongjing Tianjiaojiao	Guizhou	05ZTT6 ③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	99
1092	iron sabre	3/29	W	Dongjing Tianjiaojiao	Guizhou	05ZTY1:2 0	N	Y		(GZSWWKGYJS 2012)	99
1093	iron sabre	1	W	Dongjing Tianjiaojiao	Guizhou	05ZTT14 ②:3	N	Y		(GZSWWKGYJS 2012)	99
1094	iron sabre	5/29	W	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ②:1	N	Y		(GZSWWKGYJS 2012)	99
1095	iron sabre	6/29	W	Dongjing Tianjiaojiao	Guizhou	05ZTY1:2 1	N	Y		(GZSWWKGYJS 2012)	99
1096	iron chisel	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTT12 ③:10	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	100
1097	iron ring	1/2	T	Dongjing Tianjiaojiao	Guizhou	05ZTT11: 2	N	Y		(GZSWWKGYJS 2012)	100
1098	iron ring	2/2	T	Dongjing Tianjiaojiao	Guizhou	05ZTT10 ②:2	N	Y		(GZSWWKGYJS 2012)	100
1099	iron sword guard	1	W	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ③:3	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	100
1100	iron chisel	1/9	T	Dongjing Tianjiaojiao	Guizhou	05ZTT23 ②:1	N	Y		(GZSWWKGYJS 2012)	101
1101	iron chisel	2/9	T	Dongjing Tianjiaojiao	Guizhou	05ZTT14: 1	N	Y		(GZSWWKGYJS 2012)	101
1102	iron chisel	4/9	T	Dongjing Tianjiaojiao	Guizhou	05ZTT4 ②:2	N	Y		(GZSWWKGYJS 2012)	101

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1103	iron chisel	7/9	T	Dongjing Tianjiaojiao	Guizhou	05ZTT14 ④:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	101
1104	iron chisel	3/9	T	Dongjing Tianjiaojiao	Guizhou	05ZTT9 ③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	101
1105	iron chisel	5/9	T	Dongjing Tianjiaojiao	Guizhou	05ZTT4 ③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	101
1106	iron chisel	6/9	T	Dongjing Tianjiaojiao	Guizhou	05ZTT4 ③:17	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	101
1107	iron pliers	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTT19 ②:5	N	Y		(GZSWWKGYJS 2012)	101
1108	iron shovelhead	5/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT2 ④:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	103
1109	iron shovelhead	2/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT9 ③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	103
1110	iron shovelhead	4/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT22 ③:11	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	103
1111	iron shovelhead	1/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ②:1	N	Y		(GZSWWKGYJS 2012)	103
1112	iron shovelhead	3/5	T	Dongjing Tianjiaojiao	Guizhou	05ZTT19 ②:1	N	Y		(GZSWWKGYJS 2012)	103
1113	iron stick	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTY1:10	N	Y		(GZSWWKGYJS 2012)	103
1114	iron nail	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTT23 ③:1	N	Y		(GZSWWKGYJS 2012)	104
1115	iron net weight	1	T	Dongjing Tianjiaojiao	Guizhou	05ZTT7 ④:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	104
1116	object ear	2/2	D	Dongjing Tianjiaojiao	Guizhou	05ZTT10 ④:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	104
1117	object ear	1/2	D	Dongjing Tianjiaojiao	Guizhou	05ZTT17:8	N	Y		(GZSWWKGYJS 2012)	104
1118	unidentified	4	U	Dongjing Tianjiaojiao	Guizhou		N	N		(GZSWWKGYJS 2012)	104
1119	iron ferrule	1/2	W	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ④:14	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	104
1120	iron ferrule	2/2	W	Dongjing Tianjiaojiao	Guizhou	05ZTT20 ④:24	N	N	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	104
1121	iron nail	1/3	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 7③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	142
1122	iron rake tooth	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT ③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	142
1123	iron shovelhead	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 6③:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	142
1124	iron sicklehead	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 5②:3	N	Y		(GZSWWKGYJS 2012)	142
1125	iron chisel	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 8③:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	143
1126	iron knife	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT ③:11	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	143

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1127	iron sabre	1/7	W	Dongjing Xiaohekou	Guizhou	05ZZDNT 5③:3	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	143
1128	iron sabre	2/7	W	Dongjing Xiaohekou	Guizhou	05ZZDNT 8③:5	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	143
1129	iron sabre	3/7	W	Dongjing Xiaohekou	Guizhou	05ZZDNT 8③:13	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	143
1130	iron sabre	5/7	W	Dongjing Xiaohekou	Guizhou	05ZZDNT 8③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	143
1131	iron sabre	4/7	W	Dongjing Xiaohekou	Guizhou	05ZZDNT 9②:8	N	Y		(GZSWWKGYJS 2012)	143
1132	iron chisel	1/2	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 8③:9	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	144
1133	iron chisel	2/2	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 9③:1	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	144
1134	iron fork	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 9③:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	144
1135	iron hook	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 9③:6	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	144
1136	iron knife	1/5	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 8③:12	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	144
1137	iron nail	1/2	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 8:3	N	Y		(GZSWWKGYJS 2012)	144
1138	iron nail	2/2	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 7②:1	N	Y		(GZSWWKGYJS 2012)	144
1139	iron axehead	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 6③:3	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	145
1140	u-shaped implement cap	1	T	Dongjing Xiaohekou	Guizhou	05ZZDNT 6②:1	N	Y		(GZSWWKGYJS 2012)	145
1141	iron arrowhead	1	W	Dongjing Xiaohekou	Guizhou	05ZZDNT 6③:2	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(GZSWWKGYJS 2012)	145
1142	iron knife	1	T	Hezhangkel e	Guizhou	M281:19	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	256
1143	iron saw	1	T	Hezhangkel e	Guizhou	M281:22	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	256
1144	iron stand	1	D	Hezhangkel e	Guizhou	M281:18	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	257
1145	iron stick	1/2	T	Hezhangkel e	Guizhou	M281:21	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	257
1146	iron stick	2/2	T	Hezhangkel e	Guizhou	M281:24	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	257
1147	ring-headed iron knife	1	T	Hezhangkel e	Guizhou	M283:8	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	260
1148	iron sabre	1	W	Hezhangkel e	Guizhou	M283:7	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	260
1149	iron axehead	1	T	Hezhangkel e	Guizhou	M284:2	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	265
1150	u-shaped implement cap	1	T	Hezhangkel e	Guizhou	M284:3	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	265

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1151	unidentified	1	U	Hezhangkele	Guizhou	M284:1	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	265
1152	iron sabre	1	W	Hezhangkele	Guizhou	M284:6	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	265
1153	ring-headed iron knife	1/2	T	Hezhangkele	Guizhou	M284:4	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	266
1154	ring-headed iron knife	2/2	T	Hezhangkele	Guizhou	M284:23	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	266
1155	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M264:4	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	268
1156	iron knife	1	T	Hezhangkele	Guizhou	M269:2	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	273
1157	iron sword with bronze handle	1	W	Hezhangkele	Guizhou	M273:6	Y	Y	Warring States(late)-Western Han	(GZSWWKGYJS 2008)	283
1158	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M273:5	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	284
1159	iron knife	2/2	T	Hezhangkele	Guizhou	M274:93	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	290
1160	iron knife	1/2	T	Hezhangkele	Guizhou	M274:94	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	290
1161	ring-headed iron knife	1/2	T	Hezhangkele	Guizhou	M274:41	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	290
1162	ring-headed iron knife	2/2	T	Hezhangkele	Guizhou	M274:3	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	290
1163	iron dagger-axehead with bronze socket	1	W	Hezhangkele	Guizhou	M274:91	Y	N	Warring States(late)-Western Han	(GZSWWKGYJS 2008)	290
1164	iron sword with bronze handle	1	W	Hezhangkele	Guizhou	M274:92	Y	Y	Warring States(late)-Western Han	(GZSWWKGYJS 2008)	290
1165	iron knife	1	T	Hezhangkele	Guizhou	M275:1	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	295
1166	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M277:6	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	297
1167	iron sabre	1	W	Hezhangkele	Guizhou	M286:1	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	299
1168	iron sabre	1	W	Hezhangkele	Guizhou	M287:1	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	301
1169	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M296:7	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	306
1170	iron nail	1/2	T	Hezhangkele	Guizhou	M298:8	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	309
1171	iron nail	2/2	T	Hezhangkele	Guizhou	M298:9	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	309
1172	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M300:1	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	312
1173	iron sabre	1	W	Hezhangkele	Guizhou	M311:1	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	325
1174	iron sword with bronze handle	1	W	Hezhangkele	Guizhou	M324:1	Y	Y	Warring States(late)-Western Han	(GZSWWKGYJS 2008)	332

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1175	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M330:3	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	336
1176	iron sword	1	W	Hezhangkele	Guizhou	M331:2	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	339
1177	iron mattockhead	1	T	Hezhangkele	Guizhou	M338:2	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	344
1178	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M338:3	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	344
1179	ring-headed iron knife	1	T	Hezhangkele	Guizhou	M342:47	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	354
1180	iron sheet	1	U	Hezhangkele	Guizhou	M342:48	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	354
1181	ring-headed iron knife	1	U	Hezhangkele	Guizhou	M351:3	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	361
1182	iron mattockhead	1	T	Hezhangkele	Guizhou	M360:1	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	364
1183	ring-pommeled iron sword	1	W	Hezhangkele	Guizhou	M359:1	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	364
1184	iron stick	1	T	Hezhangkele	Guizhou	M365:4	Y	Y	8th-3rd century BC	(GZSWWKGYJS 2008)	369
1185	iron sword	1	W	Hezhangkele	Guizhou	collected area II	N	Y		(GZSWWKGYJS 2008)	372
1186	ring-headed iron knife	1/2	T	Hezhangkele	Guizhou	collected from M300 filling soil	Y	Y		(GZSWWKGYJS 2008)	373
1187	ring-headed iron knife	2/2	T	Hezhangkele	Guizhou	collected from M320 filling soil	Y	Y		(GZSWWKGYJS 2008)	373
1188	iron axehead	2/6	T	Hezhangkele	Guizhou	M176:23	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1189	iron axehead	1/6	T	Hezhangkele	Guizhou	M16:12	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1190	iron axehead	1	T	Hezhangkele	Guizhou	M13:5	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1191	iron chisel	1/4	T	Hezhangkele	Guizhou	M180:2	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1192	iron chisel	1/2	T	Hezhangkele	Guizhou	M13:6	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1193	iron chisel	1	T	Hezhangkele	Guizhou	M11:25	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1194	iron hammerhead	1	T	Hezhangkele	Guizhou	M11:6	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1195	iron mattockhead	1	T	Hezhangkele	Guizhou	M16:11	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1196	iron pliers	1/2	T	Hezhangkele	Guizhou	M178:10	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1197	iron scissors	2	T	Hezhangkele	Guizhou	M	Y	N		(GZSWWKGYJS 2008)	440
1198	iron shovelhead	2/3	T	Hezhangkele	Guizhou	M11:11	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1199	iron shovelhead	1/3	T	Hezhangkele	Guizhou	M181:6	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1200	ring-headed iron knife	1/51	T	Hezhangkele	Guizhou	M13:4	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1201	iron arrowhead	1/2	W	Hezhangkele	Guizhou	M10:23	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1202	iron sabre	21	W	Hezhangkele	Guizhou	M	Y	N		(GZSWWKGYJS 2008)	440
1203	iron spearhead	1/4	W	Hezhangkele	Guizhou	M8:62	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1204	iron spearhead	2/4	W	Hezhangkele	Guizhou	M8:63	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	440
1205	iron sword	15	W	Hezhangkele	Guizhou	M	Y	N		(GZSWWKGYJS 2008)	440
1206	iron *fu*-pot	1/8	D	Hezhangkele	Guizhou	M178:18	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	442
1207	iron *fu*-pot	2/8	D	Hezhangkele	Guizhou	M174:24	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	442
1208	iron lamp	1	D	Hezhangkele	Guizhou	M10:55	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	442
1209	iron stand	1/4	D	Hezhangkele	Guizhou	M10:39	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	442
1210	iron mattockhead	1	T	Hezhangkele	Guizhou	M156:1	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	453
1211	iron ploughshare cap	1	T	Hezhangkele	Guizhou	M153:2	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	453
1212	u-shaped implement cap	1/11	T	Hezhangkele	Guizhou	M153:2	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	453
1213	iron belt hook	1/6	A	Hezhangkele	Guizhou	M194:4	Y	N	8th-3rd century BC	(GZSWWKGYJS 2008)	454
1214	iron *fu*-pot	1/11	D	Hezhangkele	Guizhou	M58:1	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	454
1215	iron stand	1	D	Hezhangkele	Guizhou	M126:3	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	454
1216	iron stick	1/11	T	Hezhangkele	Guizhou	M46:5	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	454
1217	ring-headed iron knife	1/47	T	Hezhangkele	Guizhou	M161:3	Y	N	8th-3rd century BC	(GZSWWKGYJS 2008)	454
1218	iron sword with bronze handle	1/7	W	Hezhangkele	Guizhou	M25:3	Y	Y	Warring States(late)	(GZSWWKGYJS 2008)	454
1219	iron sword with bronze handle	2/7	W	Hezhangkele	Guizhou	M194:2	Y	Y	Warring States(late)	(GZSWWKGYJS 2008)	454
1220	iron sword with bronze handle	3/7	W	Hezhangkele	Guizhou	M104:2	Y	Y		(GZSWWKGYJS 2008)	454
1221	iron sabre	1/13	W	Hezhangkele	Guizhou	M16:2	Y	N	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	454
1222	iron sword	1/16	W	Hezhangkele	Guizhou	M146:1	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	454

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1223	iron sword	2/16	W	Hezhangkele	Guizhou	M46:2	Y	Y	202BC to 8AD (Western Han)	(GZSWWKGYJS 2008)	454
1224	iron ferrule	1	W	Laolongtou	Sichuan	M4:21	Y	Y	202BC to 8AD (Western Han)	(CDSWWKGYJS and LSYZZZZBWG 2009)	15
1225	iron spearhead	1	W	Laolongtou	Sichuan	M4:20	Y	Y	202BC to 8AD (Western Han)	(CDSWWKGYJS and LSYZZZZBWG 2009)	15
1226	iron weapon with bronze socket	1	W	Laolongtou	Sichuan	M6:51	Y	Y	early Western Han to mid Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	25
1227	iron sword with bronze handle	1	W	Laolongtou	Sichuan	M9:5	Y	Y	early Western Han to mid Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	31
1228	iron spearhead	1	W	Laolongtou	Sichuan	M11:6	Y	Y	202BC to 8AD (Western Han)	(CDSWWKGYJS and LSYZZZZBWG 2009)	36
1229	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:604	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1230	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:327	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1231	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:694	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1232	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:491	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1233	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:492	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1234	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:95	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1235	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:960	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1236	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:695	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1237	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:88	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	160
1238	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:57	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	162
1239	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:376	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	162
1240	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:326	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	162
1241	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:121	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	162
1242	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:529	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	162
1243	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:601	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	162
1244	iron sword with bronze handle	1	W	Yanyuan	Sichuan	GC:693	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	162
1245	iron spearhead with bronze socket	1	W	Yanyuan	Sichuan	GC:174	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	163
1246	iron knife with bronze handle	1	T	Yanyuan	Sichuan	GC:698	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	164

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1247	iron knife with bronze handle	1	T	Yanyuan	Sichuan	GC:699	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	164
1248	iron knife with bronze handle	1	T	Yanyuan	Sichuan	GC:697	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	164
1249	iron knife with bronze handle	1	T	Yanyuan	Sichuan	GC:700	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	164
1250	iron knife with bronze handle	1	T	Yanyuan	Sichuan	GC:420	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	164
1251	iron halberdhead with bronze socket	1	W	Yanyuan	Sichuan	GC:65	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	164
1252	iron spearhead with bronze socket	1	W	Yanyuan	Sichuan	GC:322	N	Y	Western Han	(CDSWWKGYJS and LSYZZZZBWG 2009)	164
1253	iron axehead	1	T	Yanyuan	Sichuan	GC:701	N	Y	202BC to 8AD (Western Han)	(CDSWWKGYJS and LSYZZZZBWG 2009)	165
1254	iron axehead	1	T	Yanyuan	Sichuan	GC:702	N	Y	202BC to 8AD (Western Han)	(CDSWWKGYJS and LSYZZZZBWG 2009)	165
1255	iron ox	1	O	Tomb of Wangjian	Sichuan	M	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(Feng 1964)	65
1256	iron pig	1	O	Tomb of Wangjian	Sichuan	M	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(Feng 1964)	65
1257	iron sword with bronze handle	1	W	Moutuo	Sichuan	M1:148	Y	N	late Warring State	(MXQZBWG et al. 2012)	13
1258	iron sword with bronze handle	1	W	Moutuo	Sichuan	M1:147	Y	N	late Warring State	(MXQZBWG et al. 2012)	13
1259	iron adze	1	T	Pengshan	Sichuan	M668:4	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	92
1260	iron knife	11	U	Pengshan	Sichuan	M	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	92
1261	iron spearhead	1	W	Pengshan	Sichuan	M677	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	92
1262	iron *fu*-pot	1	D	Pengshan	Sichuan	M684:26	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	93
1263	iron spoon	1	D	Pengshan	Sichuan	M900:06	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	93
1264	iron shovelhead	1	T	Pengshan	Sichuan	M656:1	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	93
1265	squared iron pot	1	D	Pengshan	Sichuan	M900:07	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	93
1266	iron nail	1	T	Pengshan	Sichuan	M901	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	94
1267	iron nail	1	T	Pengshan	Sichuan	M900:43	Y	Y	25-220AD (Eastern Han)	(NJBWY 1991)	94
1268	iron object	1	U	Pengshan	Sichuan	M550:46	Y	N	25-220AD (Eastern Han)	(NJBWY 1991)	94
1269	iron object	1	U	Pengshan	Sichuan		N	N	25-220AD (Eastern Han)	(NJBWY 1991)	94
1270	iron axehead	numerous	T	Baxian Dongsunba	Sichuan	M55:5	Y	Y		(SCSBWG 1960)	64

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1271	iron knife with bronze handle	numerous	T	Baxian Dongsunba	Sichuan	M	Y	N		(SCSBWG 1960)	64
1272	iron *mou*	numerous	D	Baxian Dongsunba	Sichuan	M61	Y	N		(SCSBWG 1960)	64
1273	iron knife	numerous	U	Baxian Dongsunba	Sichuan	M	Y	Y		(SCSBWG 1960)	64
1274	iron spearhead	numerous	W	Baxian Dongsunba	Sichuan	M61	Y	N		(SCSBWG 1960)	64
1275	iron mattockhead	numerous	T	Baxian Dongsunba	Sichuan	M	Y	N		(SCSBWG 1960)	65
1276	iron arrowhead	numerous	W	Baxian Dongsunba	Sichuan	M	Y	N		(SCSBWG 1960)	65
1277	iron sabre	numerous	W	Baxian Dongsunba	Sichuan	M	Y	N		(SCSBWG 1960)	65
1278	iron object	1	U	Xuanhan Luojiaba	Sichuan	M17:15	Y	N	8th-3rd century BC	(SCSWWKGYJY et al. 2015)	85
1279	iron object	1	U	Xuanhan Luojiaba	Sichuan	M21:5	Y	N	8th-3rd century BC	(SCSWWKGYJY et al. 2015)	94
1280	iron object	1	U	Xuanhan Luojiaba	Sichuan	M32:16	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY et al. 2015)	133
1281	iron object	1	U	Xuanhan Luojiaba	Sichuan	M32:15	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY et al. 2015)	133
1282	iron object	1	U	Xuanhan Luojiaba	Sichuan	M32:12	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY et al. 2015)	133
1283	iron object	1	U	Xuanhan Luojiaba	Sichuan	M32:18	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY et al. 2015)	133
1284	iron knife with bronze pommel	1	U	Xuanhan Luojiaba	Sichuan	M32:10	Y	N	mid Western Han	(SCSWWKGYJY et al. 2015)	133
1285	iron sword with bronze handle	1	W	Xuanhan Luojiaba	Sichuan	M32:11	Y	N	mid Western Han	(SCSWWKGYJY et al. 2015)	133
1286	iron bracelet	1	A	Xuanhan Luojiaba	Sichuan	M46:2	Y	N	8th-3rd century BC	(SCSWWKGYJY et al. 2015)	220
1287	iron ring	1	D	Xuanhan Luojiaba	Sichuan	M62:3	Y	N	8th-3rd century BC	(SCSWWKGYJY et al. 2015)	274
1288	iron nail	1	T	Xuanhan Luojiaba	Sichuan	M65-1:22	Y	N	8th-3rd century BC	(SCSWWKGYJY et al. 2015)	287
1289	iron *mou*	1	D	Shifang Chengguan	Sichuan	M67	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	141
1290	iron ploughshare	1	T	Shifang Chengguan	Sichuan	M85	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	146
1291	iron sicklehead	1	T	Shifang Chengguan	Sichuan	M20	Y	N	8th-3rd century BC	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	201
1292	iron mattockhead	1	T	Shifang Chengguan	Sichuan	M21	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	204
1293	iron ploughshare	1	T	Shifang Chengguan	Sichuan	M21:6	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	204
1294	iron sicklehead	1	T	Shifang Chengguan	Sichuan	M21	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	204

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1295	iron knife	2	U	Shifang Chengguan	Sichuan	M22	Y	N	8th-3rd century BC	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	208
1296	iron tri-pot	1	D	Shifang Chengguan	Sichuan	M53	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	250
1297	unidefined object	1	U	Shifang Chengguan	Sichuan	M53	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2006)	250
1298	iron chisel	1	T	Zhongjiang Taliangzi	Sichuan	M3:28	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY, DYSWWKGYJS et al. 2008)	91
1299	ring-headed iron knife	1	T	Guanghan Erlonggang	Sichuan	M2:50	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	32
1300	iron sword	1	W	Guanghan Erlonggang	Sichuan	M2:40	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	32
1301	ring-headed iron knife	1	U	Guanghan Erlonggang	Sichuan	M23:6	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	35
1302	iron sword	1	W	Guanghan Erlonggang	Sichuan	M23:5	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	35
1303	iron axehead	1	T	Guanghan Erlonggang	Sichuan	M42:10	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	45
1304	iron ploughshare cap	1	T	Guanghan Erlonggang	Sichuan	M12:26	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	52
1305	iron sicklehead	1	T	Guanghan Erlonggang	Sichuan	M12:3	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	52
1306	iron sword	1	W	Guanghan Erlonggang	Sichuan	M12:19	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	52
1307	iron sabre	1	W	Guanghan Erlonggang	Sichuan	M20:1	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	56
1308	iron object	1	U	Guanghan Erlonggang	Sichuan	M22:15	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	61
1309	iron sword	1	W	Guanghan Erlonggang	Sichuan	M22:14	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	61
1310	iron sabre	1	W	Guanghan Erlonggang	Sichuan	M30:20	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	65
1311	iron sword	1	W	Guanghan Erlonggang	Sichuan	M4:32	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	84
1312	iron knife	1	U	Guanghan Erlonggang	Sichuan	M21:13	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	88
1313	iron knife	1	U	Guanghan Erlonggang	Sichuan	M21:16	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	88
1314	iron sword	1	W	Guanghan Erlonggang	Sichuan	M21:1	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	88
1315	iron dagger	1	W	Guanghan Erlonggang	Sichuan	M26:8	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	104
1316	iron object	1	U	Guanghan Erlonggang	Sichuan	M27:12	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	107
1317	iron chisel	1	T	Guanghan Erlonggang	Sichuan	M01:16	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	115
1318	iron sword	1	W	Guanghan Erlonggang	Sichuan	M01:014	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	115

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1319	iron sword	1	W	Guanghan Erlonggang	Sichuan	M01:015	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	115
1320	ring-pommeled iron sword	1	W	Guanghan Erlonggang	Sichuan	M9:42	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	126
1321	iron sword	1	W	Guanghan Erlonggang	Sichuan	M39	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	131
1322	iron sword	1	W	Guanghan Erlonggang	Sichuan	M24:5	Y	N	25-220AD (Eastern Han)	(SCSWWKGYJY and GHSWWBHGLS 2014)	135
1323	iron knife	1/4	T	Anning Hewanao	Sichuan	M1:11	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1324	iron knife	2/4	T	Anning Guluqiao	Sichuan	M1:3	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1325	iron knife	3/4	T	Anning Hewanao	Sichuan	M1:8	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1326	iron knife	2/9	T	Anning Huishuitang	Sichuan	M1:4	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1327	iron knife	3/9	T	Anning Guluqiao	Sichuan	M1:9	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1328	iron knife	4/9	T	Anning Xiaohuashan	Sichuan	M1:21	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1329	iron mattockhead	1	T	Anning Xijiao	Sichuan	M1:34	Y	N	8th-3rd century BC	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1330	iron ring	1	D	Anning Lakesihe	Sichuan	M8:19	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1331	iron ring	1	D	Anning Lakesihe	Sichuan	M6:29	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1332	iron sabre	1/9	W	Anning Huishuitang	Sichuan	M1:3	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1333	iron sabre	5/9	W	Anning A'rong	Sichuan	M3:1	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	123
1334	iron sword with bronze handle	1	W	Anning Xijiao	Sichuan	M1:46	Y	N	mid Warring State period to mid Western Han	(SCSWWKGYJY, LSYZZZZBWG et al. 2006)	131
1335	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:71	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1336	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:72	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1337	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:73	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1338	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:74	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1339	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:114	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1340	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:115	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1341	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:116	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1342	iron adze	1	T	Mianyang Shuangbaoshan	Sichuan	M1:117	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1343	iron adze	1	T	Mianyang Shuangbao shan	Sichuan	M1:118	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1344	iron axehead	1	T	Mianyang Shuangbao shan	Sichuan	M1:75	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1345	iron armour lamella	1	W	Mianyang Shuangbao shan	Sichuan	M1:78	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	31
1346	iron sicklehead	1	T	Mianyang Shuangbao shan	Sichuan	M1:76	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	32
1347	iron sicklehead	1	T	Mianyang Shuangbao shan	Sichuan	M1:77	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	32
1348	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:149	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1349	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:150	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1350	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:342	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1351	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:343	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1352	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:389	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1353	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:391	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1354	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:444	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1355	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:445	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1356	iron lamp	1	D	Mianyang Shuangbao shan	Sichuan	M2:459	Y	N	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	70
1357	iron adze	1	T	Mianyang Shuangbao shan	Sichuan	M2:363	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1358	iron adze	1	T	Mianyang Shuangbao shan	Sichuan	M2:369	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1359	iron adze	1	T	Mianyang Shuangbao shan	Sichuan	M2:365	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1360	iron axehead	1	T	Mianyang Shuangbao shan	Sichuan	M2:361	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1361	iron object	1	U	Mianyang Shuangbao shan	Sichuan	M2:371	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1362	iron object	1	U	Mianyang Shuangbao shan	Sichuan	M2:362	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1363	u-shaped implement cap	1	T	Mianyang Shuangbao shan	Sichuan	M2:367	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1364	u-shaped implement cap	1	T	Mianyang Shuangbao shan	Sichuan	M2:368	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1365	u-shaped implement cap	1	T	Mianyang Shuangbao shan	Sichuan	M2:364	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94
1366	u-shaped implement cap	1	T	Mianyang Shuangbao shan	Sichuan	M2:366	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	94

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1367	ring-headed iron knife	1	U	Mianyang Shuangbao shan	Sichuan	M2:698	Y	Y	202BC to 8AD (Western Han)	(SCSWWKGYJY and MYBWG 2006)	140
1368	iron *fu*-pot	1	D	Zijingwan	Sichuan	M1:5	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	73
1369	iron scissors	1	T	Zijingwan	Sichuan	M1:4	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	73
1370	iron shovelhead	1	T	Zijingwan	Sichuan	M1:6	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	73
1371	iron axehead	1	T	Zijingwan	Sichuan	M2:9	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1372	iron chisel	1	T	Zijingwan	Sichuan	M2:15	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1373	iron chisel	1	T	Zijingwan	Sichuan	M2:8	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1374	iron knife	1	T	Zijingwan	Sichuan	M2:16	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1375	iron object	1	U	Zijingwan	Sichuan	M2:10	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1376	iron object	1	U	Zijingwan	Sichuan	M2:11	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1377	iron object	1	U	Zijingwan	Sichuan	M2:14	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1378	iron arrowhead	1	W	Zijingwan	Sichuan	M2:12	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1379	iron arrowhead	1	W	Zijingwan	Sichuan	M2:13	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	78
1380	iron mattockhead	1	T	Zijingwan	Sichuan	M13:27	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	139
1381	iron object	1	U	Zijingwan	Sichuan	M13:26	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	139
1382	iron chisel	1	T	Bolinpo	Sichuan	M1:1	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	179
1383	iron sword with bronze guard	1	W	Bolinpo	Sichuan	M1:6	Y	Y	mid Eastern Han	(SCSWWKGYJY et al. 2007)	179
1384	iron *fu*-pot	1	D	Bolinpo	Sichuan	M2:5	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	189
1385	ring-headed iron knife	1	U	Bolinpo	Sichuan	M2:32	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	189
1386	iron sabre	1	W	Bolinpo	Sichuan	M2:10	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	189
1387	iron chisel	1	T	Bolinpo	Sichuan	M5:1	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	246
1388	iron chisel	1	T	Bolinpo	Sichuan	M5:2	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	246
1389	iron tri-pot with handle	1	D	Bolinpo	Sichuan	M5:12	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	246
1390	iron arrowhead	1	W	Bolinpo	Sichuan	M5:7	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	246

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1391	ring-pommeled iron sword	1	W	Hujiawan	Sichuan	M1:6	Y	Y	25-220AD (Eastern Han)	(SCSWWKGYJY et al. 2007)	264
1392	iron spearhead	1	W	Shehong Tai'an	Sichuan	07TTT1 ②:4	N	N	10th-19th century (Ming and Qing dynasty)	(SCSWWKGYJY, SNSCBWG et al. 2008)	25
1393	iron belt hook	1	A	Luhuogalaz ong	Sichuan	Y1:2:7	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(SCSWWKGYJY 2013)	39
1394	iron chisel	1	T	Luhuogalaz ong	Sichuan	Y1:2:8	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(SCSWWKGYJY 2013)	39
1395	iron arrowhead	1	W	Luhuogalaz ong	Sichuan	Y1:2:4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(SCSWWKGYJY 2013)	39
1396	iron sword with bronze handle	1	W	Baoxing	Sichuan	GC	N	Y		(SCSWWKGYJY 2013)	94
1397	unidefined object	num ero us	U	Leshan Pengshan	Sichuan	M	Y	N	25-220AD (Eastern Han)	(Tang 1993)	121
1398	iron bar	1	U	Chaxiutang	Xizang	03QZCXT J4:32	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(XZZZQWWJ et al. 2005)	142
1399	iron strap	1	U	Chaxiutang	Xizang	QZCXTJ1 :4	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(XZZZQWWJ et al. 2005)	142
1400	iron strap	1	U	Chaxiutang	Xizang	03QZCXT J1:5	N	Y	221-960AD (Wei and Jin to the Five dynasties)	(XZZZQWWJ et al. 2005)	142
1401	iron knife	1	T	Piyangdong ga	Xizang	97ZPDG C:11	N	Y		(SCDX and XZZZQWWJ 2008)	185
1402	iron sabre scabbard	1	W	Piyangdong ga	Xizang	97ZPII26: 6-1	N	Y		(SCDX and XZZZQWWJ 2008)	185
1403	horse decoration	1	O	Piyangdong ga	Xizang	97ZPII26: 6-2	N	Y		(SCDX and XZZZQWWJ 2008)	186
1404	horse decoration	1	O	Piyangdong ga	Xizang	97ZPII26: 6-3	N	Y		(SCDX and XZZZQWWJ 2008)	186
1405	iron armour lammlla	num ero us	W	Piyangdong ga	Xizang		N	N		(SCDX and XZZZQWWJ 2008)	186
1406	iron armour lammlla	1	W	Piyangdong ga	Xizang	97ZPII26: 4	N	Y		(SCDX and XZZZQWWJ 2008)	186
1407	iron armour lammlla	1	W	Piyangdong ga	Xizang	99ZDIIIF3 :4	N	Y		(SCDX and XZZZQWWJ 2008)	186
1408	ring-pommeled iron sword	1	W	Piyangdong ga	Xizang	PGM1:1	Y	Y		(SCDX and XZZZQWWJ 2008)	230
1409	bronze mirror with iron handle	1	D	Lasaqugon g	Xizang	M203:2	Y	Y	8th Century BC	(ZGSHKXYKGYJS and XZZZQWWJ 1999)	208
1410	iron sicklehead	1	T	Cang'er Malong	Yunnan		N	N	221-960AD (Wei and Jin to the Five dynasties)	(Wu et al. 1942)	39
1411	iron sheet	1	U	Cang'er Malong	Yunnan		N	N	221-960AD (Wei and Jin to the Five dynasties)	(Wu et al. 1942)	39
1412	iron nail	1	T	Baiyun Jiazhi	Yunnan		N	N	221-960AD (Wei and Jin to the Five dynasties)	(Wu et al. 1942)	65
1413	iron sicklehead	1	T	Baiyun Jiazhi	Yunnan		N	N	221-960AD (Wei and Jin to the Five dynasties)	(Wu et al. 1942)	65
1414	iron arrowhead	1	W	Baiyun Jiazhi	Yunnan		N	N	221-960AD (Wei and Jin to the Five dynasties)	(Wu et al. 1942)	65

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1415	iron adze	1	T	Jinning Shizhaishan	Yunnan	M8:1	Y	Y	202BC to 8AD (Western Han)	(YNSBWG 1959)	107
1416	iron axehead	1	T	Jinning Shizhaishan	Yunnan	M12:82	Y	Y	202BC to 8AD (Western Han)	(YNSBWG 1959)	107
1417	iron axehead with bronze body or socket	1	T	Jinning Shizhaishan	Yunnan	M13:213	Y	N	Western Han(mid)	(YNSBWG 1959)	107
1418	iron axehead with bronze body or socket	1	T	Jinning Shizhaishan	Yunnan	M13:345	Y	Y	Western Han(mid)	(YNSBWG 1959)	107
1419	iron knife	1/6	U	Jinning Shizhaishan	Yunnan	M8:4	Y	N	202BC to 8AD (Western Han)	(YNSBWG 1959)	107
1420	iron knife	2/6	U	Jinning Shizhaishan	Yunnan	M10:34	Y	N	202BC to 8AD (Western Han)	(YNSBWG 1959)	107
1421	iron knife	3/6	U	Jinning Shizhaishan	Yunnan	M13:84	Y	N	202BC to 8AD (Western Han)	(YNSBWG 1959)	107
1422	iron spearhead with bronze handle	1/17	W	Jinning Shizhaishan	Yunnan	M12:23	Y	Y	Western Han(mid)	(YNSBWG 1959)	107
1423	iron halberdhead with bronze socket	1/2	W	Jinning Shizhaishan	Yunnan	M6:81	Y	Y	Western Han(mid)	(YNSBWG 1959)	108
1424	iron spearhead with bronze handle	2/17	W	Jinning Shizhaishan	Yunnan	M12:31	Y	Y	Western Han(mid)	(YNSBWG 1959)	108
1425	iron spearhead	1/17	W	Jinning Shizhaishan	Yunnan	M13:140	Y	Y	202BC to 8AD (Western Han)	(YNSBWG 1959)	108
1426	iron sword	1/21	W	Jinning Shizhaishan	Yunnan	M6:33	Y	Y	202BC to 8AD (Western Han)	(YNSBWG 1959)	108
1427	iron sword	2/21	W	Jinning Shizhaishan	Yunnan	M4:51	Y	Y	202BC to 8AD (Western Han)	(YNSBWG 1959)	108
1428	iron sword	3/21	W	Jinning Shizhaishan	Yunnan	M7:39	Y	Y	202BC to 8AD (Western Han)	(YNSBWG 1959)	108
1429	iron sword with bronze handle	1/48	W	Jinning Shizhaishan	Yunnan	M22:52	Y	Y	Western Han(mid)	(YNSBWG 1959)	108
1430	iron sword with bronze handle	2/48	W	Jinning Shizhaishan	Yunnan	M6:37	Y	Y	Western Han(mid)	(YNSBWG 1959)	108
1431	iron sword with bronze handle	3/48	W	Jinning Shizhaishan	Yunnan	M3:55	Y	Y	Western Han(mid)	(YNSBWG 1959)	108
1432	iron bracelet	1	A	Heqing	Yunnan	M17g:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1433	iron bracelet	1	A	Heqing	Yunnan	M609:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1434	iron bracelet	1	A	Heqing	Yunnan	M271:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1435	iron bracelet	1	A	Heqing	Yunnan	M1215:1	Y	Y		(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1436	iron knife	1	T	Heqing	Yunnan	M797:1	Y	Y		(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1437	iron knife	1	T	Heqing	Yunnan	M540:5	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1438	iron scissors	1	T	Heqing	Yunnan	M2002:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1439	iron sicklehead	1	T	Heqing	Yunnan	M1975:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1440	iron sicklehead	1	T	Heqing	Yunnan	M1959:1	Y	Y		(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1441	iron arrowhead	1	W	Heqing	Yunnan	M203:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	151
1442	iron bracelet	1	A	Heqing	Yunnan	M912:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1443	iron bracelet	1	A	Heqing	Yunnan	M2360b:1	Y	Y		(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1444	iron lock	1	D	Heqing	Yunnan	M2353a:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1445	iron nail	1	T	Heqing	Yunnan	M538:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1446	iron sheet	1	U	Heqing	Yunnan	M404:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1447	iron object	1	U	Heqing	Yunnan	M2531:1	Y	Y	221-960AD (Wei and Jin to the Five dynasties)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1448	iron sheet	1	U	Heqing	Yunnan	M1443:1	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1449	iron sheet	1	U	Heqing	Yunnan	M549:1	Y	Y		(YNSWWKGYJS, DLBZZZZWWGLS et al. 2008)	153
1450	iron spearhead with bronze socket	1/3	W	Qujing	Yunnan	M26:2	Y	Y	Western Han(late)	(YNSWWKGYJS 2003)	59
1451	iron spearhead with bronze socket	2/3	W	Qujing	Yunnan	M17:3	Y	Y	Western Han(late)	(YNSWWKGYJS 2003)	59
1452	iron sword	1	W	Qujing	Yunnan	M28:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	107
1453	iron sword	1	W	Qujing	Yunnan	M69:24	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	107
1454	iron belt hook	1	A	Qujing	Yunnan	M69:29	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1455	iron axehead	2/9	T	Qujing	Yunnan	M23:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1456	iron axehead	3/9	T	Qujing	Yunnan	M24:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1457	iron axehead	4/9	T	Qujing	Yunnan	M6:7	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1458	iron axehead	1/9	T	Qujing	Yunnan	M51:7	Y	Y		(YNSWWKGYJS 2003)	109
1459	iron chisel	1/7	T	Qujing	Yunnan	M27:7	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1460	iron chisel	2/7	T	Qujing	Yunnan	M23:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1461	horse bit	1/2	O	Qujing	Yunnan	M69:16	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1462	iron *mou*	1/3	D	Qujing	Yunnan	M49:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1463	iron arrowhead	1	W	Qujing	Yunnan	M46:4	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1464	iron spearhead	1/5	W	Qujing	Yunnan	M28:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1465	iron spearhead	2/5	W	Qujing	Yunnan	M27:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1466	ring-pommeled iron sword	1/20	W	Qujing	Yunnan	M26:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1467	ring-pommeled iron sword	1/11	W	Qujing	Yunnan	M26:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2003)	109
1468	iron knocker	1	D	Qujing	Yunnan	C242:3	N	N	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS 2003)	146
1469	iron nail	1/67	T	Qujing	Yunnan	C25:3	N	N	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS 2003)	146
1470	iron sheet	139	U	Qujing	Yunnan		N	N		(YNSWWKGYJS 2003)	146
1471	bronze knife with iron blade	1	T	Qujing	Yunnan	GC:91	N	Y		(YNSWWKGYJS 2003)	182
1472	bronze knife with iron blade	1	T	Qujing	Yunnan	GC:18	N	Y		(YNSWWKGYJS 2003)	182
1473	iron spearhead with bronze socket	1	W	Qujing	Yunnan	GC:31	N	Y		(YNSWWKGYJS 2003)	182
1474	ring-headed iron knife	1	U	Qujing	Yunnan	GC:35	N	Y		(YNSWWKGYJS 2003)	183
1475	iron spearhead with bronze socket	1	W	Qujing	Yunnan	M55:4	Y	Y	Western Han(late)	(YNSWWKGYJS 2006)	27
1476	iron spearhead with bronze socket	1	W	Qujing	Yunnan	M33:1	Y	Y	Western Han(late)	(YNSWWKGYJS 2006)	27
1477	iron sword with bronze handle	1	W	Qujing	Yunnan	M181:6	Y	Y	Western Han(late)	(YNSWWKGYJS 2006)	27
1478	ring-headed iron knife	1/8	U	Qujing	Yunnan	M133:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	34
1479	ring-headed iron knife	2/8	U	Qujing	Yunnan	M40:4	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	34
1480	ring-headed iron knife	3/8	U	Qujing	Yunnan	M55:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	34
1481	ring-headed iron knife	4/8	U	Qujing	Yunnan	M48:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	34
1482	iron dagger-axehead with bronze socket	1	W	Qujing	Yunnan	M181:18	Y	N	Western Han(late)	(YNSWWKGYJS 2006)	34
1483	iron spearhead	1	W	Qujing	Yunnan	M181:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	34

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1484	iron axehead	1	T	Qujing	Yunnan	M20:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	35
1485	iron axehead	1	T	Qujing	Yunnan	GC:14	N	Y		(YNSWWKGYJS 2006)	35
1486	iron chisel	1	T	Qujing	Yunnan	M20:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	35
1487	ring-headed iron knife	5/8	U	Qujing	Yunnan	M20:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	35
1488	iron *fu*-pot	1	D	Qujing	Yunnan	M192:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	36
1489	iron stand	1	D	Qujing	Yunnan	M192:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	36
1490	iron stick	1	T	Qujing	Yunnan	M181:5-1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	36
1491	iron stick	1	T	Qujing	Yunnan	M181:5-2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS 2006)	36
1492	iron axehead	1	T	Zhaotong	Yunnan	HSPM9:23	Y	Y	25-220AD (Eastern Han)	(YNSWWKGYJS 2006)	128
1493	ring-headed iron knife	2/6	T	Zhaotong	Yunnan	WGSM9:14	Y	Y	25-220AD (Eastern Han)	(YNSWWKGYJS 2006)	128
1494	u-shaped implement cap	1/2	T	Zhaotong	Yunnan	WGSM13:4	Y	Y	25-220AD (Eastern Han)	(YNSWWKGYJS 2006)	128
1495	ring-pommeled iron sword	1/6	W	Zhaotong	Yunnan	WGSM7:11	Y	Y	25-220AD (Eastern Han)	(YNSWWKGYJS 2006)	128
1496	iron sabre	1	W	Lianghe	Yunnan	2003YLBH4:2	N	Y		(YNSWWKGYJS 2006)	141
1497	iron nail	125	T	Gejiu	Yunnan		N	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS 2006)	183
1498	horseshoe	1	O	Mengzi	Yunnan	TM22:5	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS 2006)	262
1499	iron lock	1	D	Mengzi	Yunnan	TM24:2	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS 2006)	262
1500	iron bracelet	1/6	A	Dali Dafengle	Yunnan	HZM724:2	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS and DLSBWG 2002)	33
1501	iron spoon	1	D	Dali Dafengle	Yunnan	HZM678:6	Y	N	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS and DLSBWG 2002)	33
1502	iron sheet	203	U	Dali Dafengle	Yunnan		N	N		(YNSWWKGYJS and DLSBWG 2002)	33
1503	iron sabre	1/2	W	Dali Dafengle	Yunnan	HZM493:7	Y	Y	10th-19th century (Ming and Qing dynasty)	(YNSWWKGYJS and DLSBWG 2002)	33
1504	iron belt hook	1	A	Gejiu	Yunnan	M16:30	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1505	iron ring	1	D	Gejiu	Yunnan	M24:12	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1506	iron needle	1/3	T	Gejiu	Yunnan	M24:11	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1507	iron pliers	1	T	Gejiu	Yunnan	M29:23	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1508	iron ploughshare	1	T	Gejiu	Yunnan	M35:24	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1509	iron stand	1/2	D	Gejiu	Yunnan	M16:4	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1510	unidentified	1	U	Gejiu	Yunnan	M29:21	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1511	iron sabre	1/3	W	Gejiu	Yunnan	M22:18	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1512	iron spearhead	1	W	Gejiu	Yunnan	M41:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1513	iron sword	1/6	W	Gejiu	Yunnan	M33:13	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1514	iron sword	2/6	W	Gejiu	Yunnan	M41:6	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1515	ring-pommeled iron sword	1/20	W	Gejiu	Yunnan	M27:8	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1516	ring-pommeled iron sword	2/20	W	Gejiu	Yunnan	M29:24	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1517	ring-pommeled iron sword	3/20	W	Gejiu	Yunnan	M37:12	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2013)	138
1518	iron axehead with bronze body or socket	1/14	T	Jiangchuan Lijiashan	Yunnan	M57:201	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	158
1519	iron axehead with bronze body or socket	2/14	T	Jiangchuan Lijiashan	Yunnan	M51:19	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	158
1520	iron axehead with bronze body or socket	3/14	T	Jiangchuan Lijiashan	Yunnan	M51:17	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	158
1521	iron axehead with bronze body or socket	4/14	T	Jiangchuan Lijiashan	Yunnan	M51:20	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	159
1522	iron axehead with bronze body or socket	5/14	T	Jiangchuan Lijiashan	Yunnan	M47:130	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	159
1523	iron axehead with bronze body or socket	6/14	T	Jiangchuan Lijiashan	Yunnan	M51:23	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	160
1524	iron blade with bronze socket	2/10	T	Jiangchuan Lijiashan	Yunnan	M50:71	Y	Y	Western Han(late)-Eastern Han(early)	(YNSWWKGYJS et al. 2007)	160
1525	iron blade with bronze socket	1/4	T	Jiangchuan Lijiashan	Yunnan	M51:139	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	160
1526	iron blade with bronze socket	1/10	T	Jiangchuan Lijiashan	Yunnan	M57:210	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	160
1527	iron chisel with bronze socket	1/11	T	Jiangchuan Lijiashan	Yunnan	M51:141	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	160
1528	iron chisel with bronze socket	1/2	T	Jiangchuan Lijiashan	Yunnan	M47:199	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	160
1529	iron knife with bronze handle	1/6	T	Jiangchuan Lijiashan	Yunnan	M71:51	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	160

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1530	iron mattockhead	1/2	T	Jiangchuan Lijiashan	Yunnan	M69:193	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	160
1531	iron saw	1	T	Jiangchuan Lijiashan	Yunnan	M86:051	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	160
1532	iron sword	1/5	W	Jiangchuan Lijiashan	Yunnan	M51:137	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	160
1533	iron knife with bronze handle	2/6	T	Jiangchuan Lijiashan	Yunnan	M38:5	Y	Y	Western Han(late)-Eastern Han(early)	(YNSWWKGYJS et al. 2007)	161
1534	iron knife	1/54	T	Jiangchuan Lijiashan	Yunnan	M82:13	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	162
1535	iron knife	2/54	T	Jiangchuan Lijiashan	Yunnan	M44:35	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	162
1536	iron knife	6/54	T	Jiangchuan Lijiashan	Yunnan	M86:8	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	162
1537	iron knife	3/54	T	Jiangchuan Lijiashan	Yunnan	M57:142	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	162
1538	iron spearhead with bronze socket	1/59	W	Jiangchuan Lijiashan	Yunnan	M57:196	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	162
1539	iron sabre	5/54	W	Jiangchuan Lijiashan	Yunnan	M86:24	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	162
1540	iron sabre	4/54	W	Jiangchuan Lijiashan	Yunnan	M51:246	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	162
1541	iron sabre	7/54	W	Jiangchuan Lijiashan	Yunnan	M51:218	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	162
1542	iron spearhead with bronze socket	7/59	W	Jiangchuan Lijiashan	Yunnan	M69:153	Y	Y	Western Han(late)-Eastern Han(early)	(YNSWWKGYJS et al. 2007)	164
1543	iron spearhead with bronze socket	9/59	W	Jiangchuan Lijiashan	Yunnan	M86:35	Y	Y	Western Han(late)-Eastern Han(early)	(YNSWWKGYJS et al. 2007)	164
1544	iron spearhead with bronze socket	11/59	W	Jiangchuan Lijiashan	Yunnan	M50:6	Y	Y	Western Han(late)-Eastern Han(early)	(YNSWWKGYJS et al. 2007)	164
1545	iron spearhead with bronze socket	2/59	W	Jiangchuan Lijiashan	Yunnan	M51:46	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164
1546	iron spearhead with bronze socket	3/59	W	Jiangchuan Lijiashan	Yunnan	M68:152	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164
1547	iron spearhead with bronze socket	4/59	W	Jiangchuan Lijiashan	Yunnan	M47:247-13	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164
1548	iron spearhead with bronze socket	5/59	W	Jiangchuan Lijiashan	Yunnan	M47:247-5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164
1549	iron spearhead with bronze socket	6/59	W	Jiangchuan Lijiashan	Yunnan	M51:61	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164
1550	iron spearhead with bronze socket	8/59	W	Jiangchuan Lijiashan	Yunnan	M57:50	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1551	iron spearhead with bronze socket	10/59	W	Jiangchuan Lijiashan	Yunnan	M51:318-2	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164
1552	iron spearhead with bronze socket	12/59	W	Jiangchuan Lijiashan	Yunnan	M51:318-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	164
1553	iron spearhead with bronze socket	13/59	W	Jiangchuan Lijiashan	Yunnan	M51:56	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	165
1554	iron spearhead	1	W	Jiangchuan Lijiashan	Yunnan	M53:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	165
1555	iron spearhead	1	W	Jiangchuan Lijiashan	Yunnan	M85:100	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	165
1556	iron spearhead	1	W	Jiangchuan Lijiashan	Yunnan	M50:50	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	165
1557	iron spearhead	1	W	Jiangchuan Lijiashan	Yunnan	M69:150	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	165
1558	iron halberdhead with bronze socket	1/2	W	Jiangchuan Lijiashan	Yunnan	M57:44	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1559	iron sword with bronze handle	4/77	W	Jiangchuan Lijiashan	Yunnan	M82:12	Y	Y	Western Han(late)-Eastern Han(early)	(YNSWWKGYJS et al. 2007)	166
1560	iron sword with bronze handle	1/77	W	Jiangchuan Lijiashan	Yunnan	M71:26-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1561	iron sword with bronze handle	2/77	W	Jiangchuan Lijiashan	Yunnan	M68X1:8	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1562	iron sword with bronze handle	3/77	W	Jiangchuan Lijiashan	Yunnan	M51:111	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1563	iron sword with bronze handle	5/77	W	Jiangchuan Lijiashan	Yunnan	M51:117	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1564	iron sword with bronze handle	6/77	W	Jiangchuan Lijiashan	Yunnan	M68:360	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1565	iron sword with bronze handle	7/77	W	Jiangchuan Lijiashan	Yunnan	M68X1:46	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1566	iron sword with bronze handle	8/77	W	Jiangchuan Lijiashan	Yunnan	M47:190-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	166
1567	iron sword with bronze handle	9/77	W	Jiangchuan Lijiashan	Yunnan	M68:67-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	167
1568	iron sword with bronze handle	10/77	W	Jiangchuan Lijiashan	Yunnan	M68:25-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	167
1569	iron sword with bronze handle	11/77	W	Jiangchuan Lijiashan	Yunnan	M68:32	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	167
1570	iron sword with bronze handle	12/77	W	Jiangchuan Lijiashan	Yunnan	M68X1:6	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	167
1571	iron sword with bronze handle	13/77	W	Jiangchuan Lijiashan	Yunnan	M51:254	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	168
1572	iron sword with bronze handle	14/77	W	Jiangchuan Lijiashan	Yunnan	M57:29-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	170
1573	iron sword with bronze handle	15/77	W	Jiangchuan Lijiashan	Yunnan	M51:216	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	170

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1574	iron sword with bronze handle	16/77	W	Jiangchuan Lijiashan	Yunnan	M68:231	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	170
1575	iron sword with bronze handle	17/77	W	Jiangchuan Lijiashan	Yunnan	M68:56-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	170
1576	iron sword with bronze handle	18/77	W	Jiangchuan Lijiashan	Yunnan	M68:300	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	170
1577	iron bar	1/6	U	Jiangchuan Lijiashan	Yunnan	M47:95	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	171
1578	iron bar	2/6	U	Jiangchuan Lijiashan	Yunnan	M68:354	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	171
1579	iron bar	3/6	U	Jiangchuan Lijiashan	Yunnan	M51:177	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	171
1580	iron sword	1/33	W	Jiangchuan Lijiashan	Yunnan	M51:229	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	171
1581	iron sword	2/33	W	Jiangchuan Lijiashan	Yunnan	M51:228-1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	171
1582	iron sword	3/33	W	Jiangchuan Lijiashan	Yunnan	M57:53	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	171
1583	iron sword	4/33	W	Jiangchuan Lijiashan	Yunnan	M51:219	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	171
1584	horse bit	1/6	O	Jiangchuan Lijiashan	Yunnan	M86:042	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1585	horse bit	2/6	O	Jiangchuan Lijiashan	Yunnan	M50:41-2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1586	iron nail	1	T	Jiangchuan Lijiashan	Yunnan	M68:77③	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1587	iron bar	5/6	U	Jiangchuan Lijiashan	Yunnan	M50:35	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1588	iron bar	4/6	U	Jiangchuan Lijiashan	Yunnan	M51:215	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1589	iron decoration	1	U	Jiangchuan Lijiashan	Yunnan	M68:77①	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1590	iron decoration	1	U	Jiangchuan Lijiashan	Yunnan	M68:77②	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1591	iron arrowhead	2/43	W	Jiangchuan Lijiashan	Yunnan	M85:58	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1592	iron arrowhead	3/43	W	Jiangchuan Lijiashan	Yunnan	M85:43	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1593	iron arrowhead	1/43	W	Jiangchuan Lijiashan	Yunnan	M51:311	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	173
1594	inlaid iron object	1	U	Jiangchuan Lijiashan	Yunnan	M68:212	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2007)	174
1595	iron hair clasp	1	A	Jiangchuan Lijiashan	Yunnan	M64:14	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2007)	174
1596	ring-headed iron knife	1/5	T	Jinning Shizhaishan	Yunnan	M71:151-1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	92
1597	ring-headed iron knife	2/5	U	Jinning Shizhaishan	Yunnan	M71:152	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	92

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1598	iron chisel with bronze socket	1	T	Jinning Shizhaishan	Yunnan	M71:200 ①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1599	iron chisel with bronze socket	1	T	Jinning Shizhaishan	Yunnan	M71:200 ②	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1600	iron object with bronze handle	1	T	Jinning Shizhaishan	Yunnan	M71:158	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1601	iron spearhead with bronze socket	1/8	W	Jinning Shizhaishan	Yunnan	M71:156 ①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1602	iron spearhead with bronze socket	2/8	W	Jinning Shizhaishan	Yunnan	M71:156 ②	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1603	iron spearhead with bronze socket	3/8	W	Jinning Shizhaishan	Yunnan	M71:156 ③	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1604	iron spearhead with bronze socket	4/8	W	Jinning Shizhaishan	Yunnan	M71:156 ④	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1605	iron spearhead with bronze socket	5/8	W	Jinning Shizhaishan	Yunnan	M71:196 ①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	93
1606	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:9	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1607	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:10	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1608	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:75	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1609	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:80①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1610	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:81①	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1611	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:85①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1612	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:91	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1613	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:182	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1614	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:25	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1615	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:26①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1616	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:27①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1617	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:29①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1618	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:41	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1619	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:42①	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1620	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:43①	Y	Y	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1621	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:44①	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1622	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:45①	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	95
1623	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M71:69	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	96
1624	iron spearhead with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:99	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1625	iron sword	1	W	Jinning Shizhaishan	Yunnan	M3:155	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	176
1626	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:9	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1627	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:20	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1628	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:7	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1629	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:4	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1630	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:31	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1631	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:25	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1632	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M3:19	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	176
1633	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M4:16	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	177
1634	iron sword with bronze guard	1	W	Jinning Shizhaishan	Yunnan	M4:26	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	177
1635	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M4:42	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	177
1636	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M5:3	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	178
1637	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M5:20	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	178
1638	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M5:18	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	178
1639	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M5:5	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	178
1640	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M5:9	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	178
1641	iron dagger-axehead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M6:81	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	179

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1642	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M6:102	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	179
1643	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M6:35	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	180
1644	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M7:18	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	180
1645	iron axehead	1	T	Jinning Shizhaishan	Yunnan	M8:1	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	182
1646	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	M8:2	Y	N	Western Han(late)	(YNSWWKGYJS et al. 2009)	182
1647	ring-headed iron knife	1	U	Jinning Shizhaishan	Yunnan	M8:4	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	182
1648	ring-headed iron knife	1	U	Jinning Shizhaishan	Yunnan	M7:?	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	182
1649	ring-headed iron knife	1	U	Jinning Shizhaishan	Yunnan	M10:34	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	182
1650	ring-headed iron knife	3	U	Jinning Shizhaishan	Yunnan	M10 无号	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	182
1651	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M10:6	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	182
1652	bronze arrowhead with iron body	1	W	Jinning Shizhaishan	Yunnan	M10:47	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	183
1653	bronze arrowhead with iron body	1	W	Jinning Shizhaishan	Yunnan	M10:50	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	183
1654	iron ferrule with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M10:64	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	183
1655	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M10:18	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	183
1656	iron sword with bronze handle	3	W	Jinning Shizhaishan	Yunnan	M10:51	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	183
1657	iron axehead with bronze body or socket	1	T	Jinning Shizhaishan	Yunnan	M12:61	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	184
1658	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M12:30	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	184
1659	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M12:31	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	184
1660	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M12:23	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	184
1661	iron axehead with bronze body or socket	1	T	Jinning Shizhaishan	Yunnan	M12:82	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	185
1662	iron chisel with bronze socket	1	T	Jinning Shizhaishan	Yunnan	M12:161	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	186
1663	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M12:164	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	186

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
	with bronze socket										
1664	iron axehead with bronze body or socket	1	T	Jinning Shizhaishan	Yunnan	M13:213	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	187
1665	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	M13:123	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	187
1666	iron knife with bronze handle	1	U	Jinning Shizhaishan	Yunnan	M13:327	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	188
1667	iron spearhead with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:350	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	188
1668	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M13:302	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	188
1669	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:140	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	188
1670	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:187	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	188
1671	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:268	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	188
1672	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:354	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	188
1673	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:125	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	188
1674	iron axehead	1	T	Jinning Shizhaishan	Yunnan	M13:345	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	189
1675	iron axehead with bronze body or socket	1	T	Jinning Shizhaishan	Yunnan	M13:121	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	189
1676	iron nail	14	T	Jinning Shizhaishan	Yunnan	M13:100	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	189
1677	circular iron object	1	U	Jinning Shizhaishan	Yunnan	M13:343	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	189
1678	iron sword	1	W	Jinning Shizhaishan	Yunnan	M13:229	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	189
1679	iron sword	1	W	Jinning Shizhaishan	Yunnan	M13:14	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	189
1680	iron sword with bronze guard	1	W	Jinning Shizhaishan	Yunnan	M13:226	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	189
1681	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:85	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	189
1682	ring-headed iron knife	1	U	Jinning Shizhaishan	Yunnan	M13:127	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1683	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M13:352	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	190
1684	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M13:326	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	190

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1685	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:351	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1686	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:346	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1687	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:353	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1688	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:180	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1689	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:189	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1690	iron sword	1	W	Jinning Shizhaishan	Yunnan	M13:229	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1691	iron sword	1	W	Jinning Shizhaishan	Yunnan	M13:263	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1692	iron sword	1	W	Jinning Shizhaishan	Yunnan	M13:90	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1693	iron sword	1	W	Jinning Shizhaishan	Yunnan	M13:92	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1694	iron sword	1	W	Jinning Shizhaishan	Yunnan	M13:347	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	190
1695	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:314	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	190
1696	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:79	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	190
1697	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:93	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	190
1698	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:134	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	190
1699	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:74	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	190
1700	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M13:83	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	191
1701	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:35	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	191
1702	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:70	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	191
1703	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:54	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	191
1704	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:19	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	191
1705	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M13:18	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	191
1706	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M15:21	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	193
1707	iron sword	1	W	Jinning Shizhaishan	Yunnan	M21:72	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2009)	196
1708	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M21:69	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	196

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1709	iron chisel with bronze handle	1	T	Jinning Shizhaishan	Yunnan	M22:59	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	197
1710	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M22:34	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	197
1711	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M22:22	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	197
1712	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M22:59	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	198
1713	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M22:52	Y	N	Western Han(mid)	(YNSWWKGYJS et al. 2009)	198
1714	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M25:5	Y	N		(YNSWWKGYJS et al. 2009)	198
1715	iron axehead	1	T	Jinning Shizhaishan	Yunnan	M25:19	Y	N		(YNSWWKGYJS et al. 2009)	199
1716	iron axehead	1	T	Jinning Shizhaishan	Yunnan	M30:19	Y	N		(YNSWWKGYJS et al. 2009)	199
1717	iron chisel	1	T	Jinning Shizhaishan	Yunnan	M25:18	Y	N		(YNSWWKGYJS et al. 2009)	199
1718	iron object	1	U	Jinning Shizhaishan	Yunnan	M30 无号	Y	N		(YNSWWKGYJS et al. 2009)	199
1719	ring-headed iron knife	1	U	Jinning Shizhaishan	Yunnan	M25:9	Y	N		(YNSWWKGYJS et al. 2009)	199
1720	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M25:15	Y	N		(YNSWWKGYJS et al. 2009)	199
1721	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M30:6	Y	N		(YNSWWKGYJS et al. 2009)	199
1722	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M25:17	Y	N		(YNSWWKGYJS et al. 2009)	199
1723	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M30:2	Y	N		(YNSWWKGYJS et al. 2009)	199
1724	iron residue	1	U	Jinning Shizhaishan	Yunnan	M40:29	Y	N		(YNSWWKGYJS et al. 2009)	200
1725	iron residue	1	U	Jinning Shizhaishan	Yunnan	M40:17	Y	N		(YNSWWKGYJS et al. 2009)	200
1726	iron residue	1	U	Jinning Shizhaishan	Yunnan	M40:30	Y	N		(YNSWWKGYJS et al. 2009)	200
1727	iron residue	1	U	Jinning Shizhaishan	Yunnan	M36:3	Y	N		(YNSWWKGYJS et al. 2009)	200
1728	unidentified	1	U	Jinning Shizhaishan	Yunnan	M43:21	Y	N		(YNSWWKGYJS et al. 2009)	200
1729	iron spearhead	1	W	Jinning Shizhaishan	Yunnan	M40:11	Y	N		(YNSWWKGYJS et al. 2009)	200
1730	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M41:3	Y	N		(YNSWWKGYJS et al. 2009)	200
1731	iron spearhead with bronze socket	1	W	Jinning Shizhaishan	Yunnan	M43:16	Y	N		(YNSWWKGYJS et al. 2009)	200

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1732	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M41:4	Y	N		(YNSWWKGYJS et al. 2009)	200
1733	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M43:8	Y	N		(YNSWWKGYJS et al. 2009)	200
1734	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M43:20	Y	N		(YNSWWKGYJS et al. 2009)	200
1735	iron object with bronze handle	1	T	Jinning Shizhaishan	Yunnan	M46:2	Y	N		(YNSWWKGYJS et al. 2009)	201
1736	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	T:2:36-1	N	N		(YNSWWKGYJS et al. 2009)	202
1737	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	T:2:36-2	N	N		(YNSWWKGYJS et al. 2009)	202
1738	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	T:2:10	N	N		(YNSWWKGYJS et al. 2009)	202
1739	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	T:2:78	N	N		(YNSWWKGYJS et al. 2009)	202
1740	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	T:2:33	N	N		(YNSWWKGYJS et al. 2009)	202
1741	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	T:2:56	N	N		(YNSWWKGYJS et al. 2009)	202
1742	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	T:2:57	N	N		(YNSWWKGYJS et al. 2009)	202
1743	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	T:2:81	N	N		(YNSWWKGYJS et al. 2009)	202
1744	iron axehead	1	T	Jinning Shizhaishan	Yunnan	Disturbed :1:36	N	N		(YNSWWKGYJS et al. 2009)	203
1745	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	Disturbed :1:11	N	N		(YNSWWKGYJS et al. 2009)	203
1746	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	Disturbed :2:5	N	N		(YNSWWKGYJS et al. 2009)	203
1747	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	Disturbed :6:19	N	N		(YNSWWKGYJS et al. 2009)	204
1748	iron object with bronze handle	1	T	Jinning Shizhaishan	Yunnan	Disturbed :1	N	N		(YNSWWKGYJS et al. 2009)	205
1749	iron sicklehead with bronze handle	1	T	Jinning Shizhaishan	Yunnan	Disturbed 8	N	N		(YNSWWKGYJS et al. 2009)	205
1750	ring-headed iron knife	1	U	Jinning Shizhaishan	Yunnan	Disturbed :6:11	N	N		(YNSWWKGYJS et al. 2009)	205
1751	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	Disturbed :6:41	N	N		(YNSWWKGYJS et al. 2009)	205
1752	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	Disturbed :6	N	N		(YNSWWKGYJS et al. 2009)	205
1753	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	Disturbed :1	N	N		(YNSWWKGYJS et al. 2009)	205
1754	iron blade with bronze handle	1	T	Jinning Shizhaishan	Yunnan	5	N	N		(YNSWWKGYJS et al. 2009)	206
1755	iron sword with bronze handle	1	W	Jinning Shizhaishan	Yunnan	M10?	Y	N		(YNSWWKGYJS et al. 2009)	206

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1756	curved iron blade	1/120	T	Kunming Yangfutou	Yunnan	M409:2	Y	Y		(YNSWWKGYJS et al. 2005)	110
1757	iron axehead	1/3	T	Kunming Yangfutou	Yunnan	M510:9	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	110
1758	iron knife	1/4	U	Kunming Yangfutou	Yunnan	M157:32	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	110
1759	ring-headed iron knife	1/15	U	Kunming Yangfutou	Yunnan	M194:8	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	110
1760	iron spearhead	1/21	W	Kunming Yangfutou	Yunnan	M157:15	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	110
1761	iron spearhead	2/21	W	Kunming Yangfutou	Yunnan	M194:7	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	110
1762	iron sword	1/3	W	Kunming Yangfutou	Yunnan	M510:7	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	110
1763	iron chisel	1	T	Kunming Yangfutou	Yunnan	M99GC:3	Y	Y		(YNSWWKGYJS et al. 2005)	159
1764	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M466:5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	325
1765	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M32:1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	340
1766	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M32:4-3	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	340
1767	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M32:2	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	340
1768	iron chisel with bronze socket	1	T	Kunming Yangfutou	Yunnan	M32:10	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	342
1769	iron object	1	U	Kunming Yangfutou	Yunnan	M161:11	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	373
1770	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M194:6	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	375
1771	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M194:8	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	377
1772	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M194:7	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	377
1773	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M194:12	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	377
1774	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M194:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	377
1775	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M275:2	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	389
1776	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M390:5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	412
1777	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M390:6	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	412
1778	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M505:5	Y	Y	Western Han(early)-Western Han(mid)	(YNSWWKGYJS et al. 2005)	418

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1779	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M536:10	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	420
1780	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M536:5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	420
1781	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M536:4	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	420
1782	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M536:3	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	420
1783	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M543:10	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	422
1784	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M543:12	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	422
1785	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M543:15	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	422
1786	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M543:20	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	423
1787	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M619:2	Y	Y	8th-3rd century BC	(YNSWWKGYJS et al. 2005)	436
1788	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M10:18	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	469
1789	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M10:21	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	469
1790	unidentified iron blade with bronze socket	1	U	Kunming Yangfutou	Yunnan	M33:5-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	476
1791	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M46:6	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	480
1792	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M46:4	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	480
1793	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M46:15	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	481
1794	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M46:16	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	481
1795	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M46:1	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	481
1796	iron knife with bronze handle	1	U	Kunming Yangfutou	Yunnan	M46:10	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	482
1797	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M68:1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	484
1798	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M68:7	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	484
1799	iron object	1	U	Kunming Yangfutou	Yunnan	M68:8	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	485

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1800	iron object	1	U	Kunming Yangfutou	Yunnan	M68:16	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	485
1801	iron knife	1	U	Kunming Yangfutou	Yunnan	M122:5	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	495
1802	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M122:3	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	495
1803	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M122:6	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	495
1804	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M137:15	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	499
1805	iron chisel with bronze socket	1	T	Kunming Yangfutou	Yunnan	M137:20	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	499
1806	iron object	1	U	Kunming Yangfutou	Yunnan	M137:19	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	499
1807	iron object	1	U	Kunming Yangfutou	Yunnan	M137:9	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	499
1808	iron object	1	U	Kunming Yangfutou	Yunnan	M137:10	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	499
1809	iron object	1	U	Kunming Yangfutou	Yunnan	M137:11	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	499
1810	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M137:21	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	499
1811	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M155:16	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	510
1812	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M155:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	511
1813	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M157:29	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	512
1814	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M157:30	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	512
1815	iron chisel with bronze socket	1	T	Kunming Yangfutou	Yunnan	M157:19	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	514
1816	iron knife	1	U	Kunming Yangfutou	Yunnan	M157:32	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	514
1817	unidentified iron blade with bronze socket	1	U	Kunming Yangfutou	Yunnan	M157:18	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	514
1818	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M157:15	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	514
1819	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M157:3	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	514
1820	iron axehead	1	T	Kunming Yangfutou	Yunnan	M185:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	517
1821	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M185:13	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	517
1822	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M185:9	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	517

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
	with bronze socket										
1823	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M185:12	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	517
1824	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M197:3	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	520
1825	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M197:5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	520
1826	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M197:4	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	520
1827	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M197:11	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	520
1828	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M197:10	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	520
1829	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M297:7	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	527
1830	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M297:18	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	528
1831	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M297:16	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	528
1832	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M297:8	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	530
1833	iron chisel with bronze socket	1/3	T	Kunming Yangfutou	Yunnan	M297:12	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	530
1834	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M297:19	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	530
1835	iron sword	1	W	Kunming Yangfutou	Yunnan	M314:12	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	532
1836	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M342:8	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	542
1837	iron knife	1	U	Kunming Yangfutou	Yunnan	M342:5	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	542
1838	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M342:2	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	542
1839	iron knife with bronze handle	1	U	Kunming Yangfutou	Yunnan	M345:2	Y	Y	Western Han(early)-Western Han(mid)	(YNSWWKGYJS et al. 2005)	548
1840	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M552:9	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	559
1841	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M575:3	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	571
1842	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M575:10	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	571

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1843	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M575:5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	571
1844	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M710:10	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	585
1845	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M710:15	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	585
1846	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M710:2	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	585
1847	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M710:9	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	585
1848	iron object	1	U	Kunming Yangfutou	Yunnan	M710:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	588
1849	iron object	1	U	Kunming Yangfutou	Yunnan	M749:5	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	590
1850	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M126:7	Y	N	Western Han(early)-Western Han(mid)	(YNSWWKGYJS et al. 2005)	598
1851	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M134:5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	599
1852	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M134:7	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	600
1853	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M164:2	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	603
1854	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M164:4	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	603
1855	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M164:7	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	603
1856	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M328:14	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	607
1857	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M328:5	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	609
1858	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M494:4	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	611
1859	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M494:10	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	611
1860	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M494:1	Y	N	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	612
1861	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M518:8	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	614
1862	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M518:9	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	615
1863	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M518:2	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	615
1864	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M562:2	Y	Y	Western Han(early)-Western Han(mid)	(YNSWWKGYJS et al. 2005)	618
1865	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M562:9	Y	N	Western Han(early)-Western Han(mid)	(YNSWWKGYJS et al. 2005)	619

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1866	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M572:13	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	623
1867	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M572:3	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	624
1868	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M572:2	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	624
1869	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M572:5	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	624
1870	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M818:1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	628
1871	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M818:4	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	628
1872	iron object	1	U	Kunming Yangfutou	Yunnan	M818:7	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	631
1873	iron object	1	U	Kunming Yangfutou	Yunnan	M131:3	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	633
1874	iron object	1	U	Kunming Yangfutou	Yunnan	M131:7	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	633
1875	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M131:9-1	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	633
1876	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M131:9-2	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	633
1877	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M131:9-3	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	633
1878	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M131:9-4	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	633
1879	iron object	1	U	Kunming Yangfutou	Yunnan	M48:9	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	666
1880	iron spearhead with bronze socket	1	W	Kunming Yangfutou	Yunnan	M170:12	Y	Y	Western Han(early)-Western Han(mid)	(YNSWWKGYJS et al. 2005)	680
1881	iron sword with bronze handle	1	W	Kunming Yangfutou	Yunnan	M541:6	Y	Y	Western Han(mid)-Western Han(late)	(YNSWWKGYJS et al. 2005)	690
1882	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M541:8-1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	691
1883	iron spearhead	1	W	Kunming Yangfutou	Yunnan	M541:8-2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	691
1884	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M541:1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	692
1885	iron object	1	U	Kunming Yangfutou	Yunnan	M268:24	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	762
1886	iron object	1	U	Kunming Yangfutou	Yunnan	M268:26	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	762
1887	iron object	1	U	Kunming Yangfutou	Yunnan	M268:30	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	762

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1888	iron object	1	U	Kunming Yangfutou	Yunnan	M268:34	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	762
1889	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M268:28	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	762
1890	iron object	1	U	Kunming Yangfutou	Yunnan	M410:9	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	767
1891	iron object	1	U	Kunming Yangfutou	Yunnan	M410:36	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	767
1892	iron object	1	U	Kunming Yangfutou	Yunnan	M410:39	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	767
1893	ring-headed iron knife	1	U	Kunming Yangfutou	Yunnan	M410:35	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	767
1894	iron sword	1	W	Kunming Yangfutou	Yunnan	M410:7	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	767
1895	iron sword	1	W	Kunming Yangfutou	Yunnan	M410:30	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	767
1896	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M433:2	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	776
1897	iron object	1	U	Kunming Yangfutou	Yunnan	M433:3	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	776
1898	iron object	1	U	Kunming Yangfutou	Yunnan	M433:11	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	776
1899	iron knife	1	U	Kunming Yangfutou	Yunnan	M88:6	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	780
1900	iron object	1	U	Kunming Yangfutou	Yunnan	M96:9	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	784
1901	iron object	1	U	Kunming Yangfutou	Yunnan	M96:10	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	784
1902	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M368:9	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	796
1903	iron object	1	U	Kunming Yangfutou	Yunnan	M368:12	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	796
1904	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M398:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	799
1905	iron object	1	U	Kunming Yangfutou	Yunnan	M419:15	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	802
1906	iron sword	1	W	Kunming Yangfutou	Yunnan	M430:13	Y	Y	25-220AD (Eastern Han)	(YNSWWKGYJS et al. 2005)	820
1907	curved iron blade	1	T	Kunming Yangfutou	Yunnan	M440:7	Y	N	25-220AD (Eastern Han)	(YNSWWKGYJS et al. 2005)	824
1908	iron object	1	U	Kunming Yangfutou	Yunnan	M455:4	Y	N	202BC to 8AD (Western Han)	(YNSWWKGYJS et al. 2005)	827
1909	iron sword with bronze handle	1	W	Guangnan County	Yunnan	collected	N	Y		(YNSWWKGYJS, WSZWWGLS et al. 2008)	45
1910	iron mattockhead	1	T	Guangnan County	Yunnan	M1:6	Y	Y	8th-3rd century BC	(YNSWWKGYJS, WSZWWGLS et al. 2008)	124
1911	iron axehead	1	T	Luxi County	Yunnan	M25:4-2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141

NO.	Artefact	Qty	Type	Excavated location	Region	Artefact No.	Tomb	Pic	Date	Reference	Pg No.
1912	iron chisel	1	T	Luxi County	Yunnan	M31:5	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1913	iron knife	1	T	Luxi County	Yunnan	M38:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1914	iron knife	1	T	Luxi County	Yunnan	M32:1-1	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1915	iron mattockhead	1	T	Luxi County	Yunnan	M1:5	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1916	iron mattockhead	1	T	Luxi County	Yunnan	M1:6	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1917	iron sicklehead	1	T	Luxi County	Yunnan	M42:2	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1918	iron sicklehead	1	T	Luxi County	Yunnan	M38:3	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1919	ring-pommeled iron sword	1	W	Luxi County	Yunnan	M25:4	Y	Y	202BC to 8AD (Western Han)	(YNSWWKGYJS, WSZWWGLS et al. 2008)	141
1920	iron adze	1	T	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	34
1921	iron axehead	1/5	T	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	34
1922	iron hammerhead	1/2	T	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	34
1923	iron hoehead	1	T	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	34
1924	iron sicklehead	1	T	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	34
1925	iron knife	1/11	U	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	34
1926	iron spearhead	46	W	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	73
1927	iron sword	100	W	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	73
1928	ring-headed iron knife	5	T	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	74
1929	unidentified	7	U	Jinning Shizhaishan	Yunnan		N	N	8th-3rd century BC	(Zhang 1998)	74
1930	iron ferrule with bronze socket	2	W	Jinning Shizhaishan	Yunnan		N	N	Warring States(late)-Eastern Han(early)	(Zhang 1998)	74
1931	iron halberdhead with bronze socket	2	W	Jinning Shizhaishan	Yunnan		N	N	Warring States(late)-Eastern Han(early)	(Zhang 1998)	74

5. Metallographic analysis of excavated iron objects of China

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
1	YH04	T0204 ⑤:1	cutting edge	hollowed axe	500-221BC	Beijing		white cast iron
2	YH06	T0302 ⑤:3	cutting edge	hollowed axe	500-221BC	Beijing	small amount of graphite.	malleable cast iron
3	7117	M374:15	cutting edge	sword	+3rd/+4th century	Liaoning (northeast)	pure pearlite in the cutting edge area, 0.8% carbon; core area about 0.3% carbon with a Widmanstätten structure; slag stringers, carburized on the edge.	fined iron, forged
4	7118	M218:10	cutting edge	sword	+3rd/+4th century	Liaoning (northeast)	uneven carbon content distribution, higher on the edge with a Widmanstätten structure, 0.3% carbon, carburized. Core area is ferrite and small amount of pearlite on the grain boundaries, 0.1% carbon, single and sub-double phases inclusion stringers mostly in the core area.	fined iron, forged
5	7119	M309:13	cutting edge	sword	+3rd/+4th century	Liaoning (northeast)	uneven carbon content distribution, higher side is ferrite+pearlite on the grain boundaries, 0.1% carbon, lower side is ferrite, single phase inclusion stringers.	fined iron, cold forging
6	7112	M4:46	cutting edge	axe	+3rd/+4th century	Liaoning (northeast)	even carbon distribution, pearlite+ferrite, 0.4% carbon, few inclusions.	decarburized steel from white cast iron
7	7131	M205:11	cutting edge	axe	+3rd/+4th century	Liaoning (northeast)	ferrite+pearlite, pearlite precipitated on the ferritic grain boundaries, 0.2% carbon, very few inclusions, shrinkage cavities or gas hole in casting.	decarburized steel from white cast iron, cast
8	7134	M20:4	cutting edge	implement cap	+3rd/+4th century	Liaoning (northeast)	white cast iron, casting flaws.	white cast iron
9	FWC01	③:18		implement cap	-4th/-2nd century	Fujian (southeast coast)	badly corroded, trace of white cast iron structure in the corrosion.	white cast iron
10	FWC02	T13II③:4		implement cap	-4th/-2nd century	Fujian (southeast coast)	badly corroded, little metal left, which is pearlite with 0.8% carbon content, no inclusion.	decarburized steel from white cast iron, forged
11	FWC03			implement cap	-4th/-2nd century	Fujian (southeast coast)	pearlite+ferrite matrix with graphite.	malleable cast iron
12	FWC05	T287 ③:39		axe	-4th/-2nd century	Fujian (southeast coast)	ferrite, grain size grade 5, some carbides precipitated in the ferritic grains, few single phase inclusions.	decarburized steel from white cast iron, forged
13	FWC06	T287 ③:34		axe	-4th/-2nd century	Fujian (southeast coast)	ferrite+pearlite in the cutting edge area, 0.2% carbon, few single phase inclusions. Ferrite in the socket area, grain size grade 5.	two pieces of decarburized steel from white cast iron, forged
14	FWC16	T8III③:1		sword	-4th/-2nd century	Fujian (southeast coast)	martensite, some bandings caused by trace element, single phase inclusion stringers.	fined iron, forged

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
15	FWC 17			sword	-4th/-2nd century	Fujian (southeast coast)	uneven structure, 3-5 layers of differnet carbon content, Widmanstätten structure in high carbon content area, 0.7% carbon with some spheridized pearlite, ferrite+pearlite in lower carbon content areas, 0.4% carbon, some single phase inclusion stringers.	fined iron, forged
16	2.99 236	Tomb of Liusheng	body?	sword	165-113BC	Hebei (Central Plain)	5 layers for the central ridge, and 4 layers in the blade areas. Higher carbon layer about 0.6-0.7% carbon, and lower carbon layers about 0.3% carbon. Martensite on the cutting edge. 'carbon-free bainite' (lower bainite) on the surface.	carburized steel from bloomery iron, quenched
17	3.58 681	Tomb of Liusheng	section	sword	165-113BC	Hebei (Central Plain)	lower carbon content layer about 0.1-0.2%, higher carbon content layer about 0.5-0.6%, surface carburized, higher than 0.6% carbon, martensite observed. Layers are thin due to the repeatedly forging process. Inclusion size is small, the biggest is 0.05-0.1mm.	carburized steel from bloomery iron, partially quenched
18	HXS -4	M37:4	broken section	sword	202BC -20AD	Henan (Central Plain)	trace of forging, indistinct pearlite, forged from eutectoid steel.	decarburized steel from white cast iron, forged
19	HXS -3	T29④:1	socket	implem ent cap	202BC -20AD	Henan (Central Plain)	ferrite+pearlite, uneven grain sizes, grade 3-6, mostly grade 5.	decarburized steel from white cast iron
20	CM0 5	T2①:12	point	sabre	386-581AD	Beijing	ferrite matrix, grade 5-6 grain sizes, carbon content less than 0.1%, double phase slag stringers.	fined iron, forged
21	19	T1219⑥ H108:2		implem ent cap	150BC -20AD	Hebei (Central Plain)	pearlite-ferrite+pearlite-ferrite from core to surface.	decarburized steel from white cast iron
22	Che nggo ng:1	Shibeicu n Chenggo ng	cutting edge	iron sword with bronze handle	500-221BC	Yunnan (southwest)	pearlite+ferrite matrix, single phase inclusions, even structure, 4 layers of different grain sizes and carbon contents. 0.3-0.6% carbon.	hypoeutectoi d steel
23	Che nggo ng:3	Shibeicu n Chenggo ng	cutting edge	iron sword with bronze handle	500-221BC	Yunnan (southwest)	widmanstten structure matrix, 0.1-0.2% carbon, badly corroded, very little metal remaining.	hypoeutectoi d steel
24	GW0 1	M22	corss section ?	U-shaped implem ent cap	476-221BC	Guangxi (south)	badly corroded, some white cast iron structure.	white cast iron, cast
25	GDT 03	06GXDM 1006	broken section	*fu*-pot	202BC - 220AD	Guangxi (south)	badly corroded, some white cast iron structure.	white cast iron, cast
26	GDT 01	95.3 Han tomb Xunwang	cutting edge	sword	202BC - 220AD	Guangxi (south)	eutectoid to hypoeutectoid structure, quenched, some segragation in phosphorous, single phase slag inclusions.	fined iron, forged
27	GDT 02	95.3 Han tomb Xunwang	cutting edge	sword	202BC - 220AD	Guangxi (south)	even ferrite, slag inclusions along with working direction.	bloomery iron, hot forging

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
28	7110 8	H31① Y245:1		ring-heade d knife	202BC - 220AD	Shaanxi (Central Plain)	pearlite+ferrite+widmanstten structures, uneven carbon content, 0.3-0.4% in the core and 0.4-0.5% near the surface, carburized and annealed after decarburization.	decarburized steel from white cast iron
29	7111 7	H31① Y258		unident ifed object	202BC - 220AD	Central Plain	ferrite, grade 5-6 grain sizes, large amounts of double phase inclusions with low silica content, big differences in the ratio of phosphorous and calsium. Inclusions in layers and deformed, some stripes of segragation in phosphorous, should be folded and forged from numbers of fined iron, and annealing process applied.	fined iron
30	7111 9	H31① Y261		unident ifed object	202BC - 220AD	Central Plain	ferrite, 3-4 grain sizes, small slag inclusions, mostly double phase, some segragation of phosphorous.	fined iron
31	7112 1	H31① Y265		unident ifed object	202BC - 220AD	Central Plain	ferrite matrix, 5-6 grain sizes, many double phase slag inclusions, some segragation of phosphorous.	
32	7112 6	H31① Y250		unident ifed object	202BC - 220AD	Central Plain	ferrite matrix, two layers by different grain sizes, upper layer with 6 grain size, lower layer with 3-4 grain sizes, double phase slag inclusions, segragation of phosphorous, should be forged from two different fined iron material.	fined iron
33	7114 4(1)	H31① Y282b		salama nder?	202BC - 220AD	Central Plain	pearlite+small amounts of ferrite at the surface, 0.6-0.8% carbon content, some spherical graphite, occationally casting shrinkage, some flake graphite and hypereutectic structures in the core, probably insufficient decarburization.	decarburized steel from white cast iron
34	7114 8(1)	H31Y274		unident ifed object	202BC - 220AD	Central Plain	slag inclusions.	fined iron?
35	7115 3(3)	H31① Y280		unident ifed object	202BC - 220AD	Central Plain	cotton-like graphite on ferrite matrix, 5-6 grain sizes, some pearlite.	malleable cast iron
36	7117 0	H33Y81		unident ifed object	202BC - 220AD	Central Plain	eutectoid steel in the core, lower carbon content at the surface, occationally shrinkage of casting.	decarburized steel from white cast iron
37	7117 1	H33Y85: 1		unident ifed object	202BC - 220AD	Central Plain	ferrite.	wrought iron
38	7117 4	H33Y86: 1		unident ifed object	202BC - 220AD	Central Plain	pearlite+ferrite, hypoeutectoid steel, 0.4% carbon content, some spherical graphite.	decarburized steel from white cast iron
39	7118 6	H12Y2		unident ifed object	202BC - 220AD	Central Plain	ferrite+small amounts of pearlite, 0.1% carbon content.	decarburized steel from white cast iron

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
40	7120 3	H36Y123		knife	202BC - 220AD	Central Plain	ferrite+pearlite, hypoeutectoid steel, about 0.5% carbon content, casting shrinkage, some spherical graphite.	decarburized steel from white cast iron
41	7129 0	H28:Y61		unident ifed object	202BC - 220AD	Central Plain	pearlite+cementite, hypereutectoid steel, 1.8% carbon content, some spherical graphite.	decarburized steel from white cast iron
42		M48	corss section	bar	202-150BC	Xi'an (Central Plain)	pearlite matrix, some directional Fe3C and a few ledeburite, carbon content less than 4.3%, the directional Fe3C may dicates a fast cooling rate.	hypoeutectic white cast iron
43		M68	foot	tri-lamp	202-150BC	Xi'an (Central Plain)	spherical graphite and flake graphite on pearlite matrix, and very few pearlite on ledeburite matrix.	mottled iron
44		7:03:01		arrowh ead	202BC -20AD	Xi'an (Central Plain)	pearlite+ferrite, 0.45-0.6% carbon content.	fined iron
45		7:03:03		arrowh ead	202BC -20AD	Xi'an (Central Plain)	0.7-0.9% carbon content.	fined iron
46		7:03:04		arrowh ead	202BC -20AD	Xi'an (Central Plain)	slag stringers.	fined iron
47		7:03:04		spearh ead	202BC -20AD	Xi'an (Central Plain)	0.45-0.6% carbon content.	fined iron
48		7:03:01		halber dhead	202BC -20AD	Xi'an (Central Plain)	ferrite.	wrought iron
49		7:03:03		sabre	202BC -20AD	Xi'an (Central Plain)	pearlite in flake, partially spheridized, about 0.9% carbon content.	fined iron
50	169	89CHW5 T1:3		unident ifed object	202BC -20AD	Xi'an (Central Plain)	slag stringer, sorbite in the core, which is pearlite+small amounts of ferrite, 0.7-0.8% carbon content, some of the cementite are spheridized, lower carbon content at the surfaces, about 0.5-0.6% carbon.	fined iron, forged
51	13	88CHW5 T2:3		hook	202BC -20AD	Xi'an (Central Plain)	mostly FeO inclusions, 2 layers by different carbon content, one layer is pure ferrite which could be divided into 3 layers by different grain sizes, 2-5 grain sizes, segragation of phosphorous, P is from ore, which cannot be eliminate in the smelting at the time; the other layer is pearlite with 0.7-0.8% carbon content, there is a transition layer with 0.4-0.6% carbon between two layers, there is widmanstatten structures in the transition layer.	waste material from steel, forged
52	ZTH 105Z	M1:2	cross section (V)	unident ifed object	476-300BC	Xi'an (Central Plain)	pearlite+Fe3C+ledeburite, 4% carbon content.	hypoeutectic white cast iron

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
53	ZTH 105 H						fully corroded.	
54	ZTH 108 H	M1:3	cross section (H)	iron ring	476-300BC	Xi'an (Central Plain)	ferrite+pearlite at the surface, about 0.1% carbon content, ferrite in the core.	bloomery iron, cementation, forged
55	ZTH 108Z		cross section (V)				pearlite+ferrite, uneven carbon content, slag stringers mostly distributed in middle area.	
56	ZTH 104 H	M1:4	cross section (H)	iron ring	476-300BC	Xi'an (Central Plain)	pearlite+ferrite, lower carbon content at the core and higher carbon content at the surface with large inclusions.	bloomery iron, cementation, forged
57	ZTH 104Z		cross section (V)				pearlite+ferrite, even carbon content, about 0.4%, few inclusions.	
58	ZTH 106 H	M1:5	cross section (H)	iron ring	476-300BC	Xi'an (Central Plain)	ferrite in the core, widmanstatten structures at the surface, large slag inclusions.	bloomery iron, cementation, forged
59	ZTH 106Z		cross section (V)				ferrite, uneven grain sizes, slag stringers.	
60	ZTH 102 H	M1:6	cross section (H)	iron ring	476-300BC	Xi'an (Central Plain)	ferrite+pearlite in layers, many slag inclusions.	bloomery iron, cementation, forged
61	ZTH 102Z		cross section (V)				ferrite+pearlite, 0.4% carbon content, double phase inclusions.	
62	ZTH 110 H	M1:10	cross section (H)	belt hook	476-300BC	Xi'an (Central Plain)	fully corroded.	hypoeutectic white cast iron
63	ZTH 110Z		cross section (V)				pearlite+Fe3C+ledeburite, about 0.4% carbon content.	
64	ZTH 111 H	M1:11	cross section (H)	belt hook	476-300BC	Xi'an (Central Plain)	fully corroded.	hypoeutectic white cast iron, decarburized
65	ZTH 111Z		cross section (V)				fully corroded, higher carbon at the outer area than inner area, some ledeburite in the inner area.	
66	ZTH 112 H	M1:12	cross section (H)	belt hook	476-300BC	Xi'an (Central Plain)	ferrite.	hypoeutectic white cast iron, decarburized
67	ZTH 112Z		cross section (V)				ferrite in the outer area, ledeburite in the inner area.	
68	ZTH 115 H	M1:13	cross section (H)	belt hook	476-300BC	Xi'an (Central Plain)	fully corroded, some ledeburite inner area, low carbon at the outter area.	hypoeutectic white cast iron

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
69	ZTH 115Z		cross section (V)				fully corroded.	
70	2432	Yong:120	broken section	sabre	202BC -20AD	Jiangsu (eastcoast)	pearlite+ferrite, 0.5-0.6% carbon content, many single phase inclusions distributed in lines in the core, segragation of phosphorous, 12-18 layers by different carbon content near the cutting edge, about 10 layers away from the cutting edge, a few small inclusions.	folded and forged from fined iron and carburized steel from bloomery iron
71	2433	E1:92	broken section	*fu*-pot	202BC -20AD	Jiangsu (eastcoast)	corroded, some ledeburite and some irregular cementite.	white cast iron
72	2436 -1	back chamber	broken section	armor lamella	202BC -20AD	Jiangsu (eastcoast)	badly corroded with some metal remaining, ferrite matrix with some pearlite at the grain boundaries, 4-7 grain sizes, 0.1-0.12% carbon content, single phase slag stringers.	decarburized steel from white cast iron, cold forging
73	2436 -2	back chamber	broken section	armor lamella	202BC -20AD	Jiangsu (eastcoast)	badly corroded with some metal remaining, ferrite+small amounts of pearlite, 0.06-0.1% carbon content, widmanstatten structure in some area, small single phase slag inclusions.	decarburized steel from white cast iron, cold forging
74	2436 -3	back chamber	broken section	armor lamella	202BC -20AD	Jiangsu (eastcoast)	badly corroded with some metal remaining, ferrite, some carbon precipitate at grain boundaries, an area of small grains in the core, and bigger grains at the outter areas, deformed grains in some direction, single phase slag inclusions.	decarburized steel from white cast iron
75	2436 -5	back chamber	broken section	armor lamella	202BC -20AD	Jiangsu (eastcoast)	badly corroded with little metal remaining, uneven grain sizes, larger ones are pearlite+ferrite with 0.5% carbon, smaller ones are ferrite+pearlite with 0.2% carbon, some small deformed single phase slag inclusions distributed in lines, and some big undeformed single phase inclusions.	decarburized steel from white cast iron, forged
76	2437 -2	E5	broken section	armor lamella	202BC -20AD	Jiangsu (eastcoast)	badly corroded with little metal remaining, ferrite, grade 6 grain size, some spherical single phase slag inclusions.	decarburized steel from white cast iron, forged
77	2437 -3	E5	broken section	armor lamella	202BC -20AD	Jiangsu (eastcoast)	badly corroded with little metal remaining, ferrite, grade 6 grain size, some spherical single phase slag inclusions.	——
78	2438 -3	E5	broken section	armor lamella	202BC -20AD	Jiangsu (eastcoast)	badly corroded with little metal remaining, pearlite+ferrite, 0.5% carbon content, few small single phase slag stringers.	decarburized steel from white cast iron, forged

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
79	2440-1	——	head	chisel	202BC-20AD	Jiangsu (eastcoast)	partially carburized, some widmanstatten structures at the surface, ferrite+pearlite in the core, 0.1% carbon content, some single phase inclusions and a few double phase inclusions.	decarburized steel from white cast iron, forged
80	2440-2	——	head	chisel	202BC-20AD	Jiangsu (eastcoast)	many martensite, some troostite, less martensite and uneven carbon content in the core, forged, trace of folding and forging, quenched. Many small single phase slag stringers. A large crack in the core filled with FeO, possibly inclusions which cracked when quenching.	fined iron, folding and forging, partially quenched
81	2441-1	——	head	unidentifed object	202BC-20AD	Jiangsu (eastcoast)	ferrite, grade 4 grain size, double phase inclusions, crack in the core.	bloomery iron, forged
82	2441-2	——	broken section	unidentifed object	202BC-20AD	Jiangsu (eastcoast)	low carbon steel, uneven carbon content, few slag inclusions.	decarburized steel from white cast iron, forged
83	2442	Yong:184	cross section?	door seal	202BC-20AD	Jiangsu (eastcoast)	few pearlite from the boundaries of ferrite grains, 0.1% carbon content, ferrite in the core, grade 5 grain size, many slag inclusions, larger ones double phase, smaller ones single phase stringers.	waste material from fining, forged
84			?				a few pearlite on ferrite matrix, deformed grain, some widmanstatten structure.	decarburized steel from white cast iron, forged
85	2450	——	head	chisel	202BC-20AD	Jiangsu (eastcoast)	small martensite, single phase slag stringers, a crack in the core which shows the trace of folding and forging, double phase inclusions in the crack area.	fined iron, partially quenched
86	2453	Yong:3	cutting edge?	spearhead	202BC-20AD	Jiangsu (eastcoast)	higher carbon at the surfaces and the point, partially spheridized cementite, 0.15-0.5% carbon content, 8 layers by different carbon content and grain sizes, many single phase slag stringers.	carburized steel from bloomery iron, folding and forging
87	2454	Yong:17	cutting edge?	spearhead	202BC-20AD	Jiangsu (eastcoast)	badly corroded, ferrite+pearlite+widmanstatten structure, higher carbon at surface, about 0.5-0.8%, lower carbon in the core, about 0.3-0.4%, a few single phase inclusions close to surface.	fined iron, folding and forging
88	2457	——	head	chisel	202BC-20AD	Jiangsu (eastcoast)	mainly ferrite, 5-7 grain sizes, ferrite+pearlite at the surface, 0.3% carbon content, trace of carburization, small single phase inclusions in the core, and double phase stringers.	carburized steel from bloomery iron, folding and forging
89	2458	——	middle?	unidentifed object	202BC-20AD	Jiangsu (eastcoast)	ferrite, grade 2 grain size, small grains in some areas, unevenly distributed double phase slag inclusions.	bloomery, forged

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
90	2459	——	head	chisel	202BC -20AD	Jiangsu (eastcoast)	martensite and troostite, uneven grain sizes and carbon content, spherical cementite in the core, many small irregular single phase slag inclusions.	fined iron, folding and forging, partially quenched
91	2460	——	head	chisel	202BC -20AD	Jiangsu (eastcoast)	needle-like martensite, decreasing away from the point, different carbon content layers where has less martensite, an average of 12 layers, martensite at low carbon layers, troostite at high carbon layers. Slag inclusions along with forging direction, mostly distributed in high carbon layers, segragation of phosphorous.	two pieces of fined iron, folding and forging, partially quenched
92	1	T1119 ⑧:2		shovel head	300-221BC	Hebei (Central Plain)	some graphite stripes and very little spherical graphite on hypereutectic white cast iron+pearlite matrix.	mottled iron
93	2	T1217⑧ H191:1		sickleh ead	300-221BC	Hebei (Central Plain)	martensite.	decarburized steel from white cast iron, quenched
94	3	T1217 ⑧:1		basin?	300-221BC	Hebei (Central Plain)	pearlite+Fe3C+ledeburite, hypoeutectic white cast iron.	white cast iron
95	4	T1116⑦ H99:1		plough share	202-150BC	Hebei (Central Plain)	pearlite+Fe3C+ledeburite, hypoeutectic white cast iron.	white cast iron
96	5	T1217 ⑦:2		shovel head	202-150BC	Hebei (Central Plain)	ledeburite+primary cementite, hypereutectic white cast iron.	white cast iron
97	6	T1217 ⑦:5		adze	202-150BC	Hebei (Central Plain)	hypereutectic white cast iron--pearlite from core to surface.	decarburized cast iron
98	7	T1318⑦ F7:5		plough share	202-150BC	Hebei (Central Plain)	pearlite+Fe3C+ledeburite, hypoeutectic white cast iron.	white cast iron
99	8	T1219 ⑦:2		arrowh ead	202-150BC	Hebei (Central Plain)	ferrite+pearlite, 0.2-0.4% carbon content in layers.	fined iron
100	9	T1219⑦ L4:1		spearh ead	202-150BC	Hebei (Central Plain)	ferrite+pearlite, some widmanstten structure on the surface, 0.1-0.2% carbon cnotent, clear layers, small slag inclusions along with forging direction.	fine iron, forged
101	10	T1318 ⑦:1		arrowh ead	202-150BC	Hebei (Central Plain)	ferrite, 2-4 grain sizes, small slag inclusions along with forging direction.	fined iron (wrought iron)
102	11	T1117⑦ H135:4		nail	202-150BC	Hebei (Central Plain)	ferrite, 2-4 grain sizes, some single phase inclusions.	decarburized steel from white cast iron (wrought iron)
103	12	T1216 ⑦:3		nail	202-150BC	Hebei (Central Plain)	ferrite+pearlite, 0.2-0.5% carbon content.	decarburized steel from white cast iron

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
104	13	T1219 ⑦:7		knife	202-150BC	Hebei (Central Plain)	badly corroded, unidentified material.	——
105	14	T1416⑦ J2:4		ring-headed knife	202-150BC	Hebei (Central Plain)	ferrite+pearlite+widmanstten structures, 0.6% carbon content.	decarburized steel from white cast iron
106	15	T1417⑦ H85:1		hook	202-150BC	Hebei (Central Plain)	pearlite+Fe3C, hypereutectoid steel, 1.4% carbon content.	decarburized steel from white cast iron
107	16	T1418 ⑦:5		basin?	202-150BC	Hebei (Central Plain)	ledeburite, eutectic white cast iron.	white cast iron
108	17	T1117⑦ H135:2		unidentifed object	202-150BC	Hebei (Central Plain)	ferrite+pearlite+widmanstten structure in the core, and ferrite in the surface.	decarburized steel from white cast iron
109	18	T0127⑥ H221:1		hoehead	150BC-20AD	Hebei (Central Plain)	badly corroded, some ferrite+pearlite in the remaining metal.	decarburized steel from white cast iron
110	19	T1219⑥ H108:2		implement cap	150BC-20AD	Hebei (Central Plain)	pearlite--ferrite+pearlite--ferrite from core to surface.	decarburized steel from white cast iron
111	20	T1316⑥ H69:4		mattockhead	150BC-20AD	Hebei (Central Plain)	pearlite+Fe3C, hypereutectoid steel, 1.4% carbon content, some martensite.	decarburized steel from white cast iron, partially quenched
112	21	T1317⑥ H68:6		sicklehead	150BC-20AD	Hebei (Central Plain)	pearlite+Fe3C, hypereutectoid steel, 1.8% carbon content.	decarburized steel from white cast iron
113	22	T1318⑥ G10:6		plough share cap	150BC-20AD	Hebei (Central Plain)	pearlite+Fe3C+ledeburite, hypoeutectic white cast iron.	white cast iron
114	23	T1419 ⑥:3		plough share cap	150BC-20AD	Hebei (Central Plain)	hypereutectic white cast iron--ferrite+pearlite--ferrite from core to surface.	decarburized cast iron
115	24	T0131 ⑥:1		arrowhead	150BC-20AD	Hebei (Central Plain)	ferrite, 2-5 grain sizes, ferrite+pearlite, 0.15% carbon content, even layers.	fined iron
116	25	T0131⑥ F4:3		arrowhead	150BC-20AD	Hebei (Central Plain)	ferrite, grade 2-4 grain sizes, small slag inclusions along with forging direction.	fined iron (wrought iron), forged
117	26	T1418⑥ F1:1		arrowhead	150BC-20AD	Hebei (Central Plain)	ferrite+pearlite, even layers, 0.2-0.6% carbon content.	fined iron
118	27	T1118⑥ H126:2		arrowhead	150BC-20AD	Hebei (Central Plain)	ferrite, grade 2-4 grain sizes, small slag inclusions along with forging direction.	fined iron (wrought iron), forged
119	28	T1118 ⑥:1		hammerhead	150BC-20AD	Hebei (Central Plain)	ferrite+pearlite, hypoeutectoid steel, cold forging, about 0.4% carbon.	decarburized steel from white cast iron, cold forging

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
120	29	T1118⑥ H126:3		knife	150BC -20AD	Hebei (Central Plain)	pearlite+Fe3C, hypereutectoid steel, uneven carbon content, about 1.8%.	decarburized steel from white cast iron
121	30	T1416 ⑥:7		knife	150BC -20AD	Hebei (Central Plain)	pearlite+small amounts of ferrite, hypoeutectoid steel, 0.7% carbon content, martensite at the cutting edge.	decarburized steel from white cast iron, partially quenched
122	31	T1217⑥ H156:1		knife	150BC -20AD	Hebei (Central Plain)	hypereutectic white cast iron--pearlite--ferrite+pearlite--ferrite from core to surface.	decarburized cast iron
123	32	T1318⑥ G10:3		knife	150BC -20AD	Hebei (Central Plain)	widmanstten structure, hypereutectoid steel, 0.8% carbon content.	decarburized steel from white cast iron
124	33	T1318⑥ G10:5		knife	150BC -20AD	Hebei (Central Plain)	pearlite in the core, 0.6% carbon content, martensite at the cutting edge, single phase inclusions along with forging direction.	decarburized steel from white cast iron, forged and quenched
125	34	T1319 ⑥:3		chisel	150BC -20AD	Hebei (Central Plain)	wrought iron--hypoeutectoid steel (high carbon)--hypoeutectoid steel (low carbon) from core to surface (horizontal cut); wrought iron--hypoeutectoid steel--hypereutectoid steel--hypoeutectoid steel--hypereutectoid steel--pig iron--wrought iron--corrosion (vertical cut); 0.2-0.7mm each layer, no inclusions.	possibly perfusing steel (mixture of liquid cast iron and heated low carbon steel/wrought iron)
126	35	T1117⑥ G7:1		horse bit	150BC -20AD	Hebei (Central Plain)	pearlite+Fe3C hypoeutectoid steel, 0.8-1.4% carbon content.	decarburized steel from white cast iron
127	36	T1217⑥ H181:3		hook	150BC -20AD	Hebei (Central Plain)	ferrite+pearlite in even layers, even carbon content, 0.1-0.2% carbon, small single phase inclusions along with forging direction.	fine iron, forged
128	37	T1217 ⑥:1		unidentifed object	150BC -20AD	Hebei (Central Plain)	ferrite, grade 2-4 grain sizes, many single phase slag inclusions along with forging direction, and little double phase inclusions.	fined iron (wrought iron), forged
129	38	T1217 ⑥:2		unidentifed object	150BC -20AD	Hebei (Central Plain)	badly corroded, ferrite in the remaining metal, small single phase slag inclusions along with forging direction.	fined iron (wrought iron), forged
130	39	T0131 ⑤:6		sicklehead	20-220AD	Hebei (Central Plain)	badly corroded, unidentified material.	——
131	40	T1416 ⑤:1		sicklehead	20-220AD	Hebei (Central Plain)	ferrite+pearlite hypoeutectoid steel, 0.6% carbon.	decarburized steel from white cast iron
132	41	T1216⑤ H48:1		adze	20-220AD	Hebei (Central Plain)	graphite stripes on hypereutectic white cast iron matrix.	mottled iron
133	42	T0131 ⑤:1		knife	20-220AD	Hebei (Central Plain)	ferrite+pearlite hypoeutectoid steel, uneven carbon, 0.1-0.3%.	decarburized steel from white cast iron

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
134	43	T1418⑤ H138:1		arrowhead	20-220AD	Hebei (Central Plain)	ferrite, grade 2-3 grain sizes, small slag inclusions along with forging direction.	fined iron (wrought iron), forged
135	44	T1418⑤ H150:1		arrowhead	20-220AD	Hebei (Central Plain)	ferrite, grade 3-5 grain sizes.	decarburized steel from white cast iron (wrought iron)
136	45	T1418⑤ H138:2		hook	20-220AD	Hebei (Central Plain)	ferrite, grade 2-4 grain sizes, small slag inclusions along with forging direction.	fined iron (wrought iron), forged
137	46	T1116 ⑤:3		unidentifed object	20-220AD	Hebei (Central Plain)	stripe graphite on hypoeutectic white cast iron matrix.	mottled iron
138	47	T1216 ⑤:5		unidentifed object	20-220AD	Hebei (Central Plain)	hypereutectic white cast iron--ferrite+pearlite--ferrite from core to surface, some cotton-like graphite in the core.	malleable cast iron
139	48	T1216 ⑤:6		unidentifed object	20-220AD	Hebei (Central Plain)	badly corroded, hypereutectic structures in remaining metal.	white cast iron
140	49	T1418⑤ H149:1		unidentifed object	20-220AD	Hebei (Central Plain)	pearlite+Fe3C+ledeburite, hypoeutectic white cast iron.	white cast iron
141	50	T1418⑤ H149:2		unidentifed object	20-220AD	Hebei (Central Plain)	ferrite+small amounts of pearlite in layers, grade 2-4 grain sizes, small inclusions along with forging direction.	fine iron, forged
142	51	T1116 ⑤:2		unidentifed object	20-220AD	Hebei (Central Plain)	ferrite, grade 2-4 grain sizes.	decarburized steel from white cast iron (wrought iron)
143	52	T1416 ④:1		shovel head	+7th/+13th century	Hebei (Central Plain)	ledeburite+primary cementite, hypereutectic white cast iron.	white cast iron
144	53	T1820 ④:1		belt hook	+7th/+13th century	Hebei (Central Plain)	ledeburite, eutectic white cast iron.	white cast iron
145	54	T0129 ④:2		unidentifed object	+7th/+13th century	Hebei (Central Plain)	pearlite--ferrite+pearlite--ferrite from core to surface.	decarburized cast iron
146	55	T0131 ④:1		unidentifed object	+7th/+13th century	Hebei (Central Plain)	ferrite, grade 2-5 grain sizes, small slag inclusions.	fined iron (wrought iron)
147	56	T1216 ④:1		unidentifed object	+7th/+13th century	Hebei (Central Plain)	pearlite+Fe3C+leburite, hypoeutectic white cast iron.	white cast iron
148	57	T1219 ④:1		unidentifed object	+7th/+13th century	Hebei (Central Plain)	ferrite+small amounts of pearlite, 0.1% carbon.	decarburized steel from white cast iron
149	58	T1219 ③:2		arrowhead	+13th/14th century	Hebei (Central Plain)	ferrite+small amounts of pearlite, uneven grain sizes, grade 2-4, slag inclusions along with forging direction.	fine iron

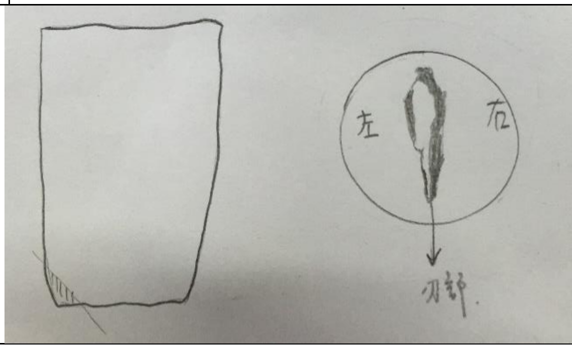
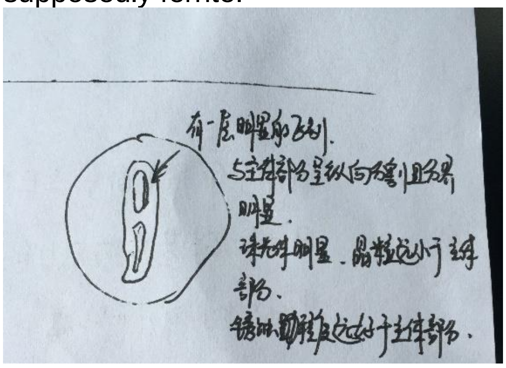
No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
150	59	T1316 ③:2		nail	+13th/ 14th century	Hebei (Central Plain)	pearlite+Fe3C+ledeburite, hypoeutectic white cast iron.	white cast iron
151	60	T0131 ③:1		unident ifed object	+13th/ 14th century	Hebei (Central Plain)	hypereutectoid white cast iron--ferrite+pearlite--ferrite from core to surface.	decarburized cast iron
152	61	T0738 ②:1		nail	+14th/ 19th century	Hebei (Central Plain)	ferrite, uneven grain sizes, grade 2-5, double phase inclusions, small and largely deformed, uneven distribution, some along with the forging direction.	fine iron, forged
153	1300 1	02SEG1: 43		mattoc khead	300-221BC	Jilin (northeast)	uneven carbon content, ferrite at the surface and increased carbon content to the core, ferrite--ferrite+small amounts of pearlite--pearlite--martensite.	decarburized steel from white cast iron, quenched
154	1300 2	02SEG1: 44		mattoc khead	300-221BC	Jilin (northeast)	almost no carbon, ferrite, small amounts of spherical single phase inclusions, and many corrosion.	decarburized steel from white cast iron (wrought iron)
155	1300 3	02SEG1: 52		mattoc khead	300-221BC	Jilin (northeast)	badly corroded, no metal remaining.	——
156	1300 4	02SEG3: 3		sickleh ead	300-221BC	Jilin (northeast)	badly corroded, no metal remaining.	——
157	1300 5	02SEG3: 15		mattoc khead	300-221BC	Jilin (northeast)	almost no carbon, ferrite, uneven grain sizes, small amounts of spherial single phase inclusions.	decarburized steel from white cast iron (wrought iron)
158	1300 6	02SEH4: 6		mattoc khead	300-221BC	Jilin (northeast)	almost no carbon, ferrite, uneven grain sizes, some segragation in phosphorous.	decarburized steel from white cast iron (wrought iron)
159	1300 7	02SET04 14①:16		mattoc khead	300-221BC	Jilin (northeast)	ferrite matrix with cotton-like graphite, very little slag inclusions.	black heart malleable cast iron
160	1300 8	02SET04 16③:10		mattoc khead	300-221BC	Jilin (northeast)	ferrite matrix with cotton-like graphite, very little slag inclusions, badly corroded at graphite.	black heart malleable cast iron
161	1300 9	02SET06 17③:10		mattoc khead	300-221BC	Jilin (northeast)	ferrite, very little slag inclusions.	wrought iron (steel decarburized from cast iron)
162	1301 0	02SET07 16②:10		mattoc khead	300-221BC	Jilin (northeast)	ferrite matrix with some corrosion.	decarburized steel from white cast iron (wrought iron)
163	1301 1	02SET08 18		mattoc khead	300-221BC	Jilin (northeast)	mostly eutectic white cast iron structure, some hypereutectic structure of cementite.	white cast iron
164		M44:19	cutting edge	sword	300-221BC	Hebei (Central Plain)	ferrite matrix, 0.05% carbon content, single and double phase slag inclusions	bloomery iron, forged
165		M44:12	cutting edge	sword	300-221BC	Hebei (Central Plain)	alternative layers of 0.5-0.6 and 0.15-0.2% carbon contents, quenched, possibly folded and forged.	bloomery iron, forged
166		M44:100	cross section	sword	300-221BC	Hebei (Central Plain)	alternative layers of 0.5-0.6 and 0.15-0.2% carbon contents, quenched, possibly folded and forged.	bloomery iron, forged

No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
167		M44:9	inner cutting edge	halberdhead	300-221BC	Hebei (Central Plain)	alternative layers of 0.5-0.6% and 0.1% carbon contents, possibly forged bloomery iron to thin sheets, carburize and then forged together and quenched.	bloomery iron, forged
168		M44:87		tail of arrowhead	300-221BC	Hebei (Central Plain)	ferrite and pearlite, 0.2% carbon content, trace of differnet layers.	low carbon steel
169		M44:115	socket	spearhead	300-221BC	Hebei (Central Plain)	slightly higher than 0.2% carbon content, grade 3 grain size, widmanstatten structure.	low carbon steel
170		M44:114	bottom	ferrule	300-221BC	Hebei (Central Plain)	ferrite and cotton-like graphite.	malleable cast iron
171		M44:123		mattockhead	300-221BC	Hebei (Central Plain)		white cast iron
172		M44:13		hoehead	300-221BC	Hebei (Central Plain)	decarburized from white cast iron, ledeburite in the core, small amounts of cotton-like graphite in the outter area.	decarburized from white cast iron
173		M264:4		ring-headed knife	300-221BC	Guizhou (southwest)	badly corroded with no metal remaining, some widmanstatten structure with ferrite and pearlite can be seen in the corrosion.	decarburized steel from white cast iron
174		M277:6		ring-headed knife	300-221BC	Guizhou (southwest)	uneven structure, widmanstatten structure at the ridge and core areas, c.0.4-0.7% carbon content; ferrite at the cutting edge, some trace of segragation, single and double phase slag stringers.	two pieces of decarburized steel from white cast iron, forged
175		M311:1		knife	300-221BC	Guizhou (southwest)	vertical section: uneven carbon content, ferrite and pearlite with 0.2% carbon and small amounts of single phase slag inclusions on one side; ferrite with more double phase slag inclusions on the other side. Carbon contents varies in between. Horizontal section: mostly similar to the vertical section, but less inclusions at the high carbon content area, and uneven grain sizes at the low carbon area with large amounts of single and double phase slag inclusions.	bloomery iron and decarburized steel from white cast iron, forged
176		M311:2		sword	300-221BC	Guizhou (southwest)	badly corroded with no metal remaining, some trace of ferrite and pearlite can be seen in the corrosion with single phase slag stringers.	decarburized steel from white cast iron
177		M274:92		iron sword with bronze handle	300-150BC	Guizhou (southwest)	badly corroded with no metal remaining, some trace of ferrite and pearlite can be seen in the corrosion with no slag stringers.	decarburized steel from white cast iron
178		M274:93		knife	300-150BC	Guizhou (southwest)	ferrite and pearlite, cementite partially spheridized, some shrinkage holes of casting.	decarburized steel from white cast iron
179		M338:2		mattockhead	300-150BC	Guizhou (southwest)	eutectic white cast iron in the core, badly corroded on the edge with some trace of ferrite and pearlite.	decarburized cast iron
180		M351:3		ring-headed knife	300-150BC	Guizhou (southwest)	ferrite and pearlite with 0.4% carbon content, some shrinkage holes of casting.	decarburized steel from white cast iron
181		M360:1		Shovel head	300-150BC	Guizhou (southwest)	vertical section: hypereutectoid steel structure formed with pearlite and cementite by a fast cooling rate in some areas, both single and double phase slag stringers, and ferrite and pearlite in the remaining areas; horizontal	decarburized steel from white cast iron, forged

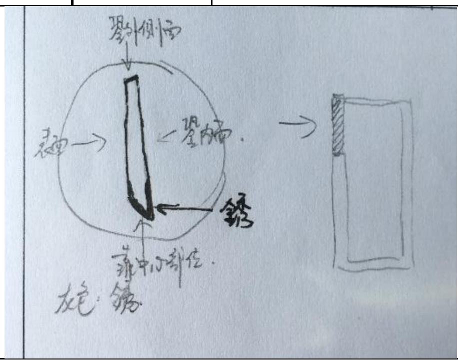
No.	Lab No.	Context	Cutting point	Type	Date	Area	Description*	Conclusion*
							section: uneven struture, ferrite on one side, and ferrite and pearlite on the other side with 0.2% carbon content, both single and double phase slag stringers.	
182		M284:1		curved blade	202-150BC	Guizhou (southwest)	badly corroded with some small metal granules remaining, ferrite and pearlite with uneven carbon content.	decarburized steel from white cast iron
183		M284:3		U-shaped implement cap	202-150BC	Guizhou (southwest)	badly corroded, ferrite matrix with cotton-like graphite can be seen in the corrosion in the core, a decarburization layer on the edge.	malleable cast iron, decarburized from white cast iron
* Note that the description and conclusion were direct translation from the Chinese reports								

6. Details of the metallographic samples

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.1	02YLIF12:1	SK0001	mattockhead	Lijiaba		ZhangMY
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: badly rusted, some metal remained in the upper half, the rest are net shaped gray rust. (pic01,02,03,04) X10: a lot of small black dots are observed in metal remained area. (pic01)					
Etch	2% Nital					
After etching	X5: the structure of the metal part matches the rust part adjacent, grey structure looks like pearlite, white dendritic structure is supposedly ferrite.  One layer is vertically distributed and different than the main part, pearlite observed, grain size is way smaller than the main part, less rusty (pic01). Pearlite structure is very clear under X10/X20/X40. (pic01,02,03)					
Conclusion						
Note						

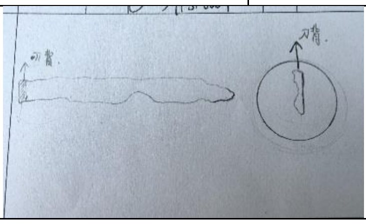
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.6.29	02YLDT0514-0615③:1	SK0002	mattockhead	LJB		ZMY
Sampling details	Sampling point	socket				
						
Before etching	X5: sample is mainly grey and white surrounded by rust, there are black and dark grey dots on the main parts. (pic01, 02, 03, 04)					
Etch	2% Nital					
After etching	X5: about 0.6% ~ 0.7% carbon, ferrite distributed in net shape. Some black dots seem to be graphite, but there is also grey rust on it, might be imperfection from sample preparing. (pic01, 02, 03) No slag inclusion.					
Conclusion	Decarburized cast iron. Hypoeutectoid steel, ca.0.6-0.7% carbon.					
Note						

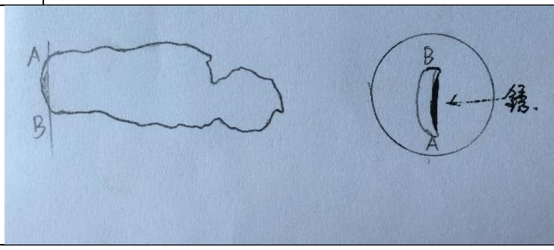
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.6	02YLIDT0409 ⑩:1	SK0003	axehead	LJB		LYN
Sampling details	Sampling point	corrosion				
Before etching	No metal. Rusted entirely, light grey and greyish white structures.					
Etch						
After etching						
Conclusion						
Note						

Recording Sheet of Metallographic Samples

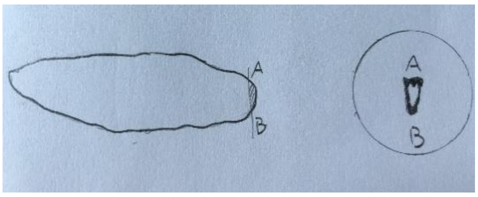
Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.1	02YLIAT0709-0810⑮:3	SK0004	iron knife	LJB		ZMY
Sampling details	Sampling point	Near the bottom end, cross section				
						
Before etching	X5: greyish white, upper and lower parts have cotton-like black dots vertically distributed in the middle of the sample. Much smaller black dots all over the sample. (pic01, 02, 03, 04, 05, 06, 07)					
Etch	2% Nital					
After etching	X5: graphite-like structures, different in grain sizes, middle part is bigger than two ends. Pearlite and Ferrite observed. Pearlites are more evenly distributed near the back of the knife. There are obvious horizontally distributed Ferrite near the cutting edge side. (pic01, 02, 03, 04, 05) No slag inclusion. X20: fine netty Ferrite can be observed. (pic01, 02, 03, 04)					
Conclusion	Cast. Carbon content nearly 0.77% eutectoid steel. Unintentional light graphitization.					
Note						

Recording Sheet of Metallographic Samples

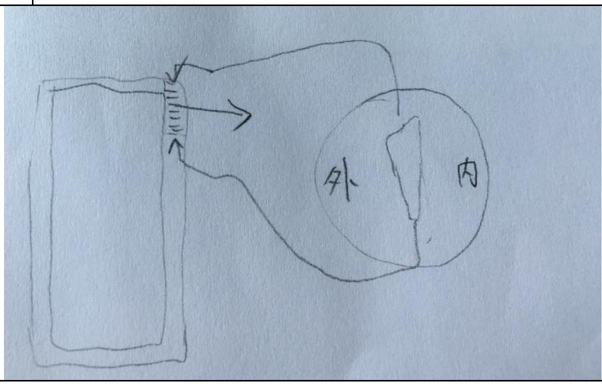
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.2</td><td>02YLIAT0208 ④:1</td><td>SK0005</td><td>Iron knife (sickle?)</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Near the bottom end, cross section</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: sample greyish white, small black dots, vertically distributed, slightly curved. (pic01, 02, 03)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: Ferrite matrix, grain boundary clear, different in grain sizes, can be divided in 3 equal parts. Middle part, grain sizes are twice bigger. Slag inclusion different in sizes, strip shape, slightly curved as the shape of the object. Slag inclusions from both sides are thinner and more in number than in the middle. The biggest slag inclusion is about 0.3 mm long. (pic01, 02, 03, 04)

X40: the slag inclusion is composed by black and grey two structures. Grey structure is 70% ~ 80% in portion. (pic01, 02, 03, 04)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Wrought iron, forged. From fined iron or bloomery iron undecided.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

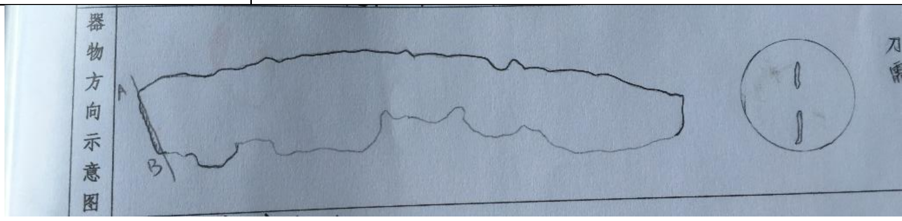
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.7	02YLIAT0207 ⑧:1	SK0006	arrowhead	LJB		
Sampling details	Sampling point	Tail end				
						
Before etching	X5: sample edge is rusted, sample is greyish white, many uneven black dots. (pic01)					
Etch	2% Nital					
After etching	X5: evenly distributed small polygon grain. Black dots still present all over the sample. Ferrite only, no pearlite. No slag inclusion. (pic01, 02, 03) X20: black dots bubble-like, probably rust. (pic01, 02, 03)					
Conclusion	Wrought iron from decarburized cast iron.					
Note						

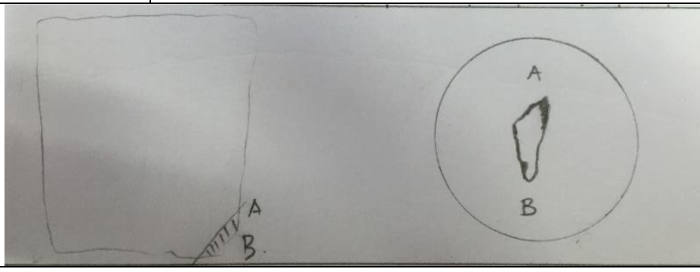
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.1	02YLIF12:2	SK0008	mattockhead	LJB		ZMY
Sampling details	Sampling point	Socket				
						
Before etching	X5: greyish white, black cotton-like nodule structure. (01, 02)					
Etch	2% Nital					
After etching	X5: grain boundary is clearer in the middle than around. Ferrite, pearlite and black cotton-like nodule are observed. Large number of pearlite in the middle but none at both sides (fully decarburized layer) (01). X10: The forms of pearlite are in flakes. The grain sizes are different (01). X20: The grain boundaries are not clear in the side areas. Some of the grains are very close to 0.8% carbon, the others contain ferrite only and no pearlite (01). X40: The black cotton-like nodule are likely graphite (01).					
Conclusion	Cast. Graphitized. Steel from decarburized cast iron.					
Note						

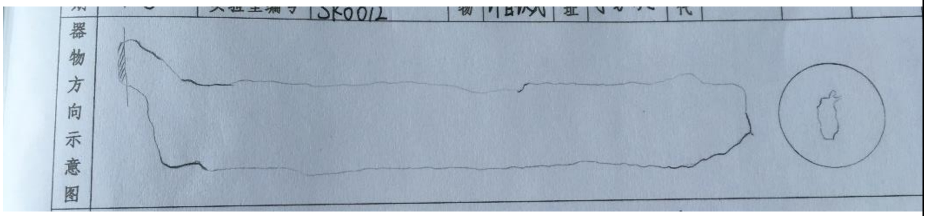
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.7	02YLIAT0511⑮:2	SK0010	iron knife?	LJB		
Sampling details	Sampling point	Tail end				
						
Before etching	X5: sample is broken into two parts, skin layer rusted.					
Etch	2% Nital					
After etching	X5: grain sizes are large, irregular polygon. Grey structures in the upper area, different sizes, similar to the rusted structures of the skin layer. Some stripe structures are discovered vertically distributed in the top area of the lower part of the sample, seem like slag inclusion distributed along with the forging direction. (pic01, 02, 03, 04) X20: some of the grain boundaries are not clear, probably due to multiple working processes. No pearlite.					
Conclusion	Wrought iron, either from fined iron or bloomery iron.					
Note						

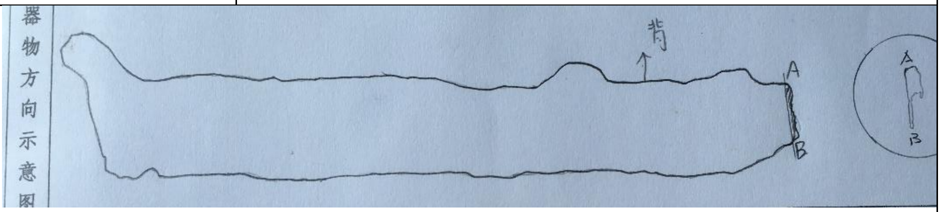
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.18</td><td>01YLIIBT1510-1611㉖:2</td><td>SK0011</td><td>axehead</td><td>LJB</td><td></td><td>ZMY</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cutting edge</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: badly rusted, metal in the middle, greyish white, uneven black and grey dots. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: clear grain boundary, large grain size, about 0.4mm in average. Directional slag inclusions. (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Fined iron or bloomery iron. Forged.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.8	02YLIAT0207 ⑧:6A	SK0012	Ring-head knife	LJB		
Sampling details	Sampling point	Cross section of the ring head.				
						
Before etching	X5: greyish white, black dots unevenly distributed. (pic01、02、03、04)					
Etch	2% Nital					
After etching	X5: pearlite and ferrite matrix. Different carbon content in layers. Some layers are slightly curved. Grain boundary not clear. (pic01、02、03、04) X10: different layers. (pic01)					
Conclusion	Decarburized cast iron. Carbon content ca. 0.5-0.6% hypo-eutectoid steel.					
Note						

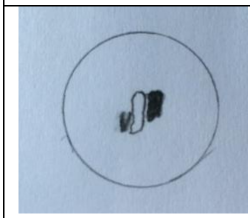
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.8</td><td>02YLIAT0207 ⑧:6B</td><td>SK0013</td><td>Ring-head iron knife</td><td>LJB</td><td></td><td></td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cross section of the front</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: badly rusted. Few metal remains, greyish white. (pic01)。</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite and ferrite, unevenly distributed. The top area of the sample is almost pearlite free. (pic01、02)
X10: unevenly distributed pearlite. (pic01、02、03、04、05、06)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Decarburized cast iron. Uneven carbon content, lower part less 0.1%, higher part ca. 0.6%.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.6	02YLIAT0511-15:15(sample1)	SK0014	mattockhead	LJB		LYN
Sampling details	Sampling point	corrosion				
Before etching	No metal. Rusted entirely, light grey and greyish white structures.					
Etch						
After etching						
Conclusion						
Note						

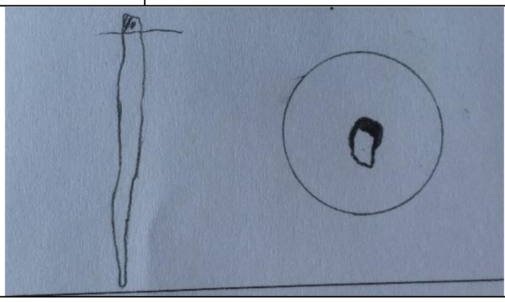
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.8</td><td>02YLIAT0511⑮::15(Sample2)</td><td>SK0015</td><td>mattockhead</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cutting edge</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: badly rusted, some metal in the middle, greyish white.</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: some pearlite and ferrite can be still identified on the rusted structures. (01)
Pearlite much less than ferrite.
Some possibly primary cementite in the top right area. (02)(10-02)
Pearlite can still be identified in the rusted area of the two sides. (03)</td></tr>
<tr><td>Conclusion</td><td colspan="6">White cast iron, cast.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.6</td><td>02YLIAT0511-15:10(sample2)</td><td>SK0017</td><td>arrowhead</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">corrosion</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">No metal. Rusted entirely, light grey and greyish white structures.</td></tr>
<tr><td>Etch</td><td colspan="6"></td></tr>
<tr><td>After etching</td><td colspan="6"></td></tr>
<tr><td>Conclusion</td><td colspan="6"></td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.8</td><td>02YLIAT0511⑮:10(Sample3)</td><td>SK0018</td><td>arrowhead</td><td>LJB</td><td></td><td></td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cross section</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: rusted badly, metal part greyish white. Many black dots. (pic01、02)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite matrix, ferrite net-like. Black dots remain. (pic01、02)

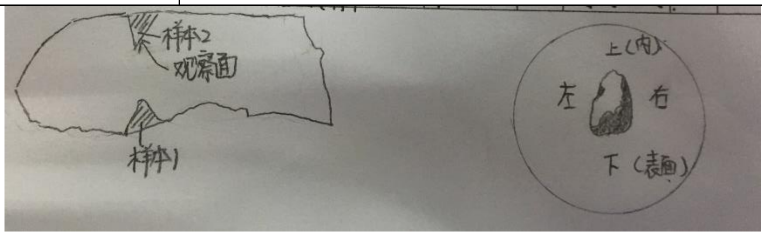
X10: can see pearlite underneath through the black dots, the dots should be rust or dirt. No obvious slag inclusions. (pic01、02)。

X20: flake pearlite. (pic01、02)。</td></tr>
<tr><td>Conclusion</td><td colspan="6">Decarburized cast iron, carbon content about 0.5-0.6%.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

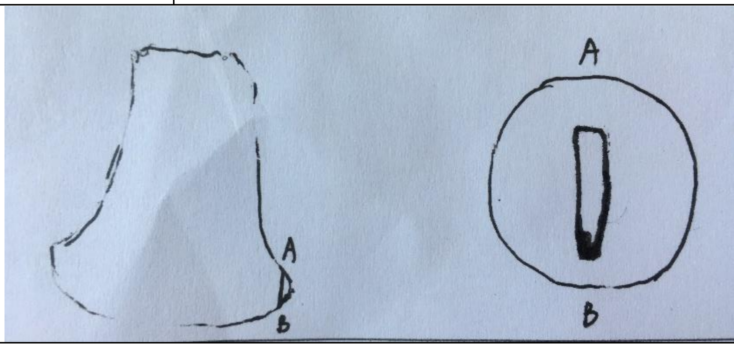
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.6	02YLIDT0712-0813 ③:1(sample1)	SK0019	iron knife	LJB		LYN
Sampling details	Sampling point	cutting edge (corroded)				
Before etching	No metal. Rusted entirely, light grey and greyish white structures.					
Etch						
After etching						
Conclusion						
Note						

Recording Sheet of Metallographic Samples

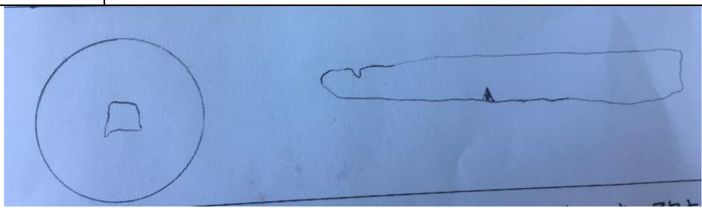
<table>
<tr><th>Date</th><th>Artifact No.</th><th>Lab No.</th><th>Type</th><th>Site</th><th>Artifact date</th><th>Processor</th></tr>
<tr><td>2016.7.15</td><td>02YLIDT0712-0813③:1</td><td>SK0020</td><td>iron knife</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Back</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: rusted on the skin, metal in the middle, greyish white, many small black dots. (01、02)
Few cotton-like black nodules. (03)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite and ferrite matrix. Scattered distributed in the top area. (01) no pearlite in the core.(02、03) small black dots still here. A nearly fully decarburized layer close to the back side. (04)The closer to the back side the more pearlite. (05、06) possibly ferrite matrix and straight stripes cementite in the core. (07) very few graphite. (08)
X10: flake pearlite. Still can see pearlite structure in the rusted areas. (01)
X20: ferrite and cementite in the core. (01)
graphite(02)。</td></tr>
<tr><td>Conclusion</td><td colspan="6">Malleable cast iron, decarburized from white cast iron, graphitized.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

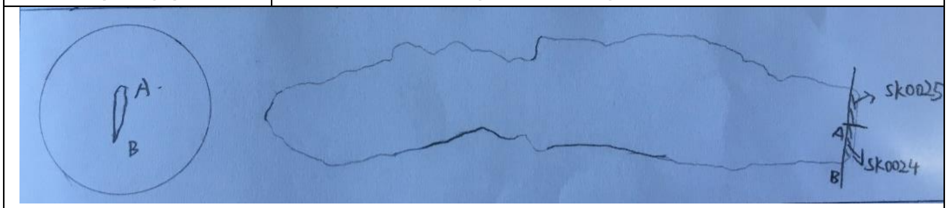
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.16</td><td>02YLIAT0511⑮:4</td><td>SK0021</td><td>Axehead</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cutting edge</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: greyish white, rusted on the skin, many cotton-like black nodules in the middle. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite matrix, ferrite net-like, cotton-like nodule graphite. Graphite is about 0.12mm. (01)
Some areas almost pure ferrite but no pearlite. (02)the rest areas, pearlite and ferrite evenly distributed. (03)
Pearlite in the middle is more than two sides, and graphite is densely distributed in the middle. (03)
The carbon content in the core is about 0.6-0.7%.

X20: flake pearlite, graphite shape like cotton nodule. (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Pearlite + ferrite + cotton nodule like graphite = malleable cast iron.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

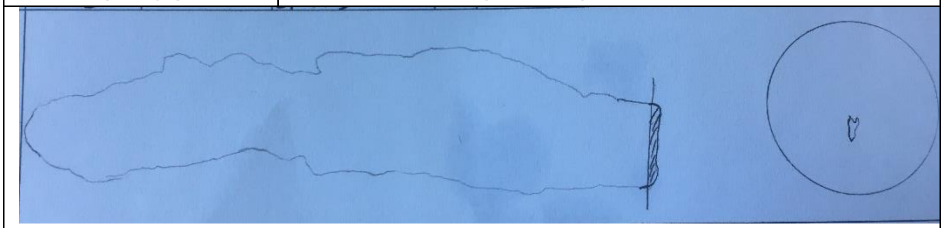
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.13	02IF16:2	SK0022	Iron knife	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: greyish white, tiny black dots. (01) the black dots disappeared in re-polishing.					
Etch	2% Nital					
After etching	X5: pearlite, ferrite. (01、02) ferrite net-like. X40: form of pearlite in flakes. (01) No obvious slag inclusions.					
Conclusion	Decarburized cast iron. Carbon content ca. 0.2% hypo-eutectoid steel.					
Note						

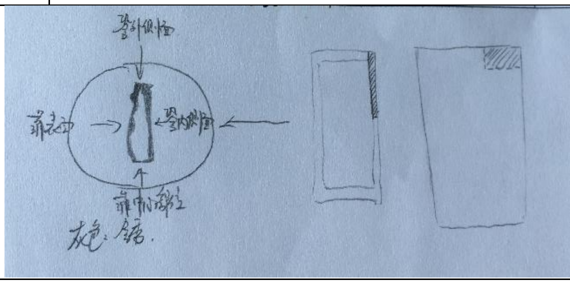
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.16	02YLIAT0608⑪:1A	SK0024	Unidentified iron fragment	LJB		LYN
Sampling details	Sampling point	Cross section (horizontal)				
						
Before etching	X5: greyish white, some vertically distributed black stripes structure. (01)					
Etch	2% Nital					
After etching	X5: pearlite, ferrite, unclear grain boundary. Pearlite in the middle is less than on two sides. (01) Widmanstatten structure. (02) X10: ferrite net-like, form of pearlite unclear. (01) X40: the black stripes do not look like slag inclusions. (01)					
Conclusion	Hypo-eutectoid steel. Low carbon content area ca. 0.1-0.3%, high carbon content area ca. 0.3-0.6%. Fined iron or carburized bloomery iron.					
Note						

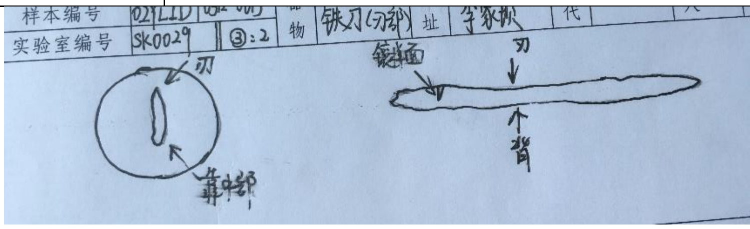
Recording Sheet of Metallographic Samples

<table>
<tr><th>Date</th><th>Artifact No.</th><th>Lab No.</th><th>Type</th><th>Site</th><th>Artifact date</th><th>Processor</th></tr>
<tr><td>2016.7.13</td><td>02YLIAT0608⑪:1B</td><td>SK0025</td><td>Unidentified iron fragment</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cross section (vertical)</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: greyish white structure, some vertically distributed thin and long stripes structure. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite, ferrite, stripes structures. (01)
Middle has more pearlite than two sides, ferrite net-like, widmanstatten structure. (01、02)
X40: grain boundaries are not clear, some of the bigger stripes are cracks or rust. (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Fined iron or carburized bloomery iron, forged.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

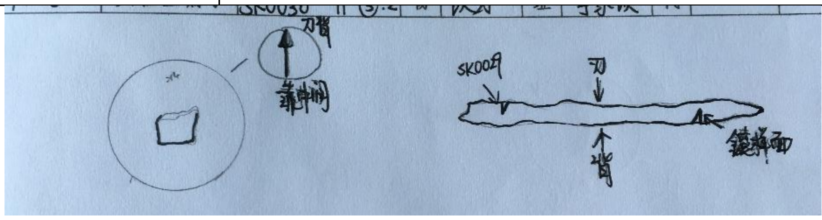
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.6.29	02YLIDT0315-0416③:1	SK0028	mattockhead	LJB		
Sampling details	Sampling point	Socket				
						
Before etching	X5: rusted on the skin, grey. Metal in the middle, greyish white. (01) Black dots in the top right area. (02) Middle left and bottom right can see grey cotton-like nodule. (03、04) Tiny grey dots allover.					
Etch	2% Nital					
After etching	X5: pearlite and ferrite, rusted structure and black dots. (01)。 Right hand side of the sample has no pearlite, uneven grain sizes. (02) X10: pearlite flake, scattered distributed. The black dos should be dirt, because it can be see though to see the pearlite underneath. (01)。					
Conclusion	Decarburized cast iron, a fully decarburized layer on the skin.					
Note						

Recording Sheet of Metallographic Samples

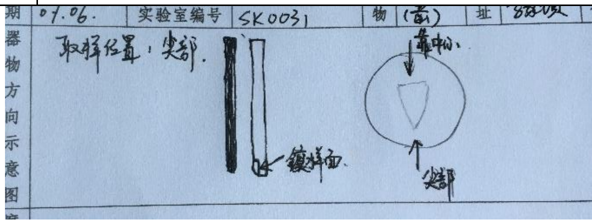
Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.6	02YLDT0512-0613③:2	SK0029	Iron sabre	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: rust on skin layer, slag inclusions stripes. More slag inclusions near the cutting edge, at least 8 stripes. (01、02) X10: small black dots.					
Etch	2% Nital					
After etching	X5: grain sizes are small in the top area of the sample(02). Bottom right pure ferrite, bigger grain size.(01). The closer to the cutting edge, the more pearlite. Slag inclusions are thin and small, the larger stripes found before etching are actually rusted structure. (02)It can be seen that the rusting happens as individual grain, the pearlite became black, and ferrite became grey. There is some black structure in the middle of the sample, doesn't look like neither pearlite nor rust. (03). Cutting edge area, pearlite, smaller grain size. Back area, almost pure ferrite, bigger grain size. X20: can be seen clear the grey stripes are actually rusted grain. (01)The tiny dots are still here after etching. (03)Pearlite distributed along with the grain boundaries, the closer to the cutting edge, the more pearlite. The cutting edge is almost pure pearlite. (02) X50: the black structure looks like rusted pearlite. (01)。					
Conclusion	Carburized bloomery iron, forged, which its cutting edge carbon content is close to 0.77% eutectoid steel.					
Note						

Recording Sheet of Metallographic Samples

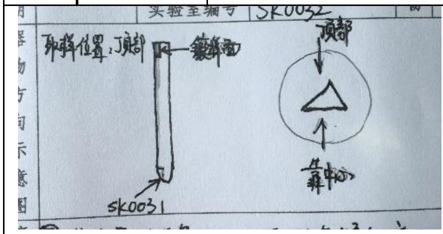
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.6</td><td>02YLIDT0512-0613③:2</td><td>SK0030</td><td>Iron sabre</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Back</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: greyish white structure. Many black dots. (01) some black stripes structure in the middle. (02)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite matrix, clear grain boundary. Grain size about scale 1-2 (according to David. Scott). (001)
A small part in the bottom left, grain size is much smaller, about scale 5-8. (002)

Slag inclusions are grey and black. (003) most are diagonally, some are vertically distributed.(004)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Forged from wrought iron (bloomery iron).</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.6</td><td>02YLVH:1</td><td>SK0031</td><td>Iron chisel</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Point (cutting edge)</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: greyish white, rusted on the skin. Vertically distributed grey and black stripes. (01、 02)
One straight black inclusion about 0.02mm all the way from the top to the bottom of the sample. (03)
Black stripes more than grey ones(04)(05)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite and ferrite. Black and grey slag inclusions. Pearlite unevenly distributed, could be divided into about 8-9 layers from left to right. (01、 02)
① low carbon layer, ferrite matrix, very few pearlite, nearly completely decarburized. ② hypo-eutectoid layer, carbon content ca. 0.2%. ③ inclusion layer, the 0.02mm thick black stripe is possibly the original surface of the object, which was folded during the repairing process. (03).④ eutectoid layer, carbon content ca. 0.77%, almost pure pearlite. (pic04) ⑤ carbon content ca. 0.4%. ⑥ low carbon layer. ⑦ carbon content ca. 0.2%. ⑧ carbon content ca. 0.4%. ⑨ carbon content ca. 0.6%.
X20: the large number of black stripes are slag inclusions, and the small number of grey stripes are possibly rust. (01)
X100: unclear pearlite form. (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Fined iron or carburized bloomery iron. Possibly repaired multiple times (obvious slag inclusions) caused the unevenly carbon distribution.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.6	02YLVH:1	SK0032	Iron chisel	LJB		ZMY
Sampling details	Sampling point	Top				
						
Before etching	X5: greyish white, rusted on the skin. Non-directional black stripes in the middle, about 0.08-0.16mm thick. (01)					
Etch	2% Nital					
After etching	X5: pearlite matrix, ferrite net-like. More ferrite in the top than the bottom. (01、02)。 X40: pearlite in flakes. The black stripes structures are possibly dirt, because it can see though when light is strong enough. (01)。					
Conclusion	Hypo-eutectoid steel. Carbon content ca. 0.6-0.7%. Possibly fined iron.					
Note						

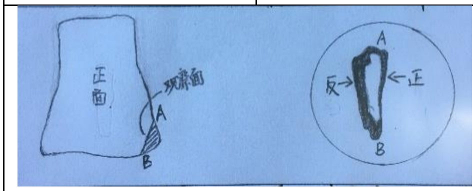
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.6	02YLVH:1(sample3)	SK0033	chisel	LJB		LYN
Sampling details	Sampling point	corrosion				
Before etching	No metal. Rusted entirely, light grey and greyish white structures.					
Etch						
After etching						
Conclusion						
Note						

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.6	02YLDT0512-0613 ③:2(sample3)	SK0034	Iron knife	LJB		LYN
Sampling details	Sampling point	corrosion				
Before etching	No metal. Rusted entirely, light grey and greyish white structures.					
Etch						
After etching						
Conclusion						
Note						

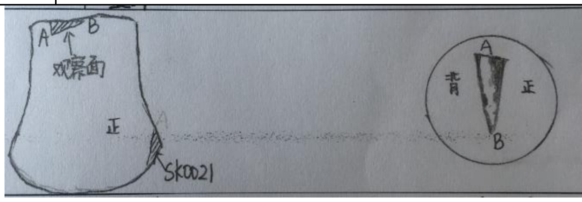
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.12</td><td>02YLDT0409
⑩:1(Sample2)</td><td>SK0035</td><td>Axehead</td><td>LJB</td><td></td><td>ZZC</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cutting edge</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: badly rusted on the skin, metal in the middle. (01)
Black chain and stripe like structures in the middle. (02、03)

X20: the grey area looks like rusted structure. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite and ferrite, pearlite on the right hand side of the sample is more than the left hand side. (01)
Pearlite volume is different in layers, uneven grain sizes, smaller on the right and bigger on the left. (02)

X20: difference of pearlite volume. Widmanstatten structure. (01、02)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Hypo-eutectoid steel. Forged. From fined iron or bloomery iron. One side is almost completed decarburized.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.20</td><td>02YLAT0511⑮:4</td><td>SK0036</td><td>Axehead</td><td>LJB</td><td></td><td>ZZC</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Socket</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: white structure matrix. Few black cotton-like granules, possibly graphite. (02、03)
Grey rust structure. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite matrix, small grain size, clear grain boundary (01、02)
Some pearlite near the socket end, unevenly distributed. (03)

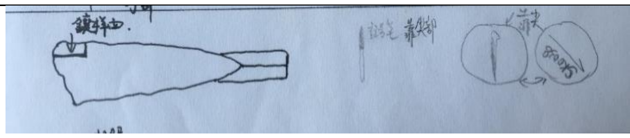
X50: flake pearlite, carbon content ca. 0.2-0.4%. (01)
Shape of the graphite. (02)

No obvious slag inclusions.</td></tr>
<tr><td>Conclusion</td><td colspan="6">Nearly completely decarburized cast iron, only few pearlite in the socket area.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

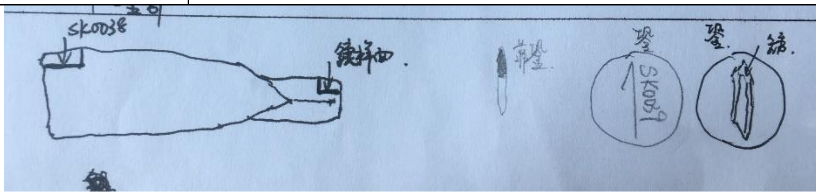
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.20</td><td>2011PSXT2 ①</td><td>SK0037</td><td>slag</td><td>XuXieBian</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">small piece from the edge</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: holes in different sizes, cracks. White structure matrix, about 60%, separated by light and dark grey structures, net-like. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">No significant changes.
X5: white structure should be ferrite. (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Possibly primary product from a bloomery furnace.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

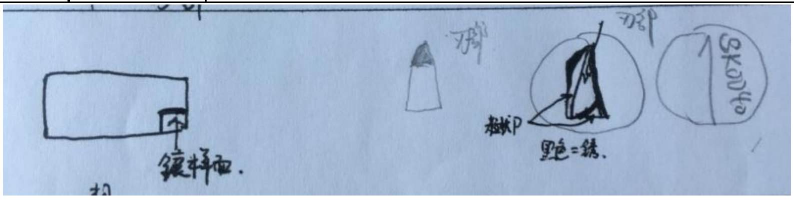
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>03YLIVM14:89</td><td>SK0038</td><td>Iron shovel</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cutting edge</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: white structure in the middle, large number of tiny slag inclusions. (01)
X20: slag inclusions mainly in stripes, uneven, more than 20 layers. Few of them are circular. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite matrix, large number of small black dots. (01)
X20: dots are densely distributed, look like granular pearlite. (01)
X50: some martensite-like structure in stripes found. (01)
X100: same as above. (01)

Note: according to SK0039, the stripes could also be widmanstatten structure, both are a reasonable out come due to the temperature during the forging process was too high.</td></tr>
<tr><td>Conclusion</td><td colspan="6">Fined iron or carburized bloomery iron.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIVM14:89	SK0039	Iron shovel	LJB		LYN
Sampling details	Sampling point	Socket				
						
Before etching	X5: white structure in the middle, grey rust on the sides. Many slag inclusions, stipes, uneven, the larger one is about 0.02mm, approximately 16 layers. (01)					
Etch	2% Nital					
After etching	X5: ferrite net-like, pearlite flake. The middle part is clearly different than two side areas. Small grain sizes overall, and side areas are smaller than the middle. Slag inclusions are grey, clearly over 10 layers. Pearlite unevenly distributed, one side is obviously less than the other and the middle areas. (01) X10: widmanstatten structure. (01)					
Conclusion	Low carbon steel, forged. Combined with the result of SK0038, the whole object was possibly made from low carbon steel, widmanstatten structure formed because the temperature in the forging process was too high. Possibly fined iron or carburized bloomery iron.					
Note						

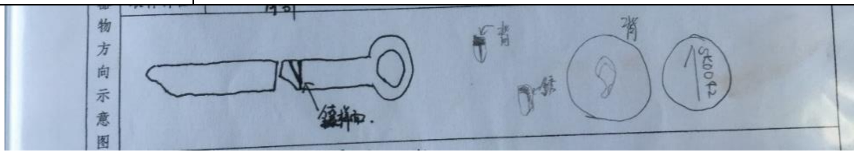
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	00YLIBT2219 ⑥:3	SK0040	mattockhead	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: white structure, many small black dots. (01) Some rust structure around can still see its microstructure. (02) X10: grey straight stipe structure. (01) No obvious slag inclusions.					
Etch	2% Nital					
After etching	X5: two obviously different areas, ferrite and pearlite near the surface, carbon content ca. 0.4-0.6%, shape of pearlite is not clear, grain boundary not clear, this layer is about 2-3 mm thick. The rest area is near the core, which is ferrite, cementite and very few pearlite. (01) X20: pearlite and ferrite near surface, granular pearlite. (01) Straight stripes cementite and small graphite in the core area. (02) X40: seems like graphite just started precipitating, still very small. (01)					
Conclusion	Decarburized cast iron. Spherical granulated pearlite near the surface, the core is insufficiently graphitized due to the low annealing temperature.					
Note						

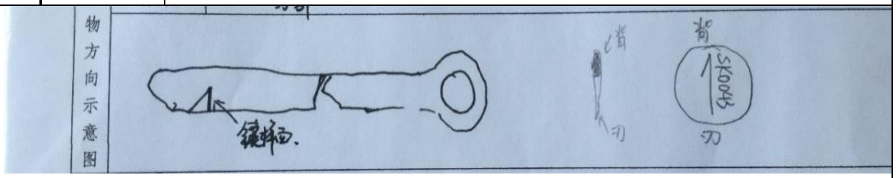
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.8.20	00YLIBT2219 ⑥:3	SK0041	mattockhead	LJB		LYN
Sampling details	Sampling point	corrosion				
Before etching	No metal. Rusted entirely, light grey and greyish white structures.					
Etch						
After etching						
Conclusion						
Note						

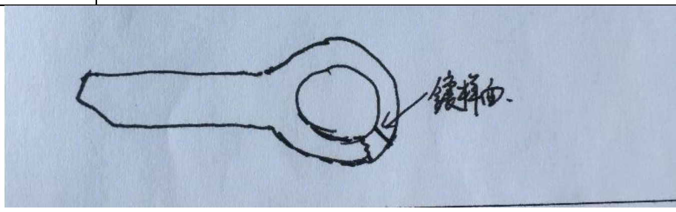
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIVM6:8	SK0042	Ring-head iron knife	LJB		LYN
Sampling details	Sampling point	Back				
						
Before etching	X5: white structure, rust in grey, few small black dots. (01)					
Etch	2% Nital					
After etching	X5: ferrite and pearlite. (01) No obvious slag inclusions. Grain boundaries not clear. X50: ferrite matrix, very small and even grain size. (01)					
Conclusion	Decarburized cast iron. Carbon content less than 0.2% hypo-eutectoid steel.					
Note						

Recording Sheet of Metallographic Samples

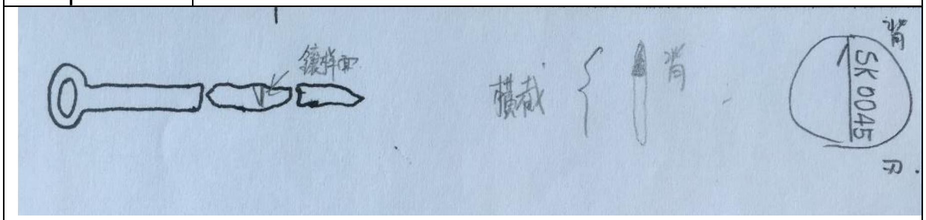
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>03YLIVM6:8</td><td>SK0043</td><td>ring-head iron knife</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cutting edge</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: white structure, grey structure on two sides, few small black dots. (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite and pearlite, back (01) and cutting edge.(02)
No obvious slag inclusions.
X50: small grain size at the cutting edge, ferrite net-like, carbon content ca.03-0.5%, some needle-like widmanstatten structure(01)(X100: 01)
Also small grain size at the back area, ferrite net-like, carbon content ca. 0.2%. (02)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Hypo-eutectoid steel. Combined with the result from SK0042, the overall carbon content of the ring-head knife's body is between 0.1-0.5%, more on the cutting edge and less on the back. Possibly decarburized cast iron.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

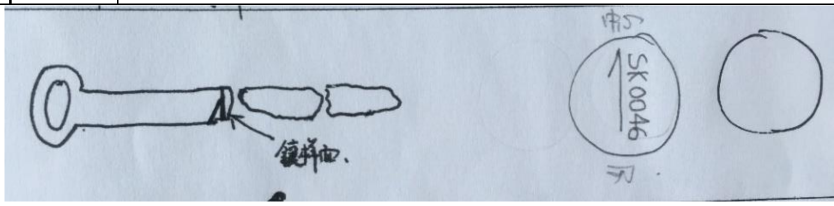
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>03YLIVM6:8</td><td>SK0044</td><td>Ring-head knife</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cross section of the ring head</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: mostly rusted, some white structure, few small black dots. (01)
No obvious slag inclusions.</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: difference in grain sizes. Tiny pearlite distributed along with the grain boundaries in the small grain size area, no pearlite in the bigger grain size area. (01)
Overall, its decarburization level is higher than the cutting edge.

X50: very low carbon content. Higher area. (01) lower area.(02), both close enough as wrought iron.</td></tr>
<tr><td>Conclusion</td><td colspan="6">Possibly decarburized cast iron, combine the results of SK0042 and SK0043, the ring-head knife is made of decarburized cast iron, where its body is decarburized to hypo-eutectoid steel and its ring head is nearly fully decarburized.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

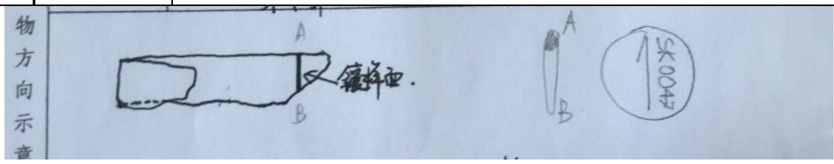
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIIIM15: 20	SK0045	Ring-head iron knife	LJB		LYN
Sampling details	Sampling point	Back				
						
Before etching	X5: white metal structure is surrounded by a layer of grey rust structure, few small black dots, more in the back side (01) than the cutting edge side. (02) No obvious slag inclusions.					
Etch	2% Nital					
After etching	X5: pearlite and ferrite, carbon content ca. 0.5-0.6%, almost the same between the back and the cutting edge parts, the sides are slightly less than the center. (01) X20: pearlite as flakes, ferrite net-like, the grain sizes of the sides are slightly smaller than the center. (01) X40: lower carbon content area. (01) higher carbon content area. (02)					
Conclusion	Decarburized cast iron. Hypo-eutectoid steel, carbon content ca. 0.5-0.6%.					
Note						

Recording Sheet of Metallographic Samples

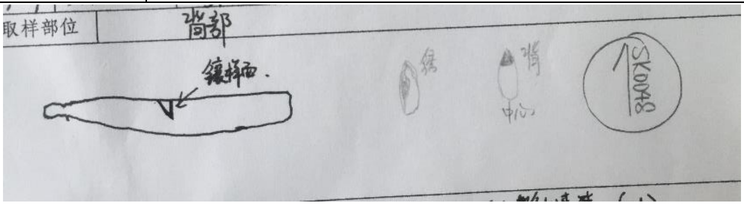
Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIIIM 15:20	SK0046	Ring head iron knife	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: few metal left, white structure, few small black dots. (01)					
Etch	2% Nital					
After etching	X5: ferrite and pearlite matrix, core part is similar to SK0045, carbon content very close to eutectoid near the cutting edge, very small grain sizes. (01) X40: carbon content near the core area is ca. 0.5%, not many flake pearlite, pearlite is becoming granular. (01) X100: carbon content near the cutting edge is ca. 0.6%. ferrite is not net-like, but surrounded by incompletely granular pearlite. (01)					
Conclusion	Hypo-eutectoid steel, carbon content ca. 0.5-0.6%. Annealed at a high temperature to force the pearlite started to become granular, but not for enough time so the pearlite is not complete granular. Decarburized steel probably from white cast iron.					
Note						

Recording Sheet of Metallographic Samples

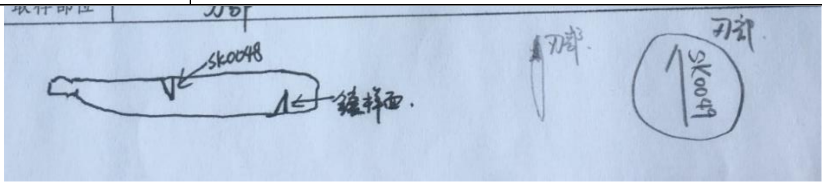
Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIVM6:38	SK0047	Belt hook	LJB		LYN
Sampling details	Sampling point	Cross section of middle part				
						
Before etching	X5: grey rusted layer surround. White structure in the middle. Large number of black chain-like slag inclusions vertically distributed. (01、02)					
Etch	2% Nital					
After etching	X5: pearlite and ferrite, clear difference of pearlite volume in different layers, less in one side area, more in the middle and the other side. (01) Vertically distributed chain-like slag inclusions are clearly seen. (02)curved, possibly formed during the forging process. (03) X10: some low carbon content area is almost carbon free. (01) X20: chain-like slag inclusions. (01) X40: carbon content of less pearlite areas ca. 0.2%. (01)more pearlite areas ca. 0.4-0.5%. pearlite in flakes.					
Conclusion	According to the slag inclusions, the object is possibly forged from fined iron or bloomery iron. The carbon content distribution is uneven, from ca. 0.2-0.5%. It is more possible the primary material is fined iron by the study of the artifact type.					
Note						

Recording Sheet of Metallographic Samples

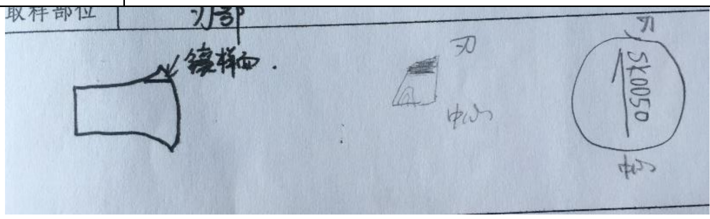
Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIVM10:5	SK0048	Iron knife	LJB		LYN

Sampling details	Sampling point	Back
		
Before etching	X5: white structure in the middle, grey rusted structure surround, large number of vertically distributed slag inclusions in stripes. (01)	
Etch	2% Nital	
After etching	X5: ferrite matrix, small grain size, clear grain boundaries. Carbon content different in layers. Some layers almost fully decarburized as pure ferrite. Some contain very few pearlite distributed along with the grain boundaries. Slag inclusions vertically distributed as long and thin stripes. (01) X10: grain sizes are even, no obvious transformation, annealing process possibly applied. (01) X40: slag inclusions are black and grey structures. (01)	
Conclusion	Fined iron or bloomery iron. Forged. Annealed. Very low carbon content.	
Note		

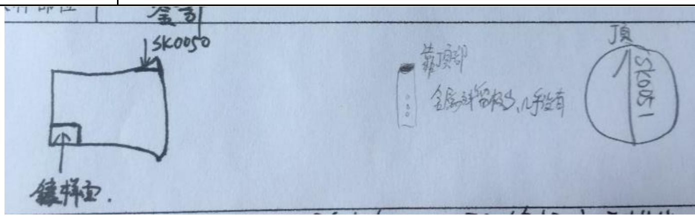
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>03YLIVM10:5</td><td>SK0049</td><td>Iron knife</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cutting edge</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: slight rusted layer to the cutting edge, the rest are white structures. Numbers of vertically distributed slag inclusions in stripes. (01、02)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite matrix, grain sizes are bigger in the core area. (01) slag inclusions are in stipes and chain, more than 10 can be identified. (02)
X20: clear grain boundaries, very few pearlite distributed along the grain boundaries in the sides areas. (01)
X40: the slag inclusions are composite with black and grey structures. (01)
X100: large number of tiny flake structures can be seen in the larger grains, possibly graphite or pearlite, more like pearlite. (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Fined iron or bloomery iron. Forged. Annealed, very low carbon content at the cutting edge, nearly pure ferrite.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIBT2219 ⑥:2	SK0050	Axehead	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: Large number of graphite like structures. (01) Large number of white and grey straight stripes. (02)					
Etch	2% Nital					
After etching	No significant changes. X20: Possible in the process of rusting. The white straight stripes are possibly primary cementite. Grey structures are rusting granular and flake pearlite. Cementite matrix, ledeburite. (01) X20: rusted level is different between the surface and the core, flake pearlite can be found in some areas. (02、03) Big black dots should be cotton nodule like graphite (no reasonable explanation) Possibly white cast iron, annealed in some way which decarburized the surface layer into flake pearlite and precipitated carbon into graphite in the core. But due to the lack of the annealing time, the outer layer became grey cast iron while the core is still white cast iron.					
Conclusion	White cast iron.					
Note						

Recording Sheet of Metallographic Samples

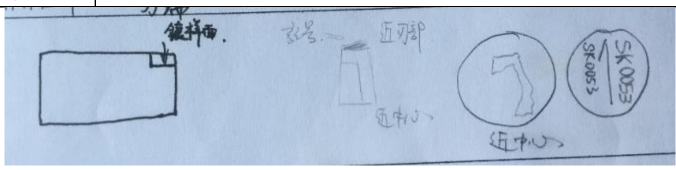
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>00YLIBT2219 ⑥:2</td><td>SK0051</td><td>Axehead</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Socket</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: badly rusted, worse than SK0050. Large black and grey straight stripes structures, few white structure which should be the original matrix. (01)
X20: according to SK0050, the primary cementite in straight stripes are rusted to grey color, indistinct pearlite and cementite matrix in different rusty levels (ledeburite) (01)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X20: Surrounding areas fully rusted. Some traces of flake pearlite. (02)

Possibly white cast iron, annealing process to decarburized the surface structure into flake pearlite. But the core is still white cast iron due to the lack of the annealing time.</td></tr>
<tr><td>Conclusion</td><td colspan="6">White cast iron.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

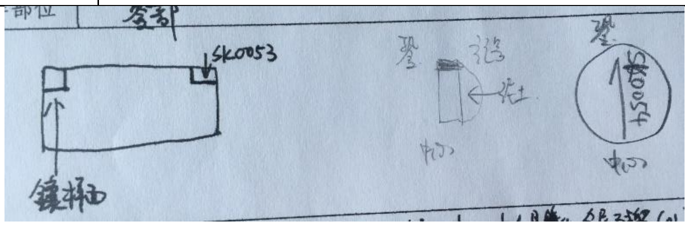
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIVM3:9	SK0052	Belt hook	LJB		LYN
Sampling details	Sampling point	Cross section of the hook				
Before etching	X5: grey rusted structures in different degree, ca. 40-50%. White structure in the middle, many small black dots. (01) No chain or stripe slag inclusions.					
Etch	2% Nital					
After etching	X5: small grain sizes, ferrite matrix, very few pearlite distributed along with the grain boundaries. (01) Evenly distributed overall. (02) X50: carbon content less than 0.1%. The black dots are unidentifiable. (01)					
Conclusion	Decarburized cast iron, carbon content less than 0.1% hypo-eutectoid steel.					
Note						

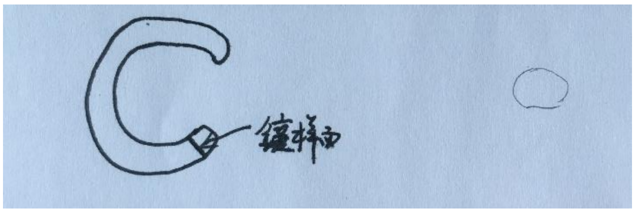
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	00YLIBT2014 ⑤:8	SK0053	mattockhead	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: completely rusted, only dark and light grey structures left, no metal. (01、02、03) Structure details are unidentifiable.					
Etch	2% Nital					
After etching	No significant change. Some differences in both light and dark fields are recorded, X5: light field: white structure grey structure dark grey brown (rust) (01) | | | | dark field: black brown brown grey (02)					
Conclusion	Unidentified.					
Note						

Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>00YLBT2014⑤:8</td><td>SK0054</td><td>mattockhead</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Socket</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: fully rusted, dark and light grey. Tiny metal-like dots. (01)
X50: the tiny dots are white (01)and mirror-like in dark field. (02)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">Same as SK0053, some indistinct flake structures.
X50: no change of the metal-like dots, too small. (03)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Unidentified.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

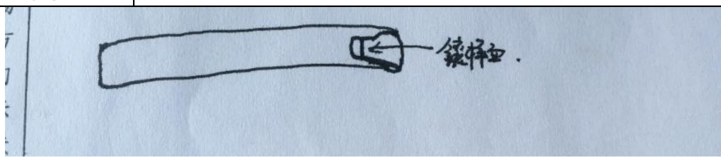
<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>97BT0205⑩</td><td>SK0055</td><td>Iron ring</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cross section</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: few grey rusted structures (around), white structure in the middle, many small black dots distributed as waved stipes. (01)Different sizes of the dots. (02)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: pearlite and ferrite matrix, different carbon content areas, ca. 0.4-0.6%. (01)

X20: some slag inclusions in stripes in dark field. (01)

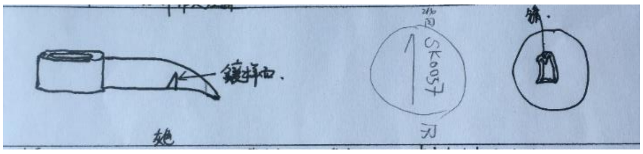
X40: flake pearlite, lower carbon content area ca. 0.4%, (01)granular slag inclusions. (01)higher carbon content area ca. 0.6%. (02)

X50: most of the slag inclusions are grey in light field, (01) and mirror-like in dark field. (02) possibly FeO inclusion.</td></tr>
<tr><td>Conclusion</td><td colspan="6">Decarburized cast iron. Hypo-eutectoid steel. Carbon content ca. 0.4-0.6%. No significant evidence of forging.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

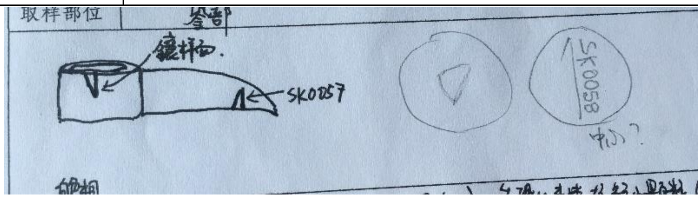
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIVM6:34	SK0056	Iron belt hook	LJB		LYN
Sampling details	Sampling point	Cross section of the hook end				
						
Before etching	X5: Grey rust structure in skin layer. White structure matrix. Large number of chain and stripe shaped slag inclusions, vertically distributed. (01) Slag inclusions are silver and light grey in dark field.					
Etch	2% Nital					
After etching	X10: pearlite and ferrite matrix, pearlite more in the middle and less on the sides. (01) There is one vertical stripe area in the middle which has more pearlite and in bigger grain, possibly segregation. (02) X40: pearlite in flakes, carbon content ca. 0.3%. Vertically distributed slag inclusions. (01) Carbon content ca. 0.4-0.5%, segregation. (02)					
Conclusion	Possibly fined or bloomery iron, forged, slightly segregation of pearlite.					
Note						

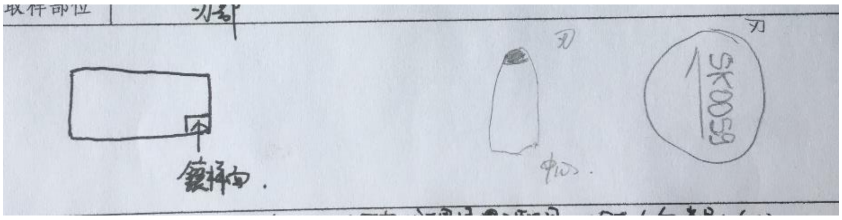
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>00YLIBT1612 ④:2</td><td>SK0057</td><td>Iron Zhuo (peck)</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Near the point</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: white structure matrix, large number of grey slag inclusions in stripes. Slag inclusions nearly horizontally distributed near the inner side (01), and vertically distributed near the back side. Many black dots in the top left area. (02)
X20: In dark field, grey slag inclusions are black (01), and black dots are silver. (02)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite matrix, small grain. Almost fully decarburized near the edge, very few pearlite appears along with the grain boundaries. (01) Large number of slag inclusions in stripes near the back side(02), the stripe inclusions are vertically distributed and curved to sides near the inner side. (03)
X20: pearlite is granule like near the edge. (01)
X40: carbon content less than 0.2%. Unclear shape of pearlite. (01)
X100: the edge of the black dots is black in light field(01), and white in dark field. Possibly graphite. (02)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Fined iron or bloomery iron, carbon content less than 0.2%. Forged.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

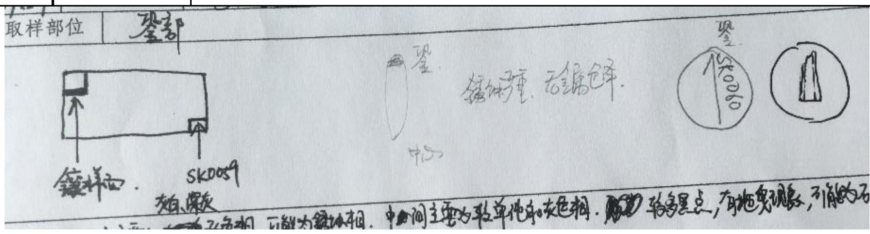
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	00YLIBT1612 ④:2	SK0058	Iron *Zhuo* (peck)	LJB		LYN
Sampling details	Sampling point	Socket				
						
Before etching	X5: large number of slag inclusions in stripes, vertically distributed. (01) Short and small granule like shapes near the socket end, (02)and more continuous as stripes near the core. (03)					
Etch	2% Nital					
After etching	X5: ferrite matrix, small grain, partially carbon free, very few pearlite appeals along with grain boundaries, large number of slag inclusions formed in chain shape, small number in stripes. (01) Top left, which is close to the socket end has large number of small black holes (02), which shows silver in dark field. (03) X50:very few pearlite, unclear shape, carbon content ca. 0.1-0.2%.					
Conclusion	Fined iron or bloomery iron, carbon content ca. 0.1-0.2%, forged.					
Note						

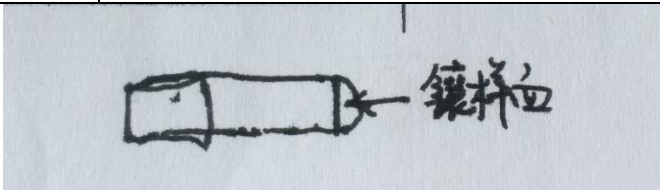
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.29	00YLIBT2014 ⑥(⑧):5	SK0059	mattockhead	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: Sample surface grey. Many large cotton-like nodules graphite, evenly distributed. (01) X10: Matrix greyish white and dark grey, possibly rusts. (01)Some black phase in flakes. X20: In dark field, graphite shows in silver, around with brown rusts. (01)					
Etch	2% Nital					
After etching	X5: Matrix greyish white, no significant change, almost fully rusted. Many large cotton-like nodules graphite in black, evenly distributed. (01) in dark field shows in silver (02) X50: traces of pearlite in flakes. (01) brighter on the edges of the graphite (02) No obvious slag inclusion.					
Conclusion	Possibly malleable cast iron, decarburized and graphitized from white cast iron.					
Note						

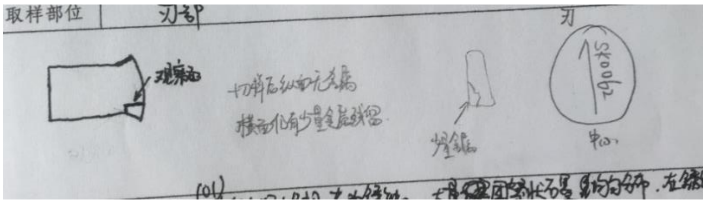
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.7.27</td><td>00YLIBT2014⑥(⑧):5</td><td>SK0060</td><td>mattockhead</td><td>LJB</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Socket</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: sides are greyish white and dark grey structures, probably rusts. (01)
Middle area grey structure, lots of black dots, possibly graphite. (02)
Very small white structure, possibly metal. (03)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: no significant changes. (01)
X20: shape of black dots is irregular, unevenly distributed, smaller than and not as many as in SK0059. (01)
In dark field, similar to the graphite structure in SK0059, silver, bright boundaries, and a rusty color in surrounding areas. (02)
X50: dark grey and greyish white structures in dark field. (01、02)
White structure shows clear grain boundaries and very few pearlite along with the boundaries. (03)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Combined with the result of SK0059, the object is possibly decarburized white cast iron, which its decarburization level is higher and graphitization is lower than the cutting edge.</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

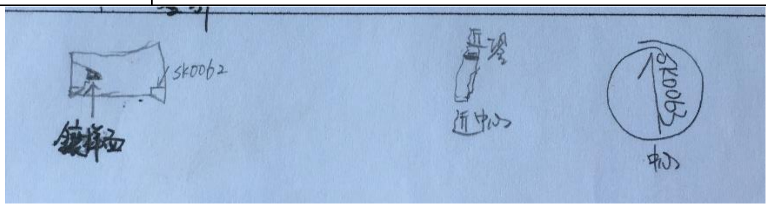
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	03YLIVM6:6	SK0061	Belt hook	LJB		LYN
Sampling details	Sampling point	Body cross section				
						
Before etching	X5: some metal in the middle, white. Small and thin slag inclusions.(01、02) X20: the form of slag inclusions are thin stripes. (01)					
Etch	2% Nital					
After etching	X5: ferrite and pearlite matrix, small and even grain size. (01) X20: pearlite in flakes, surrounded by ferrite in net, carbon content ca. 0.2%~0.4%. (01) X40: pearlite in flakes, slag inclusions in stripes. (01)					
Conclusion	Fined iron or bloomery iron, forged, ca. 0.2%~0.4% hypo-eutectoid steel.					
Note						

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	00YLIBT2520 ⑥:2	SK0062	Axehead	LJB		LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: only some metal left in the bottom left area.(01) The others are grey structures which should be rusts. A lot of cotton-like nodules graphite evenly distributed, even in the rusted area.(02) X20: form of graphite(01), also in dark field.(02、03)					
Etch	2% Nital					
After etching	X5: ferrite matrix, very few pearlite, large number of small granules mainly horizontally distributed. (01) X20: few pearlite, most are granules, the others are flakes. (01) Clear directional yellow stripes, look like cementite. (02) X50: yellow stripe structures in both light and dark fields. (01、02) No clear slag inclusions					
Conclusion	Likely to be ferrite malleable cast iron, which was decarburized and graphitized from white cast iron.					
Note						

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	00YLIBT2520 ⑥:2	SK0063	Axehead	LJB		LYN
Sampling details	Sampling point	Socket				
						
Before etching	X5: rusts outside, metal in the middle. No graphite near the socket end (01), the more graphite evenly distributed, the closer to the core (02).					
Etch	2% Nital					
After etching	X5: ferrite matrix, small grains, clear boundaries. (01、02) X20: the shape of graphite looks like chrysanthemum, the graphite flakes are connected to a core. (01) The closer to the core, the graphite flakes are thicker, some of them formed as cotton-like nodules already. (02)					
Conclusion	Combined with the result from SK0062, this object is likely to be ferrite malleable cast iron, which annealed from white cast iron by graphitization. The decarburization level of the socket area is higher than the core and the cutting edge areas, so the graphitization level is comparatively lower.					
Note						

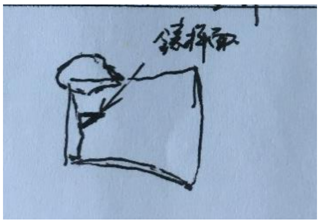
Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.7.27	01YLIIBT15155A:3	SK0064	arrowhead or iron nail	LJB		LYN
Sampling details	Sampling point	Cross section of one end				
						
Before etching	X5: badly rusted, some metal remained. Directional chain slag inclusions. (01) X10: chain slag inclusions. (01)					
Etch	2% Nital					
After etching	X5: pearlite matrix, net-like ferrite. Different sizes of grains in layers. (01) X20: carbon content about 0.4% in the small grains area, and ca. 0.6% in larger grain area. Some widmanstatten structures in the larger grain sizes area. (01) directional chain slag inclusions (02) X50: pearlite in flakes. (01)					
Conclusion	Fined iron or bloomery iron. Forged. Carbon content ca. 0.4-0.6% hypo-eutectoid steel.					
Note						

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.8.14	2011PSXT01 ②	SK0065	Iron nail?	XXB		LYN
Sampling details	Sampling point	Cross section				
Before etching	X5: nearly fully rusted, light and dark grey structures, tiny metallic nodules. (01)					
Etch	2% Nital					
After etching	Hardly to see any structure. X10: tiny metallic nodule, unidentified structure. (01) dark field (02) X50: tiny metallic nodule (01). X100: tiny metallic nodule (01).					
Conclusion	Seem like ferrite and very few granular pearlite, but the nodule itself is too small to make a conclusion.					
Note						

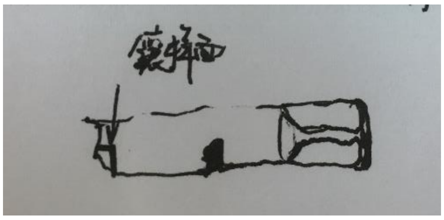
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.8.18</td><td>2011PQM3:11</td><td>SK0066</td><td>Axehead</td><td>QGT</td><td>Early western Han</td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Socket</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: nearly fully rusted, light and dark grey structures, tiny metallic nodules (01).
X50: metallic nodule (01).</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X50: no significant changes. Metallic nodules are too small to be helpful (only ferrite matrix can be identified (01).</td></tr>
<tr><td>Conclusion</td><td colspan="6"></td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.8.21	2011PQM23:11	SK0067	Axehead	QGT	Early western Han	LYN
Sampling details	Sampling point	Cutting edge				
Before etching	X5: fully rusted, light grey and greyish white structures, tiny metallic nodules, not helpful (01). X50: metallic nodule (01)					
Etch	2% Nital					
After etching	No significant change.					
Conclusion						
Note						

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.8.20	2011PQM15:1(sample 1)	SK0068	spearhead	QGT	Early western Han	LYN
Sampling details	Sampling point	Middle part				
						
Before etching	X5: mainly light grey and dark grey structures (rust), no metal. Many holes. (01, 02, 03, 04)					
Etch	2% Nital					
After etching	X5/X20: No significant changes, no obvious metal. X100: very few suspected structures, too small and unclear. (01, 02, 03)					
Conclusion						
Note						

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.8.20	2011PQM15:1(sample 2)	SK0069	spearhead	QGT	Early western Han	LYN
Sampling details	Sampling point	Head area				
Before etching	No metal. Rusted entirely, light grey and greyish white structures.					
Etch						
After etching						
Conclusion						
Note						

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.8.22	Chadiping L1	SK0070	Slag?	Datian		LYN
Sampling details	Sampling point	Strong magnetic spot				
Before etching	X5: dark grey structure, probably obsidian (01). Light grey and greyish white structures, seem like rusted metal. Tiny white nodules, seem like metal remains (02). Large number of irregular inclusions. X100: suspected trace of pearlite in flake form (01, 02)					
Etch	2% Nital					
After etching	X5: many black stripes, look like graphite flakes (01), which are slivery white in dark field (02). X50: trace of pearlite in flakes (01), graphite and trace of pearlite in dark field (02).					
Conclusion	The traces of pearlite + graphite indicate this sample might be residue of cast iron from a blast furnace, which attached to obsidian while it was in liquid form, and being cooled down very slowly which graphite flakes started to form.					
Note						

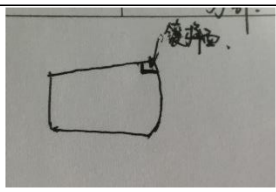
Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.8.22</td><td>Chadiping L6</td><td>SK0071</td><td>Slag</td><td>Datian</td><td></td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Strong magnetic spot</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Before etching</td><td colspan="6">X5: no metal, dark grey and greyish white structures, seem like rust. Dark grey structure seems like lithic structure, many round holes. (01 dark field 02)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X20: eutectic white cast iron like structures, ledeburite? (01 dark field 02).
X100: ledeburite? (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">White cast iron?</td></tr>
<tr><td>Note</td><td colspan="6"></td></tr>
</table>

Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.8.23</td><td>2011PQM13:4</td><td>SK0072</td><td>Iron sword</td><td>QGT</td><td>Early western Han</td><td>LYN</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">Cross section</td></tr>
<tr><td colspan="6">The sword is almost fully rusted, there is very few metal left (about 0.6 cm wide and 0.1 to 0.2 cm thick) where the sample is taken.</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: badly rusted, very few metal left, white structure, at least 4 slag inclusions are seen in stripes, thin and long, vertically distributed (01), large number of black dots.
X20: form of slag inclusion (01).
X40: form of slag inclusion (01).</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite matrix, small grain size, clear grain boundaries, low carbon content, small number of pearlite distributed along with the grain boundaries, probably formed during the forging process from the Fe_3C_{III}. Slag inclusions are distributed along with the forging direction. (01)
Grain sizes are even, no clear transformation.
X40: form of slag inclusion (01).
X100: pearlite along with grain boundaries. (01)</td></tr>
<tr><td>Conclusion</td><td colspan="6">Wrought iron, forged, tempering process applied.</td></tr>
<tr><td>Note</td><td colspan="6">Not many slag inclusions.</td></tr>
</table>

Recording Sheet of Metallographic Samples

Date	Artifact No.	Lab No.	Type	Site	Artifact date	Processor
2016.8.24	2011PQM23:9	SK0073	Axehead	QGT	Early western Han	LYN
Sampling details	Sampling point	Cutting edge				
						
Before etching	X5: metal in white. Some rust on one side, dark and light grey, greyish white structures. More than 10 slag inclusions in stripe form, long and thin, distributed along with the forging direction. (01、02) X20: slag inclusion is composed with both dark and light grey structures. (01)					
Etch	2% Nital					
After etching	X5: pearlite matrix, the cutting edge area is almost pure pearlite (01), ca. 0.77% carbon. In the core area (object), ferrite seen in the form of nets, some slag inclusions in stripes (02). The closer to the core of the object, the thicker the ferrite nets, the lower carbon content is ca. 0.2% - 0,4%. (03) X10: needle-like ferrite structures inward to grain boundaries, should be widmanstatten structure. (01) X20: the widmanstatten structure (01), in dark field (02). The slag inclusion, dark and light grey (probably fayalite and wustite 03).					
Conclusion	Carburized wrought iron (from bloomery), carbon content near the surface is close to 0.77% hypo-eutectoid steel, which is way more than the carbon content in the center of the object. Clear forging slag inclusions.					
Note						

Recording Sheet of Metallographic Samples

<table>
<tr><td>Date</td><td>Artifact No.</td><td>Lab No.</td><td>Type</td><td>Site</td><td>Artifact date</td><td>Processor</td></tr>
<tr><td>2016.8.24</td><td>2011PQM22:1</td><td>SK0074</td><td>Iron Cha</td><td>QGT</td><td>Early western Han</td><td>ZMY</td></tr>
<tr><td rowspan="2">Sampling details</td><td>Sampling point</td><td colspan="5">socket</td></tr>
<tr><td colspan="6">
</td></tr>
<tr><td>Before etching</td><td colspan="6">X5: badly rusted, very few metal left in the center (white 01), rust is grey (02).
X20: a cotton-like nodule at the center, probably graphite(01, dark field 02), cracks are seen in the edge area. (03, 04)</td></tr>
<tr><td>Etch</td><td colspan="6">2% Nital</td></tr>
<tr><td>After etching</td><td colspan="6">X5: ferrite matrix, clear grain crystal in different sizes. (01、02)
X10: small dots on grain (01,02), disappeared after re-polishing (03).
X40: the cotton-like nodule is composed with black and grey structures, more like rust than graphite (01)(02).
No slag inclusion, no trace of forging.</td></tr>
<tr><td>Conclusion</td><td colspan="6">Wrought iron. (no trace of carbon is observed)</td></tr>
<tr><td>Note</td><td colspan="6">Took longer in etching process. This type of implements was usually believed to be casted than forged, but it is strange that found no trace of carbon in this object. It may due to the sample size is too small.</td></tr>
</table>

a) More details and photos of the surveyed sites

The other 70 sites and locations were discovered in the archaeological surveys in this area. In these surveys, the names of the local locations were sometimes a very important clue in finding the iron related sites and locations. For example, '*Shazi*' or '*Tieshi*' usually indicate slags, '*ping*' means a flat ground, two words together can probably lead us to a location where lots of slags can be found on the ground. Some other example, such as '*Gaoluchong*', which '*Gaolu*' means blast furnace, thus the location was probably used to have blast furnaces and some of them are still visible now.

The information below is from the Second National Survey on the Cultural Relics and the report of the regional archaeological survey.

Only one site is from the Han dynasty (202BC-220AD):

5. Tonggucun Jigongshan

Located beside a small trench. 110m west-east and 70m north-south, a total area about 7,700m^2. Elevation 531m. Burned soil and iron slag are exposed on the ground. The deposit of the site is 0.4 to 0.6m in depth and about 0.5 to 0.6m from the surface. The date of the site is said to be Han dynasty by the excavator according to the excavated artefacts.

Fig. 1 Furnace lining and slag at *Tonggucun Jigongshan* (photo by: Zhou Guolong)

63 sites and locations are from the Tang or Song dynasties (7th to 13th centuries):

6. Tonggucun Group 7

Total area of 500m^2. Elevation 543.5m. Main relics are burned soil, slag, and furnace lining. The date of the site is said to be Song dynasty (960-1279AD).

Fig. 2 Furnace lining at *Tonggucun* Group 7 (photo by: Zhou Guolong)

7. Tonggucun Group 6

Total area of 5,000m^2. Elevation 545.7m. Large amount of iron sand, slag, and furnace lining can be found on the surface. The date is said to be Song dynasty (960-1279AD).

Fig. 3 Slag at *Tonggucun* Group 6 (photo by: Zhou Guolong)

8. Tonggucun Shaziping

Located beside a fish pond. The site is 45m west-east and 135m north-south, a total area about 6,075m^2. Elevation 538.6m. The deposit of the site is about 0.7 to 0.9m in depth. Main relics are burned soil, charcoal, charcoal ash, and slag. There are large slag depositions at the bottom of the fish pond. Song dynasty (960-1279AD).

Fig. 4 Slag at *Tonggucun Shaziping* (southwest to northeast, photo by: Zhou Guolong)

9. Qingshancun

The site is 38m west-east, 45m north-south, a total area about 1,710m^2. Elevation 528m. Main relics are charcoal, iron slag, furnace brick. The deposit of the site is 0.4 to 0.5m in depth. There used to have a broken furnace which is about 2.1m wide, horseshoe shape, and constructed from bricks that is 0.27m long and 0.6m thick. Song dynasty (960-1279AD).

Fig. 5 Overview of *Qingshancun* site (east to west, photo by: Zhou Guolong)

10. Liufenyuan

The site is 22m west-east, 37m north-south, a total area about 814m^2. Elevation 523m. Main relics are charcoal and slag. The deposit of the site is half meter from the surface. Song dynasty (960-1279AD).

11. Shengchashequ Gaoluchong

Total area about 1,000m^2. Elevation 641.6m. Main relics are slag and iron sand. One broken furnace is remaining, which is 1.6m high and 1.7m wide. Song dynasty (960-1279AD).

Fig. 6 Furnace remain at *Shengchashequ Gaoluchong* (west to east, photo by: Zhou Guolong)

13. Shuangliucun

Located on the east side of a hillside. Total area about 1,334m^2. Elevation 473.6m. Main relics are iron sand, slag, and furnace lining. Song to Ming dynasties (10th to 17th centuries).

Fig. 7 Slag, furnace lining at *Shuangliucun* (photo by: Peng Wei)

14. Manancun Gaolushan

Located on a small hill. Total area about 3,335m^2. Elevation 511.1m. Main relics are burned soil, slag, iron sand, and furnace lining. The deposit is 0.3 to 0.5m thick. One furnace is found in a comparatively good condition on the top of the hill. The furnace is 1.4m high remaining. The furnace wall is about 0.6m thick and is built from structured stones. The red iron sand is discovered in a 10m^2 area near the furnace and is about 0.5 to 1m thick. The slag deposit is about 0.3 to 0.5m thick distributing in an area of 1,500m^2 at the bottom of the hill. Song dynasty (960-1279AD).

Fig. 8 Slag and furnace lining at *Gaolushan* (photo by: Peng Wei)

15. Bajiaojingcun

The site is 200m long, 50m wide, a total area of 10,000m^2. Elevation 585m. The site was an iron coin foundry set up in the 18th year of Guangzheng (955AD) of Houshu dynasty (934-965AD). In the 4th year of Xianping (1001AD) of Northern Song (967-1127AD), it was one of the biggest three iron coin foundries in Sichuan during the Song dynasty.

Furnaces ruins were recorded in the earlier survey, but not found in the survey in 2007. By the augering result, the site is about 0.6m in depth, where charcoal ash and iron ore were discovered at the 0.25m level, and slag was discovered at the 0.55m level. On the east of the site, there is a small hill which is already being developed as farmland, but slag, burned soil, charcoal ash, broken tile and pottery can be easily found on the ground. The slag deposit of this area is about 5m in depth, the slag is over thousands of tons. The slag is used to build road now. In the mountain on the east of the site, there is hematite discovered underground. According to the broken pottery and porcelain collected, the date of the site should be from the Five dynasties (907-960AD) to Song dynasty (960-1279AD).

16. Miaofengcun

Total area of 68m^2. Elevation 557.6m. Refractory brick, charcoal, slag, and burned soil were discovered. The thickest part of the deposit is about 4m. Song dynasty (960-1279AD).

Fig. 9 Slag at *Miaofengcun* (photo by: Zhou Guolong)

17. Pengheshequ Tiekuangshan

Total area about 3,035m^2. Elevation 572.8m. Slag, burned soil, and refractory brick were discovered. The deposit is about 2m thick. Song dynasty (960-1279AD).

Fig. 10 Overview of *Tiekuangshan* site (north to south, photo by: Zhou Guolong)

Fig. 11 Slag at *Tiekuangshan* (photo by: Zhou Guolong)

18. Lupingcun

The site is 40m west-east, 30m north-south, a total area of 1,200m^2. Elevation 595.8m. A small hill was discovered piled up with burned soil and iron sand. The deposit is about 1.5m. Song dynasty (960-1279AD).

Fig. 12 Burned soil and slag at *Lupingcun* (photo by: Zhou Guolong)

19. Liudalin

Total are about 6,670m^2. Elevation 599.4m. Iron sand and burned soil were discovered. The deposit is about 3m thick. Song dynasty (960-1279AD).

Fig. 13 Burned soil and slag at *Liudalin* (west to east, photo by: Zhou Guolong)

20. Guanqiaocun

The site is 60m west-east, 30m north-south, a total area of 1,800m^2. Elevation 602.2m. Burned soil, iron sand, charcoal, and refractory brick were discovered. The deposit is about 1.5m thick. Song dynasty (960-1279AD).

Fig. 14 Burned soil at *Guanqiaocun* (southwest to northeast, photo by: Zhou Guolong)

21. Guanqiaocun Group 3

The site is 40m west-east, 30m north-south, a total area of 1,200m^2. Elevation 601.3m. Slag, burned soil, and iron ore were discovered. One furnace was found in the earlier survey, but not seen in the survey in 2007. Song dynasty (960-1279AD).

22. Shazidi

Total area about 6,670m^2. Elevation 575.8m. Burned soil, iron sand, and refractory brick were discovered. The deposit is about 2m thick. Song dynasty (960-1279AD).

Fig. 15 Overview of *Shazidi* site (north to south, photo by: Zhou Guolong)

Fig. 16 Refractory bricks at *Shazidi* (photo by: Zhou Guolong)

23. Shixiangzi

Total area about 4,000m^2. Elevation 576.8m. Burned soil and iron sand were discovered. Song dynasty (960-1279AD).

Fig. 17 Overview of *Shixiangzi* site (east to west, photo by: Zhou Guolong)

24. Shihuiqiao

Total area about 6,700m^2. Elevation 584.2m. Burned soil and iron sand were discovered. The thickest part of the deposit is about 4m. Song dynasty (960-1279AD).

Fig. 18 Overview of *Shihuiqiao* site (north to south, photo by: Zhou Guolong)

25. Wangjiashan

The site is 50m west-east, 30m north-south, a total area of 1,500m^2. Elevation 576.3m. Burned soil, iron sand, and refractory brick were discovered. The deposit is about 2m thick. Song dynasty (960-1279AD).

26. Yangfenyuan

The site is 60m west-east, 30m north-south, a total area of 1,800m^2. Elevation 592.5m. Burned soil, iron sand, and slag were discovered. The deposit is about 2m thick. Song dynasty (960-1279AD).

Fig. 19 Overview of *Yangfenyuan* site (south to north, photo by: Zhou Guolong)

Fig. 20 Slag at *Yangfenyuan* (photo by: Zhou Guolong)

27. Gaolushan

The site is 100m west-east, 80m north-south, a total area of 8,000m^2. Elevation 582.5m. Iron sand, slag, and refractory brick were discovered. The thickest part of the deposit is about 3m. Most of the iron sand and slag were now used to build road. Song dynasty (960-1279AD).

Fig. 21 Furnace lining at *Gaolushan* (north to south, photo by: Zhou Guolong)

28. Sanhechang

Total area about 3,035m^2. Elevation 590m. Burned soil, large slag, iron sand, and refractory brick were discovered. The deposit is about 0.5m thick. Song dynasty (960-1279AD).

Fig. 22 Overview of *Sanhechang* site (west to east, photo by: Zhou Guolong)

Fig. 23 Refractory bricks at *Sanhechang* (photo by: Zhou Guolong)

29. Yulongcun Group 1

The site is 50m west-east, 100m north-south, a total area of 5,000m^2. Elevation 558.5m. The deposit is 0.3 to 0.4m thick and 0.3 to 0.4m from the surface. Song dynasty (960-1279AD).

30. Datiancun Gaoluchong

The site is 50m west-east, 50m north-south, a total area of 2,500m^2. Elevation 556.3m. the deposit is 0.6 to 0.7m thick. Song dynasty (960-1279AD).

Fig. 24 Furnace lining at *Gaoluchong* site (south to north, photo by: Peng Wei)

32. Wufenyuan

The site is 50m west-east, 30m north-south, a total area of 1,500m^2. Elevation 558.7m. the deposit is 0.6 to 0.7m thick and 0.3 to 0.4m from the surface. Song dynasty (960-1279AD).

33. Futiancun

The site is 38m west-east, 30m north-south, a total area about 1,140m^2. Elevation 558.3m. Burned soil, slag, and furnace lining were discovered. The deposit is 0.5-0.7m thick and 0.2-0.3m from the surface. Song dynasty (960-1279AD).

Fig. 25 Burned soil and slag at *Futiancun* (photo by: Zhou Guolong)

34. Futiancun Group 15

Total area about 700m^2. Elevation 542.8m. Slag and furnace lining were discovered. Song dynasty (960-1279AD).

Fig. 26 Slag at *Futiancun* Group 15 (photo by: Zhou Guolong)

35. Shiqiaocun Group 8

Total area about 1,500m^2. Elevation 538.9m. Burned soil, slag and iron sand were discovered. The deposit is 0.1-0.3m thick. The slag and iron sand were used to build road in the 1960s to the 1990s. Song dynasty (960-1279AD).

Fig. 27 Overview of *Shiqiaocun* Group 8 site (south to north, photo by: Zhou Guolong)

Fig. 28 Furnace lining, burned soil, slag at *Shiqiaocun* Group 8 (photo by: Zhou Guolong)

36. Shiqiaocun Group 12

The site is 50m west-east, 20m north-south, a total area 1,000m^2. Elevation 532.9m. Iron sand, slag, and furnace lining were discovered. The deposit is 0.6 to 0.7m thick. Song dynasty (960-1279AD).

Fig. 29 Furnace lining at *Shiqiaocun* Group 12 (photo by: Zhou Guolong)

37. Yucaicun Group 7

The site is 20m west-east, 20m north-south, a total area of 400m^2. Elevation 553.2m. Slag and furnace lining were discovered. The deposit is 0.2 to 0.3m thick and 0.3 to 0.4m from the surface. Song dynasty (960-1279AD).

38. Shazidang

Total area about 3,335m^2. Elevation 550.3m. Refractory brick, slag and furnace lining were discovered. The deposit is 0.2 to 0.3m thick and 0.1 to 0.2m from the surface. One broken furnace and an ancient mine were discovered in 2007. The remaining height of the furnace is 2.2m and the inner diameter is about 1.4m. The furnace was constructed from refractory brick which has a dimension of 0.5m long, 0.33m wide, and 0.14m thick. Song dynasty (960-1279AD).

Fig. 30 Slag at *Shazidang* (photo by: Zhou Guolong)

39. Shaduizi

The site is 60 west-east, 45m north-south, a total area of 2,700m^2. Elevation 550m. Burned soil, charcoal, slag, and furnace lining were discovered. The deposit is 0.7 to 0.9m thick and 0.4m from the surface. Two pieces of furnace base were discovered, the larger one is 0.4m long, 0.38m wide, and 0.23m thick. Another location was found about 100m away from the site, which is 20m west-east, 15m north-south, a total area of 300m^2. Slag and furnace lining were discovered. The deposit is 0.3 to 0.5m thick and 0.2 to 0.4m from the surface. Song dynasty to Ming dynasty (10th to 17th century).

Fig. 31 Burned soil deposit at *Shaduizi* (southwest to northeast, photo by: Zhou Guolong)

40. Guihuacun Group 1

The site is consisted by three locations. Charcoal and furnace lining were discovered at all three locations. Location A is 20m west-east, 60m north-south, a total area of 2,400m^2. The deposit is 0.3 to 0.4m thick and 0.2 to 0.3m from the surface. Location B is about 800m southwest to location A, the site is 25m west-east, 35m north-south, a total area about 875m^2. The deposit is 0.5 to 0.6m thick and 0.2 to 0.3m from the surface. Location C is about 500m southeast to location A, the site is 50m west-east, 20m north-south, a total area of 1,000m^2. The deposit is 0.6 to 0.7m thick and 0.5 to 0.6m from the surface. Song dynasty (960-1279AD).

41. Dacaocun Group 11 *Luochang*

The site is 100m west-east, 20m north-south, a total area of 1,000m^2. Elevation 532.7m. Furnace lining, slag, charcoal, and burned soil were discovered. Song dynasty (960-1279AD).

Fig. 32 Overview of *Luochang* site (northwest to southeast, photo by: Peng Wei)

42. Dacaocun Group 11 *Youyugou*

The site is 30m west-east, 20m north-south, a total area of 600m^2. Elevation 527.9m. Slag and charcoal were discovered. Song dynasty (960-1279AD).

42. Dacaocun Group 12

The site is 40m west-east, 20m north-south, a total area of 800m^2. Elevation 539.4m. Slag, furnace lining, burned soil, and charcoal were discovered. Some of the larger pieces of slag have a squared shape, about 30 cm long and 10 cm thick. Song dynasty (960-1279AD).

Fig. 33 Overview of *Dacaocun* Group 12 (southeast to northwest, photo by: Peng Wei)

44. Dacaocun Group 6

The site is 30m west-east, 40m north-south, a total area of 1,200m^2. Elevation 507.4m. Slag and furnace lining were discovered. Song dynasty (960-1279AD).

Fig. 34 Overview of *Dacaocun* Group 6 (northeast to southwest, photo by: Peng Wei)

45. Dacaocun Group 1

The site is 40m west-east, 20m north-south, a total area of 800m^2. Elevation 524.9m. Slag, burned soil, and furnace lining were discovered. The deposit is 0.6 to 1.6m thick. One broken furnace was discovered in the earlier survey, which was recorded as 1.4m high and the furnace wall was 0.65m thick. The furnace was cylindrical and was constructed from refractory bricks. In the mountain on the east of the site, there are five mines of total area about 300m^2. The deepest part of the mine is about 3.7m. Song dynasty (960-1279AD).

Fig. 35 Furnace lining and slag at *Dacaocun* Group 1 (photo by: Peng Wei)

46. Dacaocun Group 9

The site is 20m west-east, 35m north-south, a total area of 700m^2. Elevation 527.1m. Slag, burned soil, and furnace lining were discovered. Song dynasty (960-1279AD).

Fig. 36 Burned soil at *Dacaocun* Group 9 (photo by: Peng Wei)

47. Dacaocun Group 13

The site is 65m west-east, 20m north-south, a total area of 1,300m^2. Elevation 531.9m. Slag, burned soil and furnace lining were discovered. The thickest part of the deposit is about 3m. Song dynasty (960-1279AD).

Fig. 37 Overview of *Dacaocun* Group 13 (east to west, photo by: Peng Wei)

48. Dacaocun Group 14 *Shazidi*

Total area about 5,000m^2. Elevation 532.9m. Slag and furnace lining were discovered. The deposit is 0.4m thick. There is a small hill piled up with slag and furnace lining, which is about 150m^2 and 2m higher than the surface level. Tang or Song dynasties (7th to 13th century).

Fig. 38 Overview of *Dacaocun* Group 14 *Shazidi* site (south to north, photo by: Peng Wei)

49. Tiexicun Group 1

The site is 90m west-east, 30m north-south, a total area of 2,700m^2. Elevation 531.4m. Slag, burned soil, and furnace lining were discovered. Song dynasty (960-1279AD).

Fig. 39 Overview of *Tiexicun* Group 1 site (south to north, photo by: Peng Wei)

50. Longtoucun

The site is 67m west-east, 20m north-south, a total area of 1,340m^2. Elevation 514.6m. Slag, and furnace lining were discovered. The deposit is about 1m thick. Song dynasty (960-1279AD).

Fig. 40 Slag and furnace lining at *Longtoucun* (southeast to northwest, photo by: Peng Wei)

51. Dengganping

The site is 35m west-east, 20m north-south, a total area of 740m^2. Elevation 534.6m. Slag, charcoal, burned soil, and furnace lining were discovered. The deposit is about 1m thick. Song dynasty (960-1279AD).

Fig. 41 Overview of *Dengganping* site (west to east, photo by: Peng Wei)

53. Dangoucun Group 11

The site is 100m west-east, 20m north-south, a total area of 2,000m^2. Elevation 511.8m. Slag and iron sand were discovered. The deposit is about 1m thick. The local people used the slag to build the border of the fields. Song dynasty (960-1279AD).

Fig. 42 Slag and furnace lining at *Dangoucun* Group 11 (east to west, photo by: Zhou Guolong)

54. Pangoucun Group 1

The site is 50m west-east, 100m north-south, a total area of 5,000m^2. Elevation 539.6m. Slag, and burned soil were discovered. The deposit is 0.7 to 0.8m thick and 0.3 to 0.4m from the surface. Song dynasty (960-1279AD).

Fig. 43 Slag at *Pangoucun* Group 1 (photo by: Zhou Guolong)

55. Pangoucun Group 4

The site is 30m west-east, 20m north-south, a total area of 600m^2. Elevation 531.7m. Slag, and furnace lining were discovered. Song dynasty (960-1279AD).

Fig. 44 Slag and furnace lining at *Pangoucun* Group 4 (photo by: Peng Wei)

56. Shizicun

The site is 70m west-east, 30m north-south, a total area of 2,100m^2. Elevation 561.4m. Slag, and iron sand were discovered. The deposit is 0.4 to 0.5m thick and 0.7 to 0.8m from the surface. Song dynasty (960-1279AD).

Fig. 45 Smelting waste deposit at *Shizicun* (south to north, photo by: Peng Wei)

57. Shizicun Group 1

The site is 30m west-east, 30m north-south, a total area of 900m^2. Elevation 557.2m. Slag, furnace lining, and iron sand were discovered. The deposit is 0.2 to 0.3m thick and 0.3 to 0.4m from the surface. One broken furnace was discovered, which has a remaining height and width of 1.9 and 0.5m. Song dynasty (960-1279AD).

Fig. 46 Furnace wall at *Shizicun* Group 1 (east to west, photo by: Peng Wei)

58. Tiquancun Group 4

The site is consisted with 1 broken furnace, 5 slag pile, and 5 mines. The remaining height of the furnace is 2m and the diameter of the belly is 3.5m. The furnace was constructed with refractory brick and red sand stone, half part of the furnace wall was still remained. Furnace lining and slag can be found around the furnace. Slag pile A is 44m long and 40m wide. Slag pile B is 20m long and 8m wide. Slag pile C is 7m long and 5m wide. Slag pile D is 7m long and 5m wide. Slag pile E is 42m long and 40m wide. Song dynasty (960-1279AD).

Fig. 47 Overview of *Tiquancun* Group 4 site (south to north, photo by: Peng Wei)

59. Tiquancun Group 5 *Shazidun*

The site is 35m west-east, 18m north-south, a total area of 630m^2. Elevation 566.5m. Slag, burned soil, and furnace lining were discovered. The deposit is about 2m thick. Song dynasty (960-1279AD).

Fig. 48 Overview of *Shazidun* site (west to east, photo by: Peng Wei)

60. Tiquancun Group 5 *Shazidi*

The site is 30m west-east, 20m north-south, a total area of 600m^2. Elevation 556.8m. Slag was discovered. Song dynasty (960-1279AD).

Fig. 49 Overview of *Shazidi* site (northeast to southwest, photo by: Peng Wei)

61. Honglucun Honggaolu

The site is 20m west-east, 30m north-south, a total area of 600m^2. Elevation 589.7m. Slag and charcoal were discovered. Two furnace bases were discovered 7m away from each other. Furnace A is 1m long and 0.35m wide, and furnace B is 1.2m long and 0.5m wide. Song dynasty (960-1279AD).

Fig. 50 Overview of *Honggaolu* site (northeast to southwest, photo by: Peng Wei)

62. Honglucun Gaolushang

The site is 100m west-east, 50m north-south, a total area of 5,000m^2. Elevation 553.5m. Slag, burned soil, and pottery sherd were discovered. The deposit is about 2m thick. Song dynasty (960-1279AD).

Fig. 51 Overview of *Gaolushang* site (west to east, photo by: Peng Wei)

63. Gaoluzui

The site is 60m west-east, 30m north-south, a total area of 1,800m^2. Elevation 561.1m. Slag, burned soil, charcoal, furnace lining, and pottery sherd were discovered. One broken furnace was discovered in 1987, which has a remaining height of 2.2m, diameter of 2m, and 0.45m thick of the furnace wall. Now destroyed. Song dynasty (960-1279AD).

Fig. 52 Slag at *Gaoluzui* (photo by: Peng Wei)

65. Gaolubang

The site is 50m west-east, 20m north-south, a total area of 1,000m^2. Elevation 581m. Slag, charcoal, and furnace lining were discovered. Song dynasty (960-1279AD).

Fig. 53 Overview of *Gaolubang* site (southeast to northwest, photo by: Peng Wei)

66. Shuangshuijingcun Shaluzui

The site is 30m west-east, 30m north-south, a total area of 900m^2. Elevation 536.4m. Slag, charcoal, and pottery sherd were discovered. The deposit is about 2m thick. Song dynasty (960-1279AD).

Fig. 54 Overview of *Shaluzui* site (east to west, photo by: Peng Wei)

Fig. 55 Slag at *Shaluzui* (photo by: Peng Wei)

69. Kuangkengshan

The site is 200m west-east, 300m north-south, a total area of 60,000m^2. Elevation 638.5m. The iron sand deposit is about 2m thick and 0.5m from the surface, which is distributing in an area of 25,000m^2. There are hundreds of mine holes on the site. Most of them have rounded shape, and a diameter from 2 to 5m and a depth from 1 to 2m. The largest mine hole is 30m long and 20m wide. One kiln was discovered, which has a diameter of 1.9m and 1.6m deep. Song dynasty (960-1279AD).

Fig. 56 Overview of *Kuangkengshan* site (west to east, photo by: Zhou Guolong)

70. Jianwan

Total area of 1,000m^2. Elevation 626.3m. Slag and burned soil were discovered. The burned soil deposit is distributed in an area of 300m^2. The deposit about 2m thick and 0.3m from the surface. Song dynasty (960-1279AD).

Fig. 57 Burned soil at *Jianwan* (east to west, photo by: Zhou Guolong)

71. Wanghe

The site is 30m west-east, 20m north-south, a total area of 600m^2. Elevation 630.7m. Slag, charcoal, and furnace lining were discovered. Song dynasty (960-1279AD).

Fig. 58 Slag at *Wanghe* (photo by: Zhou Guolong)

73. Tieshidui

Located at south of Qionglai county. Total area about 1,500m^2. Slag, burned soil, and refractory were discovered. One kiln was discovered. Song dynasty (960-1279AD).

74. Tiechangchong

Located at south of Qionglai county. Total area about 4,000m^2. Slag, burned soil, and furnace lining were discovered. Tang or Song dynasties (7th to 13th century).

72. Tieshiba

Located at south of Qionglai county. The site is 230m west-east, 250m north-south, a total area of 57,500m^2. Elevation 590.0m.

Six sites and locations are from the Yuan, Ming or Qing dynasties (13th to 19th centuries):

12. Shazitian

Total area about 2,000m^2. Elevation 582m. One broken furnace was discovered. The furnace belly is about 1.8m in diameter. Stone and pebble were used around the furnace for strengthen purpose. On the section of the terrace, it can be seen that the slag deposit is 0.3 to 0.5m thick and 1.3m from the surface. No cultural relics were discovered at the site. The site might be date to Ming or Qing dynasties (14th to 19th century) based on the way the furnace was built.

31. Datiancun Douyan

The site is 50m west-east, 50m north-south, a total area of 2,500m^2. Elevation 575.4m. Slag, iron sand, burned soil, and furnace lining were discovered. The deposit is 0.6 to 0.7m thick and 0.4 to 0.5m from the surface. Ming dynasty (1368-1644AD).

Fig. 59 Overview of *Datiancun Douyan* site (east to west, photo by: Peng Wei)

52. Liuhechang

A trench was discovered connected to a coal mine. The remaining of the trench is 19.1m long, and 0.25m wide and deep. The trench was used to transport coal. On the wall inside the mine, it carved 'the 19th year of the Guangxu of Qing dynasty (1893AD)'.

Fig. 60 Tunnel of coal mine at *Liuhechang* (photo by: Peng Wei)

64. Shaziwan

The site is 130m west-east, 20m north-south, a total area of 2,600m^2. Elevation 588.5m. Slag, iron sand, and furnace lining were discovered. Ming dynasty (1368-1644AD).

Fig. 61 Overview of *Shaziwan* site (southwest to northeast, photo by: Peng Wei)

67. Shaloucun

The site is 400m west-east, 30m north-south, a total area of 12,000m^2. Elevation 611.1m. Slag, iron sand, and furnace lining were discovered. The deposit is 2m thick and 0.2m from the surface. Yuan dynasty (1271-1368AD).

Fig. 62 Slag and furnace lining at *Shaloucun* (photo by: Zhou Guolong)

68. Huatouzui

The site is 35m west-east, 26m north-south, a total area of 910m^2. Elevation 607.6m. Iron sand and charcoal were discovered. The thickest part of the deposit is 3m. Yuan dynasty (1271-1368AD).

Fig. 63 Slag at *Huatouzui* (east to west, photo by: Zhou Guolong)