

Re-thinking the Emergence of Iron Metallurgy in Taiwan
a Trade Diaspora Model

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A dissertation
submitted in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

University of Washington
2022

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Abstract

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As a society is composed of waves of immigrants, overseas influences have been common to Taiwan since ancient times. Among these external forces, the overseas immigrant-influenced technological leap is believed to be the prime mover for Taiwan entering the Metal period (1800 BP) directly from the Neolithic period (5500-1800 BP). Several studies have proposed overseas influences, like foreign traders and craftspeople, for explaining the emergence of the Metal period and metallurgy in ancient Taiwan. In this doctoral research, I further apply the concept of trade diaspora and build a model to explore the introductory mechanism and localization process of foreign elements that led Taiwan from the Neolithic times into the Metal period. I hypothesize that these overseas materials, cultural elements, and metallurgy were brought by traders who were also metallurgical craftspeople in the form of trade diaspora.

A three-stage trade diaspora model is proposed to accommodate the published data from the Jiuxianglan 舊香蘭, Huakangshan 花岡山, Shihshanghang 十三行, and Chongde 崇德 sites for understanding the introductory mechanism and localization process of foreign elements.

Ceramic, burial practice, and metallurgical tradition are the primary aspects for determining the existence of trade diasporic community in the proposed model. In addition to the published data, the newly excavated Blihun Hanben 漢本 (BHB) site is the primary fieldwork site and is expected to provide new data and insight into the proposed model. There are two major cultural layers (L4 1600-1000 cal. BP and L6 2000-1600 cal. BP) in the Blihun Hanben site. Totally, over 9000 kg ceramics, 2500 kg iron slag, 200 burials were unearthed during four years of salvage project.

In this research, I applied technical typology to analyze ceramic and iron metallurgical remains. This concept reveals the embedded manufacturing stages from visible attributes on the end-product and helps us understand the choices made by the potter and smelter, and may further distinguish the hidden social boundaries between social groups. Instrumental analyses are applied to further support the technical typology.

Ceramics are the most abundant remains in Taiwan's Neolithic and Metal periods context. Based on the technical typology, both L4 and L6 cultural layers have more than fifteen ceramic types, and I have designated those types into seven (L4) and seven (L6) wares. Petrographic analysis shows five sources for the temper for both L4 and L6 specimens. Those are BHB local, the southern part of the Ilan Plain, the northern part of the Ilan Plain, the Igneous/volcanic areas, and the East Rift Valley. It is reasonable to say that the BHB ceramic temper was acquired from locations ranging all over northern and eastern Taiwan. From a technical typological perspective, this petrographic analysis of temper provenience mainly consists with the macro analysis (by naked-eye) results, in other words, the ceramics in the same ceramic ware have the same temper provenience.

The L4 ceramics match to known Shihshanhang cultural assemblage Pulowan subset, especially identical to the ceramic assemblage from the Chongde site. While L6 ceramics can hardly be matched with any known ceramic assemblage, L6 ceramics show a certain connection to the Upper Huakangshan ceramics. Multiple ceramic proveniences indicate the connectedness between the Blihun Hanben people and other eastern and northern Taiwan residents. Moreover, the ceramic analyses results fit the archaeological prediction of the proposed model.

L4 unearthed over 99% of iron slag, and the heatmap of slag chronological distribution shows an abrupt increase of slag deposit from L6 to L4. This sudden increase of iron slag deposit indicates the practice of matured iron technology at the beginning of L4. Slag technical typology shows that bloomery was the metallurgical tradition of the BHB site, and the whole slag assemblage is dominated by smithing hearth bottom, which is the indicator of smithing activity. The lack of furnace body fragments also supports this result. Commonly speaking, a bloomery furnace is a onetime-use structure since the furnace needs to be broken for bloom extraction. Under this circumstance, a large number of furnace body fragments are usually associated with smelting slag in the smelting site. However, the examined BHB slag specimens lack both furnace-lining fragments and smelting slag; in contrast, this slag assemblage reflects intensive smithing activities (ironworking) rather than smelting (ironmaking).

The micro-analyses (SEM-EDX) support the macro-analysis (technical typology). The specimens of the presumed smelting slag, which is rare in the whole slag assemblage, yielded typical iron smelting slag micro-structure and mineral composition. Long and semi-rectangular fayalite lath and dendritic wüstite are typical minerals in bloomery smelting slag. On the other hand, fat wüstite globules were found in the smithing hearth bottom specimens. Fat wüstite globule is the typical microstructure in smithing slag. While we did not find direct evidence of iron smelting, the large amount of smithing slag implied the frequent smelting practice near the Blihun Hanben site. The slag analyses result also fits the archaeological prediction of the proposed model.

In summation, the possession of matured metallurgical ability is the crucial characteristic of trade diasporic craftspeople I proposed, and both the ceramic and metallurgical analyses support that the BHB L6 fit the second stage and BHB L4 fit the third stage of the proposed trade diaspora model. The proposed model represents a long-term adaptation of hypothetical trade diaspora communities to the local societies. While subsequent studies need to be carried out, the proposed model is not denied in the current research state.

Acknowledgment

It will be impossible to finish this doctoral research without the supports of many individuals and organizations. I want to express my gratitude to my reading committee members, CHAO Chin-Yung, Jim Feathers, and Stephanie Selover, and of course, my chair Peter Lape. He is always welcoming with his warm personality. Peter is full of patience and gentle (I feel, sometimes too soft to me) and guided me through the whole doctoral training. Jim is generous and insightful, and I enjoy working in the luminescence dating lab. Stephanie is always encouraging and optimistic, and I really appreciate having a metallurgical specialist in the second half of my doctoral training. CHAO has known me for many years, and he is always caring and sharing. My committee members inspired me not only on the intellectual and professional side but also mentored me with their passion and kindness. I received valuable opinions and challenges from each of them and felt supported while developing this doctoral project.

We Archy graduate students always support each other. I received those emotional and intellectual supports from my comrade no less than the committee members. While I treasure all friendships in the group, I especially want to thank David Carlson, Joss Whittaker, Mikhail Echavarri, Ian Kretzler, Liying Wang, Rodrigo Solinis-Casparius, and Gayoung Park who I learn from and lean on the most. As an international student, I was helped way too many times by department staff Catherine Zeigler and John Cady. I have heard some terrible stories from other international students, but our department strongly supports me.

My primary fieldwork was in my motherland Taiwan, and I received a tremendous amount of assistance from many people. I especially need to thank Prof. LIU Yi-Chang 劉益昌, who was the director of Blihun Hanben 漢本 salvage archaeology project. I also need to mention the help from Prof. LIU's team, JHUANG Shih-Ying 莊詩盈, LIAO Bao-Cin 廖寶琴, YANG Yu-Chun 楊郁純, LIN Huei-Ru 林慧茹, JHENG Jhu-Yin 鄭筑尹, FAN Shu-Mei 范淑美, HSU Yu-Ling 許玉玲, LI Chun-Yu-李淳郁, CHEN Zu-Yang 陳祖陽. They helped me a lot during the ceramic analysis. My research also benefits a lot from the geological methods, and I learned and was helped by Prof. CHEN Wenshan 陳文山 (petrography), Dr. IIZUKA Yoshiyuki 飯塚義之 (SEM-EDX), WANG Yu-Siang 王宇翔 (SEM-EDX) and Prof. LIOU Ying-San 劉瑩三 (geological background). And I learn a

great deal from reading their work and talking with Dr. CHEN Kwang-Tzoo 陳光祖 and WANG Kuan-Wen 王冠文 about geoarchaeology and archaeological sciences in Taiwan. Dr. Brice Girbal and Ms. LI Jhih-Ling 李芷綾 about their experience and passion of iron archaeometallurgy.

This journey of academic exploration was supported by numerous institutes, ranging from administrative to financial supports. Taiwan Ministry of Education, Institute of History and Philology Academia Sinica, Shihsanhang Museum, Field Museum, Geological Society of America Geoarchaeology Division, University of Washington Anthropology Department, Quaternary Research Center, and Taiwan Studies Program.

Finally, I want to thank my family, Mom, Dad, Ruo-Yu, Lulu, and Shih-Ya. Thank you for wondering, exploring, and traveling with me on this memorial journey!

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1. Introduction

A pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has significantly changed our routine life since the beginning of 2020. As of September 2021, this COVID-19 pandemic has infected over two hundred million people and is responsible for the loss of four and half million of Earth's citizens.¹ The last time we had such a severe global pandemic was the Spanish flu epidemic of 1918. The massive movement of people is the primary reason for the rapid transmission of these two deadly diseases. While World War I was the main reason for population movement causing the spread of the Spanish flu epidemic, modern globalization is likely to be the primary catalyst of rapid transmission of SARS-CoV-2. Although we suffer from COVID-19, the immediate responses, like new public health policies and vaccine development, are beneficial from the timely information and resources exchanged because of globalization.

Modern globalization has flattened our world and has brought its own pros and cons to our societies. The pandemic and the vaccine are two good examples. But the intensification of interregional interactions is not the patent of modern society. The year 2024 will mark four hundred years that Taiwan has been entangled with the world trade systems. In 1624, the Vereenigde Oost Indische Compagnie (VOC, or Dutch East India Company) built a fortified trade post (Fort Zeelandia) in southwestern Taiwan and carried out trade with Japan and China for products like silver ingots and porcelain. While the VOC only colonized part of Taiwan, and for only thirty-eight years (1662-1624), the VOC and the subsequent Koxinga regime left a profound impact on the Taiwan Formosan (the ancestors of modern Taiwan Indigenous peoples) societies, especially those new tangible and intangible cultural elements brought by the Han-Chinese immigrants. Similar events took place in older times as well, in both the Neolithic and the Metal periods.²

¹ <https://coronavirus.jhu.edu/map.html>, data was retrieved on September 8, 2021.

² Previously, scholars used the Iron age or the Metal and lithic period 金石並用時代 in the context of Taiwan archaeology. The idea of the Metal and Lithic period is similar to the Chalcolithic period. The difference is that there was no clear evidence of using only 'copper' or 'bronze' in ancient Taiwan. In the context of island Southeast Asia, multiple kinds of metal (mostly iron and bronze, sometimes brass) were introduced into island Southeast Asia at the same time. So, instead of using the Iron age, Metal age (or period) seems to be a more accurate term for the period

As a society is composed of waves of immigrants, overseas influences have been common to Taiwan since ancient times. Among these external forces, the overseas immigrant-influenced technological leap is believed to be the prime mover for Taiwan entering the Metal period (1800 BP) directly from the Neolithic period (5500-1800 BP).³ In addition to change of ceramic tradition, changes happened not only with the tools for subsistence but also with the materials used for body decoration materials. Burial practices changed, as well. The ornaments and tools made of Taiwanese nephrite were replaced by the overseas-introduced glass beads, carnelian beads, and metal objects (both bronze and iron). Initially, this transition to the Metal period was considered to have happened around 1800 BP as a rapid change based on the findings from the Shihhsanhang 十三行 site in northern Taiwan. However, recent studies on eastern Taiwan have pointed out that the change may have taken place from about 2400 BP. Instead of a rapid change, there may have a period between 2400-1800 BP (or 2400-1600 BP⁴) with more changes than we recognized before.

Hence, the eastern Taiwan area may not only have been the home port of the hypothetical ancient Austronesian culture expansion and exportation of Taiwanese nephrite but may also have been the gateway for receiving the foreign cultural elements that profoundly impacted the development of Taiwan deep history (instead of using prehistory, Acabado and Hsieh (2020) proposes using deep history to reduce the inherited colonial impression in archaeological study) that lead Taiwan's entrance into the Metal period.

1.1. Main Research Question and Scope

Several studies (Hung and Chao 2016; LEE 李坤修 2015; LIU 劉益昌 2012) have proposed overseas influences, like foreign traders and craftspeople, for explaining the emergence of the Metal period and metallurgy in ancient Taiwan. While each of those previous studies has

of using metal. In Taiwan, we have a pretty similar situation with island Southeast Asia. Hence, currently more and more scholars use the Metal period to refer to this time.

³ A commonly recognized date. However, recent studies have proposed that eastern Taiwan may entered Metal period earlier than 1800 BP.

⁴ 1800 BP is the conventional dating of the Taiwan Metal period, and 1600 BP is a solid dating for local iron production.

uncovered a part of the whole story, I feel we need a model to frame the research results into a more holistic picture, and this model should be able to portray the longer transitional process. In this doctoral research, I apply the concept of trade diaspora and build a model around this concept to explore the introductory mechanism and localization process of foreign elements that led Taiwan from the Neolithic times into the Metal period. I hypothesize that these overseas materials, cultural elements, and metallurgy were brought by traders who were also metallurgical craftspeople in the form of trade diaspora.

While a few previous studies have used trade diaspora for describing the pattern of a set of sporadic but widely distributed artifacts, more lines of evidence need to be considered to support the existence of trade diaspora. Hence, I shall clearly define what a trade diaspora is and predict its archaeological material representation. Needless to say, metallurgical remains that indicate mature metallurgy are a necessity when identifying those diasporic craftspeople.

Tracing the overseas origin of the introduced metallurgy is one of my research interests, but in this dissertation, I mainly focus on building a logical model that would explain the transitional process from the Neolithic to Metal period in eastern and northern Taiwan. The reason is straightforward. All essential studies are from these two areas of Taiwan. The dating of the Jiuxianglan 舊香蘭 (JXL) site in southeastern Taiwan pushes the earliest traces of the Metal period to 2400 BP. In northern Taiwan, the iron slag deposit in the Shihshanghang 十三行 (SSH) site signifies the first mass iron production starting from 1600 BP. The recently identified Upper Huakangshan 花岡山 site in eastern Taiwan seems to link the JXL and SSH sites chronologically and geographically, but the link is weak and subtle. Besides using the data from those aforementioned sites, the newly excavated Blihun Hanben 漢本 site seemingly provides data that would strengthen the connection between eastern Taiwan and northern Taiwan.

I shall try to identify the possible existence of a trade diaspora in those sites and see if the proposed trade diaspora model could explain the transitional process from the Neolithic to Metal periods.

1.2. Dissertation Organization

This dissertation is composed of six chapters. The second chapter briefly reviews the history, development, and recent advance of Taiwan archaeological study. In addition to those archaeological backgrounds, I also introduce the related geography and geological information that would benefit the readers to comprehend the close relationship between natural and cultural environments. The recent advances section focuses on the movement of people and materials from overseas into Taiwan, and the possible explanations of those movements.

Chapter three reviews the development of the trade diaspora concept in general and in archaeological studies. The studies of Gil Stein, CHEN Pochan 陳伯楨, and Philip Curtin are three essential works I used to develop the trade diaspora model in my research. Stein and CHEN have provided examples of how they identified trade diaspora in archaeology. Curtin's focus on the interaction between diasporic people and local hosts gives chronological dynamics to the proposed model. The second half of this chapter overviews the essential information and excavation results of the Blihun Hanben 漢本 (BHB) site, which is the keystone of this doctoral research.

Chapter four focuses on the ceramic analyses. I applied the technical typological analysis to classify BHB ceramics and matched the results to known archaeological cultures in Taiwan. A systematic sampling was used to retrieve robust statistical results and examine the spatial distribution of ceramic types in the BHB site. From the ceramic perspective, the BHB L4 layer can be designated to the Shihshang culture Pulowan 普洛灣 type, and the BHB L6 is new to our understanding. While the L6 ceramic assemblage is new, some ceramic types show connections with the SSH culture and the newly identified Upper Huakangshan culture. The subsequent petrographic analysis further points out the high diversity of temper sources for the BHB ceramics (both L4 and L6). This high diversity of ceramic provenience may indicate connectedness between the BHB people and those in northern and eastern Taiwan.

I carried out extensive analyses on the BHB iron slag assemblage and have presented the results in chapter five. Both morphological and instrumental analyses were applied. Intriguingly, we found that the assemblage was mainly composed of smithing slag. This indicates off-village

smelting and on-site (in the BHB village) primary smithing. Secondary smithing is also believed to have been practiced in the BHB village. Synthetically speaking, BHB craftspeople practiced the bloomery method to produce iron, and iron sand may have been the ore. However, the ore source is uncertain. A suddenly emerged iron technology implies its introduced nature. The origin of this BHB iron metallurgy may have been mainland Southeast Asia or southern China regions.

In chapter six, I discuss if the trade diasporic communities are visible in this data and if the proposed model is valid. The analyses of the ceramics and iron slag show positive support to the existence of trade diaspora, and the model accommodates the data from both my and previous studies quite well, and nicely frames the story of how iron technology was introduced into ancient Taiwan. I also talk a bit more about observations of burial practices and include the BHB aDNA analysis result in the latter half of this chapter. The aDNA analysis shows certain relations between the BHB people and the populations in the northern part of mainland Southeast Asia.

In sum, this doctoral research demonstrates the analytical potential of trade diaspora models and offers an explanation for the transition from the Neolithic to the Metal period in Taiwan. These results suggest that more studies are needed, and I also have plotted future research directions in the conclusion chapter.

1.3. Naming conventions

In this dissertation, I include quite a few names of archaeological sites and scholars from Taiwan and mainland China. For these East Asian names and places, in addition to the Romanized names, I have included the original East Asian characters following the Romanized names, for example, the Shihsanhang 十三行 site. The East Asian surnames are presented in all caps and are arranged in front of the given name, for example, CHEN Pochan 陳伯楨. By using this writing style, I hope to represent respect to East Asian culture as well as to make clear to non-East Asian readers which part of any given name is the actual surname.

2. Taiwan Environment and Archaeology Background

Situated just next to continental East Asia, Taiwan is a large island with a current population of about twenty-three million citizens. Taiwan is recognized as the hub of the First Island Chain and known as the unsinkable aircraft carrier⁵ in modern military history because of her central position in the East Asian island arcs. Geographically, Taiwan is close to but separated from continental East Asia, and as a result, Taiwan's natural and cultural environments are related to but distinct from the mainland. Similarly, the trajectory of historical development is quite different on the two sides of the Taiwan Strait. On the west side of the strait, ancient China developed complex state societies; meanwhile, on the east side of the waterway, the ancestors of Taiwanese Indigenous people advanced through history on their own path.

This is not to say that there were no interactions between Taiwan and the outside world. Archaeologically speaking, ancient Taiwanese societies interacted with external cultures, including cultures across the Taiwan Strait and Bashi Channel, in many forms; at times continuously, discontinuously, or sporadically. Taiwan had relatively less intensive connections to the external world until the seventeenth century, when the Europeans brought the colonized parts of Taiwan into the entangled world system (LIU 劉益昌 2011b). This was the starting point when Taiwan's Indigenous peoples gradually began to lose their autonomy, and with a few pivotal political changes, Taiwan's Indigenous peoples eventually became people who are 'governed' by 'modern/ civilized' administrations.

While Han Chinese (immigrants from mainland China and their descendants) are the majority in the Taiwanese society now, most of the archeological record of human occupation on this island was created by the ancestors of Taiwan's Indigenous people. Written accounts of Taiwan are relatively scarce until European contact. As such, archaeology, with the aid of oral history among some Taiwanese Indigenous groups, is the primary method to recover ancient history. Recently, several relatively comprehensive works written in English regarding Taiwan and Taiwan-related

⁵ Memorandum on Formosa, by General of the Army Douglas MacArthur, Commander in Chief, Far East, and Supreme Commander, Allied Powers, Japan. <https://history.state.gov/historicaldocuments/frus1950v07/d86>, data retrieved on October 17, 2021.

archaeology have introduced decades of archaeological studies to English readers (CHEN 2017; Hung 2017; Kuo 2019).⁶ Based on these English works and other Chinese written works, this chapter provides an introduction and summary of contextual information related to this doctoral research, like the natural environment, history of archaeology, archaeological chronology, and recent advances in archaeological studies in Taiwan.

2.1. Cultural and Natural Settings of Taiwan Archaeology

2.1.1. Taiwan Geology and Geography Background

The island of Taiwan is located on the west end of the Pacific Ocean, in the middle position of the first island chain, next to continental East Asia (Figure 2-1) The Taiwan Strait passes between the island and mainland with the narrowest part of the strait being only 130 km across. Taiwan became connected with the Asian continent during the Last Glacial Maximum (LGM) when the sea level dropped. Salvaged fauna remains indicate human and animal activities in the current strait location during the LGM (CHEN 陳光祖 2000). During the Paleolithic period, the early residents of Taiwan may have arrived in Taiwan via the land bridge (Taiwan Strait without water). Taiwan is relatively far from her adjacent large island neighbors, like Japan and the Philippines; however, the Ryukyu Islands and Batanes Archipelago act as bridges between these large islands. A bit southwestward of Taiwan, west of the Philippines and east of mainland Southeast Asia is the Southeast Asian/South China Sea. The Southeast Asian/South China Sea is one of the busiest water bodies in the world, and the same water body might also have been quite busy in ancient times, (Bellina 2017; Favereau and Bellina 2016; Liu 2021; MIYAMA 深山繪実梨 2014).

The island of Taiwan is about 400 km from north to south and about 140 km from west to east. High mountain ranges generally parallel the long axis of the island and have traditionally been an obstacle to transportation and communication between the eastern and western sides of the island. Taiwan was formed about four to five million years ago by a series of geological tectonic activities between the Eurasian Plate and the Philippine Sea Plate (CHEN 陳文山 2016).

Generally speaking, a portion of the Philippine Sea Plate submerges under the Eurasian Plate and

⁶ Before, one could find sporadic English articles in journals like Asian Perspectives and Bulletin of the Indo-Pacific Prehistory Association.

lifts the edge of the Eurasian Plate leading to the formation of metamorphic mountain ranges in Taiwan. Jade Mountain,⁷ the highest mountain peak of the Central Mountain Range, is the product of these tectonic activities. One exception is the Coastal Mountain Range; that range is a volcanic area of the Philippine Sea Plate. These tectonic activities are still going on; hence, earthquakes frequently happen, especially in eastern Taiwan where the convergent boundary of two plates is (Figure 2-2). Those tectonic activities created the complex geological environment of Taiwan, and this complexity makes several sourcing techniques possible. I shall discuss these sourcing methods in the subsequent chapter for ceramic and iron slag analyses.

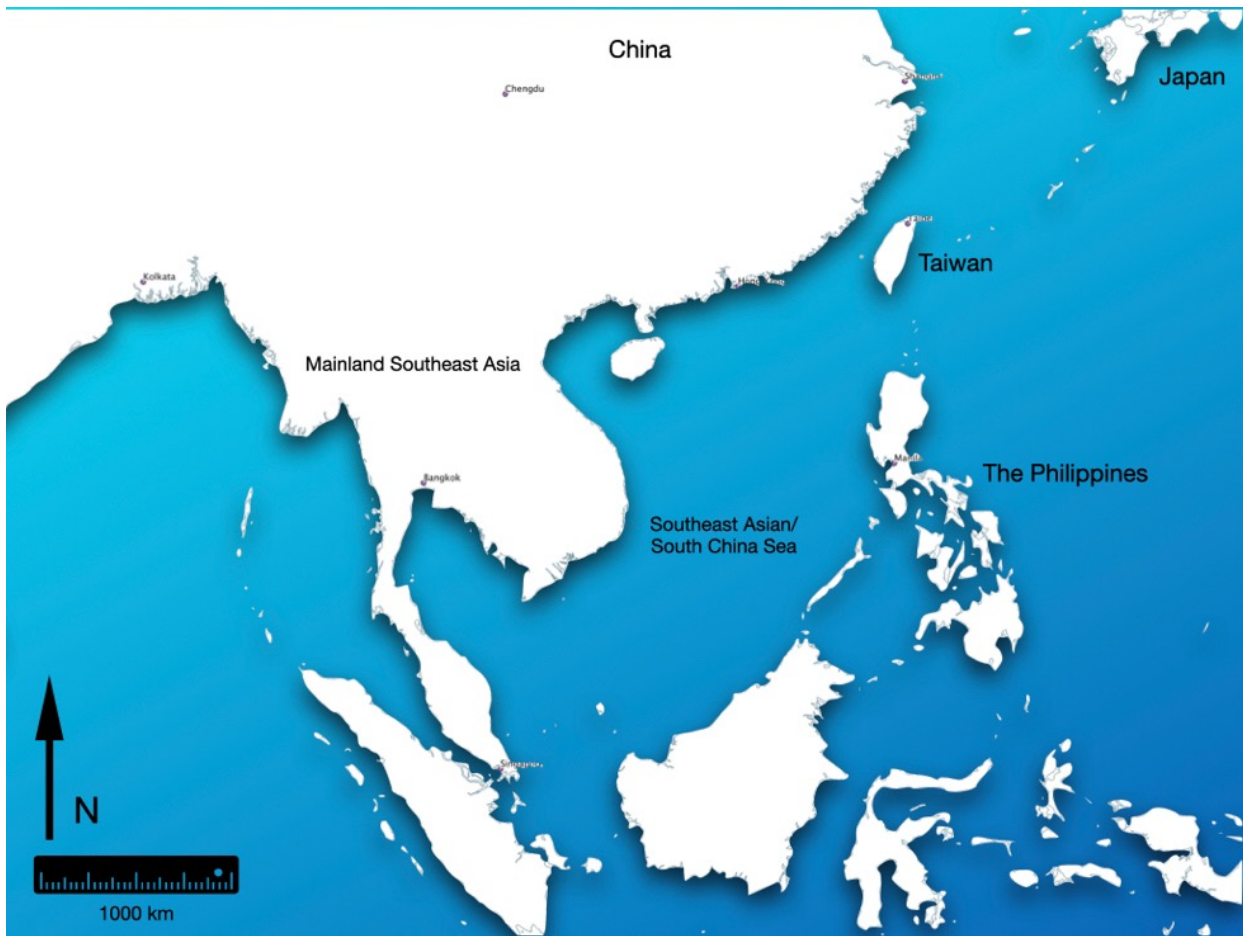


Figure 2-1 Map of East and Southeast Asia (partial), and the location of Taiwan

⁷ 3952m above sea level. The highest mountain peak in East Asia.

2.1.2. A Brief History of Taiwan archaeology

Taiwan archaeology has been influenced by academic trends in Japan, China, and the USA, and is entangled with Taiwan's modern history. When reviewing the disciplinary history of Taiwan archaeology, political shifts⁹ and scholarly orientations are two common approaches for staging its academic history (CHEN 2017; Kuo 2019; LI 李光周 1985). By review the brief history of the archaeological studies in Taiwan, the readers would understand how several academic traditions and longtime-cared research questions are formed and why archaeologists are doing them. For example, the use of archaeological culture¹⁰ and the continuous work of identifying¹¹ archaeological cultures. This section also reviews a few latest studies that shows the research trend of the last decade. Also, this review shows why large proportion of archaeological works and data are mainly from the cultural resources management (CRM) projects. The primary sites I use for this research were excavated because of CRM works.

In addition to these two common ways, Liu also proposes his four-stage model to the history of Taiwan archaeology (LIU 劉益昌 2011b).¹² The first period (1896-1945) is named 'Discovery and Groundbreaking' and mostly coincides with Japanese colonial rule. There are two stages in this period. The first stage is the construction of the knowledge for ruling a new colony by the Governor-General of Taiwan of the Japanese Empire. Scholars sent by the Government-General of Taiwan documented natural and cultural resources, including ethnographic and archaeological findings. During this stage, scholars explored the possibilities of overseas cultural affiliation with island and mainland Southeast Asia (SEA) (TORII 鳥居龍藏 1897). The second stage started in

⁹ The Japanese Empire colonized Taiwan after the First Sino-Japanese War. This Japanese Colonial Period (1895-1945) lasted for fifty years, and another external political entity, the Kuomintang (KMT)-ruling ROC government took over Taiwan. The martial law enforced by the KMT-ruling government was lifted in 1987. After that, Taiwan gradually moved toward a healthy democratic country/political entity. We experienced our first direct presidential election in 1996, and up to date, we have had three peaceful transitions of power since then.

¹⁰ While assemblage is more commonly used in the US for referring a certain set of archaeological remains, archaeological culture is still the common term in Taiwan. In addition to the long tradition of using this term in Taiwan, which I demonstrate in this chapter, archaeological culture also includes the human behaviors that reflect from studies on artifacts.

¹¹ This tendency is reducing but still on-going.

¹² CHEN (2017) and KUO (2019) have reviewed the history and development of Taiwanese archaeological studies. Here, from a slightly different perspective, I compose a concise history of Taiwan archaeology based on Liu (2011: 86-112).

1928. This year corresponds to the establishment of the Ethnology Program at the Imperial Taihoku (Taipei) University (predecessor of National Taiwan University) and marks the dawn of advanced academic research. In this stage, the chair of this program, UTSURIKAWA Nenozo 移川子之藏, with the assistance of his colleagues,¹³ accomplished many academic achievements, like 1) laying out the foundation of Taiwanese Indigenous grouping and 2) carrying out the first systematic archaeological excavation. In the same stage, independent researcher KANO Tadao 鹿野忠雄 contributed no less than the Ethnology Program. He proposed his seven 'prehistoric' cultural level model (KANO 鹿野忠雄 1955) based on the data from his detailed and comprehensive fieldworks. KANO also noticed the possible connection between Taiwan and island and mainland SEA by comparing material cultures.

The second period (1945-1963) is the time of transformation. KANASEKI Takeo 金關丈夫 and KOKUBU Naoichi 國分直一 were two representative Japanese scholars of the first stage (1945-1949) in this period. They and MIYAMOTO Nobuto 宮本延人 were the Japanese scholars who were retained and continued their teaching and research at National Taiwan University (successor of the Imperial Taihoku University) after World War II. Prof. SUNG Wen-Hsun, the pioneer of the first generation of domestic archaeologists, received his instruction from those Japanese scholars as an undergraduate student at this stage. Prof. SUNG cultivated the subsequent Taiwanese archaeologists at National Taiwan University. It is correct to say that the legacy of the Japanese school of archeology was passed on by SUNG and profoundly influenced the subsequent Taiwanese archaeologists (LIU 劉益昌 2011b). The second stage is crucial and marks the transitional time of Taiwan archaeology. This stage (1949-1963) began with the academic reboot by re-settled Chinese archaeologists who moved to Taiwan with the Kuomintang (KMT)/ Chinese Nationalist Party-ruling government from mainland China. LI Chi 李濟, also known as the founding father of Chinese archaeology, and his colleagues¹⁴ brought the excavation techniques and excavated remains from the Yin Ruins (殷墟) work. The same groups of Chinese archaeologists also taught courses in the newly established Department of

¹³ MABUCHI Tōichi 馬淵東一 and MIYAMOTO Nobuto 宮本延人.

¹⁴ As the research fellows of the Institute of History and Philology at Academia Sinica.

Archaeology and Anthropology¹⁵ at National Taiwan University (NTU), inherited from the Ethnology Program in the Japanese Colonial Period (JCP). During this transformative stage, Prof. SHIH Chang-Ju 石璋如 taught the fieldwork course with SUNG as his teaching assistant in the educational realm (LIU 劉益昌 2011b:95); hence, the Yin Ruins excavation method became the foundation of all subsequent archaeological fieldwork in Taiwan. The relative chronology and the concept of archaeological culture gradually developed from this academic tradition.

The third period (1964-early 1980s) has three signature characteristics: 1) establishment of temporal-spatial framework for archaeological cultures, 2) Han-Chinese nationalism in archaeology, and 3) the 'sciences' of archaeology. In the 50s, SUNG 宋文薰 and CHANG 張光直 (1954) proposed the first temporal-spatial framework of western Taiwan archaeological cultures with the data that had accumulated since the JCP and new data from new systematic excavations. Systematic excavation had been introduced by the re-settled Chinese archaeologists and again by CHANG Kwang-Chih in the 60s (LIU 劉益昌 2011b:102). In the third period, the framework than been expanded and revised to more detailed versions (Figure 2-3, Figure 2-5, and **Error! Reference source not found.**) with more fieldwork and research (Chang 1969, 1974; SUNG 宋文薰 and LIEN 連照美 1975) and the introduction of new dating technology (SUNG 宋文薰 and CHANG 張光直 1964). The very first set of radiocarbon dating on Taiwanese archaeological samples (shell and charcoal) was from the Yuanshan 圓山 Site and the Tapenkeng/Dabengkeng 大坌坑 Site, and the samples were dated by the radiocarbon laboratory at Yale University (SUNG 宋文薰 and CHANG 張光直 1964:5). The first interdisciplinary collaboration was held during this period by CHANG Kwang-Chih (KC CHANG)¹⁶ as well, and CHANG also directed a subsequent collaborative project in central Taiwan. These two projects in

¹⁵ This department is also the predecessor of the current Department of Anthropology at National Taiwan University.

¹⁶ KC graduated from the National Taiwan University and completed his PhD in the US. He was a well-known archaeologist of Ancient China and had a profound achievement in settlement archaeology. He proposed Lungshanoid, a hypothetic formation period of ancient China culture, and he also applied the interaction spheres for explaining the development and interaction between different regions in ancient China. The Archaeology of Ancient China was a well-known and fundamental source of Chinese archaeology for western Academia during his time. KC also contributed a lot to Taiwan archaeology by carrying out a cross-disciplinary project in southwestern Taiwan, introducing new dating techniques, and establishing Taiwan-focused research institutes.

the 60s and 70s demonstrated the potential of ecological studies to contribute to the interpretation of past human lives and society. Processual Archaeology was brought into Taiwan in the 70s by LI Kuang-Chou 李光周 (LI 李光周 1974) and was fashionable for about a decade. In addition to these developments, archaeological interpretations were primarily influenced by¹⁷ Chinese nationalism. This tendency was apparent when discussing the origin of culture in Taiwan (CHANG 張光直 1998; CHAO 趙金勇 2012; LIU 劉益昌 2006; 2011b:106-107; 2015a). Ancient China was always the origin.

SUNG's book-length article "An Archaeological Perspective of Taiwan" (由考古學看台灣) (SUNG 宋文薰 1980) marks the end of the third period and the beginning of the fourth period (early 1980s-early 2000s). SUNG synthesized the works from previous periods and proposed a comprehensive chronological table of Taiwan's prehistoric cultures (Figure 2-5 and **Error! Reference source not found.**). Although we have accumulated more data and understand more about prehistoric cultures in Taiwan since 1980, the framework laid out by SUNG still stands. There are several important events in the early fourth period that profoundly influenced the development of archaeological studies. These events shape the current archaeology of Taiwan to a certain extent. From my perspective, I consider these three events to be 1) the enactment of the Cultural Heritage Preservation Act, 2) the lifting of martial law,¹⁸ and 3) the Taiwanization movement.

In the early 80s, the implementation of the Cultural Heritage Preservation Act gave legal status to archaeological sites and opened a new sub-field, salvage archaeology (or contract archaeology).¹⁹ This sub-field has developed rapidly in the last two decades. Like in many other countries, salvage archaeology projects receive more funding than academic ones, and a significant proportion of archaeological data is from this realm. The Blihun Hanben 漢本 site, the

¹⁷ Or censored by the government under the martial law.

¹⁸ The longest martial law practice (from May 20th 1949 to July 15th 1987) in the world.

¹⁹ I do not use CRM (cultural resources management) to refer this sub-field because we have not fully engaged the 'management' practice from what I have observed in Taiwan.

primary site of this doctoral research, has also been excavated as a salvage project, triggered by the Suhua 蘇花 (Suao 蘇澳 to Hualien 花蓮) highway construction.

The Taiwanization movement has a direct relation to the lifting of martial law in 1987. The influence of these localization movements on Taiwan archaeology, and especially on cultural studies, is the research focus and interpretation of archeological finds. Before 1987, most of the interpretation on the origin of Taiwanese ancient cultures was based on Chinese nationalism. The Taiwanization movement²⁰ broke this tendency, and Taiwanese archaeological study began to have more locally-focused and broader (conceptually and physically) research themes.

Taiwanese locally-focused research contributes the most to refining and expanding our understanding of local archaeological cultures. In contrast to SUNG's general framework, LIU Yi-Chang 劉益昌 dedicates his time to refining “archaeological cultures.” His two works (LIU 劉益昌 1992, 1996) were the pioneering works for visualizing the boundary between archaeological cultures (Figure 2-6 and Figure 2-7). The refinement of archaeological culture framework has continued in recent years (e.g., CHAO 趙金勇 et al. 2013; KUO 郭素秋 2019; LEE 李坤修 2014; LIU 劉益昌 2015a; TSANG 臧振華 2013).²¹ These new advances heavily rely on ceramic studies, and I will discuss this topic more in the subsequent ceramic analysis chapter. As for the research themes, the exploration of broader archaeological issues took root during the third period when KC CHANG conducted interdisciplinary projects. This type of cross-discipline collaboration practice did not last due to the shortage of Taiwan-focused archaeologists; however, the legacy of those projects expanded the research theme for succeeding Taiwanese archaeologists. Cross-disciplinary collaboration, paying attention to quantitative and analytic data,²² and broader

²⁰ The Chinese nationalism tendency and non-Chinese perspective coexist in the current Taiwan archaeological realm. Some may argue that the Taiwanization movement creates a kind of ‘Taiwan’ nationalism. I do not fully agree with this kind of assertion. At least for the current point, the efforts of Taiwanization are merely to restore the distorted balance of the interpretation of Taiwan history.

²¹ Almost every archaeologist in Taiwan has their own version of archaeological culture framework.

²² For example, the establishment of the Scientific and Technological Archaeology Laboratory in the Institute of History and Philology at Academia Sinica.

research themes, from paleoenvironment to trade networks, became common practices after the late 90s (LIU 劉益昌 2015a).

From what I have observed, the fifth period (the early 2000s to the present) is the era of reflection on previous times, the era of trending topics and practices, and the era of rapid changes. For instance, historical and contemporary archaeological studies were popular at the start of the 2000s (CHAO 趙金勇 2012; CHAO 趙金勇 and CHUNG 鍾亦興 2012; LIU 劉俊昱 2011; LIU 劉益昌 2010b) but have received less attention in the recent decade. However, the influence of previous trending topics is evident, and the practices of historical archaeology have become one of the norms in Taiwan archaeology. The same is true of the Indigenous archaeological studies that are happening now (CHENG 鄭玠甫 2020; KUO 郭素秋 Kuo et al. 2017; WU 吳牧鏞 2019), and Taiwanese archaeologists are also self-reflecting on the inherited colonialism in Taiwan archaeology. The seed of cross-disciplinary collaboration that was planted during the third period has also gradually grown and become the common practice now. A list of conference paper topics in at the annual meeting of Taiwan archaeologists shows this clear trend (LIU 劉益昌 2015a). Geophysical and geochemical sourcing, ancient diet study by phytolith and isotope analyses, and remote sensing are popular topics in the recent decade.²³ Also, a younger generation of archaeologists who are trained with specific analytic skills are the latest workforce of Taiwan archaeology (e.g., LEE 李政益 et al. 2016; WANG 王冠文 et al. 2018; WU 吳牧鏞 2019). The research methods they use stimulates other researchers and enhances the refinement and clarity of archaeological studies. While statistical data is essential in these instrumental analytic methods, other Taiwanese archaeological studies have now begun to emphasize solid statistical data when generating their interpretations.

As an island that is populated by waves of immigrants from ancient to modern times, the population of Taiwan is complex and diverse. Archaeology as an academic discipline is entangled with the contemporary history of Taiwan and has been shaped by Taiwanese society, like the

²³ In the most recent annual conference of the Taiwan Archaeological Society, about 1/3 of presented papers were about those so-called archaeological sciences studies, and about 1/3 were about Indigenous and historical archaeology. There have gradually been fewer and fewer excavation reports in recent years.

change of explanatory paradigms and the development of salvage archaeology. Here, I can only provide an extremely concise version of the disciplinary development but have tried to cover the pivots and essences that shape current Taiwan archaeology.

2.1.3. Use of Archaeological Culture in the Context Taiwan Archaeology

Before entering the next section, a short clarification on the term 'archaeological culture' is necessary. From what I understand in the context of current Taiwan archaeology, an archaeological culture is a collection of material assemblages with similar traits with a specific temporal-spatial distribution, which Taiwanese archaeologists reconstruct past society and lifeway from.

The idea of archaeological culture was introduced during the second period of archaeological history in Taiwan by the settled Chinese archaeologists. And we see the subsequent efforts by KC Chang (Figure 2-3) and SUNG, who tried to build the chronological table of 'prehistoric cultures.' In KC's table, we see different terms, like red pottery, horizon, and culture, in the same table. This may be due to the lack of comprehensive data sets. We see also KC tried to connect these archaeological material assemblages to modern Indigenous groups (for example, modern Bunun).

Figure 2-4 shows the evolution of using different terms referring to specific archaeological assemblage by scholars (mainly KC and SUNG). We can see the use of phase in the 1970s' chronological table, and both pottery trait and site name were used as the prefix for phases. The chronology proposed by SUNG 宋文薰 and LIEN 連照美 (1975) used "period" as the higher classification unit to lump several phases together. The purpose of using period was mainly to match with KC's Lungshanoid period and include Taiwan in China's ancient development process. Figure 2-5 demonstrates the concluding opinion of SUNG in the early 80s, and this table became the foundation of all chronological tables of prehistory in Taiwan.

In Figure 2-5, SUNG started using the term 'culture' to refer to the archaeological assemblage with similar traits. Worth to notice is, the term 'phase' in SUNG's 1980 table became the subset of an archaeological culture. While SUNG did not show the tendency to connect specific material assemblage to one Indigenous group, he used the material culture of Taiwan Indigenous groups

as the analogy to his definition of archaeological culture (SUNG 宋文薰 1980). And the legacy of connecting archaeological culture (an assemblage of materials remains with distinguished traits) to modern Taiwanese Indigenous groups seems to remain until now (Figure 2-8). As mentioned in the history of Taiwan archaeology section, Processual Archaeology was brought into Taiwan in the mid-70s; however, the practice of Processual Archaeology did not last long and did not become the dominant paradigm in Taiwan archaeology. Hence, there was no visible debate of using 'archaeological culture' as a unit for referring to archaeological assemblage.

Figure 2-7 and Figure 2-8 show the splitting efforts of Taiwanese archaeologists who try to demonstrate and explain the diversity and changes within and among these 'cultures.' More and more 'cultures' are proposed based on the differences of material representation, however, there is no strict standard of to what extent the material difference is the threshold for recognizing the existence of a new archaeological culture. Especially when each scholar has their own standards.

While 'archaeological culture' somehow provides a base for understanding the chronology and regional developments. The vagueness has caused ambiguity and hardness of opinion exchange. We might see fewer and fewer scholars focusing on building and identifying 'archaeological culture' in the future.

Nevertheless, the term archaeological culture in Taiwan is widely used, but the discussion about the difference between culture, phase, horizon seem not thoroughly. Some of these terms refer to a pottery tradition, some refer to the whole material assemblage from a specific area, and some to the reconstructed ancient society and lifeways. From what I have observed, to the most extent, the term "archaeological culture" is interchangeable with cultural assemblage. While I remain using this term in this chapter (to respect the works and efforts that have been done by Taiwanese archaeologists), I use the term 'cultural assemblage' in the following chapters to refer to the collection of material remains that share similarities with specific spatial distribution. For example, Shihshang culture will be Shihshang cultural assemblage, and Shihshang culture Pulowan type will be Shihshang cultural assemblage Pulowan subset. I use 'phase' referring to the material assemblage which is distinguishable but has not been discuss thoroughly.

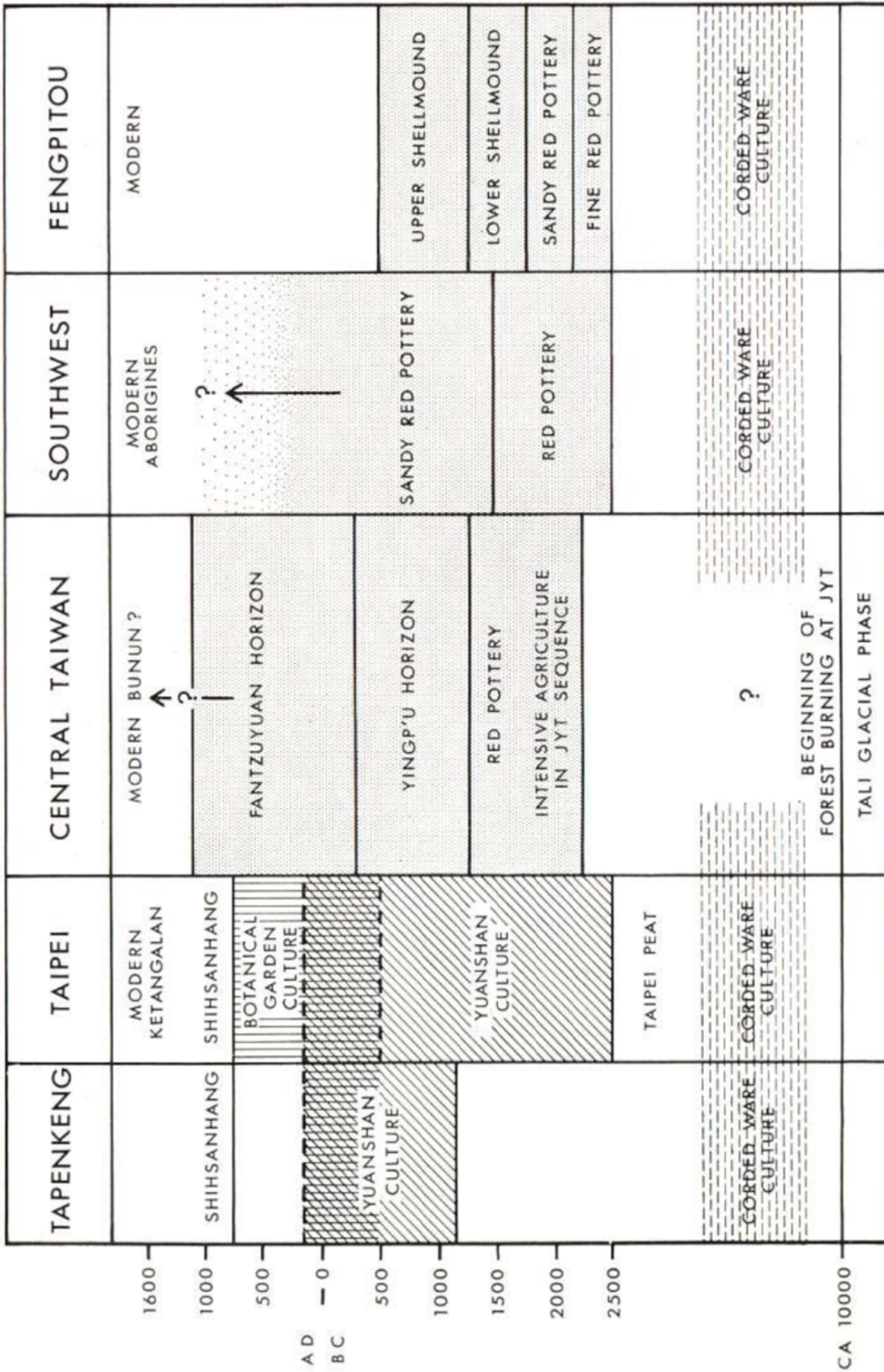


Figure 2-3 Archaeological Cultures and Chronology in Taiwan (Chang 1969)

臺灣西海岸中部地區文化層序名稱對照表
CORRELATION TABLE OF THE ARCHAEOLOGICAL CULTURE SEQUENCES
OF WEST CENTRAL TAIWAN BY AUTHORS

宋文薰、連照美編
Edited and compiled by Sung and Lien

宋 (Sung and Chang)	1954	紅色繩紋陶文化	大甲臺地第一黑陶文化	大甲臺地第二黑陶文化	漢 文 化
張 (Chang)	1954	繩紋陶文化	黑陶文化 (印文)	黑陶及灰陶文化 (刻劃文、銘文、印文)	近代漢文化 1600-1700 A.D.
石、宋 (Shih and Sung)	1956	繩紋紅陶	大甲臺地第一黑陶文化	大甲臺地第二黑陶文化	歷史時代
Chang	1956	The Core-Imprinted Pottery Culture	Black Pottery Culture c.a. 1000-1600 B.C.	Black and Gray Pottery Culture c.a. 1600-1700 A.D.	The Modern Chinese Culture 1600-1700 A.D.
宋 (Sung)	1965	繩紋紅陶文化	第一期黑陶文化 2000 B.C.	第二期黑陶文化 1000 B.C.	近代漢文化 A.D. 1600
Chang	1967*	(beginnings of deforestation) 10000 B.C.	繩紋紅陶文化 (Intensive Agriculture at Juyueh Tan) 2500 B.C.	LUNGSHANOID CULTURE: (Redware phase) 1500 B.C.	MODERN ABORIGINES A.D. 1000 A.D. 1600
藤介 (Kokubu)	1968	繩紋土器文化層	繩紋紅陶文化層	黑陶文化層	近代漢文化層
P. 204: Ceramic Horizons			Niu-ma-tou	Ying-P'u	Modern Chinese
Chang et al. P. 216: Prehistoric Cultures	1969	Beginning of Forest Burning at JUCI c.a. 10000 B.C.	Intensive Agriculture in JYI Sequence 2500 B.C.	Red Pottery 1500 B.C.	Fan-tzu-yuan ? Protohistoric
Chang et al.	1974	Coarse Cord-marked Pottery Phase 10000 B.C.	Red Cord-marked Pottery Phase 3000 B.C. 2500 B.C.	Plain Red Pottery Phase 2000 B.C.	Fanzuayan Horizon A.D. 1000 A.D. 1600
Chang	1974a	(Tapenkeng elements)	Ts'ao-hsieh-tun Phase 2500 B.C.	Tach'nyuan Phase 2000 B.C.	Gray-Black Impressed Pottery Phase A.D. 700
張 (Chang)	1974b	大芬坑式繩紋陶成分	紅色繩紋陶 2500 B.C.**	素面紅陶 1550 B.C.**	Protohistoric A.D. 700-1200
宋、連、臧 (Sung, Lien & Tsang)	1975	長濱期 Changpinian Period	牛罵頭相 Niumatou Phase 2500 B.C.	素面灰黑陶 1500 B.C.	Historic A.D. 1650
遺 址*** SITE		先 史 陶 Preceramic Pottery	粗繩紋陶 Coarse Cord-marked Pottery	龍山形成期 Lungshanoid Period 大丘正國相 Tach'nyuan Phase 2000 B.C.	香仔園期 Fanzuayan Period A.D. 261** A.D. 355±48** A.D. 765**
		牛罵頭 Niu-ma-tou 坪林 IV Pin-lin IV	海文湖 Tan-wen-hu 白沙坑 Pai-sha-t'un 火葬場 Hwo-sang-ch'ang 水源地 Sui-yan-ti 大甲東 Ta-chia-tung 麻頭路 Ma-t'ou-lu 牛罵頭 Niu-ma-tou 庄後村 Chung-hou-t'un 龍泉村 Lung-ch'uan-t'un 頂 街 Ting-chieh 下厝厝 Chia-ma-t'o 草鞋墩 Ts'ao-hsieh-tun 坪林 IV Ping-lin IV 洞角 Tung-chiao	火葬場 Hwo-sang-ch'ang 大甲東 Ta-chia-tung 牛罵頭 Niu-ma-tou 庄後村 Chung-hou-t'un 七分 Chi-fun 水底寮 Sui-t'iao 營埔 Ying-p'u 舊社 Chiu-shé 茄寮山 Chieh-lao-shan 坪林 V, XI, XII Ping-lin V, XI, XII 大厝脚 Ta-ma-lin 寬功寮 Chia-kung-liao 陸東 Yai-liao 大丘脚 Ta-ch'iu-yuan 日月潭 Jih-yueh-t'an 埔心子 Puh-shin-tzu 竹山前山 Chu-shan-shen-shih	後龍底 Hsu-lung-ti 苑 相 Yuan-ti 番仔園 Fan-tzu-yuan 麻頭路 Ma-t'ou-lu 山 脚 Shan-chiao 龍泉村 Lung-ch'uan-t'un 八卦山 Pa-kua-shan 草鞋墩 Ts'ao-hsieh-tun
		陶器層序 Sequence	繩紋陶 Cord-marked Pottery	素面紅陶 Plain Reddish Pottery	刻紋灰黑陶 Gray-Black Incised Pottery
			牛罵頭 Niu-ma-tou 坪林 IV Pin-lin IV	龍山形成期 Lungshanoid Period 大丘正國相 Tach'nyuan Phase 2000 B.C.	香仔園期 Fanzuayan Period A.D. 261** A.D. 355±48** A.D. 765**

* 為 Chang, 1970a 文中所發表, 但完稿年代為 1967, 故排於此地位, 參閱本文 P. 97. ** 原文使用 B.P., 用1950為標準計算所得 B.C. 或 A.D. *** 英文地名根據圖冊45~47年版, 聯合新舊總司令部調查處臺灣省五分一地圖。

Figure 2-4 Sung and Lien's Table of Prehistoric cultures in western Taiwan (SUNG 宋文薰 and LIEN 連照美 1975)



Figure 2-6 Boundary of Late Neolithic Cultures in Taiwan (LIU 劉益昌 1992), modified by the author

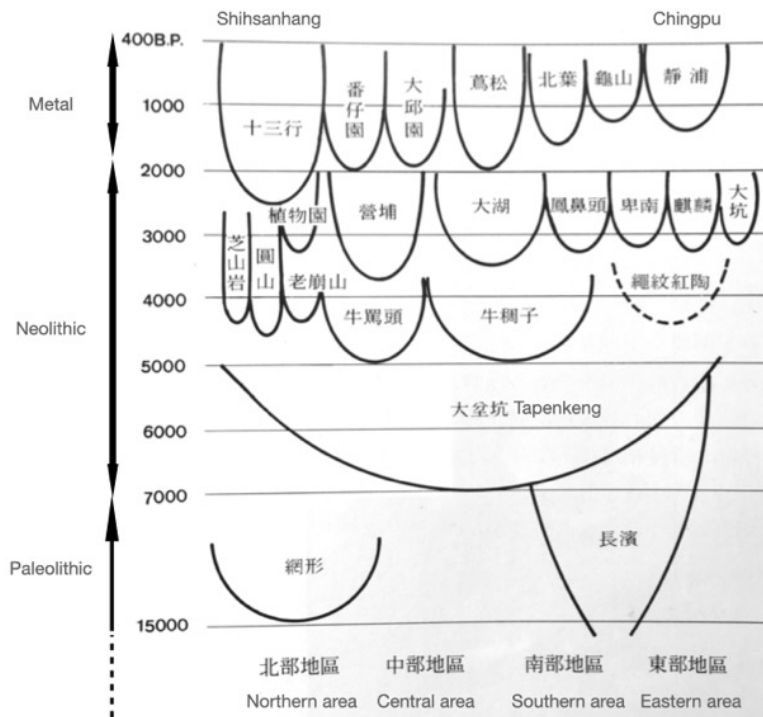


Figure 2-7 Liu's chronological framework of Taiwan's prehistoric cultures (LIU 劉益昌 1996), modified by the author

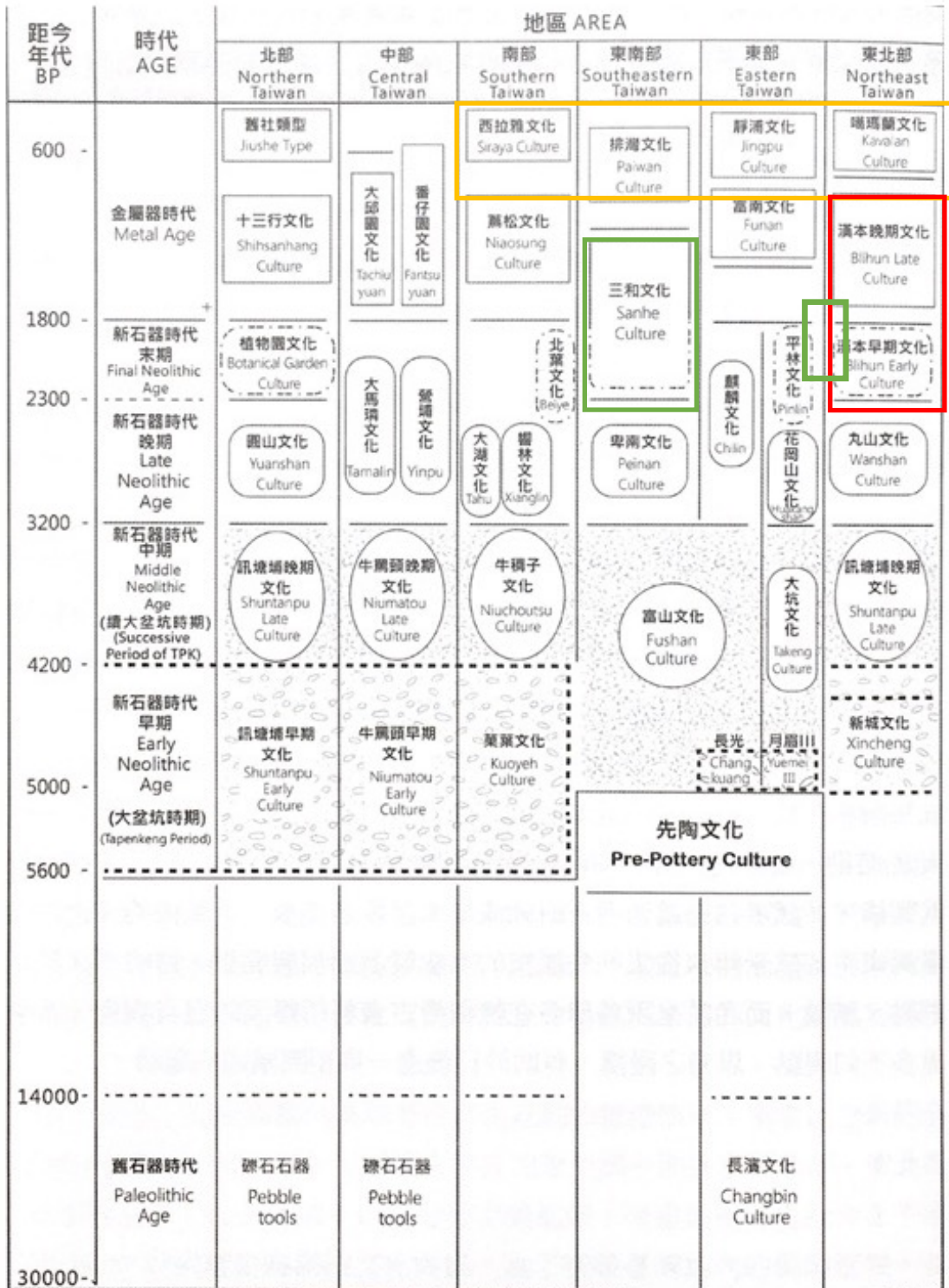


Figure 2-8 Recently updated table of Taiwanese archaeological cultures, modified from (Kuo 郭素秋 2020b:387). The two green squares mark newly identified archaeological cultures: Sanhe culture and Upper Huakangshan culture. Kuo uses early and late Bihun Hanben culture to refer to two culture layers in the BHB site; however, I disagree with Kuo's opinion (red square). The dull yellow square marks the archaeological cultures that may directly link with premodern Taiwan Indigenous groups

2.2. New Advances and Transitional Period in Ancient Taiwan

Taiwan is known as one of the hypothetical homelands of ancient Austronesian-speaking people in a global context of archaeological study.²⁴ The presumable ancient Austronesian-speaking people were the newcomers who settled, adapted to local environments, introduced agriculture into Taiwan, and then developed to different Neolithic cultures on the island of Taiwan.

Taiwanese nephrite was the primary material of ornaments in the Neolithic Taiwan. Studies also show the Taiwanese nephrite objects had distributed around the South China/ Southeast Asian Sea regions since 3500 BP, and the overseas distribution of those nephrite objects indicate the existence of exchange network and craftsmanship (HUNG et al. 2007; MIYAMA 深山繪実梨 2018).

Another wave of foreign cultural elements with pyrotechnologies of glass and metal reached Taiwan about 2000 BP and totally altered the Neolithic material cultures, and the nephrite tradition was fully replaced. This replacement left profound influence on ancient Taiwan society and the legacy lasts to modern times. There is no nephrite-using tradition in the modern Taiwanese Indigenous societies, instead, decoration system and family heirlooms are all beads and metal objects. Before the recent advances of archaeological studies in eastern Taiwan, there was an abrupt change from Neolithic to Metal periods around 1800 BP based on the upper dating limits of Shihshanhang culture.²⁵

2.2.1. The Pivotal Change: Final Neolithic Period, Initial and Early Metal Period

Recent studies (CHAO 趙金勇 et al. 2013; Hung and Chao 2016) in eastern Taiwan give us new insights and point out a possible transitional period starting from 2400 BP. This period (2400-1800/1600 BP) is quite complex, and the cultural development is asymmetric between western and eastern Taiwan. Hence, the conventional cultural staging on the whole island will be difficult

²⁴ Most of the archaeologists in Taiwan use the term Austronesian (or proto-Austronesian) people for referring those ancient immigrants, and Austronesian even becomes equal to Austronesian-speaking people for public media and among Indigenous people. This might be due to some Chinese-written archaeological articles in the early 2000s, however, most academic writing in Taiwan archaeology now prefers to use Austronesian-speaking people or Austronesian ethnic group.

²⁵ The first Iron/metal period archaeological culture/assemblage that been identified (see the discussion in Middle Metal period).

to comprehend due to the complexity of this period. Figure 2-11 shows the boundary of this uneven cultural development.

The changes in archaeological cultures in western and central Taiwan are less dramatic than those in eastern Taiwan. Artifact assemblages in western and central Taiwan remain similar to those from the late Neolithic period; hence, those cultures can still be considered in the final period of the Neolithic. Generally speaking, there is only a gradual decrease in the proportion of decorated ceramic in the whole assemblage (LIU 劉益昌 2011b). In northern Taiwan, the Chihwuyuen 植物園 (Botanical garden) culture (2400-1800 BP) is the subsequent culture of the Yuanshan culture (3400-2400 BP).²⁶ Basically, their ceramic assemblages are pretty different; Chihwuyuen culture pottery usually has paddled-impressed geometrical patterns under the pot neck and has a banded structure in the ceramic matrix (Figure 2-9). A mix of clay might be the reason for the banded structure; however, the nature of the banded structure formation is not fully deciphered (LIN 林宜羚 2009; WANG 王仲群 2017), but the banded structure is indeed the distinctive characteristic of the Chihwuyuen pottery.

As for the southeastern part of Taiwan, we see a relatively gradual evolution from the Peinan 卑南 culture to Sanhe 三和 culture. While Sanhe culture inherited some ceramic characteristics and some burial practices from Peinan culture, such as plain sandy reddish-brown pottery and rectangular slate coffins, the significant differences are new stamped and incised pottery surface decorations, triangle horizontal pot handles, and the exotic burial goods, like glass beads²⁷ and metal objects (LEE 李坤修 2005; LEE 李坤修 and YE 葉美珍 2001; LIU 劉益昌 et al. 2002). In the Hualien 花蓮 area, the Upper Huakangshan 花岡山上層 culture (2100-1600 BP) is a newly identified archaeological culture which is distinguished from the original Huakangshan culture by different burial practices, lithic tool assemblage, ceramic assemblage, and also glass beads (CHAO 趙金勇 et al. 2013). Upper Huakangshan culture looks like an embedded culture in the Hualien area. South of the Upper Huakangshan culture, the Pinglin/Ciyakang 平林/支亞干

²⁶ However, KUO (2019) questions the separation of these two cultures in the chronological table (Figure 1 6) she recently proposed.

²⁷ Small amount of glass beads were found in the upper layer (the latest layer) of Peinan culture.

phase²⁸ is clearly different from the Upper Huakangshan culture. It seems a new archaeological culture may need to be considered (Kuo 2019; LIU 劉益昌 2011b). While the ancient Formosans occupied almost all regions and ecological zones, the absence of archaeological data in northeastern Taiwan indicates no or undetectable human activities which may have been due to severe heavy rain that probably had certain relation to the El Niño-Southern Oscillation (LIN 林淑芬 2015).

The use of nephrite products declined during this period, especially the nephrite ornaments in the burial context. Instead, foreign materials like glass beads, agate beads, and metal objects become the fashion as burial goods. This change was apparent in the eastern cultures. Recent excavations and studies indicate that these foreign materials and geometric decorative patterns on the ceramics may have been introduced from the southeast part of the Asian mainland or mainland Southeast Asia (Hung and Chao 2016; LEE 李坤修 2005; LIU 劉益昌 2012; WANG 王冠文 et al. 2018). However, there is also the possibility of Fujian influences (Kuo 2019).

While the use of nephrite declined during this period in Taiwan, the manufacture of nephrite finished products and semi-finished products seemed not to decrease. Especially in the Pinglin/Ciyakang site (Pinglin/Ciyakang phase, Figure 2-11), a large amount of debitage was recovered during several excavations (Liu 劉益昌 2015b). During this time, those nephrite products and processed-ore may have been exported overseas in exchange for the foreign goods (LIU 劉益昌 and WANG 王淑津 2005), and the studies on the jade/nephrite ornaments in the Southeast Asian/South China Sea maritime regions seem to support this hypothesis (HUNG et al. 2007; Iizuka et al. 2005; MIYAMA 深山繪実梨 2018). Taiwan nephrite products continued to be visible until about 1000 years ago outside of Taiwan, but in Taiwan, the use of nephrite ornaments rapidly declined and almost disappeared 1600 years ago, replaced by glass and carnelian beads. This phenomenon happened in eastern Taiwan first, and the Blihun Hanben Early Phase at the Blihun Hanben site and the Sanhe culture Sanhe type at the Jiuxianglan site are the two sites that have currently yielded the most of those foreign materials from this

²⁸ Pinglin is the Han-Chinese name, and Ciyakang is Truku/Taroko's name. Truku is one of the Indigenous tribal groups in Taiwan.

period. The use of foreign materials as ornaments expanded to the north in the next period and further expanded to the rest of Taiwan. The legacy of this pivotal change remains to the present day. In the modern Taiwanese Indigenous Societies, glass beads, agate beads, and metal objects are heirlooms in several Indigenous tribal groups; however, Taiwan nephrite objects are absent in the modern Indigenous societies, and there is no term for 'jade' in their languages.



Figure 2-9 Chihwuyuen Culture pottery from the Chihwuyuen site (note the banded structure in the ceramic matrix) (LIU 劉益昌 2011c). Upper right corner is a bronze axe from the Chihwuyuen cultural layer of the Tudigongshan Site, redrawn from CHEN 陳仲玉 (1994)

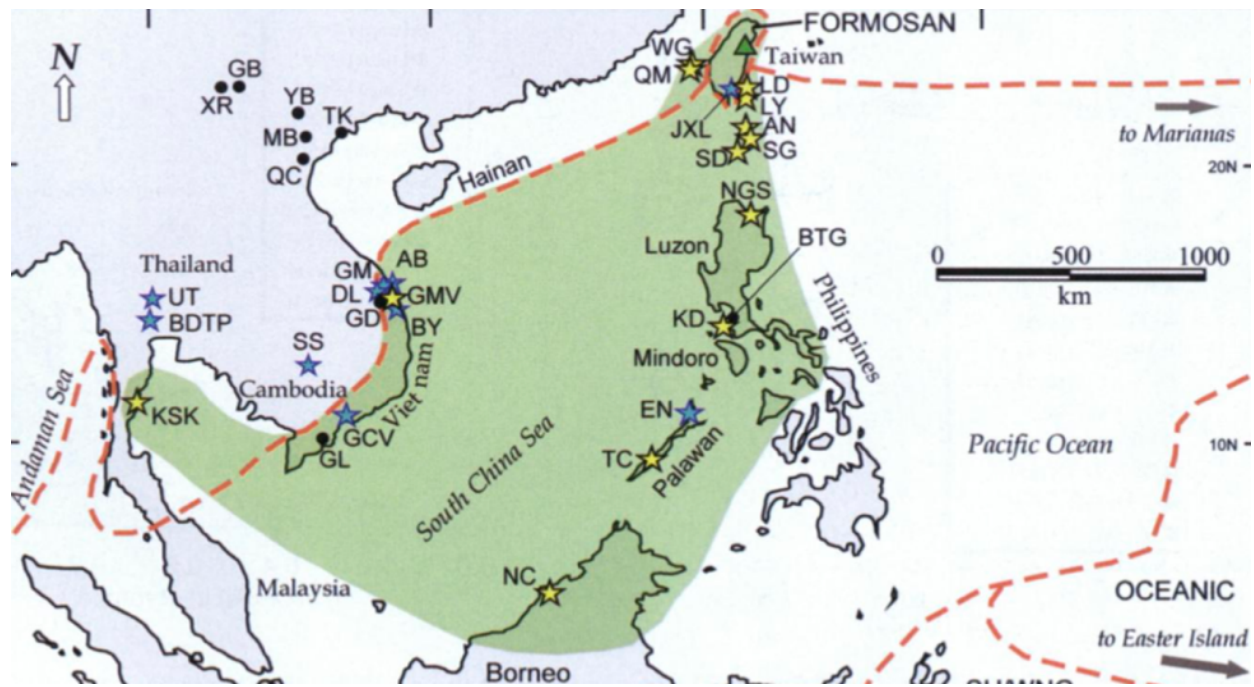


Figure 2-10 The yellow stars mark the sites with confirmed Taiwan nephrite artifacts. This map is modified from (HUNG et al. 2007)

Final Neolithic Period, Initial and Early Metal Period (2400–1800/1600 BP)

- Cities
- Archaeological sites
- Boundary of prehistoric cultures
- Boundary of prehistoric phases
- River
- - - Boundary of Final Neolithic period and initial Metal period

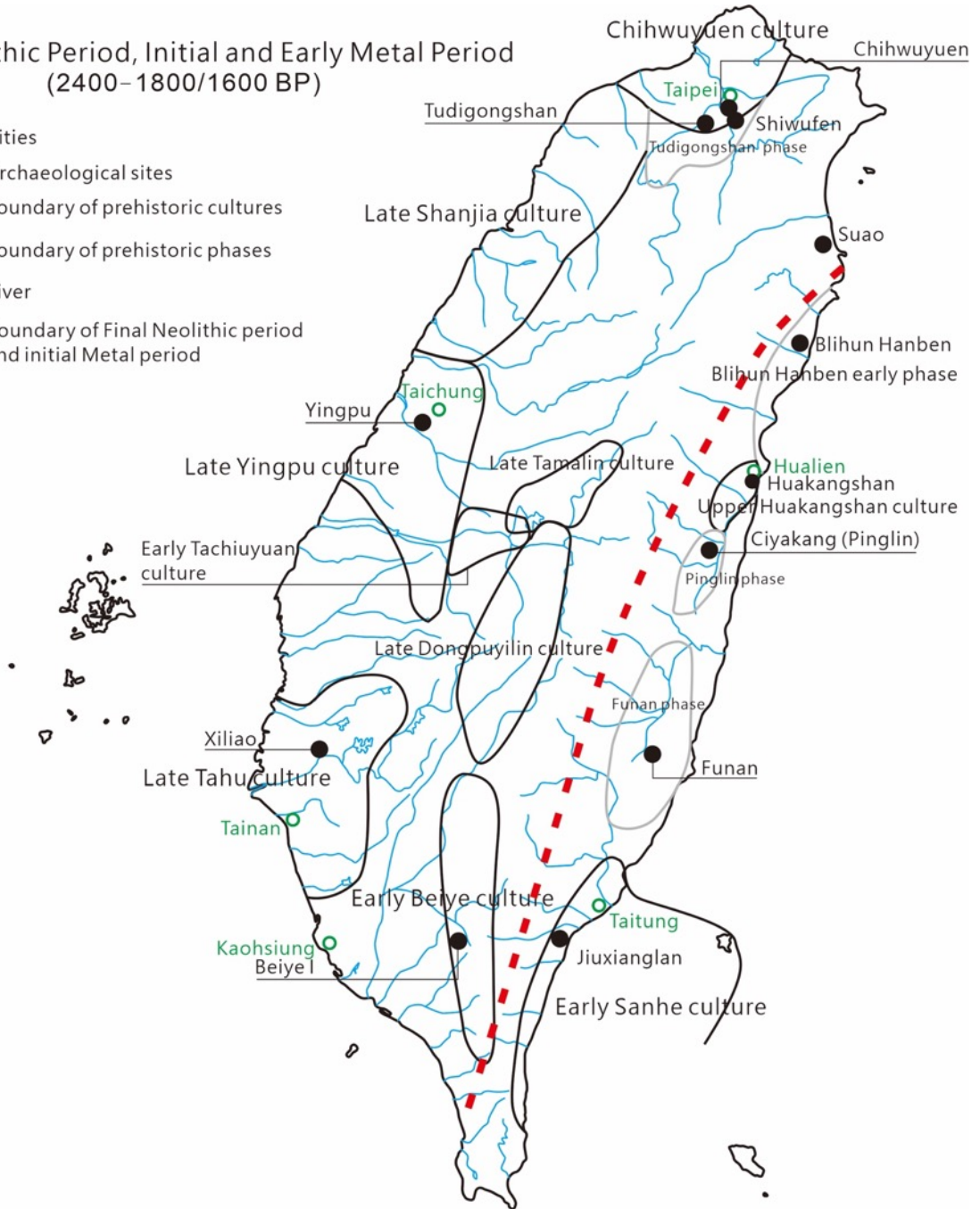


Figure 2-11 Map of the Final Neolithic period, initial and early Metal period cultures. The broken red line is the boundary of metal and lithic cultural regions. Modified from LIU 劉益昌 (2011b)

2.2.2. Middle Metal period

Except for a few cultures in the mountainous areas, 1800 BP is the time when almost all archaeological cultures (Figure 2-18) entered the Metal period (or some call Iron period, see footnote 2 of chapter 1). The material representation is quite different between cultures; some developed from their predecessors with minor foreign influences, but in contrast, some cultures developed with more foreign elements that may have included move-in migration. The cultures in central and southwestern Taiwan may have developed from the previous culture, for example the Fantzuyuan 番仔園 culture developed from the Yingpu 營埔 Culture, and the Niasung 蔦松 culture developed from the Tahu 大湖 culture. The Shihshanghang 十三行 (SSH) culture had both local cultural elements that may have been inherited from the Chihwuyuan culture (like geometric patterns on the pottery surface, Figure 2-12) and cultural elements from eastern Taiwan (like grayish-black pottery with impressed and incised decorative patterns, and exotic materials like glass beads and metal). Based on the temporal-spatial distribution, the SSH culture had many local types, like SSH , Xixinzhuangzi 西新庄子 , and Puluowan 普洛灣(Figure 2-13).²⁹ The Chingpu culture (Figure 2-16) had a similar developmental trajectory; it also contained several local types that were seemingly inherited cultural elements from preceding cultures. Some of these local types may be considered independent archaeological cultures. For example, KUO considers the Funan 富南 type as an independent culture. As for the Kueishan 龜山 culture, it may have co-existed with the Sanhe 三和 culture for a short time, and it is known by the stamped anthropomorphic patterns on its pottery ceramic (Figure 2-17). The anthropomorphic patterns and snake motif from the Sanhe culture are considered the proto-type of the decorative motif of the modern Paiwan 排灣 and Rukai 魯凱 Indigenous tribal groups.

Before discovering the Blihun Hanben (BHB) site, the Shihshanghang site was considered the largest (and maybe the only) iron production center in ancient Taiwan because of its rich ferrous pyrotechnology remains, like slag and furnace/hearths. The BHB site yielded no fewer of those ferrous pyrotechnology remains than did the SSH site Those remains will be further discussed in

²⁹ LIU Yi-Chang tries to classify SSH culture into ten local types for explaining the complexity of SSH culture in this period. However, some types he proposed seem to not be widely recognized due to the lack of data. Nevertheless, the types I mention here are generally recognized SSH cultural types.

the slag analysis chapter. Worthy of notice is the fact that recent excavations on the Jiunxianglan 舊香蘭 site (southeastern Taiwan, Sanhe culture) and Huakangshan 花岡山 site (eastern Taiwan, Upper Huakangshan culture) show that people of these two cultures may have possessed the ability of ironworking beginning about 2200 years ago (CHAO 趙金勇 et al. 2013; Hung and Chao 2016; LEE 李坤修 2005, 2015; LIU 劉益昌 and CHAO 趙金勇 2010a). Interestingly, these sites are the only few sites at which were found the remains, or traces of making, an anthropomorphic bronze knife shank or bronze bell (Figure 2-14). Nevertheless, when entering this period, it is clear that SSH culture is the only ancient culture that possessed the ability of mass iron production with at least two production centers, the SSH site and the BHB site (Figure 2-15). There is a rich iron ore deposit for the SSH site because of the adjacent volcanic environment (Figure 2-18); however, no matched iron ore source for the BHB Site has yet been discovered (?). This is one puzzling question we need to pay attention to in the future.

Although archaeologists found metal objects and foreign material like glass beads in all the coastal cultures, the amount of those exotic materials varies widely. It seems the sites with a trace of metalworking have the most foreign materials, like the Shihsanhang 十三行 site, Blihun Hanben 漢本 site, the Chongde 崇德 site, and the Jiunxianglan 舊香蘭 site. The other sites in eastern Taiwan also yield relatively more of these foreign materials than sites in western Taiwan. While we see a gradual replacement from nephrite to glass beads in southeastern Taiwan (from the late Peinan culture to the early Sanhe culture), it seems the switch from the local ornaments to the foreign ornaments in northern and western coastal Taiwan was rapid (LIU 劉益昌 2011b). While we have observed these archaeological facts of exotic materials and technologies, the distribution and transmission mechanism of these foreign materials and knowledge needs to be explored further. Did overseas immigrants introduce those exotic materials and manufacturing technologies to Taiwan? How were these materials and knowledge distributed and transmitted to the rest of the island of Taiwan? Will we see the exchange system Bronson (1977) proposed for Southeast Asia (Junker 2002)? Or are there other models to explain the archaeological facts we now see?

In summary, it seems that similar to the last period, the archaeological cultures in eastern and northern Taiwan seemingly interacted more or at least received more overseas influences. While there were a few small-scale metalworking sites close to the central coast of western Taiwan (Chen 2000; LEE 李芷綾 and LIU 劉克竑 2020), the SSH site and the BHB site were the two primary locations of ironmaking and ironworking, evident from the rich iron slag remains found there.

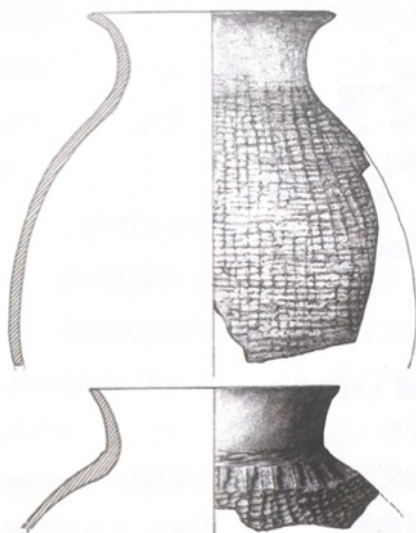


Figure 2-12 Left: drawing of the SSH pottery with impressed grid patterns, modified from LIU 劉益昌 (2011b). Upper right: SSH pottery, dominant type (TSANG 臧振華 and LIU 劉益昌 2001); lower right: geometric patterns on the ceramic surface



Figure 2-13 Left: iconic SSH anthropomorphic pottery vessel (TSANG 臧振華 and LIU 劉益昌 2001); right: black and polished pot with the same morphology but excavated from the BHB site



Figure 2-14 Left: anthropomorphic bronze knife shank excavated from the SSH site; right: anthropomorphic bronze knife shank, glass beads, and gold foil excavated from the BHB site



Figure 2-15 Left: Furnace/hearth structure of ironmaking/working in the SSH site (copyright purchased by the author from the Institute of History and Philology, Academia Sinica); right: iron slag from the BHB site



Figure 2-16 Drawing of the reconstructed Chingpu culture pottery assemblage (LIU 劉益昌 2011b)

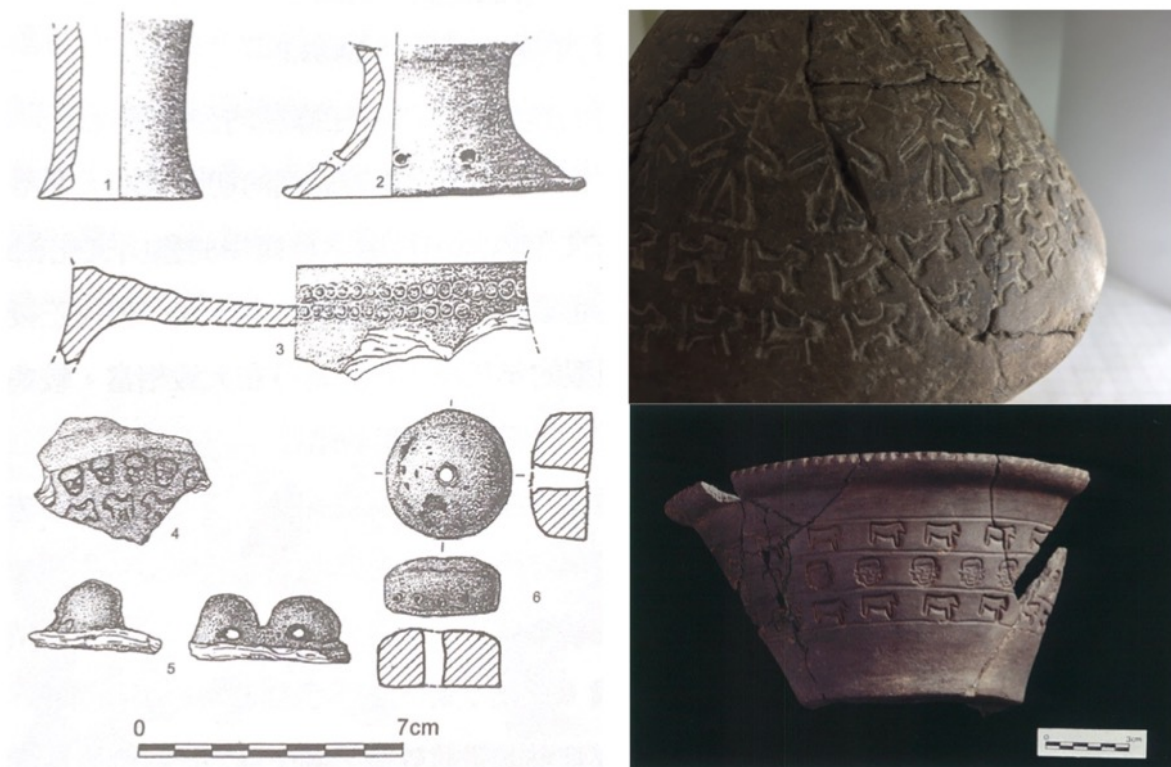


Figure 2-17 Left: human face with animal motif and stamped circles on the Sanhe culture pottery (LIU 劉益昌 et al. 2002); right: similar anthropomorphic and animal motif on the BHB ceramics, lower right from (LIU 劉益昌 et al. 2016)

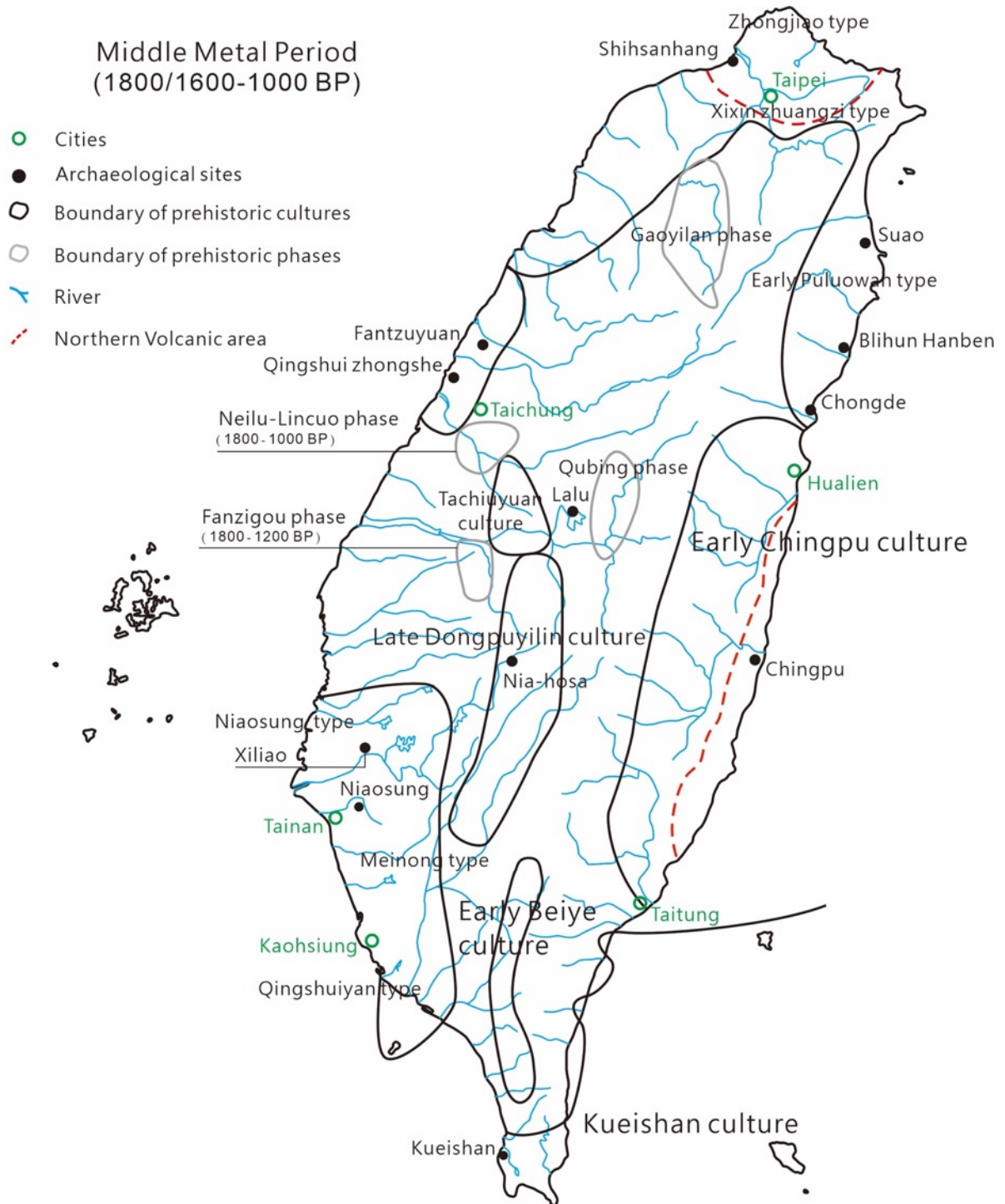


Figure 2-18 Map of Middle Metal period. Modified from LIU 劉益昌 (2011b)

2.2.3. Late Metal Period

The appearance of the Lobusbussan culture in Lanyu 蘭嶼 (Orchid island, or Botel Tobago) indicates the last big wave of migration into Taiwan from overseas in the Metal period. However, those immigrants seemed to stay only on Lanyu and Green Island. The pottery and urn burial practice of Lobusbussan Culture are distinctive to those other cultures in Taiwan at the same time but are highly similar with Batanes Islands of the Philippines (LIU 劉益昌 1994; LIU 劉益昌 et al. 2002). This difference can be observed in the modern Taiwan Indigenous groups as well. Tao 達悟 people, one of the Taiwanese Indigenous tribal groups and the current residents of Lanyu, have a distinctive culture compared to the other Austronesian cultures on Taiwan island and are more similar to their neighbors toward the south on the Batanes Islands.

The relationship between Lobusbussan archaeological culture and modern Tao people is relatively straightforward, and the connection between some archaeological cultures (and sites) and premodern Taiwan Indigenous tribal groups (and villages) is also visible. For example, the remains of Chingpu 靜浦 culture Chingpu type and the Shuilian 水璉 type (Figure 2-20) are considered modern Amis people's ancestral remains in the Hualien area in eastern Taiwan. As mentioned in the last section, Sanhe and Kueishan cultures have motifs that are identical to modern Paiwan 排灣 and Rukai 魯凱 people in southeastern Taiwan, and it is a consensus that these ancient cultures must have certain connections with these two tribal groups.

Archaeological studies also indicate that Beiye 北葉 culture is one of the ancestral cultural sources of modern Paiwan 排灣 and Rukai 魯凱 people (KUO 郭素秋 2020b; LIU 劉益昌 1990a; YEN 顏廷仔 2020). Recently, a few archaeologists start to use the names of contemporary tribal groups explicitly for some archaeological cultures that share similarities from a material perspective, for example, Paiwan culture in southeastern Taiwan, Kavalan culture in northeastern Taiwan, and Siraya culture (Figure 2-8)(CHEN 陳有貝 2012; Kuo 2019).³⁰

When archaeologists try to connect archaeological cultures to some modern tribal groups, it is illuminating to study Jiushe 舊社, a special kind of archaeological site in Taiwan. The studies

³⁰ Use modern ethnic group names for archaeological cultures is not a consensus in Taiwan archaeological studies.

mentioned in the last paragraph mainly relate to the Jiushe site. Jiushe was initially used by scholars in the Japanese Colonial Period for referring to the Taiwan Indigenous settlement that were abandoned but still existed in memories of tribal people and their descendants. In archaeology, Jiushe has two definitions, one is the same as just mentioned, but Jiushe can also refer to the archaeological sites seemingly affiliated with modern or premodern Indigenous sites which have been lost from the memories of the Indigenous peoples. HOUNG and LIU's survey work in the 80s documented several of those sites (HOUNG 黃士強 and LIU 劉益昌 1980), and Liu has tried to work with Indigenous peoples when carrying out the studies on the Jiushe sites still in memory (LIU 劉益昌 2006). In recent years, several Indigenous archaeological studies have also focused on the Jiushe of Paiwan and Bunun people (CHENG 鄭玠甫 2020; KUO 郭素秋 Kuo et al. 2017; WU 吳牧鐔 2019).

One thing that needs to be clarified is that the Jiushe 舊社 type of SSH culture was an archaeological cultural type distributed along northern coastal Taiwan to the Ilan 宜蘭 Plain in the latest stage (started around 450 BP) of SSH Culture. Jiushe type sites often yield porcelain, pipes, metal, glass beads, and small amounts of iron slag. The earthenware of the Jiushe type is thin but hard with paddle-impressed grid patterns on the exterior surface. There are no edged lithic tools, only lithic hammers, and whetstones. Studies have associated the Jiushe type with the Basay people (Figure 2-22) (CHOU 周子揚 2010; LIU 劉益昌 2011a), who were the premodern Formosan aborigines who were also documented as broker and craftspeople by the Spanish and Dutch in the seventeenth century.

In summation, the cultural development during this period was an entangled process with local and external forces. While the previous overseas influences, like Indo-Pacific glass beads and metal, had been widely incorporated into local cultures during the Middle Metal period, new external material cultures from the empires of mainland Asia, the Ryukyu Kingdom, Japan, and later the European trading powers also shaped the material appearance of local cultures in this last period of 'prehistory.' Archaeologically, Chinese glass beads, porcelain from China, Japan, and Korea, and the stoneware from mainland Southeast Asia are visible in Taiwan, especially in northern Taiwan and southwestern Taiwan (Figure 2-21). This phenomenon also indicates that

the gateway of receiving foreign cultures shifted from southeastern to northern and southwestern Taiwan. This shift and the frequent interaction between foreign cultures and local communities in this period may be one of the impulses of Sinicization of Formosan Aborigines in northern and southwestern Taiwan,³¹ and some of the archaeological sites are clearly the ancestral remains of the modern Indigenous Plains peoples. Hence, some archaeologists use Siraya culture and Kavalan culture to refer to the archaeological cultures in northeastern and southwestern Taiwan (Figure 2-8).

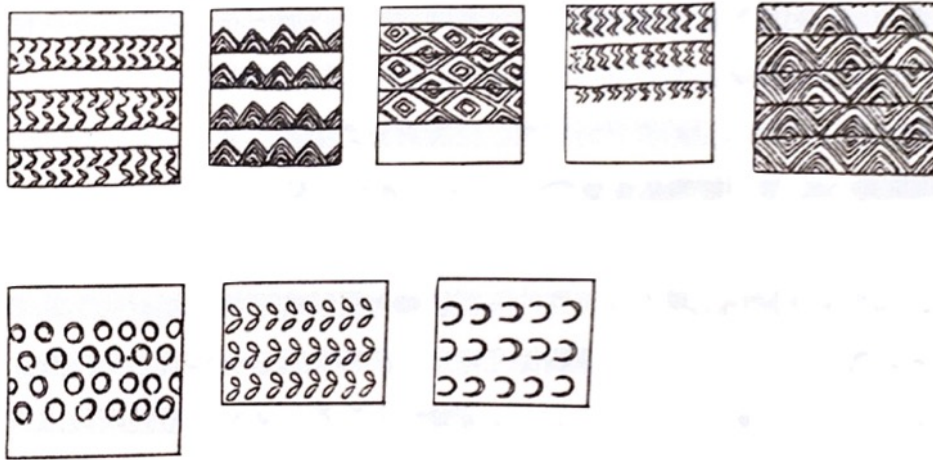


Figure 2-19 Decorative patterns on the Lobusbussan culture pottery, modified from LIU 劉益昌 (1994)

³¹ There are many discussions on this topic. See studies on ‘Plains Indigenous peoples of Taiwan’ or Pingpu 平埔 for more references.



Figure 2-20 The ceramic assemblage of the Chingpu culture Shuilian 水璉 type. Photo courtesy of Prof. LIU Yi-Chang



Figure 2-21 Upper left: Chinese celadon yielded from the TPK site; upper right: Zhangzhou 漳州 kilns (Swatow) overglaze porcelain sherds from the Mao'ergan 貓兒干 site. Lower left: Late Fantzuyuan culture local earthenware sherds from the Qingshui zhongshe 清水中社 site; lower right: seventeenth Century Chinese blue-and-white porcelain sherds from the Mao'ergan site. Photo courtesy of Prof. LIU Yi-Chang

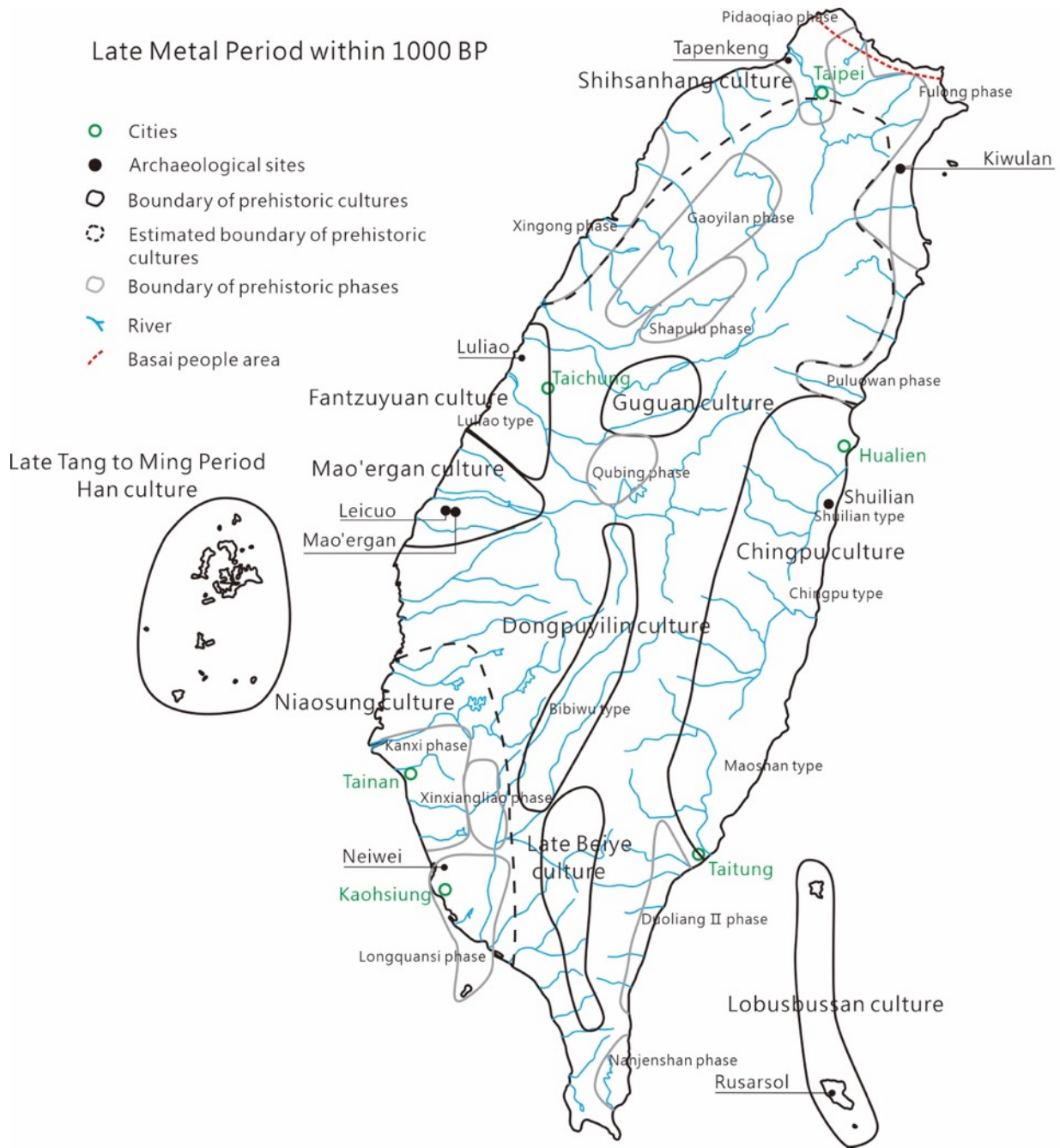


Figure 2-22 Map of the Late Metal period within 1000 BP. Modified from LIU 劉益昌 (2011b)

2.2.4. Asymmetrical development of manufacturing techniques in ancient Taiwan

While archaeological ‘culture’ allow us to easily comprehending the temporal-spatial position on the chronological table, and the maps of archaeological cultures (like **Error! Reference source not found.**, **Error! Reference source not found.**, Figure 2-11, Figure 2-18, and Figure 2-22) give us the idea of the geographic distribution of those ‘cultures.’ Those cultures that are been represent in blocks imply the uniformity of material assemblages with in a ‘culture.’ Moreover, these blocks also imply the rupture of material assemblages between cultures. As mentioned, the splitter-style of classifying archaeological cultures³² seems to be the endeavor of Taiwanese archaeologists trying to demonstrate the complexity of archaeological material assemblages and related ancient societies. While those efforts are useful and informative to Taiwanese archaeologists and practitioners, admittedly, those chronological tables and maps are confusing to some extent.

Figure 2-23 visualizes several technological traditions in ancient Taiwan, and it is clear that some of those traditions did not develop along with the ‘defined’ archaeological culture. There are continuities, like some ceramic traits, between ceramic assemblage cultures. The inherited similar trait and gradual changes developed in a ceramic tradition can be comprehended by spectrum. The closer the more similar; the furtherer, then differed more. For example in east and northeast Taiwan, we see inherited ceramic traits between ceramic assemblages among different cultures. One other thing is the use of polished and smudged black pottery in different cultures and mostly associated with exotic decorative material and metallic remains. The quantity of black pottery is small but distinctive. The development of metallurgy and the practice of metallurgy also evolve differently in different regions of Taiwan. And this technological tradition seemly associated with foreign decorative materials and black pottery.

Nevertheless, without those extra bars and arrows, those blocks of “archaeological culture” may present a misleading impression about the uniformity of material culture representation and the

³² Making more and more cultures, types, and phases to accommodate the differences between material assemblages.

static status of the ancient societies. The model I propose next chapter would provide a more dynamic perspective to explain changes in and across “archaeological cultures” through time.

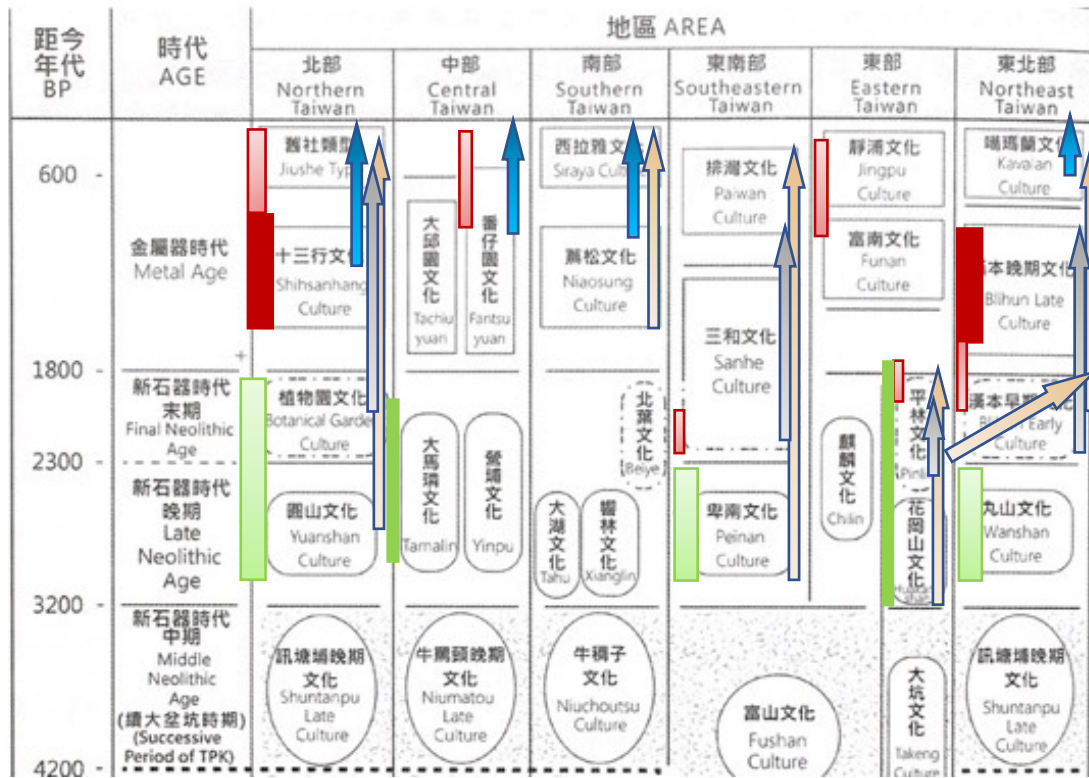


Figure 2-23 Table of Taiwanese archaeological cultures, modified from (KUO 郭素秋 2020b:387). Green bars represent the nephrite-making traditions, and gradient green bars represent the intensive nephrite usage (with basic processing ability) in each culture. Red bars represent the iron-making traditions, and the gradient pinkish red bars represent the smithing ability in different ‘cultures.’ Dull yellow arrows show the continuity of ceramic traditions between cultures. Grayish black arrows represent the use of polished and smudged ceramics. And the blue arrows point out the cultures that used significant amount of foreign porcelains

2.3. Ceramics Study in Taiwan Archaeology

2.3.1. Ceramic as the Backbone of Taiwan Archaeology

Archaeology was brought into Taiwan as a discipline in the late nineteenth century by the scholars hired by the Japanese colonial government. Ceramics, artificial objects that are durable and abundant in the Taiwanese archaeological sites, along with lithic remains, were the initial building blocks of Taiwanese archeology. Ceramic remains continue to be the foundation stone of archaeological study in the current days.

During the ethnographic and anthropological surveys in the Taiwan Indigenous villages, these Japanese scholars, such as TORII Ryuzo 鳥居龍藏, MORI Ushinosuke 森丑之助, and INO Kanori 伊能嘉矩, usually also recorded surface archaeological findings at the same time. Among these survey records, INO and TORII's observations (INO 伊能嘉矩 1897; TORII 鳥居龍藏 1897) on the contemporary Kuanawan/Kavanoan and Amis³³ pottery might be the earliest systematic descriptions of the manufacture process and morphology of the Indigenous pottery assemblage. Both INO and TORII extended their discussion beyond ethnographic observations toward archaeology and inferred ancient pot-making methods from their ethnographic observations. TORII especially pointed out the specialization of pottery-making and possible pre-modern commercial pottery trade activities of the Amis people (TORII 鳥居龍藏 1897:354-355). The subsequent studies on archaeological ceramics in the Japanese Colonial Period (JCP) basically followed similar standards for describing visible attributes of ceramics including morphology, surface treatment, and color. By the end of JCP, KANO Tadao 鹿野忠雄 synthesized several lines of archaeological evidence, including lithic, ceramic, and metal remains, and proposed his famous seven prehistoric cultural level model (KANO 鹿野忠雄 1955).³⁴ Among these levels, KANO named several levels by ceramic characteristics, such as the cord-marked ceramic level

³³ The former is the Indigenous group in the Yilan plain (northeastern Taiwan), and the latter is the Indigenous group mostly in the Hualien (eastern Taiwan) area. For these two references, I need to express my thanks to a Facebook fan page [Taiwan Archaeology 臺灣考古](#) where I found high-quality translations of INO and TORII's articles. These translations help me comprehend Japanese scholars' works.

³⁴ KANO's book was published in 1952, but the articles in this book were composed before KANO's last fieldwork departure to Borneo in 1945. KANO never returned from his mission to Borneo, a significant loss to Taiwan archaeology.

and the black pottery level. KANASEKI Takeo 金關丈夫 and KOKUBU Naoichi 國分直一 also proposed similar observations in the 1940s, but the publication of their works was postponed to 1954 due to World War II (KANASEKI 金關丈夫 and KOKUBU 國分直一 1954, 1956). By comparing the similarities between ceramics, KANASEKI and KOKUBU connected the Taiwan black pottery and painted pottery to the ‘northern system’ of the mainland (China). Nevertheless, it is valid to say that the researchers had started to notice the regional difference in ceramic morphology and surface treatment patterns by the end of the JCP. They used these ceramic characteristics to distinguish material remains into different ‘cultures.’

After the end of JCP, with the accumulation of research data, researchers gradually established the regional cultural histories within Taiwan. (CHANG 張光直 1954; CHENG 盛清沂 1962; KANASEKI 金關丈夫 and KOKUBU 國分直一 1956; LIU 劉斌雄 1955; SUNG 宋文薰 and CHANG 張光直 1954). The introduction of radiocarbon dating in the early ‘60s was the pivotal point regarding chronology since it was the first time having absolute dating to support the established cultural history chronology that primarily relied on ceramic studies (SUNG 宋文薰 1965). K.C Chang (1969) published the very first table that provided the cultural history of the whole of western Taiwan (Figure 2-3). While SUNG and CHANG’s work mainly concentrated in western Taiwan, Pearson, who was KC’s student back then, and Father Egli’s works (Egli 1972; LIU 劉益昌 2011b; Pearson 1966) established the cultural history foundation in eastern Taiwan. SUNG’s book-like masterpiece article (SUNG 宋文薰 1980) was the summary of most archaeological works before 1980, and this article has become the backbone of all subsequent studies regarding Taiwan archaeological cultures and their chronology (**Error! Reference source not found.** and REF_Ref73151261 \h * MERGEFORMAT Figure 2-5). In the same year, HOUNGHOUNG 黃士強 and LIU 劉益昌 (1980) also proposed a similar framework of archaeological cultures but with a few more details. From the ‘80s’s to present day, the subsequent works on archaeological culture primarily focus on filling gaps and updating details for these two backbone tables. Nowadays, most Taiwanese archaeologists have their version of the cultural framework, but all have developed from SUNG, HOUNG and LIU’s fundamental works.

Several new archaeological cultures have been proposed in recent years, including these which are most closely related to this dissertation: Kiwulan Culture in the Ilan Plain (northeastern), Sanhe Culture and Paiwan Culture in the southeast, and Upper Huakangshan Layer Culture in eastern Taiwan (CHAO 趙金勇 et al. 2013; CHEN 陳有貝 2005; Kuo 2019; LEE 李坤修 2014). Ceramic data is a very essential part of these recent works. While the long tradition for 'identifying' archaeological culture still stands these days, ceramic studies began to march in multiple directions after the 1990s because of the development of analytic tools and research questions.

2.3.2. Analysis Approaches

In the JCP, scholars applied the ethnographic method for observing Indigenous pottery-making and documented the ceramic attributes, including raw material preparation, forming technique, texture, surface treatment, firing process, body color, and morphology. Several of these attributes, like texture, surface treatment, body color, and morphology, were used to describe archaeological ceramics as well. KANO's work may be considered a representative of the JCP (KANO 鹿野忠雄 1955:44-62).



Figure 2-24 KANO's drawing on excavated archaeological pottery vessels from multiple sites

The first pivotal change of archaeological ceramic analysis was the introduction of Chinese archaeology in the late '40s led by LI Chi 李濟. LI Chi received his PhD in anthropology from Harvard University and is known as the father of Chinese archaeology. He came to Taiwan in 1948 and then acted as the chair of the Archaeology and Anthropology Department at National Taiwan University for over a decade. From 1955 to 1972, he was also the Institute of History and Philology (IHP) chair, Academia Sinica. While LI mainly focused on the Yinxu (Ruins of Yin³⁵) remains that were shipped from China with the KMT government, his influence on Taiwan archaeology mostly happened in the educational realm. LI introduced the typology practiced in Chinese archaeology to the first-generation domestic Taiwanese archaeologists, SUNG Wen-Hsun for example. LI Chi quantified all ceramic attributes when analyzing Yinxu (Ruins of Yin) ceramics (LI 李濟 1956). While KC CHANG commented that LI's method might be 'too' scientific,³⁶ in terms of educational influence LI's method was profound in Chinese archaeology and Taiwan archaeology. Although LI's quantification method was not fully practiced by following scholars, the typology by using macro and visible attributes, such as surface treatment, decorative pattern, body color, matrix texture, temper size, and morphology to create types of ceramics has become the primary practice by subsequent archaeologists, (e.g., SHIH 石璋如 and Liu 劉益昌 1987).

The establishment of the Scientific and Technological Archaeology Laboratory at IHP in 1990 was the second turning point regarding ceramic analysis. Before the '90s, only a few studies applied geophysical methods to analyze ceramic remains (CHEN 陳光祖 1990). CHEN Kwang-Tzu, as the director of this lab, set up the standard operating procedure for ceramic analysis. General attributes, like hardness, density, porosity, and water absorptivity, are measured; and the specimen could then be subsequently analyzed with instrumental analyses, such as petrography and XRD to determine the temper mineral composition (X-ray powder diffraction) (CHEN 陳光祖 1990, 1991). Since then, these analyses have become standard practices in ceramic study, especially for those IHP research projects. The laboratory has accumulated more than one

³⁵ Yin is considered as the capital of Shang Dynasty.

³⁶ Personal communication with LIU Yi-Chang (2020).

thousand entries of ceramic data in 2004 (CHEN 陳光祖 2004), and the data entry number is still growing today. While petrography has become the primary method for geophysical analysis of ceramics, a few scholars have explored new geophysical and geochemical methods. For example, CHEN Ma-Ling applied both physical (petrography) and chemical (acid-extraction with Inductively coupled plasma mass spectrometry) methods to yield the raw material information from the 墾丁 Kenting/Kending area ceramics to allow for discussion of the economic and social meaning of the ceramic collection (Chen 2006; CHEN 陳瑪玲 2006). Micro-Raman Spectroscopy has also been utilized for identifying the mineral composition of ceramics and glass beads from multiple sites (LIOU et al. 2006; LIOU 劉瑩三 and LIU 劉益昌 2006).

On top of those methods above, using the concept of technical choice and *chaîne opératoire* for ceramic analysis has gradually increased during this recent decade³⁷ (CHEN 陳昱婷 2013; CHEN 陳瑪玲 et al. 2016; HSU 徐尚溥 2019; LIN 林宜羚 2009; WANG 王仲群 2017; WU 吳意琳 2017). WU's research (2017) changes the previous conception of fine corded (cord-marked) ware and plainware in eastern Taiwan. Previously, scholars considered the corded wares to be older than the plain wares in eastern Taiwan. By analyzing ceramic collection from the Chaolaiqiao 潮來橋 site, WU points out that these two kinds of wares are contemporary based on the same manufacturing technique (paddled). Recently, KUO also discusses the pottery-making technique of Neolithic northern Taiwan and concludes that a slab-building method was used for pottery-making (Kuo 2019; KUO 郭素秋 2014).

2.4. Characteristics of Taiwan archaeology

In this chapter, I have briefly reviewed the development of Taiwan archaeology as a discipline, the general chronological sequence, and the attributes of several archaeological cultures. Although this review is not fully holistic and comprehensive, it should serve the purpose of providing general background information. It seems to reflect the culture and history of Taiwan island; archaeology in Taiwan is composed of several waves of traditions, from Imperial Japanese

³⁷ There are more graduate students perusing ceramic *chaîne opératoire* research at the National Cheng Kung University in Tainan, mostly because of Prof. Aude Favereau who is focusing on *chaîne opératoire* ceramic analysis on research and teaching.

colonialism, Chinese nationalism, Processual archaeology, Taiwanization, to the current diversified practices (for example, Indigenous archaeology, historical archaeology). The research focuses also change with the shift of tradition. For example, archaeological survey and study was the byproduct of the ethnographic study that served colonial purposes in the Japan Colonial Period. When under the Chinese nationalism brought by the KMT-controlled ROC government, archaeologists tended to connect Taiwan and mainland 'China' since ancient times. When Taiwanization was in fashion, archaeologists devoted enormous energy to understand more about local archaeological cultures and Taiwan's relationship with regions other than China. Nevertheless, all these previous traditions become the foundation of current archaeological studies and practices, which are an era of diversity and self-reflection.

Along with the development of Taiwan archaeology as an academic discipline, there are several long-lasting research directions, like exploring the origin of Austronesian cultures and the migration of Austronesian speakers, exchange system of materials like Taiwan nephrite and metal products, maritime cultural interaction, and the complexity of archaeological cultures and their connection with the modern Taiwan Indigenous peoples (CHANG 張光直 1992; KUO 郭素秋 2020a; LIU 劉益昌 2011b, 2015a). Those themes can be narrowed down to three themes:

- Identifying archaeological culture and enriching our understanding of cultural contents:
 - Ceramics, subsistence, and burial customs are the three main attributes for defining an archaeological culture
 - No unified standard for defining archaeological cultures and therefore no single table of temporal-spatial sequence for archaeological cultures
- Movement of people and material:
 - Austronesian expansion overseas, and the origin of ancient Austronesian culture
 - Regional, island-wide, and interregional trade and exchange systems, mainly by studying specific materials like Taiwan nephrite, basalt, glass, and agate
- Archaeological studies and modern Indigenous tribal groups:

- The connection between archaeological cultures and modern Taiwanese Indigenous tribal groups
- Self-reflection on the relationship between archaeologists and modern Taiwanese Indigenous peoples

While environmental adaptation and the relationship of humans to their environment are also research directions that have long interested Taiwanese scholars, related studies are relatively fewer than those other themes because of limited research capacity. Recently, with the newly introduced analytic methods and trained scholars, there is more research on these areas (e.g., LEE 李政益 et al. 2016; LIN 林淑芬 2015).

2.5. Recent Advances

In the history of Taiwan archaeology section above, I have mentioned a quite diversified development of research topics in the recent decade. Within those various topics, I want to bring up the advances on archaeological culture identification and movement of material and people in eastern Taiwan. In short, two new archaeological cultures in eastern Taiwan are proposed, and the sites from these two archaeological cultures yielded the earliest metalworking remains that were dated to 2400-2000 BP. As for the movement of people and materials, advances in analytic methods have provided new insights into ancient Austronesian expansion and materials exchange system around the Southeast Asian/South China Sea maritime regions.

Figure 2-11 shows the asymmetric cultural development between western and eastern Taiwan. When western Taiwan was still in the Neolithic period, eastern Taiwan had entered the Metal period starting around 2400 BP. While there were influences from the west side of the Taiwan Strait before 2400 BP, it is clear that southeastern Taiwan was the new gateway for receiving new foreign material cultures, like metal objects and technology, glass and agate beads, and new ceramic surface motif after 2400 BP (Hung and Chao 2016; LEE 李坤修 2005).³⁸ The excavations on the Jiuxianglan 舊香蘭 site and the Huakangshan 花岡山 site provide critical data for this

³⁸ Previously, the Chingpu 靜浦 culture was considered the Metal period archaeological culture with iron production and working ability because of the yielded iron slag. See Chen (2000) and iron slag analysis chapter of this research for further information.

transitional period; the former is the key site of Sanhe 三和 Culture (LEE 李坤修 and YE 葉美珍 2001), and the latter is the key site of Upper Huakangshan 花岡山上層 Culture (CHAO 趙金勇 et al. 2013; LIU 劉益昌 and CHAO 趙金勇 2010a) (Figure 2-8, Figure 2-11). These two archaeological cultures mark the transitional period from the Neolithic to the Metal period. The Ciyakang/Pinglin 平林 Phase (Figure 2-11) may also be a cultural phase with metal tools that were used for nephrite production (LEE 李坤修 2020). A bit north of the Hualien area, the middle cultural layer of the Blihun Hanben 漢本 site is roughly contemporary with early Sanhe culture and Upper Huakangshan culture. These remains from the Blihun Hanben 漢本 site may add more information about this transitional period from Neolithic to Metal periods. I will introduce the recently excavated Blihun Hanben 漢本 site in the next chapter.

As for the movement of material and people, ancient Austronesian expansion studies, especially those related to Taiwan, have also been supported by DNA research on paper mulberry and pigs (Chang et al. 2015; Larson et al. 2010) which complements previous ceramic, linguistic, and Taiwan nephrite studies (e.g., Hung 2005; HUNG et al. 2007; TSANG 臧振華 2012). While the research on Taiwan nephrite maps the possible ancient Austronesian people's migration routes and material exchange system in the Southeast Asia/South China Sea maritime regions (Figure 2-10), the subsequent study on Lingling-O earrings and double-headed animal pendants, some of which were made of Taiwan nephrite, gives us more insight into how these two ornaments evolved and the possible movement of craftspeople in the same regions (Figure 2-25) (MIYAMA 深山繪美梨 2014, 2018). This nephrite exchange system in the Southeast Asian/ South China Sea regions may have acted as the channel for the introduction of glass, agate beads, and metal into Taiwan. The studies of Indo-Pacific beads found in Taiwan indicate a strong connection between eastern Taiwan and Southeast Asia (Wang and Jackson 2014; WANG 王冠文 et al. 2018). The Sanhe culture and Upper Huakangshan culture that have been proposed recently were the two archaeological cultures acting as the gateway for receiving those external influences. Those exotic materials eventually localized and became important cultural elements and family heirlooms of both modern Taiwanese Indigenous peoples and their ancestors.

In this chapter, I have briefly summarized the disciplinary history and characteristics of Taiwan archaeology, some background information of archaeological cultures and periodization, and recent advances. These recent advances in our understanding of transitional cultures have paved a new direction for the study of the Metal period, which provide the foundation for this dissertation which will explore the detailed process and mechanism of how exotic materials and new knowledge of metallurgy were brought into ancient Taiwan. In the next chapter, I will review more about studies on the movements of people and materials and more about the Blihun Hanben 漢本 site, which is the site that will provide crucial data for my research questions.

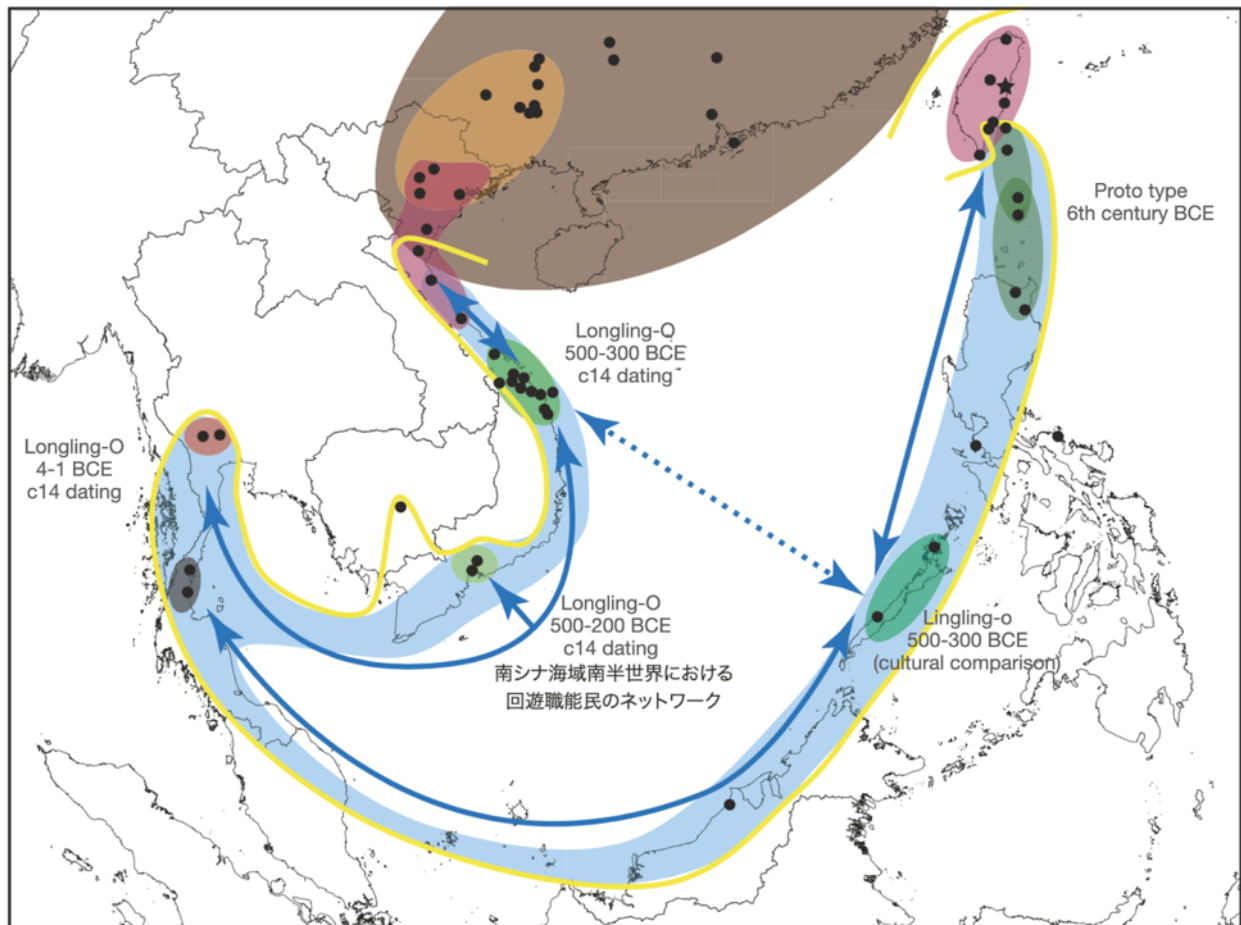


Figure 2-25 Nephrite earring Lingling-O craft production phases and possible routes of transportation, modified from (MIYAMA 深山絵実梨 2018)

3. How Do We Portray Past Movements?

In the last chapter, we have learned that there was no gradual transition from the Neolithic to the Metal period, and it seems there was a technological leap from lithic toolmaking to iron production in ancient Taiwan; hence, metal technology is considered as introduced. The conventional view of the beginning of the Metal/Iron period was 1800 BP, and the ancient Taiwan residents might have possessed mature iron production ability by about 1600 BP (Chen 2000).

Recent studies have pushed this dating from 1800 to 2000 BP and then to 2400 BP based on the new data from southeastern and eastern Taiwan (Hung and Chao 2016). While scholars have linked the change from the Neolithic to Metal period with the appearance of exotic materials and newly arrived people, the more insightful studies with refined dating and new explanatory models did not happen until this recent decade. Previously, the Shihshang site was long considered the monocenter of mass iron production at the beginning of the Metal period. While the idea of imported iron technology may still stand, the introduction process seems to have taken longer than what archaeologists expected before, and the discovery of the Blihun Hanben 漢本 site overthrows the monocentric hypothesis of mass iron production.

In this chapter, I will explore the movements of people and materials during the transitional period (2400-1600 BP) in ancient Taiwan by a refined trade diaspora model. This model can accommodate recent archaeological advances and provide a more detailed explanation of the exotic material introduction process, which not only profoundly influenced the ancient peoples of the island but continues to this day to greatly influence Taiwan's modern Indigenous peoples. The second half of this chapter will briefly describe the preliminary observation of several related sites and the primary research target, the Blihun Hanben 漢本 Site.

3.1. Previous Studies on the Movements in the Final Neolithic and Metal Period of Taiwan

While new dating, new data from glass bead analysis, and a new hypothesis of craftspeople migration have led us to journey past the trailhead for a new research direction of Metal Age Taiwan, the mechanism of how these foreign cultural elements were introduced has received relatively little attention. This section will review the previous studies on the movement of people and materials, mainly focusing on the transitional period between the Neolithic and the Metal period (2400-1600 BP).

Movement of ideas, materials, and people is one of the main catalysts for social change (Beaudry and Parno 2013; Gibson 2007) and is also one of the research themes in Taiwan archaeology. Decades of archaeological studies have shown that the development of ancient history in Taiwan was composed of serial waves of two fundamental factors. One was the movement of people, ideas, and materials, and the other was the subsequent localization of the foreign cultural elements (劉益昌 Liu 2011b). Recent studies have pointed out that southeastern Taiwan might not only be the home port of the hypothetic ancient Austronesian culture expansion and exportation of Taiwanese nephrite but also the port to receive the foreign cultural elements that had a profound impact on the development of Taiwan's ancient history that lead Taiwan to enter to the Metal period (Hung 2005; Hung and Chao 2016; LEE 李坤修 2005; LIU 劉益昌 2010a).

In the last chapter, I have mentioned an asymmetric cultural development between western and eastern Taiwan during the Final Neolithic and Initial Metal period. The western archaeological cultures are considered the direct descendants of their predecessors in the Neolithic period with few external cultural elements, on the other hand, the eastern archaeological cultures developed from their predecessors with significant external influences, and these influences range from ceramic and body decoration systems to burial practices. Among the eastern cultures, there may have been only a few sites that acted as the receiving nodes of the foreign cultural elements. I have also reviewed the development and use of archaeological culture in Taiwan context and will replace the term 'archaeological culture' to cultural assemblage here after.

LIU 劉益昌 and WANG 王淑津 (LIU 劉益昌 and WANG 王淑津 2005) proposed a three-stage model to portray the introduction process of exotic materials into ancient Taiwan, 1) small-scale importation to a few locales (3,000-1,800 BP); 2) large-scale importation to the coastal area (1,800-1,000 BP); 3) apex period (1,000- 450 BP). They pointed out how the body decoration changed from nephrite ornaments to glass and agate beads. As for the source of influences in each stage, in stage 1, ancient peoples might have received more from the Asian mainland, including ceramic style and sporadic bronze objects (see chapter 2). Also, there may have also been a direct migration from the Asia mainland, such as the Chihshanyen 芝山岩 cultural assemblage (HUNG 黃士強 1984, 1985). In stage 2 (from current data the stage 1 after 2400 BP should also be included), the external influences were mainly from mainland Southeast Asia, at least somewhere that had Indo-Pacific glass beads. In stage 3, Han-Chinese people gradually took over the trade routes, and the influences may have shifted back to the Asian mainland. LIU and WANG's observation still stands these days, and my study show that this three-stage model can be modified to a four-stage model, by splitting Liu and Wang's stage 1 into two stages.

When discussing the ancient interactions between Taiwan and overseas regions, the Migrationist model is favorable to the studies of early Austronesian expansion, which might have started from 4500 BP (Bellwood 2014; Bellwood and Dizon 2005, 2013; Hung 2005; Mijares 2006; Tanaka 2004; TSANG 臧振華 2012), and the ceramic style is the essential evidence among these studies. Exported Taiwanese nephrite objects have been found in many locations around the Southeast Asian/South China Sea (HUNG et al. 2007; Iizuka et al. 2005). Migrated or itinerant craftspeople models are also proposed for explaining the spread of Taiwanese nephrite ornaments after 2400 BP (see chapter 2 Figure 2-34) in the Southeast Asia/South China Sea maritime regions (HUNG et al. 2007; MIYAMA 深山繪実梨 2014, 2018).

The concept of mobile craftspeople groups has also been proposed for the Taiwan nephrite exchange system in the Middle to Late Neolithic period. This concept is also used to explain the emergence of the Tamalin 大馬璘 cultural assemblage in the Late and Final Neolithic period (LIU 劉益昌 2010a, 2013b). LIU 劉益昌 (LIU 劉益昌 2010a, 2011a, 2013a) has also used 'diaspora' to describe a set of sporadic but widely distributed exotic materials and the remains of

metallurgical items that might have been brought by itinerant traders into the ancient cultures in eastern Taiwan. This is the first time the term 'diaspora' was used in the archaeological study of Taiwan (see below section 1.2.1 for definitions of diaspora). As previously stated, LIU describes the spatial distribution of a specific set of archaeological remains, such as grayish black ceramics, glass beads, carnelian beads, metal, and metallurgical remains as a result of foreign craftspeople/trader diaspora. In these studies, LIU further connected the SSH cultural assemblage Pulowan subset and Jiushe subset³⁹ to the Basay⁴⁰ people, who possessed metalworking ability and had merchant characteristics, and suggested a diasporic lifestyle of these premodern Taiwan Indigenous peoples. LIU's study has pointed out the possible antiquity of diasporic peoples in ancient Taiwan. However, he did not discuss further how to define the archaeological material representation for diaspora and has not explored why this pattern happened.

Among these foreign material cultural traits, LIU (LIU 劉益昌 2012) considered the grayish-black earthenware that often appeared in the burial context as the ethnic marker of those foreign diasporic craftspeople/traders, who he hypothesized may have come from northern Luzon in the Philippines. These grayish-black pots usually have a polished surface and complex decorative patterns like incised polygonal lines and impressed circles. LIU suggested that those foreigners might have brought in glass and agate beads in exchange for Taiwan nephrite objects (from the processed raw nephrite to the end-products) starting around the beginning of the common era. Archaeological findings from the Cagayan Valley in northern Luzon indicate four phases of the prehistoric period (Mihara et al. 2002; Ogawa et al. 2006; Tanaka 2004). Among these phases, the ceramics from the decorated black pottery phase (2300-1500 BP) and the grayish-black ceramic from eastern Taiwan are similar in two aspects: decorative motif pattern and smudging technique on the pot surface. While there were a few subsequent discussions that relate to the black pottery in northern Luzon after Ogawa and Tanaka's chronological study (e.g., Mijares

³⁹ Archaeological cultural subsets with ironmaking and ironworking ability, see chapter 2 Late Metal period for details.

⁴⁰ A group of premodern Taiwan Indigenous peoples who were often mentioned in the Dutch accounts during the seventeenth century.

2006), the chronological relationship between northern Luzon and eastern Taiwan still needs to be explored more.

One argument against Luzon as a source for diasporic communities in eastern Taiwan is that archaeologists have not yet identified any remains of iron smelting in northern Luzon. Therefore, we might need to consider other adjacent regions, such as Mainland Southeast Asia (MSEA). Recent advances in glass bead production studies and archeometallurgical studies have provided new evidence for related pyrotechnologies in MSEA. For example, peninsular Thailand is one possible candidate as the source of iron technology and glass beads in ancient Taiwan, as shown by excavations at the Khao Sam Kaeo (KSK) site (Biggs et al. 2013; Carter 2016; Castillo et al. 2016; Évrard et al. 2016; Lankton and Dussubieux 2006; Pryce et al. 2006; WANG 王冠文 et al. 2018). Interestingly, studies on KSK remains indicate that foreign artisans (mainly from India) and merchants lived on different hill tops from the local residents, and this immediately reminds me of diasporic characteristics of these artisans and merchants.

Hung and Chao (2016) also point out that the Metal period of Taiwan is a transitional time for ancient Taiwan societies and suggests a new starting time around 2400 BP based on the Jiuxianglan site dating. They divided the Metal period of Taiwan into three stages: early-stage (2400-1800 BP) that with the preliminary metalworking and usage of metal and glass; mid-stage (1800-1200 BP) that with mature metalworking technique and iron production; and late-stage (1200 BP-1624) with metalworking ability and import of overseas porcelain. Hung and Chao (2016) suggest that those foreign materials and pyrotechnological knowledge were introduced via an Austronesian-based exchange network rather than the Asian mainland-related Maritime Silk Route. They also raised the question of how overseas skilled craftspeople moved into Taiwan. While there was no clear answer to the question, the Basay people's craftsmanship and merchant characteristics were also brought up in this study as an example for pointing out the future research direction on the antiquity of ancient craftsmanship in the Metal period of Taiwan.

In summation, these studies all point toward several similar conclusions: 1) the intensified appearance of exotic materials in Taiwan starting around 2400 BP; 2) the possible overseas

origins of glass, bronze, iron objects, and pyrotechnologies; 3) exotic materials might not have come to Taiwan as a single package; and 4) that manufacturing ability of these materials may not have arrived at first. While these previous studies have shown the ancient movements and exchange/trade activities from overseas into Taiwan and have used new concepts, like craftsmanship and diaspora, instead of using migration for explaining the dislocated archaeological materials; the recent excavations and research advances in Taiwan would allow us to continue the exploration on the mechanism and the influence of these foreign materials and metallurgical knowledge during the transitional time between the Final Neolithic and Early Metal period (2400-1600 BP).

In this doctoral research, I will focus on the mechanism for the emergence of ferrous pyrotechnology by the diaspora concept that LIU has proposed but did not pursue. The trade diaspora model I propose in the following section should accommodate the data from previous studies and provide a more detailed explanation to the importation process of metallurgy and exotic materials rather than contesting or disproving the previous research efforts.

3.2. Trade Diaspora: An Alternative to a Migrationist Model

As mentioned in chapter 2, the Migration model has been the most favored(?) model for portraying the early stage of hypothetical ancient Austronesian expansion (out of Taiwan) as well as migration into Taiwan from the Asian mainland during the Neolithic period. Previously, the concept of 'introduced technology' was mainly used for explaining the technological leap from the Neolithic to the Metal period in Taiwan. Recently, new concepts such as craftspeople and diasporic people are used for explaining the introduction of overseas materials and knowledge. In this section, I will propose a trade diaspora model to explore how exotic material and knowledge were introduced and the localization process of these foreign elements. In the second half of this chapter, the Blihun Hanben 漢本 site will also be briefly introduced. This newly excavated site provides new data to test the validity of the proposed trade diaspora model.

3.2.1. Definitions of Diaspora and Trade Diaspora⁴¹

The term *diaspora* was initially used to describe the exile of Jewish communities from Babylonia and had meanings related to involuntary migration and victimhood (Braziel 2008). Robin Cohen (1997) expanded the definition to not only focus on the negative factors in maintaining diasporic communities but also on positive aspects, such as the development of art, science, commerce, and industry; and the expanded definitions also included active motivations such as labor movement, flow of resources and trade. The expanded definitions allow the existence of multiple forms of diaspora such as victim diaspora, labor diaspora, trade diaspora, religious diaspora, and cultural diaspora (e.g., Franklin and McKee 2004; Lilley 2006; Lydon 2001; Mann 2001; Palmer 2000; Stein 1999, 2002a).

The term *trade diaspora* was proposed by Abner Cohen (1971) to describe the merchant groups in West Africa. In his definition, the two most essential characteristics of trade diaspora are culturally distinctive and commercially oriented diasporic communities (Cohen 1971:267). Before Cohen proposed this term, several of Renfrew's trade modes, such as *emissary trading* and *colonial enclave*, related to the concept of trade diaspora to a certain extent (Renfrew 1975). In addition to those diasporic characteristics, Philip Curtin focused on the process of learning the host community's culture by the diasporic community (Curtin 1984:2); Curtin's definition added a chronological depth to trade diaspora community and made it more dynamic, as something that evolves and transforms over time. I

In archaeology, trade diaspora was used to portray the interaction between the foreign merchants from complex societies and local indigenous people in the ancient Mesopotamia region around 5000 years ago (Algaze 2001; Stein 1999, 2002a). Stein (2002a) further expanded Abner Cohen's definition to more modes like diaspora marginality, diaspora autonomy and diaspora dominance to describe the relationship between the diaspora and host communities.

Synthesizing these definitions and usages above, this doctoral research defines trade diaspora as a group of professional merchants who share cultural identity and self-recognition with other diaspora communities. Those merchants have a strong link with their homeland, travel long

⁴¹ Dr. CHEN Pochan has inspired me a lot with regards to this trade diaspora concept.

distances, and establish settlements or enclaves on foreign lands to trade or provide services to the host community. These groups are seen as culturally distinctive to their host community. Although trade diaspora members tend to maintain their self-identity, these merchants also learn and adopt local cultural traits to conduct business smoothly.

3.2.2. Forms of Trade Diaspora

3.2.2.1. *Trade diaspora community identity*

Three factors help maintain the cohesiveness in trade diaspora communities (CHEN 陳伯楨 2014): 1) a social organization, which regulates the member behavior and prevents the entering of outsiders; 2) a distinctive cultural identity, which may come from the ideology of a shared homeland or a deliberately created homeland; 3) social independence from the host community, which may be active or passive. Gil Stein proposes three different modes to classify trade diaspora based on the power relation between diasporic and host communities (Stein 2002a, 2002b), and these modes are:

1. *Diaspora Marginality*, where the diaspora community only plays an economic role in the host community and is treated asymmetrically by the host society. The host society tolerates a marginalized diaspora mainly because of their services, which the host community usually regards as low-status behavior, such as sewage cleaners or traders. The membership of marginalized diaspora is restricted or actively emphasizes the separation from the host community. Stein also reminds us that we cannot ignore the active agency of marginalized diasporic community, who may have marginalized themselves strategically to protect their assets, both tangible and intangible.
2. *Diaspora Autonomy*, where merchants gain their autonomous status and protection from the elite host community by providing economic benefit to them. These diasporic communities typically maintain strong connections with their homeland and are usually located close to the residence of host society elites.
3. *Diaspora Dominance*, where the diaspora group has political power over the host community through economic domination. In this mode, the diaspora group demonstrates and maintains their identity by using distinctive foreign and superior material culture. The local elites may

try to imitate the material culture representation of diaspora group to maintain or uplift their social status.

I further propose the fourth mode of trade diaspora, *Diaspora Integration*, where the diaspora community is more entangled and integrated with the host community. While the material culture of a *Diaspora Integration* group may be similar to that of a host culture, the identity of the diasporic group is still persistent. This mode would have an equal relationship between diaspora and host communities and might eventually lead to a creolization of two cultures.

3.2.2.2. *How a diaspora community changes over time*

The interaction between diaspora groups and local communities is a dynamic process based on political, military, and economic powers. Following the account of Warms (1990), Stein also points out three possible endings for trade diaspora groups:

1. The trade diaspora community actively or passively leaves the host community and departs from the foreign land. The cultural traits of trade diaspora may become the legacy of host community. The medieval European commercial enclave of the Hanseatic League is one of the examples. They left London, the host place, when local English merchants took over the trade (Stein 1999). In Taiwan, the trade route and fortress built by the VOC (Dutch East India Company) were also used by Koxinga and local people after the Dutch left Taiwan.
2. The diaspora community stays and gains new social and economic status but remains a culturally distinct minority in the host society. Examples are the ethnic Han-Chinese immigrants and their descendants in Malaysia and Indonesia who only maintain an intangible or spiritual connection with their Chinese homeland. Their nationalities are now Malaysian or Indonesian, but they still keep the ethnic identity as Chinese and still learn and practice some aspects of Chinese culture inherited from their ancestors (Aldrich and Waldinger 1990; Curtin 1984; Yambert 1981).
3. The diaspora community merges into the local community and creates a creolized culture. For example, the intermarriage of Han Chinese diasporic men and local Malay women has created a new mixed culture known as *Peranakan* (or so-called *Baba Nyonya*) culture. The *Peranakan* recognizes and practices cultural traits from both patrilineal and matrilineal sides

(Curtin 1984; Lee 2008). *Peranakan* is culturally distinct from Chinese, but *Peranakan* is classified as Malaysian Chinese based on the current Malaysian government policy.

According to Warms (1990) and (Stein 1999), the interaction between trade diaspora and host communities mostly depends on the power relations. If the homeland of the diaspora community is politically, socially, or economically strong compared to the host community, then the trade diaspora community is more likely to dominate the host community. By contrast, if the power of the homeland is relatively weak or if there is little connection to the diaspora's homeland, then there will be other interaction possibilities between diaspora and host communities.

3.2.3. Using the Trade Diaspora Concept to Investigate Entangled Situations

Cross-cultural 'contacts' are often regarded as the cause or catalyst of social change, both economically and politically, so contact is a topic of long interest in archaeology (Cusick 1998; Lape 2003; Lightfoot 1995; Silliman 2005). As Silliman (2005) has discussed, the term 'contact' may not sufficiently and accurately portray the relationships between two groups of people with different cultures. It also easily misleads the readers to consider a short-term contact instead of long-term interaction. Silliman and others prefer terms like entanglement, which emphasize the time depth and complexity of these interactions that are typical to colonial situations. The concept of entanglement can encompass these complex relationships and emphasizes the importance of indigenous agency in the interactions (Dietler 2005).

Exchange/trade is one of the forms of cross-cultural interactions, which usually occurs on the boundary of two cultural entities. As exchange becomes more frequent or requires long-distance movement, specialized merchant groups will emerge to carry out the exchange activities (Clarke and Torrence 2003; Curtin 1984; Stein 1999). While Migrationist and exchange/trade theories both provide possible explanations to material displacement and cultural change, how is the concept of trade diaspora helpful to explain the archaeological data in the target research area?

Scholars have concluded that the appearance of exotic materials in ancient Taiwan is the result of migration and trade/exchange (Bellwood and Dizon 2005, 2013; Hung 2005; HUNG et al.

2007; LIU 劉益昌 2010a, 2012). Migrationist theory posits potential pull and push factors of why people start to migrate (Chapman and Dolukhanov 1992), and it mainly focuses on population pressure as the push factor of movement of people, especially for the early stage of Austronesian expansion (Bellwood 2014; Bellwood and Dizon 2013; Mijares 2006; Mijares 2005; Tanaka 2004; TSANG 臧振華 2012). When speaking to the external influences on Taiwan, some consider trade as the pull factors of these movements (Hung and Chao 2016; HUNG et al. 2007; LIU 劉益昌 2010a, 2011a, 2012, 2013a). Traders as craftspeople with new metallurgical knowledge are also mentioned in those recent studies.

While 'trade' may represent the motivation of population movement and the reason for material dislocation, there might be a more specific term for describing the entanglement process between foreign traders and local communities, especially when the foreign cultural elements are distributed sporadically. The proposed trade diaspora model would provide a better framework to accommodate previous research efforts and to examine the long-term process of cross-cultural economic-driven interactions. This framework would be beneficial when exploring the interactions between 'foreign traders' and local hosts and potentially would better portray the subsequent influences on both local and foreign communities. Lastly, trade diaspora research focuses on a set of exotic material cultures on a smaller scale rather than the massive movement of people in migration studies. For example, CHEN Pochan 陳伯楨 has shown the utility of the trade diaspora model for explaining the existence of a Chu 楚 State merchants enclave cemetery in the Ba 巴 area in the Warring States period in ancient China (CHEN 陳伯楨 2014).

3.2.4. Research Questions

While previous studies have pointed out that the concept of metallurgical craftsmanship and diaspora may be a valuable device to comprehend the archaeological material complexity in the Final Neolithic, Initial and Early Metal period, my four main research questions are:

1. How ancient iron technology emerged in Taiwan?
2. Was there a detectable trade diaspora in ancient Taiwan?
3. Craftsmanship: What is the nature of iron technology in ancient Taiwan?

4. Would the proposed trade diaspora model provide sufficient explanatory power for introducing overseas material culture in ancient Taiwan?

3.2.5. Archaeologically detectable? The material representation of trade diaspora

As stated previously, a diasporic group maintains a cohesive identity in the community by different means, but not all means are detectable to archaeology. In archaeological studies, Stein and CHEN approached this research question from different angles. Stein found differences in the foodways and ceramic objects between the trade diaspora and local indigenous peoples (Stein 2002a). CHEN used the difference of burial practices and written accounts to support the existence of diasporic Chu 楚 salt traders who were buried in the Ba 巴 area (CHEN 陳伯楨 2014). In Taiwan, LIU considered the sporadically distributed grayish-black ceramic and exotic materials, which are pretty distinctive from the other local material culture, as the marker of foreign diasporic traders in several different archaeological cultural assemblages along the east coast of Taiwan (LIU 劉益昌 2011a, 2012).

3.2.5.1. Archaeological prediction of diasporic modes

If traders with metalworking ability indeed brought the exotic materials into Taiwan, what will their material representation look like? How can trade with/without trade diaspora be distinguished? For non-diaspora trade, exotic items will only be portable objects (such as Taiwanese nephrite in Southeast Asia and glass beads in Taiwan before 2400 BP). There will be no other evidence of foreign cultural traits, such as settlement and burials. For diasporic trade, one should expect to see exotic goods, plus evidence of exotic manufacturing technology (metallurgy for example) and exotic cultural traits in foodways, burials, building style, and even settlement forms (opened, closed, or fortified). Here are the general predictions of each trade diaspora mode:

1. Diaspora Marginality, distinctive material culture between the diasporic people and the host community. That said, we expect to see differences from all aspects, from daily practices (use of ceramic, foodways), ritual practices (burial practice and goods), technological practices (way of making things), to settlement layout (opened, enclosed, fortified). Also, there should be clear spatial segregation of material remains between the

diaspora and the host communities. For example, a diasporic site should have those distinctive material representations from the other sites in the same region.

2. Diaspora Autonomy, the material culture remains distinctive between the diasporic people and the host community; however, as mentioned above, those diasporic community live closely with the elites of host community. That said, we expect to see differences from several aspects, from daily practices (use of ceramic, foodways), ritual practices (burial practice and goods), technological practices (way of making things). Notable is, we expect to see a certain level of adaptation to local material culture in the diasporic community, especially those daily practices. The residential area of diasporic and local people should live next to each other. There is a boundary but no segregation apart. Even if the host community is egalitarian, I still expect to see the same material representation.
3. Diaspora Integration, the diasporic community has adapted local material culture for their daily life, from ceramic to foodways. The remain cultural traits are ritual practices and the foreign technology they bring. We will not see any clear boundary between the diasporic residential area and the locals. As said, the remain of ritual practices and remain of foreign technology are the only two ways to distinguish diasporic and local people.
4. Diaspora Dominance, same with Diaspora Marginality, distinctive material culture between the diasporic people and the host community. Most importantly, the diasporic community should present the evidence of over-powering local people from social or technological aspects. For example, possessing exotic and valuable materials, and military advantage. Furthermore, clear spatial segregation between the diasporic and local people is usually present as fortification of the diasporic settlement. A good example is a Dutch colony in southwestern Taiwan in the seventeenth century. The Dutch Eastern Indian Company built Fort Zeelandia for their employees and carried out commercial activities by controlling local Taiwan Indigenous peoples.

3.2.6. Trade Diaspora Interactive Model

3.2.6.1. *Initial stage (short-term patterns)*

Dominant diaspora is not likely to be observed in ancient Taiwan. There is no clear evidence of unbalanced power relations between eastern Taiwan and overseas cultures. On the contrary, I

would expect to find diaspora marginality or autonomy. The trade diaspora mode might shift diachronically based on changing power relationships between two communities.

Autonomous diaspora is also likely to be observed when the diaspora community provides services or products highly valued by the host community. The foreigners will be accepted and welcomed immediately. When the host community has social differences or elite members, the most powerful host members may cooperate closely with the diaspora community or monopolize the access to them.

3.2.6.2. Subsequent stages (Long-term patterns)

One of the advantages of the proposed trade diaspora framework is evaluating the dynamic relationship between the diaspora and host communities. With an increase or decrease of power in either or both communities, the relationship may shift from one mode to another.

If there is no clear social difference or elite status in the host community, the long-term scenario may lead to diaspora integration eventually. However, it is also possible that when the diaspora community loses its connection to the homeland, exotic resources, or economic power, it has a greater chance of being marginalized by the host. At that point, the diaspora community may try to provide new products or services to maintain their social and economic status, as happened with the Chinese trade diaspora after losing their connection with China in the fifteenth century in the Malay Peninsula (Curtin 1984; Reid 1993:12).

If there is a pre-existing social difference in the host community, then we may expect to see the diaspora mode shift toward to autonomous diaspora or creation of a new social class that is a hybrid of host elite culture and diasporic culture, and this new social class may possess the core valued cultural traits and technology to manifest their power.

3.2.6.3. The model for early Metal Age Taiwan

With all these parameters above, I propose the following three-stage dynamic trade diaspora model to portray the entangled introduction process and the emergence of iron metallurgy in ancient Taiwan.

1. In the first stage, starting around 2400 BP, craftspeople with high-firing pyrotechnology knowledge, such as glassmaking and metallurgy, sailed to and traded with the local

communities on the east coast of Taiwan. These itinerant craftspeople were following the same trade routes as their ancestors. They brought glass and agate products, mostly beads, and sometimes metal tools, in exchange for Taiwanese nephrite. Nephrite quarries can only be found in eastern Taiwan. However, nephrite products have been found in archaeological sites in the Southeast Asian/South China Sea maritime regions as early as 3000 years ago. The craftspeople usually made this trip once a year since it is easier to travel north by the Kuroshio/Black Current in summer and return home by the monsoon in winter. The first stage might have initially taken place in southern/southeastern Taiwan and then expanded toward the north along with the current. In this stage, the trade diasporic community might have been small and in the Diaspora Marginality or Diaspora Autonomy mode.

2. The second stage starts around 2100 BP. As a result of the high demand for repairing metal tools and reprocessing metal and glass, some craftspeople began to settle permanently near the host community/communities, either in a segregated area of that community or a separate settlement. However, the craftspeople and their motherland seemingly still connected via the established overseas trade route and trade activities. In addition to fixing the old tools for different communities, these craftsmen also kept searching for the raw material they needed to make new iron products; thus, they expanded even further to the northern area of Taiwan along the east coast. In this stage, the trade diasporic community might have been larger than the previous one and still in the Diaspora Autonomy mode.
3. In the third stage, which began around 1600 BP, these craftspeople established settlements where they found free access to iron ore. Since smelting fuel (wood and charcoal) was relatively abundant in Taiwan, the places with accessible iron ore became the ideal location for the craftspeople's settlement. Starting from this stage, we may see a craftspeople's settlement associated with an iron production/process area, and those locally made iron products would be exchanged with other areas in Taiwan. Diaspora Autonomy is the most likely mode at the beginning of this stage; however, if the reason for overseas long-distance trade disappears, the Diaspora Autonomy will gradually integrate with the location community and become *Diaspora Integration*.

3.2.6.4. *Archaeological predictions for the proposed model*

As mentioned, the archaeological remains of a diasporic trade community include remains related to both daily and non-daily practices, for example ceramic assemblage, foodways, households, settlement patterns, burials, and pyrotechnology (CHEN 陳伯楨 2014; Stein 2002a). Here are some archaeological predictions for the proposed model.

1. In the first stage, since the hypothetical trade diaspora communities only stay one or two seasons per year⁴², the remains of these people might be archaeologically undetectable. However, we could expect to find exotic materials as trade goods used in local, non-diasporic communities. In the context of the proposed research region, we should see a small amount of glass and agate beads, and maybe exotic pottery, in local societies. Also, we might see a minimal amount of remains from metallurgy, such as smithing slag or tools for processing glass and iron. The provenance of glass and metal should be exotic to Taiwan.
2. In the second stage, we expect to see these exotic materials in both local and newly established diasporic settlements. The year-round residence of these trade diaspora people leaves archaeologically visible remains. We will be able to identify these trade diaspora communities through the physical remains of their distinct daily activities, such as foodways and ceramic assemblages that are different from local societies. Also, the remains from non-daily practices, such as burial customs, can be used as evidence of these communities. We should be able to find these practices either in a section of a 'local' settlement or adjacent to it.
3. In the third stage, we expect to find similar material remains as in the second stage but with direct evidence of iron manufacturing, such as iron smelting slag and furnace remains. From this stage, we should see evidence of use of local raw materials used for glassmaking and metallurgy.

Table 3-1 is the summary of archaeological prediction of proposed model. Here, I focus on three categories, daily-use ceramics, foreign technology (metallurgy), and burial practices.

⁴² This is similar to the 'temporary' trade hub or rendezvous point villages in Island Southeast Asia.

Table 3-1 Table of archaeological predictions of each diasporic mode

Diasporic Mode	Daily -use ceramics	Metallurgy	Burial practices
Marginality	Distinctive to local ceramic, original ceramic style of diasporic community	(re)shaped iron billet based on local demand; only smithing slag remains	Maintained the original style of diasporic community, grayish-black wares as burial goods
Autonomy	Distinctive to local ceramic or partially adapt local wares	(re)shaping iron billet to implement based on local need; repair of old implements when iron ore is located, local iron production emerged; both smelting and smithing slag remains	Maintained but with local burial goods and grayish-black wares as burial goods
Integration	Mixture	Most likely local iron production. Both smelting and smithing slag remains	Intermarriage mixed practice with local and foreign burial goods

Although we are using exotic materials to identify trade diasporas, we cannot ignore that these foreign traders also utilized local materials. For example, ceramics from local communities or made of local raw materials may have been increasingly common in diasporic settlements from the second to the third stage. This may represent the establishment of permanent settlements and deeper relationships between the trade diaspora and local community.

3.3. Related Archaeological Sites

3.3.1. Preliminary Observations on Related Sites in Previous Research

Figure 3-5 shows several important sites that yielded foreign cultural elements. While these sites are designated to different archaeological cultural assemblages, they share identical foreign material cultural traits distinctive from their 'designated cultural assemblages.' Here are a few details of these sites.

3.3.1.1. Jiuxianglan 舊香蘭 (JXL)

The JXL site sits on the top of a series of sand dunes on the south side of the Taimali 太麻里 River estuary. The approximate center coordinate is 22°34'53.9 "N 120°59'51.2 "E, and the cultural deposit is about 1 to 3 m above sea level. This site was found in 1998 and was excavated under salvage conditions in 2003 due to coastal erosion by Typhoon Dujuan 杜鵑. The site has metal objects and glass beads, and dates to 2400-2100BP (Hung and Chao 2016; LEE 李坤修 2015). Conventionally, the cultural deposit of the JXL Site is designated to the Sanhe 三和 cultural assemblage, and Sanhe cultural assemblage is considered as the direct descendant of the Peinan 卑南 cultural assemblage (3500-2400 BP) in the same region based on the similarity of ceramic assemblage and same burial practice, which is the use of a rectangular slate coffin with extended body position. However, the complex decoration pattern on the ceramic surfaces and the exotic materials from the JXL Site and other sites⁴³, such as glass beads and bronze and iron implements, become the primary factors to distinguish between the Peinan and Sanhe cultural assemblages (LEE 李坤修 2005). Recent studies on the glass bead waste and sandstone molds indicate the ability of ancient JXL people to manufacture glass and bronze objects (WANG 王冠文 et al. 2018; YANG 楊小青 et al. 2012). The 'Metal period' is pushed to 2400BP in Taiwan based on the dating results and pyrotechnological remains from this site (Hung and Chao 2016). Figure 3-1 shows the artifact assemblage in the burial context.

⁴³ Based on ceramics assemblage, Laofanshe 老番社, Chulu 初鹿, Sanhe 三和, Peinan 卑南, Shanzongliao 山棕寮, Xiaduoliang 下多良, these sites have a Sanhe cultural layer. However, until now, only the JXL Site yielded the evidence of glass and metal pyrotechnology.



B14 棺內蓋板出土情形



B14 棺內現象

Burial with extended position, slate coffin



Burial good: pottery



Black pottery with stamped circles and incised lines



Black pottery with animal and human face design



Bronze artifacts as burial goods



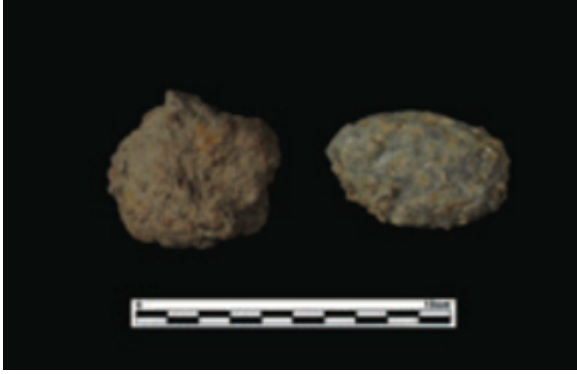
Iron implement

Figure 3-1 Artifacts from the JXL Site. Photo credit LEE 李坤修(2005)

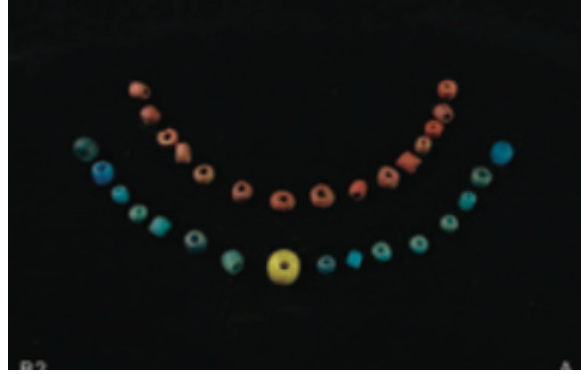
3.3.1.2. Huakangshan 花岡山 (HKS)

The HKS site sits on a sand dune tableland on the right bank of the Meilun 美崙 River mouth. The approximate center coordinate is 23°58'44 "N, 121°36'16 "E, and the datum is between 10 and 17m above sea level. This site was found in the Japanese Colonial Period (JCP, 1895-1945) and was subsequently studied in the 1990s and from 2007 to 2009. During the 2007 to 2009 excavation, five cultural layers were identified. Of these five layers, the Eastern Cord-marked Ceramic culture layer and Huakangshan culture layer, belong to the Neolithic period. The newly identified Upper HKS cultural assemblage (2100-1600 cal. BP) is the transitional time between the Neolithic and the Metal periods (CHAO 趙金勇 et al. 2013). Also, the Shuilian 水璉 subset of Chingpu 靜浦 cultural assemblage was identified (430 BP), and the layer of JCP deposit (1895-1945).

This Upper HKS cultural layer could be crucial to the proposed trade diaspora model. During the 2007-2009 excavation, over 9600 ceramic sherds were unearthed. Fifty-four burials were identified and unearthed, but no human remains were recovered. Burials had no coffins but used two pieces of slate for the bottom and the cover; as for the burial goods, orange pots, polished grayish-black pots, black pottery with anthropomorphic complex design, and glass beads were recovered. Interestingly, the black pottery was mostly found in burial context. About half of the burial pottery fragments are not local to the HKS site. The people of this cultural layer adopted exotic materials for their burial goods. Only a few pieces of iron slag (14 pieces) were found in this layer (劉益昌 Liu and 趙金勇 Chao 2010). Figure 3-2 show the ceramic assemblages, glass beads, and slag from this site.



Iron slag from the Upper HKS layer



Glass beads as burial goods of Upper HKS layer



Ceramic assemblage in burial good context of Upper HKS cultural assemblage



The daily-used ceramic assemblage of Upper HKS cultural assemblage

Figure 3-2 Ceramic assemblages, glass beads, and slags from the Upper HKS cultural layer. Photo credit: LIU 劉益昌 and CHAO 趙金勇 (2010b) and CHAO 趙金勇 et al. (2013)

3.3.1.3. Chongde 崇德 (CD)

The Chongde site's central part is buried under the modern Chongde Village, Hualien County. The current number of residents in the village is about 1800 people, and most of them are Truku 大魯閣 people. Truku is one of the government-recognized sixteen tribal groups of Taiwanese Aborigines. Previous studies show that the Chongde site sits on the upper and lower terrace of the north side of the Liwu 立霧 River Delta (Figure 3-3). Provincial Highway No. 9 of Taiwan and railway also pass through the site. The approximate center coordinate is 24°09'23 "N, 121°38'34 "E, with the datum ranging from 20 to 60m above sea level. The whole site is about 500m long from north to south and 200m wide from east to west. The CD site is one of the earliest archaeological sites found in the JCP and was named タツキリ 溪口遺跡 (Takiri River mouth site). The Japanese site name was replaced with the current Chongde site name in 1988. Although this site has been known for a long time, and multiple surveys have been conducted because of the gold artifacts and metal slag remains, the scale of excavations was relatively smaller than those of other sites mentioned above. The excavation in 2007 yielded over 10 kg of ceramics and 9 kg of iron slag within two 4 m² units (LIU 劉益昌 1990b, 2010a); this indicates a period of intense iron making or processing at this site.

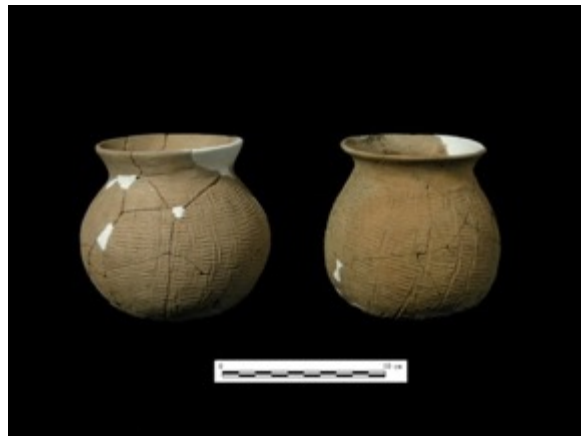
In terms of features, although the excavation scale was small, a burial (Figure 3-3) with two individuals was unearthed; burial goods consisted of pottery and glass beads. The burial is in the corner of a household structure that indicates indoor burial practices, similar to what we have found at the Blihun Hanben 漢本 site. Besides the artifacts, the excavation in 2007 also provided material for absolute dating (1300 to 1180 cal. BP, one sample by Beta Analytic). A more recent research pushes the dating to about 1500 BP (YIN 尹意智 and YAO 姚書宇 2020). There is only one cultural layer in this site, and the culture affiliation is Shihsanhang cultural assemblage Pulowan 普洛灣 subset. However, the ceramic analysis indicates the interaction between the Chongde people and the people from the south, specifically the ancient Chingpu people.



Overview of the Chongde site. Photo direction: north to south



Flexed burial with laid body position. The red arrow indicates the orange and black pots as burial goods



Reconstructed pots from the burial context



Reconstructed black pots from the burial context



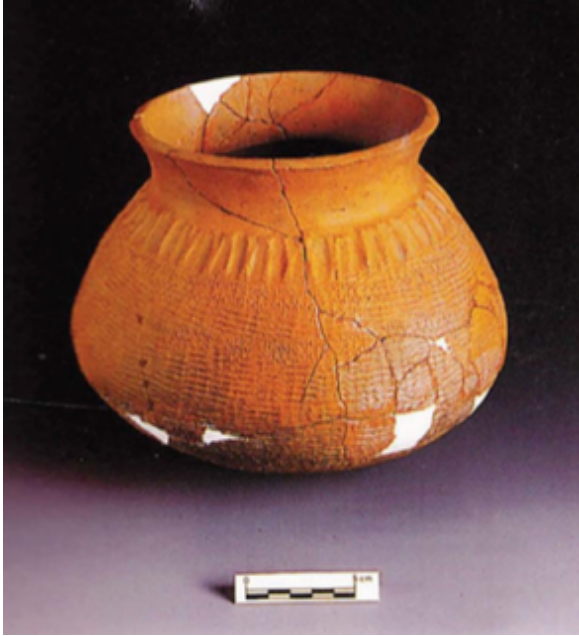
Iron slag

Figure 3-3 Landscape and artifact assemblage of the Chongde site. Artifacts photo credit (LIU 劉益昌 2012, 2013a)

3.3.1.4. *Shihshanhang* 十三行 (SSH)

The Shihshanhang site is located on the left bank of the Tamsui 淡水 River mouth and was found in 1959. The center coordinate of the site is 25°09'33.2 "N 121°24'24.3 "E, with the datum 2 to 5m above sea level. Since the site's discovery, several small-scale excavations had been carried out by the Department of Anthropology, National Taiwan University (NTU). Ironically, however, the most substantial excavation was a salvage archaeology project due to the construction of a water treatment facility during 1990-1992; the total salvage area was about 7000 m². The salvage archaeology project was directed by TSANG Cheng-Hua 臧振華 and LIU Yi-Chang 劉益昌 in the IHP at Academia Sinica. Forty-three samples of charcoal, human bone, and shell were dated by the ¹⁴C dating lab in NTU, and the result indicates that humans occupied the site ranges from 1800 to 500 BP with the apex duration 1500-1000 years ago (TSANG 臧振華 and LIU 劉益昌 2001).

There is only one archaeological cultural layer, and features such as postholes, hearths, shell middens, burials, and open-air ceramic firing pits were found. Among these features, the iron 'smelting furnace' was the most significant finding since it was the first direct evidence to be found for iron production in ancient Taiwan. About 800,000 ceramic sherds were found in the 2007 excavations and were classified into four types. In contrast, the number of lithic remains was relatively few. The major types of lithic remains were hammers and anvils. The lack of sharp-edged lithic remains indicates the presence of metal cutting tools in the SSH society. Two hundred and thirty-eight bronze artifacts, including arrowheads, coins, earrings, pendants, bowls, and an anthropomorphic knife shank, were uncovered. Thirty-five thousand, four hundred and forty-eight glass beads were excavated, and they were classified into eighteen types. Chemical analysis of these beads placed their origin in mainland Southeast Asia and coastal Southeast China, indicating that they are exotic goods (TSANG 臧振華 and LIU 劉益昌 2001; Wang and Jackson 2014). Also, 287 burials were excavated, and most of the remains were buried individually in the laid, flexed-position without coffins (but with grave goods). These burial goods included pottery, beads (agate and glass), bronze knife shanks, and gold foil. The interesting factor for the SSH burials and the burial goods is the high similarity compared to the burials from the Blihun Hanben site. Figure 3-4 shows the artifact assemblage of the SSH Site.



Dominant ceramic type



Ceramic from the burial context



Anthropomorphic bronze knife shank in SSH



Gold foil



Laid, flexed-position burials, no coffin



Iron smelting 'furnace' (copyright purchased)

Figure 3-4 SSH site artifacts and burial. Photo credit (TSANG 臧振華 and LIU 劉益昌 2001)

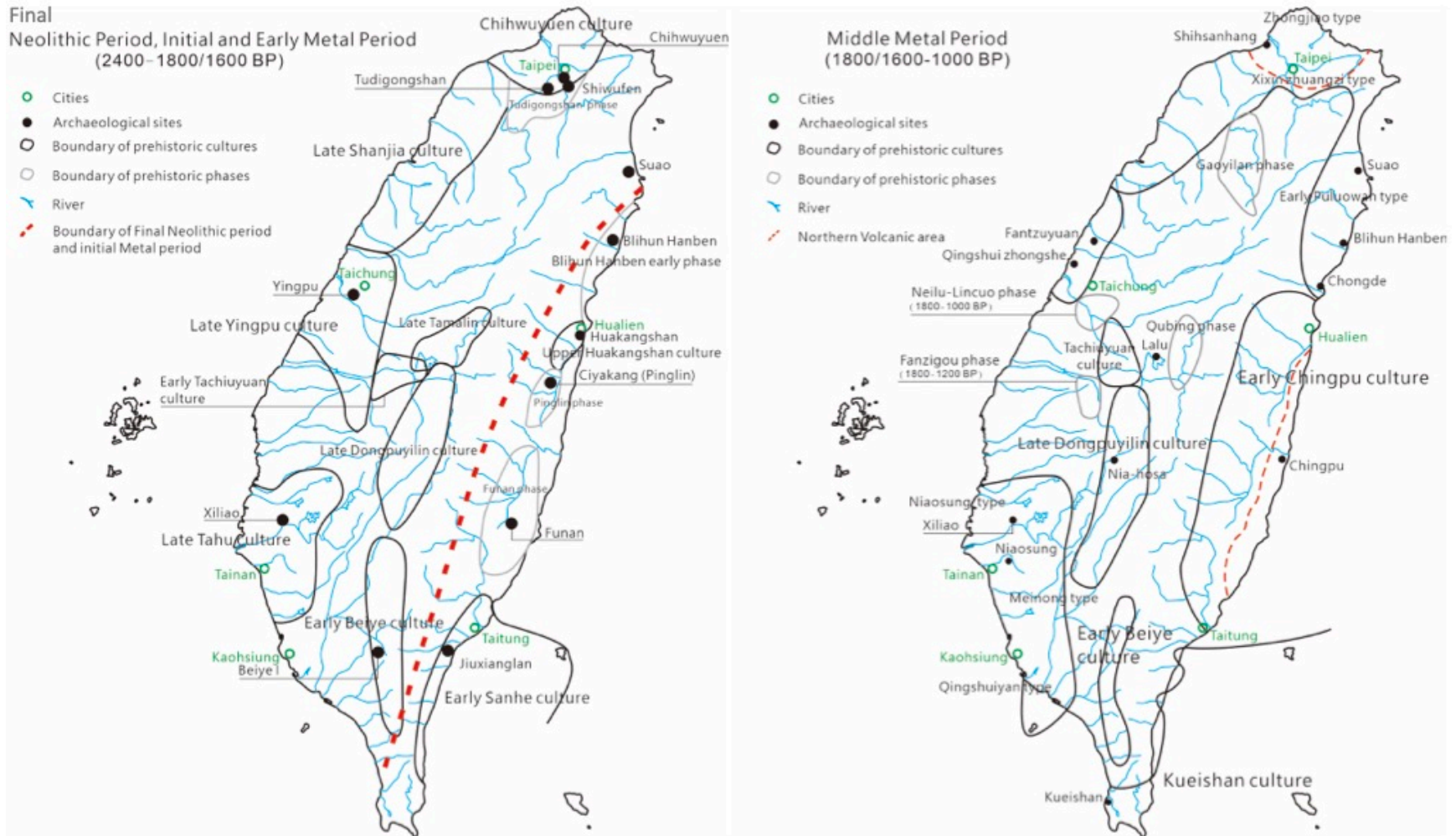


Figure 3-5 Map of archaeological cultural assemblages and important sites in two periods of ancient Taiwan. The Blihun Hanben 漢本 site is located in the midway between the eastern cultural assemblages and northern cultural assemblages

3.3.2. Scattered but distinct foreign material cultural traits

Those sites mentioned above are designated to different archaeological cultural assemblages. Still, they share similarities in some burial practices and in some materials, such as black pottery with a dot, circle, incised pattern, foreign materials like glass and carnelian beads, metal objects, pyrotechnology of glass or metal. Those cultural traits, especially the foreign elements, are found sporadically in several sites that belong to different ancient societies in eastern Taiwan.

Among these sites, the Sanhe cultural layer in the JXL site and the Peinan site dates the earliest (2400-2100/2000 BP) (Hung and Chao 2016; LEE 李坤修 2002), and it has the foreign materials like glass and agate/carnelian beads, bronze and iron objects, and possible traces of processing glass and metal (bronze). The small number of foreign materials, like beads and metal objects, from the early Sanhe cultural layers in the JXL site and the Peinan site indicate the seasonal activities of foreign craftspeople in a local community. This could match with the first stage of the proposed trade diaspora model.

Sandstone mold and iron slag recovered from the JXL site dated to 2100 BP. The Upper HKS cultural assemblage deposits of the HKS site (2100-1600 BP) yielded a limited amount of metal (bronze and iron) pyrotechnological remains, like slag. On top of those metalworking traces and yielded beads, the burials indicate a permanent residence status of the Upper HKS people. The Sanhe cultural layer after 2100 BP and the Upper HKS cultural deposit match to the second stage of the trade diaspora model.

Before the discovery of the BHB site, the SSH site (1800-1200 BP) was the only site that yielded a large amount of iron slag (over tons) and a 'furnace.' While the earliest dating of the SSH site is 1800 BP, a mature iron metallurgy may not have been practiced until 1600 BP (Chen 2000). Hence, the early remains of the SSH site should be recognized to have been in the second stage of the trade diaspora model.

Foreign material and evidence of iron production has been mentioned in association with all of the SSH remains after 1600 BP. Another site with relatively more iron slag is the CD site (1500-1000 BP). Although the amount of recovered iron slag cannot match that of the SSH site due to the scale of the excavations that were done on the CD site, this site was also considered as a

small ironworking/production sub-center of the SSH cultural assemblage in eastern Taiwan. The two sites were permanent settlements that were possibly close to the iron ore and were the ideal locations for iron craftspeople. The SSH site and CD site can also be considered as the third stage of the proposed model. Table 3-2 summarizes the above preliminary observations.

Table 3-2 Table of material representation of each trade diaspora stage before the discovery of the BHB site

Stage of Trade Diaspora	Sites and related cultural assemblages	Foreign material representation
First stage 2400-2100 BP	JXL (Sanhe cultural assemblage)	Glass and agate/carnelian beads, bronze and metal objects
Second stage 2100-1600 BP	SSH (SSH cultural assemblage SSH subset) HKS (Upper Huakangshan cultural assemblage) JXL (Sanhe cultural assemblage)	Glass and agate/carnelian beads, bronze and metal objects Metalworking remains
Third stage 1600-1200? BP	SSH (SSH cultural assemblage SSH subset) CD (SSH cultural assemblage Pulowan subset)	Glass and agate/carnelian beads, bronze and metal objects Metalworking remains, and iron production remains

3.3.3. An unexpected journey – the discovery and salvage archaeology of the Blihun Hanben 漢本 site

While those sites and studies mentioned in the above sections seem to fit the proposed trade diaspora model well, I have had limited access to the artifacts and excavation field notes of those sites since several of those sites are still under the study of the principal investigators of each excavation project. The newly discovered and excavated Blihun Hanben 漢本 site provides a great opportunity and flexibility to access the raw data and design a suitable research method. Besides that, preliminary observation during the excavation⁴⁴ on the foreign materials, like glass beads, agate/carnelian beads, bronze and iron objects, as well as the burial practices and rich iron metallurgical remains, shows a close relationship between the SSH site and this site. All these factors make the Blihun Hanben site the ideal primary target of this doctoral research.

3.3.3.1. Location of the site

The current Hanben 漢本 area (Figure 3-6) belongs to Aohua 澳花 Village, which is an Atayal⁴⁵ village of Nanao 南澳 Township in the south end of Ilan/Yilan 宜蘭 County. There are about 1000 residents in the Aohua village on the left river bank close to Heping 和平 River Estuary. There are less than ten households in the Hanben area due to unstable geographic structure and limited plain area available for housing. Provincial Highway No. 9 of Taiwan cuts through the Hanben area from north to south. The Hanben railway station mainly serves the cement factory on the other side of the river and acts as the major gateway for the Hanben area and the main Aohua settlement. The name Hanben comes from the term 半分(はんぶん) in the Japanese Colonial Period (JCP 1895-1945), which pronounced it as 'hanbun' in Japanese, and it means half or middle. In the context of this area's location, the name indicates the middle point between Yilan and Hualien 花蓮 Counties in eastern Taiwan.

⁴⁴ I participated several seasons of excavation from 2013 to 2016.

⁴⁵ One of the governmental-recognized Indigenous tribal groups in Taiwan.

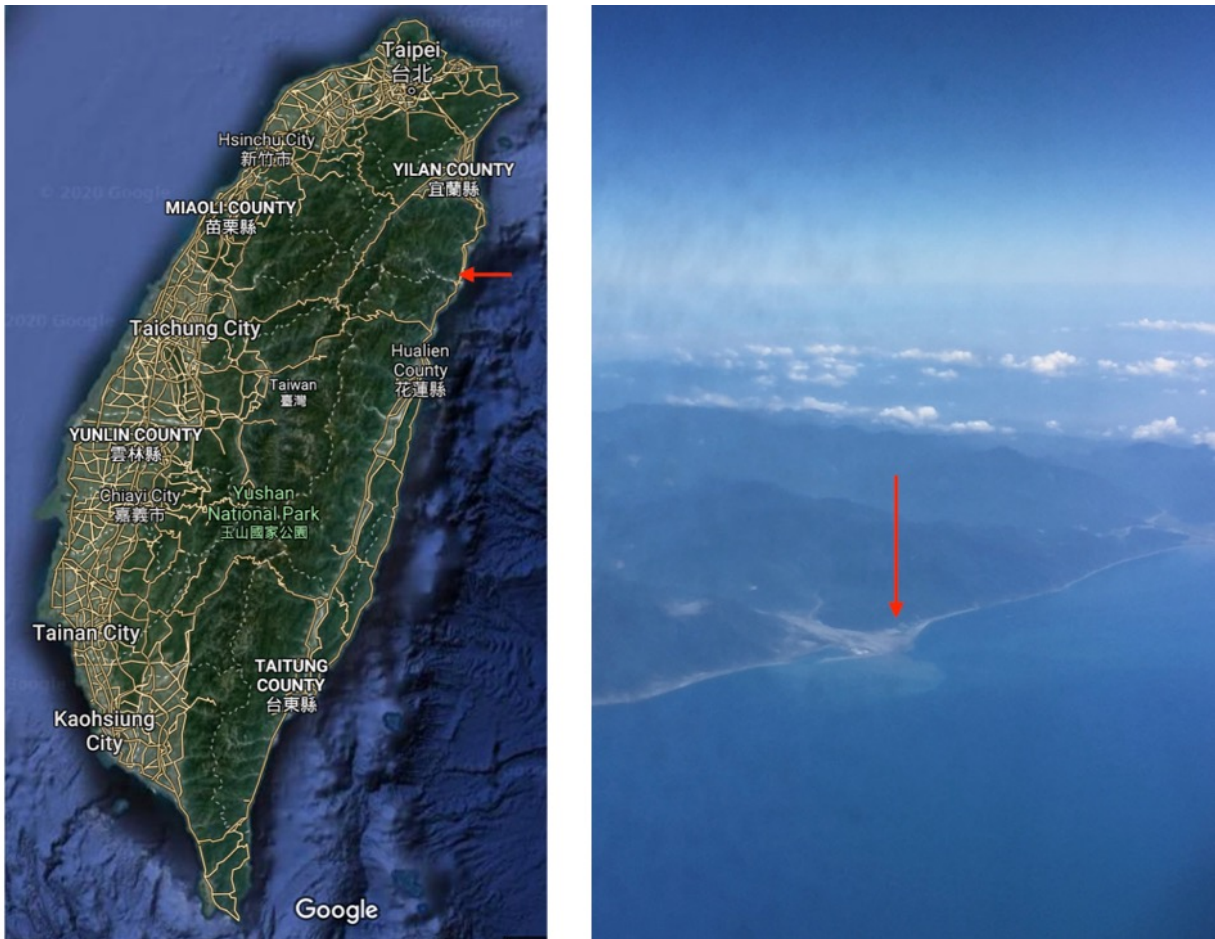


Figure 3-6 Left: Map of Taiwan. The red arrow points out the location of the Blihun Hanben 漢本 site (modified from Google Earth Pro). Right: aerial photo of the site location and Heping River. The photo was taken during a flight by the author from Taipei to Manila. This aerial photo also shows the closeness between the mountains and the coastline

Due to increasing transportation needs and unstable geographic conditions of the current road system, a new freeway-class highway was planned to connect Yilan and Hualien. This new highway passes through the Hanben area via a viaduct immediately after a tunnel. Despite the strong objection from the Environmental Protection Administration Executive due to the fragile ecosystem and unstable geography, the Ministry of Transportation and Communications of Taiwan still decided to build this highway, as it was under pressure from the Hualien County administration. During the construction, an assistant of the archaeological monitor project found a thick archaeological deposit while having his lunch. Although this cultural deposit was not in the project monitoring area, this finding immediately led to a rescue archaeology project⁴⁶ run

⁴⁶ I had the privilege to participate for three seasons of the salvage archaeological fieldwork in the summers of 2014, 2015 and 2016. I would like to thank the project principal investigator and co-workers.

by Professor LIU Yi-Chang 劉益昌 in the Institute of History and Philology (IHP) at the Academia Sinica, Taiwan. A new archaeological site was confirmed during the rescue process. The total area of the rescue project was about 4000 m², and the IHP excavated about 3250 m². The rest of the planned excavation area was excavated by Archaeo Culture, a private archaeology company. While Archaeo Culture used a different excavation method (pure arbitrary level, Figure 3-10), It will be quite challenge for me to match the spatial context of artifacts that excavated by two teams (the IHP team utilized a different method, see details in the following section). Hence, I only used the material excavated by the IHP team that I have access to and have the confidence of the excavation context.

The site sits on a gradual slope, and the approximate center coordinate is 24°19'40 "N, 121°45'56" E, with the datum from fifteen to thirty meters above sea level. The whole site is about 550 m long from north to south and 200 m wide from east to west. The Central Mountain Range of Taiwan is extremely close to the coastline in this area (Figure 3-6). Hence, a rare topographic scenery can be observed at this site. On the east side is a vast, endless oceanic view of the Pacific Ocean. On the opposite end is a giant 400m height cliff of one of the mountains of the Central Mountain Range. The mountains in this area climb up to over 1000 m elevation within two km from the coastline (Figure 3-6 and Figure 3-7). The average annual precipitation over the most recent five years in this area is 279.55mm, and the second half of the year usually receives more rain. Some creeks can be found at the bottom of the cliff after rains, and the Heping River which passes through the south of the site is about one km away. Huge rains and storms cause landslides and rockfalls from the cliff, and one of those natural disasters might have been the cause of the catastrophic end of the middle cultural layer settlement.

This site was nominated as a national heritage site during the excavation because of its rich archaeological contents and iron metallurgical remains. The site is now officially named as the Blihun Hanben 漢本 (BHB) site. 'Blihun' means 'gate' in the Atayal language. Although there is no direct relationship between the ancient BHB residents and the current Atayal community, Atayal people embrace their archaeological neighbor and use 'Blihun' as the blessed name for this site. Hence, when this site was appointed as a national archaeological site of Taiwan, both Atayal and Mandarin were included in the official site name.



Figure 3-7 The adjacent landscape of the Blihun Hanben 漢本 site. The red arrow points out the site location

3.3.3.2. Excavation

Because the BHB excavation was a salvage archaeology project, there was little room for negotiating the excavation pit location and size. All excavation pits followed the designed location and size of viaduct pillars. Figure 3-8 shows the location of excavation pits. The size of the pits varied due to the viaduct design. Among these excavation pits, P1S (11x11m), P2S(20x18m), P3N(20x18m), and P3S(20x18m) yielded the most archaeological remains and was designated as the core area of the site (LIU 劉益昌 et al. 2016). The red line marks the confirmed site boundary based on the salvage excavation result.



Figure 3-8 Map of excavation pit location and site boundary of the BHB site. The map is provided by the IHP excavation team and modified by the author

The salvage project applied the system of the stratigraphic layer with arbitrary leveling during excavation. The stratigraphic layers include the layers formed by natural forces (like water, landslide, flood) and anthropogenic forces, such as human occupation and activities. While this excavation method requires more field experience, it allows us to visualize the ancient landscape and the spatial context between artifacts, features, and structures. If one stratigraphic layer is thicker than 10 cm, then the 10cm arbitrary levels allow us to excavate and document more

precisely. The stratigraphic layers were named in numeric order, and the arbitrary levels in the layers were named in alphabetic order. For example, L4b means the second arbitrary level of the fourth stratigraphic layer.

This excavation method shows even more advantages for large scale excavation because of the visualization and contextualization (LIU 劉益昌 and CHAO 趙金勇 2010a:38-40).⁴⁷ Also, the landscape and structure uncovered by this method are more appealing for exhibition and educational purposes. Hence, while this excavation method is relatively harder to carry out, it has still been applied worldwide.



Figure 3-9 PS2 excavation pit, L6 layer structure. Well-conducted excavation revealed the piled stone wall, indoor living floor, and front yard platform made of flat schists. The excavation also uncovered a little stream that cut through the piled stone wall and indoor area. The little stream may be evidence of a natural disaster but also showed the resilience of the BHB residents since they continued to live there after the formation of this stream

⁴⁷ The subsequent excavation conducted by the Archaeo Culture was by pure arbitrary level. This created difficulties for integrating the excavation data.



Figure 3-10 A comparison of two excavation methods carried out by two different institutes. The lower photo shows the excavation pit dig by the IHP team

A grid coordinate system (Figure 3-11) was applied for laying out the excavation units (2x2m) in the excavation pit (usually is 18x20m). The datum point was the southwest corner of each pit, and the southwest corner excavation 4m² unit (2x2m) was T0P0. The basic excavation units were numbered from T0 to T8 along the X-axis in a 2m increment from the datum point. The same was done for the excavation units on Y-axis, named from P0 to P9. For example, the excavation unit in the northeast end was numbered as T8P9. While the basic excavation unit was 4m², this unit was divided into four zones (A to D) by a quadrant system, starting from the upper-right (northeast) corner counter-clockwise. Each quadrant was 1x1m in terms of size. With the coordinate system for the horizontal control and the stratigraphic layer (L) with arbitrary level (a) system for the datum control, the IHP team excavated the natural and cultural layers and numbered each 10 cm arbitrary level by lowercase alphabet within the layers. Synthesizing the rules above, a regular basic artifact bag from the BHB site was recorded as P2S (horizontal coordinate in BHB site), T5P2-A (horizontal coordinate in P2S, where A is a quadrant in the T5P2), L4a (vertical coordinate within T5P2, the first arbitrary level of layer 4), ceramic (content), Jun/6/2017 (date). With this system, anyone could locate where the artifacts originated from within an area of 1 m².

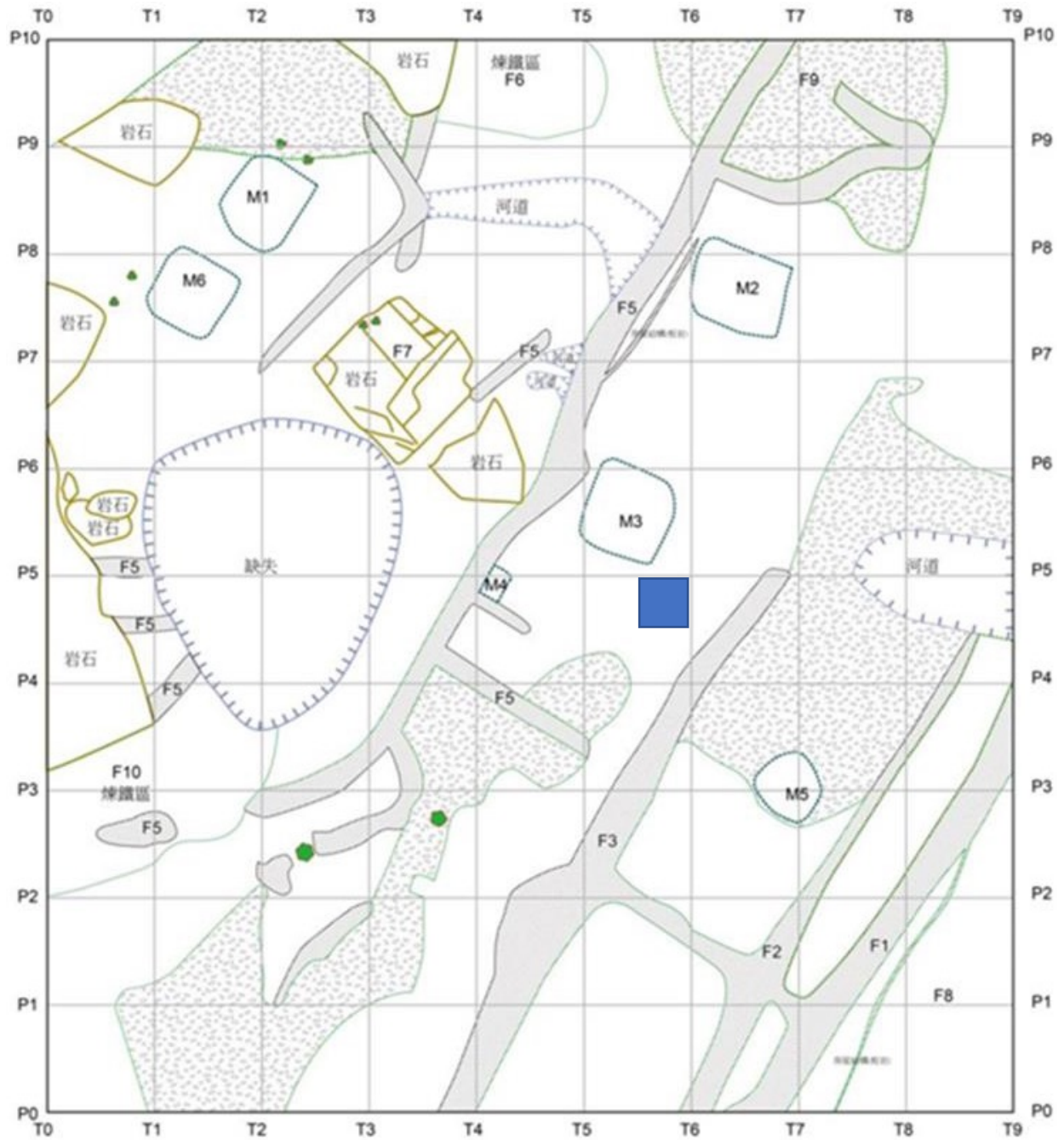


Figure 3-11 The grid coordinate system of P2S pit L4c (LIU 劉益昌 et al. 2016). One can find M4 (mortuary no.4 in the T5P5 unit). The blue square in the T5P4 unit marks the A quadrant (1×1m) in a standard excavation unit (2×2m). All other pits applied the same principle for laying out the record system during excavation

3.3.3.3. *Archaeological facts*

The excavation uncovered several layers of human activity deposits, including a modern rice paddy ruin, deposits of JCP, archaeological cultural layer 4, archaeological cultural layer 6, and two archaeological agricultural layers at the bottom. The modern and contemporary cultural deposits are thin and sporadic across the whole site; only a small number of Japanese and Qing porcelain sherds were found. In contrast, the archaeological cultural deposits are relatively thick. On average, the archaeological deposits are thicker in the west and gradually become thinner toward the east. There is a sterile layer (L5) between two archaeological cultural layers (L4 and L6). This sterile layer contains sediments and rock of various sizes, from silt to large rock with a two-meter diameter. The closer to the cliff, the bigger size of the sediment and the thicker the L5. On the southeast end of the site, L5 is merely about a 10 cm silt deposit. L5 could be the result of landslide(s).

The thickness of L4 ranges from 30 cm to 100 cm and distributes from A1S pit to P4S pit (Figure 3-8, Figure 3-13 and Figure 3-14). The radiocarbon dating of L4 ranges from about 1600 to 1000 BP⁴⁸ (Table 3-3), and luminescence dating on ceramic specimen show similar dating result (Table 3-4, UW3286).⁴⁹ Several artificial platforms that step down from the northwest to southeast were uncovered. Artifacts like ceramic, lithic tools, fauna remains, flora remains, glass beads, agate beads, and metal objects (bronze and iron) were found. In addition to those portable remains, building structures, burials, and metallurgical remains (slag, hearth, and 'furnace') were recovered. The thickness of L6 ranges from 20 cm to 100 cm and 200 cm in certain excavation units. L6 mainly distributes from the P1S pit to the P3S pit (Figure 3-8, Figure 3-13 and Figure 3-14) and has platforms created by retaining walls (Figure 3-9). The radiocarbon dating of L6 ranges from approximately 2000 to 1600 BP, and luminescence dating on ceramic and sediment specimens agree with this dating range (Table 3-4 and Table 3-5). Notable is, some luminescence dating results have large error margin and some are quite off from expected dating range (L6e expects to be around 2000 BP), and this is an interesting topic for further exploration, although

⁴⁸ 33 samples by Beta Analytic and DirectAMS

⁴⁹ All luminescence dating works were carried out by Prof. Feathers in the luminescence dating laboratory at the University of Washington.

currently out of my research scope in this doctoral study. Considering the geological environment around the BHB site, one possible cause for large error margins might relate to the metamorphic and volcanic source of ceramic raw materials. The overall artifact assemblage is similar to the L4 assemblage; however, there were no evident traces of metallurgical remains in this layer. Building structures and indoor burials were also found. There are two more agricultural layers beneath L6, but no date-able materials were acquired; they are presumably older than the L6.

The excavation team noticed that the BHB ceramic types in L4 and L6 are diverse, and that the dominant ceramic types between the two cultural layers are distinctive to each other. The L4 dominant ceramic type is mainly reddish to yellowish-brown, sandy earthenware. Complex and rich paddle-impressed patterns like veins, grids, cloud, and stripes are common on the ceramic surface. There are two types of grayish-black pottery. One type is Guishan 龜山 style black pottery with the anthropomorphic surface pattern, and another type is polished smudged grayish-black pottery with stamped circles and incised lines on the surface. Two types of black wares were primarily found in the burial context and also in L6. The dominant ceramic type of L6 is grayish-yellow, coarse, sandy earthenware. The surface decoration is simpler than the L4 ceramics, mainly decorated by paddle-impressed stripes.⁵⁰

As for the burial remains, of the ninety-four L4 burials, the common practice was laid with the flexed body position in rectangular coffin made of slate, and many of the burials contained multiple individuals. Locally made reddish-brown pottery, grayish-black pottery, and glass objects were commonly found as burials goods. In some burials, we found bronze, gold, and iron objects as burial goods. A few other practices such as seated and squatting position burials were also found. Regarding the L6 burials, sitting, squatting, and assorted human remains were commonly found; however, the coffins are mainly made of schist piles (Figure 3-15). The burial goods are similar to the L4 burials. The L4 burial practice is similar to the Shihshang cultural

⁵⁰ See the next chapter for a detailed analysis on the BHB ceramics and see chapter 5 for analyses on the metallurgical remains.

assemblage burials, and the L6 burial practice is quite unique for its contemporary period. Both the L4 and L6 burials were mostly found inside of house structures.

On average, the indoor area of the L6 house structure is larger than that of the L4 structure. Schist and slate are two common materials of those structures. While postholes were uncovered, a lithic foundation with wooden pillars is the presumed style of the ancient BHB buildings (LIU 劉益昌 et al. 2016). Based on these observations, it is hard not to think about the similarity between the L6 house structure (that with indoor burial practice and large front yard platform) and the Paiwan 排灣 traditional style house. Also, from the above archaeological facts, the salvage excavation team pointed out that the L4 can be considered as the Shihshanhang cultural assemblage Pulowan subset. Some of the L6 material remains are similar to Upper Huakangshan cultural assemblage and Shihshanhang cultural assemblage, but further evaluation will be needed in order to conclude the cultural designation.



Figure 3-12 L4 ceramic sherds, metal objects, and iron slag from the BHB site

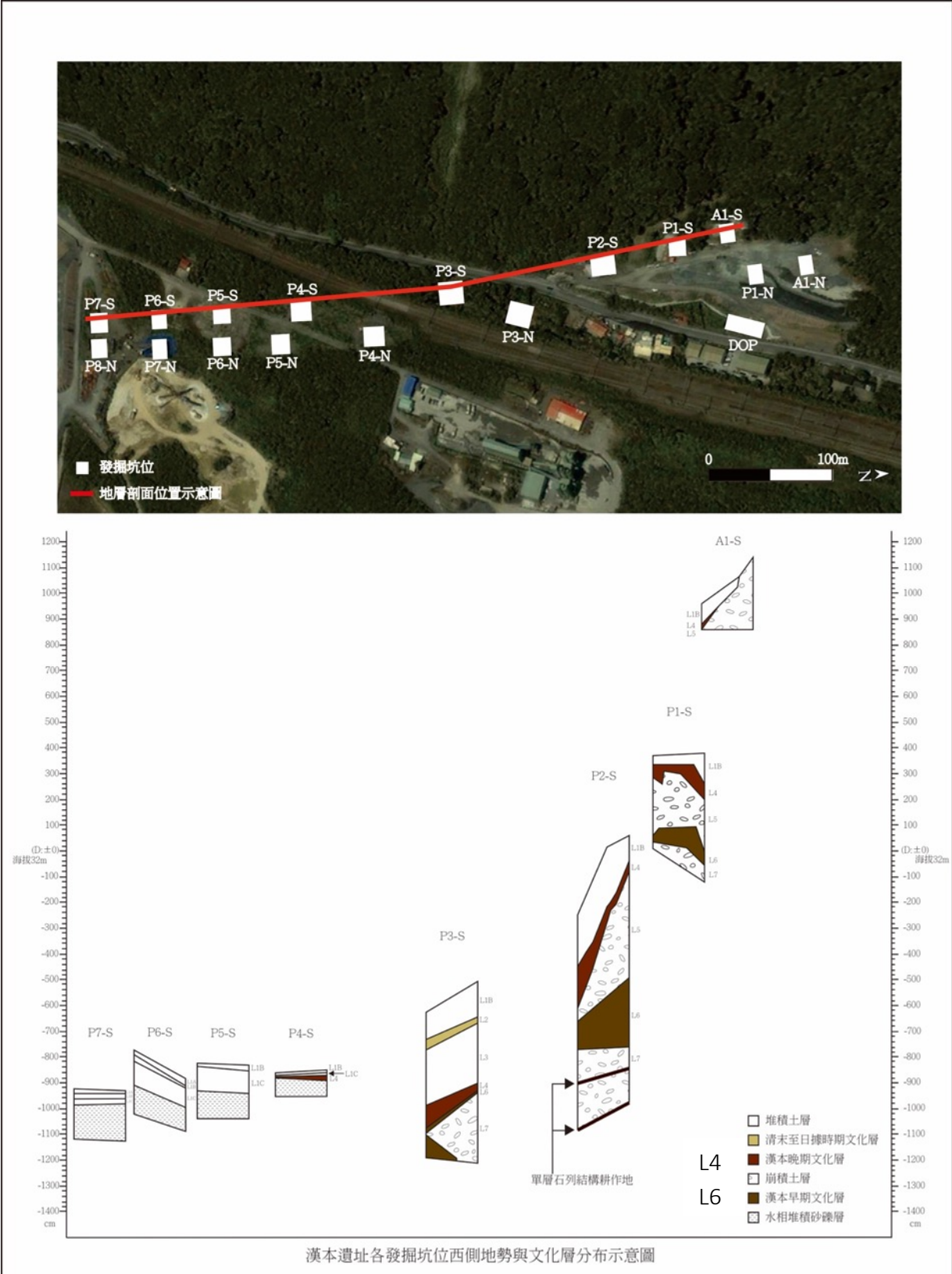


Figure 3-13 The excavation pit location and stratigraphic profile of the west-side pits

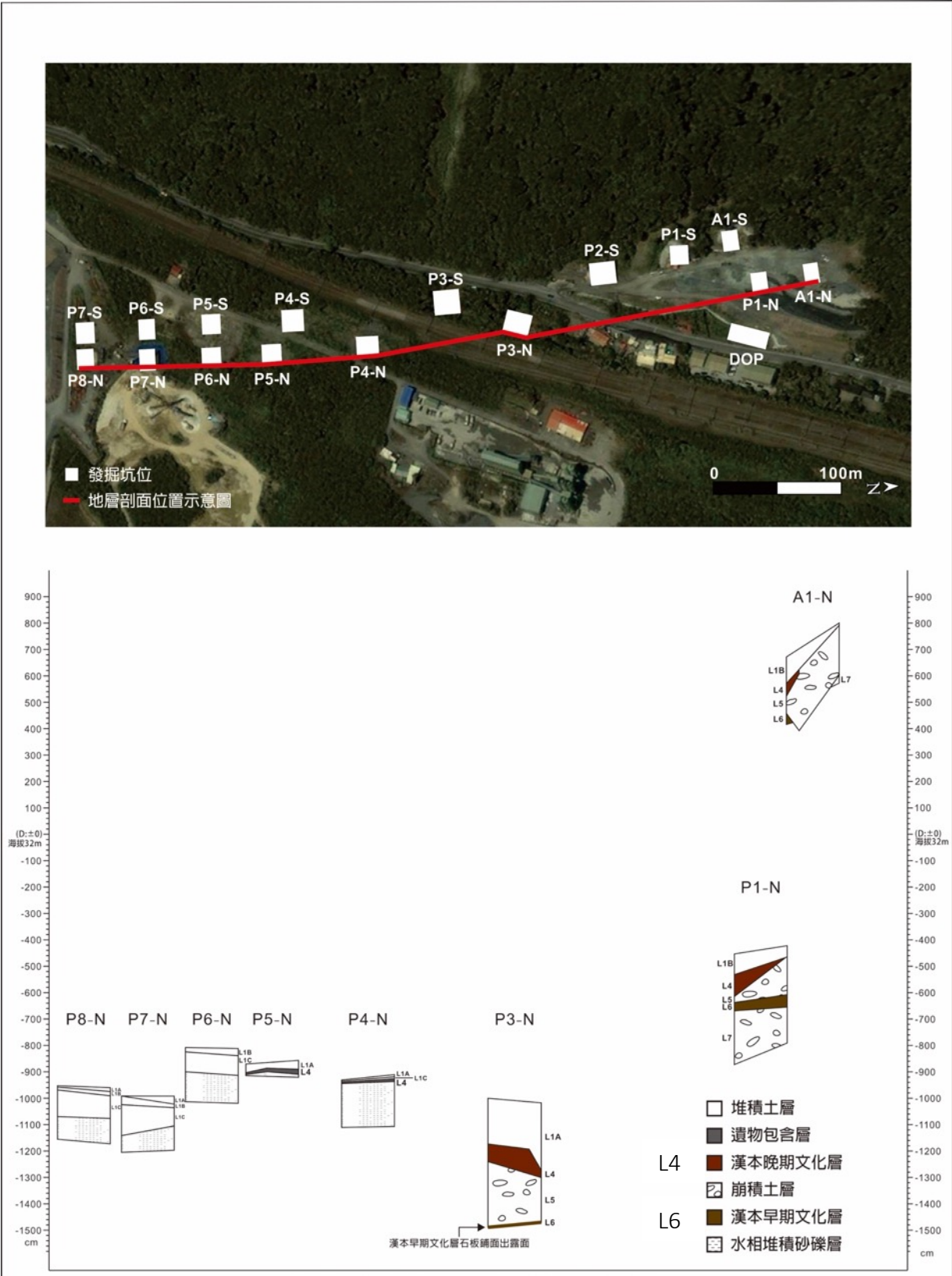


Figure 3-14 The excavation pit location and stratigraphic profile of the west-side pits



Figure 3-15 Two burial practices. Upper practice usually found in L4, and lower style usually found in L6



Figure 3-16 Building structures of the L4 (upper two) and the L6 (lower two) (LIU 劉益昌 et al. 2016)

Table 3-3 Radiocarbon dating sample details of the BHB site and the SSH site (selected samples, the SSH data is from TSANG 臧振華 and LIU 劉益昌 (2001))

Sample number	Lab ID	Site	Pit	Unit-Zone	Layer	Result	Cal. BP 2-sigma	Lab
HB-101-427		BHB	P2-S	T2P3-C	L4C-a	1310+/-50BP	1175-1306 BP (90.7%)	NTU
HB-101-095		BHB	P2-S	T6P2-A	L4C-b	1160+/-40BP	971-1154 BP (89.2%)	NTU
HB-101-483		BHB	P2-S	T5P0-B	L4C-d	1580+/-50BP	1355-1543 BP (100%)	NTU
HB-101-485		BHB	P2-S	T5P0-D	L4C-d	1590+/-40BP	1384-1537 BP (100%)	NTU
HB-101-1067		BHB	P2-S	T2P2	L6a	1620 +/- 30 BP	1409-1544 BP (100%)	BETA
HB-101-1346		BHB	P2-S	T4P0-D	L6b	1640 +/- 30 BP	1411-1531 BP (100%)	BETA
HB-101-1517		BHB	P2-S	T5P1	L6g	1960 +/- 30 BP	1822-1950 BP (91.7%)	BETA
SSH-II-5	NTU-1211	SSH	C7	NA	L5	1650 +/- 80 BP	1376-1708 BP (100%)	NTU
SSH-II-6	NTU-1257	SSH	C8	NA	L3	1330 +/- 100 BP	1052-1403 BP (97.2%)	NTU
SSH-II-7	NTU-1205	SSH	C9	NA	L2	1500 +/- 50 BP	1345-1534 BP (100%)	NTU
SSH-V-19	NTU-3012	SSH	HT11P1B-a	NA	L5	1270 +/- 40 BP	1175-1289 BP (78.2%)	NTU
SSH-V-1	NTU-2064	SSH	HT10P1Eex	NA	L6	1060 +/- 120 BP	730-1178 BP (95.9)	NTU
SSH-BM-13	GX-19458-G	SSH	BM-13	burial	NA	1390 +/- 135 BP	1050-1541 BP (96.9%)	GX
SSH-BM-75	GX-19460-G	SSH	BM-75	burial	NA	1455 +/- 175 BP	1049-1709 BP (97.4%)	GX

* All specimens are charcoal except for Lab ID GX-19458-G and GX-19460-G

** Dates calibrated by RADIOCARBON CALIBRATION PROGRAM CALIB REV8.2 IntCal20.14c copyright 1986-2020 M Stuiver and PJ Reimer (<http://calib.org/calib/calib.html>)

Table 3-4 Luminescence dating results of ceramic specimens

Sample	Age (ka)	% error	Basis for age	Calendar date (years CE/BCE)	Excavation level
UW3286	1.45±0.12	8.2	OSL/IRSL/TL	CE 570 ± 120	L4c
UW3365	1.11±0.06	5.5	OSL/uncorrected TL	CE 900 ± 60	L6e
UW3366	1.51±0.47	31.4	Uncorrected TL	CE 510 ± 470	L6e
UW3367	2.33±0.15	6.5	OSL/IRSL	BCE 310 ± 150	L6e
UW3368	2.05±0.12	5.6	OSL/uncorrected TL	BCE 30 ± 120	L6e
UW3369	0.69±0.17	24.7	Uncorrected TL	CE 1330 ± 170	L6e
UW3373	1.90±0.43	22.9	Uncorrected TL	CE 120 ± 430	L6e
UW3374	2.10±0.23	11.2	IRSL/uncorrected TL	BCE 80 ± 230	L6e
UW3375	1.53±0.23	14.9	Uncorrected TL	CE 490 ± 230	L6e
UW3376	2.11±0.26	12.1	OSL/corrected TL	BCE 90 ± 260	L6e
UW3905	1.78±0.22	12.5	Uncorrected TL	CE 240 ± 220	L4c

* The original report uses AC/BC for marking date

Table 3-5 Luminescence dating results of sediment specimens

Sample	Age (ka)	% error	Basis for age	Calendar date (years CE/BCE)	Excavation level
UW3370	2.57±0.44	17.2	Central age model	BCE 550 ± 440	L6e
	1.72±0.19	11.1	2nd component FMM	CE 300 ± 190	
	4.00±0.38	9.6	3rd component FMM	BCE 1980 ± 380	
UW3372	1.92±0.44	22.9	Minimum age model	CE 100 ± 440	L6e

* The original report uses AC/BC for marking dating

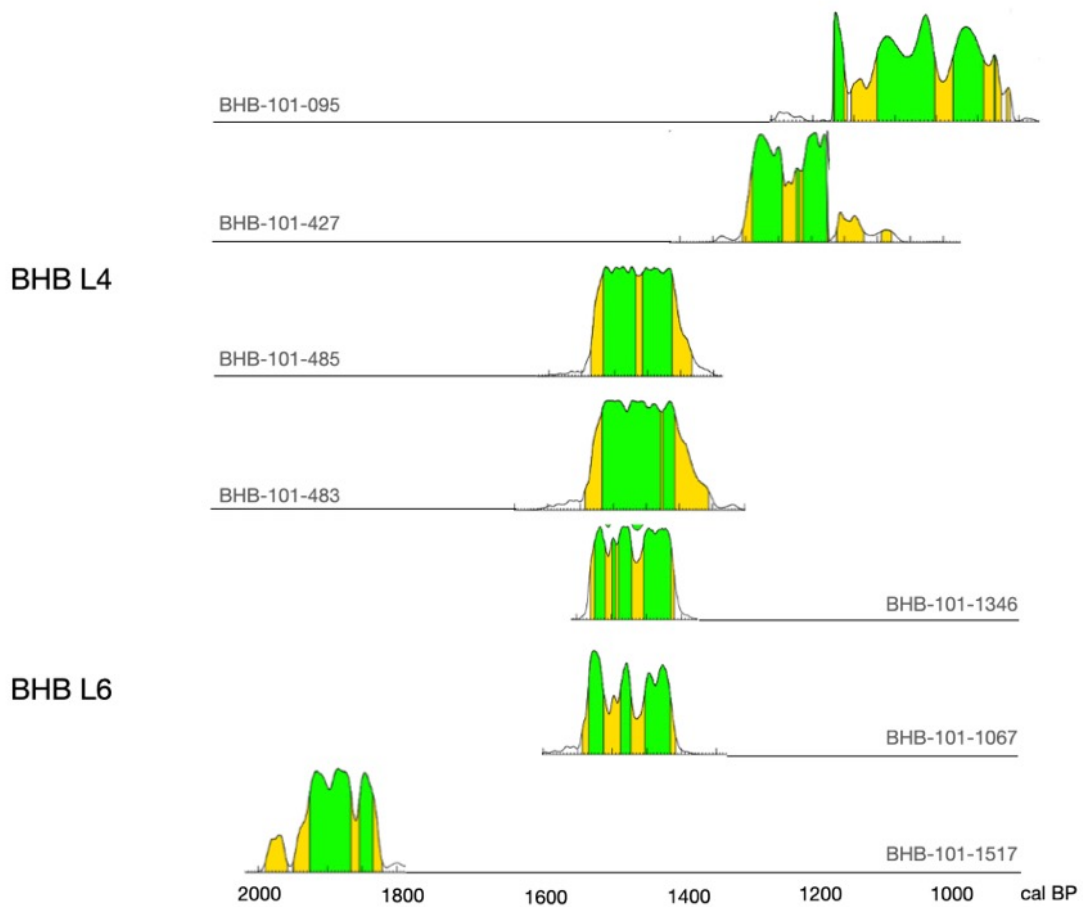


Figure 3-17 Calibrated dating of BHB L4 and L6. The L6 dating sample number is limited; hence there seems to be a gap between sample 1517 and 1067. However, the L6 deposit was continued, it is legit to presume that L6 people occupied the site without absence

3.3.3.4. Summary

The newly discovered BHB site yielded findings that match the SSH site findings, from scale to the similarity of material cultural. These two sites are relatively large in terms of the residential area and burial numbers that have been recovered. While the daily-used ceramic assemblages are slightly different, burial practices, burial goods, and metallurgical remains are pretty similar between the BHB site and the SSH site. While these two sites and the CD site were permanent settlements, we only know the iron ore source of the SSH site (within 2 km) and lack of iron ore sources of the CD and the BHB sites. Nevertheless, the SSH, BHB, and CD sites should belong to the third stage of the trade diaspora model because of the large number of recovered foreign materials and presumable iron production ability.⁵¹

I will conduct more detailed analyses on the ceramic and iron metallurgical remains in the following chapters to see if the BHB findings support the proposed research model.

Table 3-6 Updated table of material representation of each trade diaspora stage

Stage of Trade Diaspora	Sites and related cultural assemblages	Foreign material representation
First stage 2400-2100 BP	JXL (Sanhe cultural assemblage)	Glass and agate/carnelian beads, bronze and metal objects
Second stage 2100-1600 BP	SSH (SSH cultural assemblage SSH subset) BHB (unknown, newly excavated) HKS (Upper Huakangshan cultural assemblage) JXL (Sanhe cultural assemblage)	Glass and agate/carnelian beads, bronze and metal objects Metalworking remains
Third stage 1600-1200? BP	SSH (SSH cultural assemblage SSH subset) BHB (presumably SSH cultural assemblage Pulowan subset) CD (SSH cultural assemblage Pulowan subset)	Glass and agate/carnelian beads, bronze and metal objects Metalworking remains, and iron production remains

⁵¹ I will discuss more about this issue in the slag analysis chapter.

4. Identification of a Trade Diasporic Community: The Ceramic Analyses

In the previous chapter, I have summarized how scholars use multiple approaches to trace and identify ancient trade diaspora communities (Cohen 1971; Stein 1999, 2002; CHEN 陳伯楨 2014) using archaeological remains. Ceramics are one essential archaeological remain among these discussions. As the most abundant archaeological artifact category in the Taiwan archaeology context, ceramics are undoubtedly the primary data source for this project.

I analyzed a sample of ceramic specimens from the BHB site by technical typology (identifying technical process of ceramic-making tradition with the support from petrographic analysis). The L4 ceramic assemblage shows a solid link to the known archaeological cultural assemblage, the Shihshanghang 十三行 cultural assemblage Pulowan/Puluowan 普洛灣 subset; but it is hard to designate the L6 ceramics to any known archaeological cultural assemblage. My analyses show that the ceramic-making traditions of the dominant ceramic types between L4 and L6 layer are distinctive. However, L4 and L6 ceramics do share similarities in terms of ceramic type and their raw material source. Both L4 and L6 ceramics show multiple raw material provenience by petrographic analysis of temper inclusions.

A high diversity of ceramic provenience may indicate frequent interactions between BHB people (both L4 and L6) and the other communities from northern to southeastern Taiwan. These long-distance connections are not so common in the Taiwan archaeology context and may indicate the intense interactions between BHB people and their neighbors (near and far away). Although I do not have a firmly conclusive result to support my proposed model by only the ceramic data, the data indeed shows some diasporic traits and partially fit my proposed trade diaspora model prediction.

4.1. Preliminary Observation on Ceramic Assemblage during Excavation

As described at the end of Chapter 3, the Blihun Hanben site contains multiple cultural layers that ranges from ancient times to modern days. To serve the purpose of this doctoral research,

here I only introduce the deposit in the ancient times. The upper archaeological layer⁵² (L4) ranges from 30 to 100 cm in terms of thickness and distributes from A1S to P4S (mostly 18m×20m pits). Piled stone structures are found in all excavation pits; these lithic structures configure several living platforms that are stepping down from northwest toward southeast. L4 dates from 1574 to 971 cal. BP. In L4, archaeologists discovered earthenware, lithic, faunal and floral remains, glass and agate beads, and metal artifacts. A piled stone building foundation, burial remains, and the remains of metallic pyrotechnology were also uncovered. One or several catastrophic landslides form L5. The thickness of L5 ranges from 500cm to 10cm from the northwest toward the southeast. Multiple sizes of rocks are all mixed in this layer, from a gigantic rock (5m in diameter) to silt. Beneath the cultural sterile L5 layer is the lower archaeological layer (L6). L6 dates from 1992 to 1600 cal. BP. The thickness of L6 ranges from 200cm to 20cm, and L6 has a similar category of artifacts with L4, but only very few metallic pyrotechnology remains were found. Among those rich artifacts, the total weight of ceramic is 9252.45kg (about 20,400 pounds). During the excavation, archaeologists have noticed the high diversity of ceramic 'types' and the differences of primary ceramic types between L4 and L6. The preliminary salvage report (LIU 劉益昌 et al. 2016) stated that the primary L4 ceramic ware is reddish-brown earthenware with fine sand temper, about 2 to 3 on the Mohs scale of mineral hardness, 3-5mm thick. This ceramic ware is decorated with paddle-impressed patterns. In addition to this primary ceramic ware, there are two grayish-black ceramic types (later I designate into the same ceramic ware in my classification system) in small quantity that have mostly been found in the burial context. One is Kueishan/Guishan 龜山 type with impressed anthropomorphic and animal motif pattern, and the other type is smudged and polished grayish-black pottery with incised lines and impressed hole circles and dots. Sherds are distributed evenly within L4, and most of the intact or refit-able pots are found in a burial context. The major L6 ceramic type is yellowish gray to dull yellowish-brown with coarse sand temper. The thickness of those sherds ranges from 3-8mm, and the hardness is about 2 to 3 on the Mohs scale. Fine clay slip can usually be observed on the pottery surface with paddle-impressed stripes

⁵² Recently, instead of prehistory 'deep history' is proposed, see Acabado and Hsieh (2020) for details.

and cord-marks. Kueishan type pottery and smudged-polished grayish-black pottery (similar to L4) have also been uncovered in the burial context of this layer (L6). The distribution pattern of sherds is similar to L4, evenly across the living space (inside of the building structures) and outside of building structures. The salvage excavation report concludes that the L4 remains seem to be the Shihshang Cultural assemblage Pulowan/Puluowan 普洛灣類型 subset. As for the L6 remains, although a few ceramics types are similar to Upper Huakangshan Cultural assemblage; currently it is hard to associate the L6 remains to any known archaeological cultural assemblage in Taiwan (LIU 劉益昌 et al. 2016).

4.2. Sampling Strategy

All the excavation pits (P1S, P2S, P3N, P3S...etc.) are the pillar locations of the Suao-Hualien Highway (Figure 4-1). While the salvage project team could only excavate the designated pillar locations, those excavation pits can be considered a sampling system throughout the whole site. This is why the salvage team could determine where the site core area is by the thickness of the cultural deposit and the quantity of remains.

The Institute of History and Philology (IHP) team has defined the 'core area' of the site as being between P1S and P3S pits. The core area means the concentration of archaeological remains, including ceramic, lithic, iron slag, building structures, and burials. Figure 4-1 shows the location of pits and quantity of unearthed ceramic by artifact boxes. P2S, as a single pit, yields the most ceramic remains (also the most for all other types of remains). Contained between these three pits, P2S and P3N is a natural landslide layer (L5) in between the upper (L4) and lower cultural layer (L6); hence, there is a sterile layer between the two cultural layers. In contrast, this sterile layer is very thin and only covers a partial area of P3S. During excavation, we encountered challenges in determining the layers in P3S. In that P2S and P3N have a clear boundary in between, I selected P2S and P3N as the primary source for ceramics analysis.

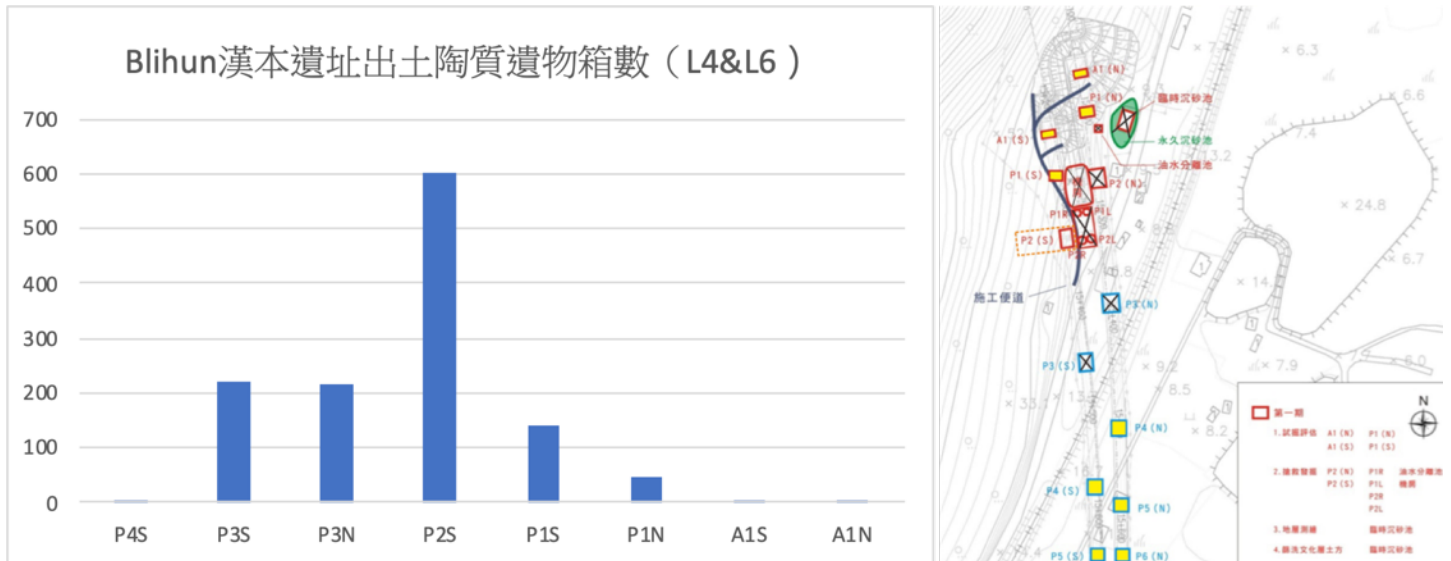


Figure 4-1 Left: chart of total box number of the ceramic remains for each salvage pit (sum of L4 and L6). Right: map of salvage pits. All salvage pits were the designed location of the viaduct abutment. P2S marks by broken red rectangular line

P2S is an 18x20m² pit but yielded almost half the amount of the whole BHB ceramic assemblage; hence, a sampling strategy is necessary for this research scale. After reviewing the excavation records and discussing with the principal investigator of the salvage project, I chose all the ceramic remains from the T5P2 unit⁵³ in P2S pit (Figure 4-2) at all excavation levels to analyze. T5P2 is a 2x2m² unit in P2S with the thickest cultural deposit. In addition to the sherds from P2S pit-T5P2 unit, I also randomly selected one quadrant zone (1x1m²) from five designated excavation units (T7P2, T2P2, T4P4, T7P7, and T2P7, Figure 4-2) in each level. These five excavation units evenly spread across P3N pit.

Through these sampling processes, I have acquired the sampled ceramic specimens from P2S and P3N. The total weight of sampled specimens is about 110kg (242.5lb), approximately 12% of the whole ceramic assemblage. If by excavation pit, 8142 pieces (97.76kg) are selected from P2S, and 832 pieces (13.02kg) from P3N. While the sampled percentage seems small, the sampling strategy should allow me to extract representative ceramic data from those selected units in the site core area.

⁵³ For the grid coordinate system details, see chapter 3.

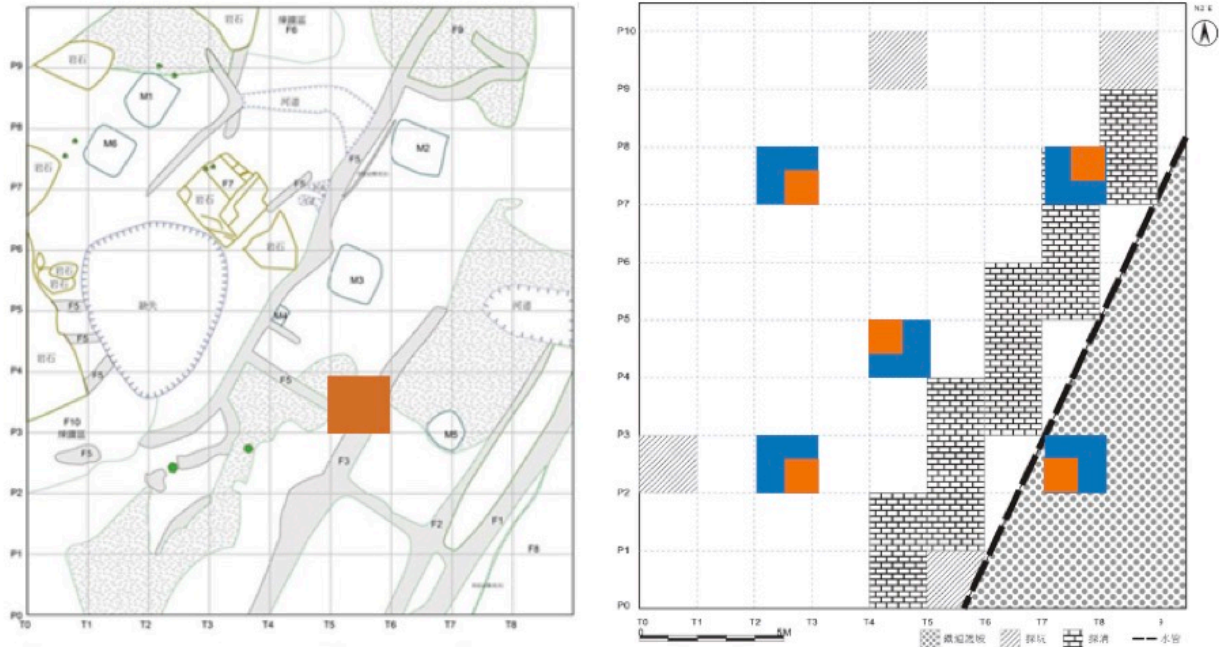


Figure 4-2 The grid coordinate system of P2S (left) and P3N (right) pit. Orange squares mark the excavation unit ($2 \times 2 \text{m}^2$) in P2S (left). I analyzed all ceramic specimens from this excavation unit. The five blue squares on the right (P3N pit) mark the designated excavation units where I applied randomizer for selecting quadrants ($1 \times 1 \text{m}^2$) in each excavation level. I analyzed the ceramic specimens from the selected quadrant in all excavation levels

4.3. Technical Typological Analysis

4.3.1. Principle

As one of the most durable materials that humans have ever created in ancient times, ceramics are used in various activities, from daily use, to industrial production and as burial goods. As such, a broken piece of ceramic, the sherd, can tell us much about its user and maker (Hunt 2016; Rice 1987; Stark, et al. 2000). Ceramics are also the most abundant remains in Taiwan archaeological context (except for the Paleolithic period), and Taiwanese archaeologists have applied different methods for examining ceramics and research questions.

In Taiwan, the early typological analysis mainly focused on morphology and surface decoration; other attributes like surface color and matrix texture were added with the development of research. Since the '90s, temper type has become an essential attribute when discussing ceramic provenience. In this research, I chose to add the concept of technical process (manufacturing sequence) to the established typological method. This concept reveals the embedded ceramic-making stages (Table 4-1) from visible attributes on the end-product and helps us understand the choices made by the potter; and may further distinguish the hidden social boundaries

between social groups (Roux 2016; Stark 1999; Stark et al. 2000). This method has been well developed and applied widely, but examining technical process of ceramic-making is fairly recent in Taiwan. Several recent studies have shown the potential of this analytic method (CHEN 陳瑪玲 et al. 2016; Favereau 2010; LIN 林宜羚 2009; WANG 王仲群 2017; WU 吳意琳 2017). I believe this method will also provide insights into my research question related to distinguishing different groups of people.

Table 4-1 Ceramic-making stages, related activities, and diagnostic attributes, adapted and modified from (Stark 1999)

CERAMIC-MAKING STAGES	ACTIVITIES	RELATED ATTRIBUTES
RAW MATERIAL PROCUREMENT AND PREPARATION	CLAY AND TEMPER COLLECTION	PASTE AND TEMPER
	PASTE PREPARATION: MIX COLLECTED RAW MATERIALS	PASTE AND TEMPER, MATRIX COLOR
SHAPE FORMING	PRIMARY FORMING: SLAB BUILDING, COILING, HAND FORMING	MATRIX MICRO-STRUCTURE: PORE SHAPE, TEMPER ORIENTATION...
	SECONDARY FORMING: PADDLING, WHEELING, TRIMMING	TRACES ON INTERIOR AND EXTERIOR SURFACES: IMPRESSIONS, HORIZONTAL-PARALLEL THIN LINES
SURFACE TREATMENT	SMOOTHING, SLIPPING, DECORATING	SLIP, DECORATION (METHOD AND PATTERN)
FIRING	OXIDIZATION, REDUCTION.	SURFACE COLOR, MATRIX COLOR
POST-FIRING TREATMENT	SMUDGING	SURFACE COLOR

4.3.2. Classification Workflow

All the ceramic specimens analyzed for this project were from the common cultural deposits, not from burial or feature contexts. Hence, specimens are mostly fragmented sherds, and it is hard to determine the original shape of the pot. Under such constraints, my typological analysis focuses on using temper, matrix texture, manufacturing technique, and decorative techniques for determining the technical tradition of ceramic-making of each type. Also, I have arranged the ceramic types into a sequence number based on these analytic attributes. In other words, ideally, the closer the two ceramic type numbers are, the more similar they are and the more shared attributes they have.⁵⁴ Therefore, certain ceramic types contain decimal numbers (e.g., type 11.9 is more similar to type 12 than it is to type 11). For this research, I have designed the following table (Table 4-2) as a data card to record the attributes, measurements, and additional

⁵⁴ This naming system makes the ceramic type more intuitive. However, there is still much room for improvement. Also, petrographic analysis has amended the basic classification results. See the petrographic analysis section for details.

information. ☐ Each data card is placed in the same bag with the same types of classified sherds that have been examined. This is to record and save the first-hand examination result for curatorial purpose, future studies, and future evaluation of my work.

There are four color-coded areas on the data card. Each colored area contains attributes with different kind information:

- The green area contains attributes with spatial information. For example, HB-101 P2S (excavation pit), T5P2 (excavation unit), L4b (second 10cm arbitrary level of L4 cultural layer), F4-L1 (level 1 of Feature 4), M1-L1 (level 1 of Burial 1).
- The purple area contains manufacturing attributes. Part stands for different part of ceramic, rim, neck, body, base, or foot ring for example. M-trace stands for manufacture trace, such as pore shape in matrix and anvil impression. B-color stands for the matrix color. Ex/In Slip stands for exterior and interior slip, and their color. And finally, the decal tech/motif stands for decorative technique and motif, for example, paddle-pressed vein pattern.
- The orange area contains counts and measurements. For thickness measurement, one random sherd will be selected from the same classified ceramic pile (from the same provenience, same level bag). One thickest, one thinnest, and one random point are measured for calculating an average thickness from these three measurements. For the length (Rim/Foot-L) and height (Rim/Foot-H) of the mouth rim and the foot rim, two points will be measured on the opposite side of the sherd, and an average measurement will be recorded. As there are four columns for the decal technique, motif, and orange-marked attributes, up to four decoration techniques and motifs can be recorded on the same card (in case of multiple decoration techniques and patterns within the same forming technique).
- The yellow area contains information like typological designation (type) and serial number (SN).

Table 4-2 The data card with classification attributes (see previous page for detailed description of each attribute)

HB-101 P	SN:			Type:
T P	Part:			
L	M-trace		B-Color	
F L	Ex / Slip		In / slip	
M L	Misc.			
Decal Tech				
Decal Motif				
Number				
Weight				
Thickness-1				
Thickness-2				
Thickness-3				
Thickness-4				
TH-Average				
Rim/ Foot-L				
Rim/ Foot-H				
Rim/ Foot-R				
Misc.				
Analyst		Date		

During fieldwork, all ceramic remains are collected by their spatial location (the green attributes); in other words, those ceramics in the same level bag share the same spatial location (to the basic excavation unit). Specimens are examined by naked eye and magnifying glass and then been sorted into different types based on the attribute observation.⁵⁵ Essentially, these analytic attributes have no hierarchical relationships, and not a single attribute is the most important or the least important.⁵⁶ As typology is a subjective product for serving specific purposes in archaeological research (Adams and Adams 1991:5-6, 157), typological system should be redesign for specific purpose and research question. Hence, to carry out the

⁵⁵ The examination was carried out by me and Ms. 莊詩盈 CHUANG, Shih-Ying who was the salvage excavation project assistant, however, I basically review all the works done by Ms. 莊. After classification, the specimens are counted, and measured by part-time colleagues. I sincerely thank them for their work and help.

⁵⁶ In practice, it will be extremely difficult to curate and manage without a hierarchical system. Table 4-2 is designed for serving both for research and curatorial purposes.

typological process of this doctoral research, the technical attributes, like matrix texture and manufacturing traces, have a higher hierarchical status than decorative technique and pattern. Instead, attributes like color, thickness, and rim size are not essential to this research. However, those less-doctoral research related attributes have also been examined and recorded to fulfill the requirement by the law and the request from the BHB salvage project team. I have promised the project director that I will carry out a detailed analysis and share information for the salvage team to compose the project report.

In sum, to examine the technical process of ceramic-making (Table 4-1), I classified the sampled BHB ceramic specimens into different types by a hierarchical order of temper, matrix texture, manufacturing technique, decorative techniques, then surface treatments and firing atmosphere (decorative pattern and color), and thickness. The classified types are then lumped into the same 'ware,' when types share the same raw material provenience and forming techniques. The lumped wares should serve the analytic purpose of my research question, distinguishing different groups of people.

In short, I classify the L4 specimens into sixteen ceramic types and then designate these types into seven wares. L6 specimens have seven wares from seventeen ceramic types. L4 Ware C (type 3, 4, 5, and 6) is the dominant ware in the upper layer in terms of quantity. Ceramic surface color ranges from orange to dull yellowish-brown. As for the L6 lower layer, the dominant ware is Ware A (type 0.9, 1, and 2). The surface color is mainly yellowish gray. The dominant ceramics from the L4 layer can also be found in L6 as the minority type (in terms of quantity), for example, type 10 and 11 in L6 are type 5 and 6 in L4, and this pattern is vice-versa in L6.

Regarding the decoration technique and pattern, cord-marking and paddle-pressing are two primary techniques, and there are at least seventeen major motif patterns with multiple sub-types for each pattern.⁵⁷ The dominant patterns in L4 include CD (cloud), G (geometric), and S (square/grid); in contrast to L4, CM (cord-marked) is the only dominant pattern for L6. Other than these dominant ceramics, in both upper and lower layer, a kind of grayish-black pottery (type 11.9 and 12) is few in quantity but quite distinguishable regarding their manufacturing

⁵⁷ See appendix for motif patterns.

technique and decoration pattern. These grayish-black ceramics are mostly found intact in the burial context. These black pots are usually fully polished on the exterior surface but with clear concave traces or figure impressions on the interior surface. The decorative techniques of black pottery are mainly incising, dotting, and impressing (especially those with anthropomorphic patterns, Kueishan style ceramic). The designs are usually dots, lines, and waves. The total sherd count of Type 11.9 and 12 is small in the common cultural layer but abundant in burials.

One thing worth to mention is, the prime attributes of ceramic analysis vary in different regions in Taiwan.⁵⁸ For example, on the western side of Taiwan, quartz sand, sedimentary and slate lithic fragments are the primary temper material. If only by mineral or rock type, it is challenging to determine the source of temper. However, surface decoration pattern is known to be an ideal attribute to distinguish ceramic from different archaeological cultural assemblages in western Taiwan at current research state.⁵⁹ In contrast to western Taiwan, the geological environment is quite complex in the east; various kinds of rocks can be found, from igneous rocks to metamorphic rocks. During the excavation, we also have noticed the high temper type diversity in the ceramic assemblage.

⁵⁸ Personal communication with CHAO Ching-Yung.

⁵⁹ There has not been any trial for using technical typology to examine the archaeological ceramic assemblage from southwestern Taiwan yet.

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4.3.3. Results of L4 Upper Layer

The sampled L4 specimens are classified into sixteen types and can be collapsed into seven wares. Overall, ceramic types in the same ware share the same kind of temper, matrix texture, forming technique, and decoration technique but are different in other attributes. Here are the details of these seven wares.

4.3.3.1. *Ware A*

Ware A has only one ceramic type (type 0) with fine-grain sandy clay texture matrix. The ceramic thickness ranges from 3.3 to 7mm, and the average is 4.8mm. The matrix color is grayish bright brown (Hue 7.5YR 5/6). There is no clear laminated structure for the matrix fabric, but some narrow thin pores parallel to the ceramic surface (Figure 4-3). The temper proportion is less than 5% but evenly distributed in the matrix. The temper sorting is good and are fine-grain whitish mineral and lithic fragments. Very fine mica fragments can also be observed in the matrix. The ceramic exterior surface is smoothed before the drying process and is coded with dull yellow orange (Hue 10YR 6/3) slip. In contrast, the interior is not smoothed, and some beating anvil impression can still be seen. The interior color is identical to the exterior. As for the surface decoration, paddle-impress with vein, cloud, wave, square, circle, and weaving pattern. The total weight of this type is about 1.2% in the sampled specimens.

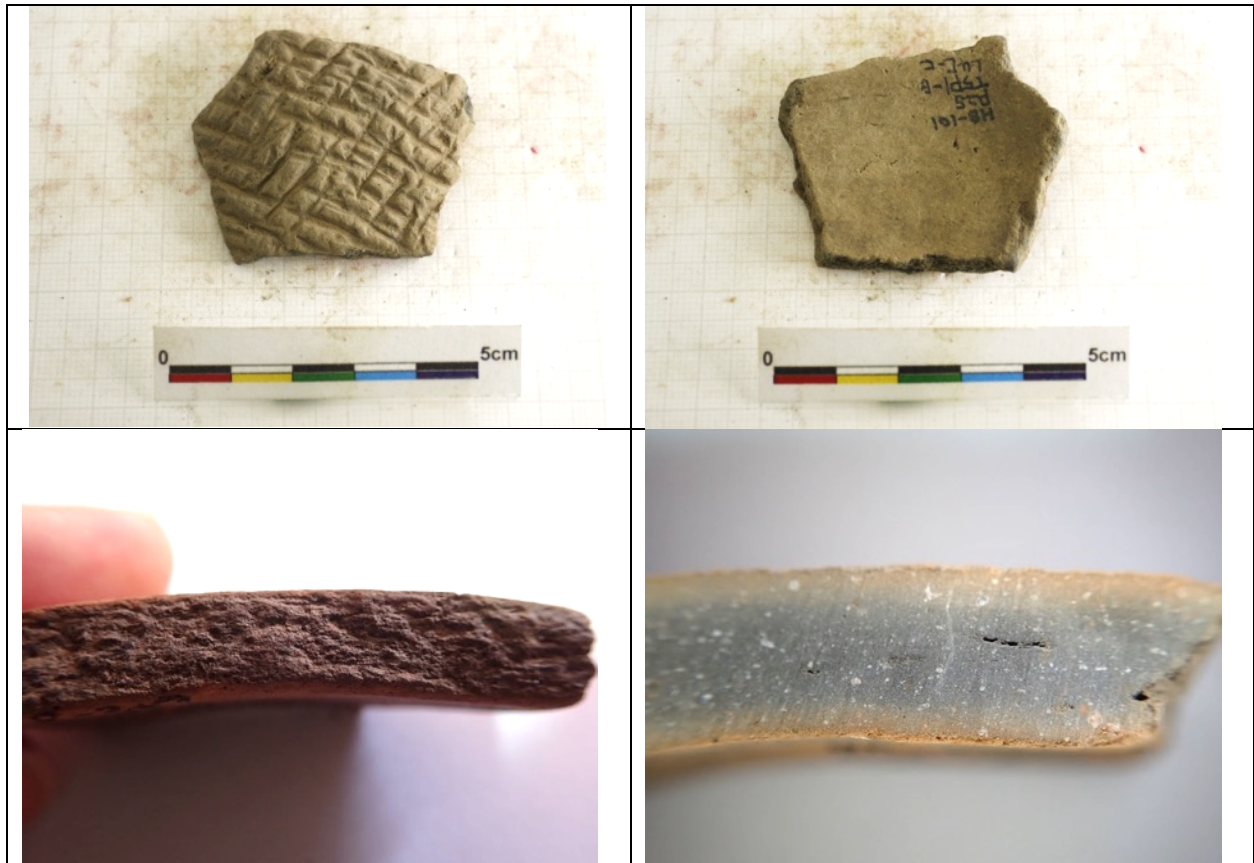


Figure 4-3 L4 Type 0. Upper left: exterior surface with slip and impressed motif; upper right: interior surface, two beating anvil impressions can be observed in the upper and lower part of this sherd; lower left: cross-section broken by hand, slightly laminated; lower right: cross section by cut shows slipped surfaces, thin pores, and whitish minerals

4.3.3.2. *Ware B*

There are two fine-grain sandy clay ceramic types (type 1 and 2) in this ware. The difference between these two types is the temper sorting; type 3 is slightly less sorted than type 2. The ceramic thickness is around 3 to 6mm, and the average is 5mm. The matrix color is bright brown (Hue 7.5YR 5/6). A few underfired matrix areas are grayish or grayish yellow. A semi-laminated structure can be observed in the cross section, some thin and narrow pores parallel to the ceramic surface. The temper proportion is less than 5% but evenly distributed in the matrix. Temper sorting is good, smaller than 1mm; and a few reflective black igneous minerals and lithic fragments can be seen. Numerous fine golden mica fragments evenly distribute in the matrix and on the surface. The shining golden mica is the signature characteristic of this ceramic ware. Beating anvil impressions are clear with about 20-30mm diameter. On the neck and rim, there are clear horizontal parallel lines which indicate the wet-smooth technique. The ceramic surface texture is delicate, but no slip is observed, and the color is about dull orange (7.5 YR 6/4). Stripes lines were paddle-impressed on the surface, and some specimens have cloud, square, and geometry patterns. The weight of these two types (Ware B) is about 9.1% of the sampled specimens.



Figure 4-4 L4 Type 1. Upper left: impressed stripe lines on the exterior surface; upper right: interior surface, a few golden reflective minerals can be observed on the surface; lower left: cross section broken by hand, slightly laminated; lower right: cross section by cut shows a homogenous matrix

4.3.3.3. *Ware C*

Four ceramic types (type 3, 4, 5, and 6) belong to this ware, and all are fine-grain sandy clay ceramic. The differences between these types are thickness, temper quantity, and decoration location. For example, only type 4 and 5 have decoration pattern in the interior. The thickness is around 2-6mm, and the average is 4.5mm. The matrix has a mix of sandy and silty texture; the silty texture is noticeable, especially when rubbing the sherd surface. The matrix color is grayish yellow brown (Hue 10 YR 6/2). There is no laminated structure in the matrix cross-section, but a few long and thin pores sometimes do not parallel the ceramic surface. On the interior surface impressions from anvil beating (usually less than 20mm in diameter) and hand-traces are clear. The temper proportion is less than 10% in the matrix. Whitish mineral, mica, and schistosity texture lithic fragments are evenly distributed in the matrix, and no igneous mineral is observed. The temper sorting is good and smaller than 0.5mm. No slip is observed on the ceramic surface, and the surface color ranges from dull yellow orange to grayish yellow brown (Hue 10YR 6/4 to 10YR 4/2). Paddle-impressed vein and cloud are the two major patterns of surface decoration. Square, striped, circular, and geometric patterns can also be observed. The quantity of mica fragment, texture, and average thickness are different between the ceramic types. For example, type 5 and 6 contain more mica fragments than type 3 and 4, and the average thickness is thinner. Ware C contains the primary ceramic types of L4 upper layer, 56.4% of the sampled specimens' weight. Some heavily burned ceramic sherds of this ware are found in the metallic pyro-technological remains. I will discuss those burned sherds in the following chapter about ironworking remains.

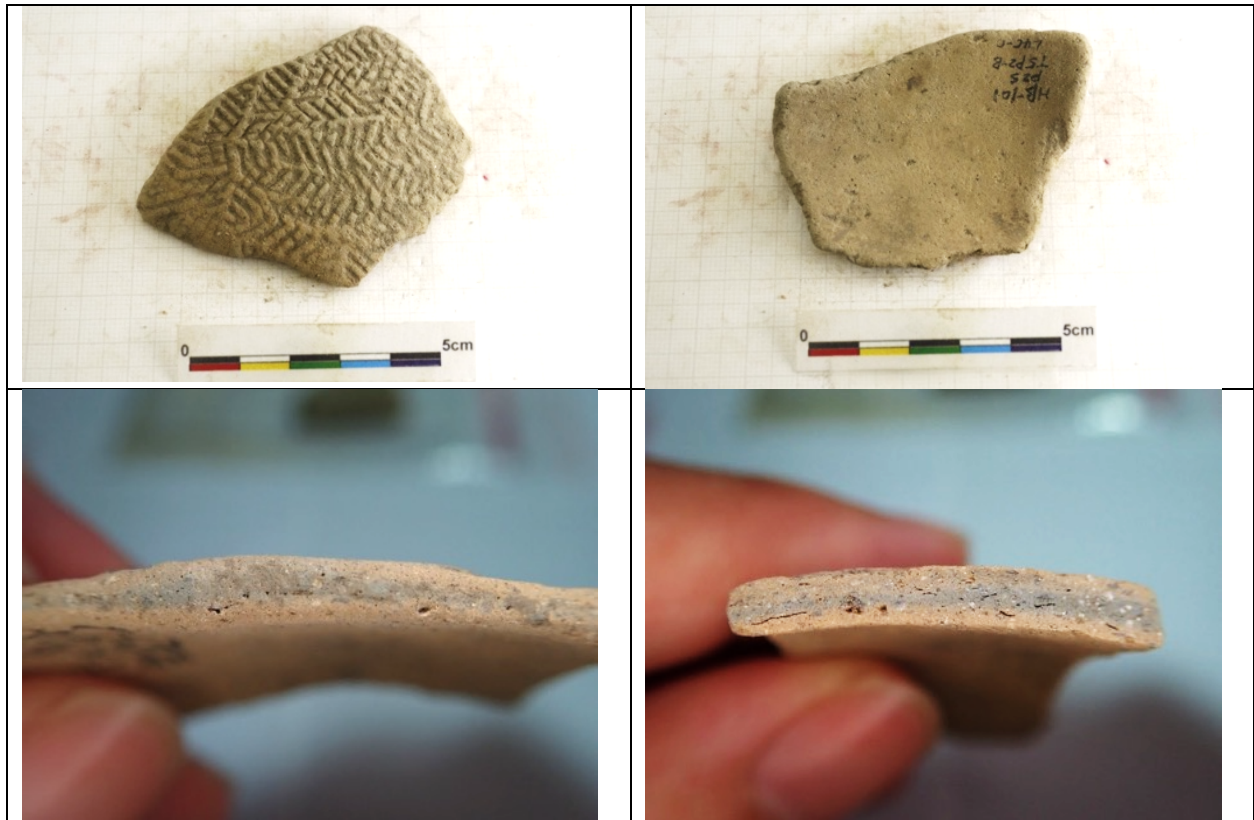


Figure 4-5 L4 Type 5. Upper left: exterior surface impressed vein motif; upper right: three anvil impressions can be seen on this interior surface; lower left: cross section broken by hand, a few pores. Notice the curved impression from anvil beating; lower right: cross section by cut shows many voids, whitish minerals, and different colors between surfaces and matrix

4.3.3.4. *Ware D*

Ceramic types 7 and 8 are in the same Ware D. Type 7's fabric has a sandy texture, and type 8 has a fine-grain sandy. Temper composition is the same, but the temper quantity proportion and body thickness are different. Type 7 thickness ranges from 2 to 4mm, and type 8 is 4 to 8mm. The matrix color is grayish yellow brown (Hue 10 YR 6/2). Relatively large schistosity texture lithic fragments (2-4mm) temper can be observed, and the proportion is also relatively high in the semi-laminated matrix, in type 7 is around 20 to 35% and 40 to 55% in type 8. Narrow and thin pores are unevenly distributed in the matrix. Slip on the surfaces (dull yellow orange Hue 10YR 6/3) is fragile and has a powdery texture to the touch. On the uneven interior surface, shallow traces of figure impressions can be observed; some smaller sized vessels (observed by the sherd curve) have more clearer figure traces (Figure 4-6, upper right). As for the surface decoration, paddle-impressed veins, weaving, stripes, and square patterns are observed. The weight of this ware is 5.5% of the sampled assemblage.



Figure 4-6 L4 Type 7. Upper left: exterior surface shows paddle-impressed zig-zag motif; upper right: figure impressions are clear on this interior surface; lower left: cross section broken by hand shows a few pores in the matrix and around the temper; lower right: cross section by cut shows the temper size (darker gray) and also the soft and crumble texture of both surfaces

4.3.3.5. *Ware E*

This ware consists only of type 9, a coarse-grain sandy clay ceramic. The thickness ranges between 5-7mm, and the average is 5.5mm. There is no clear laminated structure in the matrix (grayish yellow brown Hue 10 YR 6/2), but a few pores developed around the temper inclusions and some parallel to the surface. There is no trace of beating anvil impression and hand-making marks. The temper is mainly dark brown and grayish-black schistosity textured lithic fragments. The sorting is poor, and the temper diameter ranges from 1 to 5mm, with a few 10mm in length inclusions. The proportion of temper in the matrix is about 40 to 55%. Dull yellow orange (Hue 10YR 6/3) slip was applied to both the interior and exterior surfaces. The slip has a powdery texture and is mostly eroded. Paddle-impressed weaving pattern is the main surface decoration. This type is scarce in the L4 upper layer and only weighs about 0.1% of the sampled assemblage. This ware is similar to L6 Ware A.



Figure 4-7 L4 Type 9. Upper left: this exterior surface shows an incised-like motif, quite unique for Type9; upper right: smoothed and slipped interior surface. Also, a relatively colossal temper can be seen on the surface (above the black ink coding); lower left: cross section broken by hand shows some different sizes of voids in the matrix and around the temper; lower right: cross section by cut shows the temper size (light gray, white, rectangular, and semi-rounded) and also the soft and crumble texture of both surfaces

4.3.3.6. *Ware F*

Three ceramic types (types 10, 11, 12) are in this ware, and all of them are fine-grain sandy clay ceramics. The thickness ranges from 3 to 7mm, and the average is 4.4mm. The ceramic color ranges from grayish black to black (Hue 10YR 2/1-3/1). The matrix texture is fine and delicate, and a certain extent laminated structure can be seen. A few long and thin pores parallel the surface. Clear traces of hand crafting can be observed on the interior surface. Some slab building joint traces can also be seen. The primary temper of this ware is very fine grayish-white lithic fragments; occasionally, 1-3mm fine sand can also be observed. The exterior surface is almost silky smooth, mostly preserved well. Based on the ethnographic studies (Longacre 1991), this kind of semi-reflective, smooth surface is created using pebble or leather to polish a dried clay surface. Smudging is one other method to create black ceramic other than the deoxidizing process. Incised lines, dots, and punctation circles are the decorative patterns on the exterior surface. Ceramic sherd in this ware is lightweight, hard, and tough; some almost feel like plastic products. Basically, type 12 is the finest in terms of craftsmanship and technique. Type 10 and 11 are similar to type 12 but less delicate. The weight of this ware is 18.5% of the sampled assemblage.

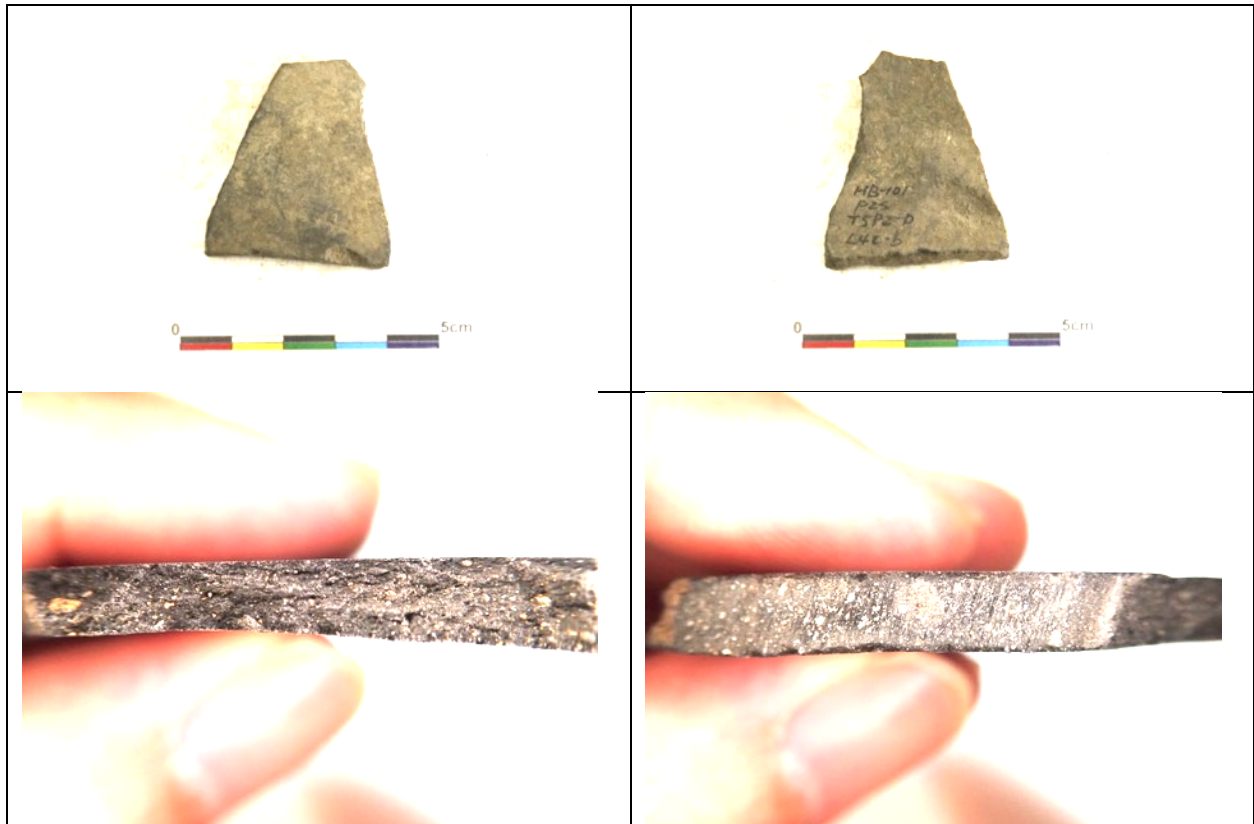


Figure 4-8 L4 Type 9. Upper left: smoothed and polished exterior surface but covered by fine dirt; upper right: the interior surface is quite uneven (not polished) and sometimes with figure impression traces; lower left: cross section broken by hand shows some different sizes and colors of temper. Laminated structure can be seen on this cross section; lower right: cross section by cut clearly shows the temper size and percentage in the matrix

4.3.3.7. *Ware G*

Type 13, 4.1, 4.2 are fine-grain sandy clay ceramics in this ware. The thickness ranges from 3-5mm, with the average being about 4mm. Some 10mm thick specimens (probably base parts) are also found. The matrix color is Hue7.5YR 5/6 bright brown that sandwiches a darker (brownish black Hue 7.5YR 3/2) middle portion, and the texture is compact, fine, and sandy. The matrix is slightly laminated with very few thin pores. The temper mostly consists of tiny (less than 1mm) whitish-gray lithic fragment and reflective black igneous mineral. The sorting of these evenly distributed tempers is good. A few workmanship traces can be observed on the interior surface. A very thin grayish yellow brown (Hue 10YR 5/2) slip (this may just be from water smoothing on the surface) was applied to both the interior and exterior surfaces; however, the surface texture is still sandy. Most of the analyzed specimens are plain without decoration.⁶⁰ The weight of this ware is 0.9% of the sampled assemblage.

⁶⁰ Type 4.2 is extremely similar to Type 4.1, only found when analyzing PSN ceramic assemblage. In my research, it could be classified in Type 4.1.



Figure 4-9 L4 Type 4.1. Upper left: plain exterior surface with sandy texture; upper right: the interior surface is similar to the exterior surface. A few figure impression traces may be observed on the bigger sherds; lower left: cross section broken by hand shows slightly laminated structure of the cross section; lower right: cross section by cut clearly shows the whitish temper and some tiny pores in the matrix

The primary forming technique of Ware A, B C, and D might have been coiling, and slab building for Ware F. The major means of secondary forming the L4 ceramic assemblage seems to have been either purely or by using a paddle to beat the ceramic on an anvil. Ware A, B, and C ceramics have clear traces of those anvil concaves on the interior surface. Also, Ware D ceramics have the deepest and most concentrated concave traces among all wares on the interior surface. Ware E ceramics are covered with relatively thick slip on both surfaces, and no anvil impression is observed. Ware F ceramics usually have figure impressions on the interior surface but sometimes not quite visible. Ware G has no clear shaping traces or only very shallow concaves on the interior surface.

For these wares that share similar secondary forming techniques, matrix texture (pores, sandy, or silty) and temper inclusion are two diagnostic attributes as the raw material procurement and preparation, and primary forming technique. For example, the tempers of Wares A, B, C, D and E are distinct, and the subsequent geophysical analysis basically support this macro analysis by naked-eye. As for the surface treatment, paddle-impression was the major technique among Wares A, B, C, D, and E. Ware E ceramics have the thickest slip. Incision and impression are two techniques for Ware F ceramic decoration.

Table 4-3 shows the summary of L4 results. Ware C has the most abundant ceramics. Paddle-impressed vein and cloud motif are the primary decorative method and pattern (Figure 4-10) in Ware C. Ware F is the black pottery that Liu refers to as the ethnic marker of metallic pyro-technological craftspeople (LIU 劉益昌 2010a, 2012) and quite distinctive from the rest of the wares.

Table 4-3 Summary of L4 ceramic ware attributes

WARE/TYPE	TEMPER	MATRIX	EX. SURFACE	IN. SURFACE	DECOR. MOTIF	WEIGHT %
A/0	FINE-GRAIN WHITISH MINERAL. LITHIC FRAGMENTS	SEMI-SANDY TEXTURE WITH NARROW THIN PORES	SLIPPED, SMOOTHED, GRAYISH BRIGHT BROWN (HUE 7.5YR 5/6)	BEATING-ANVIL IMPRESSIONS	PADDLE-IMPRESSED VEIN	1.2%
B/1 AND 2	REFLECTIVE BLACK IGNEOUS MINERALS	MOSTLY SEMI-SANDY TO SILTY TEXTURE WITH THIN AND NARROW PORES LAMINATED SECTION	FINE GOLDEN MICA FRAGMENTS, BRIGHT BROWN (HUE 7.5YR 5/6)	BEATING ANVIL IMPRESSIONS	PADDLE-IMPRESSED STRIPES LINES	9.1%
C/3, 4, 5, AND 6	WHITISH MINERAL, MICA, AND SCHISTOSITY TEXTURE LITHIC FRAGMENTS	SANDY AND SILTY TEXTURE WITH LONG THIN PORES	DULL YELLOW ORANGE TO GRAYISH YELLOW BROWN (HUE 10YR 6/4 TO 10YR 4/2)	BEATING ANVIL IMPRESSIONS, FIGURE TRACES	PADDLE-IMPRESSED VEIN AND CLOUD	56.4%
D/7 AND 8	LARGE SCHISTOSITY TEXTURE LITHIC FRAGMENTS	SEMI-COARSE SANDY TEXTURE WITH NARROW AND THIN PORES. SEMI-LAMINATED SECTION	SLIPPED. DULL YELLOW ORANGE HUE 10YR 6/3	SLIPPED, SHALLOW TRACES OF FIGURE IMPRESSIONS. DULL YELLOW ORANGE HUE 10YR 6/3	PADDLE-IMPRESSED VEIN, STRAW MAT, STRIPES, AND SQUARE	5.5%
E/9	POORLY SORTED DARK BROWN AND GRAYISH BLACK SCHISTOSITY TEXTURE LITHIC FRAGMENTS	COARSE SANDY TEXTURE WITH PORES DEVELOPED AROUND THE TEMPER INCLUSIONS	SLIPPED. DULL YELLOW ORANGE (HUE 10YR 6/3)	SLIPPED. DULL YELLOW ORANGE (HUE 10YR 6/3)	PADDLE-IMPRESSED STRAW MAT	0.1%
F/10, 11, AND 12	VERY FINE GRAYISH WHITE LITHIC FRAGMENTS	PLASTIC SURFACE TEXTURE. SEMI-SANDY AND SILTY TEXTURE WITH FEW NARROW PORES SLIGHTLY LAMINATED	SILKY SMOOTH, SLIPPED, POLISHED, SMUDGED(?). BLACK (HUE 10YR 2/1-3/1)	SMUDGED(?). BLACK (HUE 10YR 2/1-3/1). FIGURE IMPRESSIONS	INCISED LINE AND DOT, AND PUNCTATION CIRCLE	18.5%
G/4.1, 4.2, AND 13	TINY (LESS THAN 1MM) WHITISH GRAY LITHIC FRAGMENT AND REFLECTIVE BLACK IGNEOUS MINERALS	SANDY AND COMPACT TEXTURE. SLIGHTLY LAMINATED	VERY THIN GRAYISH YELLOW BROWN (HUE 10YR 5/2)	VERY THIN GRAYISH YELLOW BROWN SLIP	PLAIN	0.9%

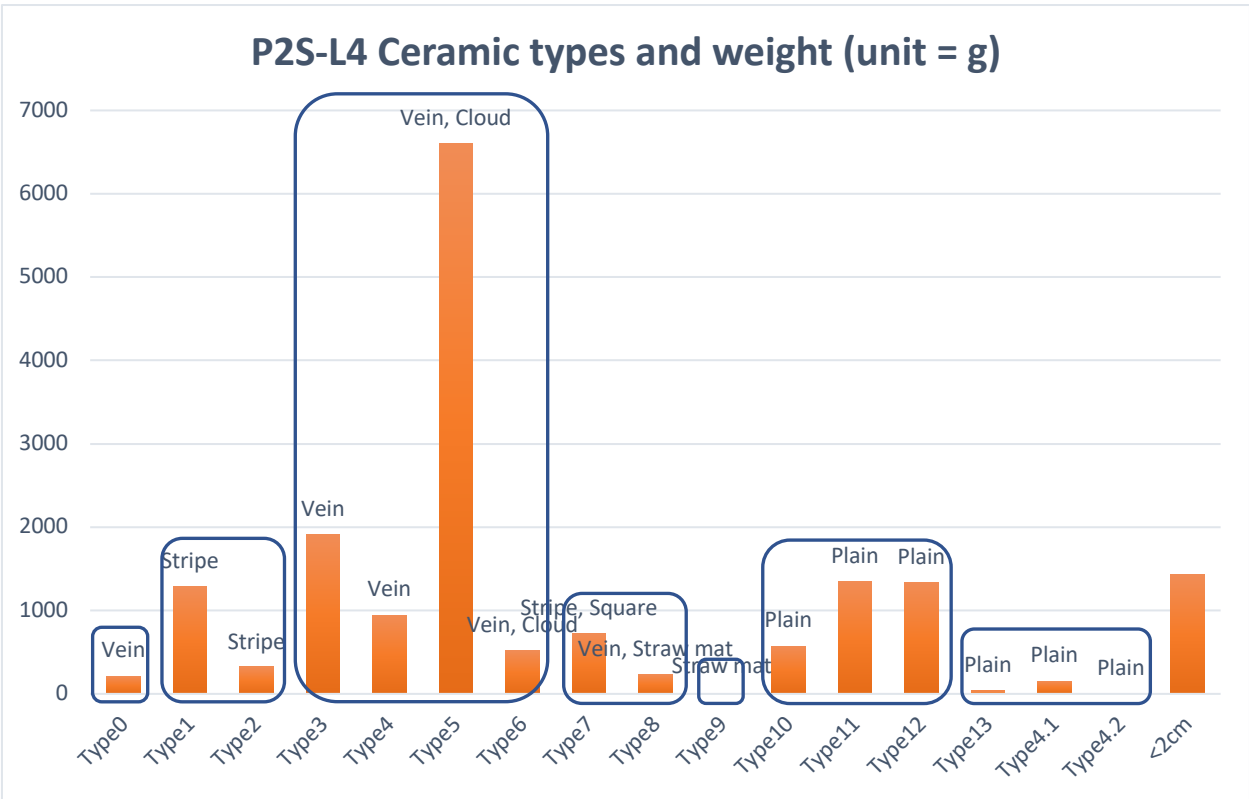


Figure 4-10 Chart of L4 ceramic types and their weight. The label(s) above each column show the major decorative motif in each type. Each rounded-rectangular area is one ware

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4.3.4. Results of L6 Lower Layer

4.3.4.1. Ware A

Three types of coarse, sandy clay ceramics (type 0.9, 1, 2) are in this ware. The common characteristics are their thickness and temper material, and the difference is the proportion of temper in the matrix. The thickness of these ceramics is 5-10mm, with an average around 6.4mm. The matrix is basically brownish gray (Hue 10YR 5/1) in terms of color and has a gentle laminated structure. A few pores can be observed, mostly around the tempers. Temper is dark brown and grayish black schistosity texture lithic fragments (Figure 4-11). Compared with the other types of ceramics from the L4 upper layer, the temper in the Ware A ceramics is large and more angular. Although a few oversized lithic fragments have been observed, most temper diameter is around 3 to 6 mm. The temper sorting is poor, and the temper proportion in the matrix is from 20 to 50%. The interior surface is mostly smooth and covered with slip. The exterior surface is also covered with dull yellow orange (Hue 10YR 6/4) slip, but the exterior slip has eroded more than the interior slip. Paddle-impressed stripes and weaving, and coarse cord-marked are the main patterns on the exterior surface. In addition to these two patterns, vein, square, and polygonal line patterns are also present. The weight of Ware A ceramic is 60.1% of the sampled assemblage, and these three types are the dominant ceramic types in the L6 lower layer. This ware is similar with L4 Ware E.

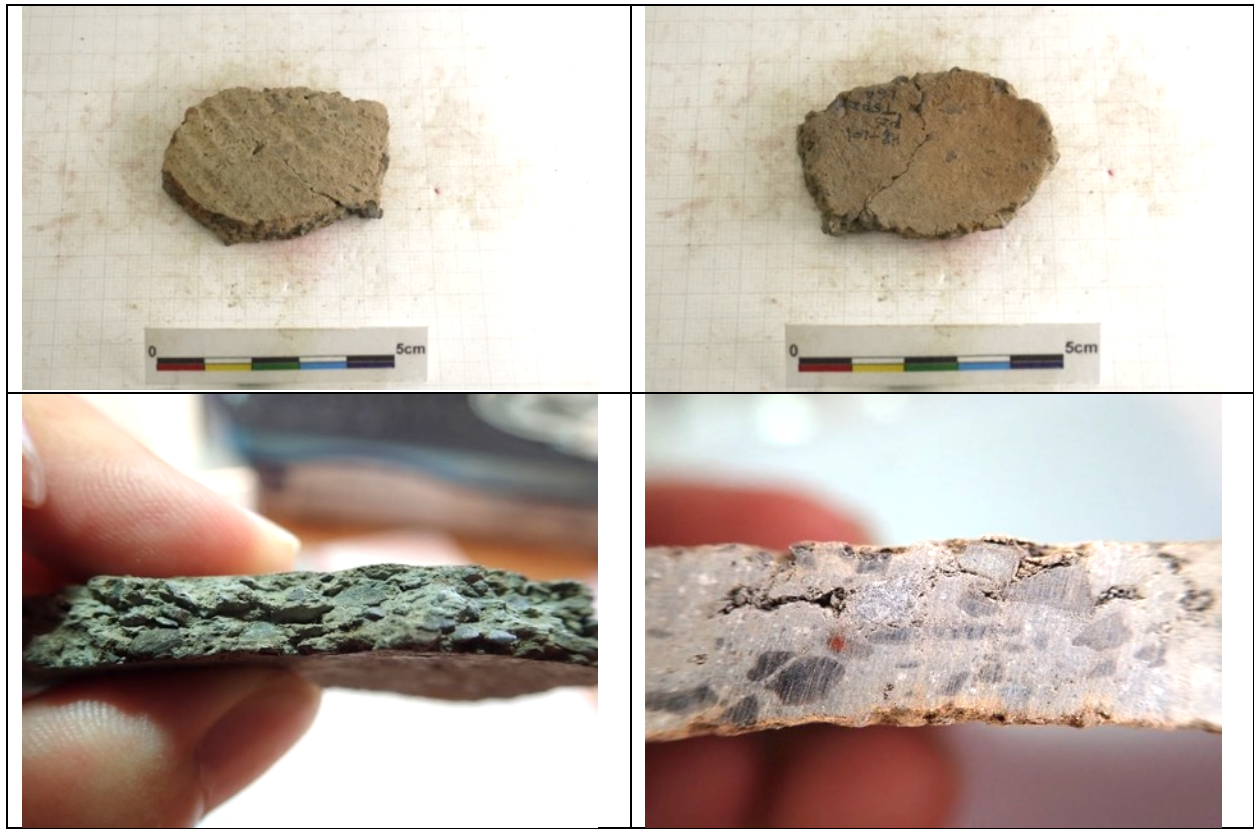


Figure 4-11 L6 Type 1. Upper left: slipped exterior surface with paddle-impressed stripe motif; upper right: the interior surface is also slipped; lower left: cross section broken by hand shows some different sizes of temper and laminated structure; lower right: cross section by cut clearly shows the poor sorting of temper and the voids around the tempers

4.3.4.2. *Ware B*

There are also three ceramic types in this ware (type 3, 4, and 4.1); all of them are coarse-sandy clay ceramics. All the attributes are similar, except for two types, Type 4 does not have white mineral tempers, and there are mica fragments and red paint on type 4.1. The thickness is from 5 to 9mm with an average of 5.9mm. The matrix is brownish gray (Hue 10YR 5/1), and the texture is quite compacted and slightly laminated. Both interior and exterior surfaces were smoothed and slipped, so almost no workmanship traces can be found on the interior surface. The temper proportion is around 10% of the matrix, and is composed of semi-rectangular grayish black schistosity texture lithic fragments (2-3mm). In addition to the semi-rectangular inclusions, eroded whitish lithic fragment and mineral are evenly distributed in the matrix and can also be observed on the surface. The applied slip color is a dull yellow orange (Hue 10YR 6/4). The exterior surface is basically decorated with coarse cord-marked stripes. The depth of these cord-marked stripes ranges from 3 to 5mm which is not common compared to the ceramics from other archaeological cultural assemblages. Other surface decorative patterns, like weaving, squares, and veins are fewer in terms of quantity. Ware B sherds are generally large and thick with lower curvature, presumably broken from large vessels. The weight of Ware B specimen is 21.5% of the sampled ceramics.

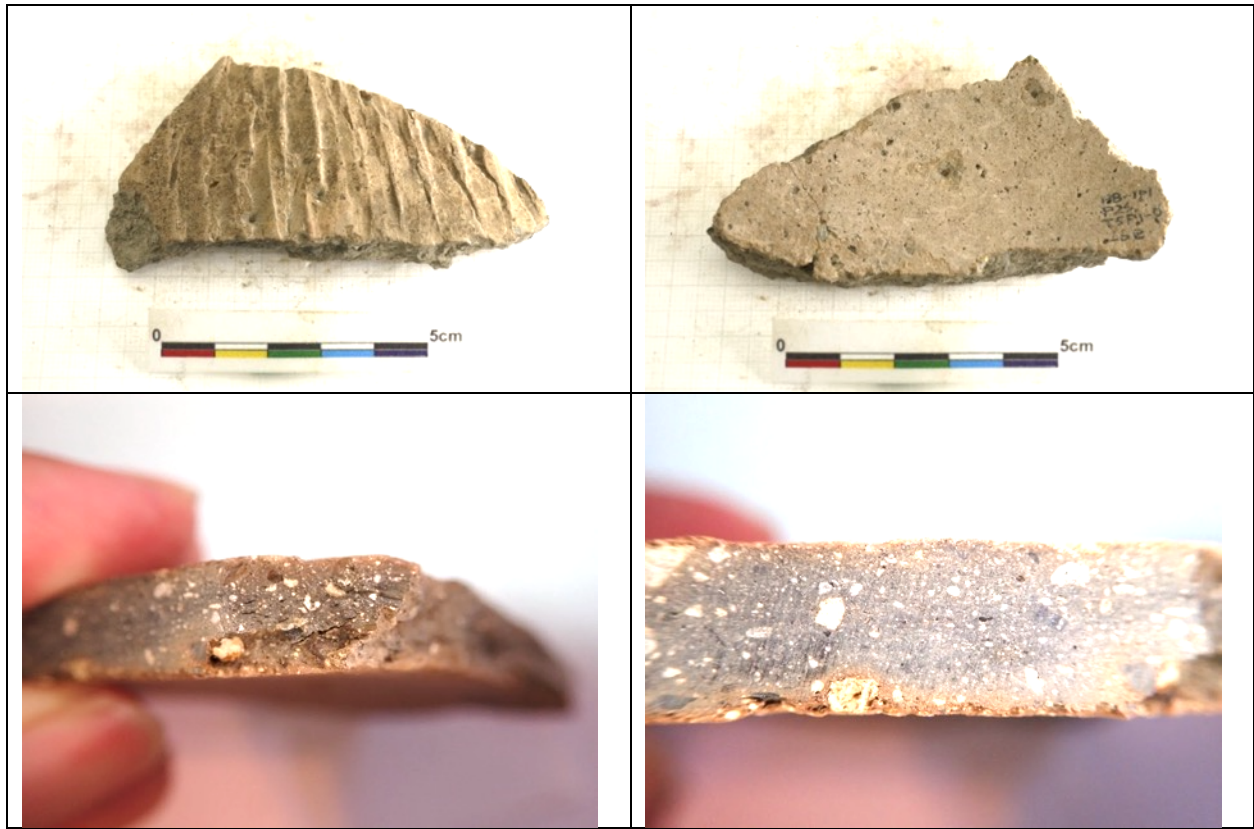


Figure 4-12 L6 Type 1. Upper left: slipped exterior surface with paddle-impressed stripe motif; upper right: the interior surface is also slipped; lower left: cross section broken by hand shows some different sizes of temper and laminated structure; lower right: cross section by cut clearly shows the poor sorting of temper, two kinds of temper, and the voids around the tempers

4.3.4.3. *Ware C*

There are two types (type 5 and 6) of sandy clay ceramics in this ware. The major differences between these two ceramic types are surface color and thickness; one is dull orange (Hue 7.5 YR 6/4) and the other one is grayish brown (Hue 7.5 YR 5/2). Most of the sherds are thin and brittle. The sherd curvature is relatively high; hence the original vessel might be relatively small in the whole pottery assemblage. The matrix is medium-fine with semi-laminated texture (color Hue 10 YR 5/1 Brownish gray). A few thin pores can be observed. Finger impressions can be seen on the interior surface. The temper sorting is poor, and the size ranges from fine whitish mica and black schistosity lithic fragments to 3mm white mineral and black schistosity lithic fragments. The temper proportion in the matrix is around 10 to 15%. Both interior and exterior surfaces are coded with slip. The powdery texture of the slip may have been caused by the weathering process. Also, carbon smudge traces are typical on both interior and exterior surfaces which may indicate a baking purpose of these ceramics. Paddle-impressed vein is the primary decorative pattern; some other patterns are grids, stripes, weaving, and polygonal lines. The weight of Ware C specimen is 4.7% of the sampled ceramics.

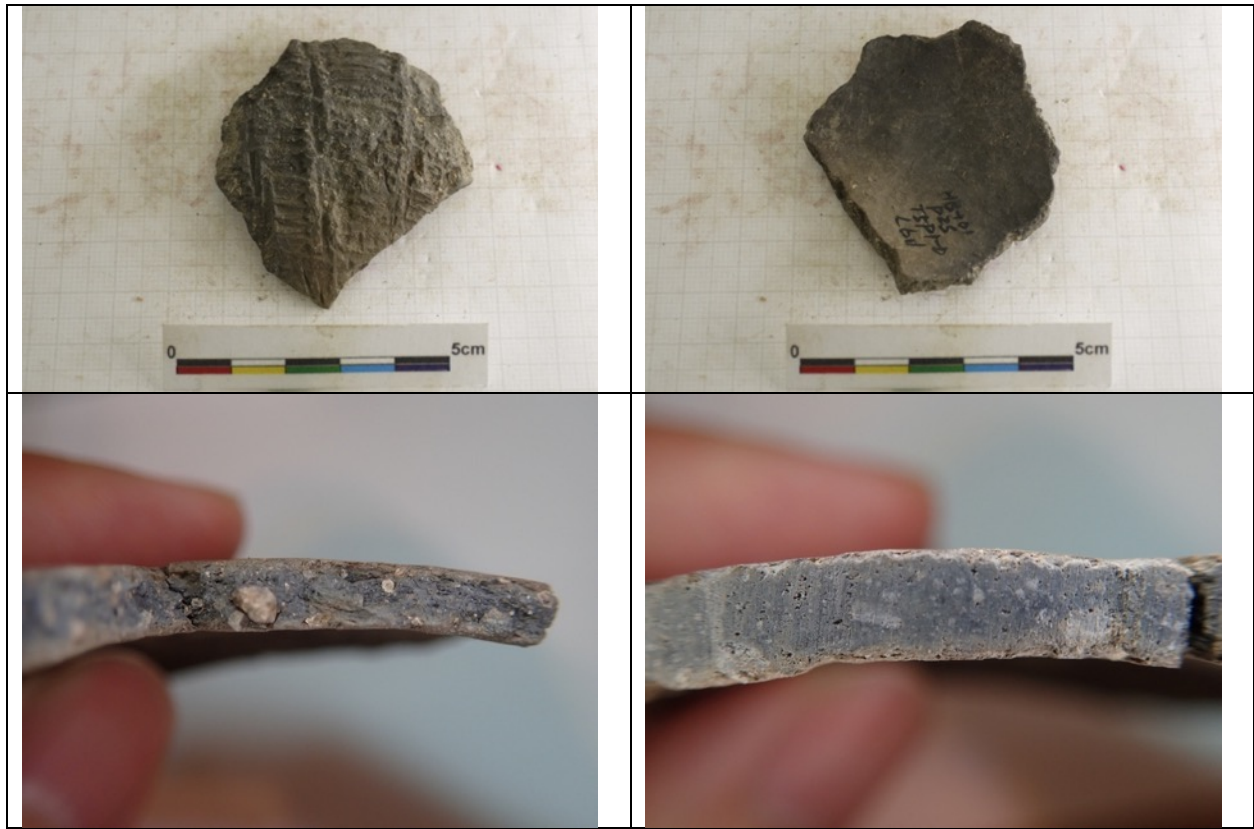


Figure 4-13 L6 Type 6. Upper left: exterior surface with paddle-impressed stripe motif; upper right: the interior surface is also slipped; lower left: cross section broken by hand shows some different sizes of temper and laminated structure; lower right: cross section by cut clearly shows the poor sorting of temper, two kinds of temper, and the voids around the tempers

4.3.4.4. *Ware D*

This ware consists of type 10 and type 11; the former is silt clay ceramic, and the latter is sandy clay ceramic. The sherd thickness ranges from 3.5 to 6mm with an average of 5.1mm. The matrix color is primarily gray, and the body color ranges from gray to brownish gray (Hue 10 YR 6/1). The overall texture of type 10 is chalky but sandy for Type 11; there is no laminated structure, and only a few pores can be observed. Well-sorted whitish minerals evenly distribute in the matrix as temper, and the temper size is usually under 1mm. Mica fragments also evenly distribute on the surface. Type 10 exterior surface usually coated with dull orange (Hue 7.5 YR 6/4) slip but not type 11. Workmanship impressions can usually be seen on the interior surfaces of both types. Paddle-impressed veins, grids, and stripes are the decorative patterns, and a few stamped circles are also present. The specimens weigh about 2% of the sampled ceramics. Type 10 in this layer is almost identical to type 3 in the L4 upper layer, and type 11 is identical to type 5 of L4. One thing worth mentioning is that the paddle impressed pattern on the 'interior surface' has only been observed on these two identical L4 type 5 and L6 type 11 ceramics.

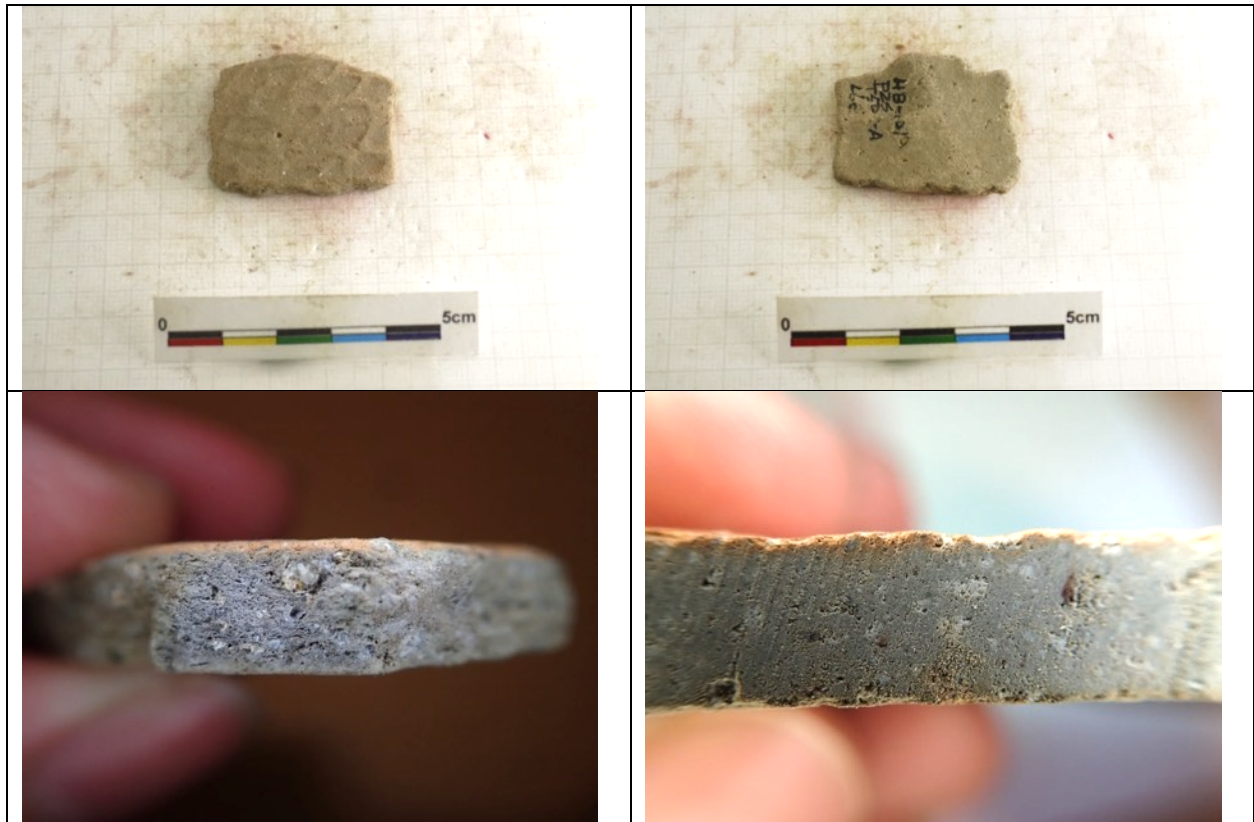


Figure 4-14 L6 Type 10. Upper left: exterior surface with paddle-impressed motif; upper right: the interior surface with beating anvil impressions; lower left: cross section broken by hand shows some pores but no laminated structure; lower right: cross section by cut clearly shows the whitish tempers and a few pores

4.3.4.5. *Ware E*

Type 7 is sandy clay ceramic with a thickness ranging from 5 to 10mm and an average of 7mm. The matrix color is brownish gray (Hue 7.5YR 5/1), and it has a gentle laminated structure. The ceramic interior surface is usually uneven, with clear workmanship marks and traces. The temper proportion in the matrix is less than 10%. Whitish rounded minerals, with a 0.5 to 2mm diameter, are the primary temper material. A few fine-grain mica fragments and black schistosity lithic fragments distribute evenly and sporadically. Both interior and exterior surfaces are coded with slip, but only the exterior surface is smoothed and semi-polished. The surface treatment of this type is quite similar to L4 Type 12 and L6 Ware F; however, the polished surface and slip quality are slightly poor compared to L4 type 12. The texture of the surface treatments feels silty and easily susceptible to being scratched off the ceramic surface. The slip color is usually brownish black (Hue 5YR 3/1-2/1) on the exterior surface and dull orange to dull reddish brown (Hue 5YR 6/3-4/3) on the interior surface. It is mostly without surface decoration, having only a few paddle-impressed stripes, veins, and polygonal line patterns. The quantity is low, only 0.4% of the sampled specimens in terms of weight.

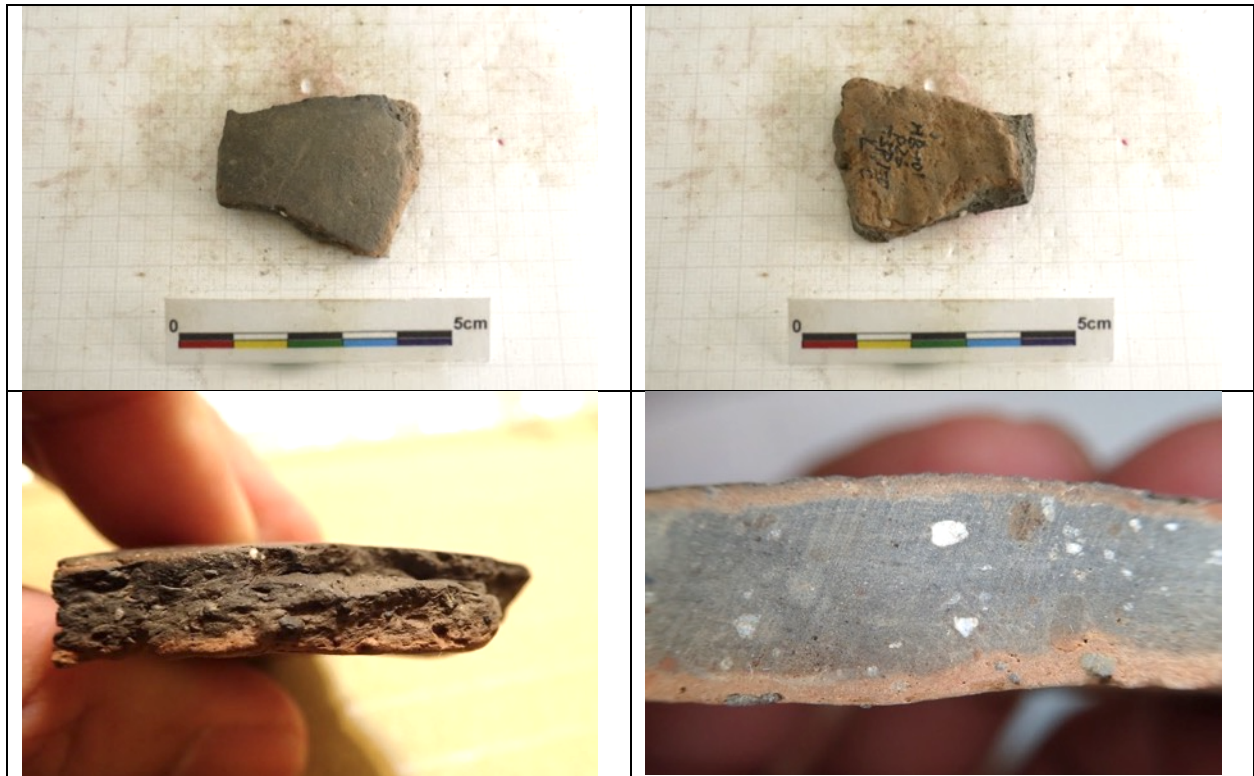


Figure 4-15 L6 Type 7. Upper left: exterior surface with a layer of black slip; upper right: the uneven interior surface with figure impressions; lower left: cross section broken by hand shows the semi-laminated structure; lower right: cross section by cut shows the whitish tempers. One unmistakable feature of Type 7 is the 'sandwich' structure of matrix color having two orange layers on both surface sides and a gray matrix body in the middle

4.3.4.6. *Ware F*

Ware F consists of three types of silty clay ceramic (types 8, 11.9, and 12). The major difference between these three types is the surface color. Type 8 is orange (Hue 7.5YR 6/6)⁶¹; type 11.9 and type 12 are brownish black (Hue 10YR 3/1) to black (Hue 10YR 2/1). The ceramic thickness ranges from 3 to 5mm with an average of 4.6mm. The matrix color is dark gray to black with a fine texture. It has a semi-laminated structure with a few long-thin pores that parallel the sherd surface. The overall texture is light in weight, hard, and tough; some almost feel like plastic. Hand-impressed workmanship traces are clear on the interior surface, and slab building joint traces also can be observed on some sherds. The primary temper of this ware is very fine grayish white lithic fragments; occasionally, 1-3mm fine sand can also be observed. The manufacturing techniques of Ware F ceramics may be identical to L4 upper layer Ware F. The exterior surface is well preserved and feels silky smooth. Based on the ethnographic studies (Longacre 1991), this kind of semi-lustrous, smooth surface might have been created by pebble or leather polishing on a dried clay surface. Smudging is another method to create a full black ceramic besides the deoxidizing process. The exterior decorative patterns consist of incised lines, dots, and punctuation circles. The proportion of Ware F's weight is 4.6% of the sampled specimens. Although upon macro examination there appear to be similarities between two layers of Ware F (L4 upper layer and L6 middle layer), subsequent petrographic analysis reveals a different story. I shall discuss the differences in the following chapter section.

⁶¹ When considering surface color and treatment, type 8 can also be assigned to Ware G or isolated as one ware. Nevertheless, type 8 clearly is an independent ceramic type.

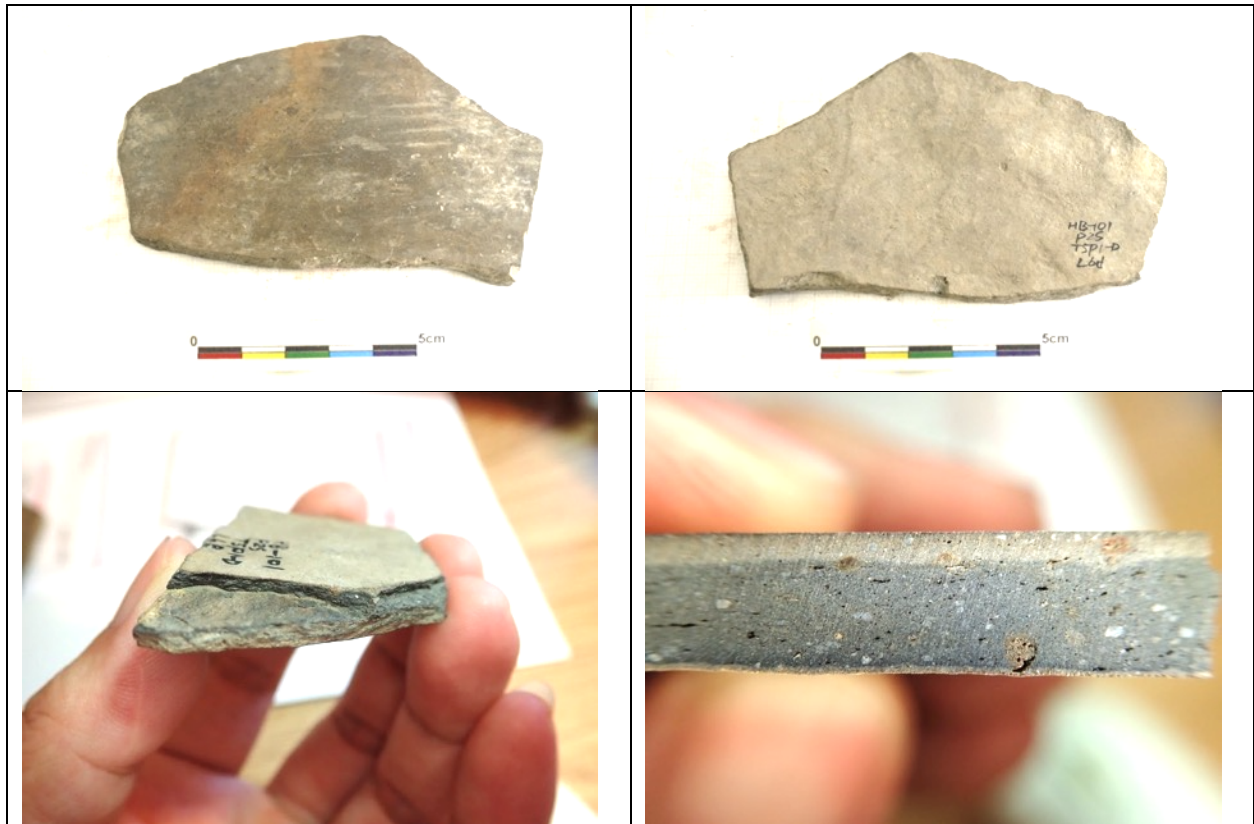


Figure 4-16 L6 Type 11.9. Upper left: smoothed and polished exterior surface; upper right: the interior surface is quite uneven (not polished) and sometimes with figure impression traces; lower left: cross section broken by hand shows laminated structure and slab-building structure; lower right: cross section by cut shows some long, thin voids in the matrix

4.3.4.7. *Ware G*

This ware has two types of sandy clay ceramics, types 8.9 and 9. The surface slip has been preserved better on type 8.9 than type 9 which is the only difference between these two types. The ceramic thickness ranges from 4 to 8mm, and the average is 6mm. The matrix color is brownish gray (Hue 7.5 YR 5/1), and the matrix texture is compact and hard. When hitting the sherds against each other, instead of the common dull sound of earthenware, the sound is relatively clear and sharp, showing the hardness of these sherds. A few long, thin pores can be observed from the slightly laminated matrix profile. The temper sorting is good, and the size ranges from 0.5 to 1mm diameter. Black and reflective igneous mineral is the primary temper type. The blackish minerals and a few whitish minerals are evenly distributed in the matrix. Both interior and exterior surfaces are slipped and smoothed. Traces of wheel smoothing are visible on both the mouth ring and foot ring parts. The ceramic surface color ranges from orange to dull orange to dull reddish brown (Hue 7.5 6/4 and Hue 5YR 5/4). The surface is mostly plain with only a few sherds with paddle-impressed striped patterns. The total weight occupies 1.6% of the sampled specimens. This ware is similar to L4 Ware G.



Figure 4-17 L6 Type 9. Upper left: plain exterior surface with sandy texture; upper right: the interior surface is similar to the exterior surface. A few figure impressions on this specimen; lower left: cross section broken by hand shows a slightly laminated structure of the cross section and a few whitish tempers; lower right: cross section by cut shows the whitish temper proportion and the compactness of the matrix

The primary forming traces are invisible for all ceramic wares. Except for Ware F, some Ware F sherds have the slab building trace. The secondary forming technique may have been mainly by paddling the ceramic on an anvil; however, no clear traces can be observed. This could be the result of thicker slip on the ceramic surfaces. In L6, matrix texture and temper are the first two attributes to determine wares. Each ware has quite distinctive matrix attributes from the others. Ultimately, I have designated these seventeen ceramic types into seven wares (Table 4-4). Ware A is the most abundant ceramic. Paddle-impressed striped (maybe cord-marked) and straw mat motifs are the primary decorative method and pattern in this Ware A. Ware B is the second largest ware in terms of ceramic numbers. Ware B shares many ceramic-making attributes with Ware A. Paddle-impressed coarse cord-marked striped is the primary motif on the exterior surface (Figure 4-18). Ware F is almost identical to the L4 Ware F and is also quite distinctive from the rest of the L6 ceramic wares.

Table 4-4 Summary of L6 ceramic ware attributes

WARE/TYPE	TEMPER	MATRIX	EX. SURFACE	IN. SURFACE	MAJOR DÉCOR. MOTIF	WEIGHT %
A/0.9, 1, 2	DARK BROWN AND GRAYISH BLACK SCHISTOSITY TEXTURE LITHIC FRAGMENTS	COARSE-SANDY TEXTURE WITH PORES DEVELOP AROUND THE TEMPER INCLUSIONS. SLIGHTLY LAMINATED. BROWNISH GRAY (HUE 10YR 5/1)	SLIPPED. DULL YELLOW ORANGE (HUE 10YR 6/4).	SMOOTHED, SLIPPED	PADDLE-IMPRESSED STRIPES AND STRAW MAT, COARSE CORD-MARKED	60.1%
B/3, 4, 4.1	SEMI-RECTANGULAR GRAYISH BLACK SCHISTOSITY TEXTURE LITHIC FRAGMENTS. WHITISH LITHIC FRAGMENTS AND MINERALS	SEMI-COARSE SANDY AND COMPACT TEXTURE. SLIGHTLY LAMINATED. BROWNISH GRAY (HUE 10YR 5/1)	SMOOTHED, SLIPPED. (HUE 10YR 6/4)	SMOOTHED, SLIPPED	PADDLE-IMPRESSED COARSE CORD-MARKED STRIPES	21.5%
C/5, 6	POORLY SORTED WHITISH MICA AND BLACK SCHISTOSITY LITHIC FRAGMENTS	SEMI-LAMINATED. A FEW ROUNDED PORES. COLOR HUE 10 YR 5/1 BROWNISH GRAY)	SLIPPED. DULL ORANGE (HUE 7.5 YR 6/4) AND GRAYISH BROWN (HUE 7.5 YR 5/2)	SLIPPED	PADDLE-IMPRESSED VEIN	4.7%
D/10, 11, 11.1	WELL SORTED WHITISH MINERALS AND MICA	SEMI-SANDY TO SILTY TEXTURE WITH A FEW ROUNDED PORES. COLOR BROWNISH GRAY HUE 10 YR 6/1)	VERY THIN SLIP. DULL ORANGE (HUE 7.5 YR 6/4)	SLIPPED, SHALLOW TRACES OF FIGURE IMPRESSIONS	PADDLE-IMPRESSED VEIN, GRID	2%
E/7	WHITISH ROUNDED MINERALS. FINE-GRAIN MICA FRAGMENTS AND BLACK SCHISTOSITY LITHIC FRAGMENTS	SEMI-SANDY TO SILTY TEXTURE. SLIGHTLY LAMINATED. COLOR BROWNISH GRAY (HUE 7.5YR 5/1)	SMOOTHED, SLIPPED, BROWNISH BLACK (HUE 5YR 3/1-2/1)	SLIPPED, UNEVEN, FIGURE IMPRESSION DULL ORANGE TO DULL REDDISH BROWN (HUE 5YR 6/3-4/3)	PLAIN	0.4%
F/8, 11.9, 12	VERY FINE GRAYISH WHITE LITHIC FRAGMENTS	PLASTIC, SILTY TO SEMI-SANDY TEXTURE WITH A FEW LONG-THIN PORES. SEMI-LAMINATED STRUCTURE. COLOR IS BROWNISH BLACK (HUE 10YR 3/1)	SILKY SMOOTH, SLIPPED, POLISHED, SMUDGED(?) BROWNISH BLACK (HUE 10YR 3/1) TO BLACK (HUE 10YR 2/1)	FIGURE IMPRESSIONS, UNEVEN, SMUDGED(?)	INCISED LINE AND DOT, AND PUNCTATION CIRCLE	4.6%
G/ 8.9, 9	BLACK AND REFLECTIVE IGNEOUS MINERAL WHITISH MINERAL	SANDY AND COMPACT TEXTURE. SLIGHTLY LAMINATED. COLOR IS BROWNISH GRAY (HUE 7.5 YR 5/1)	SMOOTHED, THINLY SLIPPED. DULL ORANGE TO DULL REDDISH BROWN (HUE 7.5 6/4 AND HUE 5YR 5/4)	VERY THIN DULL ORANGE TO DULL REDDISH-BROWN SLIP	PLAIN	1.6%

Table 4-5 L4 Wares attributes

Ware	Temper					Forming Traces		Surface Treatments					
	Whitish grain	mica	schistosity lithic frag.	grayish white lithic frag.	reflective igneous minerals	Anvil impressed.	Finger impressed.	Slipped	Paddle-impressed	Stamped	Incised	Polished	Smudged
A	x					x		x	x				
B		x			x	x			x				
C	x	x	x			x	x		x				
D			x					x	x				
E			x					x	x				
F				x			x	x		x	x	x	x
G				x	x								

Table 4-6 L6 Wares attributes

Ware	Temper					Forming Traces		Surface Treatments					
	Whitish grain	mica	schistosity lithic frag.	grayish white lithic frag.	reflective igneous minerals	Anvil	Finger	Slipped	Paddle-impressed	Stamped	Incised	Polished	Smudged
A			x					x	x				
B	x	x	x					x	x				
C		x	x					x	x				
D	x	x				x	x		x				
E	x	x	x				x	x	x				
F				x			x			x	x	x	x
G				x	x								

Table 4-7 Ware percentage (weight)

Ware	A	B	C	D	E	F	G	Total
L4	1.2%	9.1%	56.4%	5.5%	0.1%	18.5%	0.9%	100%
L6	60.1%	21.5%	4.7%	2%	0.4%	4.6%	1.6%	100%

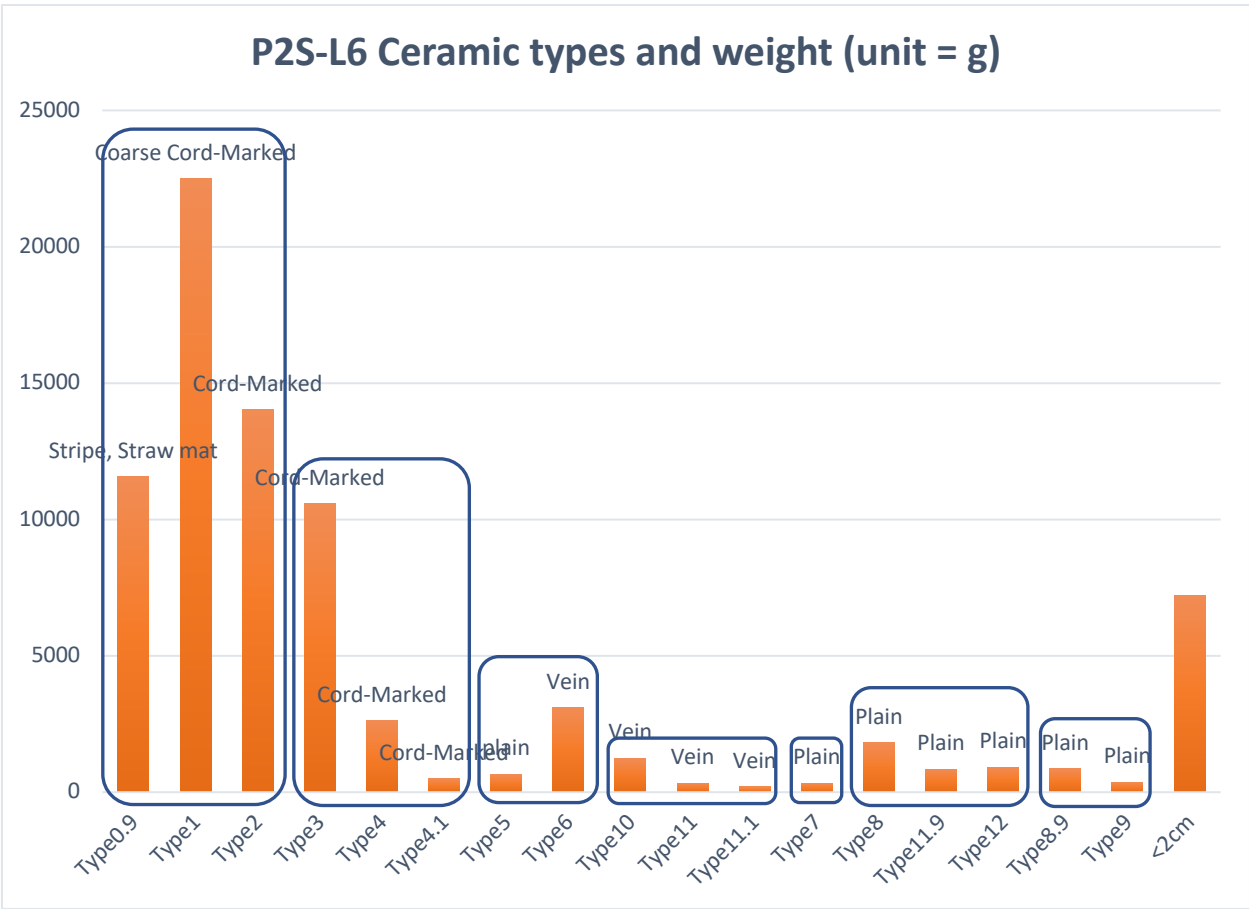


Figure 4-18 Chart of L6 ceramic types and their weights. The label(s) above each column show the major decorative motif in each type. Each rounded-rectangular area is one ware

4.3.5. Summary of Technical Typological Analysis

Both L4 and L6 cultural layers have more than fifteen ceramic types, and I have designated those types into seven (L4) and seven (L6) wares. In the same ware, the manufacturing techniques are basically the same or similar (Table 4-3 and Table 4-4).

Overall, the ceramic assemblages in L4 and L6 are distinctive regarding manufacturing traditions (Table 4-5 and Table 4-6), but also share some similarities (Table 4-7). The dominant ceramic wares between L4 and L6 are pretty different in terms of matrix (temper and texture), forming technique traces, and decoration motif (Figure 4-19, Figure 4-20, Figure 4-21, Figure 4-22), and vessel size (L6 is larger than L4). As for the similarities, both layers have Ware F and G ceramics that are identical to each other from the technical typological perspective.⁶² Also, several ceramic types appear in both layers. For example, the dominant L4 Ware C is very similar to L6 Ware D (in lower quantities, 2% in L6), and the dominant L6 Ware A is quite identical to L4 Ware E (also in lower quantities, 0.1% in L4).

⁶² Petrographic analysis provides a different insight. For example, L4 type 4.1 is not similar to Type 4, and the temper source of Ware F in between L4 and L6 is quite different.

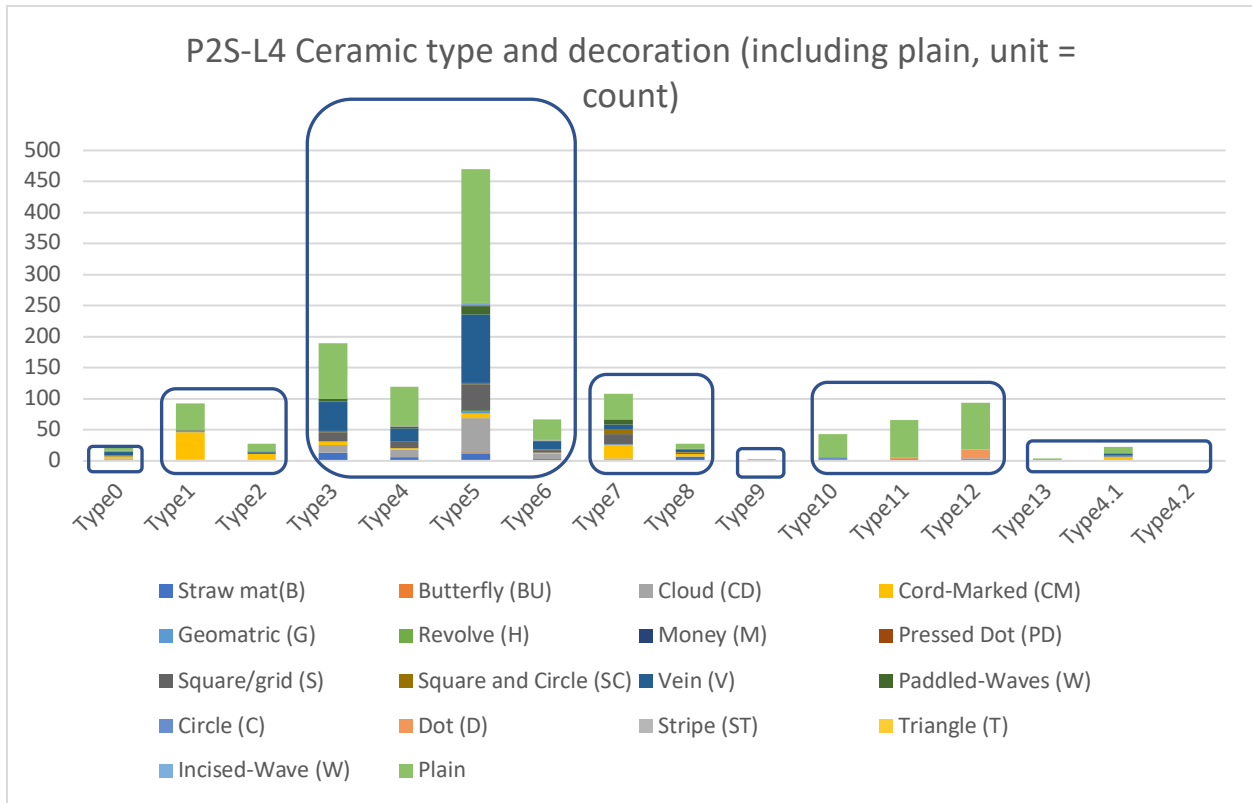


Figure 4-19 Chart of L4 ceramic types, decorative motifs, and their counts. This chart includes the plain count (green part on top of each column). Each rounded-rectangular area is one ware

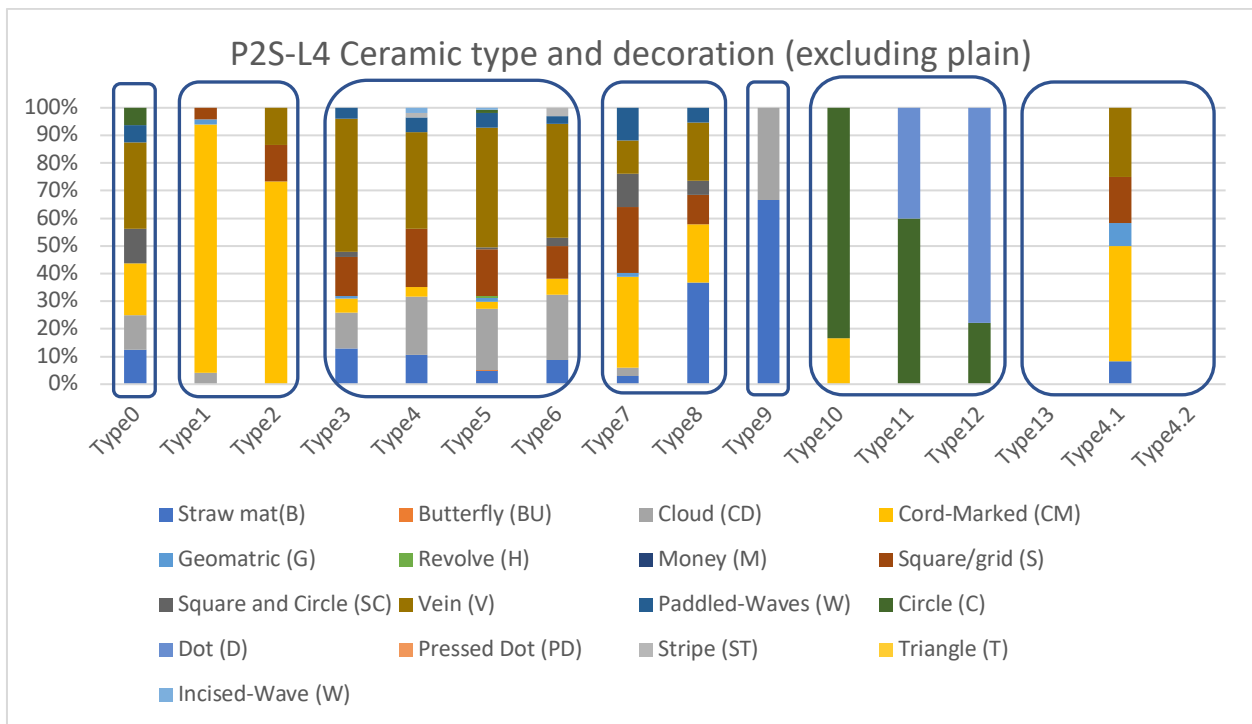


Figure 4-20 Chart of L4 ceramic types and decorative motifs in percentage. This chart excludes the plain count; hence, it is easier to determine the primary motif in each ceramic type. Each rounded-rectangular area is one ware. See appendix for pattern photo

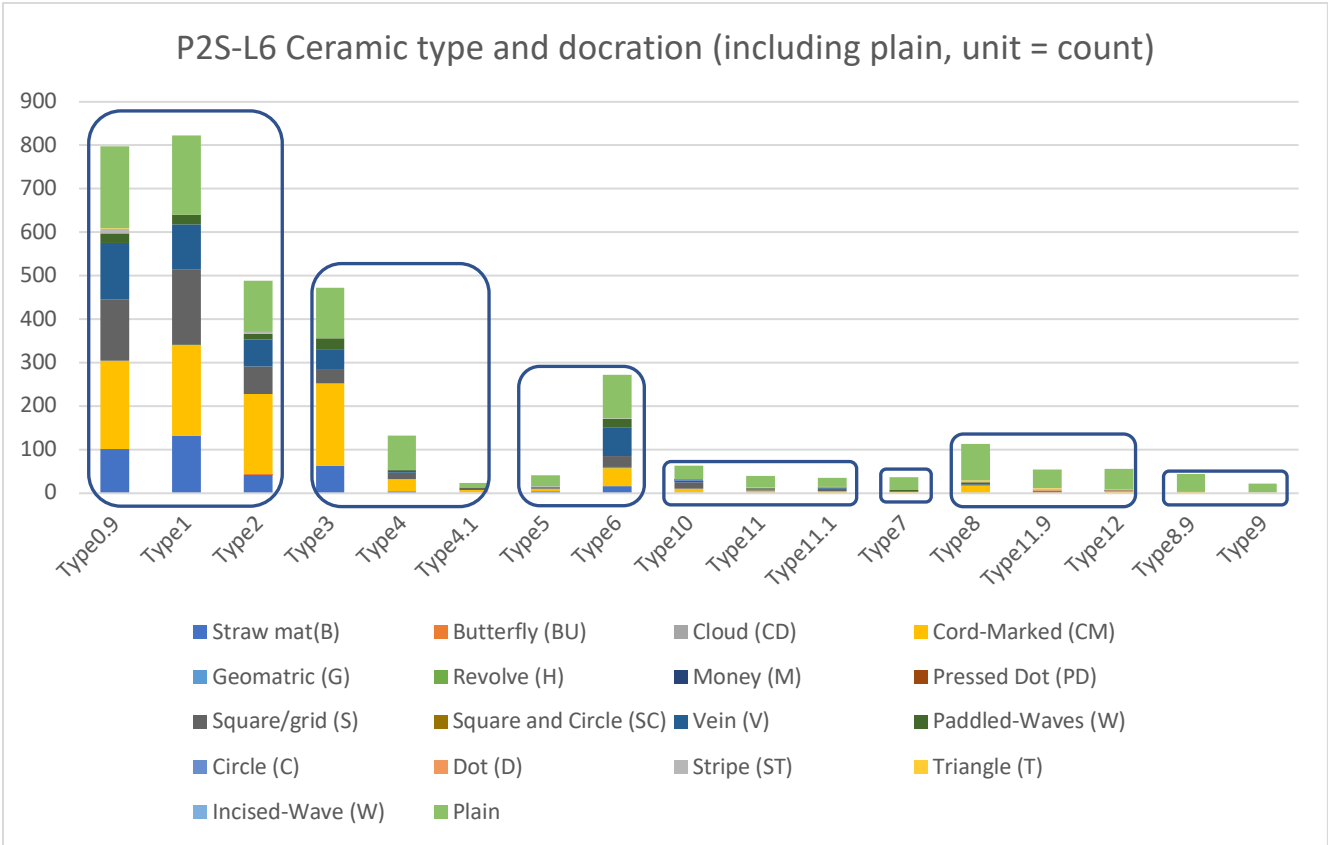


Figure 4-21 Chart of L6 ceramic types, decorative motifs, and their counts. This chart includes the plain count (green part on top of each column). Each rounded-rectangular area is one ware

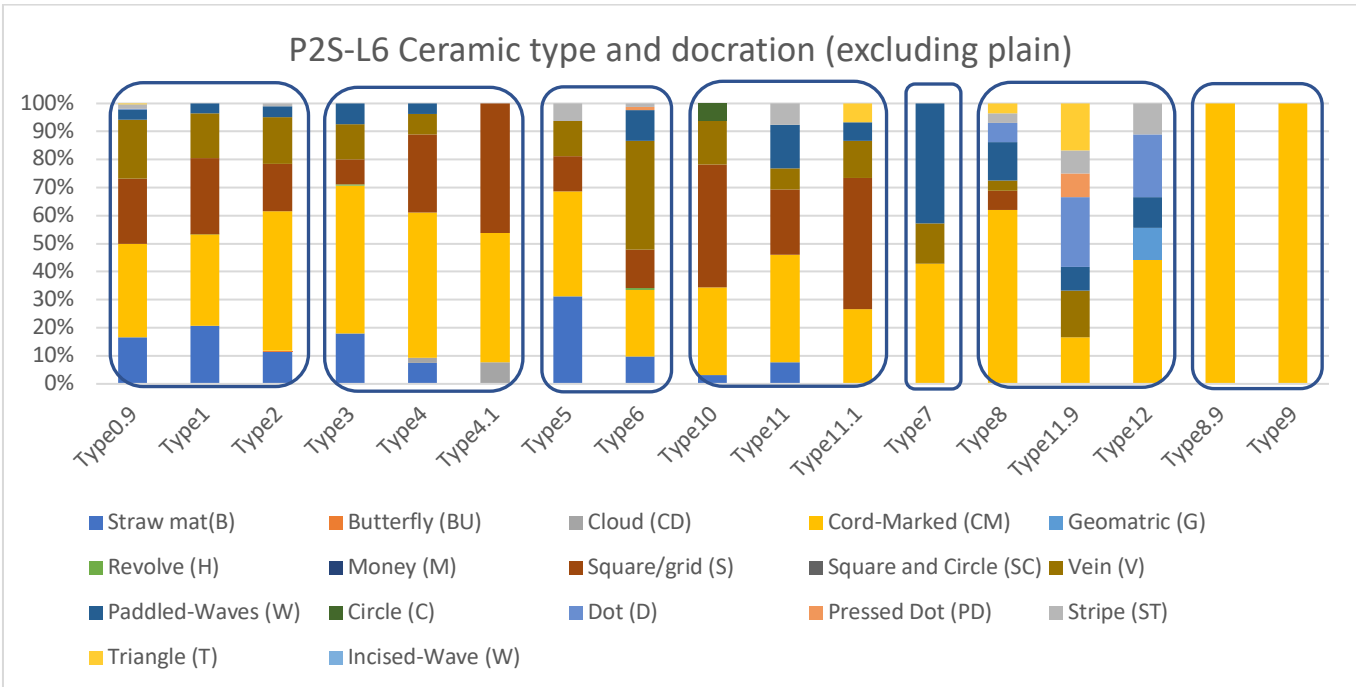


Figure 4-22 Chart of L6 ceramic types and decorative motifs in percentage. This chart excludes the plain count; hence, it is easier to determine the primary motif in each ceramic type. Each rounded-rectangular area is one ware. See appendix for pattern photo

4.4. Geophysical Analysis: Petrography

The two essential raw materials of ceramic are clay paste and temper inclusion. By comparing the mineral and chemical composition from these two ingredients of ceramics to geological data, archaeologists could identify the original raw material procurement area and possible manufacturing area (Neff et al. 1996). Understanding the provenience of ceramics would benefit the discussion of interaction and exchange between people from different locations. While the technical typological analysis of the BHB L4 and L6 ceramics has indicated different ceramic-making traditions (including techniques and temper origin) between two cultural layers, it is worth further characterizing those ceramics by instrumental analysis. Also, from a technical tradition perspective, the raw material procurement is the very first stage of ceramic-making, so temper kind is the prime of attribute hierarchy. While we have used our best effort to examine the temper by our naked-eye, petrographic analysis certainly benefits and provides solid backup data for identifying minerals.

I have applied petrographic analysis as the primary method for examining the mineral composition of the BHB ceramic assemblage. Since Shepard generated the first dataset on archaeological ceramics in the 1930s, thin section has provided profound qualitative and quantitative information relevant to the classification, engineering, and production and exchange of ceramics (Degryse and Braekmans 2017; Stoltman 2001).

In Taiwan, the first petrographic analysis on the archaeological ceramic was in the late 1960s (SUNG 宋文薰 1967), but this method was not widely applied until the Scientific and Technological Archaeology Laboratory began practicing the method frequently at IHP in the 1990s (CHEN 陳光祖 1990, 1991, 2004). Most of the archaeo-petrographic works since then are mostly attached as the appendix of articles and excavation reports. In the recent decade, with the shift of the ceramic research paradigm (as mentioned at the beginning of this chapter), more and more studies have used robust quantitative data generated from instrumental analyses to discuss provenience, trade and exchange, and inter-regional interactions.

Currently in Taiwan, petrography is the most common method in ceramic analysis for yielding mineral composition, although Raman spectrometry is also being used for the same purpose.

Geochemical analysis of ceramics is somewhat limited (Chen 2006; CHEN 陳瑪玲 2006), and it is mostly on the other materials, such as nephrite, basalt, glass, and metal (CHENG 鄭玠甫 2007; CHEN 陳光祖 2002, 2011; HUNG et al. 2007; Hung 洪曉純 et al. 2004; LIOU 劉瑩三 et al. 2014; Liu 劉益昌 and Liou 劉瑩三 2002; TAN 譚立平 et al. 1997; Wang et al. 2019; WANG 王冠文 et al. 2018).

One of the attributes of my technical typological analysis is temper type and its sorting. Generally, during this typological analysis, semi-translucent to whitish mineral grain, grayish green to grayish brown lithic fragment, and reflective silver, golden, and black mineral grain are observed. Based on the adjacent geological environment, the whitish mineral grains could be quartz and marble lithic fragments; the grayish green to grayish brown could be metamorphic lithic fragments, such as schist, slate, and argillite; and those reflective minerals could be igneous minerals, such as pyroxene and amphibole. Those theories need to be tested by petrographic analysis.

4.4.1. Principle and Workflow

Petrographic analysis is particularly applicable in Taiwan. Taiwan is a relatively 'new' island from a geological perspective, and it consists of complex topography and geological structures. Because of this complexity, the content of deposits varies over short distances, especially in eastern Taiwan. This complexity directly relates to the formation of Taiwan island. Although there is no consensus about the detailed processes of the island formation, there is no doubt that Taiwan was formed because of the tectonic activities between the Philippine Sea Plate and the east end of Eurasian Plate (CHEN 陳文山 2016). Five mountain ranges⁶³ with complex topography and geological structures are the traces of those complicated geological movements. Even now, these tectonic activities are still ongoing, so Jade Mountain is still growing taller, and the Coastal Range is still moving northward.

⁶³ From east to west, the Coastal Mountain Range, Central Mountain Range, Snow Mountain Range, Jade Mountain Range, and Ali Mountain Range.

4.4.1.1. Geological information related to the BHB site

From a macroscale perspective (Figure 4-23), the east side of the Central Mountain Range is a from medium to high metamorphic area. Highly metamorphosed rocks are the major components in the deposit, such as quartz-mica schist, gneiss, and granite. The Snow Mountain (Xueshan) Range is a light to medium metamorphosed area; hence slate and argillite are likely to be found in the deposits. There are two volcanic areas in Taiwan: The Coastal Mountain Range and the Tatun Mountains, so the deposit from these two areas consists of igneous rocks and minerals such as andesite, pyroxene, and amphibole (CHEN 陳文山 2016).

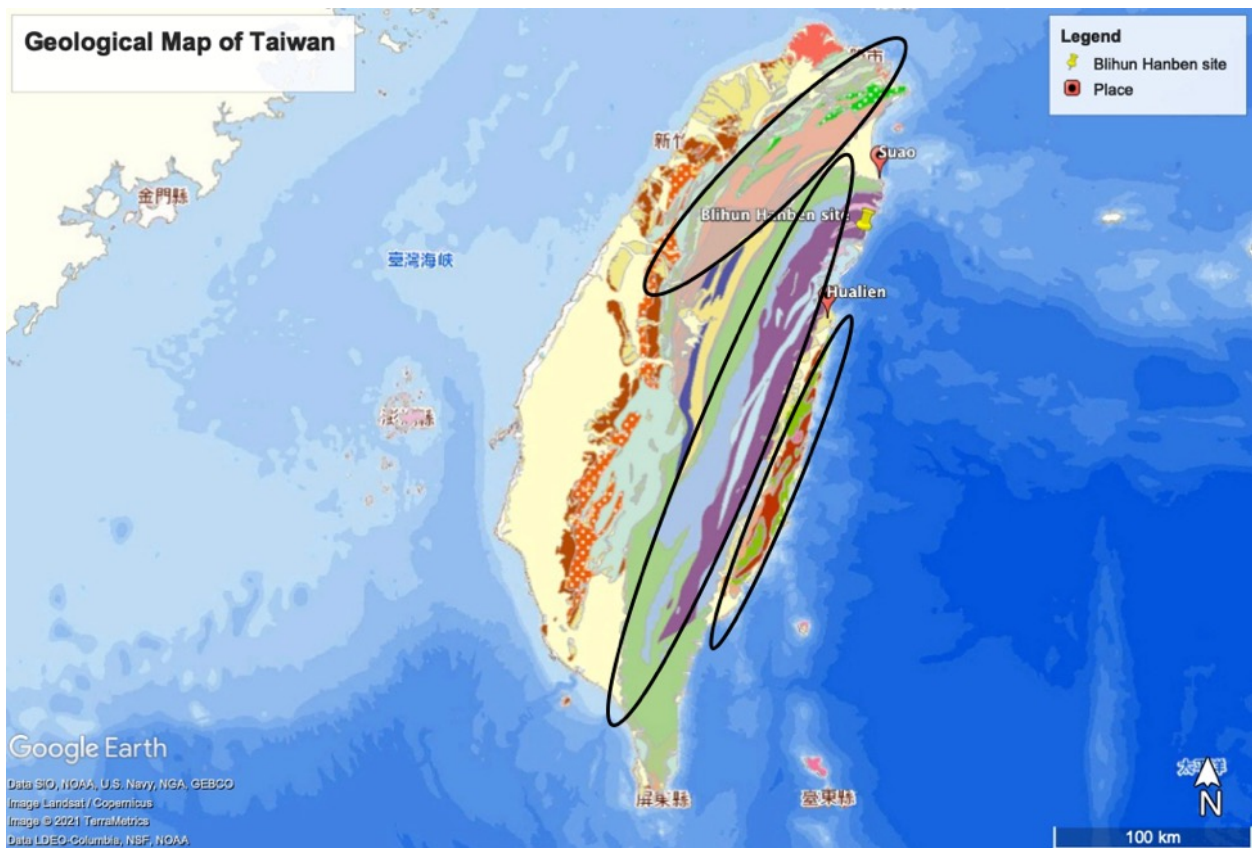


Figure 4-23 A geological map of Taiwan. The black ovals from top-left to bottom-right respectively indicate Xueshan Mountain Range (Snow Mountain Range) that consists of bright green, pink, and light purple areas; the Central Mountain Range that consists of light green, purple, and blue areas; and the Coastal Mountain Range that consists of grassy green and red areas. Those colors represent different geological area. The narrow area between the Central and Coastal Mountain Ranges is the East Rift Valley⁶⁴. The orange-red in the northern tip indicates the Tatun volcanic mountains

⁶⁴ The geological metadata is extracted from the National Geological Warehouse (<https://gis3.moeacgs.gov.tw/gwh/gsb97-1/sys8/t3/index1.cfm>) and then been integrated with Google Earth.

Tananao Schists 大南澳 (Figure 4-24, no. 6 and 7), which include different types of schist, gneisses, and metamorphosed limestone, are the major local rocks in and around the BHB site. The Heping 和平 River, which flows by the south tip of the BHB site, cuts through several lighter metamorphosed areas (Figure 4-24 no. 4 Lushan Formation and no. 5 Hsinkao Formation) that contain argillite, slate, and meta-sandstone in its upper stream and flows through Tananao Schists in the mid-stream and estuary. Hence, schists and metamorphosed limestone fragments and minerals should be the primary deposits around the Heping River estuary.

The Tananao Schists distribute from the site northwards to the Lushan Formation (Figure 1-28 no.4) where the rock type in the Suao area shifts to slate and meta-sandstone. The rock type changes again when crossing the Ilan/Yilan 宜蘭 Plain. The Aoti Formation and Tatungshan Formation contain shale, argillite, and slate (Figure 4-24 no.2 and 3). Hence, the Ilan Plain deposit is mainly a mixture of slate and argillite. This is why the ceramic temper of the Kiwulan site, one of the important sites in the late Metal Age Taiwan, mainly consists of these two rock fragments.⁶⁵

When looking southward from the site, Tananao Schists extends southbound to Taitung 台東; the rock type remains similar to the BHB area until the Huakangshan site in Hualien. A bit south of Hualien City is the northern tip of the Coastal Mountain Range, which is a mix of volcanic (Tuluanshan Formation) and sedimentary (Paliwan Formation) geological environment (Figure 4-24 no.8). Hence, the East Rift Valley in between the Coastal Mountain Range and Central Mountain Range has a mixed deposit of metamorphic and volcanic rocks and minerals.

⁶⁵ Personal communication with WANG Li-Ying in 2018.

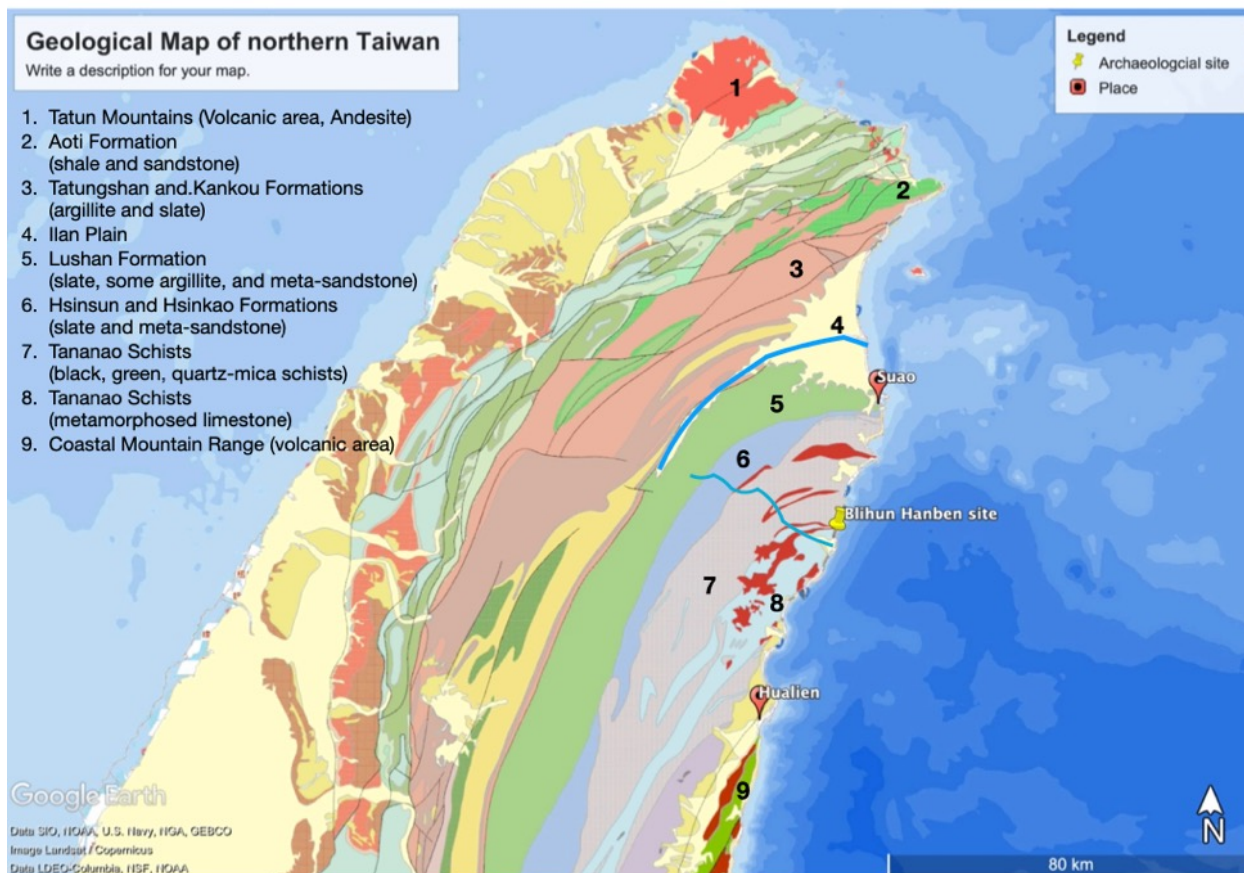


Figure 4-24 Geological Map of northern Taiwan, showing a more detailed geological environment adjacent to the BHB site. No.1 is Andesite. No.2 is Aoti Formation (contains shale and sandstone). No.3 is Tatungshan and Kankou Formations (contain argillite and slate). No.4 is Ilan Plain, Lanyang River carries the deposit from No.3 and No.5; hence, the deposit in Ilan Plain is the mix of these two geological areas. However, the proportion of slate and argillite is different between north and south of the Lanyang River. No.5 is Lushan Formation (mostly slate, some argillite, and meta-sandstone). No.6 is Hsinsun and Hsinkao Formations (contain slate and meta-sandstone). No.7 is Tananao Schists (contains black, green, quartz-mica schists). No.8 is also a part of Tananao Schists but mostly is metamorphosed limestone. No.9 is Coastal Mountain Range (Tuluanshan Formation and Paliwan Formation)

4.4.1.2. Sample selection

I selected three sets of specimens for the petrographic analysis, mostly from the P2S excavation pit. For the first two sets, each set contains 33 specimens (16 ceramic types from L4 and 17 types from L6) that were randomly selected during the technical typological examination. The third ceramic set contains both L4 and L6 primary ceramic types from different levels. This selection aims to examine if there are any chronological differences within the same ceramic type. The sherd size is usually larger than 30×30mm. This is to gain the maximum observation area on the thin section slide.

4.4.1.3. Petrography and slide preparation

Mr. LIANG 梁 and I made all of the thin section slides in the thin section lab⁶⁶ in the Department of Geosciences at National Taiwan University. The basic process of making a ceramic thin-section is similar to a rock thin-section, but one crucial difference is solidifying the ceramic by saturating the specimen in epoxy resin. After being solidified and attached to a glass slide, the specimen is then polished to 0.03mm thickness. At this thickness, most minerals in the specimen become translucent and ideal for optical identification. The final step is to cover the polished specimen with Canada balsam and a layer of thin glass for protection (Figure 4-25, upper left and right); however, this protection is optional if one plans to carry out other analysis on the same thin-section slide (LIN 林宜羚 2009).

I examined all the prepared thin-section slides at the Petrography Laboratory directed by Prof. CHEN Wen-Shan, who also supervised me during the analysis, in the Department of Geosciences at National Taiwan University. The microscope was a Zeiss Axioplan with polarized filters, and a Canon EOS 500D was attached to the microscope for taking digital photos. The magnification of the eyepiece was 10x; 10x or 40x for the objective lens (Figure 4-25, lower left and right). Except for a few specimens that were too small, over 500 points were counted for each specimen in order to achieve more robust statistical results.⁶⁷ The count was controlled by a step counter attached to the microscope stage (Figure 4-25, middle left and right). Point counting is a systematic sampling process when observing the thin section by a determined interval (Stoltman 1989, 1991).

Temper type, quantity, and shape were documented during the examination. Color and pleochroism, relief, cleavage, interference colors, and extinction were several attributes I used for mineral identification under both plane and cross-polarized lights. The works of Barker (2014) and Mackenzie and Guilford (2014) were the two primary references⁶⁸ I used for the basic

⁶⁶ Mr. LIANG is an experienced technician who has worked in the department for over 30 years. He also kindly and unselfishly taught me how to make ceramic thin-section slides.

⁶⁷ I followed the same protocol for counting point number with the Scientific and Technological Archaeology Laboratory at the IHP.

⁶⁸ I cannot express enough thanks to Prof. CHEN Wen-Shan who led, guided, and supervised me in the world of petrography. However, I am responsible for all analysis results.

knowledge of optical mineralogy. Cleavage is observable in any lighting condition. The crystal structure of a mineral tends to cause the mineral to break along or in specific directions. Some minerals have clear cleavage, but some do not. For example, quartz does not have clear cleavage, but feldspar does. Under plane-polarized light, relief and pleochroism can be observed. When the relief is high, the mineral grain edge is clear and sharp. As for the pleochroism, mineral with this characteristic shows different colors when rotating the specimen stage to a different angle. Under cross-polarized light, mineral colors become interference colors. Usually igneous minerals have multiple vivid colors. As for the extinction, some minerals become invisible (fully blackened) when rotating the specimen stage (feldspar, for example).

In summation, comparing with the known geological data, the thin-section analysis results show five possible sources of temper: BHB local, the southern part of the Ilan Plain, the northern part of the Ilan Plain, the igneous/volcanic area, and the East Rift Valley (Figure 4-24).

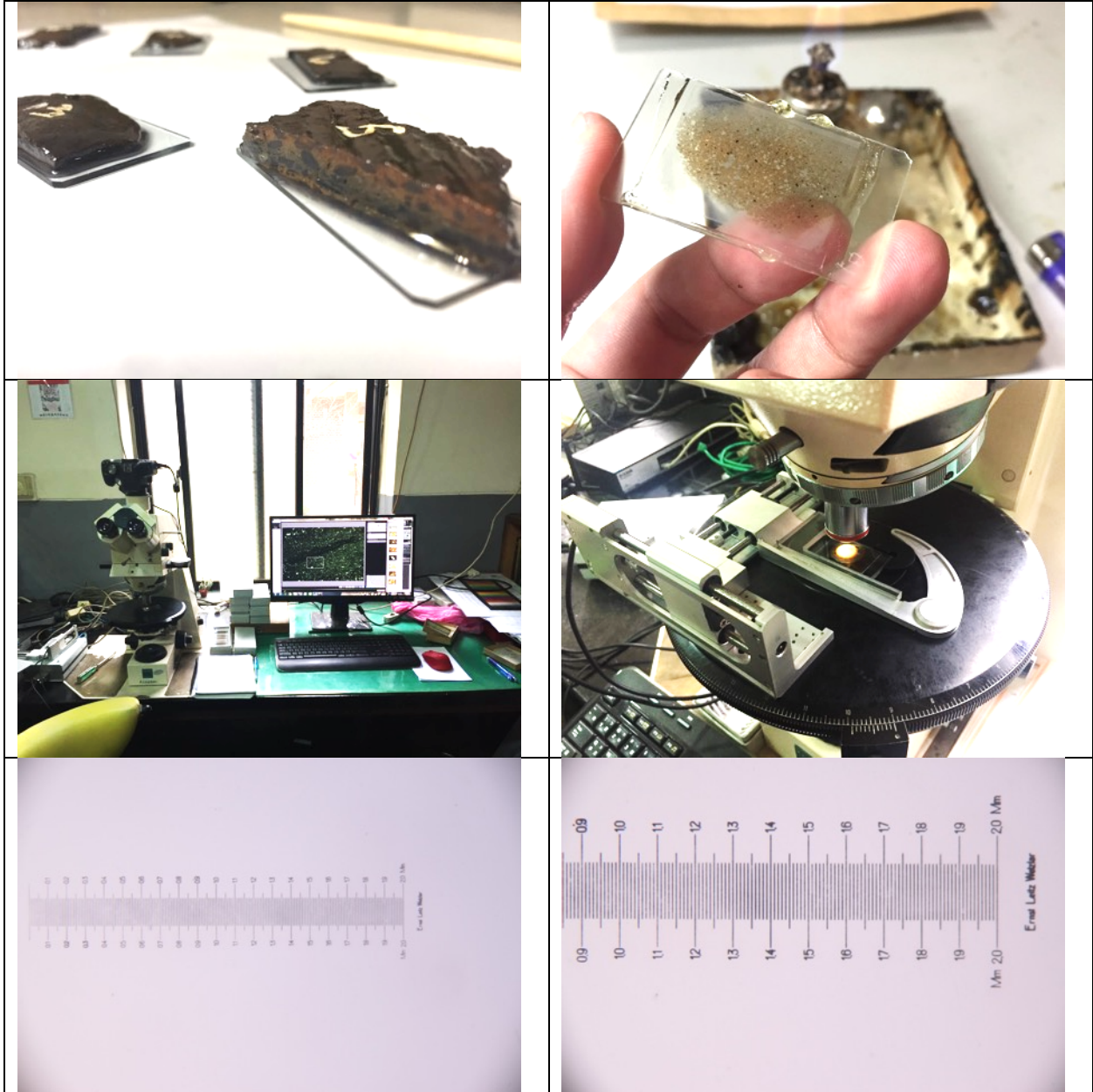


Figure 4-25 Upper left: epoxy resin saturated ceramic chips that have been glued onto the slide; upper right: finishing the thin-section; the specimen is translucent. Middle left: the polarized microscope with a digital camera; middle right: microscope stage with step counter. Lower left: 2mm scales for reference, 40x; lower right: 2mm scales for reference 100x

4.4.2. Results of L4 Upper Layer

The results of L4 specimens show multiple sources of temper, even in the same typological ware. The dominant Ware C ceramics, which matches the known SSH cultural assemblage Pulowan subset, use local BHB temper, and the temper of Ware F black pottery is from the igneous area. In the following section, I shall present the result by wares and temper sources. Most thin-section photos were taken at 40x, except for a few that were taken at 100x. I took about ten sets of open-nicol and crossed-nicol photos for each specimen. Selected open and crossed-nicol photos are presented side-by-side in the following illustration.

4.4.2.1. Ware A

The source of Type 0 is from the Suao area, the northeastern tip of the Central Mountain Range. There is a piece of slate in the middle; quartz-mica schist on the left and bottom; one chunk of meta-sandstone on top. There are also quite a few quartz fragments and calcite, which is the base mineral of marble. Temper evenly distributes in the matrix. This temper combination is quite unique from the Baimi 白米 River watershed.⁶⁹ The Baimi River is a bit south of modern Suao (Figure 4-24), approximately between the Tananao Schist and the Lushan Formation.

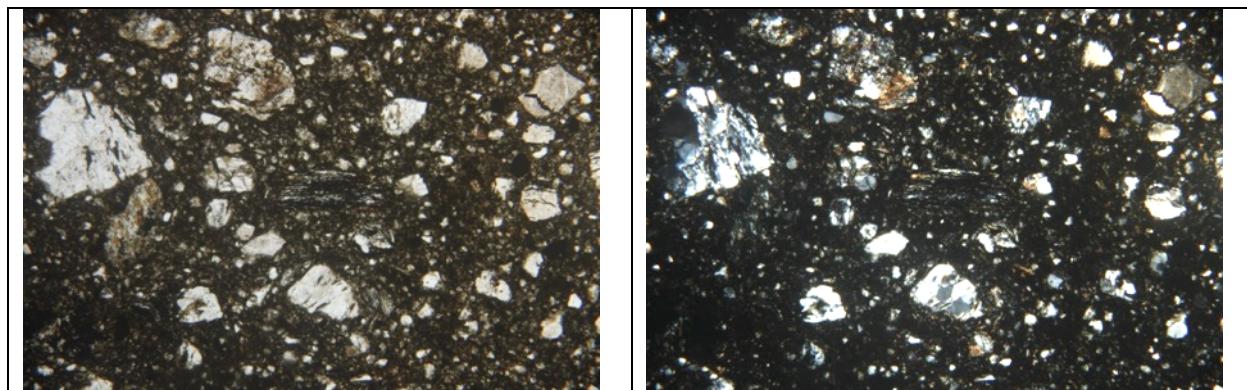


Figure 4-26 Ceramic type 0, specimen number L4-0-1c-40x. Left open-nicol, right: crossed-nicol

⁶⁹ Personal communication with Prof. CHEN Wen-Shan, and I subsequently confirmed Prof. CHEN's opinion by collecting and examining (petrographic examination) the river sand of the Baimi 白米 River.

4.4.2.2. Ware B

There are two ceramic types in this ware. The difference between these two types is minor. Petrographic analysis shows the mix of igneous and metamorphic minerals, like granite fragment, meta-sandstone, schist, and pyroxene. The northern half of the East Rift Valley might be the provenience of this mixture. However, biotite and mica are found in both types (Table 4-8). These two minerals are not very common in the East Rift Valley.

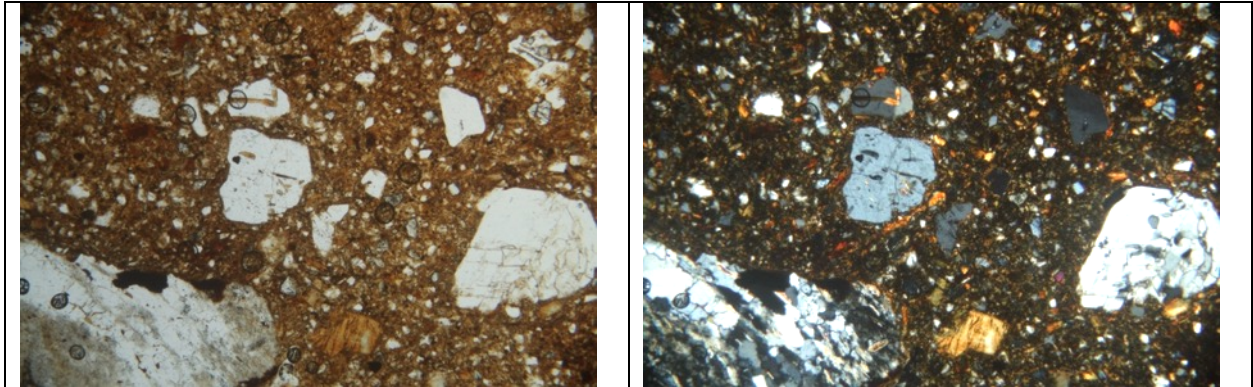


Figure 4-27 Ceramic type 1, specimen number L4-1-6c-40x. A chunk of granite fragment in the middle, and quartz-mica schist in the lower-left corner with a piece of pyroxene on its right. A bright white round chunk of quartz from granite can also be seen

4.4.2.3. Ware C

Analysis shows that the temper of Ware C ceramics mainly comes from the BHB local environment (or at least, the adjacent Tananao Schists area, Figure 4-24, no.7). As mentioned in the previous section, the Heping River cuts through several formations that contain schists, marble, slate, argillite, and meta-sands; hence, ideally, if the temper is collected from river deposits, it should be a mixture of those lithic fragments and related minerals. If the temper is collected from non-river deposits, the usual Tananao Schist at the BHB site should have quartz-mica schist, calcite, and meta-sandstone. Figure 4-28 shows a heavily folded quartz-mica schist in the middle, a smaller piece of the same kind of schist at the bottom, and a large number of meta-sandstone fragments in the matrix.

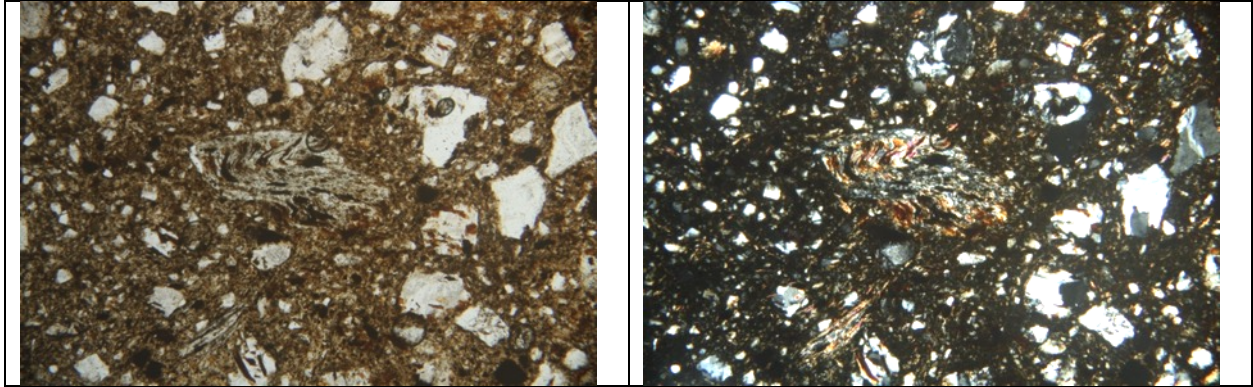


Figure 4-28 Ceramic type 5, specimen number L4-5-3c-40x

4.4.2.4. Ware D

The temper for both type 7 and 8 may come from an area ranging between the south side of the Lanyang River to Suao (Figure 4-24, no.4). Figure 4-29 shows both slate (right side of photo) and meta-sandstone (left side). The shape of these lithic fragments is semi-rounded, and this indicates an alluvial source of these tempers.

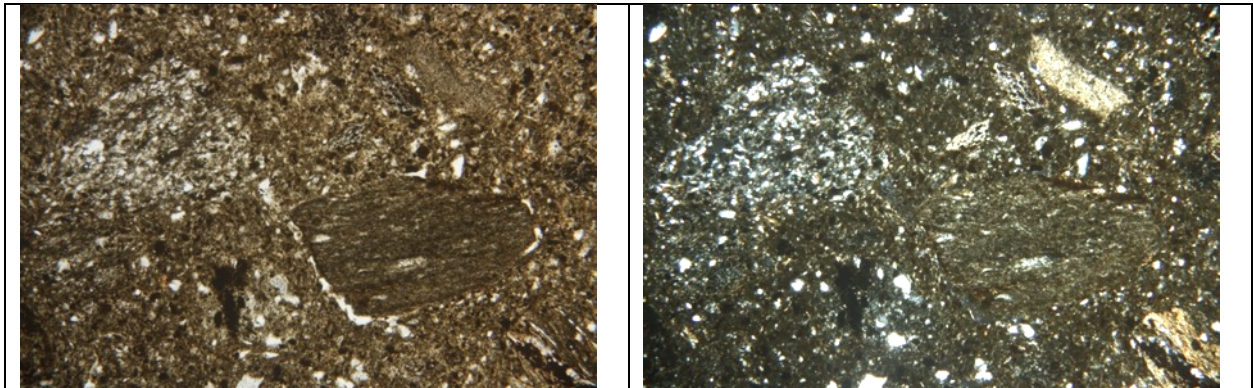


Figure 4-29 Ceramic type 7, specimen number L4-7-1c-40x

4.4.2.5. Ware E

Figure 4-30 shows a huge chunk of argillite (there is almost no laminated structure in argillite) in the matrix. Huge temper size is the index feature of L4 type 9 ceramic. L4 ceramic Wares D and E ceramic share typological similarities with L6 dominant ceramic Wares A and B. The temper analysis also matches this result. This temper is foreign to BHB, and the closest source is Suao and the southern portion of the Ilan Plain.

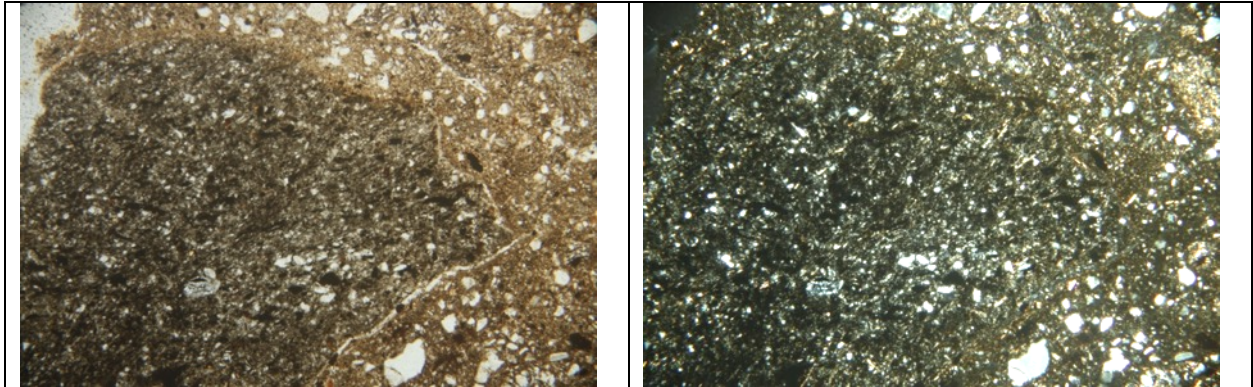


Figure 4-30 Ceramic type 9, specimen number L4-9-1c-40x

4.4.2.6. Ware F

The temper in this ceramic ware mostly comes from an igneous area, especially type 12 black pottery. This means type 12 may come from the Coastal Mountain Range in eastern Taiwan or the Tatun mountains in northern Taiwan. Figure 4-31 lower right photo shows a colorful pyroxene chunk (right), plagioclase (left), and a piece of igneous rock fragment (above the pyroxene chunk).

Type 10 ceramic has a mixed temper of igneous and metamorphic rocks which leads to the East Rift Valley as the only possible provenience, and the lack of slate fragment indicates the northern half of the East Rift Valley as the more precise source. The upper two photos show two pyroxene pieces (light yellow and emerald when crossed-nicol). There are several undulatory extinction quartz grains, crossed-nicol upper left for example. The temper size of this ceramic ware is relatively smaller than the other wares; the photos in Figure 4-31 are taken at 100x.

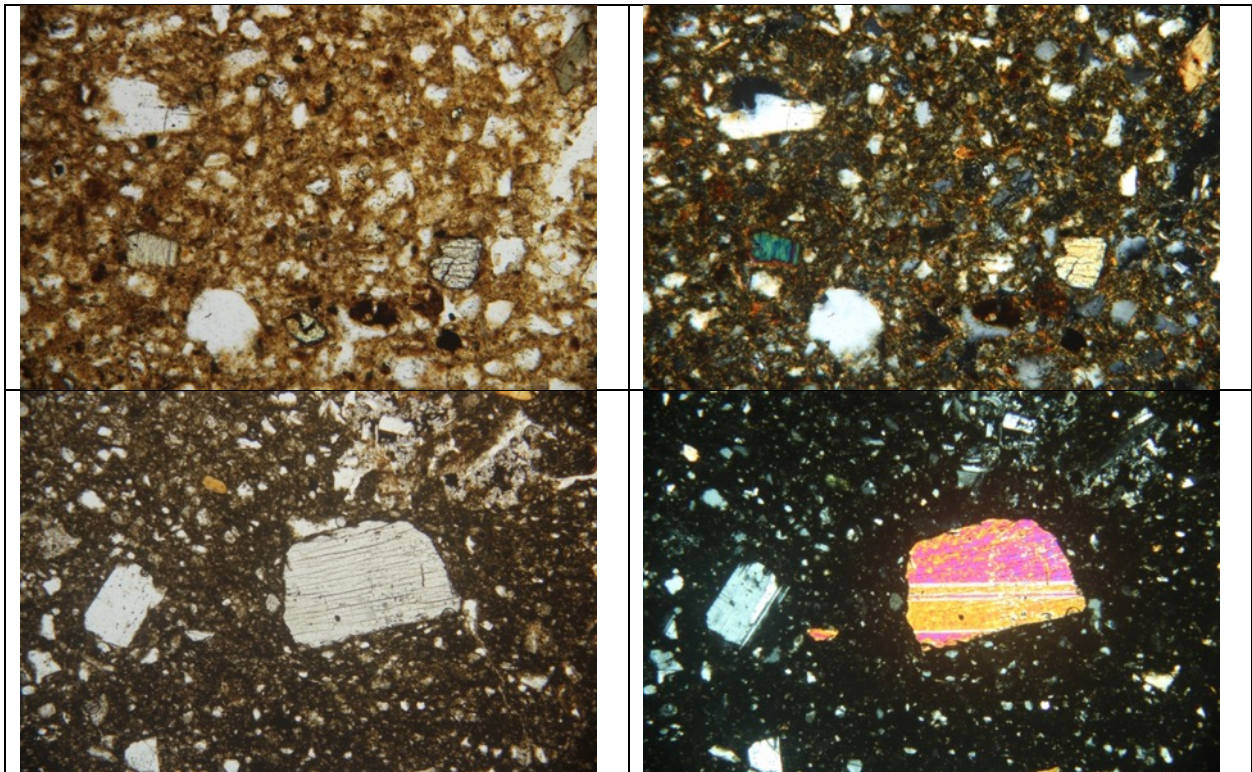


Figure 4-31 Uppers: ceramic type10, specimen number L4-10-4c-100x. Lower: ceramic type 12, specimen number L4-12-3c-40x

4.4.2.7. Ware G

The southern half of the East Rift Valley is the location when pyroxene, plagioclase, quartz-mica schist, and slate appear at the same time. The yellow pieces in the crossed-nicol (Figure 4-32, right) are pyroxene grains; the white grains are mostly plagioclase grains, and a schist-slate fragment is in the upper left.

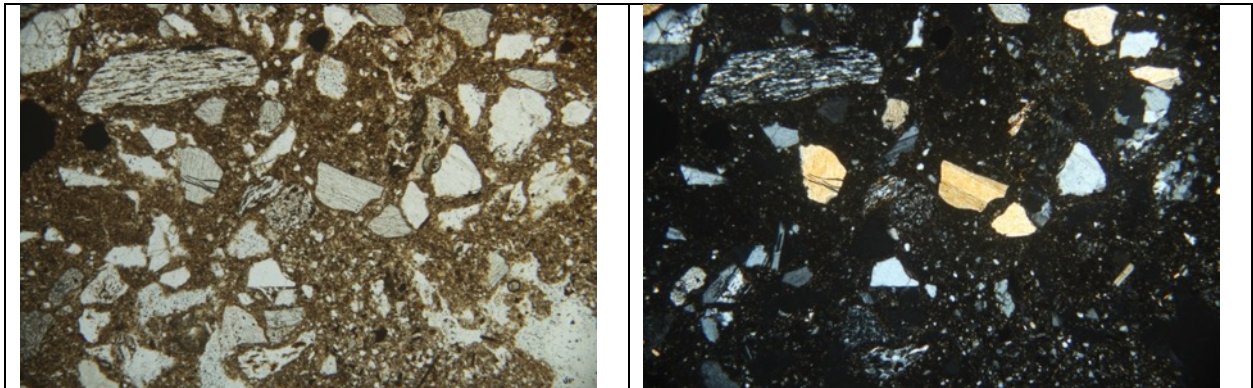


Figure 4-32 Ceramic type4.1, specimen number L4-4.1-1c-40x

Table 4-8 Possible proveniences of L4 ceramic temper, including both set1 and set3 results.

LAB_NUMBER	PROVENIENCE	NOTE	LAB_NUMBER	PROVENIENCE	NOTE	WARE
HB-L4-0-1	SUAO	BAIMI RIVER	HB-L4-0-3	EAST RIFT VALLEY	CLOSE TO COASTAL M. RANGE	A
HB-L4-1-1	EAST RIFT VALLEY	CLOSE TO COASTAL M. RANGE	HB-L4-1-3	EAST RIFT VALLEY		B
HB-L4-2-1	EAST RIFT VALLEY	UNCERTAIN	HB-L4-2-3	BHB	OR CENTRAL M. RANGE	
HB-L4-3-1	BHB		HB-L4-3-3	BHB		C
HB-L4-4-1	CENTRAL M. RANGE		HB-L4-4-3	BHB	OR CENTRAL M. RANGE	
HB-L4-5-1	CENTRAL M. RANGE		HB-L4-5-3	BHB	OR CENTRAL M. RANGE	
HB-L4-6-1	BHB		HB-L4-6-3	BHB	OR CENTRAL M. RANGE	
HB-L4-7-1	ILAN PLAIN	SOUTH OF LANYANG RIVER	HB-L4-7-3	ILAN PLAIN	SOUTH OF LANYANG RIVER	D
HB-L4-8-1	ILAN PLAIN	SOUTH OF LANYANG RIVER	HB-L4-8-3	ILAN PLAIN	SOUTH OF LANYANG RIVER	
HB-L4-9-1	SNOW M. RANGE	OR NORTH OF LANYANG RIVER	HB-L4-9-3	SNOW M. RANGE	OR NORTH OF LANYANG RIVER	E
HB-L4-10-1	EAST RIFT VALLEY	CLOSE TO COASTAL M. RANGE	HB-L4-10-3	IGNEOUS ROCK AREA	SSH OR COASTAL M RANGE ?	F
HB-L4-11-1	IGNEOUS ROCK AREA		HB-L4-11-3	IGNEOUS ROCK AREA	TATUN MOUNTAINS	
HB-L4-12-1	IGNEOUS ROCK AREA		HB-L4-12-3	IGNEOUS ROCK AREA	SSH OR SNOW M. RANGE	
			HB-L4-13-3	IGNEOUS ROCK AREA		G
HB-L4-4.1-1	EAST RIFT VALLEY		HB-L4-4.1-3	BHB	UNCERTAIN	
			HB-L4-4.2-3	IGNEOUS ROCK AREA		

* Lab number code: HB-L4-9-1 = Site=Layer-Ceramic type-Specimen set

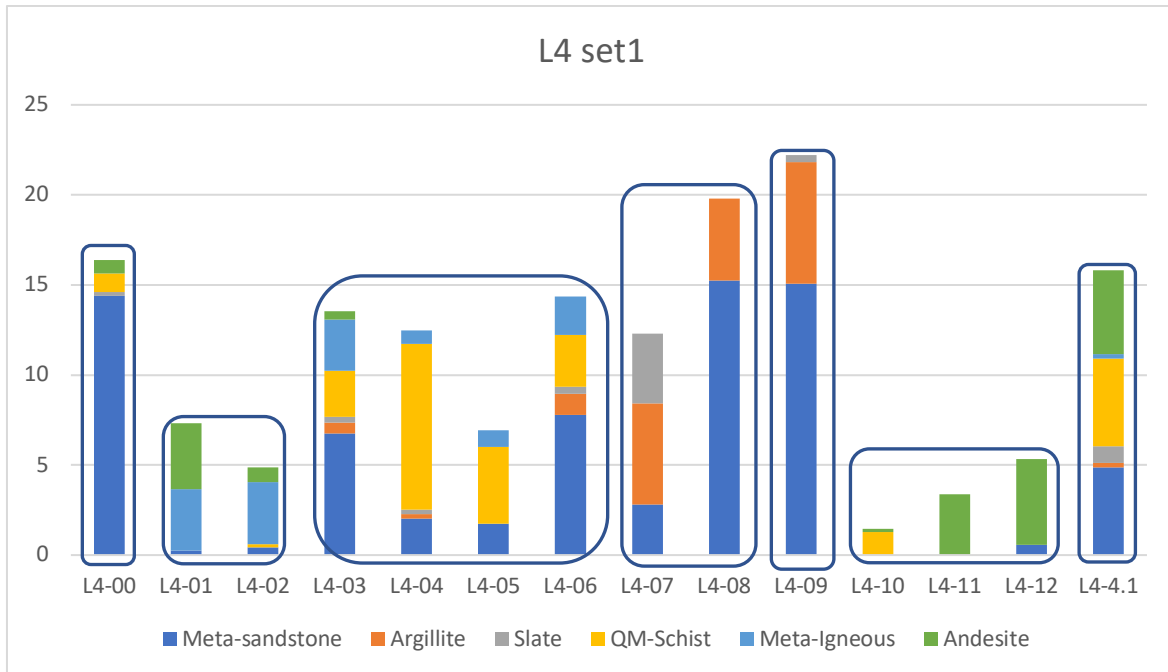


Figure 4-33 Percentage of temper types in each ceramic type. From left to right is ceramic ware A to G. Petrographic analysis shows that Ware D (type 7 and 8) and Ware E have similar temper compositions. Y-axis stands for temper percentage in matrix

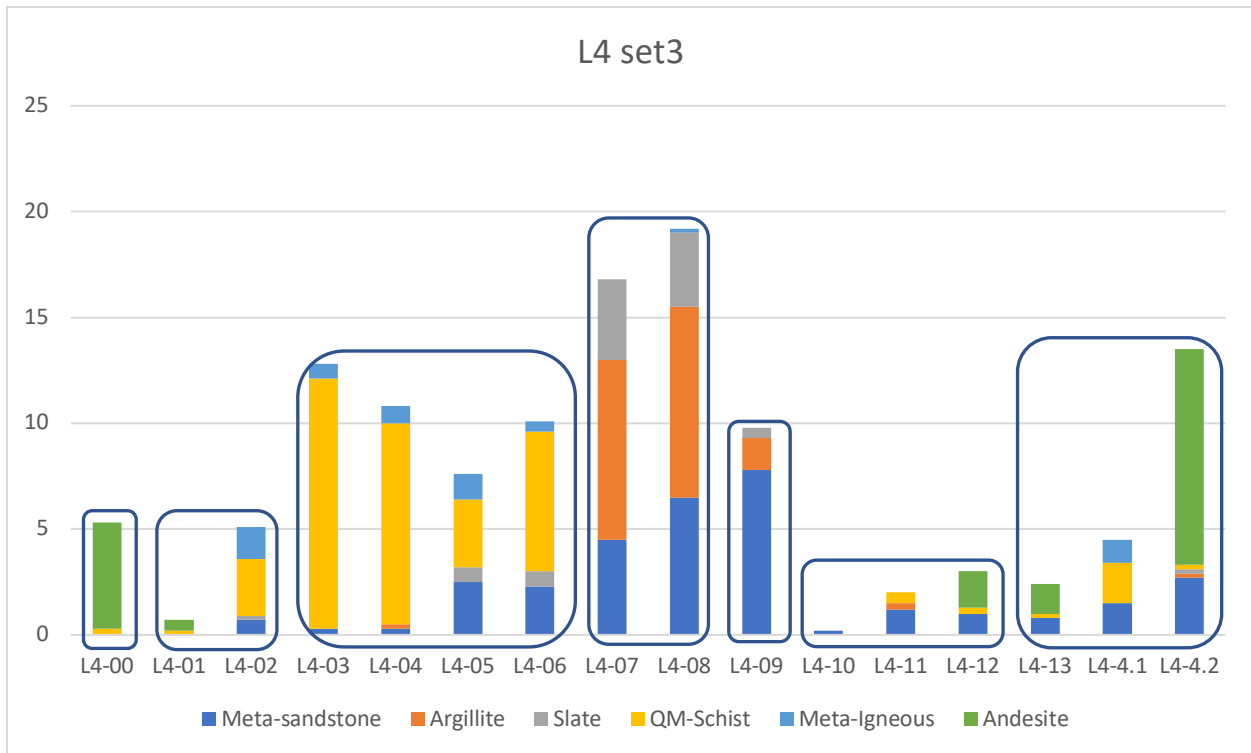


Figure 4-34 Percentage of temper types in each ceramic type. From left to right is ceramic ware A to G. Y-axis stands for temper percentage in matrix

Table 4-9 L4 set1 thin section results. Percentage of lithic fragment and minerals in each ceramic type. Data is processed and trimmed for better visualization. Meta-ss=meta-sandstone, Arg=argillite, Sla=slate, QM-sch=quartz-mica schist, Gran=granite, Ande=andesite, Qp=quartz-poly, Qm=quartz-mono, cal=calcite, Bio=biotite, Fel=feldspar, Pla=Plagioclase, Pry=Pyroxene, Hor=Hornblende. These abbreviations also apply to Table 4-10, Table 4-12, Table 4-13.

	META- S S	ARG	SLA	QM-SCH	META- IG N	GRAN	ANDE	QP	QM	MARBLE/CA L	MICA/BI O	FEL/PLA	PRY/HO R
L4-00	14.4	0	0.22	1	0	0	0.78	5.76	6.31	0.44	0	2.66	0
L4-01	0.26	0	0	0	0	3.39	3.66	1.04	4.18	0	1.17	1.44	3.79
L4-02	0.41	0	0	0.2	0.41	3.05	0.81	0	3.66	0	1.42	2.44	1.62
L4-03	6.77	0.6	0.3	2.56	0	2.86	0.45	4.22	6.18	2.86	0.3	2.56	0
L4-04	2.02	0.25	0.25	9.21	0.5	0.25	0	6.31	3.03	0.5	0	0.13	0
L4-05	1.73	0	0	4.26	0.4	0.53	0	6.92	6.12	0.27	0	0.53	0
L4-06	7.77	1.17	0.39	2.91	0.19	1.94	0	2.91	10.49	0.78	0.19	0.77	0
L4-07	2.81	5.62	3.87	0	0	0	0	0	1.23	0	0	0	0
L4-08	15.25	4.54	0	0	0	0	0	0	0	0	0	0	0
L4-09	15.06	6.76	0.39	0	0	0	0	0	0.77	0	0	0	0
L4-10	0	0	0	1.29	0	0	0.18	2.39	13.6	0	0.18	0.74	0.37
L4-11	0	0	0	0	0	0	3.37	0.45	6.05	0	0	2.02	1.35
L4-12	0.57	0	0	0	0	0	4.75	0.95	4.36	0	0	4.75	2.47
L4-4.1	4.88	0.23	0.93	4.88	0.23	0	4.65	2.79	4.88	0	0.23	5.11	3.95

Table 4-10 L4 set3 thin section. Percentage of lithic fragment and minerals in each ceramic type. Data is processed and trimmed for better visualization

	META- S S	ARG	SLA	QM-SCH	META- IG N	GRAN	ANDE	QP	QM	MARBLE/C AL	MICA/BI O	FEL/PLA	PRYO/HOR N
L4-00	0	0	0	0.3	0	0	5	3.5	1.8	0	0	3.3	2.7
L4-01	0	0	0	0.2	0	0	0.5	0.7	3.3	0	0	2.4	1.4
L4-02	0.7	0	0.2	2.7	1.5	0	0	6	2.2	6.7	0	1	0
L4-03	0.3	0	0	11.8	0.2	0.5	0	7.2	2.3	4	0.5	0.5	0
L4-04	0.3	0.2	0	9.5	0.5	0.3	0	3.3	1.2	4.9	1.3	0	0
L4-05	2.5	0	0.7	3.2	0	1.2	0	4.3	1.2	2.5	0.3	0	0
L4-06	2.3	0	0.7	6.6	0.5	0	0	1.5	1.5	0.7	0.8	0	0
L4-07	4.5	8.5	3.8	0	0	0	0	1.5	0.5	0	0	0	0
L4-08	6.5	9	3.5	0	0.2	0	0	0.8	0.3	0	0	0	0
L4-09	7.8	1.5	0.5	0	0	0	0	0.3	0	0	0	0	0
L4-10	0.2	0	0	0	0	0	0	1.3	6.3	0	0	1.1	0.5
L4-11	1.2	0.3	0	0.5	0	0	0	0.5	7.7	0	0	1.5	0.5
L4-12	1	0	0	0.3	0	0	1.7	0.8	0.7	0	0.2	2.5	3.3
L4-13	0.8	0	0	0.2	0	0	1.4	0.4	1.6	0	0	3	1.4
L4-4.1	1.5	0	0	1.9	0.3	0.8	0	5.3	4.7	1.7	0.5	0.3	0
L4-4.2	2.7	0.2	0.2	0.2	0	0	10.2	0.7	0.3	0	0	5	3.7

4.4.3. Result of L6 Lower Layer

The results of L6 analyses also show multiple temper sources among the ceramic wares. The technical typological analysis shows that no known archaeological ceramic assemblage can be associated with the L6 ceramics. However, the ceramics similar to the dominant L6 ceramic Ware A are indeed recovered from several other sites, such as the Huakangshan site in Hualien. Intriguingly, the temper of L6 Ware A is not local to the BHB site, and the Ware F black pottery temper is also not as I expected it to be the same as L4 Ware F. In the following section, I shall present the result by wares and temper sources. Like the L4 specimens, most thin-section photos were taken at 40x, except for a few taken at 100x. Roughly ten sets of open-nicol and crossed-nicol photos are taken for each specimen. Selected open and crossed-nicol photos are presented side-by-side.

4.4.3.1. Ware A

In this ware, large pieces of argillite and slate fragments are tempers. Broadly speaking, the Ilan Plain is the provenience of those tempers; however, based on the proportion of argillite and slate in the matrix, it is possible to distinguish which side of the Lanyang River the temper comes from. Figure 4-35 (upper) shows a huge chunk of argillite and meta-sandstone fragment next to it. The lower side of the figure shows meta-sandstone and slate. Slate has a laminated structure.

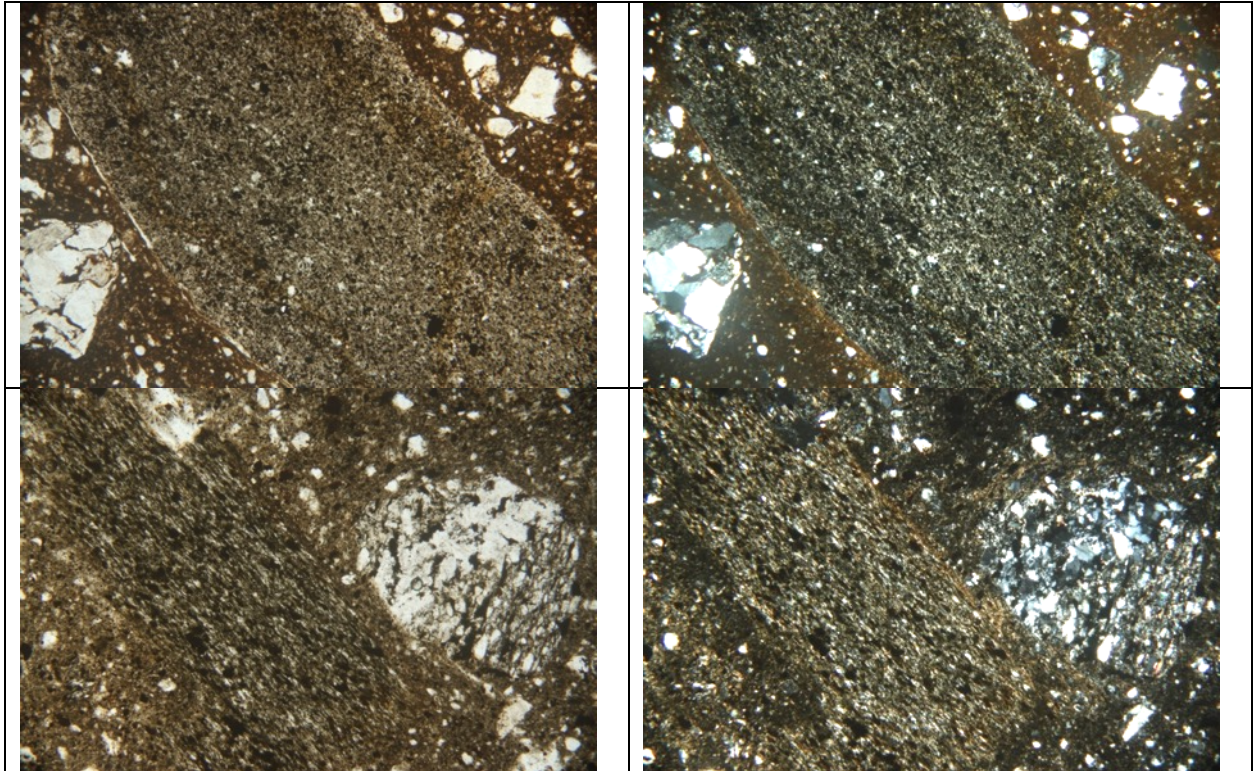


Figure 4-35 Uppers: ceramic type 1, specimen number L6-1-1a-40x. Lower: ceramic type 2, specimen number L6-2-1c-40x

4.4.3.2. Ware B

Type 3 and 4 share similar temper composition. Both have meta-sandstone, argillite, and slate. Figure 4-36 shows a huge slate fragment with two calcite pieces next to it. The combination of these rocks and minerals could come from the Baimi River close to Suao. Type 4.1 (lower photos) has calcite, meta-sandstone, biotite, and mica as temper. This temper combination is rare and might be from BHB local.

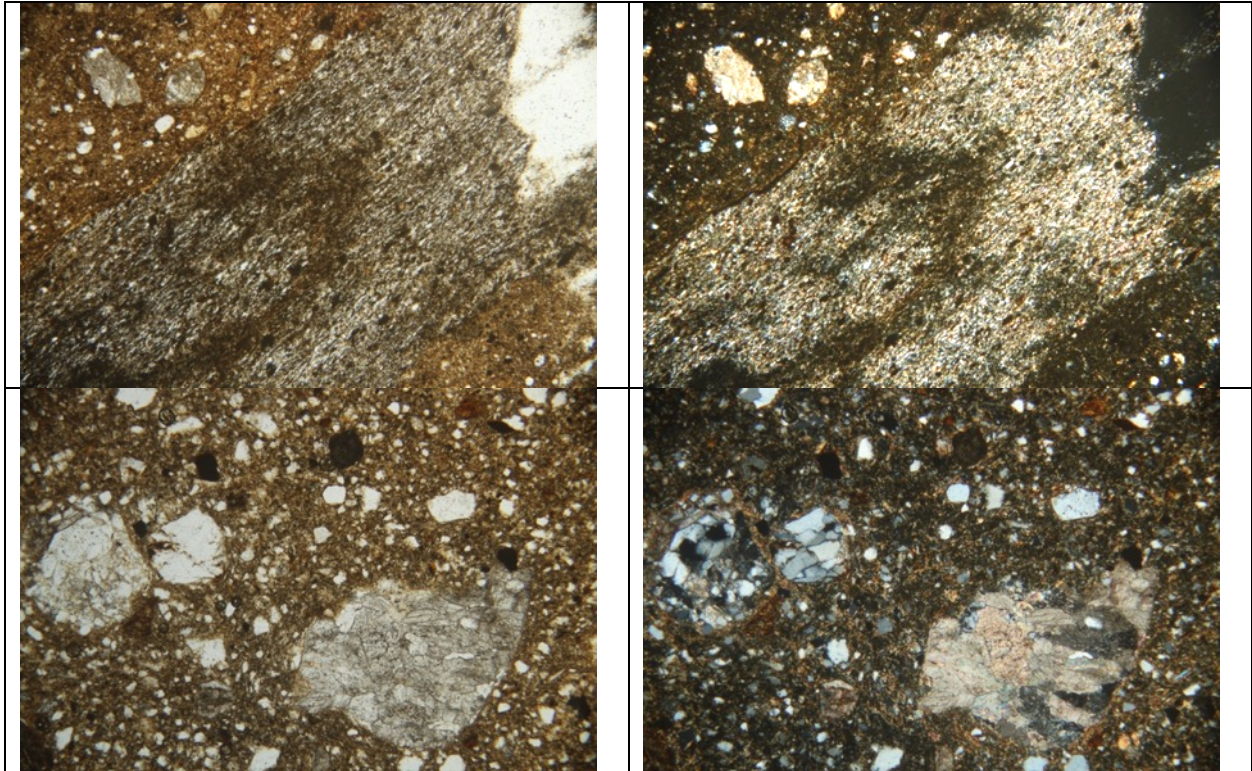


Figure 4-36 Uppers: ceramic type 3, specimen number L6-3-6c-40x. Lower: ceramic type 4.1, specimen number L6-4.1-6c-40x

4.4.3.3. Ware C

Several slate and meta-sandstone fragments can be observed easily under open-nicol lighting. Figure 4-42 and Table 4-11 also reveal quartz-mica schist, argillite, and calcite (especially type 6) as temper. Basically, this temper combination should come from the Suao area in that the Baimi River watershed contains calcite.

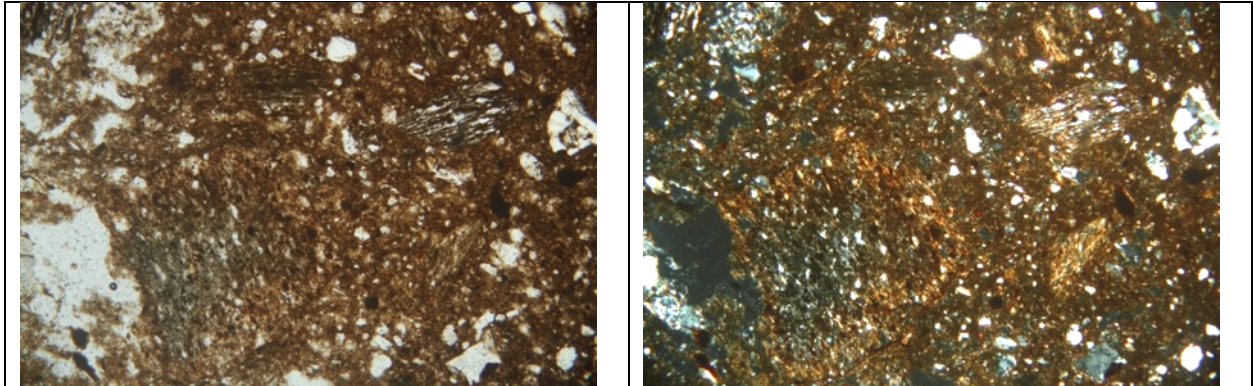


Figure 4-37 Ceramic type 5, specimen number L6-5-5c-40x

4.4.3.4. Ware D

The temper of three ceramic types in this ware is BHB locally sourced. Figure 4-38 shows the typical combination of the Heping River estuary deposits. From right to left, there are chunks of schist, marble (calcite), and granite. As mentioned before, the Heping River cuts through various formations and rock types. The downstream portion of the Heping River cuts through the Tananao Schists containing some gneiss intrusions and marble formation in the quartz-mica schist.

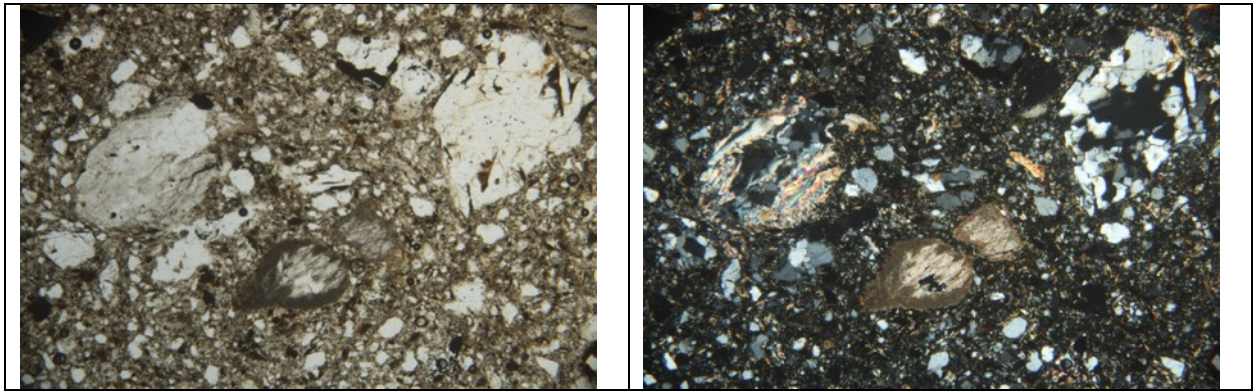


Figure 4-38 Ceramic type 10, specimen number L6-10-4c-40x

4.4.3.5. Ware E

Meta-sandstone and argillite fragments evenly distribute in the matrix. Figure 4-39 shows one large chunk of argillite and two pieces of meta-sandstone. This combination indicates the Ilan Plain, the northern side of the Lanyang River, and the Snow Mountain Range as the provenience.

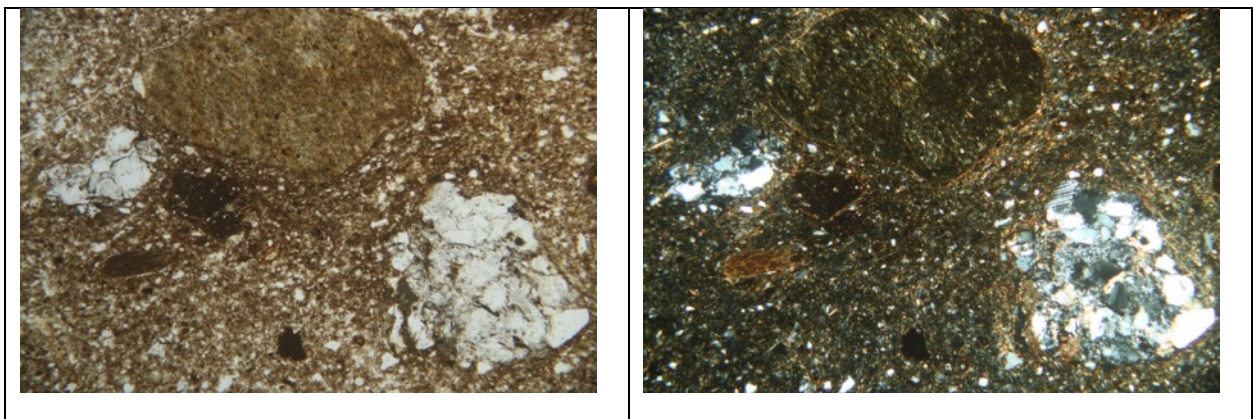
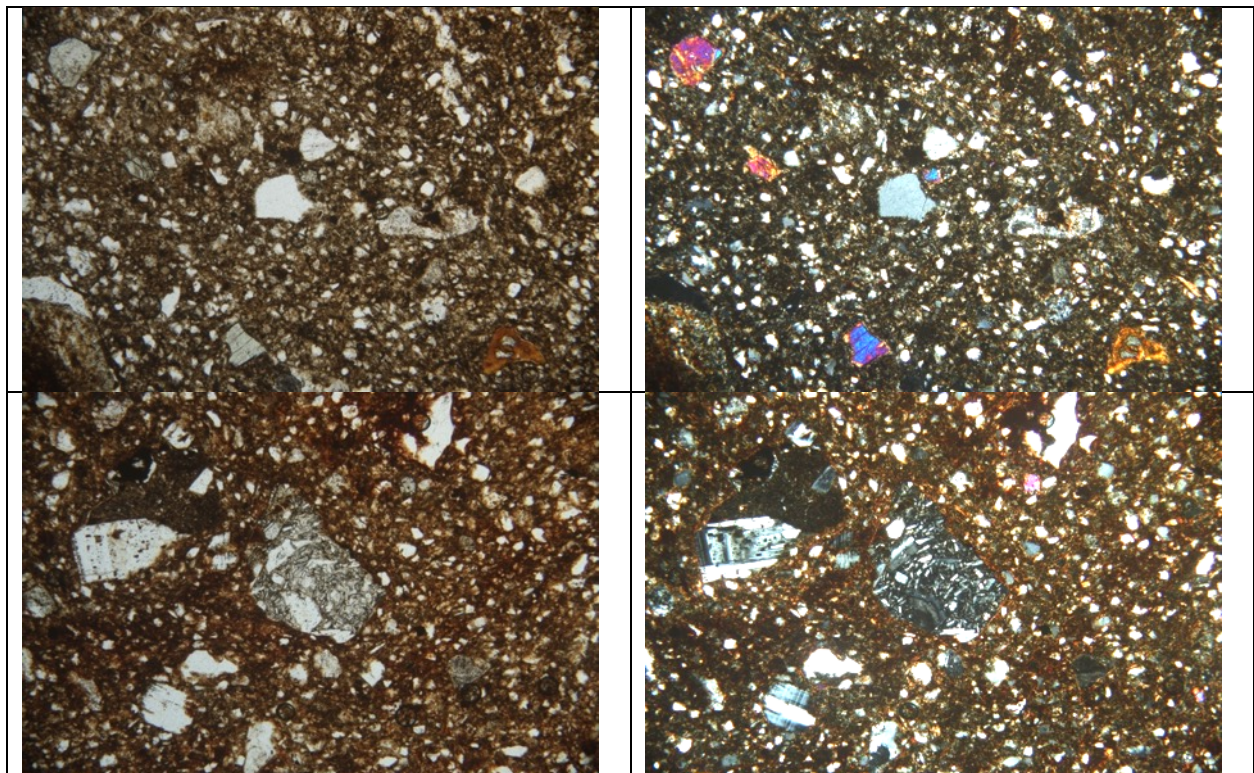


Figure 4-39 Ceramic type 7, specimen number L6-7-7c-40x

4.4.3.6. Ware F

The petrographic analysis of this ceramic ware resolves one difficulty when conducting typological analysis. It was difficult to assign type 8 to Ware F or Ware G. Type 8 ceramic shares similarities with both wares. The thin section result shows that from the temper point of view, type 8 is closer to Ware G which has a provenience in the north part of Taipei Basin or north coastal area far from the BHB site.

Type 11.9 has quartz-mica schist, metamorphic materials, and igneous materials. This combination indicates the East Rift Valley as the temper provenience. Type 12 temper has two possible sources, Suao and the East Rift Valley. Suao is an unexpected source for type 12 black pottery. There is no previous report of grayish black pottery from that area. I currently do not have any reasonable explanation for this result.



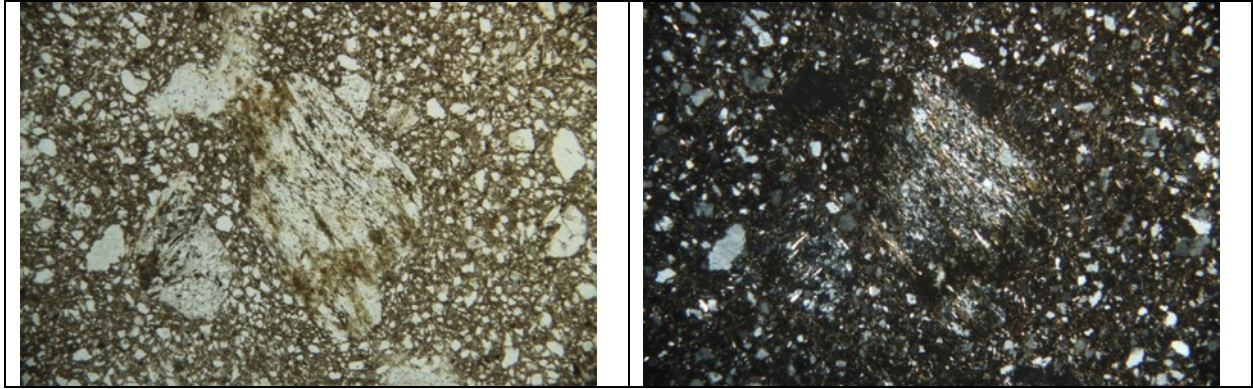


Figure 4-40 Ceramic type 8, specimen number L6-8-9c-40x; ceramic type 11.9, specimen number L6-11.9-4c-40x; ceramic type 12, specimen number L6-12-9c-40x

4.4.3.7. Ware G

Figure 4-41 shows mostly igneous rock fragments and minerals. There are several polygonal and yellow pyroxene grains on the left. Plagioclase appears in smaller grain and mostly on the right side. There is also one large piece of Andesite fragment in the upper right corner. Although not shown in Figure 4-41, argillite is also a part of the matrix (Figure 4-42 and Table 4-12). The combination of igneous materials and a tiny amount of argillite indicates the Taipei Basin (Tatun mountains) as the possible provenience.

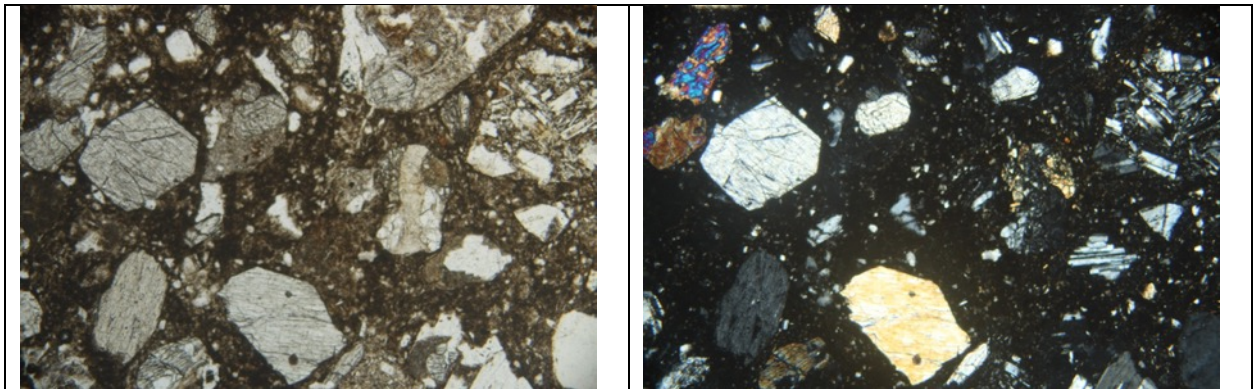


Figure 4-41 Ceramic type 9, specimen number L6-9-2c-40x

Table 4-11 Possible proveniences of L6 ceramic temper, including both set1 and set3 results.

LAB_NUMBER	PROVENIENCE	NOTE	LAB_NUMBER	PROVENIENCE	NOTE	WAR E
HB-L6-0.9-1	SUAO		HB-L6-0.9-3	ILAN PLAIN	CLOSE TO SUAO	A
HB-L6-1-1	SNOW M. RANGE		HB-L6-1-3	ILAN PLAIN		
HB-L6-2-1	ILAN PLAIN		HB-L6-2-3	SUAO		
HB-L6-3-1	ILAN PLAIN		HB-L6-3-3	SUAO		B
HB-L6-4-1	ILAN PLAIN	BAIMI RIVER?	HB-L6-4-3	SUAO		
HB-L6-4.1-1	BHB		HB-L6-4.1-3	CENTRAL M. RANGE	BHB?	
HB-L6-5-1	SUAO	SOUTH OF LANYAN G RIVER	HB-L6-5-3	SUAO		C
HB-L6-6-1	SUAO	BAIMI RIVER?	HB-L6-6-3	SUAO	BAIMI RIVER?	
HB-L6-10-1	BHB		HB-L6-10-0	CENTRAL M. RANGE	BHB?	D
HB-L6-11-1	BHB		HB-L6-11-3	SNOW M. RANGE	?	
HB-L6-11.1-1	BHB		HB-L6-11.1-3	ILAN PLAIN	NORTH OF LANYANG RIVER	
HB-L6-7-1	SNOW M. RANGE		HB-L6-7-3	SNOW M. RANGE	COULD BE FROM META- SANDSTON E OUTCROP	E
HB-L6-8-1	IGNEOUS ROCK AREA	COULD BE SSH	HB-L6-8-3	IGNEOUS ROCK AREA	SHOULD BE SSH	F
HB-L6-11.9-1	EAST RIFT VALLEY		HB-L6-11.9-3	COASTAL M. RANGE		
HB-L6-12-1	SUAO	COULD BE EAST RIFT VALLEY	HB-L6-12-3	EAST RIFT VALLEY	CLOSE TO COASTAL M. RANGE	
HB-L6-8.9-1	IGNEOUS ROCK AREA	SHOULD BE SSH	HB-L6-8.9-3	COASTAL M. RANGE		G
HB-L6-9-1	IGNEOUS ROCK AREA	WITHOUT QM- SCHIST	HB-L6-9-3	IGNEOUS ROCK AREA	SHOULD BE SSH	

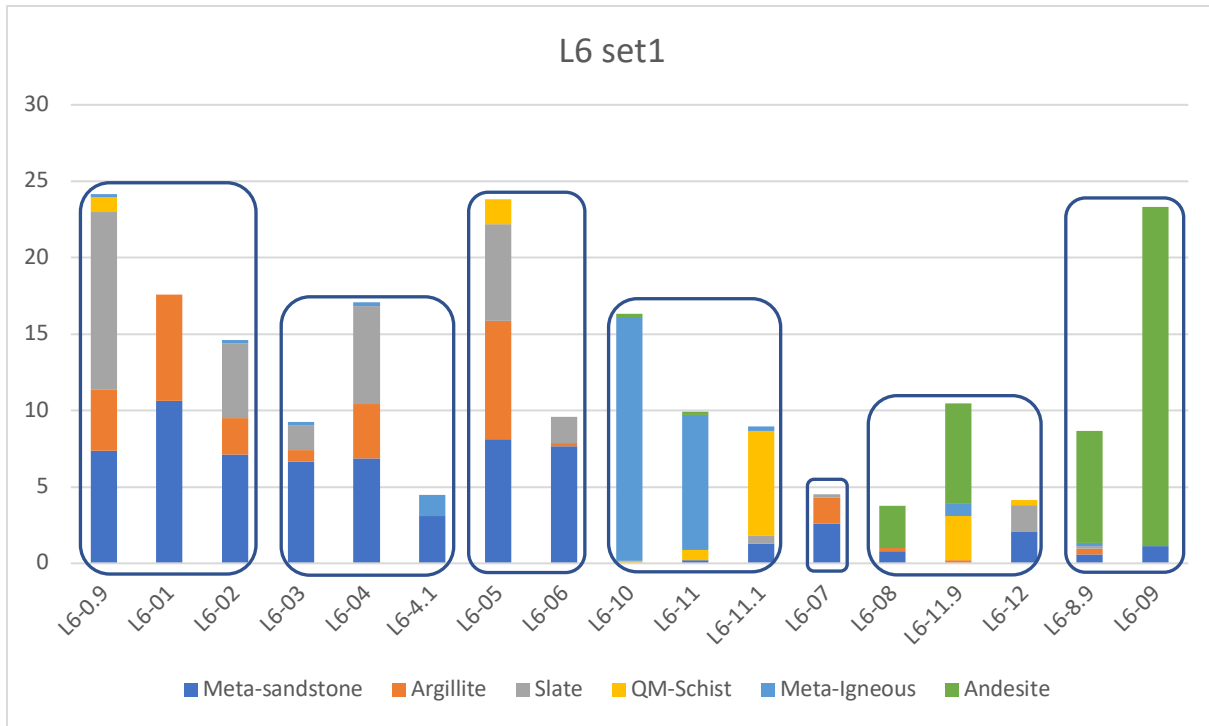


Figure 4-42 Percentage of temper types in each ceramic type. From left to right is ceramic ware A to G. Y-axis stands for temper percentage in matrix

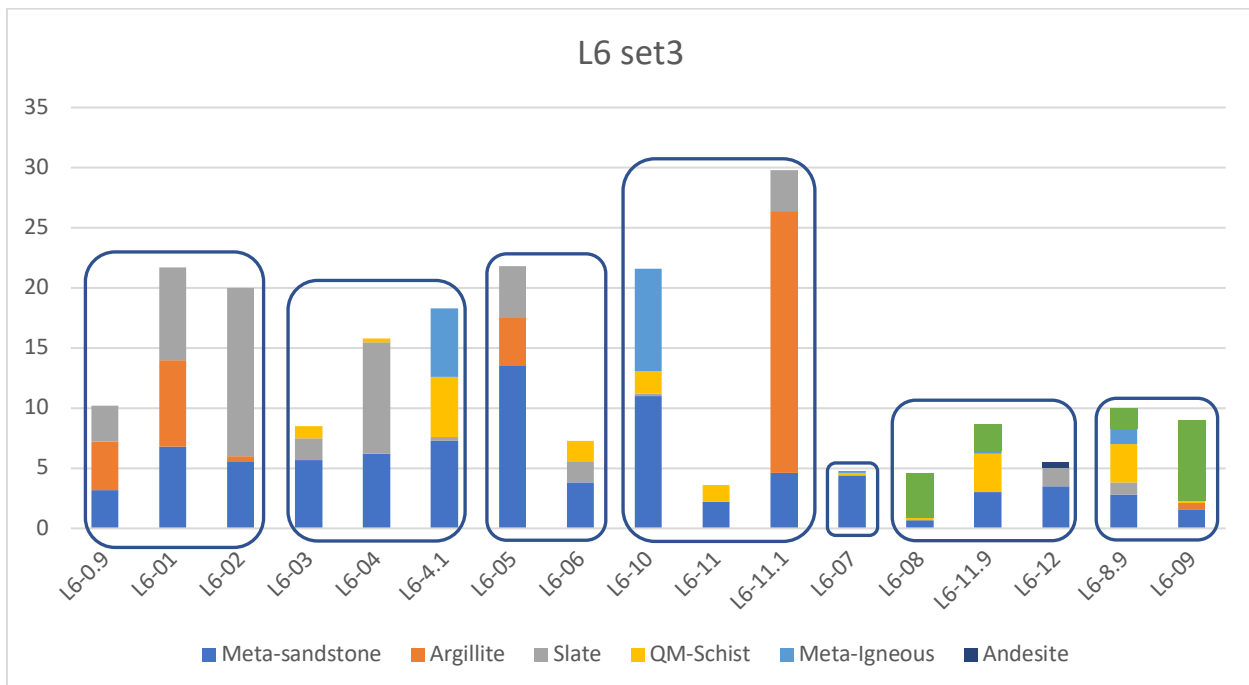


Figure 4-43 Percentage of temper types in each ceramic type. From left to right is ceramic ware A to G. Y-axis stands for temper percentage in matrix

Table 4-12 L6 set1 thin section. Percentage of lithic fragment and minerals in each ceramic type. Data is processed and trimmed for better visualization

	META- S S	ARG	SLA	QM-SCH	META- IG N	GRAN	ANDE	QP	QM	MARBLE/C AL	MICA/BI O	FEL/PLA	PRYO/HOR N
L6-0.9	7.35	4.03	11.61	0.95	0	0.24	0	0.95	0.71	0	0	0	0
L6-01	10.64	6.963	0	0	0	0	0	0	3.87	0	0	0	0
L6-02	7.12	2.37	4.93	0	0	0.18	0	0.18	2.01	0	0	0	0
L6-03	6.65	0.74	1.66	0	0	0.19	0	0	1.85	4.43	0	0.56	0
L6-04	6.87	3.56	6.4	0	0	0.24	0	1.9	0	0	0	0	0
L6-4.1	3.1	0	0	0	1.21	0.17	0	2.41	10.69	4.66	2.76	0.87	0.17
L6-05	8.14	7.74	6.31	1.63	0	0	0	3.26	3.46	0	0	0	0
L6-06	7.66	0.21	1.7	0	0	0	0	0.85	0.43	5.96	0	0	0
L6-10	0	0	0	0.18	0	15.96	0.18	1.65	12.11	5.69	0.18	0	0
L6-11	0.22	0	0	0.65	0	8.84	0.22	3.88	5.17	1.08	1.51	0.44	0
L6-11.1	1.28	0	0.51	6.89	0	0.26	0	2.04	3.06	0	0.26	0	0
L6-07	2.58	1.71	0.21	0	0	0	0	0.21	1.71	0.21	0	0.43	0
L6-08	0.79	0.2	0	0	0	0	2.76	1.18	19.29	0	0	1.57	0
L6-11.9	0	0.19	0	2.9	0.39	0.39	6.58	2.13	14.31	0	0	1.93	0.39
L6-12	2.08	0	1.73	0.35	0	0	0	0.52	0.87	0	0	0	0
L6-8.9	0.57	0.38	0.19	0	0.19	0	7.35	0.38	3.58	0.57	0	1.7	2.07
L6-09	1.12	0	0	0	0	0	22.2	1.12	3.14	0	0	6.28	3.812

Table 4-13 L6 set3 thin section. Percentage of lithic fragment and minerals in each ceramic type. Data is processed and trimmed for better visualization

	META- S S	ARG	SLA	SCH	META- I G N	GRAN	ANDE	QP	QM	MARBLE/C AL	MICA/BI O	FEL/PLA	PRYO/HOR N
L6-0.9	3.2	4	3	0	0	0	0	0.2	0	0	0	0	0
L6-01	6.8	7.2	7.7	0	0	0	0	0.5	0.2	0	0	0	0
L6-02	5.5	0.5	14	0	0	0	0	1.7	0.2	0	0	0	0
L6-03	5.7	0	1.8	1	0	0	0	1.5	0.2	6.3	0	0.2	0
L6-04	6.2	0	9.3	0.3	0	0	0	0.2	0.2	0	0	0	0
L6-4.1	7.3	0	0.3	5	5.7	0	0	1.3	2	0	0	0	0
L6-05	13.5	4	4.3	0	0	0	0	0.5	0.8	0	0	0	0
L6-06	3.8	0	1.7	1.8	0	0	0	0	0.2	12.4	0	0	0
L6-10	11	0	0.2	1.9	8.5	0	0	2.2	0.8	0	0	0	0
L6-11	2.2	0	0	1.4	0	0	0	9.6	1.2	5.6	0.2	0.2	0
L6-11.1	4.6	21.8	3.4	0	0	0	0	0	0	0	0	0	0
L6-07	4.4	0	0	0.2	0.2	0	0	1	0	2.2	0	0	0
L6-08	0.7	0	0	0.2	0	0	3.7	1.3	0.5	0.2	0.2	2.3	0.5
L6-11.9	3	0	0	3.2	0.3	0	2.2	1.8	0.2	0	0.2	1.3	0.5
L6-12	3.5	0	1.6	0	0	0	0.4	0.5	0	0	0	1.7	0
L6-8.9	2.8	0	1	3.2	1.3	0	1.7	2.2	0.3	0.2	0	1.8	0.3
L6-09	1.6	0.5	0	0.2	0	0	6.7	0.9	0.9	0	0	3.3	3

4.4.4. Summary of Petrographic Analysis

In sum, petrographic analysis shows five sources for the temper for both L4 and L6 specimens. Those are BHB local, the southern part of the Ilan Plain, the northern part of the Ilan Plain, the Igneous/volcanic areas, and the East Rift Valley. It is reasonable to say that the BHB ceramic temper was acquired from locations ranging all over northern and eastern Taiwan.

From a technical typological perspective, this petrographic analysis of temper provenience mainly consists with the macro analysis (by naked-eye) results, in other words, the ceramics in the same Ware have the same temper provenience. However, it is hard to ignore the inconsistency between L6 Type 11.1 in and other two types in Ware D (Figure 4-42 and Figure 4-43). Same ceramic technical tradition but with two temper proveniences (BHB local and Snow Mountain Range). L6 Ware D is identical to L4 Ware C. While L6 Ware D is the minority in L6 assemblage, but L4 Ware C is the dominant in L4.

The dominant ceramic types (Ware C) in L4 could mostly be BHB local products (Figure 4-44), and in contrast, L6 dominant ceramic types (Ware A and B) mostly come from the southern part of the Ilan Plain, some especially can be identified to the Baimi River next to Suao (Figure 4-45). Non-local ceramic as the dominant type is not common but indeed exist in the context of Taiwan archaeological studies. While seven km radius is usually the rational economic distance for raw material procurement (Arnold 2011:87), it seems that ancient eastern Taiwanese people had a long tradition of acquiring non-local pottery.⁷⁰ The meaning behind this result is intriguing. Was there a ceramic specialization? Or the non-local wares were used as vessels containing commodities that BHB L6 people gained from southern Ilan where they went to provide services and trade.

One case of using non-local ceramic as daily-use ware is the SSH cultural assemblage, Jiushe 舊社 subset ceramics. The SSH Jiushe (abandoned settlement) subset⁷¹ ceramics are mostly Ilan Plain products (CHEN 陳有貝 2005; LIU 劉益昌 2002). This could associate with the subsistence

⁷⁰ Personal communication with Dr. CHAO Chin-yung (2021).

⁷¹SSH cultural assemblage Jiushe subset distributes from Tamsui 淡水 River estuary along the north coast to the northern part of the Ilan Plain.

of the Basay people who exchanged food and ceramic wares with the Kiwulan people in the Ilan Plain. I will explore this more later in the discussion. The black pottery (L4 and L6 Ware F) could mostly be from igneous area, Taipei, or the Coastal Mountain Range, based on the temper source.

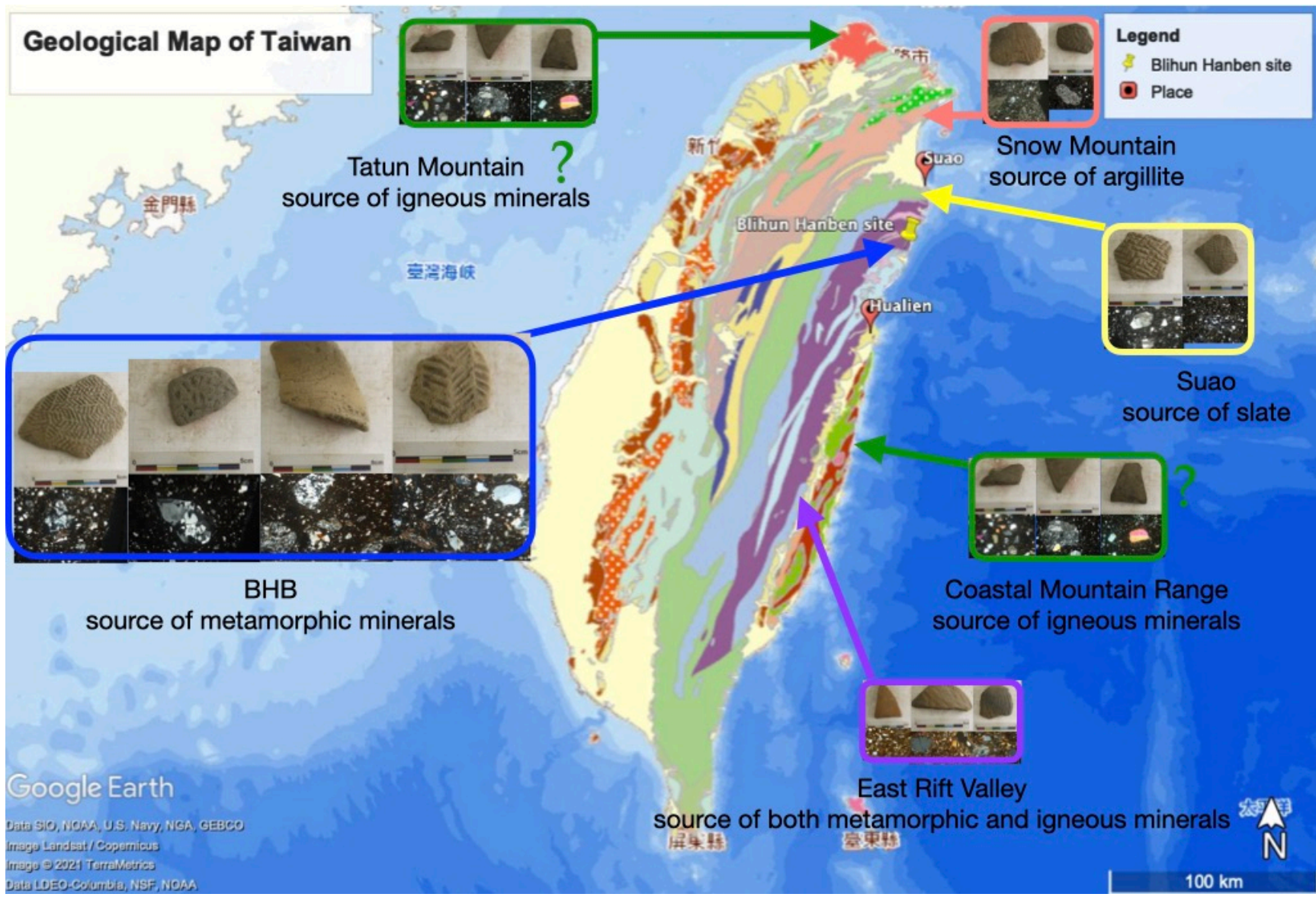


Figure 4-44 L4 ceramic petrographic analysis shows five possible sources of temper. The size of each rounded square ceramic ware is proportional to their amount in the examined ceramic assemblage

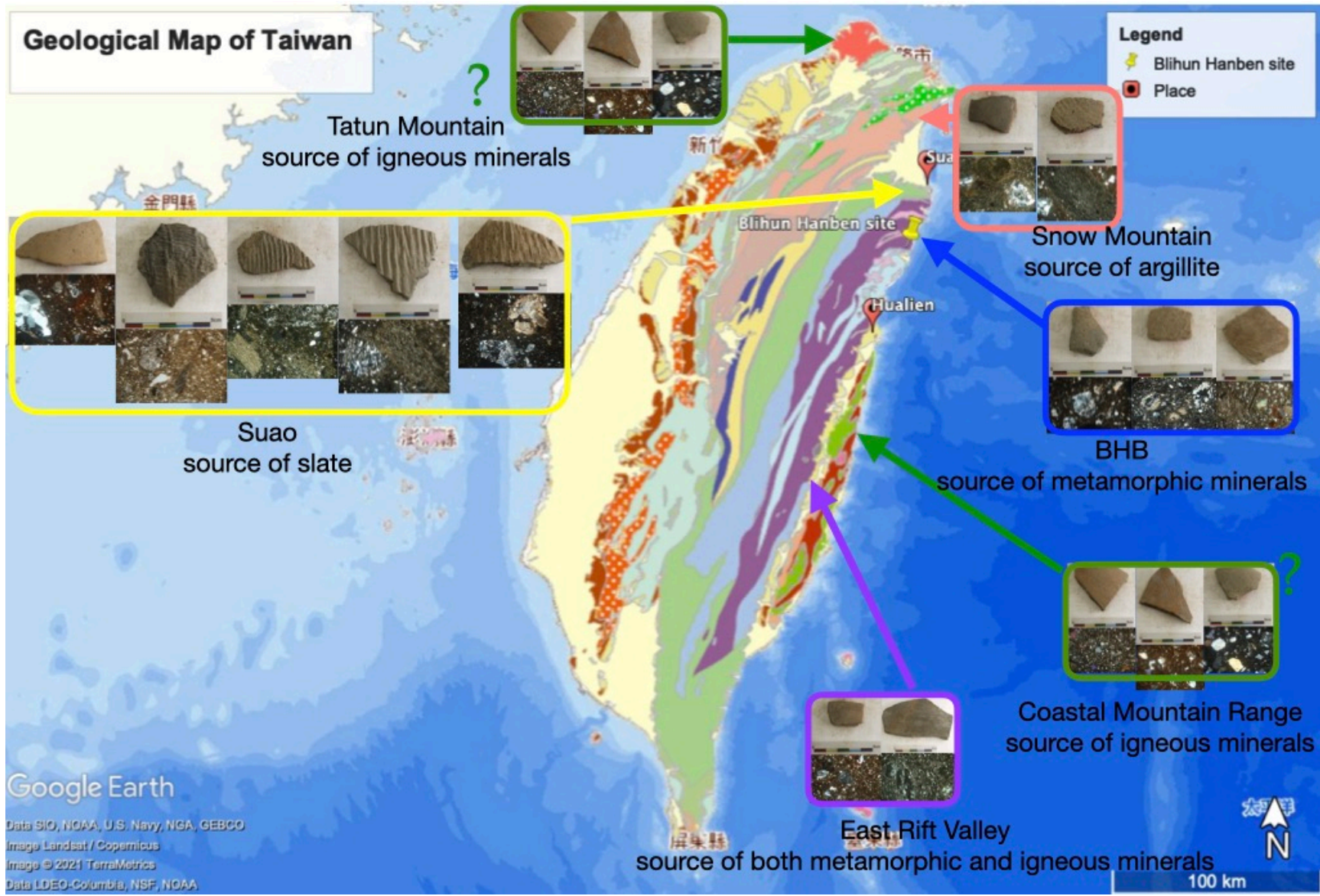


Figure 4-45 L6 ceramic petrographic analysis shows five possible sources of temper. The size of each rounded square ceramic ware is proportional to their amount in the examined ceramic assemblage

4.5. Interpretation of the BHB Ceramic Analyses

With the results from both technical typological and petrographic analyses, I have outlined the characteristics of the BHB ceramic assemblages. Are those ceramics known to Taiwan archaeologists? Are we seeing the ceramic remains from hypothetical trade diaspora communities?

4.5.1. Are These Known Archaeological Cultural assemblage in Taiwan?

In the salvage project report, BHB L4 upper layer is identified as the Shihshanghang cultural Pulowan/Puluowan 普洛灣類型 subset (LIU 劉益昌 et al. 2016). The Pulowan subset was proposed in the 1990s (LIU 劉益昌 1990b, 1990c) and has been better understood because of subsequent research (LIU 劉益昌 2008, 2009; YIN 尹意智 and YAO 姚書宇 2020) in recent years. These recent studies have revised the dating of this cultural assemblage subset to 1500-300 cal. BP, and the new dating results from the BHB site push the earliest date to 1600 cal. BP. The northern boundary of this Pulowan subset is a bit north of the Lanyang River, and the southern boundary is the Chongde site (a bit south of the Liwu River, Figure 4-47). The Pulowan subset is well known for the geometric motif and black-polished ceramic, metal and metallic pyro-technological remains, and flexed, laid position indoor burials in rectangular slate and schist coffins (Figure 4-46).

LIU 劉益昌 (1990c) classified eight ceramic types for this assemblage subset, and the subsequent studies mostly follow his classification. Table 4-14 shows the comparison between previous ceramic types and my ceramic wares. It is clear that my ceramic typological system matches the previously defined ceramic types. Also, the BHB L4 ceramic assemblage shows the 'southeast element,' such as horizontal pot handles, ceramic with grid/geometric/cloud patterns, and Kueishan ceramic with anthropomorphic patterns; the same as the other Pulowan-subset sites. Hence, from a ceramic perspective, it is reasonable to say that the BHB L4 ceramics could be designated to the previously defined SSH cultural assemblage Pulowan subset.

Table 4-14 Comparison of Pulowan subset ceramic type between previous studies and my research (also confirmed with the pioneer researcher Prof. LIU Yi-Chang)

CHONGDE	BLIHUN HANBEN
TYPE1, DOMINANT TYPE	WARE C, DOMINANT WARE
TYPE2	WARE D AND E
TYPE3	MAY BE WARE A
TYPE4	WARE B
TYPE5, REDDISH AND POLISHED	MAY BE WARE F
TYPE6, POLISHED BLACK	WARE F
TYPE7	WARE G
TYPE8, CHINGPU	MAY BE WARE G

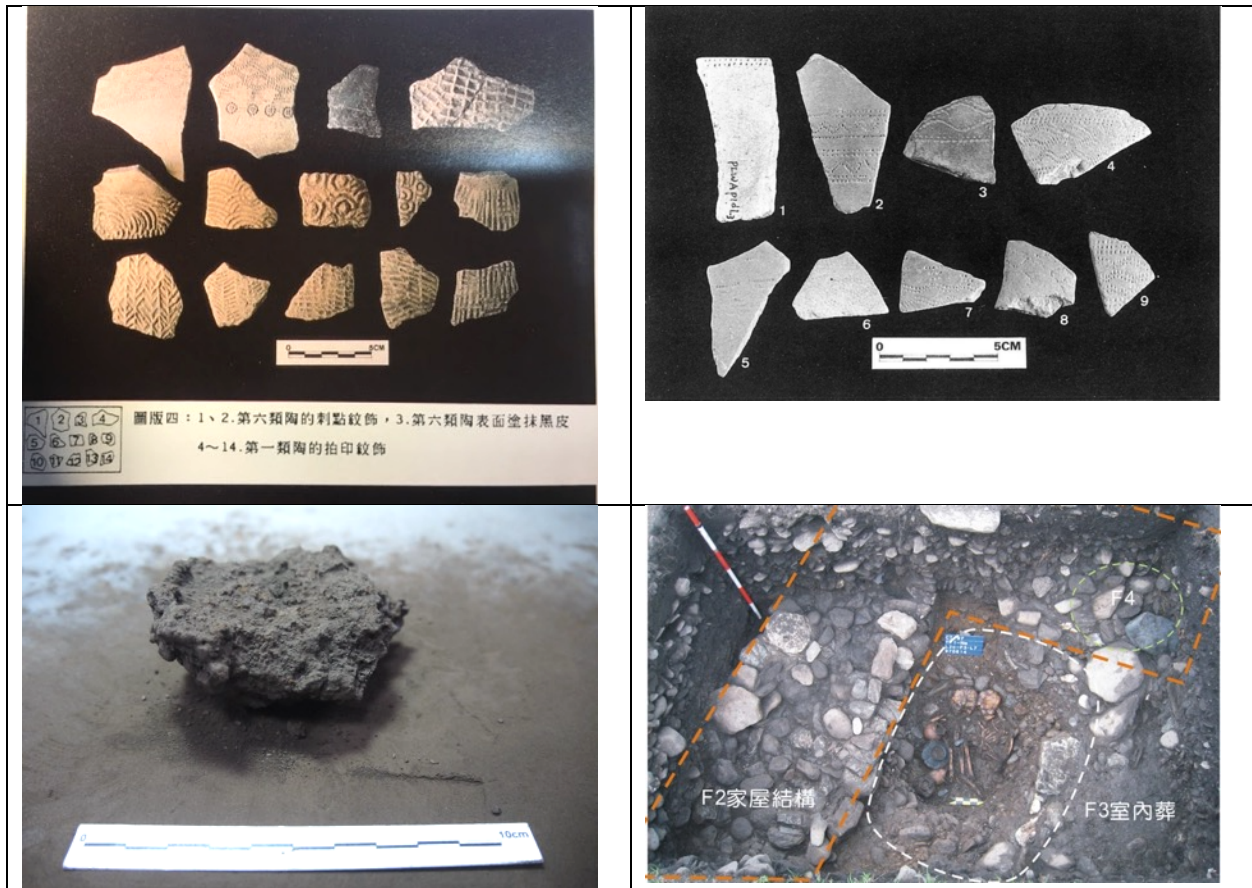


Figure 4-46 Upper left: ceramics from the Chongde site. Numbers one to three are LIU Yi-Chang (LIUYC)'s Pulowan type 6, and the rest are type 1; upper right: Pulowan subset type 6 ceramic sherd from the Pulowan site; lower left: smelting hearth bottom from the Chongde site; Lower right: house foundation structure and indoor burial of two individuals with flexed, laid position. There are a pair of burial pots, one is orange (LIUYC's type 1) and the other one is black (LIUYC's type 6). Upper left, right, and lower right figures are courtesy of LIU Yi-Chang (Liu 1990a, 1990b, 2008)

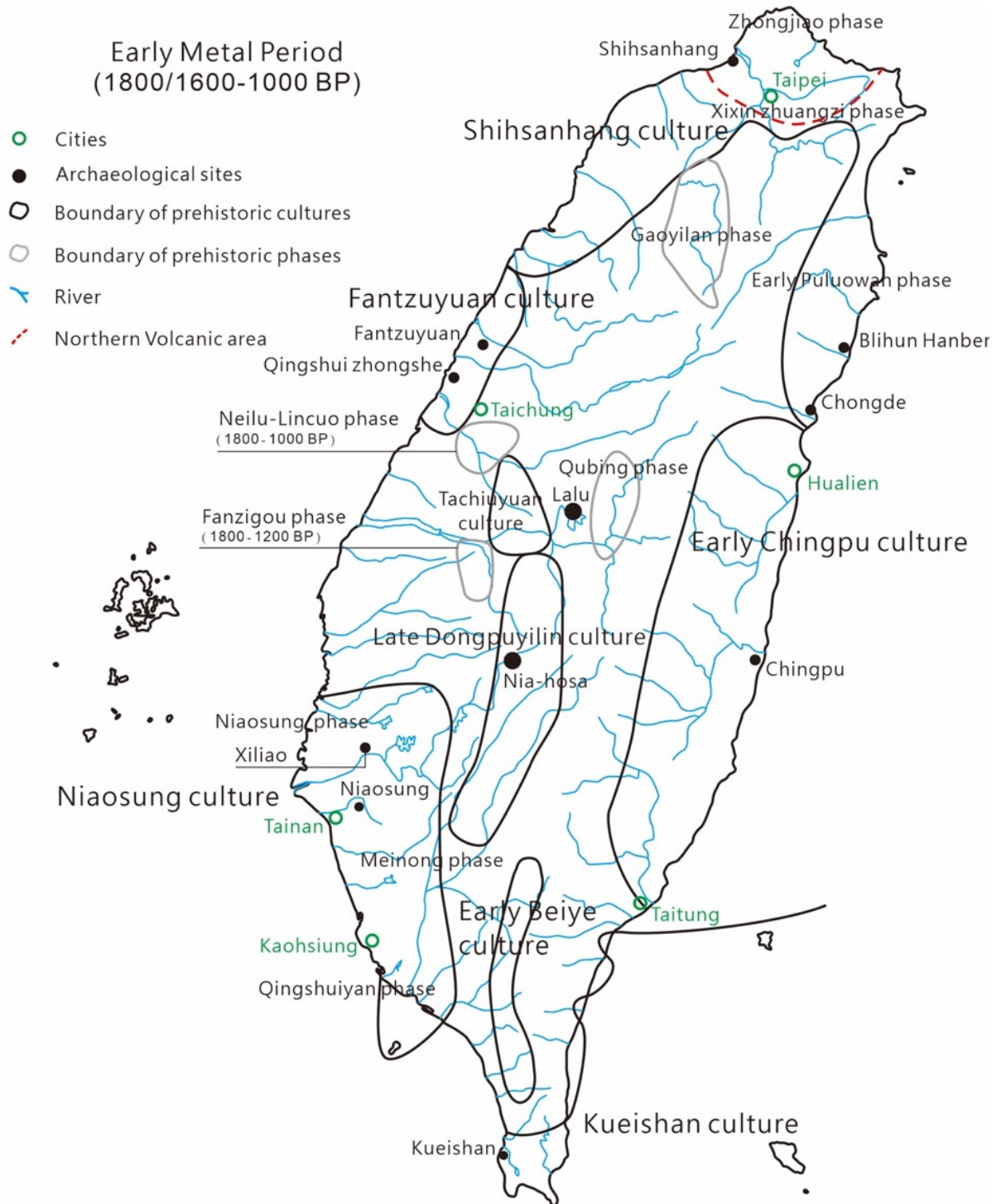


Figure 4-47 Map of archaeological cultures (cultural assemblages and its subsets) in the Early Metal period

Regarding the L6 ceramic assemblage, the salvage project does not reach any conclusive remarks in the report. I also agree that it is hard to associate this L6 ceramic assemblage with any known archaeological cultural assemblages in the current research state. However, similar ceramics to those L6 dominant ceramics (Ware A) with large grayish and black schistosity texture lithic fragments (confirmed as slate and argillite) as temper are indeed visible but in a small quantity from some sites in Hualien, Taipei, the mountainous area of Taoyuan, and Taichung area (CHAO 趙金勇 et al. 2013; CHU 朱正宜 and CHANG 張益生 2020; LIU 劉益昌 2010a; PAN 潘怡仲 2004). Currently, it would be too bold to relate the Taichung and Taoyuan mountainous area (west side of Taiwan) with the BHB site as there is an over 3000m mountain range in between these two locations.

As for the nearby region, the newly identified Upper Huakangshan cultural assemblage (Figure 4-49) (CHAO 趙金勇 et al. 2013) from the Huakangshan site in Hualien indeed shares similarities regarding ceramic types (Upper Huakangshan cultural assemblage type B-V, B-VI, B-VII, and B-III⁷²) with the BHB L6 ceramic Wares A, D and F. While the BHB L6 layer is contemporary to the Upper Huakangshan cultural assemblage (2100-1600 cal BP, *ibid*, p.70) and is geographically close to the Huakangshan site, the relation between these two sites is noteworthy.⁷³ CHAO and LIU also mention (CHAO 趙金勇 et al. 2013:71; LIU 劉益昌 2013a), besides the ‘southern’ ceramics (BHB L4 and L6 Ware F, Upper HKS type B-VII, polished smudged black pottery), the Upper HKS type-V and VI ceramics (Figure 4-48) (same as the BHB L6 Ware A) seem to have certain connections with northern Taiwan mountainous area archaeological cultures. By analyzing temper source and ceramic morphology, CHU 朱正宜 and CHANG 張益生 (2020) also points out the interaction between the Taipei basin, north coast, and southern Ilan Plain during the late Neolithic to initial Metal period.

⁷² B-V and B-VI ceramics are 9.9%, and B-III is 1.5% in the Upper HKS Culture ceramic assemblage.

⁷³ Other than ceramic, BHB L6 layer shares similarities with the Upper Huakangshan Culture from lithic remains to burial practice. I shall come back to this in the discussion chapter.

Although it is too early to designate BHB L6 ceramics to any known archaeological cultural assemblage, both technical typological and petrographic analyses imply the connections between the BHB L6 ceramics to the south and to the north of eastern Taiwan.

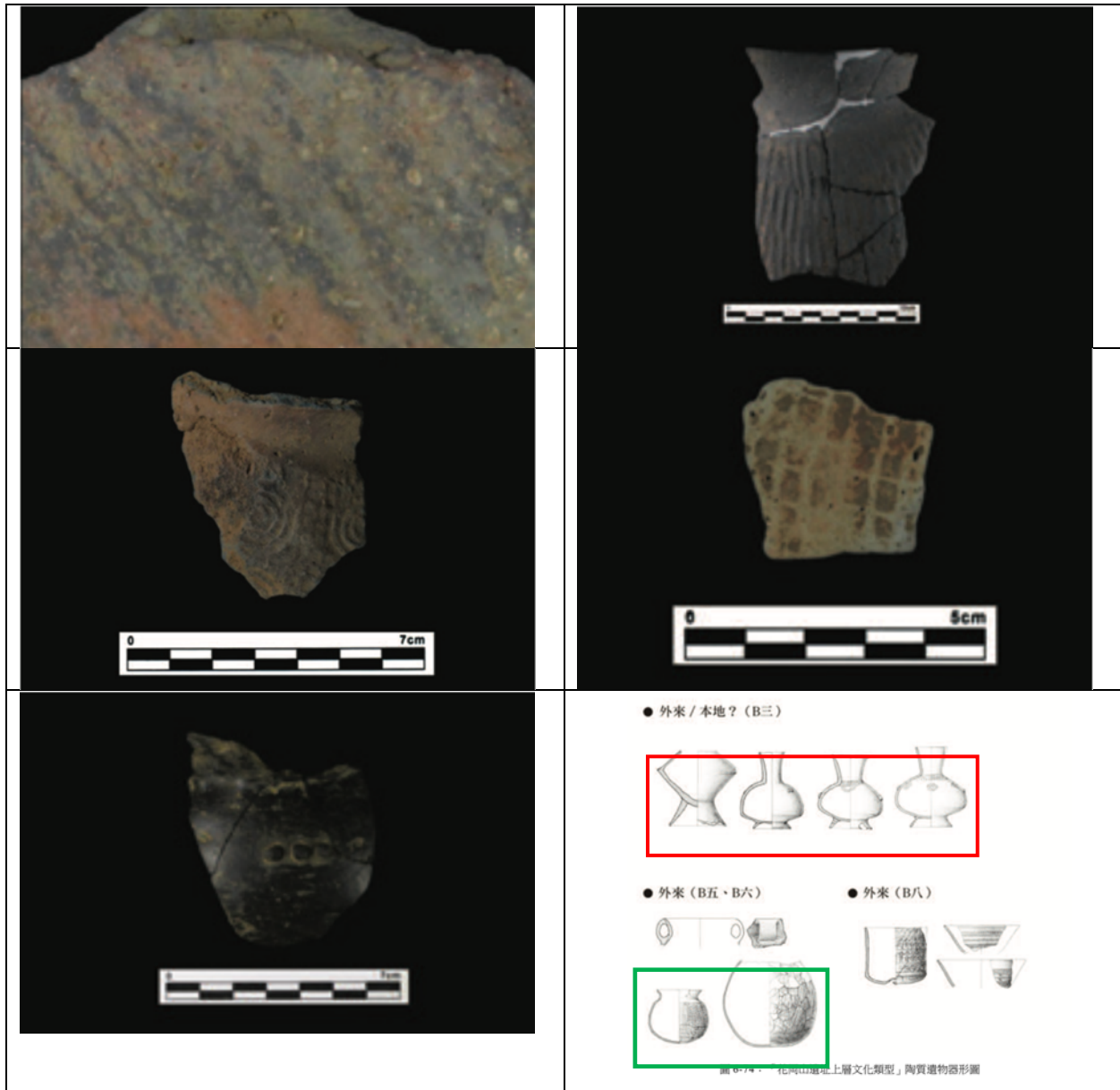


Figure 4-48 Upper Huakangshan cultural assemblage, type B-V (upper left and right, mid-left), type B-VII (mid-right) and type B-III (lower left). Upper Huakangshan cultural assemblage type B-V morphology (green rectangular); type B-III (red rectangular). Figures are courtesy of LIU 劉益昌 and CHAO 趙金勇 2010

Final Neolithic Period and Initial Metal Period
(2400–1800/1600 BP)

- Cities
- Archaeological sites
- Boundary of prehistoric cultures
- Boundary of prehistoric phases
- River
- - - Boundary of Final Neolithic period and initial Metal period

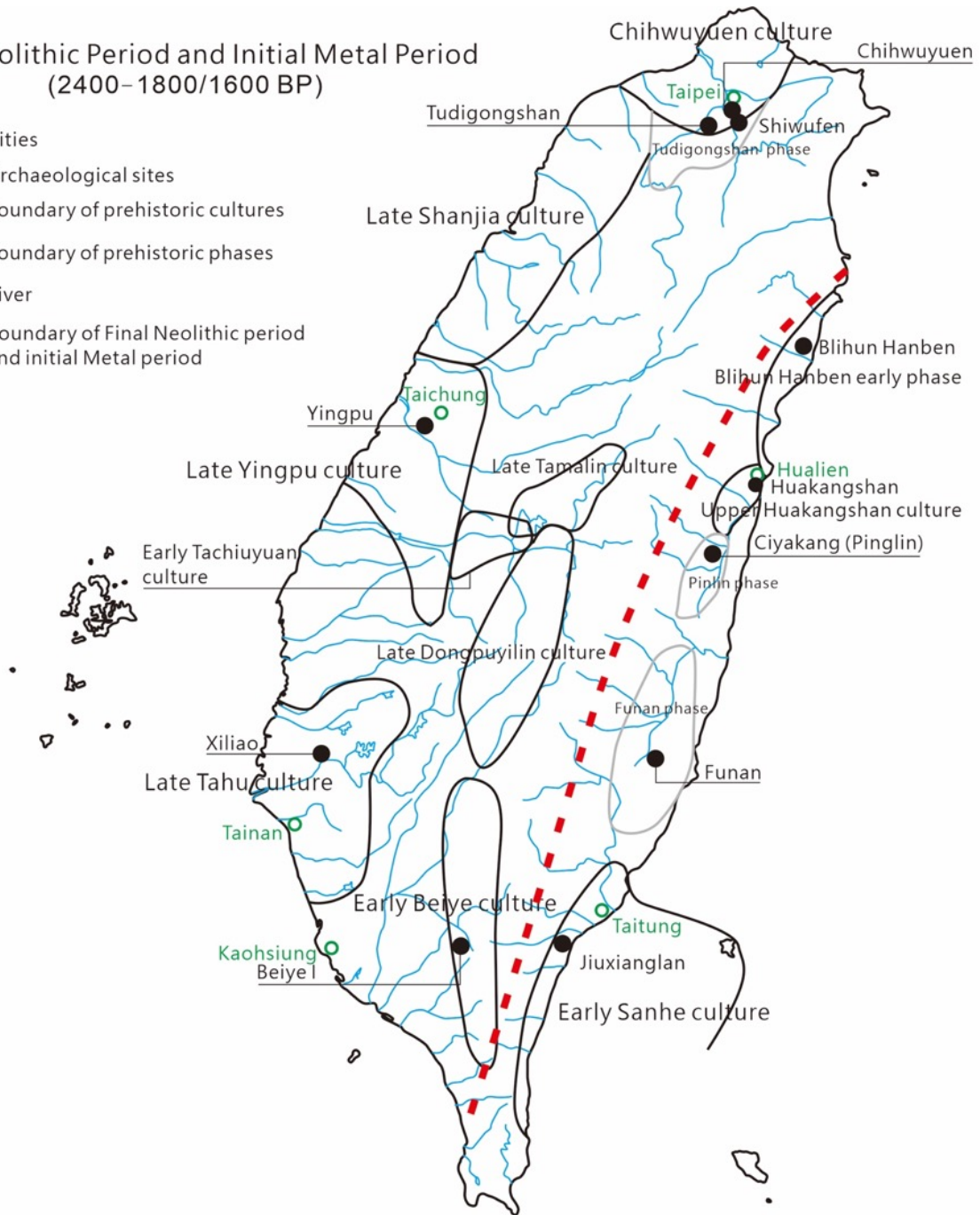


Figure 4-49 Map of archaeological cultures (assemblages and their subsets) in the final Neolithic and initial Metal period

4.5.2. Does the Ceramic Data Support the Trade Diaspora Model?

In the previous chapter, I have introduced the trade diaspora model and the predicted material remains of each diasporic mode (marginality, autonomy, integration). For the daily-use wares, the ceramics of diasporic marginality and autonomy could be distinguishable from the host/local communities, and regarding the diasporic integration, the daily-use ceramic assemblage presents a mixture of local and diasporic style. As for the ceramic for burial goods, if the black pottery is indeed the ethnic marker (LIU 劉益昌 2009, 2012), I should be able to see black pots in the burials from all diasporic modes. However, one situation needs to be considered. If there are no or limited potters in a diasporic community, the daily-use ceramic assemblage of this foreign community could still be provided by the local/host people, like the relationship between Basay and Kiwulan people (LIU 劉益昌 2011a)⁷⁴. Basay people provided services in exchange for food and ceramics. Hence, the ceramic assemblage of the Basay villages is similar to Kiwulan people's villages.

I have summarized several archaeologically predicted characteristics in the model (Table 4-15). For the marginal and autonomous diasporic communities, we should see boundaries between the local/host community and the diasporic community. From only the BHB site scale, I do not find any clear ceramic difference in the examined ceramic assemblage regarding spatial distribution (Figure 4-50). I need to mention that the examined specimens mostly concentrate in the site center, which could lead to the result of not finding the diasporic remains in the site periphery.

Table 4-15 Diasporic modes and their predicted archaeological characteristics

INTERACTION MODE	ARCHAEOLOGICAL CHARACTERISTICS
DIASPORA MARGINALITY	CLEAR BOUNDARY BETWEEN LOCAL AND FOREIGN MATERIALS; SPATIAL SEGREGATION
DIASPORA AUTONOMY	CLEAR BOUNDARY BETWEEN LOCAL AND FOREIGN MATERIALS; SOME SPATIAL OVERLAP
DIASPORA INTEGRATION	NO BOUNDARY, MIXED MATERIAL CULTURE, MIXED BURIAL GOODS AND FOODWAYS. BURIAL PRACTICE REMAINS THE SAME

⁷⁴ I have summarized the detailed Basay people description and studies in the previous chapter.

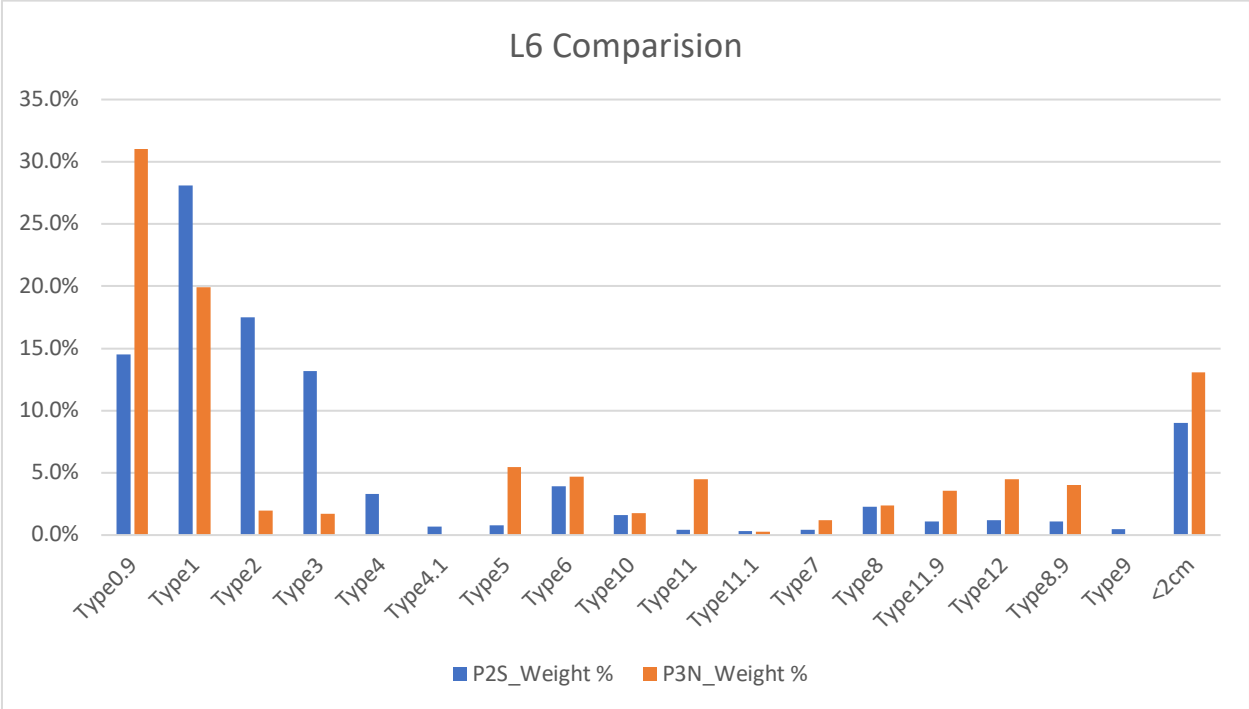
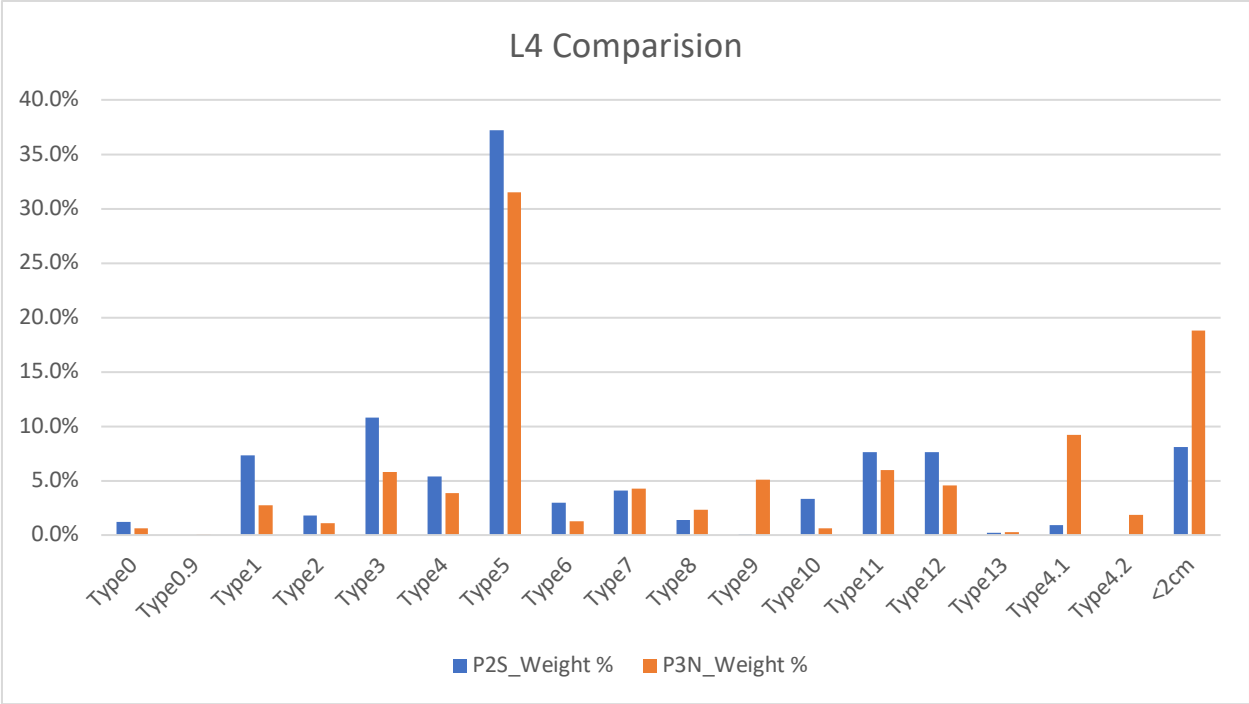


Figure 4-50 These two comparative graphs show the proportion of each ceramic type in P2S and P3N pits. There is no significant spatial difference for the ceramic distribution

The L6 ceramic assemblage has two characteristics: 1) dominance by non-local ceramic wares; 2) cannot be designated to a known archaeological cultural assemblage but shows certain connections to both northeastern and southeastern Taiwan (multiple sources of raw material). These two characteristics seem to portray a community with high mobility who frequently interacted with their neighboring communities and even acquired ceramics from their neighbors. If so, this seems to fit the marginal or autonomous diasporic modes.

From a regional perspective, both BHB L6 and Upper HKS ceramic assemblages seem to be a sudden appearance instead of a gradual evolution from known previous cultural assemblages. Nevertheless, they share a few similarities in daily-use ware and metallic pyro-technological remains; and the burial practices are quite identical. While we often associate burial practice with identity, we could be seeing two marginal or autonomous diasporic communities, one in the Liwu River estuary and one in the Hualien River estuary.

The BHB L4 ceramic assemblage clearly matches the previously defined SSH cultural assemblage Pulowan subset, and the dating associated with this assemblage also pushes the upper date to 1600 cal. BP which is the earliest Pulowan subset date by far. BHB L4 assemblage shares ceramic type similarities with L6 assemblage. The amount of each type and ware is the major difference between these two assemblages. This shows a diachronic connection between BHB L4 and L6. BHB L4 Pulowan subset also shows synchronic connections with the other known Metal period sites, such as the SSH site (SSH subset layer) in the north and the Jiuxianglan 舊香蘭 site (Gueishan Cultural layer) in the south. The assemblage with local dominant ceramic wares and many other non-local ceramic wares indicates a relatively lower mobile community that still had active interaction between the BHB L4 people and their neighbors from north to south.

Does this look like a trade diaspora community? It is hard to have a solid answer from only a ceramic perspective. Optimistically speaking, a newly created ceramic assemblage with a few inherited elements from previous cultural assemblages does match the predicted integrated trade diaspora community. However, can this still be considered as 'trade diaspora?' A trading hub could show a similar ceramic remain pattern. To resolve this difficulty, I should seek more lines of evidence for supporting or disproving the proposed model.

Any sufficiently advanced technology is indistinguishable from magic.

Arthur Charles Clarke

5. Ways to Pursue a Trade Diasporic Community: The Ferrous Pyrotechnology Analyses

Iron has been one of the essentials in modern human society since the first Industrial Revolution (Killick and Fenn 2012), and its alloy, steel, has been the frame of modern human society. Every year, at least 2 million metric tons of crude steel are produced.⁷⁵ The importance of iron was also true to our ancestors, for instance, new iron agricultural implements and weapons have had a profound influence on the development of Qin and Han Dynasty (LAM 林永昌 et al. 2017).⁷⁶

There are two major research themes regarding ancient metallurgy: the technological aspect of metallurgy and the influence of metallurgy on society (and vice versa). In many cases, the emergence of metallurgy indicates a certain level of social complexity (Pleiner 2000; Tylecote 2002). Archaeometallurgy typically uses three analytic modes: style of artifact, manufacturing techniques, and geochemical sourcing. Those analytic modes aim to establish the technological aspect of metallic pyrotechnology (Pryce 2014b). Metallurgy is a labor-intensive activity and requires precise control in each step. In this scenario, a temporary command system may emerge. To explore the second theme, it is often necessary to include other archaeological data sets, such as ceramic and burial analyses for measuring the complexity of a society before and after metallurgy is applied. Prior to exploring the second theme, scholars usually need to tackle the first theme that mainly focuses on understanding the nature of this complex technological system.

In Taiwan, as in island Southeast Asia but different from mainland Southeast Asia and China, the Metal/Iron Period was the immediate successor of the Neolithic Period. There is no Bronze Period in between. Although the earliest bronze object is dated to 3500 BP, the findings are sporadic without a confirmed manufacturing tradition. Hence, ancient metal technology and objects are considered to be imported rather than developed locally. Archeometallurgical study

⁷⁵ <https://www.worldsteel.org/media-centre/press-releases/2021/march-2021-crude-steel-production.html>

⁷⁶ We need to notice that such early application of the blaster furnace for producing iron in ancient China was a unique case comparing the to the rest of the world.

has been relatively limited in Taiwan archaeology. However, in recent years, a few rapid advances have been made and I will review these advances in the following section. This chapter synthesizes the results of macro and micro analyses on the Blihun Hanben (BHB) site iron slag in order to explore the essence of this ancient iron technology in Taiwan. While the data can only provide partial explanatory power to the proposed trade diaspora model, this archeometallurgical attempt has yielded promising results and is worthy of further exploration.

In this chapter, I shall briefly introduce the principle of ancient ironmaking/working and their regional history in areas adjacent to Taiwan. The related studies in Taiwan shall be reviewed as the contextual background. The second half of this chapter focuses on the analysis of ironworking remains, iron slag, from the Blihun Hanben site. Both macro and micro analyses were applied for determining the method of ironmaking and ironworking. Finally, I shall connect the analytic results to the core question of this research to see if these results support the proposed trade diaspora model.

5.1. Metallic and Ferrous Pyrotechnologies

The use of metal dramatically changed the way people live. People started to modify the landscape faster and more extensively than ever. Copper and gold were usually the metals people utilized first because of their natural metallic form. Metallic copper forms naturally with copper ores, such as malachite. The earliest evidence of copper smelting is about 7000 years ago in Çatalhöyük, Turkey. In addition to Çatalhöyük, the Middle East area yields a group of early dates for copper artifacts dating around 6500 years ago (Tylecote 2002:8-9). In the European Alps, the copper ax of Ötzi, the Ice man, indicates the cold forge, smelting ability, and long-distance interactions over 5000 years ago (Artioli et al. 2017). However, copper is too soft to be an efficient tool, thus it was not until the invention of bronze (an alloy of copper and tin) that metallic tools truly became the primary implements for subsistence.

Iron is the most common element on Earth by its mass and is common in most surface environments. However, the use of iron began far later than copper (around 7 KYA⁷⁷) and its alloys, like bronze (6-5.5 KYA). The main reason is that iron rarely exists in its metallic form

⁷⁷ KYA stands for thousand years ago.

except for meteoritic iron, and extracting metallic iron from ores is far more challenging than bronze smelting (Killick and Fenn 2012; Tylecote 2002). Like copper and bronze artifacts, the Middle East is also the core location for finding early iron artifacts dated 3.8-3.5 KYA (Killick and Fenn 2012; Pleiner 2000).

In the East Asia context, meteoritic iron was crafted to blades and hafted on bronze handles as weapons in the late Shang Dynasty around 3000 years ago (LI 李京华 2007). Ancient China is well known for its bronze and cast-iron technology. It has the earliest cast iron mass-production industry in the world. Studies show the relationship between iron farming tools and food production in the early Han Dynasty (BAI 白云翔 2005). In mainland Southeast Asia (MSEA), while the long debate between two chronological models, that the metallurgy was locally developed or influenced by ancient China, has not been settled, it is the consensus that the Iron Age in MSEA probably started around the fifth to fourth century BCE (Glover and Bellwood 2004). In terms of island Southeast Asia (ISEA), despite the archaeological data from the region showing an intensive human maritime mobility from at least 3000 years ago (40,000 years ago if considers the early expansion of modern human), most of ISEA remained ametallic until 200 BCE when bronze and iron appeared simultaneously (Pryce 2014a, 2014b).

Taiwan, an island off the coast of continental East Asia, is usually considered a part of East Asia based on the current geopolitical situation. However, archaeologically and historically, Taiwan/Formosa has connections with ISEA and possibly MSEA. While the Neolithic Period was followed immediately by the Metal Period in Taiwan, most Taiwanese archaeologists believe that metal technology was introduced (LIU 劉益昌 2011b; Tsang 2000; TSANG 臧振華 and LIU 劉益昌 2001). Sporadic bronze object findings that are dated up to 3500 BP (CHEN 陳光祖 2011) in northern Taiwan indicate interactions between Taiwan and continental East Asia (Kuo 2019; KUO 郭素秋 2001), but there is no evidence of any copper/bronze metallurgical working at that time on the island. The only case with bronze metalworking remain is the Jiuxianglan site, although the remains are still pretty limited to southeastern Taiwan (LEE 李坤修 2005, 2015).⁷⁸

⁷⁸ The Blihun Hanben site salvage excavation projects unearthed a few sandstone molds for making bronze objects. This may imply the bronzeworking ability of the BHB people.

In contrast to bronze, iron and related remains are the major metallic findings in Metal Period Taiwan. The tremendous amount of ferrous pyrotechnological remains with a corresponding date from 1600 to 1200 BP from both the Shihshang site and Blihun Hanben site indicate the starting time of local ancient iron technology (Tsang 2000; TSANG 臧振華 and LIU 劉益昌 2001).

5.1.1. Metallurgical Traditions and craftsmanship

The melting point of pure iron is around 1540°C, and human societies did not acquire sufficient technology to reach such high temperatures until the nineteenth century (Tylecote 2002:48). Except for meteorite iron, iron is hard to find in its metallic form. Metallic iron needs to be extracted from iron ores, such as hematite, magnetite, and limonite. There are two primary ironmaking traditions: the direct method and indirect method. The former is also known as the bloomery method, and the latter is also known as the cast iron method. These two methods are quite distinctive from each other in terms of furnace structure, smelting process, refining process, and end products (Figure 5-1).

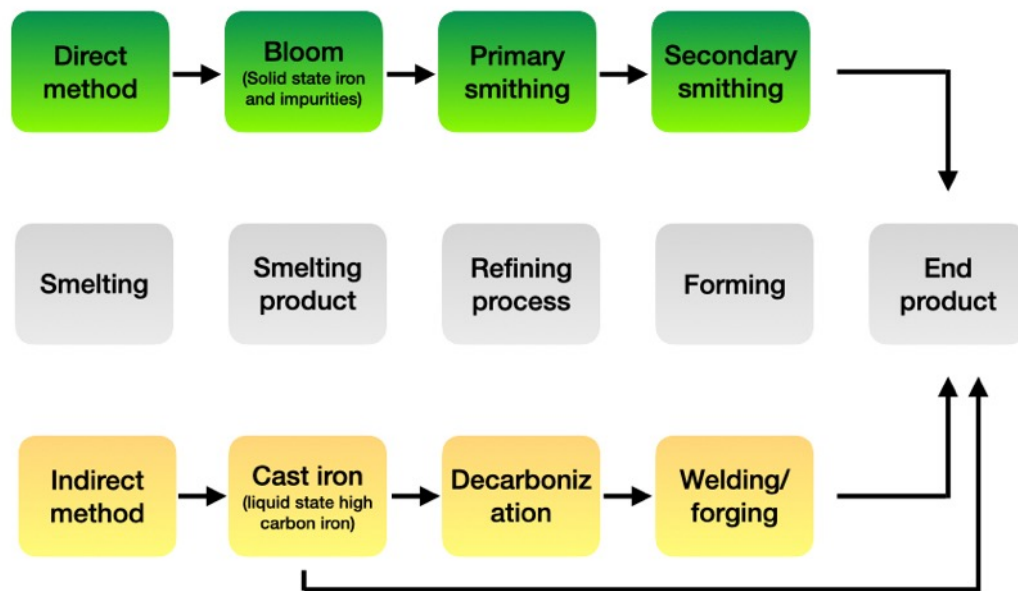


Figure 5-1 Workflow of ironmaking traditions, modified from Larreina-Garcia et al. (2018)

As mentioned, ancient China possessed the ability to produce cast iron around 200 BCE and was a unique case in metallurgical development worldwide. In the rest of the world, using blast furnaces (Figure 5-2) for making cast iron did not happen until the eleventh or twelfth century,

at least from the Western European evidence (Pleiner 2000; Tylecote 2002:78). Cast iron is produced by blast furnace, which is the mainstream method to produce iron now. Blast furnaces are usually built with refractory materials (high-temperature resistance materials) and are usually taller than two meters (Tylecote 1980:215). Batches of charges (mixture of ore and fuel) are added continuously from the top opening during the smelting operation. A blower powered by different forces, such as natural wind, human force, watermill, supplies air into the lower part of a furnace. When the ore/fuel ratio, flux, and air supply reach an ideal equilibrium, iron oxide in the ore reacts with the reducing agent (usually carbon monoxide) and is liquified. The molten iron then flows down to the furnace bottom. The unwanted 'impurities' form molten calcium silicate slag (e.g., Tylecote 2002, Table 42 and 45), and the slag flows downward as well. Liquified iron and slag can be separated easily by their density. Slag is lighter and floats on the surface of molten iron. Since the iron and slag are both liquified and flow out of the blast furnace, iron production with this method could be a continuous process when the charge (mixture of ore and fuel) supply is nonstop.

Pig iron is the intermediate product in this method. It contains a high percentage of carbon (usually more than 4 percent) and silica inclusions that make pig iron hard and brittle. Hence, its direct implementation for use is difficult. Pig iron is then reheated and forged to remove carbon and silica to produce wrought iron (very low carbon content). Wrought iron is tough and is cold forge workable. The refining process was carried out in the by forging before and by the usage of a puddling furnace (or so-called reverberatory furnace) after the Industrial revolution (Tylecote 2002). Cast iron has more carbon (more than 2 percent and less than 4 percent) and silica than wrought iron and less than pig iron. Cast iron is hard and brittle but is widely used for implements that need not bear external impacts.⁷⁹ If the carbon content in iron is around one to two percent, it becomes the ideal iron-carbon alloy, steel.

⁷⁹ For example, cast iron pans are widely used, but cast iron would be too brittle for farming tools like hoes.

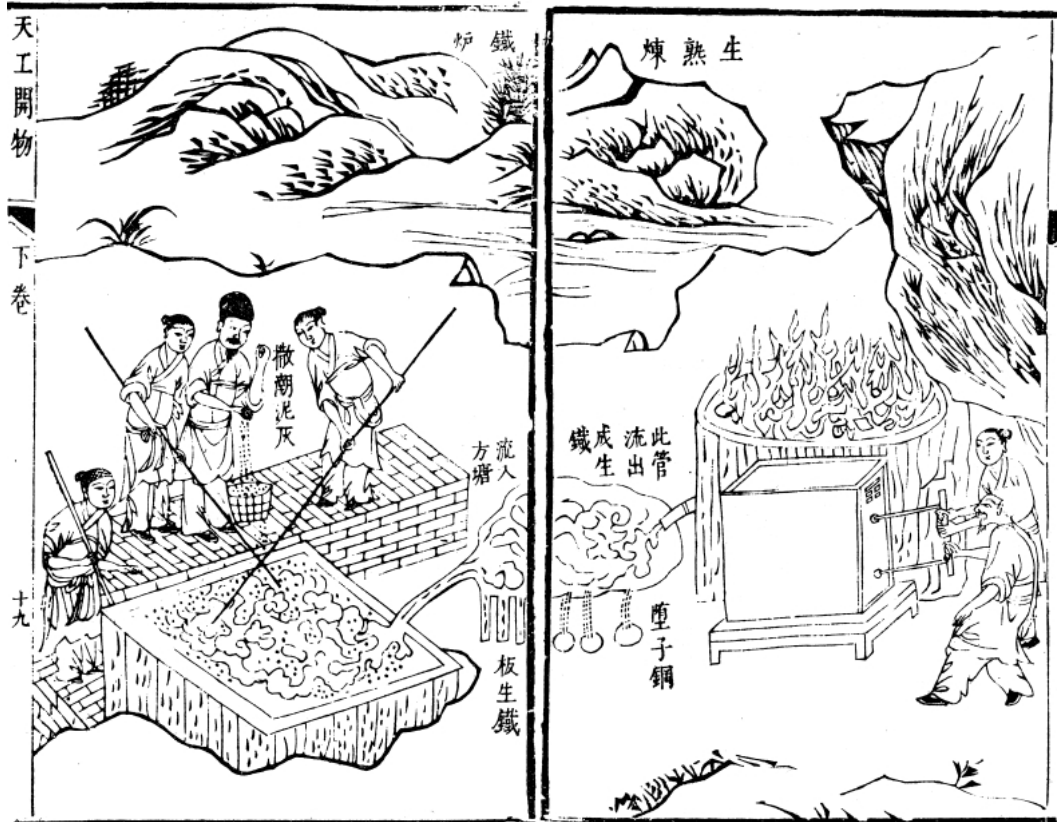


Figure 5-2 Blaster furnace with a piston blow (right) and a puddling furnace that cooks the cast iron (raw iron) to wrought iron (ripped iron) in ancient China (drawing from *Tiangong Kaiwu*, *The Exploitation of the Works of Nature* written by SONG Yingxing and published in 1637)

The Bloomery method, also known as the direct method, is the most ancient method used to extract iron from ore. The oldest practice of this method was somewhere in the Anatolian-Iranian region in the middle of the second millennium BCE (Pleiner 2000; Tylecote 2002:47). The bloomery method differs from the indirect method in many aspects, from furnace structure to smelting process to end products. The average size of a bloomery furnace is smaller than a blast furnace; the typical height is between one and two meters, and the inner diameter is around or smaller than thirty to forty centimeters (Pleiner 2000). Instead of liquidizing the iron in the ore, siliceous gangue (unwanted non-metallic siliceous based compound and minerals) in the ore becomes molten and flows downward to the furnace bottom. If these slags are tapped out from a hole at the furnace bottom by using a stick to guide the liquified-slag flow, the consolidated slag is then called tap slag, which is primarily rich in silica. The iron oxide in the ore is reduced by exposure to carbon monoxide during the process and forms a malleable 'bloom' or 'sponge' iron as the initial product of this method.

Figure 5-3 shows a schematic profile of a bloomery furnace and its working principle. Similar to a blast furnace, charges (a mixture of prepared ore and fuel) are also added before and during the smelting process. However, the chemical reaction in the bloomery furnace is quite different due to the lower furnace temperature (up to about 1400°C).⁸⁰ Charcoal has acted as the primary fuel for this method of smelting since ancient times. The reducing agent, carbon monoxide, derives its carbon mostly from charcoal. Carbon monoxide is formed in the combustion zone and then reacts with the descending ore (silica + iron oxide + other oxides) around the blowhole, where the air supply is greatest, to form the bloom, the initial product of this process. Since pure silica has a very high melting point of 1723 °C, a flux to reduce its melting point is necessary. Here, wüstite (FeO) that is reduced from iron oxides (usually Fe₂O₃ and Fe₃O₄) becomes the flux to combine with silica and then forms fayalite (Fe₂SiO₄). Fayalite has a much lower melting point of 1150 °C. Molten fayalite then descends to the furnace bottom. When tapped out, it forms a lava-like surface and texture. Using wüstite (FeO) as the flux to form fayalite for removing silica in the bloomery process consumes lots of iron elements, leading to a much lower yield rate than the indirect method.

⁸⁰ See (Pleiner 2000:133-136) for the detailed reaction process. I also benefited a lot from the HMS datasheet (The Historical Metallurgy Society Datasheets, <https://historicalmetallurgy.org/publications/hms-datasheets/>).

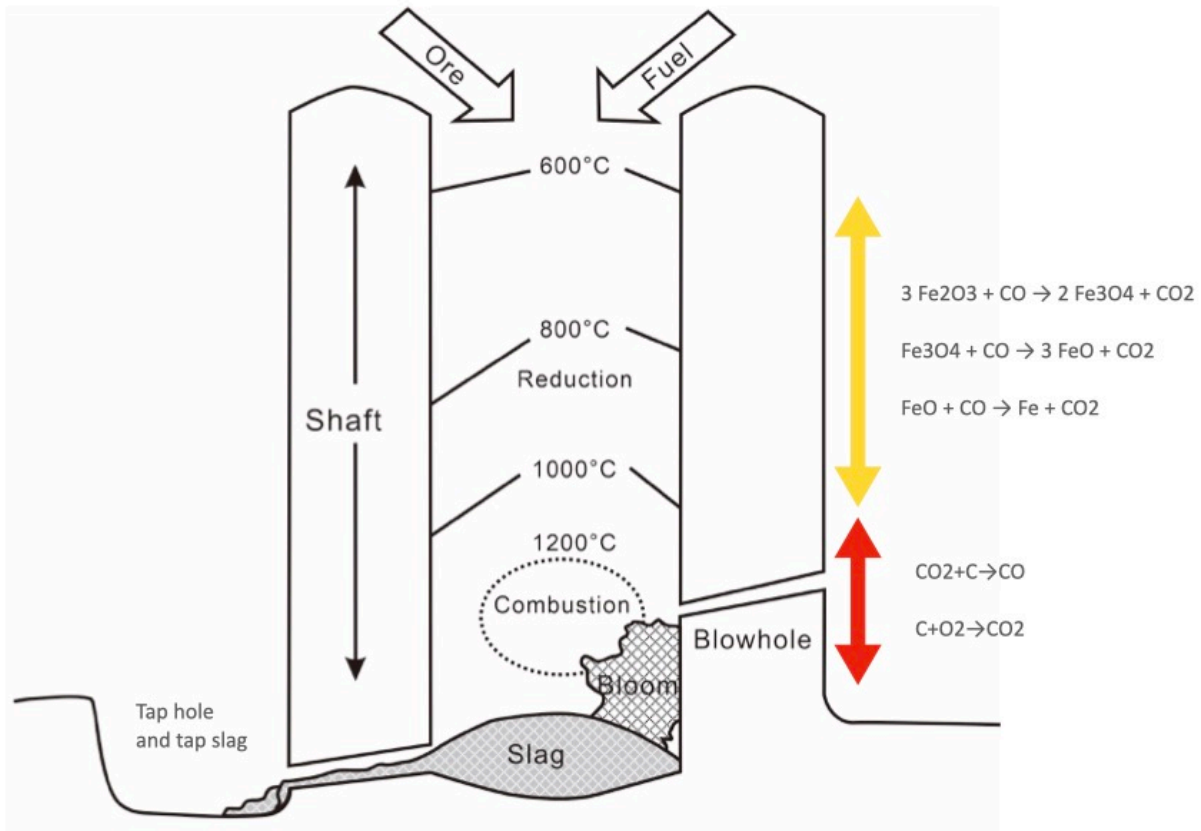


Figure 5-3 Principle of bloomery method and profile of bloomery furnace, modified from Pleiner (2000:134, 258) and Charlton presentation slide (2015)

Iron production by the direct method is a one-time event. In every production cycle, the formed bloom needs to be extracted from the furnace. Freshly extracted bloom usually has many pores and unwanted impurities, such as unburned fuel and slag inclusions. Hence, a bloom needs to be refined during the primary smithing to exclude those unwanted materials (Figure 5-1). The refined bloom then will be forged into iron bars or implements during the secondary smithing. The bloom produced by the direct method has a very low carbon content, usually less than 1.5%. It is wrought iron and is immediately workable. However, cast iron and steel sometimes also coexist in a bloom (Pleiner 2000).

Nevertheless, the direct method and indirect method of ironmaking are distinctive, from furnace to production waste. As mentioned, the iron slag from the indirect method mainly consists of silicate and calcium; hence, it has no magnetic property. In contrast to the cast iron slag, we have found during the excavation that most BHB iron slags have a magnetic property, and previous research indicates a bloomery tradition in ancient Taiwan. Hence, synthesizing the very

preliminary fieldwork observation with previous Taiwan ancient ironworking studies, I highly suspect that the bloomery method was practiced at the BHB site, and we will explore if this hypothesis stands true throughout this chapter.

5.1.2. Remains of Ferrous Pyrotechnologies.

There are four steps (Figure 5-4) of iron metallurgy by bloomery method: 1) ore extraction, 2) smelting, 3) primary smithing, and 4) secondary smithing (Arnoldussen and Brusgaard 2015; Killick and Fenn 2012; McDonnell 1995; Pleiner 2000). Different archaeological remains correspond to each step, such as smelting/smithing slag, furnace/hearth lining, furnace/hearth bottom, tuyère, hammerscale, prill, and anvil (Arnoldussen and Brusgaard 2015:116). The following summarizes the purpose for each step and its possible archaeological debris of ironmaking by the bloomery method:

Step 1: Preparation

Purpose: collecting ore and fuel.

Debris: iron ore mining location or facilities, charcoal-making remains. Hard to be observed in archaeology

Product: ore and fuel (mostly charcoal).

Step 2: Smelting

Purpose: reducing iron ore to metallic iron.

Debris: furnace, charcoal, smelting slag (tap slag and furnace bottom), furnace lining, tuyère, bellows.

Product: bloom or sometimes called sponge iron.

Step 3: Primary smithing

Purpose: refining the smelting product to pure metallic iron.

Debris: smithing hearth, charcoal, smithing slag (plano-convex or concave-convex hearth bottom or generally called smithing hearth bottom, SHB), hearth lining, tuyère, bellows.

Product: purified metallic iron, iron billet/bar.

Step 4: Secondary smithing

Purpose: making implements from iron billet/bar.

Debris: smithing hearth, smithing slag (plano-convex or concave-convex hearth bottom or generally called smithing hearth bottom, SHB), hearth lining, tuyère, bellows, hammerscale, prill.

Product: iron tools.

Those metalworking steps can occur in multiple locations, and corresponding archaeological remains can tell these steps. If the BHB settlement was an ironmaking site, then it is probably hard to find many iron products, such as iron billet and iron implements; instead, the 'wastes' will be the essential material remains for us to study and reconstruct the nature of iron metallurgy. One thing that needs to be recognized is, it is extremely challenging to distinguish Step 3 primary smithing and Step 4 secondary smithing since they may use the same hearth to perform these two activities. Hammerscale (little flake) and prill (little sphere) that are produced during the hammering are two indicators of secondary smithing (Crew 1996).

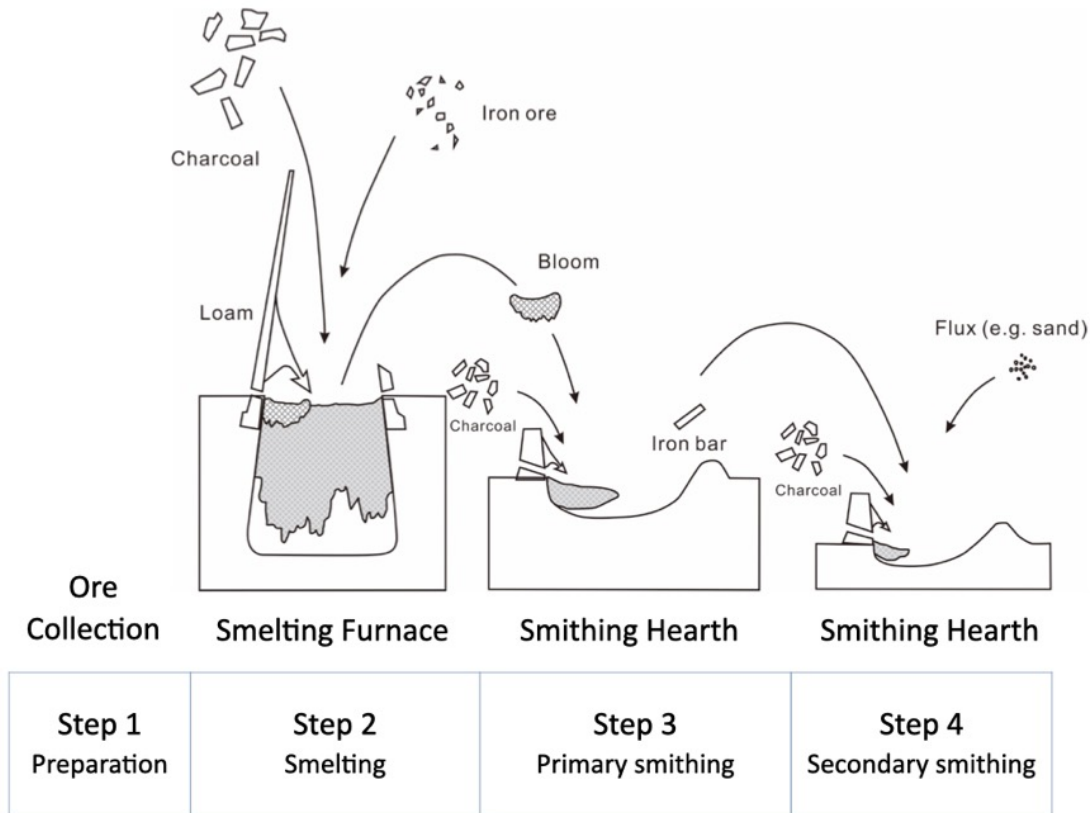


Figure 5-4 Four steps of bloomery method; modified from Arnoldussen and Brusgaard (2015)

5.1.3. Regional Contexts: East Asia

China⁸¹ was one of the ancient bronzeworking centers. The earliest evidence dates back to 2000 BCE (CHEN 陈建立 2014; Tylecote 2002). Noticeable is that the ancient Zhongyuan⁸² (中原 Central Plain) craftsman organization and bronze smelting technology differed from the other regions in the contemporary global context. The bronze smelting in ancient China was controlled by the elite class, especially in Shang Period (about 3600-3000 BP), and most of the bronze objects served as ritual vessels and weapons for warfare. In terms of technology, blast furnaces and ceramic pieced-molds for casting were used to build objects with complex shapes and motifs. Due to these significant differences and Chinese nationalism, ancient bronze technology was often considered as an independent invention for a long time in China; however, more and more discussions in the recent two decades favor the 'western-orientated' model that the prototype copper/bronze technology was transmitted into ancient China from the west by nomads (CHEN 陈建立 2016; HWANG 黄铭崇 2014). This imported bronze technology was integrated with the local high firing-ceramic technique (for example, the ceramic technology of the Lungshan/Longshan Culture) and its decorative pattern, and then rapidly became a mature industry controlled by the elite class.

The trajectory of iron studies for the Zhongyuan area is similar to that of bronze. Iron technology was seldom considered as imported until the 1990s. However, since the 1990s, the two major hypotheses to explain the origins of iron technology in the area have been either western importation or local development (LAM 林永昌 et al. 2017; TANG 唐际根 1993). Nowadays, although the debate of technological orientation has not been settled yet, most discussions tend to conclude that the cast iron technology by blast furnace was established from the combination of imported bloomery tradition and a well-developed local bronze casting tradition (Bronson 1999; CHEN 陈建立 2016:229-233). The bloomery technology probably was introduced via the

⁸¹ The terms 'China and mainland China' that I use in my dissertation are geographic terms for an area which partially overlaps the territory of a modern political entity, the People's Republic of China. From my perspective, the current Xingjiang area is culturally distinctive to and has a parallel development trajectory to the traditional Han Chinese occupied Zhongyuan area.

⁸² Zhongyuan is approximately the mid and downstream areas of the Yellow River area, and is roughly the current Henan Province, China.

current Xinjiang area (CHEN 陈建立 et al. 2012; Lin and Liu 2017) no later than 400 BCE. This introduced iron metallurgy which then merged with Zhongyuan bronze technology and soon developed into a unique blaster furnace cast iron tradition within two to three hundred years. Nevertheless, it is reasonable to say that making cast iron from blast furnaces became the primary iron production method at least after the late Warring States Period and early Han Dynasty, approximately 200 BCE (Bronson 1999; CHEN 陈建立 2016).

In contrast to the northern cast iron tradition that dominated the Central Plain area, the bloomery method was the typical approach for ironmaking in the southern part of East Asia, especially south of the Yangtze River and the Lingnan 岭南 area (Zhang et al. 2020). In the current Fujian, Canton (Guandong), and Guanxi areas, more and more studies (CHEN 陈建立 2016; HUANG 黄全胜 and LI 李延祥 2008, 2011, 2012; LI 李映福 2014b) show the practice of the bloomery method and the usage of bowl shaped furnaces that were mostly contemporary to the Zhongyuan (Central Plain) area. Those findings suggest cultural interactions between southern 'China' and its adjacent regions, such as northern Vietnam and Thailand before the Qin and Han periods. The studies on Sichuan and Yunnan also suggest the presumable connection between southern 'China' and the adjacent mainland Southeast Asia (LI 李映福 2014a; QIU 仇敏华 and XIA 夏保国 2016). The practice of bloomery ironmaking decreased with the expansion of cast iron technology from Zhongyuan. However, even now this ancient method has not been entirely replaced. Nevertheless, the connection and interaction between the Lingnan 岭南 and northern parts of mainland Southeast Asia is undoubtable. Compared to Zhongyuan, this southern 'China' area shares more cultural similarities with northern Vietnam, Laos, and Thailand.

5.1.4. Regional Contexts: Mainland Southeast Asia and the Philippines

The ancient bronze metallurgy in mainland Southeast Asia (MSEA) was considered as introduced because of its well-developed form from the very beginning. There is a long debate about the origin of bronze metallurgy in MSEA. Both White and Higham use the Ban Chiang excavation as the primary data source but derive totally different interpretations. On the one hand, White proposes that the bronze technology was introduced from pre-Andronovo Eurasian forest-

steppe metals technology by experienced craftspeople in the late third millennium BCE; on the other hand, Higham criticizes White's dating data and favors the Sinocentric model that the bronze technology was transmitted to MSEA from the Central Plain to the south of the Yangtze River and then spread into SEA by trade and exchange around 1100 to 1000 BCE⁸³ (Higham 2011; Higham et al. 2011; Pryce 2014a; White and Hamilton 2018; White and Hamilton 2009). In White's model, the introduction of copper/bronze was not necessarily associated with social complexity and had limited cultural impact to the local communities; in contrast, the early local elites used copper/bronze to enhance their social status in Higham's model. Nevertheless, there are a few areas of consensus among these debates: 1) bronze technology was mainly introduced; 2) accurate dating and an understanding of the metallurgical process are crucial for tracing the origins of that technology (Pryce 2014b).

In terms of the Iron Age in MSEA, ferrous remains and technologies receive much less attention than bronze. Tropical environments and lack of scholarly⁸⁴ interest are two primary reasons (Pryce 2014a). The dating of iron objects leads us to believe that the Iron Age in MSEA started around 2500 BCE; however, the evidence of iron production is relatively limited, and the earliest dating of an ironmaking workshop was about 300 BCE in northern Thailand (Nitta 1997). Ferrous-related studies have been sporadic but are gaining attention recently. In the Isthmus of Kra area, studies on the iron slag and ferrous metallurgical remains from Khao Sam Kaeo (about 2400-2200 BP) and Phu Khao Thong⁸⁵ indicate a village-scale bloomery tradition, and this technology might have transmitted from the other side of the Bay of Bengal (Biggs et al. 2013; Petchey et al. 2018; Pryce et al. 2006). While those studies imply western-oriented influences for the lower MSEA area, Laos and northern Vietnam metallurgical studies remind us not to exclude the influence from the north-- ancient China (Évrard et al. 2016; Pryce 2014b). Studies in Cambodia which mainly focus on the Angkor period (ninth to fifteenth century) provide information about

⁸³ See W and H 2008, 2009, Higham et al 2011 for the debate details

⁸⁴ Hot and humid tropical environment leads the rapid corrosion of iron objects, and this condition leaves very limited iron remain for scholarly research. This limited iron remains may lead to the lack of interest among scholars.

⁸⁵ No exact date but referred as "few centuries at the turn of the first millennium BC/AD" in Biggs et. al 2013.

iron production system and the social implications of iron (Hendrickson et al. 2019; Pryce et al. 2014).

As for the region across from mainland Southeast Asia and the South China Sea, the ferrous-focused study is somewhat limited in the Philippines, and the tropical environment is probably the primary reason. Dizon (1988) pointed out that 'iron-using' society is a more proper term than Iron Age since there was no direct evidence of iron production.⁸⁶ The Philippines remain ametallic until about 400 BCE, and then metals were introduced via the exchange spheres from MSEA (Bellina 2014; Favereau and Bellina 2016). Although a few studies show the ironworking or production in the Cebu and Visayas area⁸⁷ (Nishimura 2012), the ironmaking industry established in the fourteen century is chronologically out of my research scope.

While the exploration and debate on ancient metallurgical technologies and their origin seem to be an endless mission, based on current understanding, most scholars find consensus on:

1) the social organization for metalworking in MSEA (and southern China) differed from northern China, the Central Plains; 2) the metallurgical technologies were also different between these two regions. Generally speaking, in northern China, an elite-controlled top-down cast bronze and iron metallurgical system was practiced in a state-level society, and the cast iron technology was established based on the bronzemaking technology. In contrast, smaller scale bronze and iron production by household, families, and itinerant metalworkers seem to be the case in most of MSEA.

The trajectory of social development between MSEA and the southern part of mainland China is similar but differs from the Philippines (and the rest of island SEA). This developmental track is also reflected in metalworking technologies. Despite the fact that the archaeological data from the Philippines shows an intensive human interaction across the South China Sea from at least 3000 years ago (Bellwood and Dizon 2013), the Philippines remained ametallic until c. 400 BCE.

⁸⁶ Dr. Dizon has mentioned that the depositional rate of coastal Luzon is much higher than expected. Many Metal Age sites may be deeply buried.

⁸⁷ Personal communication with Dr. Mary Jane Louise Bolunia (National Museum of the Philippines).

In contrast, the continent parts had well-developed metal technologies, from bronze to iron, and show connections northward and westward.

5.2. Previous Studies on Ironworking in Taiwan

5.2.1. KANO's Observation

The exploration of metal technology started from the early phase of archaeology in Taiwan, the Japanese Colonial Period (JCP: 1895 to 1945). As mentioned in the previous chapters, Japanese scholars conducted multiple environmental and cultural surveys at the beginning of the JCP. The results of these surveys became the ruling policy foundation of the colonial government. Usually, archaeological surveys were carried out simultaneously with the ethnographic studies on Taiwan's Indigenous tribal groups during the first to second decades of the colonial times. These archaeological surveys and studies paved the foundation of our present knowledge of Taiwan archaeology (LIU 劉益昌 2011b). Among these Japanese scholars, KANO Tadao was the one who paid the most attention to iron slag and ironworking in Taiwan.

KANO Tadao 鹿野忠雄(1906-1945⁸⁸) was an active Japanese naturalist from the 1920's until 1945 in the JCP of Taiwan. In addition to his extraordinary contribution to geography and biology (for example, he extended the Wallace Line up toward Taiwan and identified glacial topography in the high mountains in Taiwan), he is also known for his ethnographic and archaeological studies. Many of his insights are still valid or revalidated by current studies. For example, the Two- Cultural Layer hypothesis, the formation of the ancient societies in Taiwan, and the relationships between the societies in Taiwan and her adjacent region (KANO 鹿野忠雄 and YANG 楊南郡 2000; LIU 劉益昌 2011b).

Regarding the metalworking-related observations in his final work *An Overview of Archaeology and Ethnology in Taiwan* (台灣考古學民族學概觀), he argued that metal and lithic tools might have been used at the same time in ancient Taiwan based on the association of these two different material artifacts that he excavated in the Asang-daingaz 郡大社 (an old Bunun village in central mountainous Taiwan). He also reported 'iron slag' from two sites, Youzihu 油子湖 on

⁸⁸ KANO disappeared in the jungle of the Philippines.

Green Island and Pinglin⁸⁹ 平林 in Hualien and used the slag remains to argue for the possible presence of iron technology in ancient Taiwan. However, the lack of archaeological evidence blocked further discussion on the iron technology for KANO. Based on the ethnographic study on a bronze knife shank with an iron blade, an heirloom of Paiwan elites (Figure 5-5), he tried to connect Taiwan and the Dong Son culture in Vietnam, located in the northeastern part of mainland Southeast Asia (KANO 鹿野忠雄 1955:107-108).

Constrained by contemporary technologies, KANO could only make those inferences by comparing the style and observable manufacturing techniques. However, his achievements are still stimulating today. There is no way for us to revisit the artifacts since we have lost track of those collections with KANO's disappearance in the Southeast Asian jungle. Not until the discovery of the Shihsanhang (SSH) site, which unearthed a large amount of iron slag in a series excavation conducted in the 90s, did Taiwanese archaeologists pay attention to archaeological ironworking remains in Taiwan⁹⁰ (Chen 2000:165).

⁸⁹ KANO was not the first one to mention iron slag in archaeological context. Isao HIRAYAMA 平山勳 reported iron slag from the Shezi 社子 site in Taiwan in 1935.

⁹⁰ The very first scientific study on the SSH slag was carried out by geologists (Chen 2000:167-166)



Figure 5-5 Left: Heirloom bronze knife shank of the Paiwan tribe; right: the bronze shank with iron blade knife from the Rovanian (Rovaniyaw) family. Note the anthropomorphic shank design. (KANO 鹿野忠雄 1955)

5.2.2. Studies on the SSH and SSH Related Sites:

十三行 Shihshang cultural assemblage (1800-400 BP) is in Metal Age⁹¹ and was distributed mostly in northern coastal Taiwan. The Shihshang (SSH) site (Figure 5-6 and Figure 5-7) is the naming site of this cultural assemblage. The site was discovered in the late 1950s and was known for its iron slag remains. A large-scale salvage archaeology project in the 1990s yielded a large number of ceramics, metal, glass beads, ferrous pyrotechnological remains, and over two hundred burials from a settlement site on the south bank of the Tamsui 淡水 River estuary. Generally speaking, ceramic morphology, decorative pattern, flex and laid burial position, and remains from ferrous pyrotechnology, especially the presence of slag, are the indicators that Taiwan archaeologists use to recognize SSH cultural sites. Hence, SSH cultural assemblage is

⁹¹ Different terms are used for this period, such as Iron Age, Metal Age, and Metal and lithic Age. Personally, I prefer Metal Age or Metal period.

widely conceived of as the remains of a society with ironmaking ability without further discussion of the nature of the iron technology (Tsang 2000; TSANG 臧振華 and LIU 劉益昌 2001).



Figure 5-6 Upper left: Reddish orange is the primary color for the SSH ceramics. These three pots with folded shoulder are one of the SSH pottery characteristics (TSANG 臧振華 and LIU 劉益昌 2001). Lower left: the 'furnace' built with clay and cobble from the SSH site (photo copyright is purchased by the author). Right: anthropomorphic bronze knife handle from the SSH site (photo was taken in the SSH Museum by the author)

The first scientific analysis of SSH iron slag was carried out by CHEN Pei-yuan⁹² who responded to a report of 'meteorite' remains located close to the contemporary Shihshang village. From the appearance and chemical composition, CHEN Pei-yuan concluded the reported 'meteorite' fragments were iron slag from ancient times, and the ore of this ancient ironmaking tradition is likely to have been iron placer deposits on the Tamsui River banks (CHEN 陳培源 1965). Long after CHEN Pei-yuan's study, CHEN Kwang-Tzu's doctoral dissertation (Chen 2000) was the first comprehensive archaeological study on ancient Taiwan iron technology. By examining the microstructure, geochemical composition, and ethnological studies, CHEN concluded two ironworking traditions in ancient Taiwan. One tradition was the well-known SSH ironworking

⁹² Professor of the Geology Department at the National Taiwan University.

technology, and the other one was the ironworking technology of the Jingpu cultural assemblage.

CHEN's research set up a working procedure for analyzing the iron slag from the SSH and Chingpu sites. He analyzed the geophysical properties, such as density, porosity, magnetism, and geochemical properties by SEM (Scanning Electron Microscope) and EPMA (Field Emission Electron Probe Microanalyzer). His study showed that wüstite and high-titanium magnetite are the major minerals in the SSH iron slag. He concluded that the local iron placer deposit (high-titanium magnetite) was likely the ore of the SSH iron tradition. These iron sands can still be found in the Tamsui River estuary (and the whole northern Taiwan coast). Also, the study of the SSH iron objects and slag indicated a bloomery method for producing iron (low-carbon) which was then used to make implements in the early stage of SSH cultural assemblage. Later, after establishing a connection with Chinese merchants around the tenth century, SSH people might have used iron Chinese woks (high-carbon) obtained in trade as the raw material to produce iron implements and gradually lost their ironmaking ability.⁹³ The SSH iron technology might have been a local invention since there is no contemporary iron technology that uses iron sand as ore (Chen 2000:263, 276).⁹⁴

There were very limited discussions that focused on Taiwan ancient iron technology after Chen's study, only one research case on the iron slag from the Longmen-Jioushe 龍門舊社 site. SONG's research focused on the ironworking remains of the Longmen-Jioushe site (SONG 宋昱潔 2008). The Longmen-jioushe site is designated as belonging to the Shihshanghang cultural assemblage Jioushe/Jiushe subset. The Jiushe 舊社 subset sites are mostly located from the north coast to the Ilan Plain and are dated about 600 BP, the last stage of the SSH cultural assemblage. Alongside the study on the slag, SONG was the pioneer in conducting experimental archaeology on ironworking in Taiwan. Based on the unearthed slag, hammerscale, prills, and ethnographic observation of modern smiths, Song concluded that the people of Longmen-jioushe might have

⁹³ This phenomenon is similar to what scholars have observed in East Africa.

⁹⁴ Only Korea has similar iron technology, but CHEN excludes the possibility of the Korean peninsula due to the distance and lack of other archaeological connections.

used Chinese iron obtained in trade for the raw material to produce iron implements instead of making iron by themselves.

The most recent studies on the SSH-related iron technology center around the ferrous pyrotechnological remains of the SSH site and the Blihun Hanben site. Since 2018, a series of researchers have revisited the SSH remains with a more precise method of analyzing the iron-related remains. The progress reports (CHEN 陳光祖 et al. 2020; CHEN 陳光祖 et al. 2019) of these studies provide comprehensive and contextual descriptions on all kinds of artifacts. Although the explanation of the iron technology does not surpass CHEN (2000), the data from the updated methods establishes a good foundation for future comparative study. The Blihun Hanben studies are all in progress. As mentioned previously, the site is being excavated by two teams; hence, the artifact analyses are also carried out separately. The data integration will be a challenge for future studies. The progress exhibition catalog by the Lanyang Museum, *Archaeo Cultures*⁹⁵ reports a piled stone cylindrical structure as a smelting furnace (CHU 朱正宜 2017). Neither Girbal¹⁸ nor I (Liu 2019) agree with this bold assertion. Instead, both of our preliminary analyses on the BHB ferrous remains agree that most BHB iron slag is smithing slag (Girbal 2020; Liu 2019).

5.2.3. Chingpu/Jingpu 靜浦 cultural assemblage Metallurgy and other Metal-related Issues: Compared to the SSH ferrous studies, Chingpu cultural assemblage (Figure 5-7) iron remains have received less attention. While Chingpu cultural assemblage in eastern Taiwan is considered to have had ironworking ability because of its iron slag remains, only CHEN has carried out detailed analysis on Chingpu-related iron slag (Chen 2000). Based on the geochemical composition of slag, CHEN concluded that the Chingpu iron tradition used different ore compared to the SSH iron tradition based on the difference of slag chemical composition. He also pointed out that the Chingpu iron tradition might have used the double-piston bloomery method similar to that used in MSEA (Chen 2000:257). One thing worth noting is, several

⁹⁵ A private CRM company. http://www.archaeo-c.com/english/Default_en.aspx

specimens of slag from the Pasanan 八桑安 site showed a high percentage of fayalite, an index mineral of the bloomery iron smelting method.

Bronze artifacts have also been discovered at the Metal Age sites, especially in the sites of SSH cultural assemblage. However, Jiuxianglan (Figure 5-7, Figure 5-8), a site with Sanhe and Gueishan cultural assemblage contemporary to SSH cultural assemblage, also yielded bronze artifacts and sandstone molds for making bronze bells (LEE 李坤修 2005, 2015). Hung and Chao (2016) consider the upper limit of the Taiwan Metal Age to be 2300 BP based on the findings from the Jiuxianglan site. CHEN concludes the high possibility of local manufacture in Taiwan for these bronze artifacts in the Metal Age, although the technology may have been imported from MSEA (CHEN 陳光祖 2011). There are a few bronze artifacts from the late Neolithic Period as well. Shang-style bronze arrowheads and an ax were discovered at the Yuanshan 圓山 site and Tudigongshan 土地公山 site in the Taipei Basin. Based on stylistic analysis, KUO suggests that those bronze artifacts were imported from across the Taiwan Strait. (KUO 郭素秋 2001, 2014).

In summary, while the archaeological study of metallurgy in Taiwan began with KANO in the JCP, most of the subsequent metallurgy studies in Taiwan concentrate on the stylistic comparison (LEE 李坤修 2005, 2015; TSANG 臧振華 and LIU 劉益昌 2001; TSANG 臧振華, et al. 2000; KUO 郭素秋 2001, 2014). Only a few studies focus on the remains of metallic pyrotechnology to explore the nature of iron technology and search for the possible provenance of this technology (CHEN 2000; 宋昱潔 2008). However, in the past five years, studies of ferrous pyrotechnology have applied an increased number of analytic methods (Girbal 2020; LEE 李芷綾 and LIU 劉克竑 2020; Liu 2019).

Archaeological interpretation has also shifted. Before the 1980s, due to political reasons and historical facts that shaped their contemporary academic explanatory paradigm, archaeological studies tended to connect Taiwan's ancient societies to the societies on the continent across the strait before the 1980s. Hence, the archaeological 'metal' remains and iron technology were usually interpreted as imported, mainly from across the strait. In the past two decades, the explanatory paradigm has become more academically neutral. In the second half of this chapter, I shall lay out the details of my exploration of the ancient Blihun Hanben iron technology. Ideally,

the remains from a whole chain of ironworking should be examined, but I can only examine the iron slag due to the research scale and constraints. With this constraint, I have reconstructed, at least partially, the Blihun Hanben iron technological sequence.

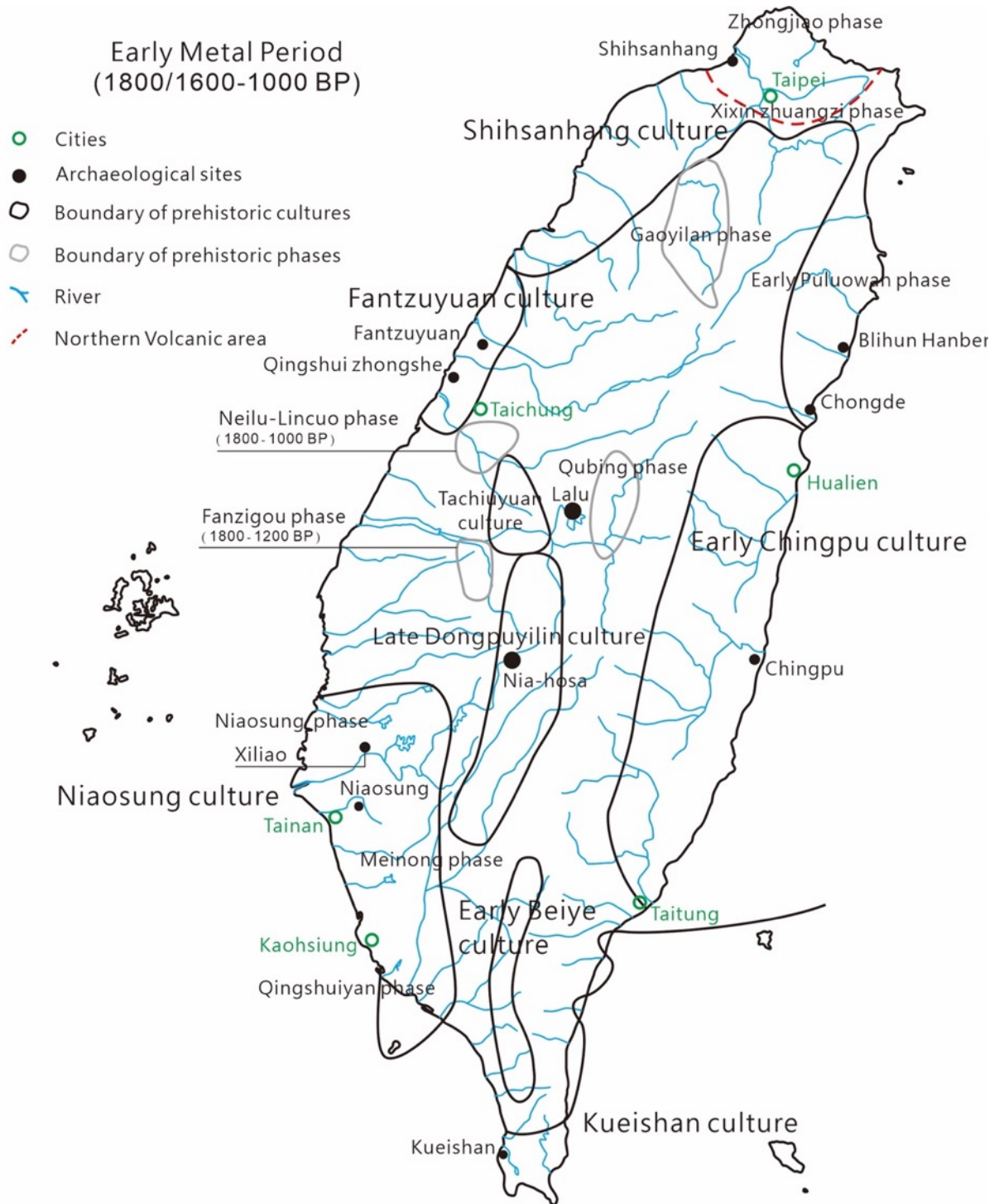


Figure 5-7 Early Metal Age archaeological cultural assemblages and sites (redraw by Ms. YANG Yu-Chun, and the original map provided by Prof. LIU Yi-Chang)

Final Neolithic Period and Initial Metal Period (2400–1800/1600 BP)

- Cities
- Archaeological sites
- Boundary of prehistoric cultures
- Boundary of prehistoric phases
- River
- - - Boundary of Final Neolithic period and initial Metal period

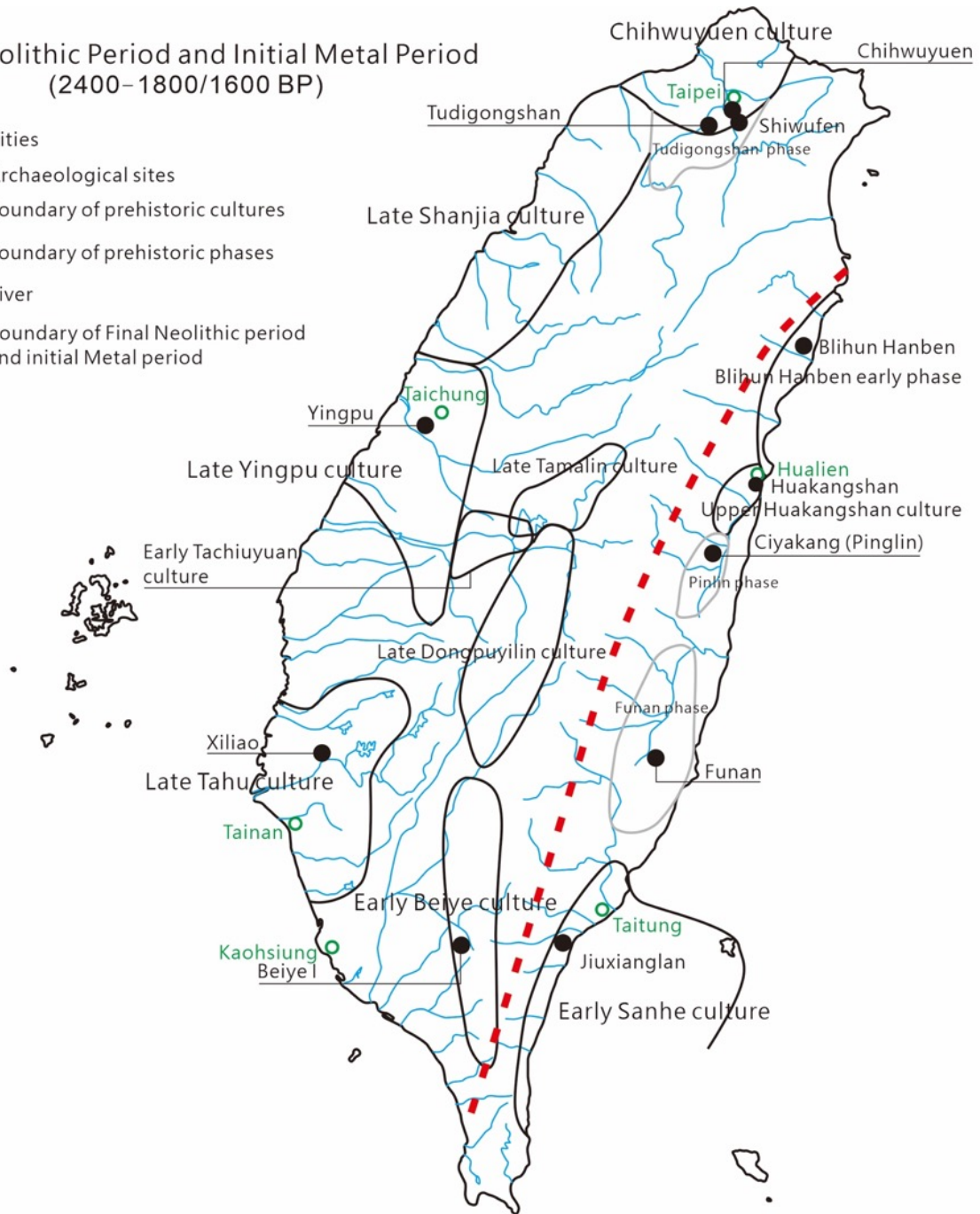


Figure 5-8 During this period, the archaeological cultural assemblages in the western part of Taiwan were still in their Neolithic time; in contrast, the east side cultural assemblages had already entered the Metal Age

5.2.4. Craftsmanship

Metallurgy as a technological system is extremely complex compared to lithic tool-making technology and ceramic-making. Metallurgy involves applying a series of techniques that need sets of knowledge for accomplishing one goal, extracting metal out of ore. Roughly speaking, metallurgy can be considered a set of technologies that have been put together to make metal and metallic products. This 'complex technological system' can be defined as a system involving a set of technologies that interact with each other for processing more than one material and having more than one step. The system then generates a final product that is essentially different from the product's raw material. A certain division of labor often participates into a sequence of manipulating and processing materials that serve different purposes for making final products. (Costin 2005:1054; Schiffer 2005; White and Hamilton 2009:360). Smelting and smithing involve laborers who act in an ordered sequence to acquire ore, process ore, acquire fuel, build furnaces, mix fuel and ore into charges, extract metal, refine the rough molten metal, shape or cast, and any post-treatment for making metallic products.

Although the step of lithic reduction can be very complex, it does not involve the transformation at a chemical level as does metallurgy. Chemical reactions are invisible to the naked eye. Hence, preindustrial metallurgy often includes acts that seem irrational to modern eyes, such as adding non-reactive materials as ritual purpose. Those acts were often regulated by myths and taboos (Schmidt 1997). Furthermore, even the simplest metallurgy system involves a vast amount of knowledge and number of skills and steps; hence, it is hard to imagine the transfer of metallurgy to a society with no prior metalworking experience without direct instruction. That means a sudden appearance of well-established metallurgy presumably involves skillful craftspeople. Also, craftspeople with different technical traditions may choose different actions to reach the same goals; for example, different types of air supply systems all serve the purpose of increasing furnace temperature; or the inclusion of certain chemically irrelevant materials in the ironworking process (e.g., Hendrickson et al. 2019) finds quartz crystals that serve a ritual purpose in the furnace bottom.

In the previous chapter, I have applied a 'technical process' concept to carry out ceramic classification. For the iron metallurgy tradition, I also consider it as a sequence of regulated

actions; hence in this chapter, the same technical process concept is applied to explore the essence of ancient ironworking at the BHB site. *Chaîne opératoire* is a well-developed French school approach that has been widely applied to analyze the sequence of lithic and ceramic production (Roux 2016; Roux and Courty 2013). A few archeometallurgical studies have also applied *Chaîne opératoire* to reconstruct the whole technological sequence of iron/steel making (Arnoldussen and Brusgaard 2015; Bauvais and Fluzin 2009; Fluzin et al. 2011). Several studies have applied a similar concept to examine the wastes from every step of iron making without mention of *Chaîne opératoire* (Larreina-Garcia et al. 2018; Petchey et al. 2018). Identifying the complete technical sequence benefits the sourcing of metallurgy origin.

5.3. Blihun Hanben ironworking remains

The BHB site yielded about 2.4 tons of slag, iron implements, two 'furnaces',⁹⁶ and numerous features of 'ironworking,' such as fired stone piles, fired and rusty sediment on the ground, and stone with slag attached to it (Figure 5-9). Among the excavation pits, P2S yielded the most slag, similar to the ceramic assemblage, almost fifty percent of the total site iron slag was found in this pit. Regarding the cultural layer, L6 has very little slag (Figure 5-10). While most of the iron implements are rusty and heavily corroded; several huge iron object pieces are quite unique in the context of Taiwan archaeology. Usually, the unearthed iron objects are implements for hunting, farming, or other daily tasks; however two double-edged swords in burial contexts are also reported for the first time. We are current have no explanation for the large iron objects found in the site. Does the sword have certain symbolic function in the BHB society? One more topic worth for future exploration.

While a large amount of pyrotechnological remains, especially iron slag, give us the impression of intensive on-site ironworking activities, examining those remains would elucidate the essence of BHB ironworking.

⁹⁶ Those structures were referred as smelting furnaces, but both mine and Dr. Girbal's analyses point out that these structures are not quite possible being used as the smelting furnace. In short, the diameter is too big.



Figure 5-9 Upper left: fired and rusty sediment on the ground in Pit P3N; upper right: 'furnace' in Pit P1S; unearthed iron knife (LIU 劉益昌 et al. 2016). Iron slag (photo taken by the author)

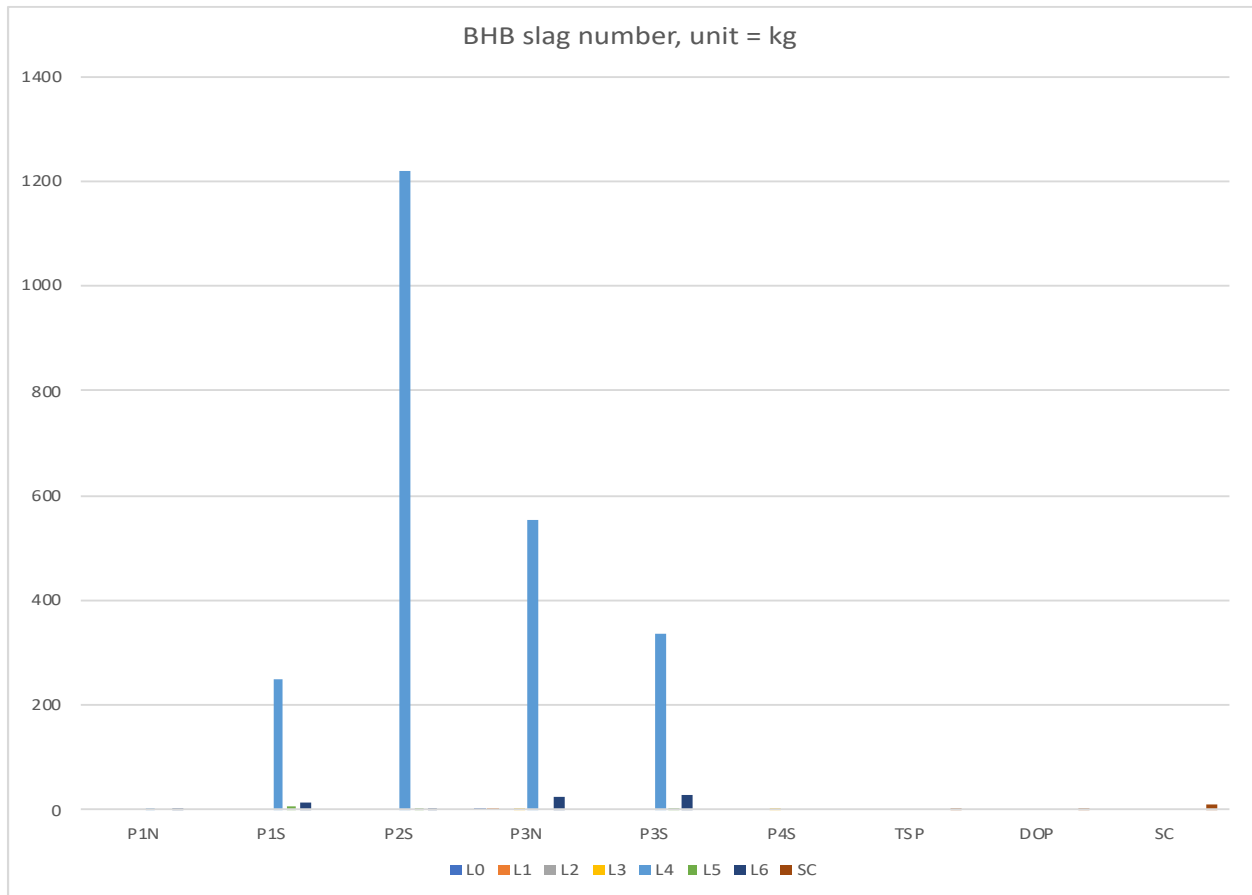


Figure 5-10 Slag weight of each excavation pit. P2S unearthed the most slag

Unlike mass-manufacturing facilities after the Industrial revolution, the preservation condition of furnace structures at ancient ironworking sites is usually less ideal. Indeed, iron products and their slag inclusion (Biggs et al. 2013; Blakelock et al. 2009) could reveal many metallurgical details, such as manufacturing tradition and possible ore provenience; however, scholars need to overcome challenges like corrosion, scarcity, and limited access to iron objects. Due to these constraints and research scale, my research focuses on the wastes and residues of ironworking, especially on the 2.5 tons of iron slag from the BHB site. Besides being easier to access because of its abundance, iron slag encapsulates metallurgical information within it. Since slag is structurally strong, the information that has been sealed inside could last for a long time. Recently, more and more archeometallurgical studies focus on slag analysis (HUANG 黄全胜 et al. 2016).

5.4. Slag: Macro Analysis

5.4.1. Sampling Strategy, Workflow, and Analytic Method

As with the ceramic analyses, I carried out slag analyses from both macro and micro perspectives. A systematic sampling strategy was also applied to select bags of slag to examine. First, we⁹⁷ organized the bag order (Figure 5-11, upper left and right) based on excavation context (2m by 2m basic unit and level). Second, for every ten bags, we extracted one bag. If the bags from the same excavation context were less than 4, we rounded it down to zero, in contrast, if bag numbers were from 5 to 9, we rounded it up and selected one bag. Under this strategy, we selected about 10% of the slag systematically to represent the whole slag assemblage of the excavated BHB site.

The slag in the selected bags was then classified into different types. Although iron slag may look amorphous, slag from different stages of ironmaking may still be distinguishable (McDonnell 1983, 1995). The classification of slag by its morphology is always the first step in the macro-analysis. I also measured the magnetic property, which is one indicator of bloomery slag, of each type of slag. Specific morphological characteristics can be taken as indicators for determining the metallurgical stage. For example, tap slag⁹⁸ is generated in most bloomery smelting traditions and has a weak magnetic property. Tap slag has a smooth or ripple-like surface, and its texture is similar to solidified lava. Plano/concave-convex shaped slag is the typical remnant of smithing activities (Bachmann 1982; Tylecote 2002). To distinguish between primary and secondary smithing, hammerscale (little iron flakes) and prill (little iron pellet) are two indicators.

I have classified the sampled BHB iron slag assemblage into five types based on the morphological characteristics (smooth or ripple-like surface tap slag, plano/concave-convex shaped smithing slag, amorphous slag, dendritic, and flat shaped slag), and there are basically two sub-types (except for Type A) for each type. The classification standards and attributes to be measured were based on those previous classic studies (Bachmann 1982; Chen 2000; McDonnell

⁹⁷ I sincerely thank Mr. WANG Shih-Hao 汪詩豪 who was an undergraduate student at the National Taiwan University and provided great help on the slag analysis works. I also need to thank Ms. WU Pei-Chi 吳珮琪 and Ms. ZHUANG Pei-Xuan 莊珮瑄 who were part-time co-workers and gave great help to me and Mr. WANG.

⁹⁸ Or the slag that not been 'tapped' out.

1983), but I also adjusted to fit the BHB slag assemblage characteristics. For example, I did not measure porosity that was measured in Chen's doctoral research since the porosity measure seemed not to provide additional information for illuminate the essence of iron technology.



Figure 5-11 Upper left and right: re-arranging artifact boxes and bags by their excavation context. Mid-left: classifying slag into different types. Mid-right: weighing slag for each type. Lower left: teamwork for morphological analysis. Lower right: Dr. Brice Girbal discussing and checking the examination results with the author (not visible)

5.4.2. Slag Types

Type A: approximately round shape but mostly amorphous, heavily rusted appearance, relatively smooth surface. Type A slag could form in any stage of the iron metallurgical process.

Sub-type AI (Figure 5-13, upper left): smaller in size, diameter less than 5cm, with a strong magnetic property.

Sub-type AII (Figure 5-12, upper right): larger in size, diameter more than 5cm.

Sub-type AIII (Figure 5-12, lower left): irregular shape but with the trace of penetration while still hot and soft. Possible penetration by tapping stick.



Figure 5-12 Upper left: Type AI, slag with amorphous shape; upper right: Type AII, larger slag with amorphous shape. Lower left: Type AIII, amorphous slag but with a trace of penetration (red arrow). All these pieces of slag have magnetic properties

Type B: this type is the typical smithing hearth bottom (SHB), and some call it a plano-convex bottom (PCB). SHB forms mainly during the primary smithing; however, in many cases, primary and secondary smithing is performed in the same hearth. SHB is usually convex or flat on top and concave on the bottom. The overall shape is roundish or oval. The convex or flat top has a strong magnetic property. Some Type B slag fragments have pieces of slate attached to them.

Sub-type BI (Figure 5-13, uppers): broken piece of BII, diameter less than 5cm.

Sub-type BII (Figure 5-13, lowers): whole or large piece of SHB. The top of SHB usually has a strong magnetic property and has been covered with rust. In some cases, prills can be observed on top of BII slag. Also, some SHB has a ripple-like surface that indicates the usage of an air blow system during smithing.



Figure 5-13 Uppers: Type BI, broken piece of BII (SHB). Lowers: Type BII, relatively complete SHB

Type C: usually with sharp edges, and the side surfaces are very smooth with steel-gray metallic luster. Type C could also be smithing hearth bottom; however, the appearance is different with Type B. Generally, Type C is thinner than Type B.

Sub-type CI (Figure 5-14, uppers): diameter usually smaller than 5cm. Magnetic property is not as strong as Type B.

Sub-type CII (Figure 5-14, lowers): surface is coarser than Type CI. Magnetic property is not as strong as Type B.



Figure 5-14 Upper: Type CI slag with sharp edges, usually smaller than five cm and has steel-gray metallic luster. Lower: Type CII slag, coarser surface than CI

Type D: two different types of 'slag.'

Sub-type DI (Figure 5-15, uppers): high porosity and very light. The original color is relatively whitish. Sometimes can see the vitrified glassy phase if broken. The diameter is usually smaller than 5cm. No magnetic property.

Sub-type DII (Figure 5-15, lowers): like tap slag, DII slag has a lava-flow shape. Smooth surface. The diameter is usually smaller than 5cm. No magnetic property. However, some Type DII has rust attached to it, and the rusty part has a weak magnetic property.



Figure 5-15 Upper: pumice-like slag. The most porous slag among all types. Inside is glassy vitrified. Lower: Type DII is similar to tap slag but the size is too small compared to the typical ones

Type E: two very different types of slag

Sub-type EI (Figure 5-16, uppers): another kind of amorphous but pointy, heavily rusted. Might be smelting slag. The holey concave areas might be the space left by the burned charcoal.

Sub-type EII (Figure 5-16, lowers): flat, the thickness is usually less than 5mm. The EII slag could be the working floor that has been 'glued' together by rust, high heat, and constantly being stepped on.



Figure 5-16 Upper: amorphous shape but with many pointy and holey parts. Could be smelting slag. Lower: flat and thin compared to other slag types, could be the working floor close to smithing hearth or iron workshop floor

5.4.3. Interpretation of Analysis Results

Figure 5-17 shows the amount of each slag type of all examined specimens. It is clear that the whole slag assemblage is dominated by type B, which is the indicator of smithing activity. SHB has a unique convex/plano-concave shape and can be easily identified. On the other hand, the smelting process also produces distinctive slag, the tap slag (the most similar slag we have is type DII). Tap slag is usually 'tapped' out from the furnace bottom part via a tap hole during the smelting process. It flows like lava; hence it shapes like folded lava with a smooth and rippled surface. However, based on the data we have, the proportion of possible smelting slag (DI, DII, EI, and AIII) is small in the whole assemblage. Type DI slag could also be the reacted/vitrified furnace lining (clay). Lastly, type EII could be the furnace/hearth bottom or the area of the working floor near the furnace/hearth.

In general, a bloomery furnace is a onetime-use structure since the furnace needs to be broken for bloom extraction. Under this circumstance, a large number of furnace body fragments are usually associated with smelting slag in the smelting site. However, the examined BHB slag specimens lack both furnace-lining fragments and smelting slag; in contrast, this slag assemblage reflects intensive smithing activities (ironworking) rather than smelting (ironmaking).

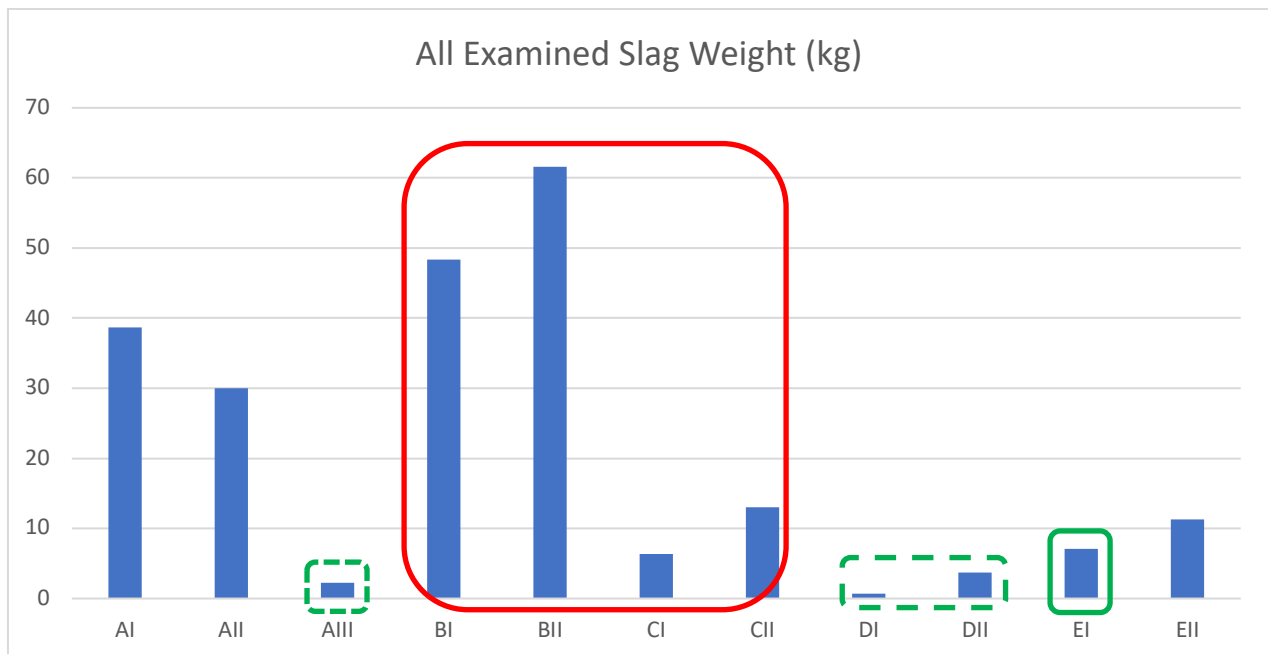


Figure 5-17 Red-lined types are smithing slags, green-lined type is smelting slag, and the green dashed line areas could be smelting slag

5.5. Slag Microstructural and Geochemical Analyses

5.5.1. Sampling Strategy and Analytic Method

Micro-analyses could reveal information that macro-analysis cannot, for example, the microstructure of minerals in slag and their geochemical composition. Slag micro-structure reflects the smelting and smithing stages, and the geochemical composition of minerals could determine the ore source (Killick and Fenn 2012; Killick and Miller 2014; Pleiner 2000). Combining the results of micro and macro analyses would give us a more solid inference of slag type and information on the metallurgical process.

The microstructure of blast furnace slag is mainly glassy phase. Since the yield of the indirect method is high, the iron constituent in the slag is relatively low. Occasionally, a very few tiny metallic iron fragments and tephroite can be found in the blast furnace slag (HUANG 黄全胜 et al. 2016). In contrast to the indirect method, the yield rate of the direct method is much lower; hence, lots of iron oxides remain or reform in the bloomery furnace slag. As mentioned, iron element reacts with silica and then forms fayalite in the iron ore during bloomery smelting. Molten fayalite then flows down to the bottom and forms smelting slag or tap slag. In short, smelting slag contains lots of fayalite. Fayalite and silica-rich minerals may be observed in the primary smithing slag. Some of these silica-rich 'impurities may result from the bloom refining, and some may be from a refractory lining and charcoal ash that react with iron elements. Iron oxide like FeO (wüstite) then forms again after the bloom refining and during the secondary smithing (Pleiner 2000; 2006:119-120).

Due to the research scale and constraints, I only analyzed one specimen for each type. Specimens were randomly selected from examined slag assemblage. I carried out all the micro-analyses in the Laboratory of Electron Probe Micro-analyses of the Institute of Earth Sciences at the Academia Sinica, Taiwan. With the generous help from the laboratory assistant Mr. WANG Yu-Shiang 王宇翔 and laboratory director Dr. IIZUKA Yoshiyuki 飯塚義之, I was able to operate the Scanning Electron Microscopy with Energy Dispersive X-Ray Spectroscopy (SEM-EDS, JEOL JSM-6360LV and Oxford X-Max^N 80T) to observe the slag micro-structure and extract the chemical composition. Working distance was 10mm with 15.0kV current. All slag specimens were mounted in resin and polished with no conductive coating.

5.5.2. Results of Analysis

SG-04 (Figure 5-18):

This type EI slag is considered as smelting slag morphologically. The holey surface may indicate the existence of unburned charcoal in the bloom. SEM image (Figure 5-19) shows three phases. The white phase is the semi-dendritic and semi-globous iron oxide. EDX spectrum 1 and 2 results indicate that FeO should be wüstite.⁹⁹ The light gray phase is semi-rectangular fayalite lath (Fe_2SiO_4 , spectrum 3 and 4). The dark gray phase is the silica-aluminum glassy material (spectrum 5 and 6). The microstructure and chemical composition (Table 5-1) of this slag support the morphological classification.

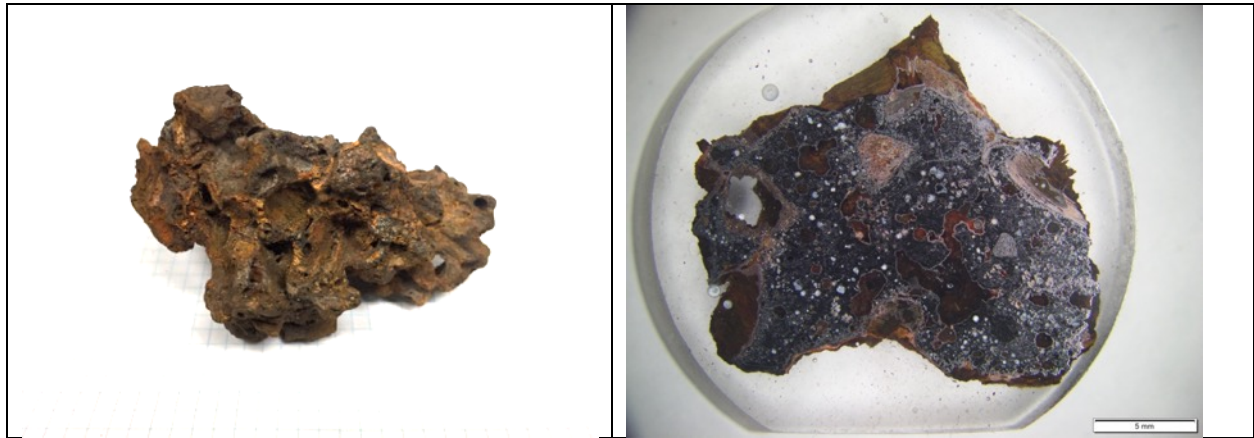


Figure 5-18 Sample number SG-04. Type EI slag and its specimen block (left: the square is 3mm by 3mm; right: the scale is 5mm)

⁹⁹ I use <http://www.webmineral.com/> as the mineral database, recommended by Dr. Brice Girbal.

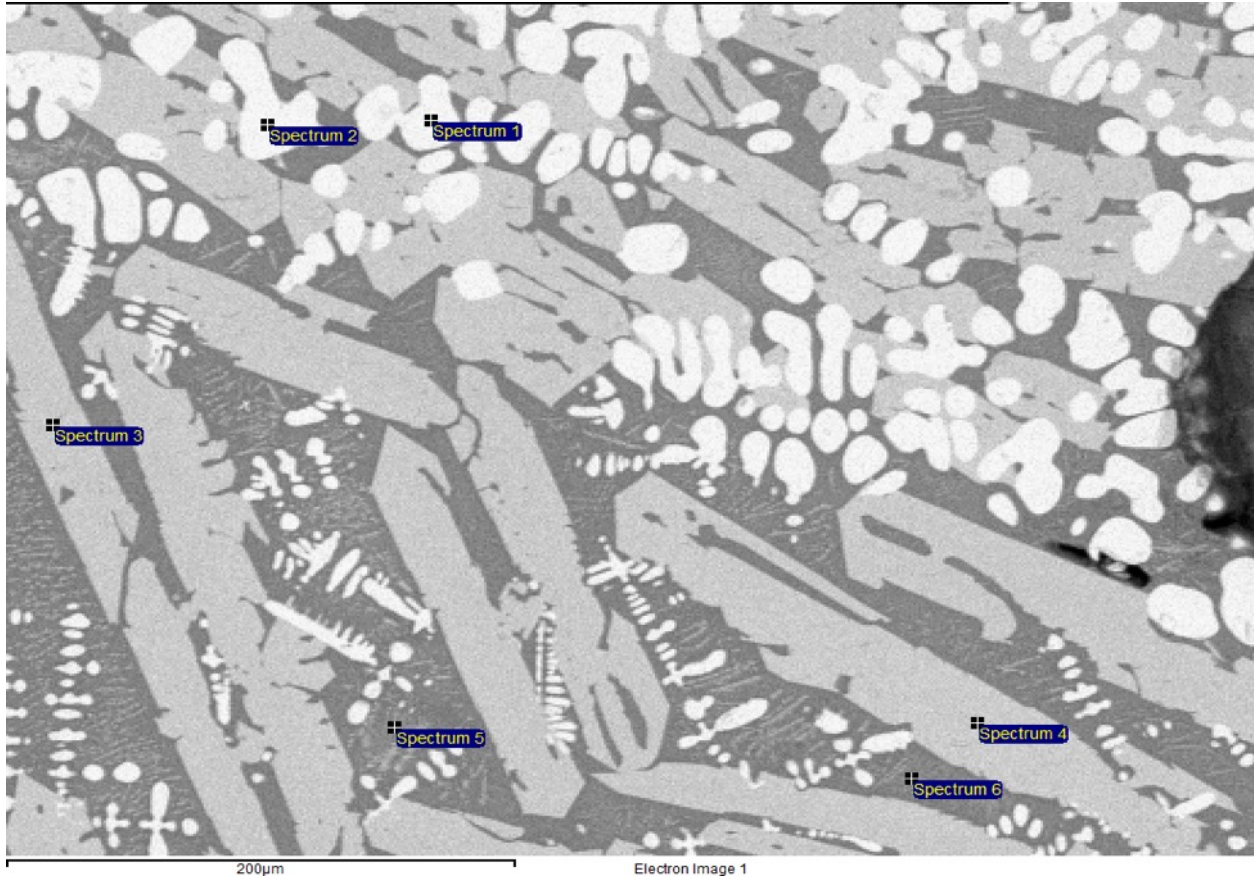


Figure 5-19 SG-04 Type EI slag SEM image (scale size 200 μm). SEM image shows three phases. The white phase is the semi-dendritic wüstite; medium gray is the predominant fayalite; dark gray phase is silica-based glassy material. Photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica

Table 5-1 SG-04 chemical composition by the SEM-EDX, normalized results in wt%

Processing option: All elements analyzed (Normalized)											
All results in weight%											
Spectrum	In stats.	O	Na	Mg	Al	Si	P	K	Ca	Fe	Total
Spectrum 1	Yes	27.38			1.5	2.75				68.36	100
Spectrum 2	Yes	27.03			1.49	2.52		0.49		68.48	100
Spectrum 3	Yes	36.32		0.85	1.33	12.41		0.55	1	47.55	100
Spectrum 4	Yes	35.96		0.92	1.41	13.14		0.52	0.71	47.35	100
Spectrum 5	Yes	45.96	2.35		10.3	16.96	0.4	5.44	4.05	14.55	100
Spectrum 6	Yes	42.66	1.79		9.39	16.69	0.72	5.54	5.03	18.18	100

SG-01-temp-EI (Figure 5-20):

This specimen is also type EI slag. The rectangular hole in the specimen block center may be the charcoal inclusion. SEM image (Figure 5-21) shows four phases, bright dendritic and globous wüstite (spectrum 1 and 2), light gray rectangular high Fe-Ti compound (spectrum 3 and 4), gray long semi-rectangular fayalite lath (spectrum 5 and 6), and dark gray glassy phase (spectrum 7 and 8). This specimen is also identified as smelting slag from micro-analyses.

SG-01-temp-EI has a Titanium-rich phase that does not exist in SG-04. Pseudobrookite's chemical composition is very close to what spectrum 3 and 4 have (Table 5-2). Pseudobrookite usually associates with other common iron oxides like hematite, magnetite, and ilmenite, and its mother rock is those titanium-rich volcanic rocks such as andesite, rhyolite, or basalt. In Taiwan, this mineral could be found in volcanic areas (Tatun Mountains and Coastal Mountain Range).

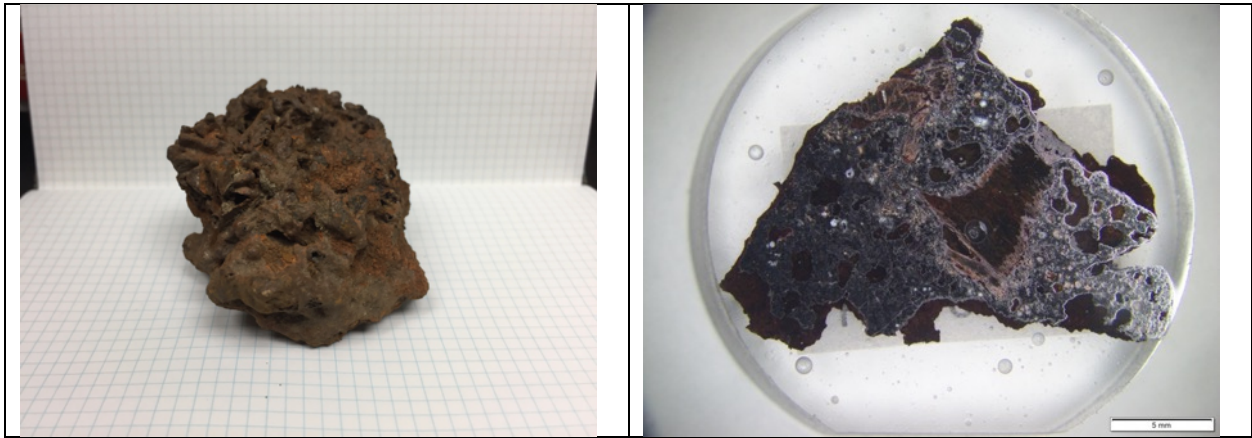


Figure 5-20 Sample number SG-01-temp-EI. The rectangular hole in the specimen block center may be the charcoal inclusion (left: the square is 3mm by 3mm; right: the scale is 5mm)

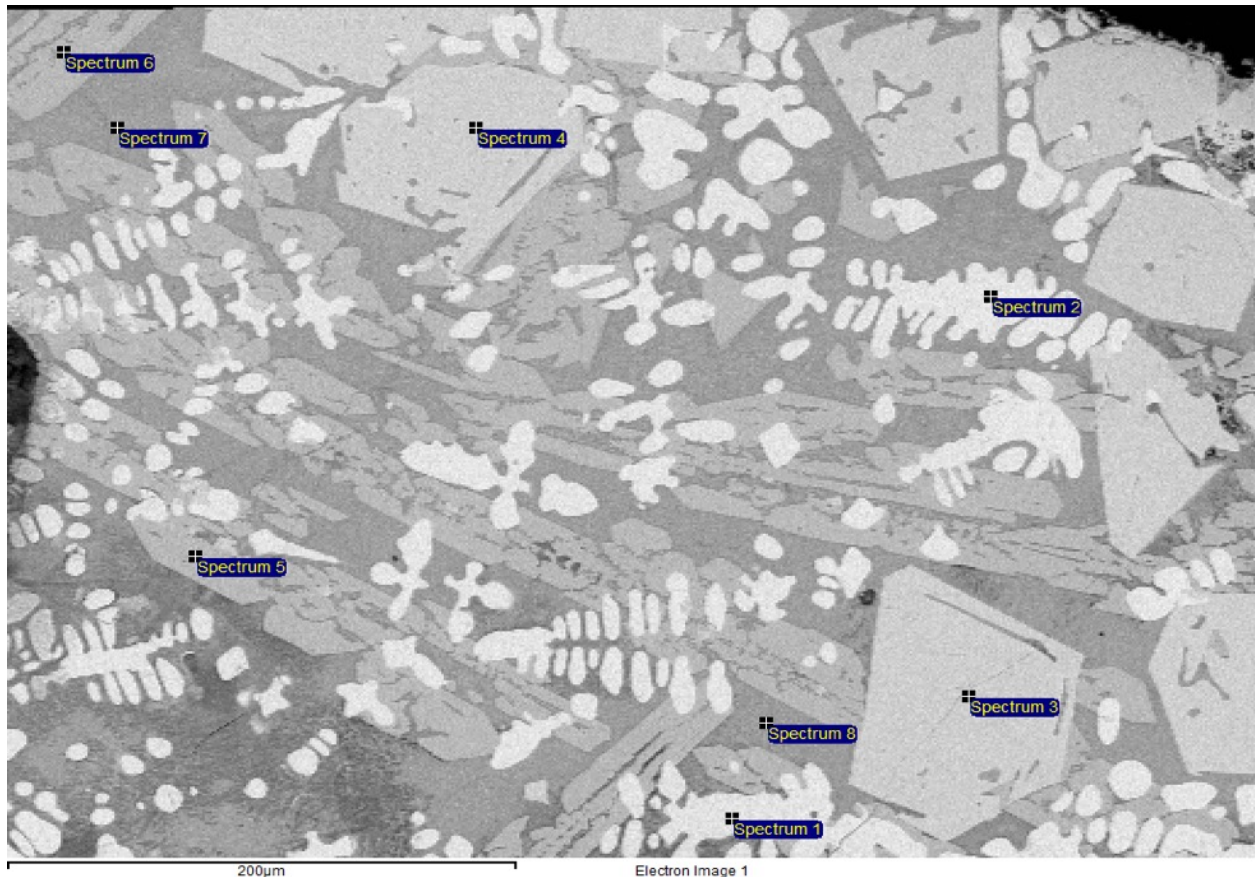


Figure 5-21 Sample number SG-01-temp-EI (scale size 200 μm). SEM image shows four phases, dendritic wüstite, rectangular high Fe-Ti compound (could be pseudobrookite), long semi-rectangular fayalite lath, and glassy phase. Photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica

Table 5-2 SG-01 chemical composition by the SEM-EDX, normalized results in wt%

Processing option: All elements analyzed (Normalized)													
All results in weight%													
Spectrum	In stats.	O	Na	Mg	Al	Si	P	S	K	Ca	Ti	Fe	Total
Spectrum 1	Yes	28.42			0.71	1.62				0.76	2.44	66.06	100
Spectrum 2	Yes	28.62			0.81	1.8				0.53	2.21	66.03	100
Spectrum 3	Yes	34.5		0.47	2.24	1.18				0.52	13.68	47.42	100
Spectrum 4	Yes	34.11			2.39	1.27				0.55	13.98	47.69	100
Spectrum 5	Yes	36.73		1.35	0.6	12.5				1.95	0.73	46.13	100
Spectrum 6	Yes	36.84		1.4	0.64	12.4				2.48		46.24	100
Spectrum 7	Yes	40.65	1.08		3.74	13.31	1.46	0.49	3.81	6.81	1.54	27.1	100
Spectrum 8	Yes	40.77	1.1		3.63	12.67	1.68		3.7	8.02	0.9	27.53	100

SG-23 (Figure 5-22):

Type C1 is broken fragment of type B slag. This type usually has limited magnetic property on the steel-gray lust profile surface but has high magnetic property on the plano/convex top. SEM image shows two phases; the predominant white phase is thick globous wüstite (Figure 5-23, spectrum 1 to 3), and the interstitial filling is silica-calcium glassy matters (Figure 5-23, spectrum 4 to 6). SG-23 shows typical smithing slag characteristics from both macro and micro analyses.



Figure 5-22 Sample number SG-23. Type C1 slag is a broken piece of type B. Left photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica (right: the square is 3mm by 3mm)

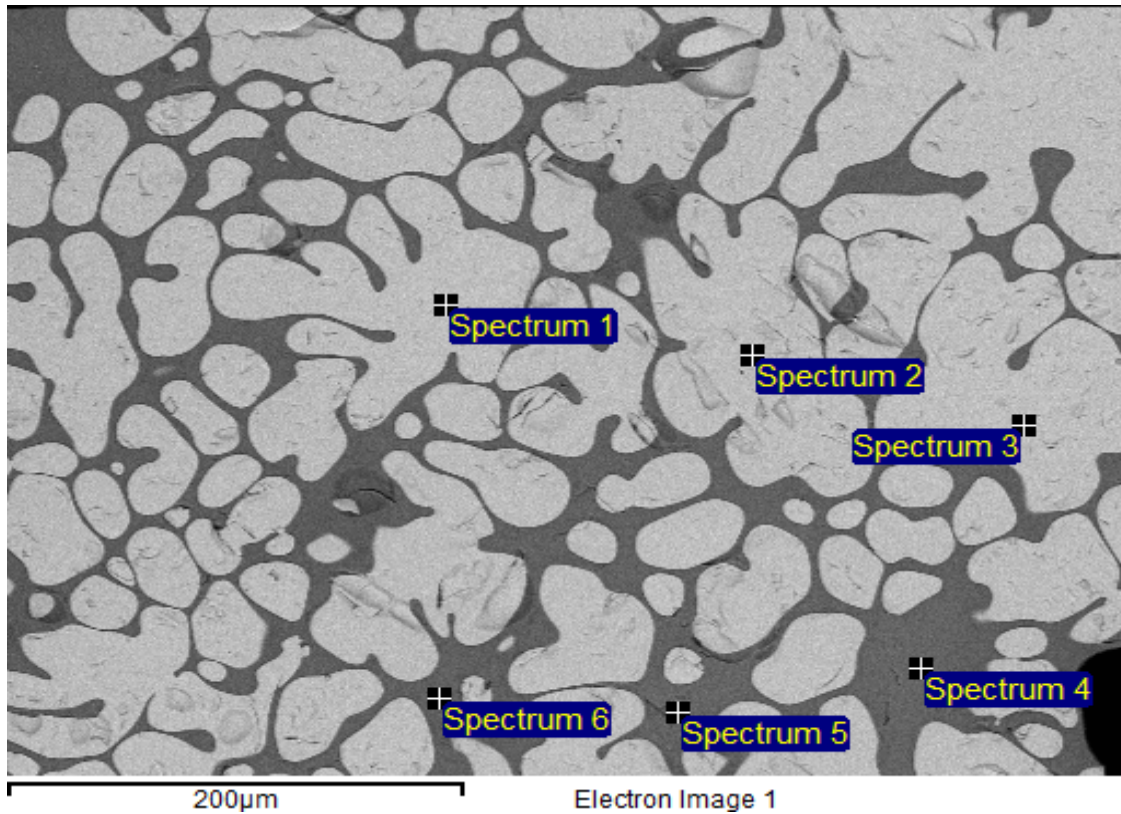


Figure 5-23 SG-23. SEM image shows two phases: the white phase with thick globules of wüstite that usually grow in smithing slag and the dark gray phase with the glassy materials. Photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica

Table 5-3 SG-23 chemical composition by the SEM-EDX, normalized results in wt%

Processing option: All elements analyzed (Normalized)												
All results in weight%												
Spectrum	In stats.	O	Na	Mg	Al	Si	P	S	K	Ca	Fe	Total
Spectrum 1	Yes	26.44			0.44	0.93				0.59	71.6	100
Spectrum 2	Yes	26.29			0.46	0.77				0.54	71.94	100
Spectrum 3	Yes	27.26			0.43	0.79				0.72	70.81	100
Spectrum 4	Yes	41.31	1.52	0.43	3.27	13.93			1.96	9.69	27.9	100
Spectrum 5	Yes	41.26	1.64		3.18	13.53		0.38	2.01	10.15	27.85	100
Spectrum 6	Yes	39.21	1.3	0.39	3.09	14.24	0.35		2.58	10.48	28.36	100

SG-11 (Figure 5-24):

Type BII slag. This type also has limited magnetic property on the shiny, steel-gray cross-section surface but has high magnetic property on the plano/concave top. Type B usually has a robust appearance (Figure 5-13) and quite rusty top surface. On the bottom surface, some ground materials, such as sand, fuses with the slag bottom. This piece has a clear concave top and a convex bottom. Pleiner uses the term, *calottes*, to refer this kind of slag (Pleiner 2006). The freshly cut profile shows high porosity.

SEM image shows two phases (Figure 5-25): the predominant white phase with thick globous wüstite (Table 5-4, spectrum 1 and 2), and the interstitial filling with silica-calcium based glassy matter (Table 5-4, spectrum 3 to 4). As with SG-23, SG-11 also shows typical smithing slag characteristics from both macro and micro analyses.

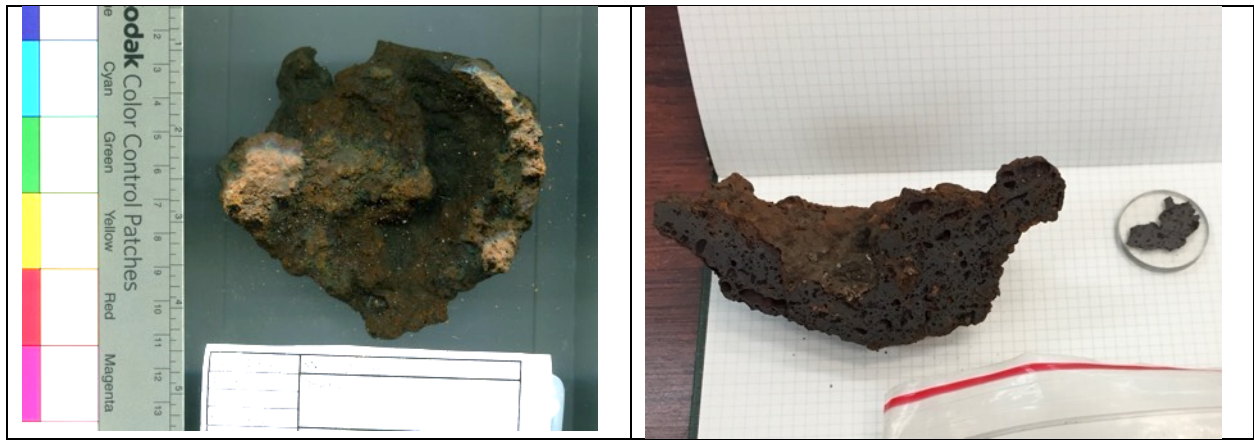


Figure 5-24 Sample number SG-11. Type BII slag also known as smithing hearth bottom (SHB). Left photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica (right: the square is 3mm by 3mm)

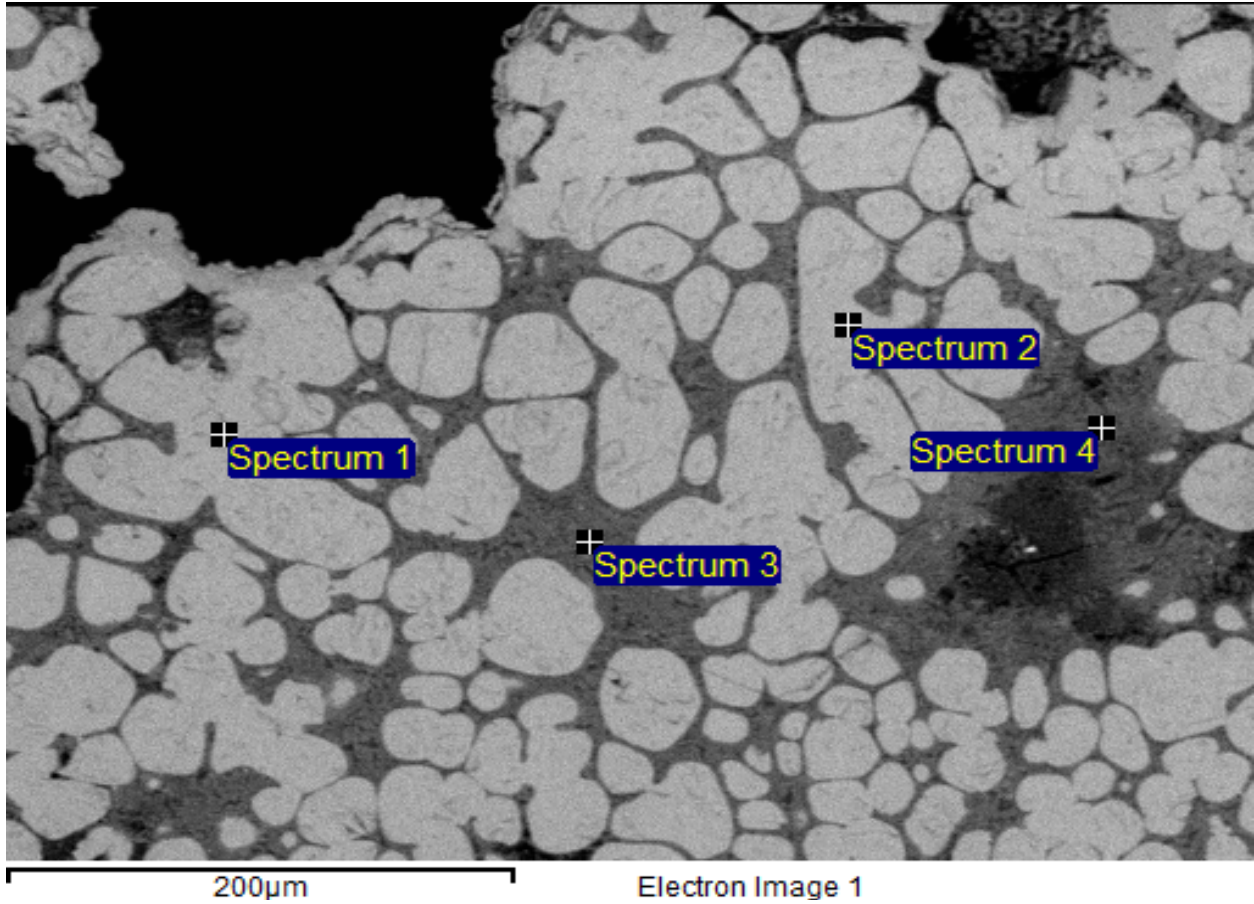


Figure 5-25 Two distinct phases. The white phase is wüstite, and the dark gray phase is glassy matter

Table 5-4 SG-11 chemical composition by the SEM-EDX, normalized results in wt%

Processing option: All elements analyzed (Normalized)												
All results in weight%												
Spectrum	In stats.	O	Na	Mg	Al	Si	P	S	K	Ca	Fe	Total
Spectrum 1	Yes	26.26		0.64	0.62	0.94					71.54	100
Spectrum 2	Yes	26.51		0.56	0.51	0.98					71.44	100
Spectrum 3	Yes	39.75	1.32		5.77	12.57	1.01	0.97	2.75	10.46	25.4	100
Spectrum 4	Yes	42.4			1.56	11.12	1.1			11.99	31.83	100

SG-07 (Figure 5-26):

Type DI slag is light and porous. It has no magnetic property at all. DI slag was documented as pumice during excavation because of its light weight. DI slag does float on water. In the Huakangshan excavation, researchers also encountered this 'pumice' (LIU 劉益昌 and CHAO 趙金勇 2010a).¹⁰⁰ The amount of DI slag is small in the whole assemblage. SEM image (Figure 5-27) shows only one glassy phase, and the chemical composition (Table 5-5) is predominantly Si and Al. This specimen could be part of vitrified furnace/hearth lining.



Figure 5-26 Sample number SG-07. Type DI. Si constituent is high. Glassy phase. Probably part of furnace lining. Photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica (right: the square is 3mm by 3mm)

¹⁰⁰ I suspect there is more 'pumice' that has not been reported during archaeological excavation.

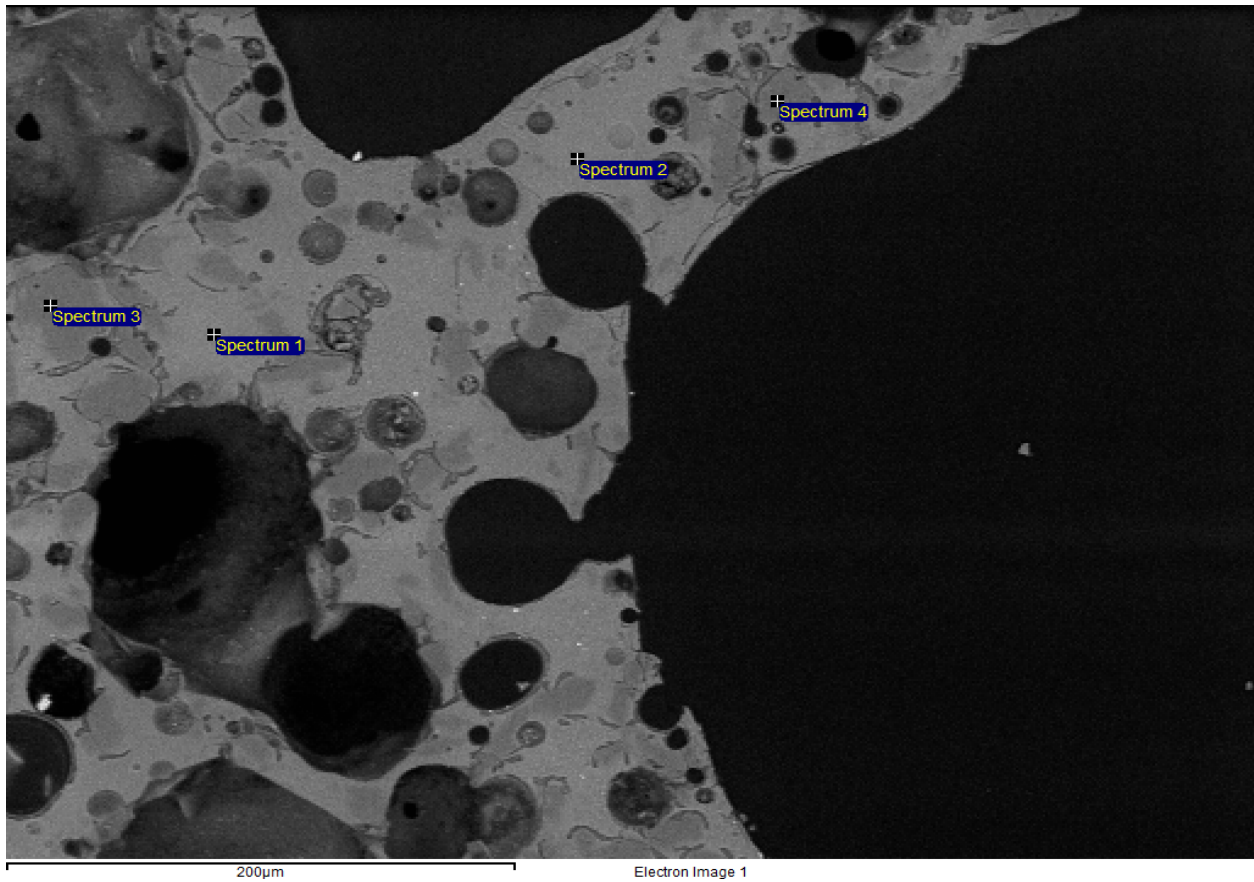


Figure 5-27 Sample number SG-07. Type DI. Si constituent is high. Glassy phase. Probably part of furnace lining. Photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica

Table 5-5 SG-07 chemical composition by the SEM-EDX, normalized results in wt%

Processing option: All elements analyzed (Normalized)										
All results in weight%										
Spectrum	In stats.	O	Na	Mg	Al	Si	K	Ca	Fe	Total
Spectrum 1	Yes	52.2	2.1	2.04	10.82	24.65	2.16	1.39	4.64	100
Spectrum 2	Yes	52.36	2.11	1.66	10.46	24.82	2.83	1.4	4.36	100
Spectrum 3	Yes	57.92			1.23	40.84				100
Spectrum 4	Yes	58.16			1.23	40.61				100

SG-09 (Figure 5-28):

There is no typical tap slag from the examined BHB slag assemblage; however, type DII slag is the most similar type we have. DII slag has no magnetic property and has a smooth surface texture. The typical size of tap slag is much larger than the BHB DII slag.

SEM image shows a well-fused phase with tiny mineral crystal structures (Figure 5-29, note the scale of this image), indicating a fast-cooling environment when this slag is formed. EDS results indicate the well-fused phase is the Si-Ca-Al-Fe compound (Table 5-6). Both microstructure and chemical composition indicate the possible tap slag of this specimen.

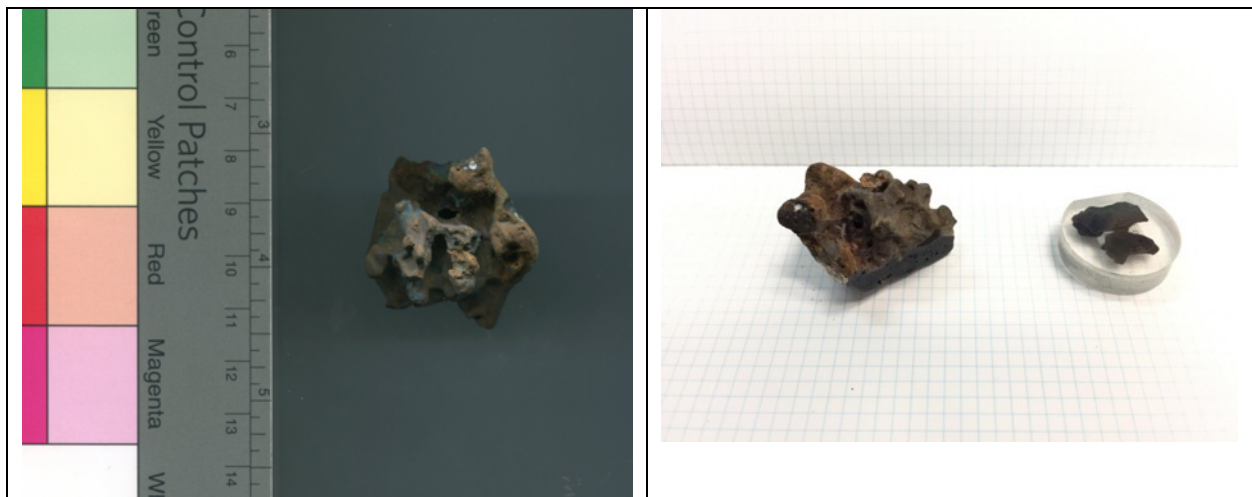


Figure 5-28 Sample number SG-09- (scale size 60 μm). Left photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica (right: the square is 3mm by 3mm)

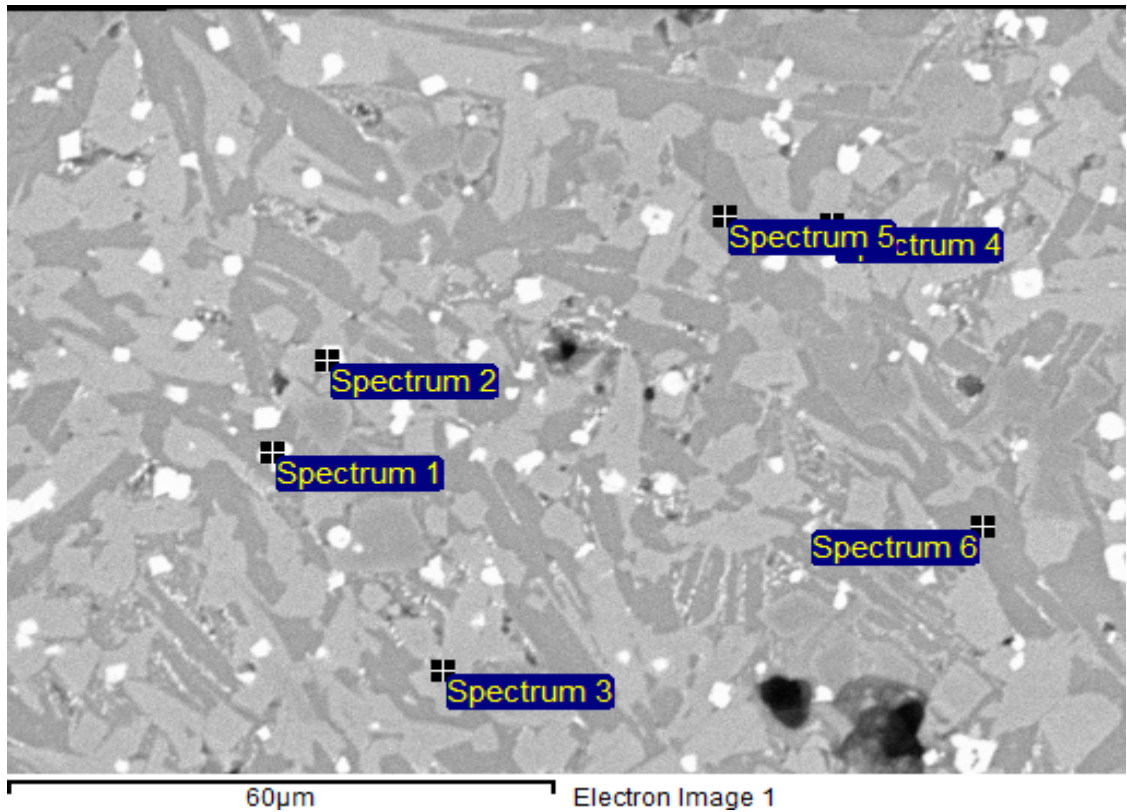


Figure 5-29 Sample number SG-09- (scale size 60 μm). SEM image shows well-fused structures from a rapid-cooling environment. Photo credit: EPMA lab in the Institute of Earth Science at the Academia Sinica.

Table 5-6 SG-9 chemical composition by the SEM-EDX, normalized results in wt%

Processing option: All elements analyzed (Normalized)													
All results in weight%													
Spectrum	In stats.	O	Na	Mg	Al	Si	P	K	Ca	Ti	Cr	Fe	Total
Spectrum 1	Yes	41.79	0.97	4.68	5.72	7.08			2.66	3.08		34.02	100
Spectrum 2	Yes	41.8	0.6	4.56	7.15	6.2			2.6	2.55	2.89	31.65	100
Spectrum 3	Yes	48.23	0.61	5.92	6.3	17.66	0.29		12.01	1.9		7.07	100
Spectrum 4	Yes	48.01	0.72	6.2	6.07	16.88	0.34		12.13	2.03		7.61	100
Spectrum 5	Yes	50.79	2.58	1.98	12.39	20.97		0.38	7.84			3.06	100
Spectrum 6	Yes	50.62	2.4	1.68	12.73	20.46			7.75	0.69		3.68	100

5.5.3. Summary of Micro-analyses

The micro-analyses support the macro-analysis, in short. For the presumed smelting slag, type EI, typical iron smelting slag micro-structure and mineral composition are both observed in the specimens. Long and semi-rectangular fayalite lath and dendritic wüstite are typical minerals in bloomery slag. On the other hand, fat wüstite globules were found in type B and type C, the former is a broken piece of SHB, and the latter is a complete SHB. As for type DI, the chemical constituent is too homogenous for natural pumice. I highly suspect that type DI slag is the vitrified furnace/hearth lining. Type DII slag's surface is smoother than other types. The well-fused state and microstructure indicate rapid cooling when forming this kind of slag. These are tap slag characteristics.

Table 5-7 Summary of analyzed slag with classification type and the corresponding minerals

Classification Type	Slag designation	Minerals	Specimen No.
EI	Smelting slag	Semi-rectangular fayalite Semi-dendritic and semi-globous wüstite	SG-04
EI	Smelting slag	Semi-rectangular fayalite Dendritic and globous wüstite Rectangular high Fe-Ti compound	SG-01-temp-EI
CI (broken piece of type B)	Smithing heath bottom	Thick globous wüstite	SG-23
BII	Smithing heath bottom	Thick globous wüstite	SG-11
DI	Vitrified furnace/hearth lining	Glassy, rich of Si and Al	SG-07
DII	Tap slag (?)	Well-fused phase with Si-Ca-Al-Fe compound	SG-09

5.6. More Observations on Slag and Metallurgical-related Remains

The slag morphology allows us to distinguish between smelting and smithing slag, for example, smelting slag, tap slag, and SHB. A few features on the slag surface could reveal more information. Some smithing prills are observed on top of type B slag (Figure 5-30, left). Prills and hammerscale (flat, thin iron fragments) are indicators of secondary smithing, which is the process of shaping iron bars/billets to desired implements. Charcoal impressions also have been

found on the slag surface (Figure 5-30, right). Study on the impressed charcoal fibers could determine the tree species and further explore the issues on paleoclimate and environment.

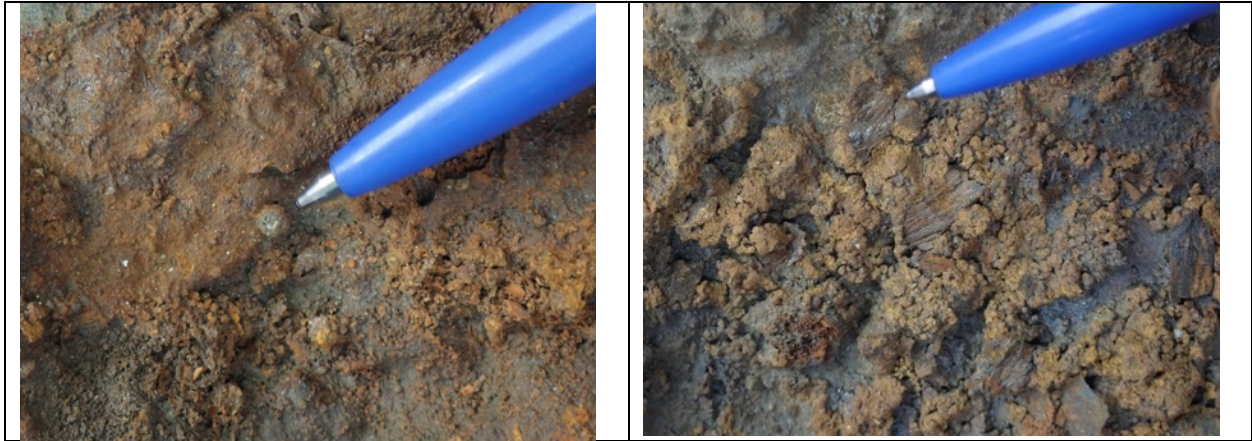


Figure 5-30 Left: prill on the SHB. Right: charcoal impressions on slag

The rippled or tilted top of type B slag (SHB) shows the air blowing directions (Figure 5-31). Hence, although we did not find any blowpipe or tuyère remains, an air blowing system was indeed used by the BHB ironworkers.



Figure 5-31 Air blowing direction pointed out by Dr. Girbal (left) and blue pen (right)

Besides slag, I also noticed a few burned slate plates and ceramic sherds (Figure 5-32). In the current research state, I have no conclusion about this phenomenon. However, one needs to bear in mind; the nearest slate resource is more than 20 km away. The BHB residents also used slate for their burial coffins. The use of slate for burial coffins and metallurgy may reflect a special meaning of slate in the BHB society. The number of burned ceramic sherds is somewhat limited. All these burned sherds are L4 type 5, the dominant ceramic type. Also, within these

burned sherds, many of them have cloud decoration patterns¹⁰¹ on the interior surface. Ceramic products in metallurgy are usually the tuyère and crucible. Currently, no tuyère remains have been located. From the ceramic texture and manufacturing technique, type 5 ceramic is not quite possible for use as the metallurgical crucible since type 5 ceramic cannot bare such high heat from smelting. Heat-resist is the basic characteristic of crucible. These burned ceramics may have served other purposes in the BHB iron metallurgy.

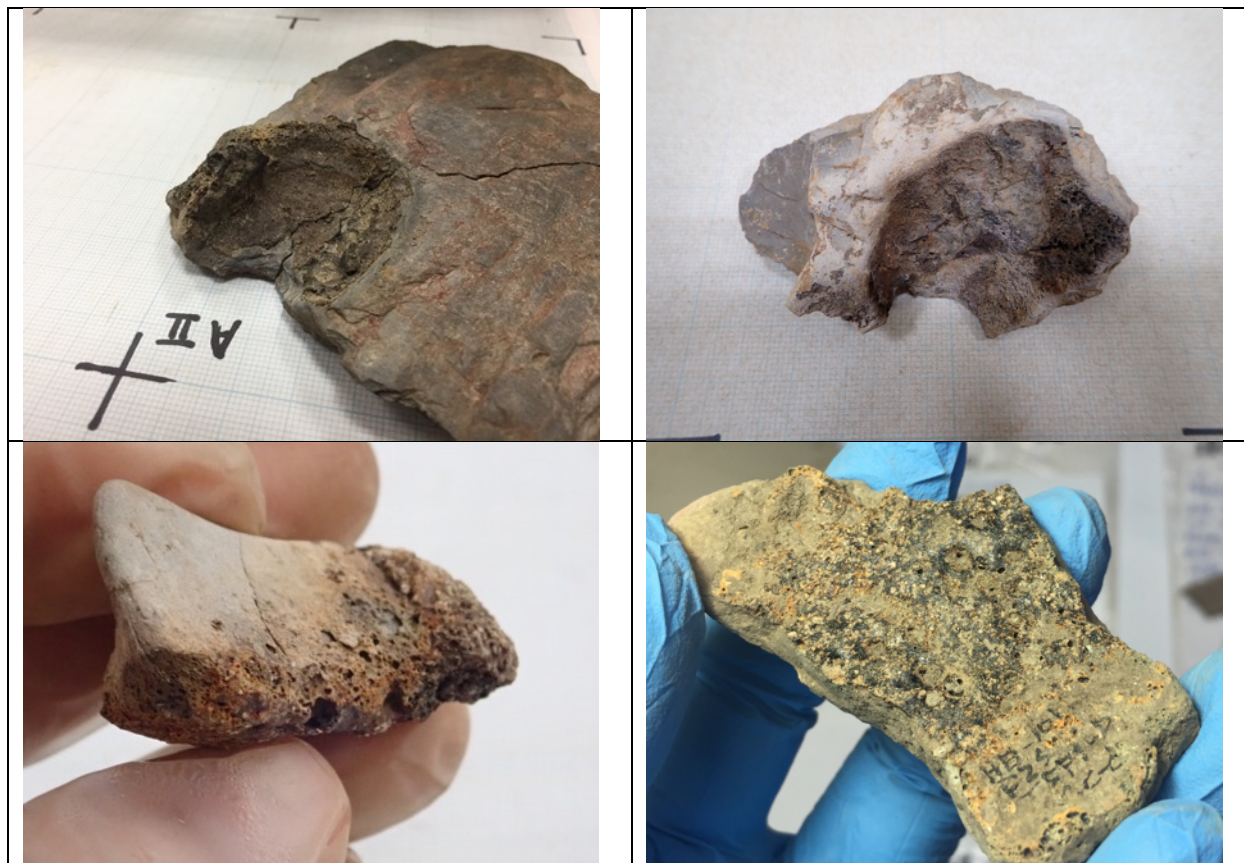


Figure 5-32 Upper: burned slate plates. Lower: burned L4 type 5 ceramic sherds. Vitrified porous section is clear

Both the preliminary excavation report by the IHP team and the exhibition album by the Lanyang Museum report the finding of smelting 'furnaces.' The 'furnaces' were formed by the piling of schist and slate (Figure 5-9, upper right). No tuyères, blowholes, tap holes, or clay lining were identified when excavating this structure although the charcoal and burned stones in the structure bottom indicate high-firing activities. The size of this structure in the BHB site is bigger than the ideal size of a bloomery furnace. Usually, the inner diameter is around thirty to forty

¹⁰¹ See ceramic chapter appendix.

cm. Also, these two furnace structures lack interior clay lining. Clay lining is critical to the direct method since the lining acts as insulation that prevents heat loss and the flux that reacts with ore to form slag. The lack of blowholes and tuyères is even more puzzling. In short, the suspected furnace structures in the BHB site are less likely to be smelting furnaces. In my recent publication about the BHB metallurgy, I conclude that these structures are more likely to be smithing hearths (Liu 2019). However, Girbal (2020) does not fully agree with my conclusion. His observation on a South Asia smith indicates a much simpler and smaller structure of smithing hearth.¹⁰² I also agree with his latest opinion that those structure may not be smithing hearths. Nevertheless, all these observations and analyses point out intensive smithing activities (primary and secondary) in the BHB site.

5.7. Interpretation of the BHB Ferrous Remains

Previous studies on the SSH site and related sites have indicated that the bloomery method was possibly used for iron making/working in ancient Taiwan. Before the discovery of the Blihun Hanben site, the Shihshang site was the only site that yielded a large amount of iron slag. Hence, the SSH site has been considered the only mass production center of iron for a long time. A large amount of iron slag from the BHB site excavation doesn't conform this mono-center ironmaking/working hypothesis in ancient Taiwan. This doctoral research is the very first systematic examination of an ancient slag assemblage in Taiwan to explore the nature of ferrous pyrotechnology. So, what is the essence of the BHB slag? Does the result fit the proposed trade diaspora model?

5.7.1. The Nature of the BHB Iron Technology

Since the ironmaking process is very different between the direct (bloomery) and indirect (blast furnace) methods, the wastes from these two methods are also different. The yield rate of the indirect method is significantly higher than the direct method. Hence, blast furnace slag contains very little iron; in contrast, the metallurgical wastes of the direct method usually have a high

¹⁰² Personal communication and presentation slide of Dr. Girbal in the 台灣史前金屬高溫技術系列專題演講 (The Serial Talk of Ancient Metallic Pyrotechnology in Taiwan). Talks hold by the Institute of Archaeology, National Cheng Kung University, Tainan, Taiwan in 2020. I was the invited speaker in the same talk as well.

percentage of iron element in different forms, such as wüstite (FeO) and fayalite (Fe₂SiO₄). The macro and micro analyses of sampled slag specimens show two results: 1) the direct method is the BHB ironmaking tradition, 2) smithing slag (type B and C) is the primary slag in the assemblage.

In the bloomery smelting slag, fayalite lath and dendritic wüstite are two principal iron oxides. As mentioned in the earlier section, the forming of fayalite is an essential stage in the bloomery method. This chemical reaction is used to extract silica from iron ore. Nevertheless, in the analyses, a limited amount of smelting-like remains (smelting slag and furnace lining) are identified. On the other hand, the large amount of smithing slag indirectly implies the existence of ironmaking, probably near the BHB site. It is irrational to carry a heavy bloom for long distances. Also, the slag is concentrated in the core residential area of the BHB settlement. While smelting activities tend to be conducted away from the settlement area, smithing activities could have been carried out next to the smelting area and next to/in a settlement. In short, the blooms might have been brought back to the BHB site from a nearby smelting location and then refined and smithed into desired iron billets or implements.

The SEM-EDS of SG-01-temp-EI (Figure 5-20) shows an interesting result. Besides the regular phases, such as dendritic wüstite, long semi-rectangular fayalite lath (Figure 5-21), a rectangular high Fe-Ti (14%) compound (Table 5-2) is observed in this specimen. Pseudobrookite (Fe₂TiO₅), a mineral usually paragenesis of Anatase (TiO₂) and high-titanium hematite, can be found in igneous rocks.¹⁰³ This high Fe-Ti compound could be either recrystallized mineral or unmolten iron ore. The SEM-EDS result of the BHB iron sand¹⁰⁴ (Figure 5-33) also shows titanium in the iron sand; however, the proportion of titanium differs. Is this difference caused by the natural Ti-constituent in ore, or is it caused by the elemental concentration during the smelting and smithing process? It is challenging to have a clear answer in the current research state.

¹⁰³ <https://twgeoref.moeacgs.gov.tw/>

¹⁰⁴ With the assistance of Mr. WANG Shih-Hao, we collected Heping River sand and BHB beach sand. Then I separated the iron sand from the collected bulk sand at National Dong Hwa University.

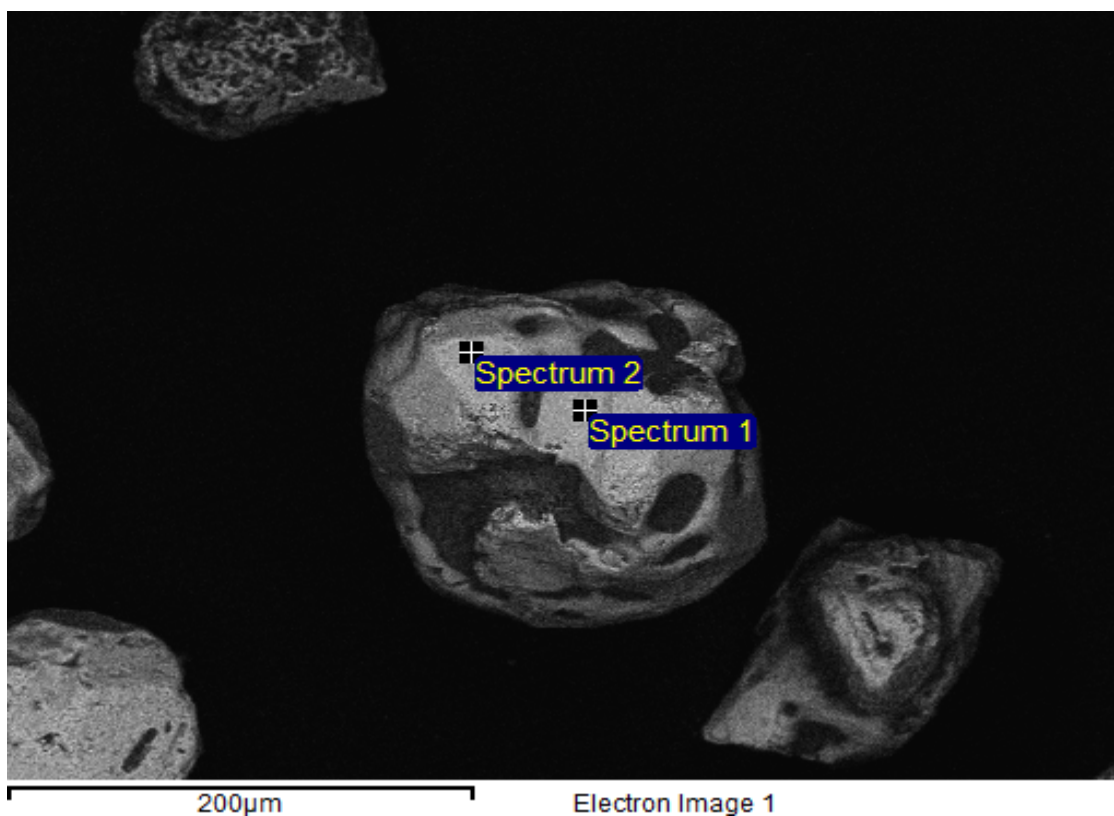


Figure 5-33 Heping River iron sand SEM image

Table 5-8 EDS result of the Heping River iron sand

Processing option: All elements analyzed (Normalized)								
All results in weight%								
Spectrum	In stats.	O	Mg	Al	Si	Ti	Fe	Total
Spectrum 1	Yes	39.41	1.41	1.63	0.67	3.88	52.98	100
Spectrum 2	Yes	39.1	1.39	1.77	0.6	4	53.15	100

Nevertheless, if the BHB iron craftspeople used local iron sand as ore, it is logical to see a titanium signal in the metallurgical wastes and in the iron product. If this iron sand assumption is valid, then the BHB iron technology is similar to the known SSH iron metallurgy, at least from the perspective of ore usage. To compare and trace the provenience of the BHB iron technology, a fully reconstructed technical sequence is ideal. Currently, I have only been able to reconstruct parts of the BHB ironmaking/working process.

Here is a possible scenario (Figure 5-34). The BHB settlement iron craftspeople used iron sand to produce bloom with bloomery furnaces (or bowl furnaces). The smelting process may have taken

place outside of their village and close to the fuel source or ore source. The produced bloom was then brought back to the village for further refining and shaping processes. The smithing hearth type is unknown but probably had an air blowing system without a ceramic tuyère. The smithing hearth could have just used a single vertical slate plate to block heat and support the air blow system (Girbal 2020). A few type B slags indeed have attached slate plates. Slate plates and L4 type 5 ceramic may have played specific roles during the smelting and smithing process, which left those burned remains seemingly not directly related to metallurgy.

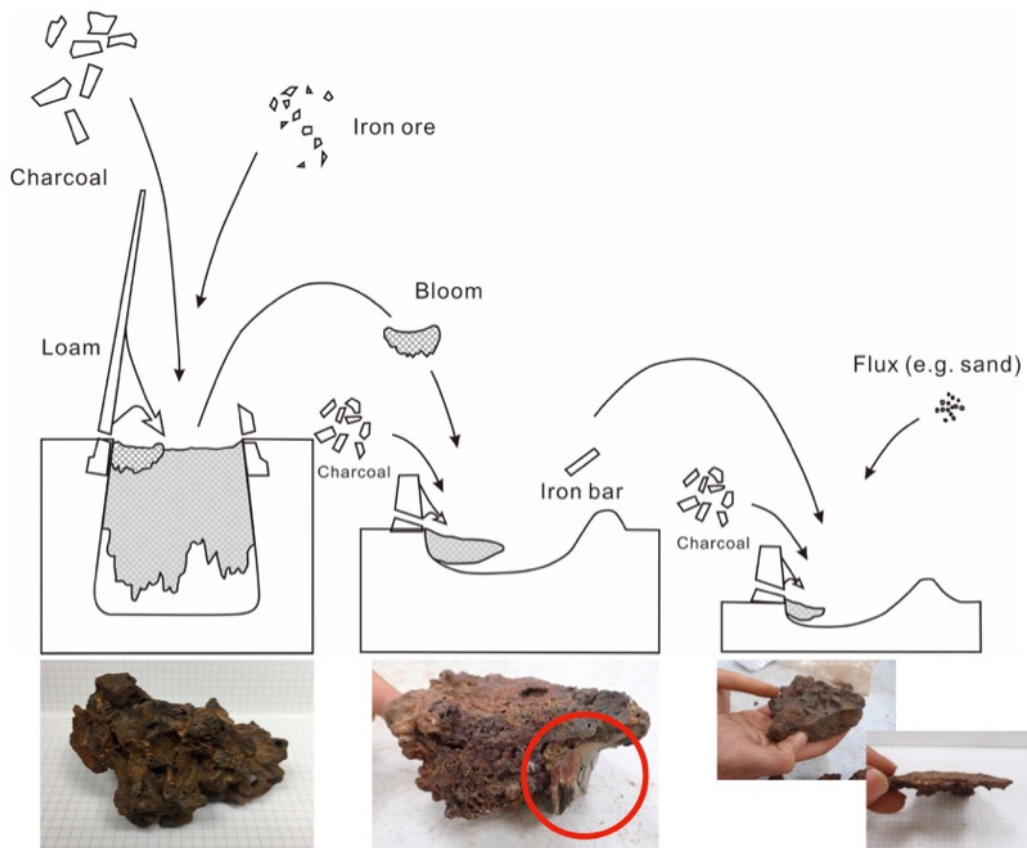


Figure 5-34 Reconstruction of the BHB metallurgical process. Schematic drawing and analyzed slag correspond to each metallurgical step (except for the first ore collecting step). The red circle on the SHB marks the slate plate. Modified from Arnoldussen and Brusgaard (2015)

5.7.2. The Provenience of Technology

Regarding the provenance of BHB ferrous pyrotechnology, we have no fixed area yet, but it is clear that the BHB iron technology was similar to SSH's. Both technologies are the bloomery tradition. The similarities of the ceramic assemblage and the burial practice show a close

relationship between the BHB and SSH site. Noticeable is that a typical bloomery method usually applies limonite or hematite as ore to extract metallic iron; however, the BHB and SSH sites data imply that iron sand (magnetite) was used as ore in these two sites. This is quite rare in the early bloomery tradition. Although Japan had started to apply iron sand as the ore for the Tataro furnace (Figure 5-35) in the medieval period, there is no clear evidence to connect Japan and Taiwan for that period, and the dating is also incompatible. Not far from Japan, South Korea seems to have developed a mature bloomery method with magnetite as ore in the early third century (PARK and Rehren 2011).

In China, especially the Zhongyuan (中原) area, bloomery and cast iron might have developed simultaneously. Although bloomery might have developed earlier, cast iron (based on the bronze-making technique) was the major approach. Also, mostly smelting and casting/forging activities coexisted at most sites from the Warring States period (Bronson 1999; CHEN 陈建立 2016). In contrast, until recently, in MSEA and the southern part of regions of present-day China (Guangxi 廣西, Guangdong 廣東, Yunnan 雲南), bloomery was the primary and traditional method of ironmaking (Pryce 2014a). In recent years, there have been more and more studies on the direct method in ancient China (e.g., CHEN 陈建立 2016; HUANG 黄全胜 and LI 李延祥 2008, 2011, 2012; LI 李映福 2014b).

These are the regions for searching the potential provenance of ancient Taiwan iron technology. However, we cannot ignore the possibility of local innovation from its prototype iron technology. The original method could have used iron ore which is common to bloomery furnaces, such as hematite or limonite. The ancient Taiwan iron technology could have been altered from this common practice. For example, a group (or groups) of foreign craftspeople who possessed the ironmaking technology may have provided services to the local communities while the locals searched for new iron ore. Once new iron ore was found, those craftspeople could have continued to produce iron locally and even settled in Taiwan.



Figure 5-35 Upper left: iron sand from the river. Upper right: Tatara furnace. The rectangular furnace body in the middle with air being blown in from two bottom sides. Lower left: a closer look at the metal tuyère. Lower right: tap slag from the Tatara furnace. (All photos were taken by the author at the Historical Museum of Iron <http://www.tetsunorekishimura.or.jp/history>)

5.7.3. Metallurgical Data and the Trade Diaspora Model

It has been over twenty years since CHEN's research (2000), and more studies have been published on ancient iron technology in MSEA and the southern part of China (combined with the current northern MSEA area). Those new lines of evidence help us to trace the origin of Taiwan's ancient iron technology. While the technical provenience is always an essential question in the ancient metallurgical study, how this technology was introduced to Taiwan has not been well-discussed. In the previous chapter, I have introduced a trade diaspora model that could provide a more detailed mechanism of how iron technology emerged in ancient Taiwan. Here I review the three-stage model previously discussed Chapter Three:

1. In the first stage, craftspeople with the knowledge of high-firing pyrotechnology, such as glassmaking and iron metallurgy, sailed to and traded with the local communities on the east coast of Taiwan. ... The first stage might have taken place

in the southern/southeastern areas..., the trade diasporic community might have been small and sporadic. It could be seen as temporary Diaspora Autonomy or Diaspora Marginality mode.

2. The second stage. As a result of the high demand for repairing metal tools and reprocessing metal and glass, some craftspeople began to settle permanently near the host community/communities, ... In addition to fixing the old tools, these craftsmen also kept searching for the raw material they needed to make new iron products; thus, they expanded further to the northern area of Taiwan along the east coast. In this stage, the trade diasporic community might have been larger than the previous stage and in the Diaspora Autonomy mode.
3. In the third stage, these craftspeople established settlements where they found free access to iron ore. ... Starting from this stage, we may see craftspeople's settlements with iron production/process areas and the locally made iron products that had been exchanged with other areas in Taiwan. The Diaspora Autonomy is the most likely mode at the beginning of this stage; however diachronically, if the reason for overseas trade disappeared, the Diaspora Autonomy would gradually integrate with the local community and became Diaspora Integration.

The metalworking remains from the first stage is probably almost archaeologically invisible due to the scarcity of metal objects. Starting from the second stage, one might see a small amount of iron slag in the local communities. That slag was the remains from reshaping and customization of iron objects (secondary smithing), or even some smelting and smithing slag from trial ironmaking if new iron ore had been located. When proceeding to the third stage, one may see a large amount of smelting and smithing slag in the diasporic communities, and a small amount of secondary smithing slag shall be found in the local communities. From the second to the third stage, the ferrous pyrotechnological remains may increase rapidly.

5.7.3.1. Single site scale

From the one site scale, if the iron technology was introduced following the proposed model, one shall see a sudden emergence of mature iron technology with a very short adaptation period. The iron slag amount from L6 is much smaller than L4 (Figure 5-10). It increases significantly starting from the bottom of L4 (Figure 5-36, L4c-e, the lowest level of L4). This represents an intensive and well-established ironmaking/working technology. The shift from L6 to L4 seemly matches with the progress from the third stage to the second stage of the proposed model.

Figure 5-37 shows the slag amount by type in each excavation pit. This graph points out that the P2S¹⁰⁵ area is the ironworking center of the BHB settlement. However, all slag types seem to distribute evenly in all pits. Synthesizing with the L4 ceramic data, there is no spatial difference among the whole L4 BHB site. One thing worth mentioning is, during the L6 period, it seems P3S was the ironworking location of the BHB site. I currently have no conclusive remarks on the shift of the ironworking center in the BHB site.



Figure 5-36 Heatmap of L4 iron slag distribution in the P2S excavation pit. The red areas are the units with the most slag. L4 and L4a represent the top layers of L4 (youngest), in contrast, L4c-e is the lowest layer (oldest). This heatmap shows the sudden emergence of large number of ironworking remains which indicate an introduced mature ironworking technology in the beginning of L4

¹⁰⁵ And also P2N, a pit excavated by the ARCHEO CULTURE CRM company. P2N also yielded more than 2000kg of iron slag.

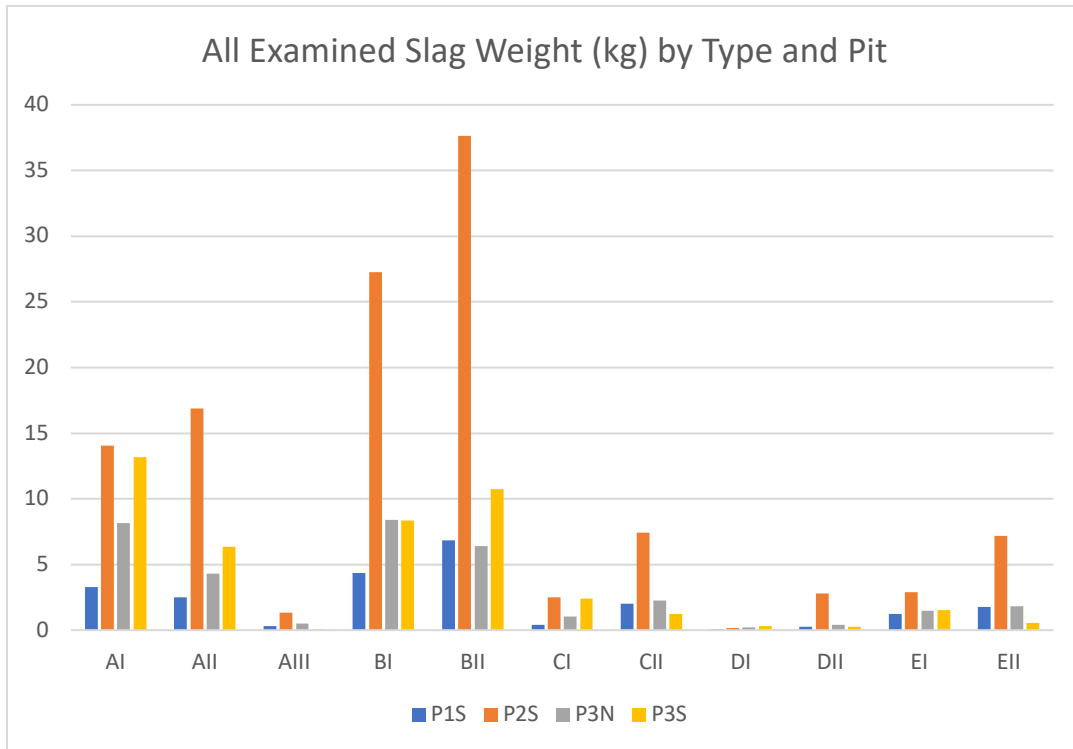


Figure 5-37 Column chart of slag amount for each type in different excavation pits

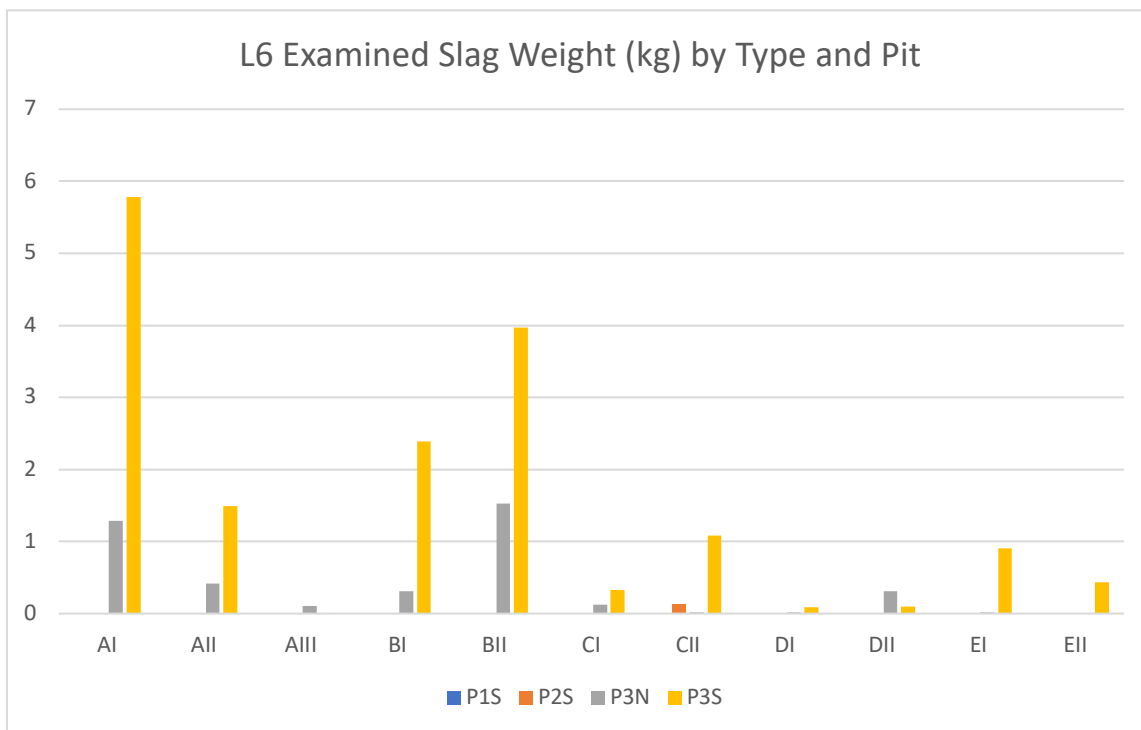


Figure 5-38 L6 slag amount of each type in the excavated pits

5.7.3.2. *Regional scale*

Based on the proposed model (stage one to three), the hypothetical craftspeople probably arrived in southern Taiwan and gradually moved northward. Then, what is the archaeological evidence from the other two target sites, the Jiuxianglan (JXL) site and the Huakangshan (HKS) site?

JXL (from the Sanhe cultural assemblage layer) yielded about ninety iron pieces of slag (Hung and Chao 2016), and HKS (from the upper HKS cultural assemblage layer) also yielded a relatively small amount of iron slag (LIU 劉益昌 and CHAO 趙金勇 2010b). I did not have the opportunity to examine the slag; however, these remains seem to be the smithing slag from the description and published photos. If my observation is correct, these two sites from southeastern and eastern Taiwan may represent the first to the second stages (JXL) and the second stage (HKS) of the proposed model.

6. Discussion and Conclusion: Trade Diaspora and the Emergence of Iron Technology

In previous chapters, I have clearly defined trade diaspora and predicted the archaeological material representation of a diasporic community. I proposed a model that would accommodate research advances from different scholars for explaining the importation process of exotic materials and metallurgical knowledge. These foreign cultural elements played crucial roles in the development of iron technology in ancient Taiwan. This chapter will synthesize the results of ceramic and iron slag analyses to see if the trade diaspora is detectable in archaeology and the proposed model is valid.

6.1. A Detectable Trade Diaspora?

A diaspora community maintains a cohesive identity by different approaches, but not all these means are detectable to archaeology. As mentioned in chapter three, several archaeological studies have used ceramics, foodways, and burial practices for identifying trade diaspora communities, like the ancient Mesopotamia's long-distance traders and the Chu 楚 salt traders in ancient China (CHEN 陳伯楨 2014; Stein 2002a). In Taiwan, a set of unevenly distributed and distinctive materials like grayish-black ceramics and exotic materials like beads and metals are considered the marker of foreign diasporic traders/metal craftspeople in several different archaeological cultural assemblages along the east coast of Taiwan (LIU 劉益昌 2011a, 2012). Hung and Chao (2016) also note the possible presence of overseas craftspeople who might have brought both foreign materials and technology.

Stein proposed several diaspora modes. The presence of diaspora dominance is when the diasporic community significantly overpowers the local community, which is less likely to appear in ancient Taiwan during our target periods (2400-1200 BP). The closest case in Taiwan is probably the VOC-related personnel and Fort Zeelandia, a fortress set up by the Dutch East India Company (VOC) on the southwest coast of Taiwan. Instead, I expect to see diaspora marginality, diaspora autonomy, and integration in the early stages of interaction.

Table 6-1 summarizes the characteristics of each trade diaspora mode. Besides the presence of the exotic materials, the spatial distribution of those foreign materials is also one key for

identifying the existence of trade diaspora. Hence, from a single site point of view, I expect to see the distinctive diasporic material culture distributed at the edge or a corner of one site. From a regional point of view, such as eastern Taiwan, I expect to see trade diaspora communities in several different host cultures.

Table 6-1 Table of characteristics for each diasporic mode

Diasporic Mode	Diasporic Characteristics
Marginality	A clear boundary between local and foreign materials, and cultural practices; spatial segregation.
Autonomy	A clear boundary between local and foreign materials, and cultural practices; may have some spatial overlap, or at least spatially close.
Integration	A mix of material culture and cultural practices, but the cultural legacy is still visible, like mixed burial goods and foodways.
Dominance	A clear boundary between local and foreign materials, and cultural practices; spatial segregation. But the Dominant diaspora overpower the locals.

In the context of this research, I hypothesize the existence of these overseas craftspeople and their entrance into ancient Taiwan in the form of trade diaspora. The foreign materials were brought by those craftspeople in exchange for Taiwanese nephrite processed ore or end-products. While portable exotic objects may have been used in exchange for local products, the presence of those exotic items may not be enough to distinguish the trade diaspora from the local communities. The remains of ferrous metallurgy are the essential marker of the trade diaspora I define. The kind of metallurgical remains depends on whether the craftspeople had access to iron ore or not. In the initial contact times, shaping imported iron bars into locally desired implements and fixing these implements might have been the primary task of those craftspeople; hence, a small amount of smithing slag should constitute the metallurgical remains. The presence of both smelting and large amounts of smithing slags should begin when the craftspeople had access to a local source of workable iron ore.

Table 6-2 summarizes archaeological predictions for different diasporic modes. The Blihun Hanben site has at least two cultural layers (L4 and L6). I will summarize my analyses on the BHB ceramic and slag in the following sections and see if those analyses' results fit the predictions.

Table 6-2 Table of archaeological predictions of each diasporic mode

Diasporic Mode	Daily -use ceramics	Metallurgy	Burial
Marginality	Distinctive to local ceramic, original ceramic style of diasporic community	(re)shaped iron billet based on local demand; only smithing slag remains	Maintained the original style of diasporic community, grayish-black wares as burial goods
Autonomy	Distinctive to local ceramic or partially adapt local wares	(re)shaping iron billet to implement based on local need; repair of old implements when iron ore is located, local iron production emerged; both smelting and smithing slag remains	Maintained but with local burial goods and grayish-black wares as burial goods
Integration	Mixture	Most likely local iron production. Both smelting and smithing slag remains	Intermarriage mixed practice with local and foreign burial goods

6.1.1. Ceramic Analyses

Based on the technical typological analysis on the sampled ceramic specimens (about 90 kg), the BHB L4 ceramic assemblage shows a solid link to the known archaeological cultural assemblage, the Shihshanghang 十三行 Cultural assemblage Pulowan/Puluowan 普洛灣 subset; in contrast, it is hard to designate the L6 ceramics to any known archaeological cultural assemblage. However, the BHB L4 and L6 ceramics do share similarities in terms of ceramic type and their provenience. Both the L4 and L6 ceramics show multiple raw material sources by petrographic analysis on temper inclusion. This high diversity of ceramic provenience indicates the connectedness (Peterson 2015) between the BHB people (both L4 and L6) and the other contemporary communities from northern to southeastern Taiwan. This connectedness may have resulted from the long-distance interactions (Peterson 2015) between BHB people and their neighbors (near and far away). Figure 4-44 and Figure 4-45 show the proportion of ceramic types and their proveniences by petrographic analysis on the inclusions.

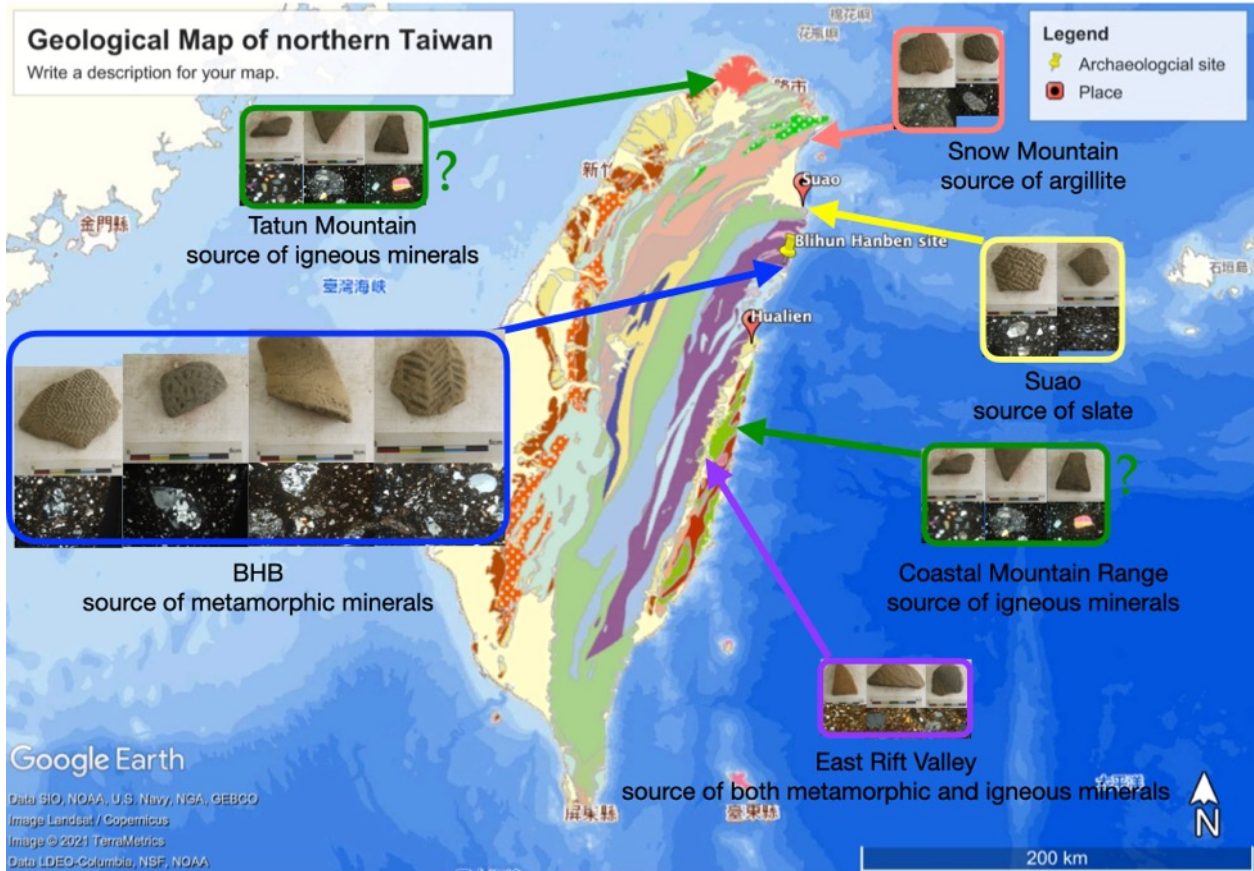


Figure 6-1 Ceramic petrographic analysis on L4 specimens shows five possible sources of temper. The size of each rounded square group is proportional to their amount in the examined ceramic assemblage

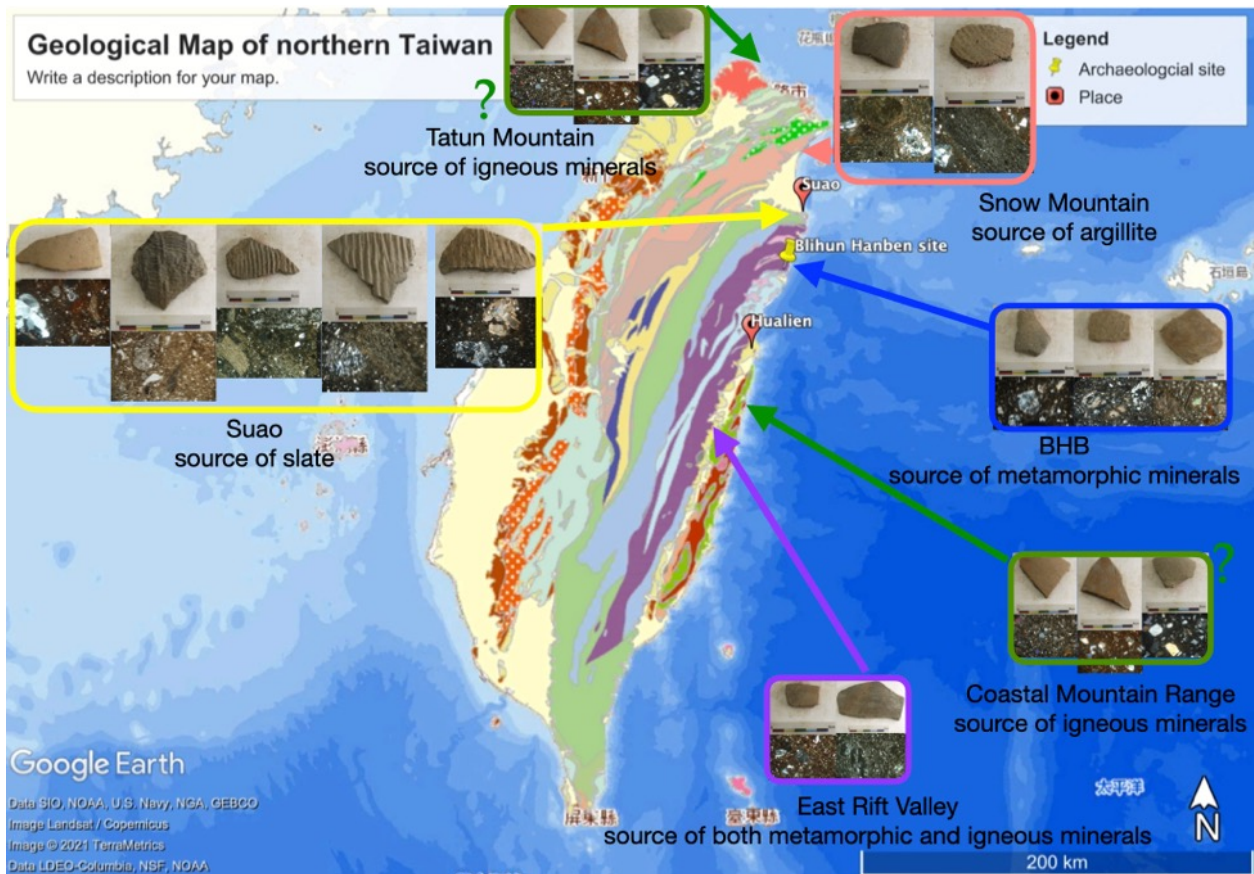


Figure 6-2 L6 ceramic petrographic analysis on L6 specimens shows five possible sources of temper. The size of each rounded square group is proportional to their amount in the examined ceramic assemblage

Both marginal and autonomous diasporic communities should show evidence of boundaries between the local/host community and the diasporic community. From only the BHB site perspective, I did not find any clear boundary in the examined ceramic assemblages regarding spatial distribution (**Figure 4-50**). This may be because of the examined specimens were mostly concentrated in the site center, which may be why diasporic remains were not found in the site periphery. A future investigation on the archaeological remains from the site periphery is needed. Although we did not see diasporic traces at this single site scale, the L6 ceramic assemblage presents interesting characteristics from a regional perspective. The L6 ceramic assemblage has two characteristics: 1) dominated by non-local ceramic groups; 2) cannot be associated with any known archaeological cultural assemblage but shows certain connections to both northeastern and southeastern Taiwan (multiple sources of raw material). These two characteristics best fit a situation of a community with high mobility who frequently interacted with their neighboring communities and acquired ceramic from their neighbors. The ceramic

assemblage of the Upper Huakangshan 花岡山上層 cultural layer in the Huakangshan site also shows multiple proveniences and a strong link to southeastern Taiwan (CHAO 趙金勇 et al. 2013).

From a ceramic perspective, both the BHB L6 layer and Upper HKS cultural assemblage layer seem to suddenly appear, rather than as a result of a gradual evolution from known previous cultural assemblages. Besides the sudden appearance and shared similarities in daily-use ware, both cultural layers yielded a small amount of metallic pyro-technological remains. The burial practices of the BHB L6 and the Upper HKS layer are similar to a certain extent.¹⁰⁶ Nevertheless, it seems the BHB L6 indeed shows a trade diasporic characteristic from a regional point of view, and the Upper HKS cultural layer may also be the settlement of another diasporic community. We might be seeing two marginal or autonomous diasporic communities, one in the Liwu 立霧 River estuary and one in the Hualien 花蓮 River estuary.

The BHB L4 ceramic assemblage matches the known Shihshang cultural assemblage Pulowan subset, and the dating of the L4 assemblage pushes the upper limit of the Pulowan subset to 1600 cal. BP. This dating is the earliest Pulowan subset by far and the crucial evidence that the Shihshang subset and Pulowan subset developed almost simultaneously. This finding contradicts our previous understanding that the Pulowan subset is a local assemblage subset emerging in the middle stage of the SSH cultural assemblage, and the Pulowan subset people might be the descendants of the SSH subset immigrants. Instead, the synchronic developments, similarities, and differences in ceramics between the SSH subset and Pulowan subset may suggest the influence of original local cultures on the trade diaspora potters.¹⁰⁷

The BHB L4 ceramic assemblage shares similarities with the L6 assemblage regarding ceramic types. The proportion of each type and group in the assemblage is the major difference between these two assemblages. In short, the L4 major ceramic types are the minor ceramic types in L6 and vice-versa. Also, both L4 and L6 layers yielded specific grayish-black ceramics (L4 Group F

¹⁰⁶ See details in the following sub-sections.

¹⁰⁷ Personal communication with Prof. Aude Favereau in the Institute of Archaeology at the National Cheng Kung University.

and L6 Group F). These grayish-black ceramics from Group F of both L4 and L6 are mostly identical in terms of pot-making technique and raw material. While I did not explore the reason for the proportional change, the assemblage similarity indeed indicates a diachronic connection between the BHB L4 and L6 residents. BHB L4 Pulowan subset also shows synchronic connections with the other known Metal period sites, such as the SSH site (SSH cultural assemblage SSH subset layer) in the north and the Jiuxianglan 舊香蘭 site (Gueishan 龜山 cultural layer) in the south. The assemblage with local ceramic groups dominant compared with non-local groups indicates relatively lower mobility of the L4 people compared to L6 people, but also indicates that they still had active interactions with their neighbors from the north to southeast of Taiwan.

Does the analysis of the L4 ceramic assemblage support the presence of a trade diaspora community from a regional perspective? The answer is uncertain, although, a newly emerged ceramic assemblage with few inherited elements from previous cultural assemblages does match the predicted integrated trade diaspora mode in the proposed model. Especially when we take the grayish-black ceramics into account, it is clear that these black wares appeared in four sites that belong to three archaeological cultural assemblages in different periods.

While the grayish-black ceramic plays a crucial role, a determining factor for identifying the proposed trade diaspora craftspeople community/communities is evidence of the knowledge of metallurgy-- in other words, the presence of metallurgical remains, from iron slag to smelting furnaces and smithing hearths.

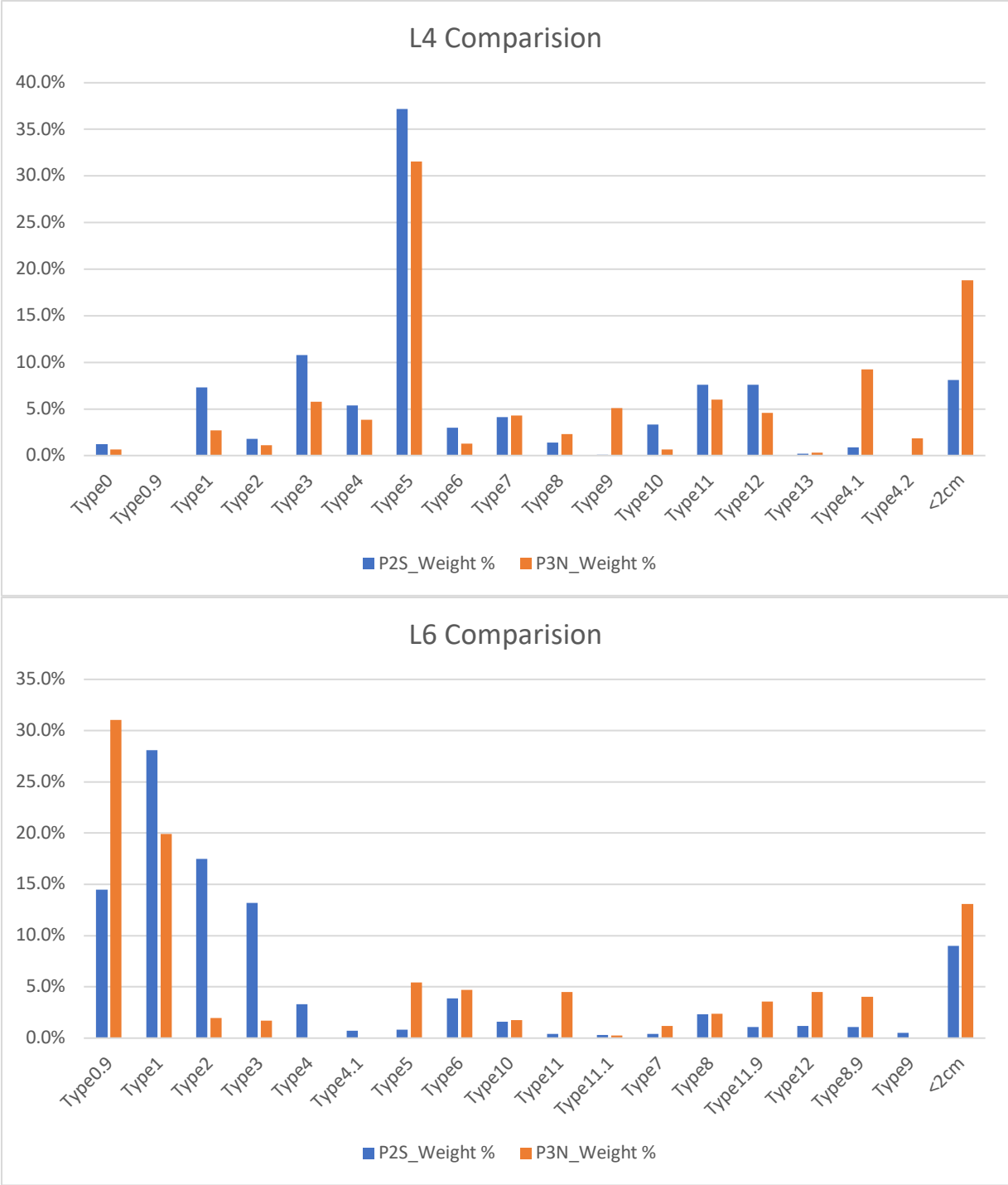


Figure 6-3 These two comparative graphs show the proportion of each ceramic type in P2S and P3N pits. There is no significant spatial difference for the ceramic distribution

6.1.2. Metallurgical Remains Analyses

As summarized in Chapter 4, the BHB site slag assemblage is dominated by type B slag (Figure 6-4), which is the 'indicator' of smithing activity. Type B slag is also called smithing hearth bottom (SHB). SHB has a unique convex/plano-concave shape and can be easily identified. In contrast to the SHB, the smelting process also produces a distinctive slag type, tap slag. Tap slag derives the name because it is usually 'tapped' out from the furnace bottom part via a tap hole during the smelting process. Tap slag flows like lava; hence it shapes like folded lava with a smooth and rippled surface. However, the proportion of possible smelting slag (DI, DII, EI, and AIII) is relatively small in the whole assemblage. This small proportion of smelting slag may be due to slag that attached to the bloom surface or infrequent small-scale smelting event happened in the BHB village.

Nevertheless, the inference that smithing was the primary metallurgical activity at the BHB site has also been backed up by other related evidence. Generally, a bloomery furnace is a single-use structure since the furnace needs to be broken apart for bloom extraction. Under normal circumstances, a large number of furnace body fragments will be associated with smelting slag in a smelting site. However, the examined BHB slag specimens lack both furnace-lining fragments and smelting slag; in contrast, this BHB slag assemblage reflects intensive smithing activities (ironworking—making tools from billet iron or repairing tools) rather than smelting (making new iron from ore).

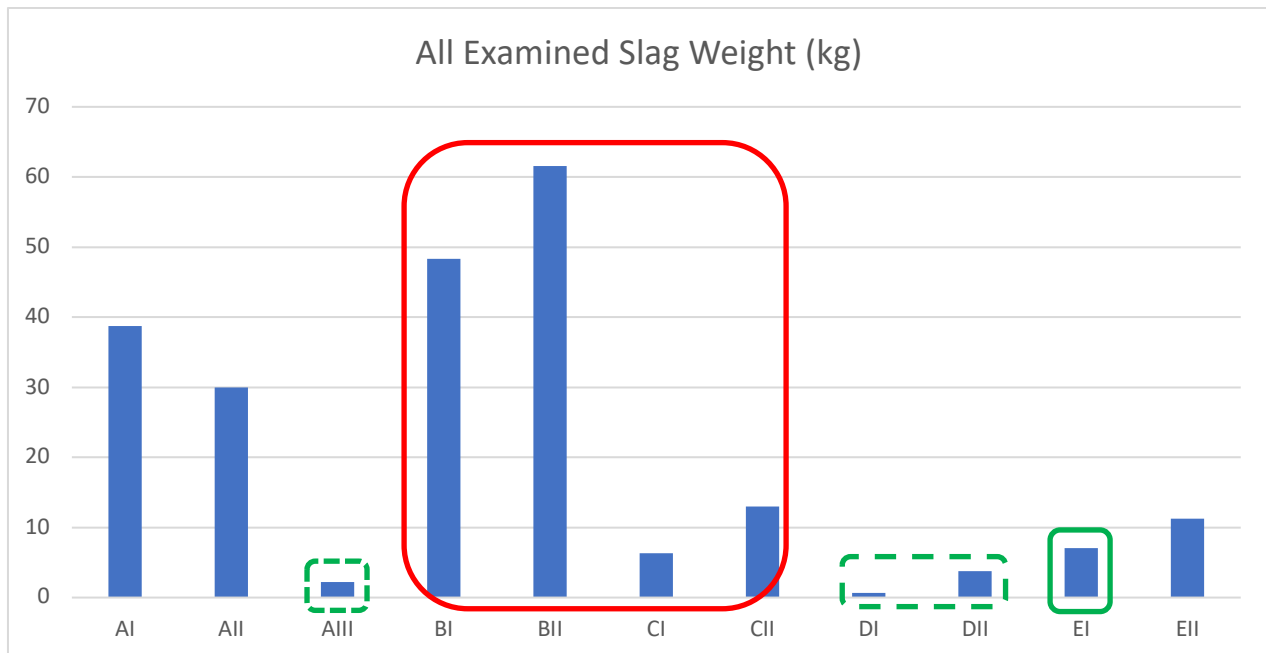


Figure 6-4 Red-lined types are smithing slag, green-lined type is smelting slag, and the green dashed line areas could be smelting slag

So, do the BHB slag analyses support the proposed model? I would say the answer is affirmative. From a single site scale, if the iron technology was introduced following the proposed model by skilled craftspeople, a sudden emergence of mature iron technology with a relatively short adaptation period is expected. The L6 iron slag amount is significantly less than L4.¹⁰⁸ Starting from the bottom of L4, the slag number is rather high already (Figure 6-5, L4c-e, the lowest level of L4). This represents an intensive and well-established ironmaking/working technology. The shift from L6 to L4 seemingly matches the progress from the third stage to the second stage of the proposed model. I will discuss this in the subsequent section.

Figure 6-6 shows the slag amount by type in each excavation pit and points out that the P2S¹⁰⁹ area was the ironworking center of the BHB settlement. However, all slag types seem to distribute evenly in all pits. Synthesizing with the L4 ceramic data, there is no spatial difference among the whole L4 layer in the BHB site. One thing worth mentioning is, during the L6 period, it

¹⁰⁸ See chapter 5 for the details.

¹⁰⁹ And also P2N, a pit excavated by the ARCHEO CULTURE CRM company. P2N also yielded more than 2000kg of iron slag.

seems P3S was the ironworking location of the BHB site. I currently have no conclusive remarks on the shift of the ironworking center in the BHB site.

As for the regional scale, the hypothetical craftspeople probably arrived in southern Taiwan and gradually moved northward based on the proposed model (stage one to three). Then, what is the archaeological evidence from the other two target sites, the JXL site and the HKS site? The JXL site (Sanhe cultural assemblage layer) yielded about ninety pieces of iron slag (Hung and Chao 2016), and the HKS (Upper HKS cultural assemblage layer) also yielded a relatively small amount of iron slag (LIU 劉益昌 and CHAO 趙金勇 2010b). Although I did not have the chance to examine the slag in person, these remains seem to be the smithing slag from the published descriptions and photos. If my observation is correct, these two sites from southeastern and eastern Taiwan may represent the first to the second stages (JXL) and the second stage (HKS) of the proposed model.



Figure 6-5 Heatmap of L4 iron slag distribution in the P2S excavation pit. The red areas are the units with the most slag

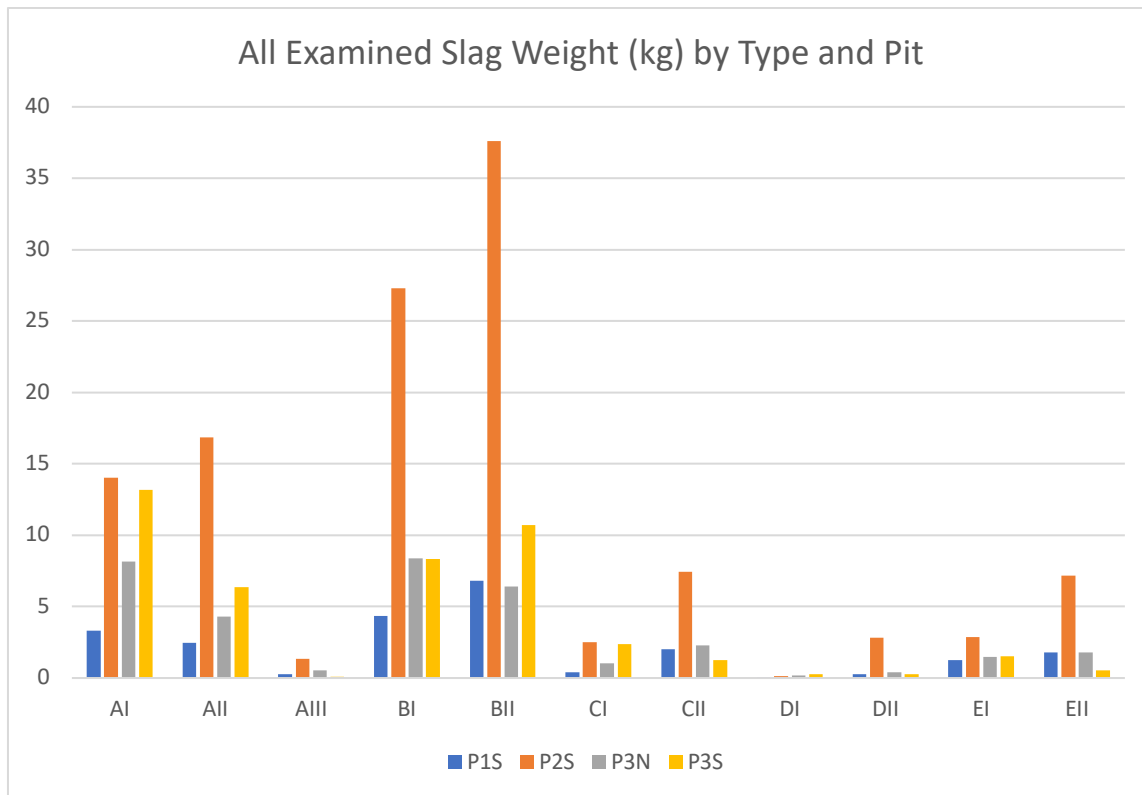


Figure 6-6 Column chart of slag amount for each type in different excavation pits

Regarding the provenance of BHB ferrous pyrotechnology, I do not have a solid answer yet, but it is clear that the BHB iron technology was similar to the SSH's metallurgy. Both technologies are the bloomery tradition. Noticeable is that a typical bloomery method usually applies limonite or hematite as ore to extract metallic iron; however, the BHB and SSH data indicate that iron sand (magnetite) was used as ore in these two sites.

Boomery was the primary and traditional method of ironmaking in mainland Southeast Asia and the southern part of regions of present-day China (Guangxi 廣西, Guangdong 廣東, Yunnan 雲南)(Pryce 2014b). There have been more studies on the direct method in ancient China(CHEN 陈建立 2016; HUANG 黄全胜 and LI 李延祥 2008, 2011, 2012; LI 李映福 2014b) in recent years. However, there is no evidence of using iron sand as ore in those early bloomery ironmaking studies. If contemporary to the BHB site, South Korea with a mature bloomery method using magnetite as ore in the early third century CE (PARK and Rehren 2011) seems to be a leading contender.

6.1.3. Additional Observation on the Burial practices

Table 6-2 summarizes the archaeological prediction of burial practice for each trade diaspora mode. Although I did not have the opportunity and resources to carry out the BHB burial analysis, I have tried to derive some observations from the field notes and salvage excavation report. The salvage excavation yielded more than two hundred burials. I have assorted these burials by their layer and practices, and I excluded the burials without clear field notes or context (Table 6-3).

There are two major coffin styles among these burials. One is rectangular shaped using slate plates as walls, top, and bottom (Figure 6-7, upper two photos), and the other is oval shaped using piled schist and slate as walls, and a slate plate as top (Figure 6-7, lower two photos). It is clear that the rectangular slate coffin is the dominant style of L4; in contrast, the oval style is relatively more common among the L6 burials than in L4 burials. As for the burial position, assorted secondary burial practice was frequently observed in the coffin with multiple individuals; for example, Figure 6-7 lower right shows assorted femurs. In addition to the assorted practice, the flexed, laid position is usually associated with rectangular slate coffins in L4, and in L6 the squatted position is usually associated with both the oval and rectangular shaped coffins.

Most BHB burials contained burial goods, such as pots, marine and terrestrial fauna remains, glass beads, and metal objects. While some field notes did not specify the type of pot, there are sixty-six burials with pot goods, and at least fifteen burials with grayish-black pottery. The burials with grave goods distributed evenly in both cultural layers.

Those observations show the connections between the BHB cultural layers and their contemporary societies. The BHB L4 layer is identified as the Pulowan subset of the SSH cultural assemblage. Its burial custom is identical to the Pulowan subset layer in the Chongde site (another site with metallurgical remains at the Liwu 立霧 River estuary, see chapter 3 for the details), and the flexed, laid position is the common and signature practice among the whole SSH cultural assemblage, including the SSH subset at the SSH site. The only difference between the SSH subset burial and Pulowan subset burial is the usage of slate coffins. As for the L6 burials,

the squatted position is unique and similar to the Upper Huakangshan burials. Upper HKS cultural assemblage utilized squatted or seated positions without coffins but using slate plates to mark the tops and bottoms of the graves.

While a more detailed analysis is needed for further discussion, the current observations on the burials from the BHB L4 and L6 demonstrate a gradual transition of burial practice from L6 to L4 and connections of these two burial practices to the other contemporary societies (SSH and Upper HKS), that also yielded metallurgical remains.

Table 6-3 Table of coffin style in the two BHB cultural layers

Layer	Rectangular	Oval	Special	None	Sum
L4	35	5*	0	43	83
L6	18	12	1	40	71
Sum	53	17	1	83	154

* Two of these five burials may be counted to L6.



Figure 6-7 Two burial practices. Upper practice usually found in L4, and lower style usually found in L6 (LIU 劉益昌 et al. 2016)

6.1.4. A Valid New Model?

The analyses on the BHB ceramic and metallurgical remains show the diasporic characteristics of the L4 layer and L6 layer, and those characteristics indicate different trade diaspora modes for the L4 layer and the L6 layer. While many more future studies are needed for a solid conclusion, optimistically speaking, the L4 remains fit the proposed integrated diaspora, and the L6 remains fit the autonomous diaspora from a regional perspective. While we receive partial affirmative results for identifying the presence of trade diaspora by the BHB site data, do these results support the proposed diachronic trade diaspora model I proposed?

The proposed trade diaspora model portrays the importation process of foreign materials and metallurgy as a gradual process instead of a sudden introduction. Ideally, this model would accommodate previous research advances and the result of this doctoral research then provides a more detailed story of the emergence of the Metal period in Taiwan. Here I summarize the proposed model from chapter three:

1. In the first stage, starting around 2400 BP, these itinerant craftspeople followed the same trade routes as their ancestors. They brought glass and agate products, mostly beads, and sometimes metal tools, in exchange for Taiwanese nephrite. The first stage might initially have taken place in southern/southeastern Taiwan and then expanded toward the north along with the current. In this stage, the trade diasporic community might have been small and in the temporary Diaspora Autonomy mode, or invisible to archaeology.
2. The second stage starts around 2100 BP. As a result of the high demand for repairing metal tools and reprocessing of metal and glass, some craftspeople began to settle permanently near the host community/communities, either in a segregated area of that community or a separate settlement. They expanded even further to the north area of Taiwan along the east coast. In this stage, the trade diasporic community might have been larger than the previous one and still in the Diaspora Autonomy mode.
3. In the third stage, which began around 1600 BP, these craftspeople established settlements where they found free access to iron ore. We may see a craftspeople's settlement with an iron production/processing area. The Diaspora Autonomy is the most likely mode at the beginning of this stage; however, diachronically, if the reason for overseas long-distance trade disappears, the Diaspora Autonomy will gradually integrate with the local community and become *Diaspora Integration*.

The first two columns of Table 6-4 summarize the stages of the proposed model and the predicted presence of foreign materials. Based on what I have reviewed in chapter three and the BHB site study results, the third column shows the corresponding archaeological sites and their cultural designations. Figure 6-8 and Figure 6-9 visualize the proposed model and show the responsive sites with supporting archaeological remains.

Table 6-4 Table of material representation of each trade diaspora stage and corresponding mode

Trade Diaspora model	Foreign material representation	Sites and related cultural assemblages
1st stage (2400-2100 BP) Autonomous mode or invisible to archaeology	Glass and agate/carnelian beads, bronze and metal objects	JXL, early Sanhe cultural assemblage layer
2nd stage (2100-1600 BP) Autonomous mode	Glass and agate/carnelian beads, bronze and metal objects Metalworking remains	SSH, early SSH cultural assemblage SSH subset layer, 1800-1600 BP BHB, L6 layer (unknown but related to Upper KHS cultural assemblage), 2000-1600 BP HKS, Upper Huakangshan cultural assemblage layer, 2100-1600 BP JXL? Sanhe cultural assemblage layer after 2100 BP
3rd stage (1600-1000 BP) Autonomous mode and then Integrated mode	Glass and agate/carnelian beads, bronze and metal objects Metalworking remains, and iron production remains	SSH, SSH Cultural assemblage SSH subset layer, after 1600 BP BHB, SSH Cultural assemblage Pulowan subset layer (L4), 1600-1200 BP CD, SSH Cultural assemblage Pulowan subset layer, 1500-1000 BP Chingpu? Chingpu cultural assemblage layer JXL? Sanhe cultural assemblage layer after 1600 BP

In the first stage (2400-2100 BP) of the model, a small number of foreign materials should have emerged in the local societies. These foreign materials were brought by a group of seasonal itinerant craftspeople who may or may not be visible to archaeologists because of their

temporary stay in Taiwan. Those craftspeople can be considered as the autonomous trade diaspora community. The archaeological findings in the Jiuxianglan (JXL) 舊香蘭 site support this assumption positively. As mentioned in chapter two, the Sanhe 三和 people should presumably be the direct descendants who inherited cultural elements from the Peinan 卑南 cultural assemblage based on the ceramic style and the burial practice. However, we see new cultural elements in the Sanhe cultural assemblage. The new ceramic type (stamped and incised surface decoration) and foreign materials like Indo-Pacific glass beads and metal objects are the new cultural element in Sanhe cultural assemblage (LEE 李坤修 2005; LEE 李坤修 and YE 葉美珍 2001; LIU 劉益昌 et al. 2002). More importantly, the JXL site yielded glass rework debitage, sandstone molds of the bronze items, and iron slag. These remains of high-temperature pyrotechnology indicate the presence of craftspeople, and this is the crucial attribute of the proposed model. We need to remember that most of the JXL pyrotechnological remains were dated to after 2100 BP, but still, the JXL site should have been the initial gateway for receiving overseas cultural elements from the site location.

In the second stage (2100-1600 BP), some of these itinerant craftspeople should have settled for the increasing demand for metal tool repairment. Archaeologically speaking, I expect to see settlements with burials that are distinctive to the local societies. The burial practice of the Upper Huakangshan cultural assemblage people and Blihun Hanben L6 people is similar to a certain extent but totally different from the previous cultural assemblages at the same locations and other contemporary cultural assemblages in eastern Taiwan. From the ceramic perspective, the Upper HKS and the BHB L6 ceramic assemblages share some similar ceramic types, such as yellowish-orange earthenware with paddled grid, cloud, and vein patterns on the exterior surface. While those ceramics only occupied a small proportion in the BHB L6 and Upper HKS ceramic assemblages, it is hard to miss the similarity between these eastern ceramics and late Chihwuyuan cultural assemblage and early SSH cultural assemblage ceramics in northern Taiwan. Also, both the Upper HKS and the BHB L6 ceramic assemblages show connections with southeastern Taiwan, including the plain earthenware with visible igneous mineral (from the east coast of Taiwan) and the grayish-black earthenware that has also been found in the Sanhe cultural assemblage area.

In addition to the ceramic style similarity, the complexity of ceramic provenience of the BHB L6 layer also supports the strong connection between the BHB L6 people and those others from southeastern to northern Taiwan. Was this phenomenon the result of BHB L6 people traveling in order to have their tools repaired? In the current research state, I do not have an answer for this question, although the non-local dominant ceramic types do imply the high mobility of the BHB L6 people. Nevertheless, we see a gradual expansion of those craftspeople from the south toward the north, and the presumed reason is the search for suitable iron ore.

The sudden appearance of different burial practices, long-term occupation sites, foreign materials like Indo-Pacific glass beads, and metalworking remains fit the second stage of the proposed model. Both the Upper HKS layer in the HKS site and the BHB L6 layer yielded a small amount of smithing slag. Ideally, the early SSH culture layer (1800-1600 BP) in the SSH site should also have smithing remains. The current research project by the IHP on the SSH site artifacts may reveal more details on the SSH slag assemblage. While the three mentioned cultural layers in three sites fit the model affirmatively, I am not entirely comfortable including the JXL site Sanhe culture layer as a diasporic community in this stage. The burial practice remains the same with the first stage. Does this mean that the local JXL people merely adapted to foreign technology and tried to carry out glassworking and metalworking by themselves? There is indeed a possibility for this assertion.

For the third stage of the proposed model (1600-1000 BP), the trace of iron production remains is the critical factor. These diasporic craftspeople should have found suitable iron ore (or even in the second stage) and started to produce iron locally in Taiwan. Hence, we found a large amount of iron slag immediately appearing after 1600 BP, representing the practice of a mature iron production technology instead of gradual evolution. The SSH site (after 1600 BP) and the BHB site L4 layer belong to this stage. Both sites have yielded a large quantity of iron slag. The analysis of the BHB iron slag assemblage points out the assemblage mainly consists of primary smithing slag. This means the BHB L4 people conducted primary smithing (refining the bloom to iron bars) in the village and indicates a smelting workshop nearby the BHB site (residential area). From the current data, there were at least two smithing centers in the BHB village starting from 1600 BP.

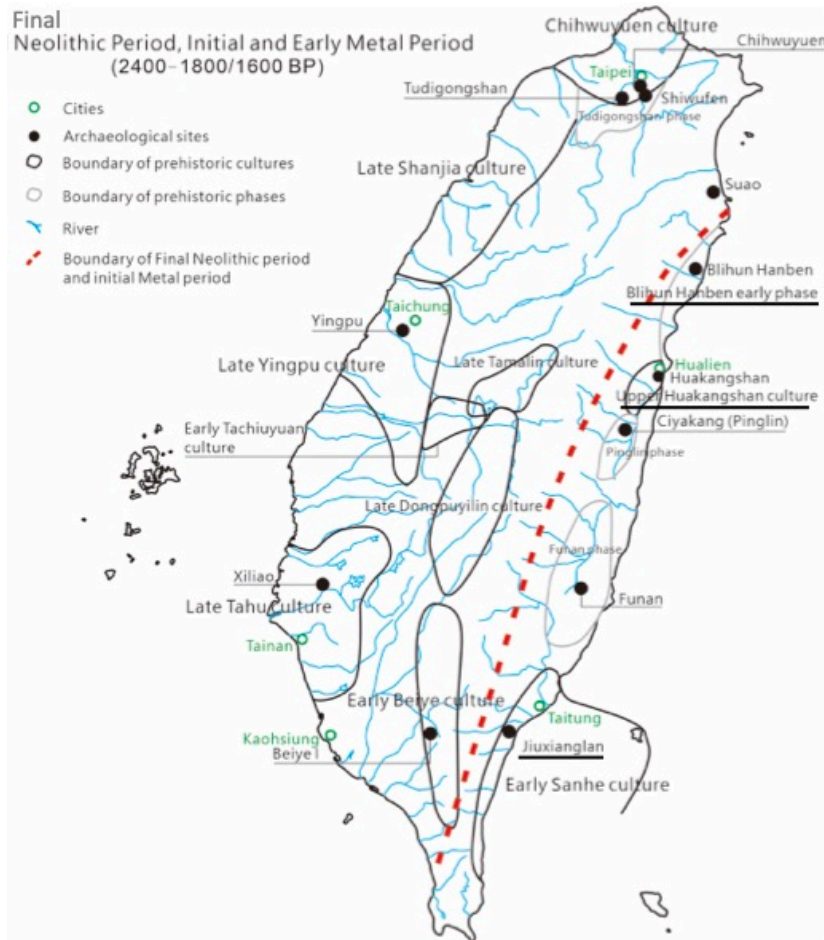
The ceramic assemblages and burial practices from the SSH and BHB sites show the shared identity of these two groups of iron craftspeople. Reddish to yellowish-orange ceramic with geometric patterns and grayish-black ceramics with polished and incised and stamped patterns are two signature ceramic styles of the SSH culture. The SSH culture SSH cultural subset ceramic assemblage from the SSH site shows the frequent interactions of the SSH people with other cultural assemblages along the northern half of the west coast and north coast. As for the BHB L4 assemblage (SSH cultural assemblage Pulowan cultural subset), the ceramic provenience points out the interactions of the BHB L4 people with the east coast of Taiwan, from the north tip to the south end. As for the burial customs, the flexed, laid position is another crucial characteristic of the SSH cultural assemblage. In those burials, ceramic pots (both orange and black), glass beads, agate beads, and metals are commonly used as grave goods. While the burial positions are identical in the BHB and the SSH sites, the BHB burials indeed show more eastern elements, like using slate plates as the coffin.

While the BHB site and the SSH site share cultural similarities, we also can see the local differences in their ceramic assemblages. The local differences may have been inherited from the cultural assemblages of their predecessors. This may represent the local adaptation of trade diaspora communities. Local adaptation is a characteristic of integrated diaspora. Nevertheless, the BHB L4 ceramic assemblage, which consists of dominant local ceramic types and many other types from across the whole east coast of Taiwan, implies that the BHB L4 people were more stationary than the BHB L6 people but still had continuous interactions with others along the east coast. This more stationary lifestyle may have resulted from the practice of iron smelting.

The practice of mature iron metallurgy and iron production are the key factors for the third stage in the proposed model. Previously, the SSH site was the only site with such a large amount of iron slag that indicates mature metallurgy and iron production. The slag analysis on the BHB slag shows that the BHB L4 people (SSH cultural assemblage Pulowan cultural subset) undoubtedly possessed the ability to mass produce iron as early as the SSH site. As with the SSH site, the BHB L4 craftspeople may have produced iron from titanium-rich iron sand; however, the provenience of the iron sand is worth further exploration. To summarize, from the perspective of ceramic and

iron technology, both the BHB and the SSH site (after 1600 BP) can be confidently designated to the third stage of the proposed model.

The data from the BHB site plays a crucial role in the second and the third stage of the proposed model. Although I did not have the opportunity to examine the archaeological remains from the JXL site and the HKS site, which are crucial to the first and second stages of the model, based on published works, the proposed trade diaspora model seemingly frames the data nicely and does compose a more detailed story of how iron technology emerged in ancient Taiwan.



SSH site SSH subset layer (1800-1600 BP)

BHB site L6 layer



HKS site Upper HKS layer



JXL site early Sanhe layer



Figure 6-8 Map of sites and yielded archaeological remains indicate the first and second stage of the proposed trade diaspora model. Photos courtesy of LEE 李坤修 (2005), LIU 劉益昌 and CHAO 趙金勇 (2010b), and LIU 劉益昌 et al. (2016)

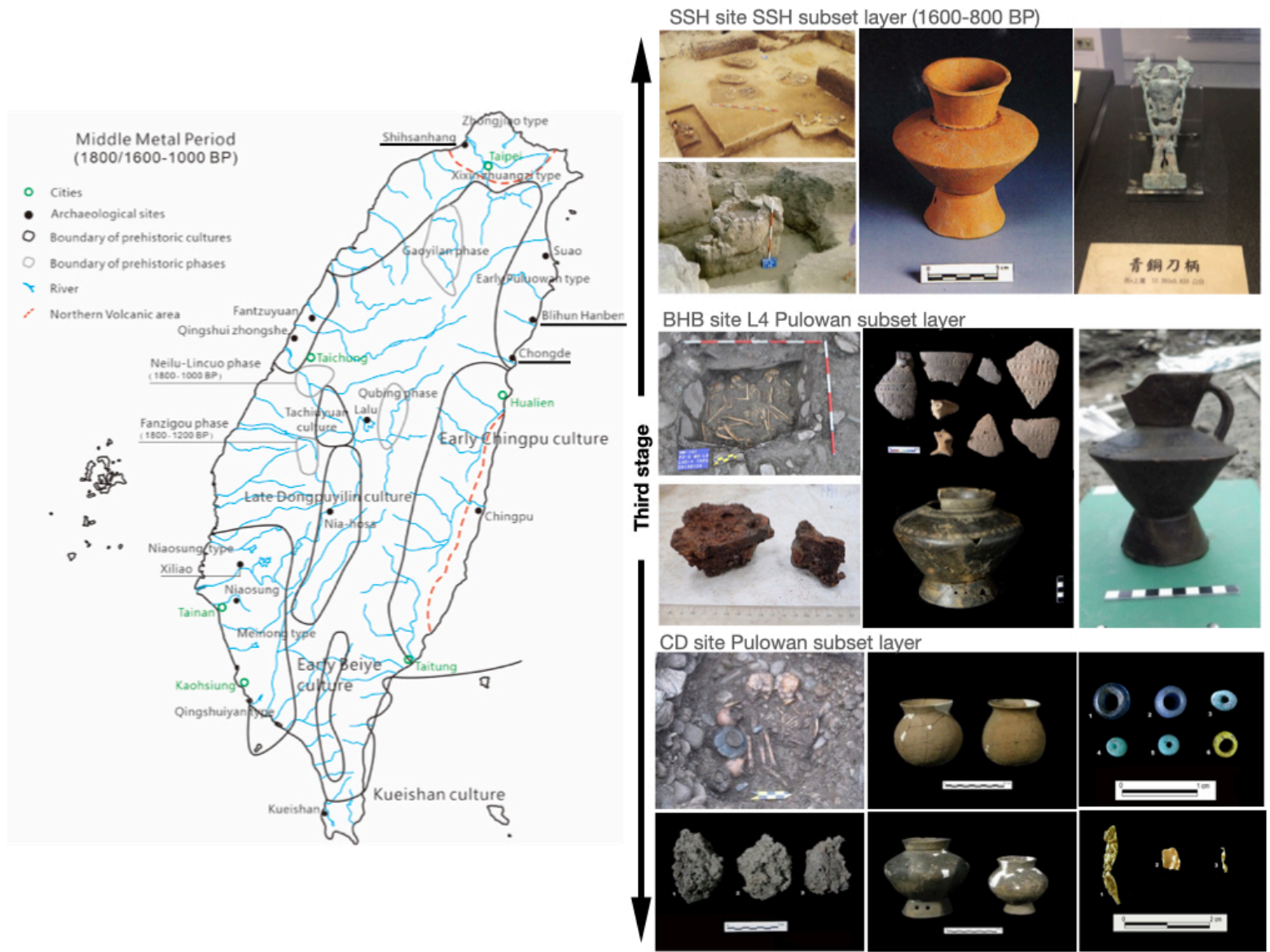


Figure 6-9 Map of sites and yielded archaeological remains indicate the third stage of the proposed trade diaspora model. Photo courtesy of Prof. LIU Yi-Chang 劉益昌, LIU 劉益昌 et al. (2016), and TSANG 臧振華 and LIU 劉益昌 (2001)

6.2. DNA and diet studies at BHB

In addition to ceramic and slag studies, I also participated in several collaborative projects on the BHB ancient DNA and ancient diet study. The ancient diet study on the BHB remains shows a combination of terrestrial and marine foodstuffs, and the ancient DNA (aDNA) analysis indicates overseas connections from a genetic perspective. Both studies demonstrate solid and intriguing results but may need more data for further comparative research. Here, I restate the results from one article draft¹¹⁰ of the ancient diet study and one other poster (Yeh et al. 2018) of the aDNA study, with permission of the authors. The BHB aDNA data has been incorporated with other East Asian datasets to illustrate ancient migrations and formation of the East Asia population (Wang et al. 2021).

Twenty specimens of bone were taken from the BHB site for collagen isotope analysis to explore the ancient diet of the BHB people. All specimens were collected during the early excavation; hence, no L6 specimens were taken. Of these twenty specimens, ten were human, four were deer, one was pig, and five were fish. All specimens were processed and analyzed at the Laboratory for the Analysis of Early Food-Webs at Washington University in St. Louis. The mean $\delta^{13}\text{C}$ value for humans is -15.1‰ and is 5.8‰ higher than the herbivore (deer) value of -20.9‰ (Figure 6-10). While there is an estimated 0-2% increase between trophic levels in $\delta^{13}\text{C}$, the $\delta^{13}\text{C}$ value difference between human and animal specimens (Bocherens and Drucker 2003), the values we have here strongly suggest that herbivores were not the only food source of the BHB people. Although herbivores were not the only food source of the Hanben people, surprisingly in this work, human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values are notably lower than that of fish, which means that fish were also not the dominant protein source of the Hanben people. The BHB L4 people's $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values are, in fact, intermediate between herbivores and fish; thus, a combination of terrestrial and aquatic foodstuffs was more likely to be the case. Regarding the staple starch source, the BHB L4 people have a mean $\delta^{13}\text{C}$ value of -15.1‰ ($\pm 1.0\text{‰}$), ranging from -13.2‰ to -16.5‰ in $\delta^{13}\text{C}$. These values seem to be between the conventional value of C_3 and C_4 plants.

¹¹⁰ See chapter 6 appendix

However, as consuming millet as staple food tends to have a mean $\delta^{13}\text{C}$ value under -17‰ (Liu 2010), the BHB $\delta^{13}\text{C}$ result may also indicate that millet was also one of the staple starch sources. The aDNA study obtained positive aDNA results from forty-four BHB individuals from both the L4 and L6 layers. All specimens were processed and analyzed in the David Reich Lab with the cleanroom facilities at the Harvard Medical School at Harvard University. Both Y-chromosomal and mitochondrial DNA (mtDNA) were analyzed. A Principal Component Analysis (PCA) was carried out to assess the genetic affinities of the ancient individuals qualitatively by projecting them onto the variations of present-day East and Southeast Asian populations (Figure 6-11) and published ancient populations (Figure 6-12).

It is not surprising that the BHB people have a strong genetic continuity with the present-day Taiwanese aboriginal groups, such as the Ami and Atayal. The dominant paternal Y chromosome lineage, O3a2c2-N6, and maternal lineages E1a, B4a1a, F3b1, and F4b, also pointed out the connection between these Taiwan ancient individuals and present-day Austronesian-speaking people in island Southeast Asia and the Pacific. As for the overseas relations, there are some unexpected close linkages with mainland Southeast Asia and the southern Philippines (Figure 6-11). The BHB samples share more alleles with some Austronesian speaking groups in northern Luzon, such as the Kankanaey, Ilocano, and Igorot than with the Tai-Kadai groups in northern mainland Southeast Asia and southern China. However, the BHB people share fewer alleles with the Mamanwa and Tagalog people from central Luzon and the central Philippines than the Tai-Kadai groups. The BHB samples are equally related to Visayan and Tai-Kadai peoples. Those observations may be caused by the fact that different Philippine groups inherited different amounts of ancestry from Papuan-related indigenous southeast Asians, which creates a deep lineage branching off earlier than the split between the BHB and Tai-Kadai people.

When comparing the BHB results to published aDNA data (Figure 6-12), we also see close relationships between the BHB people and ancient people from the northern part of Southeast Asia (SEA), like people from the Dongson culture and Halong culture in Vietnam and people from Thailand and Laos. Those observations also roughly match with the result when projecting the BHB signals to the present-day populations. Nevertheless, the relationship with mainland SEA

may provide a new direction for us to consider the possible provenience of the BHB people (or their ancestors) and the pyrotechnologies of glass and iron they brought into Taiwan.

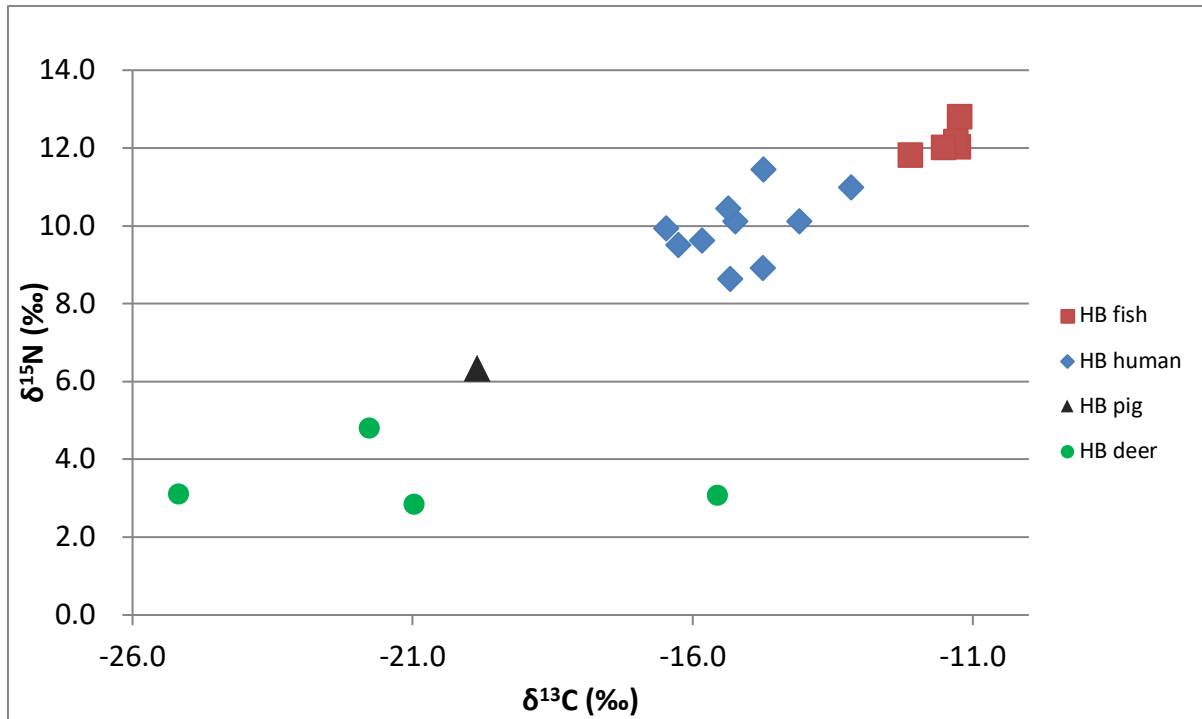


Figure 6-10 $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ for humans and animals from the Blihun Hanben site (from an article draft by me and other collaborators)

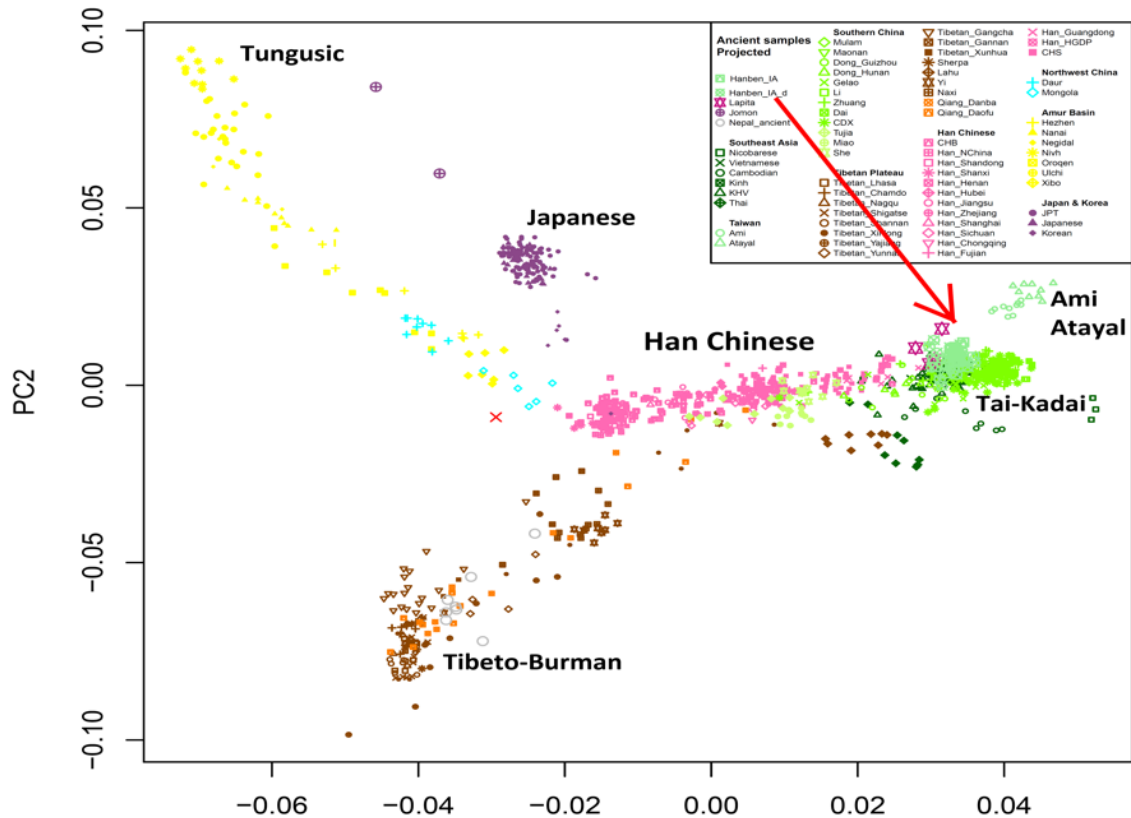


Figure 6-11 Principal Component Analysis (PCA) to assess the genetic affinities of the ancient individuals qualitatively by projecting them onto the variations of present-day East Asian populations. The red arrow points out where the BHB people's signals are (Yeh et al. 2018)

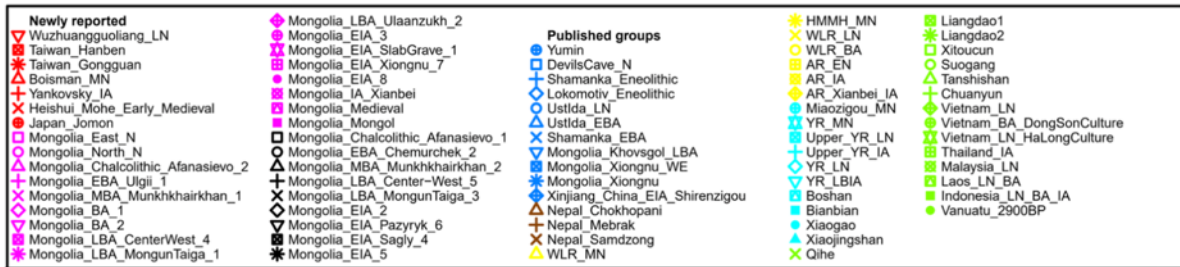
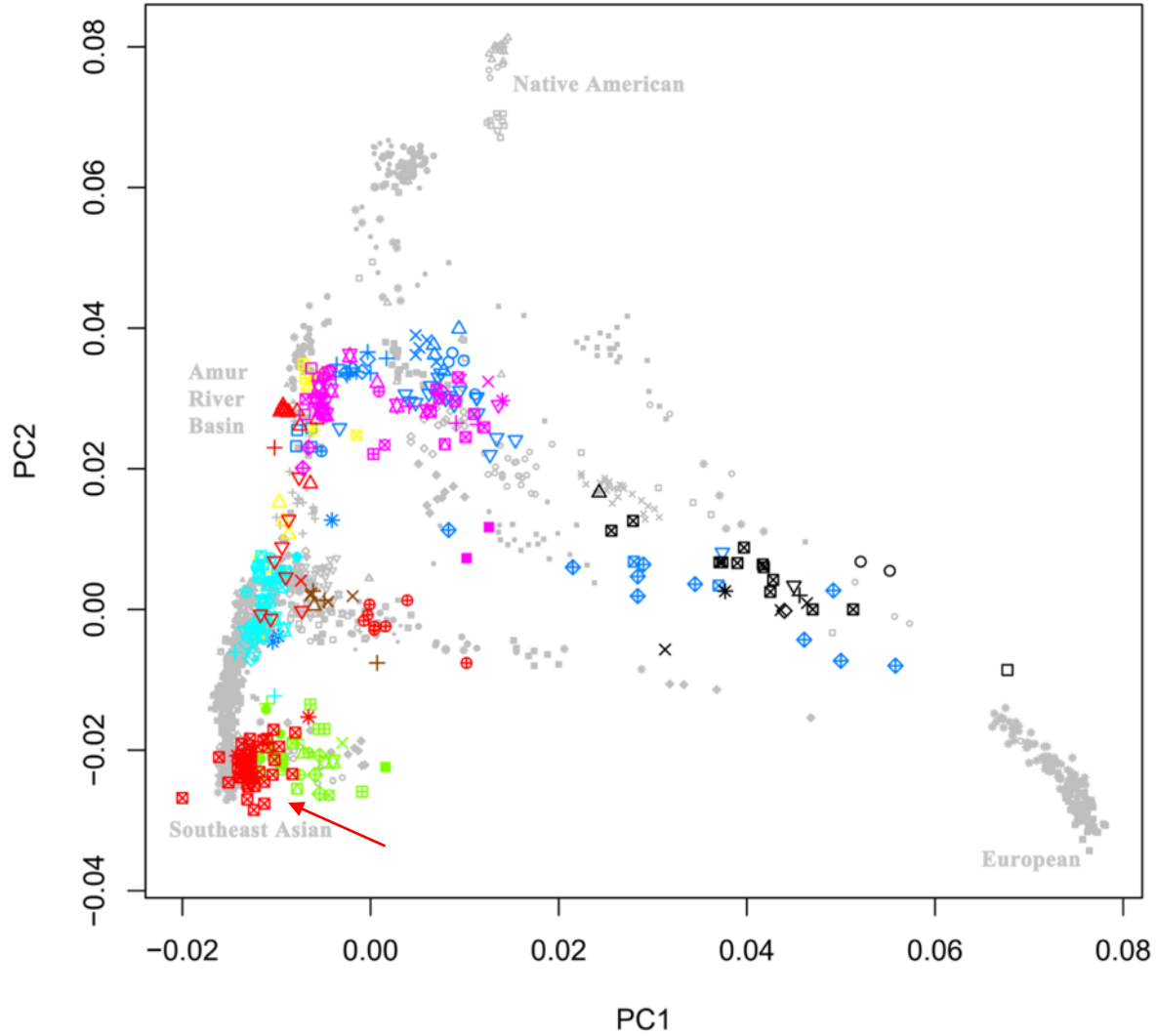


Figure 6-12 PCA of ancient samples. Projection of ancient samples onto PCA dimensions 1 and 2 defined by East Asian, European, Siberian, and Native American populations (Wang et al. 2021). See the lower left corner (pointed by red arrow), a cluster of the BHB people's signals are closed to the other ancient mainland Southeast Asians

6.3. Concluding Remarks

This doctoral research defines what trade diaspora is and has predicted the archaeological material representation of a diasporic community at a single-site scale. I further propose a regional scale trade diaspora model that could accommodate research advances for explaining the importation process of exotic materials and metallurgical knowledge. In this chapter, I have summarized BHB ceramic and metallurgical analyses to see if the BHB site archaeological remains fit the predicted material representation. Further, the trade diaspora model is examined to see if the model could portray the story of how iron technology emerged.

The ceramic analysis and burial observation do not show spatial differences in the BHB site; hence in the current research state, we do not find the classical material remains distributional pattern of trade diaspora in a single site, like what Gil Stein found in ancient Anatolia where a Mesopotamian Uruk enclave clearly occupied a corner of a local site (Stein 2002a). However, when we observe from a regional perspective when a trade diaspora community occupied a single site and embedded themselves in a region of local communities with similar cultural practices, the embedded trade diaspora community's material representation should demonstrate some differences and stand out from the local communities. In the context of this research, when we consider ceramic, metallurgy, and burial practices together, we indeed see several sites stand out from their contemporary sites. For example, the JXL site stands out from the other early Sanhe cultural assemblage site in 2400-2100 BP (Figure 6-8); the Upper HKS cultural assemblage at the HKS site and the BHB L6 layer share similarities but stand out from the other sites of different archaeological cultural assemblages in 2100-1600 BP (Figure 6-8), and the SSH site and the BHB site stand out from the other early Shihanshang cultural assemblage sites (Figure 6-9).

Although the cultural affiliations of these mentioned sites are designated to different and diachronic archaeological cultural assemblages, it is clear that these sites share several similar archaeological attributes, like grayish-black pottery, foreign items as grave goods, pyrotechnologies of glass and metals, and unique burial positions. In other words, on top of the 'Black ceramic' that LIU (2013a) proposed as the ethnic marker of those foreign traders, I believe

adding pyrotechnologies of glass and metals as factors are the key for identifying those diasporic traders/craftspeople.

While the BHB site provides rich research materials, the story of how iron technology emerged in ancient Taiwan cannot be told without the studies on the other sites in different times. Like the story of the Blind Men and the Elephant, everyone is holding a piece of the puzzle but lacks a complete picture without sharing their part with others. Those previous studies have provided us with almost all the ingredients, and those ingredients just need a cookbook to arrange the ingredients properly when making a meal. The proposed trade diaspora model seemingly frames these previous studies and the BHB data nicely for portraying how metallurgy existed in ancient Taiwan as early as 2400 BP.

The current model accommodates the data from the JXL site, Upper Huakangshan cultural assemblage at the HKS site, the BHB site L6 layer, the BHB site L4 layer, and the SSH site. Following the model, the data from those sites shows the importation process of foreign material, ideology, and knowledge by craftspeople group(s). This whole process can be separated into three stages: 2400-2100 BP, 2100-1600 BP, and 1600-1000 BP. These three stages mark the different levels of interaction between the foreign craftspeople and the local residents and relate to the different metallurgical practices. Instead of a sudden introduction that may have been caused by a single immigrational event, this proposed model demonstrates a gradual importation process of matured metallurgy by a long-term adaptation of the craftspeople.

While we are almost certain that the importation of exotic materials like glass beads, carnelian beads, and metals began in southeastern Taiwan, where did this mature iron technology come from? The detailed ceramic and iron slag analyses are aimed at reconstructing the manufacturing process of the BHB ceramics and iron metallurgy, and this could help us trace the possible origin of those craftspeople and the provenience of metallurgy. I do not have an affirmative answer for the origin and provenience question in the current research state. However, the geometric decorative pattern on the ceramic surfaces is similar to the ceramics in the southeastern part of the Asia continent (the current Guangdong, Guangxi, and the northern Vietnam region). It seems challenging to find a suitable overseas provenience for bloomery iron

production by titanium-rich iron sand; however, more studies show that bloomery iron production was practiced in the south and southeastern part of East Asia and mainland SEA beginning around 2500 BP. Could this slightly earlier iron technology be the provenience of ancient Taiwan's iron metallurgy? On top of those possible orientations, the BHB aDNA analysis also shows strong connections between the BHB people and certain groups in Luzon and Tai-Kadai speaking people in the northern part of mainland SEA.

6.3.1. Limitations

Before discussing the research limitation and future works, I think the most significant limitation of this research is social responsibility. While I have given lectures and public talks about this doctoral research, I feel that I did not engage enough with the Indigenous community.

Archaeological studies in Taiwan generally are concerned with the ancestors of modern Taiwan Indigenous tribal groups. A more engaged and collaborated relationship between archaeologists (especially non-Indigenous) and Indigenous communities should always be considered. In recent years, archaeologists in Taiwan have begun to work more with Indigenous communities. See CHENG 鄭玠甫 (2020) and YIN 尹意智 and YAO 姚書宇 (2020) for the recent effort of collaborations. Also, from my observation in the educational realm, there is the prospect of a new generation of Indigenous archaeologists. Those are great examples I should aim to emulate in the future.

The most apparent limitation is the nature of BHB site data. The BHB site was excavated as a salvage project. While the IHP team has conducted extremely high-quality excavation, the field data collection may not fit the research requirement of this doctoral research. For example, while the project had extracted a tremendous amount of soil samples, not all soil samples of the metallurgical features were collected. The almost invisible hammerscales and prills from secondary smithing need to be carefully screened from the soil samples. Also, two factors may bias the BHB data: the first is that the IHP team was only able to excavate a designated location, where the bridge pillars were designed; and the second is that another institute excavated a part of the core area by a different excavation method. This may cause difficulties for data integration in the future.

As for the artifact analyses, the significant limitation is the sample size for the instrumental analyses. While I have analyzed a relatively larger sample size for the BHB ceramic petrographic examination, the sample size needs to be larger to discuss the refined diachronic changes in the ceramic assemblage. Also, the sample size of iron slag is significantly small. While I tried to compensate for the sample size by analyzing multiple points of the same specimen, expanding the iron slag sample size is a more ideal approach.

The third limitation relates to the research scale and modeling. In this doctoral research, I only carried out detailed analyses on ceramic and iron slag from the BHB site. Ideally, detailed foodway (by expanding the preliminary stable isotope analysis and carry out new project on phytolith analysis) and burial analyses (by analyzing burial customs and burial goods) should be incorporated to derive more reliable data to support the existence of a trade diaspora community. Also, I did not have the resources and access to carry out the same detailed analyses on the artifacts from the other sites with possible trade diaspora craftspeople and the local sites to conduct comparative study. Nevertheless, the BHB data indeed shows diasporic characteristics, and the proposed model has not been refuted by the current research results. However, the proposed model does provide new insight into the emergence process of ancient metallurgy in Taiwan.

6.3.2. Advances and Future Research Directions

While I am confident that this study marks considerable progress in understanding the BHB site's cultural affiliation and iron technology, these findings raise as many questions as research results. In addition to the research results of the trade diaspora study, we have made some advances on the BHB aDNA and ancient foodways. Clearly, I should carry on those collaborative projects that would lead to many research directions, including but not limited to questions like:

- Differences between the BHB L4 and L6 people.
- The biological relationship between the BHB people and other published data, like aDNA database and cranial morphology database (Lipson et al. 2018; Matsumura and Oxenham 2014). The close relationship between the BHB people and Tai-Kadai speaking people (Wang et al. 2021) is especially fascinating.

- Differences between the foodways of BHB people and their contemporary neighbors. How have iron objects been used as implements of subsistence?

Further, a detailed diachronic analysis of the BHB iron technology could reveal the technological evolution of metallurgy in the Metal period. The comparison of the BHB and SSH iron technology will be intriguing as well. Did they share the same iron ore source? What was the relationship between the two groups of craftspeople between the two sites? What was the exact origin of the BHB and SSH iron technology? Are Southeast Asia and Asia mainland the only two candidates? Is the Korean peninsula a possible origin?

The ceramic analysis and preliminary burial examination has revealed the cultural affiliation of the BHB L4 with the SSH cultural assemblage Pulowan subset and has shown the uniqueness of the BHB L6 remains. The BHB L4 layer is the earliest known Pulowan subset (1600 BP), and given this fact, we need to re-think the relationship between the Pulowan subset people and the SSH subset people. As for the BHB L6 remains, it is likely that there will be a new 'archaeological cultural assemblage' on the chronological table of Taiwan ancient history. Of course, we need a more comprehensive discussion before proposing a new archaeological cultural assemblage. Lastly, I plan to include social network analysis (SNA) for those mentioned future studies. The SNA would benefit calculating the relation between research subjects, both intra-site and inter-site.

While the macro and micro analyses on the BHB iron slag and related metallurgical remains yield promising results, many tasks and questions still need to be tackled. The first is to refine the classification system based on this doctoral study. I suspect some smaller funnel shape, with high magnetic property, type B slag (Figure 6-13) might be the secondary smithing slag. Instead of a concave bottom, this slag has pointy bottoms. We must combine the study of hammerscale and prill distribution (Petchey et al. 2018) to determine the location of secondary smithing. Also, a refining examination would benefit the study on the technological evolution of iron metallurgy. Has the iron technology changed within the BHB ironmaking/working period (1600-1200 BP)? Second, the mystery of burned slate and ceramic sherds has not been solved yet. Do they serve a practical function or have symbolic meaning during smelting? Smelting is sometimes considered

magical¹¹¹ or activity with spiritual elements in many case studies (Hendrickson et al. 2019; Schmidt 1997). Third, the current study focuses on slag analysis but not the iron objects. In the future, researchers should examine the iron objects which in turn would enrich our understanding of the change of iron technology through time and the provenience of ore.

By applying the macro and micro analyses on ferrous pyrotechnological remains and the concept of technical sequence, I conclude intensive smithing iron activities took place in the BHB site and point out a close relationship between the BHB site and the SSH site regarding the cultural affiliation and iron technology tradition. The proposed trade diaspora still stands but with only partial explanatory power. Nevertheless, those attempts have gained relatively positive results and pave the road for future research.

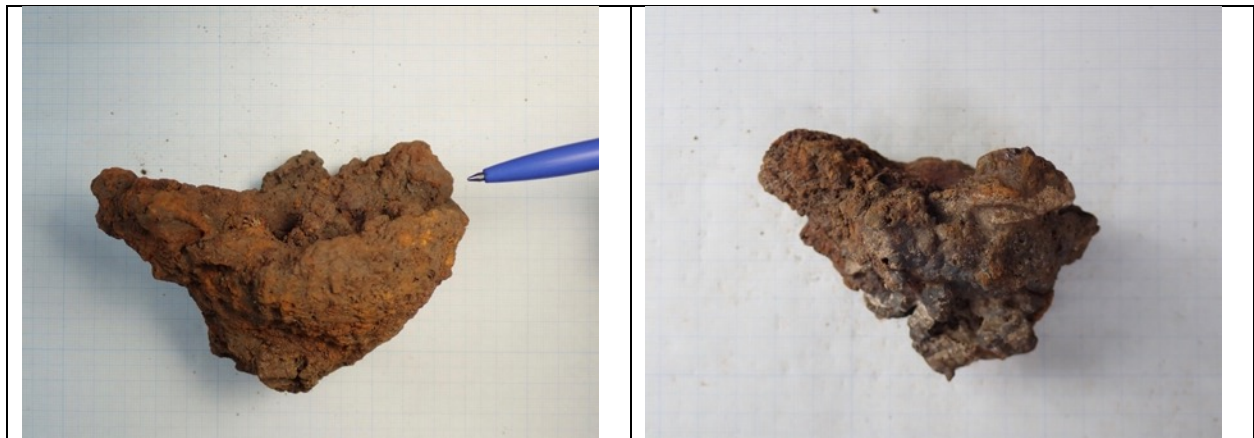


Figure 6-13 Type B slag with a pointy bottom. Pen indicates the air blow direction.

In addition to those academic oriented directions, the practice of community-based future research is necessary. Indigenous machete 山刀 is one of the important elements in the Taiwanese Indigenous culture and is also important to cultural revitalization. The collaboration of ancient iron technology research and modern practice of Indigenous machete-making would widen and deepen the story of this vital tradition in the Taiwanese indigenous society.

6.3.3. Some Final Words

Starting from 2400 BP, the intensification of interregional exchange is visible in archaeology around the Southeast Asian/South China Sea. The early Formosan traders not only shared

¹¹¹ Any sufficiently advanced technology is indistinguishable from magic - Arthur Charles Clarke (1973).

language similarities with other Austronesian speaking people but might also have shared craftsmanship systems (Hung and Chao 2016; MIYAMA 深山繪実梨 2018). Synchronically, the material culture in ancient Taiwan rapidly changes.¹¹² This marks the interaction between ancient Taiwanese residents and the outside world. Since then, Taiwan has entangled with her adjacent regions and even farther places and powers, and the development of this island is no longer detachable from the outside world.

Living on this island, what more can we do as archaeologists? The story Taiwanese archaeologists generate is to enrich the understanding of our shared past in Taiwan and with her adjacent regions. I need to remind myself about the power of storytelling, which influences people and society profoundly. I need to remind myself that the story I tell should aim to bring us a mutual understanding of each other in these modern times today. This dissertation has been completed during a global pandemic, and we have seen the good, the bad, the brightest, and the darkest of us during these difficult times. The world may recover soon, but our lives may have changed forever. I shall always remind myself to aim to have integrity by the following quotes from *The Plague* (Camus 1991):

"It's a matter of common decency. That's an idea which may make some people smile, but the only means of fighting a plague is — common decency."

"I don't know what it means for other people. But in my case, I know that it consists in doing my job."

¹¹² Personal communication with CHAO Chin-Yung in 2016.

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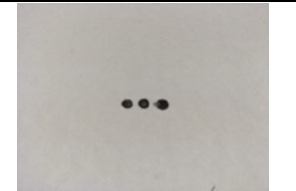





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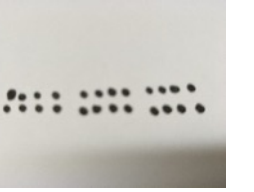
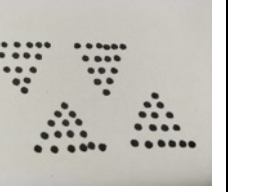




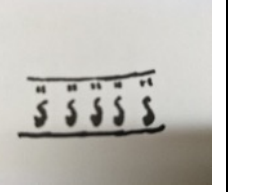
8. Appendix 1 Selected Ceramic Decoration Pattern

<p>蓆紋 B Straw mat</p>	 <p>B-A</p>	 <p>B-B</p>	 <p>B-C</p>	 <p>B-D</p>	 <p>B-D</p>
	 <p>B-E</p>	 <p>B-F</p>			
<p>蝴蝶結紋 BU Butterfly</p>	 <p>BU-A</p>	 <p>BU-A</p>			
<p>圓紋 C Circle</p>	 <p>C-A</p>	 <p>C-B</p>	 <p>C-C</p>	 <p>C-D</p>	
<p>雲紋 CD Cloud</p>	 <p>CD-A</p>	 <p>CD-B</p>	 <p>CD-C</p>	 <p>CD-D</p>	 <p>CD-D</p>

					
	CD-E	CD-F	CD-G		
繩紋 CM Cord-marked					
	CM-2	CM-3	CM-4		
幾何印紋 G Geometric					
	G-A	G-B	G-C	G-D	G-E
					
	G-K 龜山式人臉				
迴紋 H Revolve					
	H-A	H-B			

<p>錢幣紋 M Money</p>	 <p>M-A</p>	 <p>M-B</p>			
<p>捺點紋 PD Pressed dot</p>	 <p>PD-A</p>	 <p>PD-A</p>	 <p>PD-A</p>		
<p>方格紋 S Square/grid</p>	 <p>S-A</p>	 <p>S-B</p>	 <p>S-C</p>	 <p>S-C</p>	 <p>S-D</p>
 <p>S-E</p>  <p>S-F</p>  <p>S-F</p>					
<p>方圓紋 SC Square and circle</p>	 <p>SC-A</p>	 <p>SC-A</p>	 <p>SC-B</p>	 <p>SC-C</p>	

						
	SC-C					
條紋 ST Stripe						
	ST-A	ST-B	ST-C	ST-D		
	三角紋 T Triangle					
		T-A	T-A			
葉脈紋 V Vein						
	V-A	V-A	V-A	V-A		
	葉脈紋 V Vein					
		V-A	V-A	V-A	V-A	V-A

					
	V-A	V-B	V-C	V-C	
波浪紋 W Wave					
	W-A	W-B	W-B		
點點 D Dot					
	D-A	D-B	D-B	D-C	D-D
					
	D-E	D-F	D-G	D-H	D-I

9. Appendix 2 Article Draft of the Foodways Analysis on the BHB People

A Preliminary Result of the Carbon and Nitrogen Stable Isotope Analysis of Hanben Site

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Abstract

Hanben site is located at the south end of Yilan County in eastern Taiwan. This site is situated on the coastline near the Pacific Ocean, only a few meters from the sea today. According to the current data, the site center is at 24°19'40" north latitude and 121°45'56" East longitude and about 19m above sea level. At least two prehistoric cultural layers in this site. Based on the ceramics and burial practices, the remains from L4 (1,600-1,200BP) could be considered to Shihshanhang culture. The remains from L6 (2,000-1,650BP) cannot be identified with any exist prehistoric culture in eastern Taiwan. However, the flexed with sit position burial practice indeed shows some similarity with other prehistoric culture in eastern Taiwan. 20 specimens were taken from the site for collagen isotope analysis. Of the 20 specimens taken from the site, 10 were human, 4 were deer, 1 was pig and 5 were fish. The mean $\delta^{13}\text{C}$ value for humans is -15.1‰, which is 5.8‰ higher than the herbivore (deer) value of -20.9‰. There is an estimated 0–2% increase between trophic levels in $\delta^{13}\text{C}$, strongly suggesting that herbivores were not the humans' only food source. Although herbivores were not the only food source of Hanben people, surprisingly in this work, human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values are notably lower than that of fish, which means that fish were also not the dominant dietary staple of Hanben people. The human values are, in fact, intermediate between herbivores and fish. Thus they are likely to have consumed a combination of foodstuffs. The result also indicates millet as one of the diet sources.

台灣漢本遺址出土人骨與獸骨碳氮穩定同位素初步分析

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摘要：

漢本遺址位於宜蘭縣南澳鄉澳花村漢本聚落附近，大致位於漢本車站南側與和平溪北岸之間的海岸平原緩坡，東側緊鄰太平洋，西側坐落於濁水山的山腳下。截至目前為止，漢本遺址至少有兩層史前文化層，L4 與 L6。由出土陶器與側身屈肢的墓葬形式來看，L4 大致屬於十三行文化；而 L6 的陶類與埋葬形式甚為複雜，文化類屬則仍須討論。本研究採取 20 件漢本遺址出土之人骨與獸骨進行碳氮同位素分析。分析結果顯示，人類碳氮同位素之碳十三平均值為 $-15.1‰$ ($\pm 1.0‰$)，範圍為 $-13.2‰$ 至 $-16.5‰$ ；而氮十五的平均值為 $10.0‰$ ($\pm 0.9‰$)，範圍為 $8.6‰$ 至 $11.5‰$ 。在這十個個體當中，碳氮數值皆相當接近，未出現極端值者。而漢本草食性動物(鹿科動物)共獲得四個個體的數據，該鹿科動物的碳十三平均值為 $-20.9‰$ ($\pm 4.0‰$)，範圍為 $-15.6‰$ 至 $-25.2‰$ ；氮十五的平均值則為 $3.4‰$ ($\pm 0.9‰$)，範圍為 $2.8‰$ 至 $4.8‰$ 。雜食性動物樣本方面，目前僅送驗一個樣本(豬)。此個體的同位素數值為碳十三 $-19.9‰$ ，氮十五 $6.3‰$ 。魚骨方面，漢本遺址出土的魚骨被鑑定為海洋魚類，總計共有五個魚骨樣本在本次的分析中獲得數據，其碳十三平均值為 $-11.5‰$ ($\pm 0.4‰$)，氮十五平均值為 $12.2‰$ ($\pm 0.4‰$)。若將漢本的人類以及草食性動物的飲食同位素所得平均值比較，碳十三的差異為 $5.8‰$ ，氮十五的差異為 $6.6‰$ ，顯示了草食性動物不是漢本先民唯一飲食來源。總的來說，漢本先民在飲食上偏向綜合的取食系統，並未因靠近太平洋而完全依賴海鮮類的攝取，且在植物性的飲食攝取方面，也顯示了偏向小米飲食的可能性。

Introduction

Stable isotope analyses are widely applied in archaeology as a powerful tool for providing the data to reconstruct ancient diets and growth background. Synthesizing the isotope data from both teeth and bones, we can further infer more human activities, such as population movement, subsistence, gender and social differentiation and so on (e.g. Cerling et al., 1997; Sponheimer and Lee-Thorp, 2001). In this research, we extract the collagen from human and animal bones from Hanben site to analyze the carbon and nitrogen stable isotope to reconstruct the basic diet of Hanben people. The result indicates that Hanben people adopt a mixed strategy to consume both herbivores and aquatic resource even the Pacific Ocean is just a few meters away.

Hanben site

Hanben site is located on the south end of Yilan County in eastern Taiwan and was discovered recently during the Suhua Highway Improvement construction. Hanben site is situated on the coastline near the Pacific Ocean, only a few meters from the sea today. According to the current data, the site center is at 24°19'40" North latitude and 121°45'56" East longitude and about 19m above sea level. The whole site is 1500-2000m from north to south and 150-200m from west to east¹¹³. There are at least two prehistoric cultural layers in this site. The first (L4) is dated to 1,600-1,200BP, which belongs to the Taiwanese Iron Age, and the second (L6) is dated to 2,000-1,650BP which is in the transition of Neolithic to Iron Age in Taiwan. Based on the ceramics and burial practices, the remains from L4 could be considered to Shisanhang culture. One of the key characteristics of Hanben site is that all of the burials in L4 are sideways flexed, similar with other Shisanhang culture sites. The other similar characteristic is the iron metallurgy at Hanben site, and this is also the other important feature of Shisanhang culture. The remains from L6 cannot be identified with any exist prehistoric culture in eastern Taiwan. However, the flexed with sit position burial practice indeed shows some similarity with other prehistoric culture in eastern Taiwan.

Material and Methods

Hanben site is still undergoing excavation, detail information regarding botanic remains and artifacts is currently under management, but significant numbers of marine fish bones, coupled with a number of terrestrial animal bones such as those of deer and pigs, have been exhumed at the site. 20 specimens were taken from Hanben site for collagen isotope analysis. Of the 20 specimens taken from the site, 10 were human, 4 were deer, 1 was pig and 5 were fish.

In order to extract collagen from the bone samples, the samples were subjected to cleaning, demineralisation, gelatinisation and freeze-drying. This procedure follows the lab protocol of the Dorothy Garrod Laboratory, University of Cambridge, which is based upon the method given by Privat et al. (2005). Bone samples were cleaned using a sandblaster unless the sample was powdered. This involved holding the sample securely with the non-dominant hand using tweezers. Once the sample was securely held, the nozzle of the sandblaster was held using the dominant hand and aluminium oxide powder was sprayed against the exterior of the bone. Exposure to

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sandblasting using this method ensured that all superficial dirt or residue was removed from the surface of the sample. This is important as a clean sample is required to complete the following three phases of collagen extraction. Each of the bone slices or powder samples were allocated a 12ml glass test tube. Each of the test tubes was labelled and weighed. The weight of each test tube after the sample had been added was recorded. Around 8ml of aqueous 0.5M HCl was added to the test tubes. The tubes were then placed into a test tube rack and covered with a layer of aluminium foil. The sample rack was kept refrigerated for a number of days. However, each of the samples was lightly shaken either once or twice a day. The acid was changed every 2 to 4 days by pouring the acid carefully into a waste beaker. Where very small shards of bone were in the test tube, an Ezee filter was employed in order to prevent the loss of bone when decanting the acid. The sample was considered ready when the bone pieces became soft or floated in the test tube. A Pasteur pipette was used to determine the softness of the samples. When the samples were ready, the supernatant liquor was poured off carefully into a waste beaker and disposed of along with any excess water by pouring into a sink. The samples were rinsed with distilled water at least three times.

The collagen pellet left behind was gelatinised by heating in around 7ml of pH 3.0 water at a temperature of 75°C for two full days. More specifically, 8ml of pH 3 water was added to each of the samples and the test tubes were then placed in an oven which was heated to a temperature of 75°C. A plastic lid was placed on each of the test tubes and each of these lids was then covered by a layer of aluminium foil. It was important that the lids remained on the test tubes as they could spring off when subjected to hot temperatures, in which case the liquid would evaporate. This was avoided by using a pencil to press the lid firmly into the tube, but care had to be taken to avoid cracking the top of the tube by applying an excessive amount of force when attaching the lids. Each lid was inspected at regular intervals throughout the 48-hour period. Once two days had passed, all of the collagen had dissolved and an insoluble acid substance remained in the test tubes. This supernatant liquor was decanted carefully using an Ezee filter into plastic test tubes that had already been weighed and labelled. The collagen was contained in this supernatant substance. The plastic tubes were frozen at a temperature of -20°C. After being left overnight, the test tubes were then placed into a different freezer at a temperature of -80°C for a total of four hours before being transferred into a freeze-drier. The samples were left in the freeze-drier for between one and four days until the contents were completely dry. The dried contents comprised of collagen and there might also be acid salts contained in the mixture. Once the samples had been dried, they were then weighed. The weight of the test tube was then subtracted from the total weight measured in order to accurately determine the collagen yield of each sample. Triplicate samples of collagen were analysed for each specimen using a Costech elemental analyser connected to a Thermo Finnigan MAT253 mass spectrometer. As noted in Section 3.2.1., carbon and nitrogen stable isotope values are expressed as delta values relative to international standards (VPDB and AIR, accordingly) in units of ‰ known as permil (Sharp, 2007) (Hoefs 2009). (Sharp 2007)

Results

The quality of samples was determined through the following criteria: (1) an atomic C : N ratio of 2.9 to 3.6 (DeNiro, 1985) (DeNiro 1985); (2) a 'collagen' yield of >1% by mass; (3) final carbon yields of >13%; and (4) final nitrogen yields of >4.8% (Ambrose, 1990) (Ambrose, et al.

1997). As shown in Table1, isotopic values were successfully obtained from both human and faunal samples.

The humans have a mean $\delta^{13}\text{C}$ value of -15.1‰ ($\pm 1.0\text{‰}$) and a mean $\delta^{15}\text{N}$ value of 10.0‰ ($\pm 0.9\text{‰}$), ranging from -13.2‰ to -16.5‰ in $\delta^{13}\text{C}$ and from 8.6‰ to 11.5‰ in $\delta^{15}\text{N}$. Among these 10 individuals, there is no individual that has a significantly different value that could be identified as an outlier. The human isotope values have a smaller range in $\delta^{13}\text{C}$ than the animal values. The herbivore values (deer) have a mean $\delta^{13}\text{C}$ value of -20.9‰ ($\pm 4.0\text{‰}$) and $\delta^{15}\text{N}$ of 3.4‰ ($\pm 0.9\text{‰}$), ranging from -15.6‰ to -25.2‰ in $\delta^{13}\text{C}$ and from 2.8‰ to 4.8‰ in $\delta^{15}\text{N}$. There was only one omnivore (pig) sample available for this analysis. The omnivore has a $\delta^{13}\text{C}$ value of -19.9‰ and $\delta^{15}\text{N}$ of 6.3‰ . The sampled fish bones were identified as marine fish and have a mean $\delta^{13}\text{C}$ value of -11.5‰ ($\pm 0.4\text{‰}$) and $\delta^{15}\text{N}$ of 12.2‰ ($\pm 0.4\text{‰}$). When the mean values of Hanben people and the herbivores are compared, the mean difference between humans and herbivores are 5.8‰ and 6.6‰ for $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ respectively, although it is noted that there are only four herbivore samples.

Table1 Summary of positive results from Taiwan.

Sample ID	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	Date	Time Period
HB1 (human)	-14.1	10.1	Iron Age	1600-1200BP
HB3 (human)	-15.2	10.1	Iron Age	1600-1200BP
HB4 (human)	-14.7	11.5	Iron Age	1600-1200BP
HB5 (human)	-16.3	9.5	Iron Age	1600-1200BP
HB6 (human)	-13.2	11.0	Iron Age	1600-1200BP
HB7 (human)	-15.8	9.6	Iron Age	1600-1200BP
HB 3 (human)	-16.5	9.9	Iron Age	1600-1200BP
HB 4 (human)	-15.3	8.6	Iron Age	1600-1200BP
HB 5 (human)	-15.4	10.4	Iron Age	1600-1200BP
HB 6 (human)	-14.7	8.9	Iron Age	1600-1200BP
Mean-Human	-15.1	10.0		
S.D.- Human	1.0	0.9		
HB 7 (fish)	-11.3	12.0	Iron Age	1600-1200BP
HB 8 (fish)	-12.1	11.8	Iron Age	1600-1200BP
HB 9 (fish)	-11.3	12.1	Iron Age	1600-1200BP
HB 10 (fish)	-11.2	12.8	Iron Age	1600-1200BP
HB 11 (fish)	-11.5	12.0	Iron Age	1600-1200BP
Mean -Fish	-11.5	12.2		
S.D.- Fish	0.4	0.4		
HB 12 (pig)	-19.9	6.3	Iron Age	1600-1200BP
HB 13 (deer)	-21.0	2.8	Iron Age	1600-1200BP
HB 14 (deer)	-25.2	3.1	Iron Age	1600-1200BP
HB 15 (deer)	-15.6	3.1	Iron Age	1600-1200BP
HB 16 (deer)	-21.8	4.8	Iron Age	1600-1200BP
Mean-Deer	-20.9	3.4		
S.D.- Deer	4.0	0.9		

Discussion- the Dietary of the Hanben People

The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values for humans and animals from the Iron Age Hanben site are presented in Figure 1. The mean $\delta^{13}\text{C}$ value for humans is -15.1‰ , which is 5.8‰ higher than the herbivore (deer) value of -20.9‰ . There is an estimated 0–2% differences between trophic levels in $\delta^{13}\text{C}$ (Bocherens and Drucker, 2003), the higher the trophic level the higher $\delta^{13}\text{C}$ is. The study result strongly suggests that herbivores were not Hanben people's only food source. However, the mean $\delta^{13}\text{C}$ value for humans is lower than that of the fish (-11.5‰). The humans were also found to have a lower mean $\delta^{15}\text{N}$ value (10.0‰) than the fish (12.2‰). The fish $\delta^{15}\text{N}$ value is in accordance with the work of Ambrose et al. (1997) who found that marine animal isotopic values from the Pacific Ocean ranged from 4.3‰ to 13.0‰ . An enrichment of 3–5% in $\delta^{15}\text{N}$ is to be expected between diet and consumer (DeNiro and Epstein, 1981) (DeNiro and Epstein 1981a; DeNiro and Epstein 1981b). In fact, high nitrogen differences between animals and humans is often interpreted as being the result of a high proportion of animal protein in human diets (Hedges et al., 2008) or the consumption of aquatic resources. In this work, human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values are notably lower than that of fish, which is surprising given the site's proximity to the Pacific Ocean. Therefore, it is clear that fish were not the sole dietary staple of Hanben people. The human values are, in fact, intermediate between herbivores and fish, thus they are likely to have consumed a combination of foodstuffs. However, in term of the source of carbon dietary, Hanben people have a mean $\delta^{13}\text{C}$ value of -15.1‰ ($\pm 1.0\text{‰}$), ranging from -13.2‰ to -16.5‰ in $\delta^{13}\text{C}$. As consuming millet as staple food tends to have a mean $\delta^{13}\text{C}$ value under -17‰ (e.g. Liu, 2009), the result of this preliminary study also indicates that millet was also one of the diet sources.

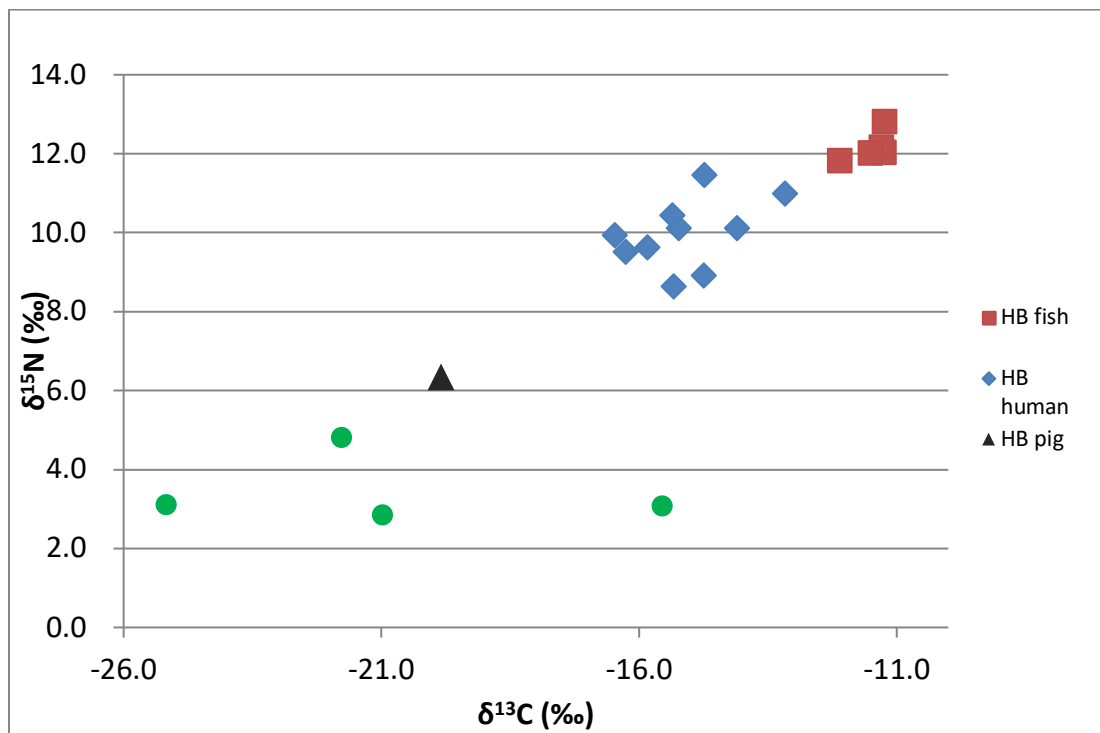


Fig. 1 $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ for humans and animals from the Iron Age Hanben site in northern Taiwan.

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