Environmental Preconditions and Human Response: Settlement Patterns and Subsistence Practices in the Prehistoric Liangshan Region, Southwest China

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Abstract: *The Liangshan region in southwest Sichuan is known for its great diversity both in geographic layout and ethnic composition. Unsurprisingly, it is also characterized by a highly diverse archaeological assemblage. An increasing number of settlement excavations and surveys conducted in recent years are helping us to understand how past people used this highly varied landscape; however, much of the material is still insufficiently published, and paleoenvironmental, archaeobotanical, and archaeozoological data are lacking.*

This paper for the first time introduces this little-known body of material to a greater audience. At the same time, it uses the Liangshan region as a case study on how to infer past forms of subsistence from archaeological material alone when archaeobotanical data are missing. Based on stone-tool analysis combined with information on ceramics, settlement structure, and site-distribution data, this study identifies the major differences and similarities between the assemblages from different sites and sub-regions, suggesting patterns of past land-use, subsistence systems, and inter-community interaction.

This paper suggests that past populations exploited the Liangshan region in a variety of ways, including hunting and gathering, shifting cultivation, and collaboration between various groups specializing in different subsistence practices and trading what they had plenty of for what they were lacking. The archaeological material furthermore suggests that past decisions about subsistence were not shaped by geographic preconditions alone, but also by cultural factors.

Key Words: *Southwest China; settlement analysis; spatial analysis; human-environment interaction; stone tool analysis*

1. Introduction

Located in the Hengduan 横断 Mountains, the Liangshan 凉山 Region in Southwest China is characterized by a variety of environments located in close proximity to each other. These ecological niches require different forms of human adaptation; therefore, in this region a variety of very different lifeways and cultures emerged in close proximity. At present, the Liangshan region is thus inhabited by a considerable number of ethnic groups practicing various forms of subsistence. Similarly, the archaeological record is highly complex and still not well understood.

While previous studies have largely focused on burial materials, this study gathers and evaluates the local settlement material, focusing on issues

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of settlement function, location choice, and their geospatial correlates. As the history of archaeological research in southwest Sichuan commenced only in the 1970s, with settlement material coming into focus since the 1990s, the amount of available material is limited and has so far remained largely unknown to scholars outside of China. Furthermore, until recently, paleoenvironmental, archaeobotanical, and archaeozoological data have not been collected systematically throughout Southwest China and they are not at all available for the Liangshan region.

In the absence of adequate paleobotanical and zooarchaeological data, lithic analysis is particularly important. Stone tools have played a major role in food procurement and processing since early human history. As they furthermore preserve well and show clear traces of use-wear, stone tools form an excellent basis for conclusions on past economies. Ceramics are another type of archaeological artifact that can be used to understand these issues. Formal attributes furnish indicators for the function of ceramic vessels, and these in turn allow inferences about the degree of food production, storage, and transport taking place at a given settlement.

In this study, I combine the analysis of the lithic assemblages from prehistoric settlement sites in the Liangshan region with information on ceramics and other objects as well as building features and site locations to infer upon site functions and patterns of location choice. In this fashion, I highlight how past inhabitants of the research area interacted with this highly varied environment, adapting to local circumstances, and developing a variety of unique cultural responses. At the same time, this paper serves to introduce this little-known body of material to a greater audience and provides a case study on how to infer from archaeological evidence on past forms of subsistence, even in the absence of archaeobotanical remains.

2. The Local Environment: Natural Resources, Soils, and Climate

2.1 Environmental conditions past and present: soil, climate, vegetation, and land use

The Liangshan region is circumscribed by the Dadu River 大渡河, the Jinsha River 金沙江, and the Shaluli 沙鲁里 Mountains. It is largely covered by the present-day Liangshan Yi Autonomous Prefecture 凉山彝族自治州 and also includes Panzhihua 攀枝花 City and adjacent parts of northwest Yunnan, specifically Ninglang 宁蒗 and Yongsheng 永胜 Counties (Figures 1 and 2; Plate Ⅳ). The area lies at the intersection of the Qinghai-Tibet and the Yunnan-Guizhou Plateau, and borders on the Sichuan Plain. The mountain ranges of western China emerged from the continuous movement of the Indian plate into the Eurasian since the early Tertiary (Cheng 2011; He and Ikeda 2007). Coupled with changes in climate and therefore vegetation and sediment, these movements have led to the emergence of a highly complex geological pattern (Sichuan Sheng di fang zhi 1992; Ma et al. 2002).

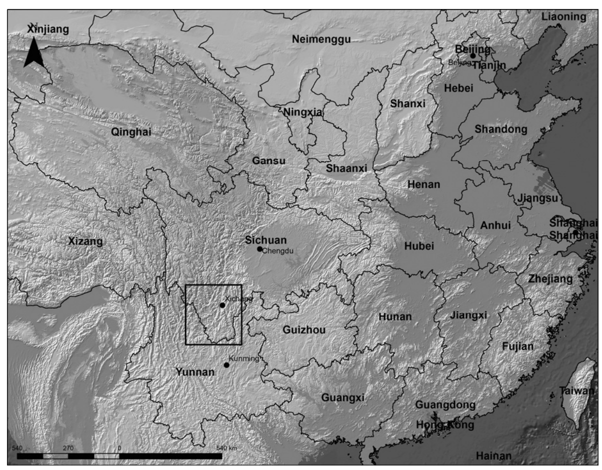

Figure 1. Location of the research area in China.

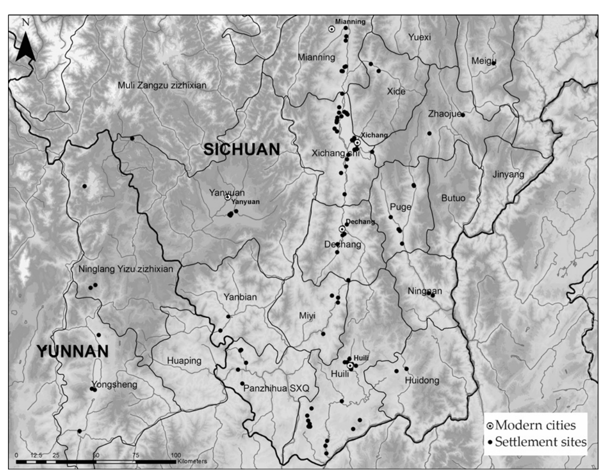

Figure 2. Map of the research area with county boundaries and settlement site locations.

The Liangshan region is a transition zone between the temperate flora of North China, the subtropical lowland flora of South China, and the subalpine highland flora of the Qinghai-Tibet Plateau (Sichuan zhi bei 1980: 341). The climate has marked dry and wet seasons with 90% of the rain falling between July and October, carried by the Southwest Asian monsoon. The annual variation in temperature is low, but fluctuates extensively throughout the day. The average temperatures for most areas lie between 14℃ and 18℃, but the temperatures are significantly lower in the Northeast and Northwest and increase toward the South (Chengdu di tu 2010; Sichuan Sheng ce hui ju 1981: 19–24).

Precipitation is generally ample, with an annual rainfall of 600–1400 mm, but unevenly distributed throughout the region. The highest precipitation is measured in the upper Anning River 安宁河 valley, the lowest in Yanyuan 盐源 County and along the Jinsha River 金沙江 in the South. Although water resources are generally abundant, the Northwest is rather dry. In modern times the Northeast has also suffered from dryness, as the annual precipitation cannot compensate for the deforestation-induced water runoff eroding the mountains (Wang 1993: 4–64). Latitude and elevation affect precipitation (Aldenderfer and Zhang 2004: 11), making it necessary to consider all these factors together when making determinations about local ecology and agricultural potential.

The paleoecology of the region is not yet well researched. The work that has been done on the Tibetan Plateau, Yunnan, and Guizhou suggests that Southwest China went through a slightly different paleoenvironmental development than other parts of China, reaching the Holocene optimum already at 11,000 cal. BP (An et al. 2000, Shen et al. 2006, Yu 2005, Yu et al. 2006). There was a decline in monsoonal intensity around 3550 BP (Dykoski et al. 2005) and cooling events around 4100–4000 BP (Dearing et al. 2008) and 3200 BP (Shen et al. 2006). Human influence altered the landscape as well, most significantly through processes of deforestation, intensification of agriculture, and subsequently erosion, particularly since the Han dynasty (Dearing et al. 2008; Elvin et al. 2002).

2.2 General trends and geo-climatic sub regions

The northeastern mountains—comprising Ganluo 甘罗, Leibo 雷波, Meigu 美姑, Yuexi 越西, and Zhaojue 昭觉 Counties—are cool, dry, and lack arable land.[1] Due to large-scale logging, the hillsides around the Zhaojue Plain are mostly deforested and eroded; the acidic yellow-reddish soils have lost most of their fertility and can only support hardy crops such as barley and potato. In the southern river valleys with an elevation below 1,000 m asl., fertile patches of reddish-purple soil allow for cultivating wheat, maize, and vegetables, but arable land is very limited. Given the wide range of elevation, the climate varies highly. The mountains experience long periods of heavy frost and temperatures that hardly ever reach 20℃, but the river valleys have a mild temperate climate. Besides timber, the northeast is rich in mineral resources, mainly copper, iron, zinc, limestone, dolomite, silver, and other metallic- and nonmetallic deposits.

The northwest—comprising Muli 木里, Ninglang, and Yanyuan Counties, and the mountains of Mianning 冕宁 and northern Yongsheng Counties—is dominated by towering north-south oriented mountain ranges of 3,500–6,000 m asl., intersected by a multitude of narrow river valleys cutting deep ridges into the landscape. At elevations of over 4,000 m asl., alpine cold desert and shrub meadow prevail, useful only as pastureland. The lower elevations of Muli in the utmost northwest are densely forested, but below 3,500 m, much of the forest has been cleared, leaving weathered and acidic reddish podzolic soil not very suitable for agriculture. Only the river valleys hold a few patches of lateritic soils supporting wheat and other hardy crops. Above 2,500 m, temperate climate brings cool, rainy summers and six months of heavy frost and snow, while some peaks remain snow-covered all year. Flat arable land is sparse

1. For example, Zhaojue County is dominated by high mountain ranges averaging 2,000–2,500 m asl. The highest peaks of 3,000–4,300 m asl. are largely barren or used as pasturelands.

and concentrated in the river valleys, especially in the depression of Yanyuan, which also has a more favorable climate, with cool summers, mild winters, and the largest amount of sunshine hours and sun intensity in the whole Liangshan region. The main resources the mountains provide are timber, medical plants, and rare species. Yanyuan is also rich in mineral resources (e.g., coal, iron ore, copper, granite, gold), especially salt.

The valley formed by the Anning River and its tributaries is the largest mountain plain in the Liangshan region. This area comprises Xichang 西昌 City, the northern part of Panzhihua Township, and Dechang 德昌, Mianning, and Xide 喜德 Counties. In its upper reaches in Mianning, the river flows in a narrow delta at high elevations of up to 4,000 m; in its middle reaches around Xichang it is surrounded by a wide plain at ca. 1,500 m asl., and in Miyi the elevation dips to below 800 m. This plain is the main agricultural strip of the Liangshan region, and the landscape has thus been transformed substantially by human hands. Rich purple soils are widely distributed and can bear up to two crops of wetland rice a year. The temperate climate, with marked wet and dry seasons, warm winters, mild summers, a high sunshine intensity, and abundant rain, allows for a large variety of produce, at present mostly rice, but also corn, wheat, and various kinds of vegetables and fruit.

The southeast—consisting of Huili 会理, Huidong 会东, and Ningnan 宁南 Counties—is similarly fertile. Towards the north, mountains of up to 3,000 m asl. prevail, separating this sub-region from the Anning River valley and the northeast. Toward the south, the ground slopes down significantly and the rivers flow through wide plains below 900 m asl. The southeast has a temperate-subtropical climate with short winters and mild summers. Amount and intensity of sunshine as well as rain are similar to the Anning River valley, but with even more well-marked rain- and dry-seasons. The area is very rich in mineral resources, especially bronze and tin, and the ground is very fertile, at present yielding up to three crops of rice.

The southwest—consisting of Panzhihua Township and Huaping 华平 and Yongsheng counties—has an average elevation of 600–900 m asl. The climate is subtropical with warm, frost-free winters, 2,300–2,700 hours of annual sunshine, and intense radiation. At the lowest elevations of Panzhihua, summer temperatures regularly rise over 40℃; it is thus the hottest place in Sichuan and also one of the driest, with an annual precipitation of about 800 mm and well-marked dry and rain seasons. At present, the economy of Panzhihua relies nearly entirely on the exploitation of its exceptionally rich mineral resources, especially iron ore and titanium, but also copper, zinc, silver, marble, limestone, and gold. Yongsheng and Huaping Counties, on the other hand, live mostly on agriculture. The major crops are wetland rice, to a lesser extent corn, winter wheat, and cash crops such as tobacco, sugarcane, tea, and coffee. Due to the high sunshine intensity and the warm, humid climate, here wetland rice can be grown at altitudes of up to 2,100–2,700 m, i.e., 500 m higher than in other regions (Yu 1984), but this only applies to the cultivation of modern-day varieties of rice (i.e., *O. indica*, temperate varieties of *O. japonica*, Champa rice) coupled with irrigation (d'Alpoim Guedes 2013: 274–275).

Based on an analysis of growing-degree days and risk of failure, during the Holocene Optimum only the middle reaches of the Anning River valley would have been suitable for growing temperate or tropical varieties of *O. japonica* (d'Alpoim Guedes 2013). Foxtail millet, on the other hand, could have been grown throughout the whole research area without major risks. Buckwheat and barley have an even higher tolerance for frost and dry climates and are indeed rather common in the Liangshan mountains at present (Gardner, Pearce, and Mitchell 1985). Nevertheless, at the Neolithic site of Haimenkou 海门口 in neighboring Jianchuan 剑川 County in Yunnan, there is evidence that wetland rice was grown along with foxtail and broomcorn millet, buckwheat, barley, wheat and other crops (Jin 2012; Yunnan Sheng, Dali zhen, and Jianchuan Xian 2009a and 2009b). As the proportions of rice at the site decreased over time and were finally replaced by wheat, d'Alpoim Guedes argues that rice was a short-lived experiment (d'Alpoim Guedes 2013: 272). The presence of a wide range of other crops at the same site shows that new crops were tested along with other plants to ensure that crops did not fail entirely. In the marginal environments of the Liangshan mountains, diversification would likewise have helped to minimize the risks that agricultural modes of subsistence pose.[2] Furthermore, we need to keep in mind that the many small ecological niches of the Hengduan Mountain Range provide a variety of resources that could have been exploited by hunting and gathering without a great need to shift to large-scale agriculture.

Even though past climate conditions are currently not entirely clear, it is reasonable to assume that the relative suitability for agriculture of the different regions would have been similar to present-day conditions. The main centers of early agriculture and settlement would thus have been the fertile Anning River valley, possibly the Yanyuan Basin, the wide plains of Huili, Huidong, and Yongsheng Counties, and to a lesser extent the river valleys in Zhaojue County. Rice agriculture was presumably restricted to the middle and southern reaches of the Anning River valley and other flat expanses of land in the south and the east. Medium-level forested mountain slopes throughout the area would have provided good ground for hunting and foraging, especially considering the great species richness characterizing the area. The widely available wild nuts with their high caloric density would have been a particularly valuable resource. A subsistence based on animal husbandry would have been an option in the mountainous northwest, and mixed forms of economy with potentially semi-permanent settlements or seasonal migration would have been a viable option in the mountainous parts of the whole region. How this environment was actually used in the past requires an evaluation of object assemblages in relation to local geographic preconditions.

3. Range of Materials and Analytical Approach

The material analyzed in this paper encompasses all known archaeological material from the research area pre-dating the intrusion of the Han during the AD 1st century, including Neolithic, Bronze Age, and Iron Age materials from 106 sites. The few radiocarbon dates available for the research area were obtained from single samples of charcoal, leading to inconsistent results (Jiang 2007). Therefore, the first comprehensive chronological scheme of the region that I recently suggested relies solely on evidence from stratigraphy, typology, and object comparison with securely dated sites from adjoining regions (Hein 2013). The majority of datable sites were found in the Anning River valley in the center of the research area, and they range from around 2400 BC to 200 BC while later periods up to AD 200 are mainly represented by megalithic graves (Table 1). Earlier settlement finds have been reported from the south, both from cave site and open-air sites, but securely-dated later settlement sites are less common here. In the northwestern and northeastern mountains research on settlement material is largely lacking and hardly any datable settlement remains have been discovered there. The availability of relevant material is therefore rather uneven between the sub-regions.

The accuracy of information on archaeological remains, their date, and their exact location varies widely from site to site. Of the 106 sites featured in this study, 33 (31%) have been excavated but most only partially (Appendices 1 and 2; Figure 3; Plate Ⅴ: 1). Furthermore, local settlements tend to have shallow cultural deposits with very few layers. A further issue hampering research on this region is the incomplete manner of publication. To obtain sufficient material, I therefore took part in various surveys and excavations at three sites; I also visited 23 additional sites in person and spent several months in local archives to collect original material from 58 sites. I conduct all analyses by both including and excluding questionable datasets, comparing both to computer-generated random points to judge the significance of the results.

2. For an overview of the ethnographic and historical literature on agricultural risk management and a discussion of the two main approaches to managing risk see Marston 2011.

Table 1. Chronological table for settlement finds from the Liangshan region (the dates of megalithic graves are provided for reference) (based on Hein 2013: Table 7.14)

Date	Anning River Valley	Northeast	Southeast	South and Southwest
Late Paleolithic			Huili Yangjia Wuji	Renhe Huilongwa and Xicaoping caves
Neolithic			Huili Houzidong	Xiqu Yanwan Renhe Gonghe
	Dechang Maojiakan		Huili Hewanwan, Liantang, Tangjiaba, Tianbacun	Renhe Yangjiashan
	Dechang Wangjiaping (2470–2270 BC) Xichang Henglanshan 4 (2575–2480 BC)		Huili Guantianshan/ Yingpanshan	
	Xichang Henglanshan 3 (2150–2030 BC)			
	Xichang Ma'anshan, Qimugou Ⅰ, Lower Yingpanshan			Yongsheng Duizi Ⅰ
	Xichang Lizhou (early)	Puge Tianba, Zhongcun	Huili Dongzui Ⅰ	
Early Bronze Age /Shang (1600–1046 BC)	Xichang Dayangdui (early) Xichang Yangjiashan Gaopo (1410–1050 BC)	Puge Xiaoxing-chang	Huili Dongzui Ⅱ	Yongsheng Duizi Ⅱ?
Western Zhou (1046–771 BC)	Dechang Dongjiapo Xichang Dayangdui (middle), Mimilang Mianning Zhaojiawan (1390–840 BC)	Puge Wadaluo		Yongsheng Duizi Ⅲ?
Spring and Autumn (771–476 BC)	Megalithic Graves Ⅰ Xichang Dayangdui (late)			
	Megalithic Graves Ⅱa Xichang Yingpanshan (upper)		Huili Fenjiwan Ⅰ	
Warring States (475–222 BC)	Megalithic Graves Ⅱb		Huili Fenjiwan Ⅱ	
	Megalithic Graves Ⅲa Xichang Qimugou Layer 3 Dechang Wangjiatian Mianning Sanfentun		Fenjiwan Ⅲ	
Qin (221–206 BC)	Megalithic Graves Ⅲb		Huili Washitian?	
Han (206 BC–AD 220)	Megalithic Graves Ⅳ			Yongsheng Duizi Ⅳ

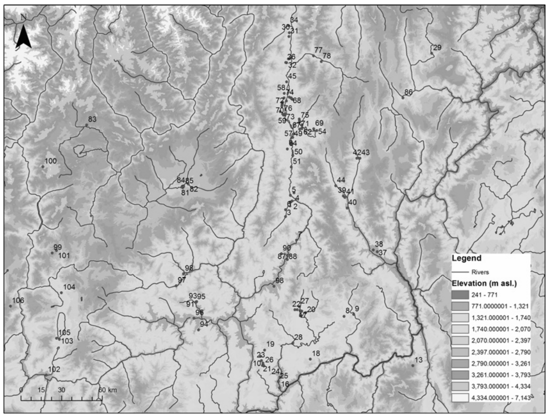

Figure 3. Location of settlement sites in the research area (for list of sites by number consult Table 1).In the following, a detailed analysis of the lithic assemblages is combined with an evaluation of the ceramic material and geospatial analysis to infer on past subsistence practices. The main aim of both lithic and ceramic analyses is to determine object function. I then use the combination of functional types at each location to infer on site functions. In a third step, I apply statistical and spatial analyses to infer on the relative frequency of various kinds of features and object types at different sites and their relationship to the local environment.

4. Ceramic Analysis

The main functions of ceramic vessels include: **food preparation** (with or without heat), **storage** (for longer or shorter periods of time), **serving** (for a single person or for groups), and **transport** (for long or short distances) (Juhl 1995; Longacre 1991; Nashinski 2001; Skibo 1992; Rice 2005). The main factors influencing practical usage are capacity, stability, accessibility of content, transportability, resistance to mechanical/ thermal stress, and porosity.

Most of these factors are difficult to measure. Determining the center of gravity, for example, requires complex calculations, while ascertaining relative "graspability" seems to be rather subjective. Although several authors have tried to devise schemes of correlation, these remain fairly coarse and account only for a small number of basic vessel functions (e.g., Rice 2005: Tab. 7.2; Smith 1985). It follows, therefore, that an estimate of function must still be based on a relatively small number of measurements and overall visual assessment. What can be ascertained, however, is the range of variables that can give indications as to vessel function.[3]

The variables recorded in this study comprise: **raw material and technical details** (ware texture, color, temper, manufacture technique, surface finish, hardness), **object form** (body profile, opening, rim, lip, neck, shoulder, base, lid, handle number and shape, spout shape), **object measurements** (used to infer on proportions and size categories), and **use wear** that could be ascertained through macroscopic analysis.

Statistical analysis including combine descriptive statistics, combination statistics, and visual assessment of object form and use wear can then be used to ascertain object function for ceramics as well as stone tools. To ascertain object function, I combine descriptive statistics, combination statistics, and visual assessment of object form and use wear. The form of vessel rims, tool handles, and working edges, as well as the raw material used and the ways in which it was employed, inform about the range of potential uses; observation of use wear help to ascertain actual handling patterns. Descriptive statistics and graphs allow differentiating between different size classes for various vessel forms, and combination statistics helped identifying recurrent variable combination and ascertain object types. The combination of these attributes allows ascertaining object function that can help to infer on site function and economic patterns.

4.1 The ceramic assemblage

The reported ceramic assemblage consists of over 5,500 vessels and vessel fragments from 74

3. This list was compiled with reference to technological studies of ceramics largely based on ethnoarchaeological research, microscopic analyses, and experimental archaeology (Orton, Tyres, and Vince 1993; Rice 2005; Shepard 1968; Sinopoli 1991; Skibo 1992; Smith 1985 and 1988). Aside from these variables, which can be ascertained through simple measuring and macro observation, there is a large array of micro-analytical procedures that can provide further clues (Barnard and Eelkens 2007, Quinn 2013, Scarcella 2011, Vieugué 2014). Given the large body of material, these avenues remain to be explored in various future studies.

sites, but these numbers are highly skewed as over 4,000 of these were reported from Dechang Maojiakan 毛家坎 alone; several hundred ceramic items each came from Dechang Wangjiatian 王家田 and Xichang Qimugou 棲木沟 respectively, while only vague notions of the presence of "few" or "many" objects of certain types have been published for another 58 sites. To balance out this unevenness of information, I compare absolute numbers and percentages as well as the general presence/absence of ceramic forms and technical details at the various sites. Collating the material from my field research and publications, I was able to collect detailed information on 1,114 ceramics from 28 sites. This sample is large enough to conduct typological, functional, and statistical analyses.

4.2 Raw material and technical details

Most of the ceramic assemblage consists of coarse sand-tempered pottery. Fine ware usually makes up only a very small percentage of the ceramic material of any given site, typically below 2% and rarely over 10%, with most of it appearing in later layers (e.g., at Xichang Qimugou and Yangjiashan 杨家山). Fine ware occurs only at a few sites throughout all layers and features in similar percentages, most remarkably at the middle Bronze-Age site of Xichang Mimilang 咪咪啷, whose ceramics also differ markedly in form and decoration from those found at earlier sites around Xichang. The occurrence of fine ware is thus likely a chronological marker, and an indicator of a later differentiation between coarse and fine ware.

Vessels of both coarse and fine material are usually hand-formed, the larger ones coil-built, and only very few might have been produced on a wheel, most of them fine ware (Figure 4; Plate Ⅵ). While the fine ware is mostly grey or black, the coarse ware is mostly of reddish color, reflecting an oxidizing firing atmosphere. Only the ceramics from Dechang Maojiakan and most sites in the southeast are yellowish in color, indicating the use of a particular local raw material source. Many specimens from all sub-regions are mottled in color showing that the firing atmosphere was not well-controlled; this is consistent with the use of simple pits such as those reported from Xichang Lizhou 礼州 (Figure 5). However, such pits cannot produce a reducing atmosphere or high temperatures, so the few known black or grey ceramics must have been fired in more complex kilns. While the earliest high-fired dark-bodied ceramics found at Xichang Qimugou show clear Qijia 齐家 Culture (2400–1900 BC) influence and might have been imported, later objects from the same site have strong local characteristics.[4] These later wares are nevertheless high-fired and dark in color; it is therefore clear that complex kilns must have existed here as least from Middle Qimugou onward (1000–700 BC).

As far as surface finish is concerned, burnished/polished vessels have been reported from eight sites.[5] Vessels with black slip were found at only six sites.[6] Black slip is very rare, and is often combined with high polish as seen at Xichang Dayangdui, Qimugou, and various sites in Puge. Both kinds of surface finish are mainly found with small forms (bowls, cups, goblets, vases) fired at medium to high temperatures and in a reducing atmosphere. Burnishing/polishing alone or combined with a neutral-colored slip, on the other hand, can occur with stout jars as well and even with large urns. In these cases, this finish might have served to seal the surface and prevent leakage when storing liquids, or the intrusion of water when storing grains. For bowls, goblets, and vases, which might have served as fine tableware and/or for holding liquids, the purpose might have been both decorative and practical.

4. For a discussion of migration movements and cultural exchange throughout the Liangshan region consult Hein 2014.

5. These sites are Dechang Dongjiapo 董家坡 H4, Mianning Gaopo 高坡 Layer 3, Puge Wadaluo 瓦打洛, all layers of Xichang Henglanshan, Lizhou, Mimilang, Ma'anshan 马鞍山, and Yingpanshan 营盘山.

6. These sites are Huili Houzidong 猴子洞, Mianning Gaopo, Ningnan Tangjiawan 唐家湾, and Xichang Henglanshan, Lizhou, and Qimugou.

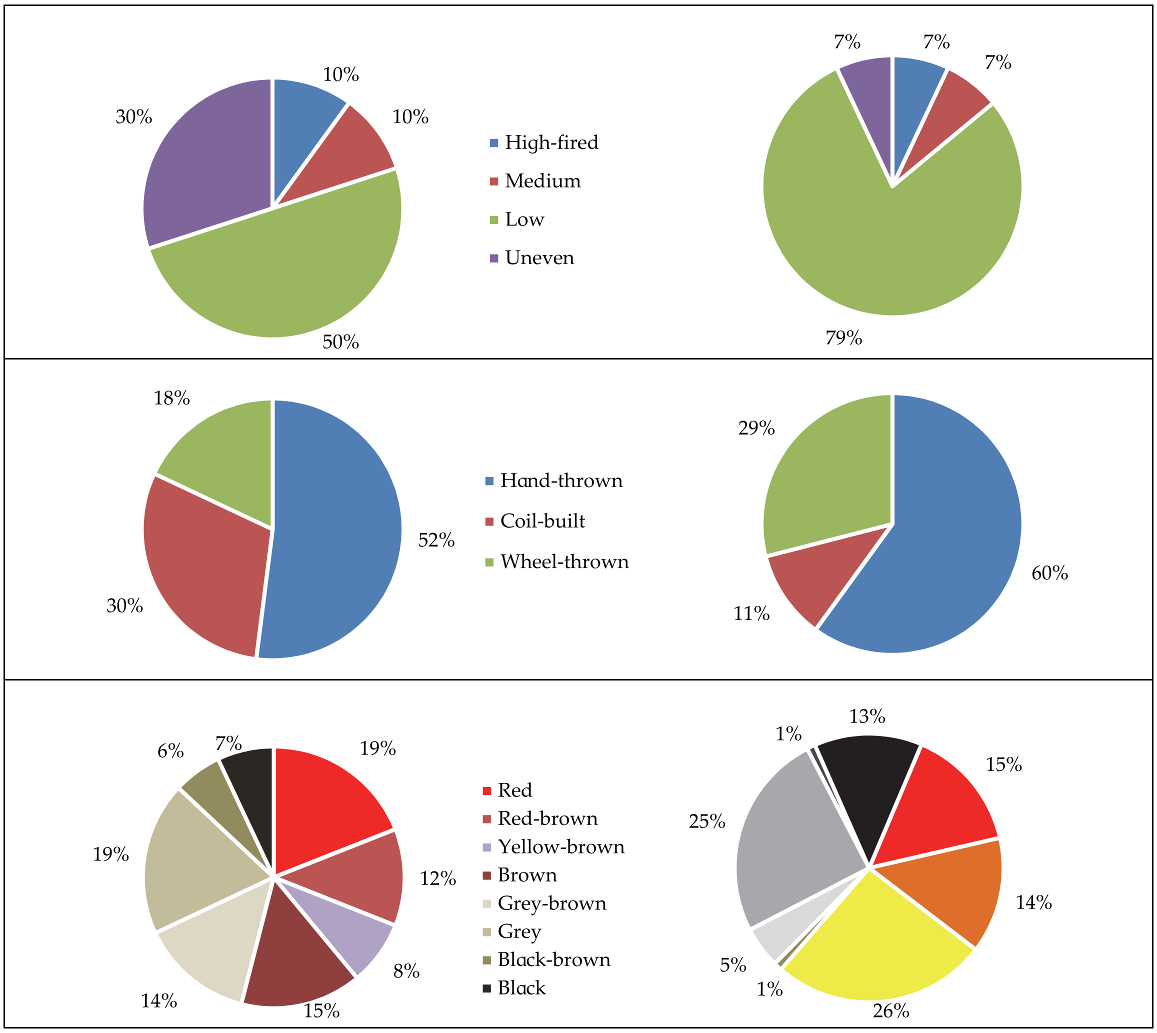

Figure 4. Relative frequency of various technical properties of ceramics from settlement sites by presence/absence (left) and number of vessels (right).

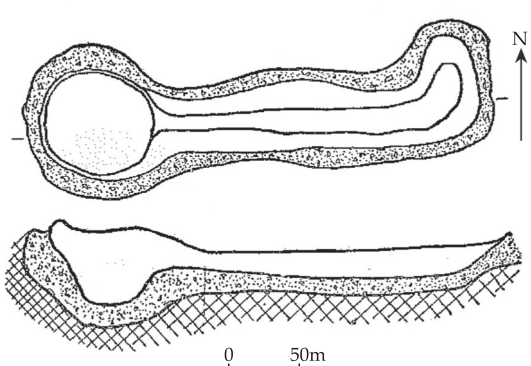

Figure 5. Kiln BY1 at Xichang Lizhou (after Lizhou 1980: fig. 4).

4.3 Object forms and usage

Open-mouthed vessels with constricted necks and rounded or high-ellipsoid bodies and flat bottoms are most common (Figures 6–8). Ring-foot vessels appear at a limited number of sites, mostly in the Anning River valley, and even there only in some layers, indicating regional as well as chronological differentiation.[7] Overall, the most common types are large coarse *guan* 罐 jars and urns; they by far outweigh all other object types, occur at all sites

7. Ring-foot vessels are most prominent at Xichang Qimugou Layer 3, where they occur together with high pedestals and flat bottoms. Such pedestals as well as trumpet-shaped ring-feet are also common in Mianning Gaopo and Zhaojiawan 赵家湾, as well as in Maojiakan Layers 4 and 5. High stems were also reported from Xichang Yangjiashan, and shorter ring feet appeared at Dechang Wangjiatian 王家田, Mianning Sanfentun 三分屯, and Xide Wadegu 瓦得姑. Xichang Mimilang and Henglanshan, each one ring-foot was found, but only in the surface collection, so they might be of a later date than most of the material from the site.

and in settlement layers (Figure 9). They mostly have rim diameters of 20–30 cm, making them useful as serving or storage vessels. Some are a little smaller (10–20 cm rim diameter), allowing for a usage as drinking vessels. A few vessels also reach diameters of up to 38 cm. These large vessels are often burnished and/or have a slip preventing leakage or intrusion of water. They were thus likely used for long-term storage of grains, liquids, or food items with a liquid proportion such as certain kinds of preserved foods. Particularly large specimens were observed in the center of the Anning River valley. Considering their size, these vessels were likely not moved much, indicating a sedentary mode of living of their users. Many sites, however, held only medium-sized vessels that were more easily transportable.

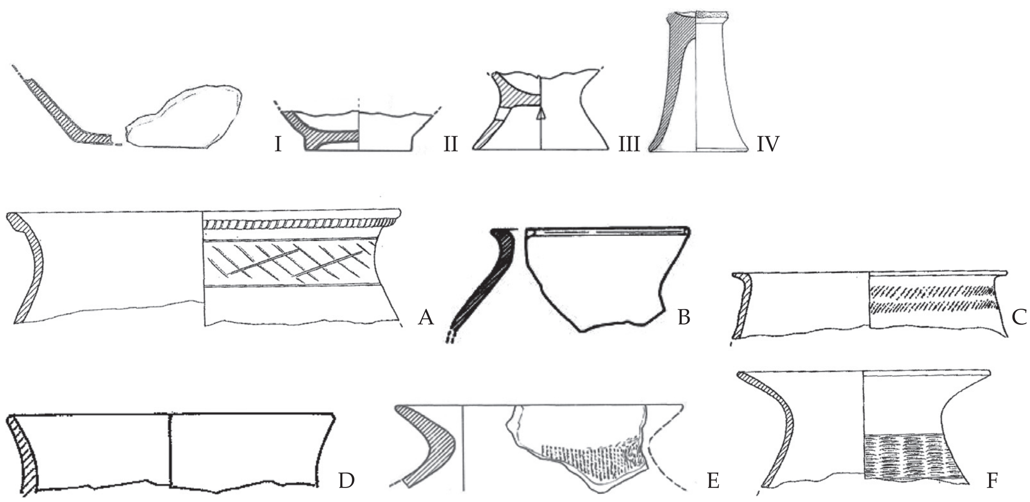

Figure 6. Vessel bottom types Ⅰ (XWNM1.23 [Sichuan Sheng, Liangshan, and Xichang Shi 2006a: Figure 76.6]), Ⅱ (XYUM1.5 [Sichuan Sheng, Liangshan, and Xichang Shi 2006a: Figure 76.14]), Ⅲ (XYPW11.2 [Chengdu, Liangshan, and Xichang Shi 2007: Figure 16.3]), Ⅳ (XQGM1.16 [Chengdu, Liangshan Zhou, and Xichang Shi 2008: Figure 7.6]), and rim types A (XHS3.30 [Chengdu, Liangshan, and Xichang Shi 2006: Figure 14.14]), B (DWT3.12 [Sichuan Sheng and Liangshan 2006: Figure 9.1]), C (XHS3.59 [Chengdu, Liangshan, and Xichang Shi 2006: Figure 15.4]); E (XGSM1.16 [Sichuan Sheng, Liangshan, and Xichang Shi 2006a: Fig. 75.9]); D (HDJH5.6 [Sichuan Sheng, Liangshan, and Huili Xian 2009: Figure 13.3]); XHSH3.10 (Chengdu, Liangshan, and Xichang Shi 2006: Figure 12.5).

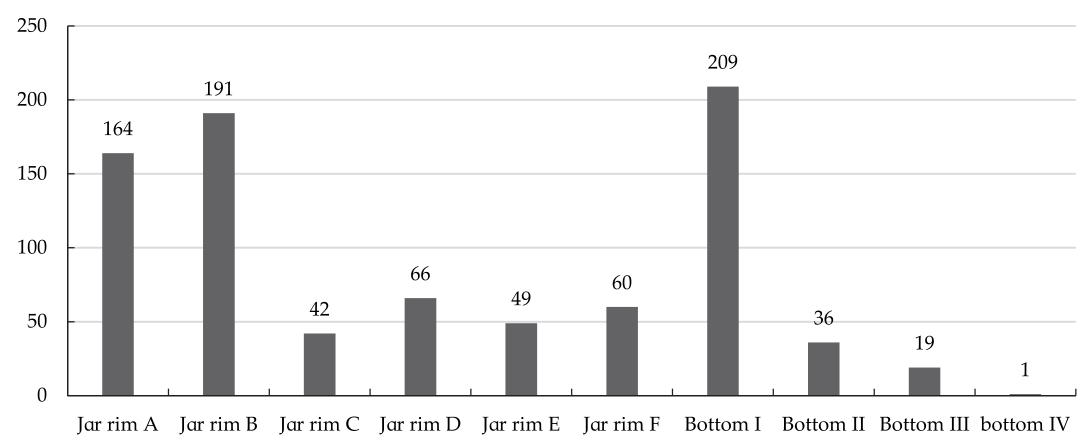

Figure 7. Frequency of various rim and bottom forms at settlement sites.

Rims: Type A: curved outward-flaring rim; Type B: angular everted rim; Type C: short rectangular everted rim; Type D: straight upward-pointing or slightly everted rim, no neck; Type E: dish-shaped rim; Type F: trumpet-shaped outward-flaring rim/neck;

Bottoms: Type Ⅰ: flat bottom; Type Ⅱ: ring foot; Type Ⅲ: pedestal base; Type Ⅳ: round bowl-shaped foot with narrow stem.

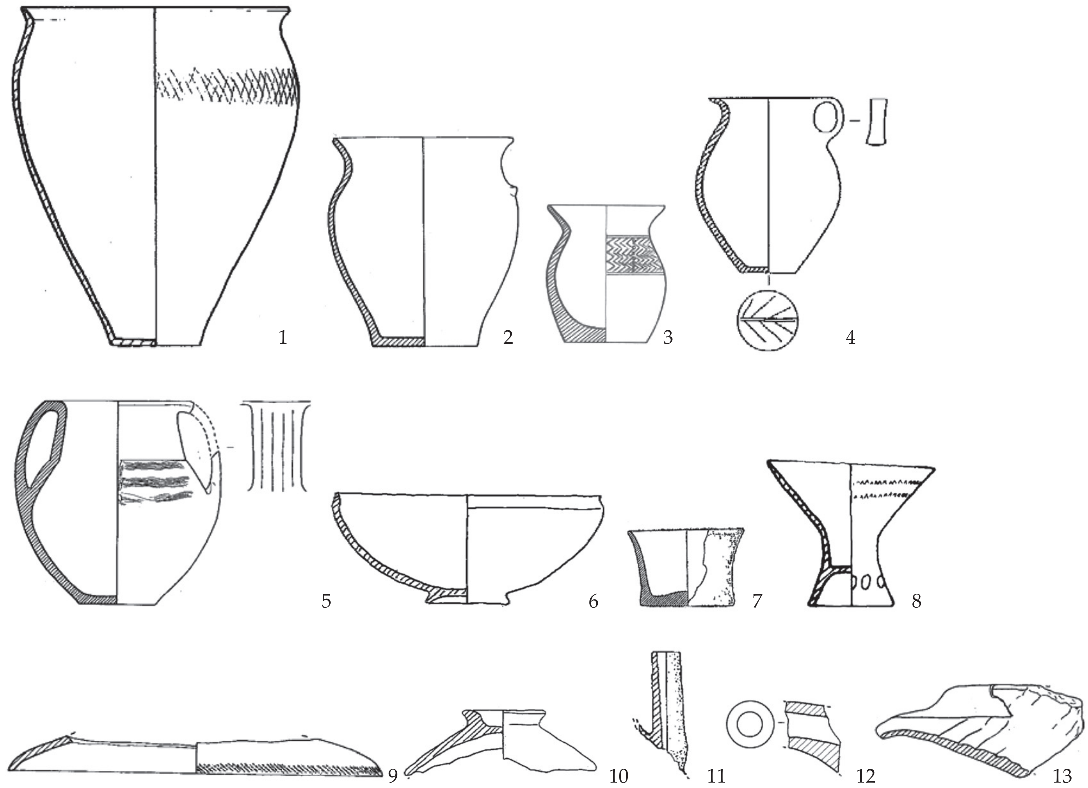

Figure 8. 1. XYPW3.1 (Chengdu, Liangshan, and Xichang shi 2007: Fig. 8.3); 2. HFJ76 (Huili Xian, Liangshan, and Sichuan Sheng 2004: Fig. 4.3); 3. XLHC3 (Sichuan Sheng, Liangshan, and Xichang Shi 2006a: Fig. 63.4); 4. HFJM3.1 (Huili Xian, Liangshan, and Sichuan Sheng 2004: Fig. 11.9); 5. YGJC210 (Liangshan and Chengdu 2009: Fig. 4.1), 6. MGP3.6 (Drawing by author); 7. PXC0.8 (Liangshan and Puge Xian 1982: Fig. 4.10); 8. XDYH2.1 (Xichang Shi, Sichuan Sheng, and Liangshan 2004: Fig. 25.3), 9. XHS3.73 (Chengdu, Liangshan, and Xichang Shi 2006: Fig. 15.9); 10. XMI3.38 (Liangshan, Chengdu, and Xichang Shi 2006: Fig. 10.6); 11. XHS0.15 (Xichang Shi wen wu 1998: Fig. 4.7); 12. XMS5.3 (Chengdu, Liangshan, and Xichang Shi 2007: Fig. 21.3); 13. MGP3.61 (Drawing by author).

Large to medium-sized storage vessels are usually combined with smaller jars likely meant for serving and communal consumption, and bowls, either for serving or for single person consumption. They comprise mostly smaller jars with or without handles and various types of bowls, mainly *bo* 钵 with a slightly inward-curving rim and less often a few open *wan* 碗 bowls. Basins occur only infrequently with no discernible distribution pattern. The same applies to the occurrence of small *bei* 杯 cups, goblets, beakers, and other potential drinking vessels. Bowls might have served as tableware as well. Overall, small forms for personal usage are rare, suggesting that it was customary to eat and drink from large communal vessels, or that individual cups and plates were made of organic material and were not preserved.

Handled jars occur only at a limited number of sites.[8] Not surprisingly, knobs and lug handles that may have lent support to a thread wound around the body for easier shifting exclusively occur on particularly large vessel forms. Band handles attached to small or middle-sized vessels are limited to later cultural layers commencing with the early phases of Xichang Qimugou and then particularly sites associated with megalithic graves, indicating a chronological marker. Overall, band handles appear only at a small number of sites, mainly along the Anning River and in Huili in the southeast, while lug handles and knob applications have been reported exclusively from the

8. Dechang Wangjiatian, Huili Dongzui 东咀, Mianning Sanfentun, Xichang Dongjiapo, Mimilang and Qimugou, Dechang Dongjiapo, Mianning Zhaojiawan, Puge Tianba 田坝 and Zhongcun 中村, and Yanyuan Jiaodingshan 娇顶山.

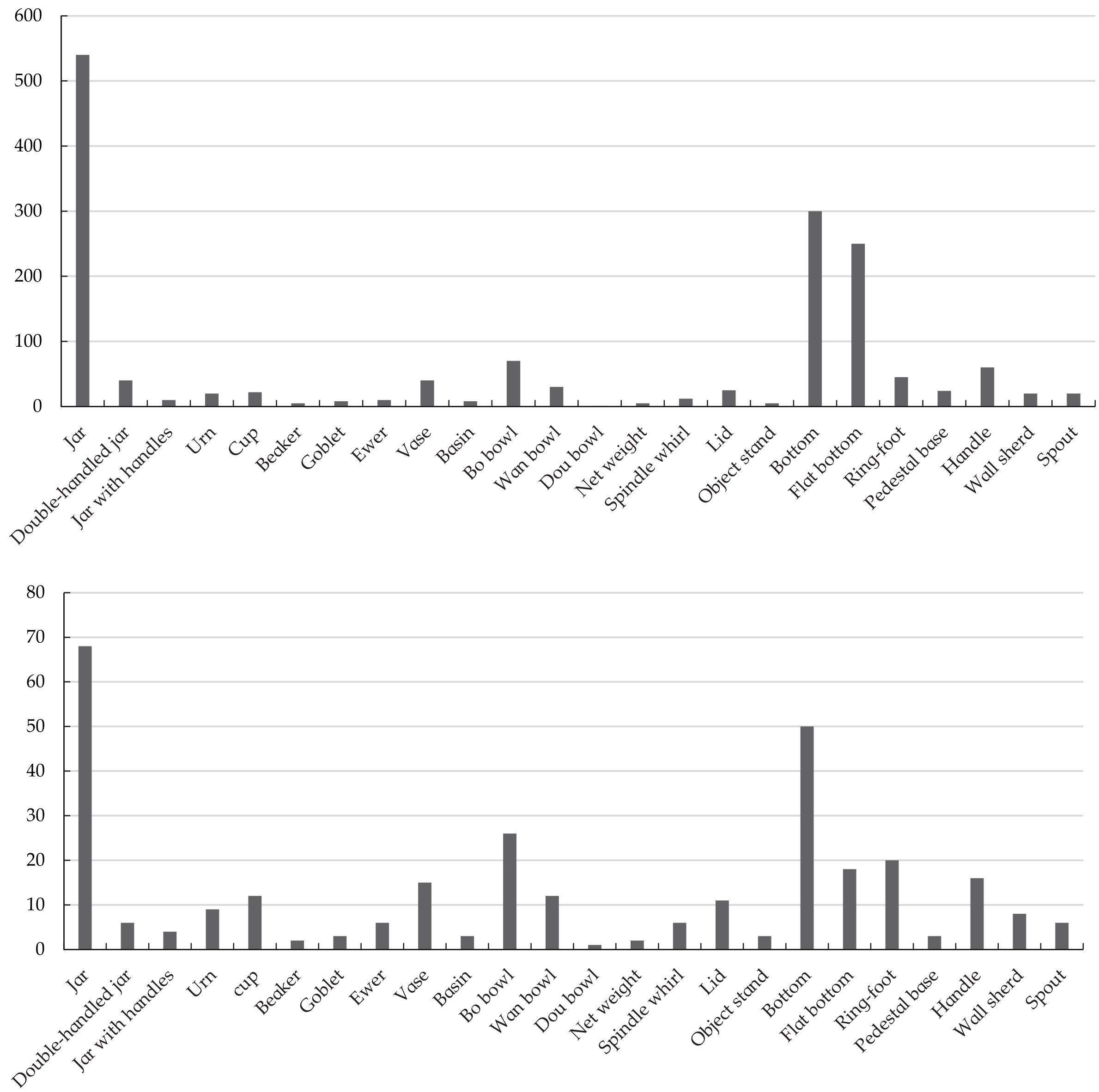

Figure 9. Number of ceramic objects of the various types found at settlement sites, by absolute number (top) and presence/ absence (bottom) (n=1097).

northern and southern extreme of the Anning River valley (i.e., Dechang and Mianning) and from Huili in the Southeast. This indicates regional differences in domestic vessel assemblages and, we may infer, in ways of living.

Spouts and ewers used for pouring of liquid (presumably into cups or bowls for single consumption) are even rarer, occurring in small numbers only at Mianning Gaopo, Xichang Henglanshan, Lizhou, Ma'anshan, and Qimugou. While the spouts found in Xichang are all tubular-shaped, of medium length, and usually attached at a 45° angle, those in Mianning are extremely large, coarse, coil-built, and conical or horn-shaped. What kind of vessels they may have belonged to is unclear, but it is obvious that they were rather different in function from the small, fine spouted ewers and vases from Xichang.

Vase-shaped ceramics and wide outward-flaring rims, which might also have been used for pouring liquids, have been observed throughout all of the Anning River valley and even in Puge and Huili in the east; however, both vases and ewers as well as single-serving cups, small bowls, and goblets are much more common in graves than in settlements. In the megalithic graves of the Anning River valley, they often occur in sets with one serving vessel and several cups or bowls, presumably meant to be used in drinking rituals performed at the grave (Hein 2013). Such utensils and customs may therefore have been restricted to mortuary practices but were not common in everyday life.

Bowl-shaped lids with knob handles and object stands are rare; they have only been reported from a few sites in Xichang and Dechang. Only one ceramic net weight was found in Xichang Qimugou, and ceramic spindle whorls are known from a few sites throughout the Anning River valley, but spindle whorls made of stone are very common (Figure 10). Their distribution will be evaluated below together with other tools made of stone and bone.

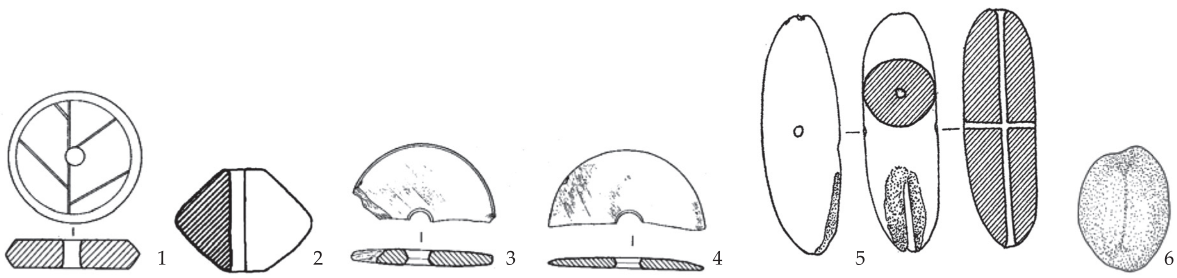

Figure 10. 1, 2. Ceramic spindle whorls (XMI5.13 [Liangshan Yizu et al. 2006: Figure 8.6], MST0.2 [Liangshan and Mianning Xian 20062006: Figure 6.2]); 3, 4. stone spindle whorls (DDP3.66 [Zhou Zhiqing 2011: Figure 20.2]); 5, 6. ceramic net weights (XQG3.30 [Chengdu, Liangshan Zhou, and Xichang Shi 2008: Figure 14.5], XBBM6.8 [Sichuan Sheng, Liangshan, and Xichang Shi 2006a: Figure 66.9]).

4.4 Decoration

The majority of the ceramics (80–90%) are undecorated, and at 28 sites no decorated sherds were found at all. The lowest percentages of decoration are reported from the early Neolithic site of Dechang Maojiakan (below 1% for all layers), followed by Xichang Yingpanshan Layer 5 (2%; middle Neolithic), while Xichang Qimugou has the largest amount of decorated ceramics throughout all layers (17.9–19.5%, early to middle Bronze Age), followed by Xichang Mimilang Layer 4 (10.1%, middle Bronze Age). This distribution pattern indicates a chronological development from less to more decoration as time progresses.

The most common decoration techniques are impressions, incisions, and applications (Figure 11; Plate Ⅶ). The main fields for decoration placement are directly under the rim, on the neck and shoulders, sometimes on the bottom, and rarely on the lip or body. About 40% of the decoration is placed on the upper part of the vessel, indicating a view from a sitting position on the floor or looking from above when standing, but not from below as it would occur when placing objects on a shelf or pedestal. The most common decorative programs are finger-tip impressed horizontal clay-strips below the rim, and various combinations of incised lines, impressed points, or corded-ware pattern on lip, neck, or shoulder, sparingly applied.

Decoration right below the rim, mostly in the form of clay-strips running around the whole vessel, might have a practical as well as a decorative function, reinforcing the rim and improving graspability. Although very prominent in frequency, finger-tip impressed appliqué bands are restricted in their distribution. They are reported nearly exclusively from settlement sites and mostly in early layers of sites in the Anning River valley and more rarely in the southeast.[9] This decorative motive is therefore a local particularity and a chronological marker. Incised lines, corded ware, point designs, and net patterns, on the other hand, are widely dis-

9. Most prominently among them are Xichang Henglanshan, but also Ma'anshan, Yingpanshan, Qimugou layer 3, Dechang Maojiakan, Huili Houzidong and most other sites in Huili.

tributed. Leaf-vein impressions on the bottom are very common as well, but might be the outcome of placing the freshly-formed vessels on leaves to dry (thus preventing them from sticking to the ground), rather than an actual decoration. That these impressions can be observed on pottery from sites throughout all parts of the research area may nevertheless indicate shared technological traditions.

5. Stone Tool Analysis

One major issue with analyzing lithic assemblages is that the process of abandonment differs between different types of sites. Additionally, on surveys in China artifacts are mostly not collected systematically but only objects deemed representative are kept. As much of the material in this study stems from surface collections, the absence of specific tool types never proves their overall absence at the site in question. Inferences based on the material analyzed here can therefore only be preliminary and have to be tested through further excavations.

Considering the large number of technical constraints connected with the production of stone tools, raw material and production technique are essential criteria in organizing the corpus of material at hand and receive most attention in this study. Many aspects of object form are related to function in the technical sense as well. Assigning function in a reliable mechanical way is therefore difficult or impossible. This is especially true for flaked stone tools that were often multi-purpose objects. For most ground stone tools and core tools worked with both flaking and grinding, however, intended function can be much more reliably assigned. As the majority of the material from the research area consists of ground-stone tools, it is therefore possible to make suggestions as to likely functional types (Adams 2002; Andrefsky 1998; Odell 2004; Semenov 1964; Whittaker 1994); however, ideally these suggestions should later be tested through microscopic analysis and experimental tests. Based on previous archaeological, experimental, and ethnographic research (Adams 2002, Bennett 2002, and Cunnar 2007), I suggest the following list of functional categories: **woodworking** (axe, adze, hammer, chisel), **planting** (plow, shovel), **harvesting** (knife, sickle), **food processing** (millstone, grinding stone, pestle, handstone), **tool and object production** (drill, saw, awl, groove abrader, polishing stone, anvil, scraper, point, hammer), **spinning and weaving** (spindle whorls, other weights, needles) **fishing, hunting, warfare** (net weight, projectile point, knife, axe), **ritual objects** (natural stone, figurine), and **personal ornament** [pendant, earring, bracelet, finger ring, (hair) needle, bead].[10]

While formal analysis can provide some indicators of intended usage, inferences on actual use require use-wear analysis, preferably microscopic observations and residue analyses, which were not possible for this body of material. Nevertheless, macroscopic observations allowed me to identify coarse traces of use-wear such as striations or grinding and percussion marks. The overall object form provided indicators for object function as well.[11] Stone material types were assigned by visual impression, so it was not possible to distinguish between all different subtypes of the large categories of igneous, sedimentary, and metamorphic rock; however, I could identify distinctive materials such as slate, serpentinite, sandstone, limestone, quartzite, chert, and a single piece of obsidian.

As far as suitable raw material is concerned, different types of sandstone, some associated with limestone and volcanic rock deposits, are most widely distributed in the Liangshan region.[12] A few volcanic deposits, embedded in sandstone or psepholite, are dispersed throughout the region, but obsidian deposits have not been reported. Small scattered deposits of basalt exist in adjacent parts of Yunnan. Serpentinite occurs only on the northwestern rim of the

10. Further categories not relevant for the purposes of this study include containers (identifiable by smoothness and overall shape), and structural stones (identifiable by size, stability, form, and possibly visual appeal).

11. A seminal study on prehistoric technology was written by Semenov (Semenov 1964). For more recent literature consult Whittaker 1994, Odell 2004.

12. Consult maps in Ma, Qiao, and Liu 2002: 278–279 and 311–312.

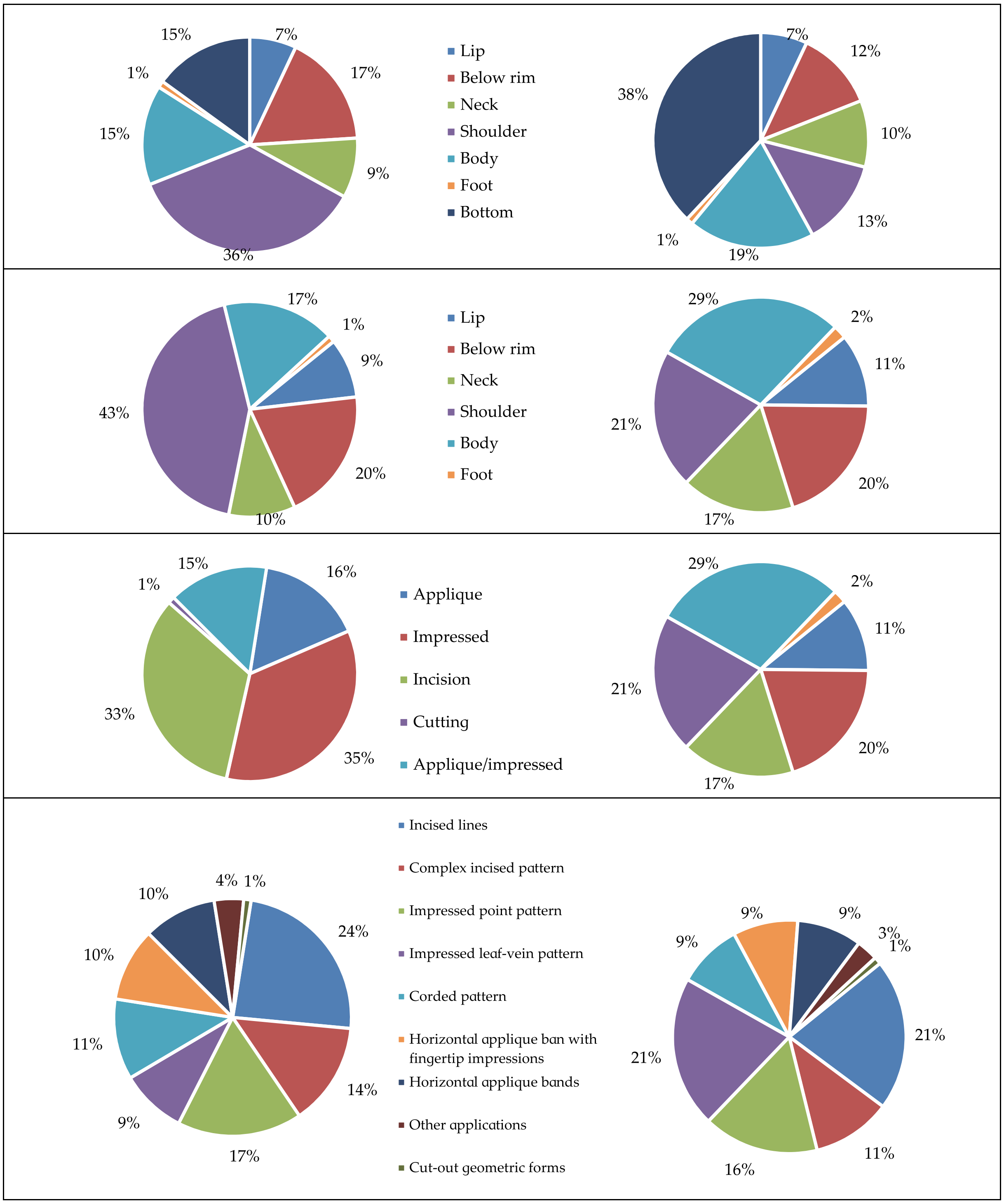

Figure 11. Frequencies by presence/absence (left) and absolute number of vessels (right): a. decoration placement; b. decoration placement excluding bottom decoration; c. decoration techniques; and d. decorative programs.

Chengdu Plain, as well as in the far west of Sichuan on the border to Tibet. Flint or chert has not been recorded, but large deposits of quartz diorite are known from Panzhihua and along the full extent of the Anning River. Overall, flakeable stones are rare, while grindeable material and coarse-grained stones with abrasive qualities are widely available. Additionally, the rivers contain naturally smoothed cobbles that could be used as tools without reshaping or they could serve as cores for the production of various types of tools. Besides stones, bones have sometimes been used as raw material for tools as well.

5.1 The tool assemblage: lithics and bone objects

Most tools were made of stone, but three sites yielded limited numbers of bone tools.[13] The overall lithic assemblage recorded for this study consists of 1,868 objects, but 1,021 of them were only listed in brief reports, while details on measurements and form could be obtained for 847 specimens (Figures 12–14; Table 2). The actual number of objects was probably much higher, as for many sites only a few examples were published and the overall numbers are rarely provided. Although this level of detail is not suitable for fine-grained statistical calculations of exact percentages, it still provides an indication on "much" vs. "little," especially when conducting intra-site comparison. 1,160 of the 1,868 reported stone objects were primarily worked through grinding and 708 primarily through flaking. The number of flakes and microliths is very small, comprising 151 specimens from seven sites,[14] while all other stone tools (flaked and/or ground) are core tools. Nevertheless, as the excavation area varies greatly from site to site, these absolute numbers are not a reliable basis for statistical analyses. It is remarkable that the overall number of flake tools reported is high, but the number of sites at which they occur is small. The same holds true for hunting and fishing tools and grinding equipment. By absolute number, woodworking tools outweigh all other types, followed by possible agricultural tools, percussion tools, multi-purpose flake tools, and grinding tools, while tools for clothing and tool production are less frequent, and decorative items are very rare, as can be expected from settlement sites (Figure 12; Plate Ⅷ: 1; Table 3). In graves, however, stone beads and pendants are very common (Hein 2013). Additionally, a fair amount of half-products and fragments have been reported, indicating on-site tool production.

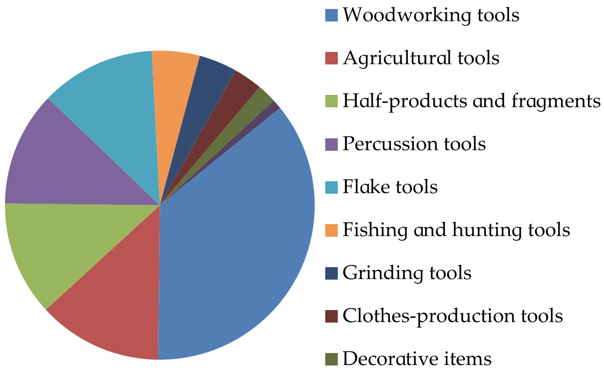

Figure 12. Relative frequency of stone tools by type throughout all sites.

5.2 Woodworking tools

The main woodworking tools are axes, adzes, and chisels. The adzes are smaller and more finely polished than axes, but otherwise rather similar in form.[15] Although the axes are coarser, for both object types most traces of the initial flaking process have been ground away and the blades are well-polished. There is no apparent correlation between artifact size, form, and degree of grinding and polishing, but there is some correlation between all these factors and the choice of stone material (Tables 4–7). The few chert and basalt specimens are all highly polished axes. Igneous rock, basalt, or serpentinite were used for both axes and adzes polished to varying degrees. Gabbro was only coarsely worked and used for medium-sized axes, while slate was less commonly employed and nearly exclusively for adzes of small or medium size.

Chisels are on average more finely polished than axes or adzes and differ in form: they are

13. Bone objects have been reported from Renhe Huilongwan 回笼湾, Yongsheng Duizi 堆子, and Ninglan Jinyangcun 金杨村. For Jinyangcun, it has been reported that bone hammers and needles as well as other tools of ram's horns and deer antlers have been found, but at Yongsheng Duizi, bone was only used for personal ornaments.

14. These sites are Dechang Maojiakan, Wangjiatian, Huili Yangjia Wuji 杨家屋基, Renhe Gonghe 仁和共和, Huilongwan 回笼湾, and Xicaoping 席草坪, and Xiqu Yanwan 西区岩湾, all of them except for Renhe Xicaoping and Xiqu Yanwan contain microliths.

15. Axes have average measurements of 11.6 × 5.8 × 2.6 cm (lengths between 6.0 cm and 28.3 cm); for adzes the average measurements are 7.1 × 4.0 × 1.3 cm (lengths between 3.8 cm and 17.0 cm). The main distinguishing criterion between these two types is the cross-section shape of the working edge (Semenov 1964: 126–134)

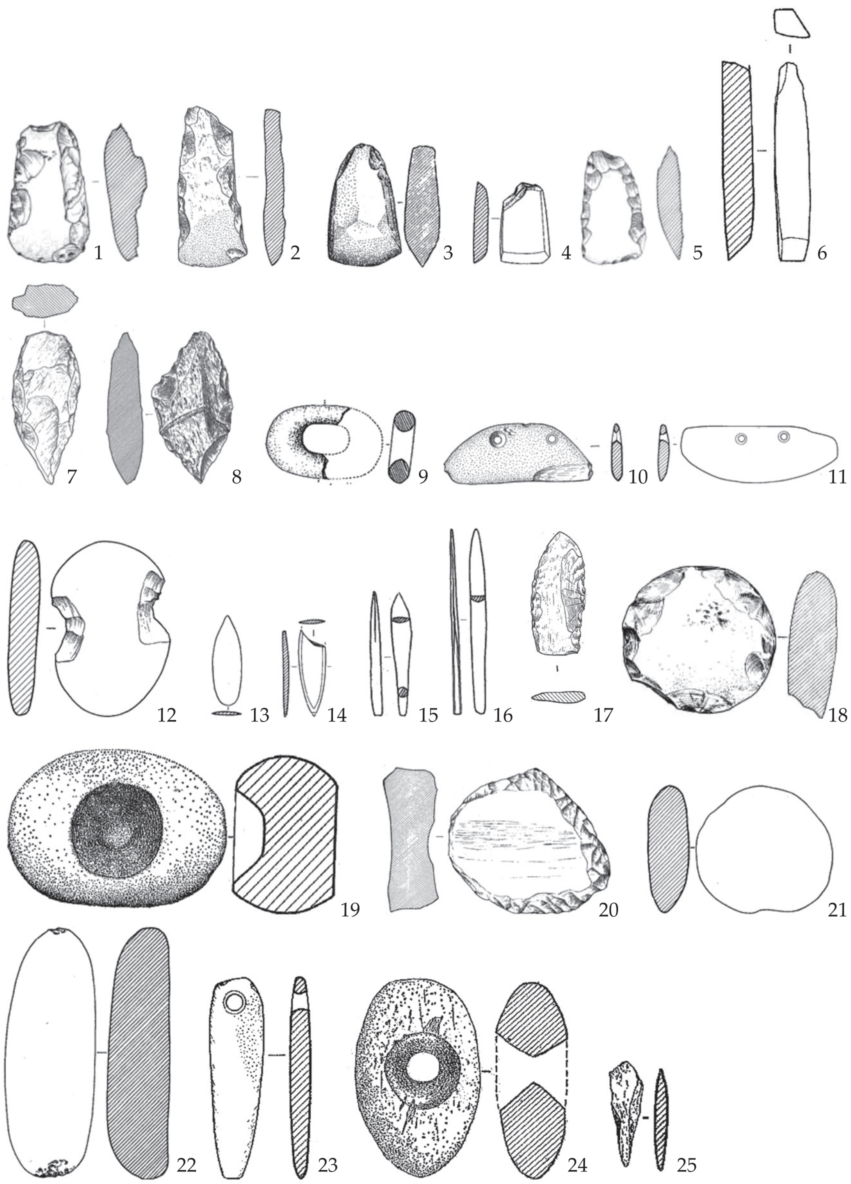

Figure 13. **Woodworking tools**: *axes*: 1. HDZ0.25 (Sichuan Sheng, Liangshan, and Huili Xian 2009: Figure 3.2), 2. DDP0.5 (Zhou Zhiqing 2011: Figure 27.3), 3. HLJM1.47 (Chengdu, Liangshan Zhou, and Huili Xian 2009: Figure 16.2); *adzes*: 4. XHS4.33 (Chengdu, Liangshan, and Xichang Shi 2006: Figure 10.1), 5. HZD0.34 (Sichuan Sheng, Liangshan, and Huili Xian 2009: Figure 3.4); *chisel*: 6. XMS8.13 (Chengdu, Liangshan, and Xichang Shi 2007: Figure 18.2); **potential agricultural tools**: *potential plows*: 7. DDP1.11 (Zhou Zhiqing 2011: Figure 25.2), 8. DWP3.20 (Chengdu Shi, Liangshan Zhou, and Dechang Xian 2009: Fig. 12); *ring stone*: 9. XHS0.40 (Xichang Shi wen wu 1998: Figure 2.1); *stone knives*: 10. DDP3.58 (Zhou Zhiqing 2011: Figure 7), 11. XMSH3.4 (Chengdu, Liangshan, and Xichang Shi 2007: Figure 24.5); **hunting/ fishing tools**: *net weight*: 12. XYPW12 (Chengdu, Liangshan, and Xichang 2007: Figure 17); *arrowheads*: 13. XMSH4.7 (Chengdu, Liangshan, and Xichang Shi 2007: Figure 25.7), 14. XHS3.78 (Chengdu, Liangshan, and Xichang Shi 2006: Figure 16.5), 15. YGJC714, 16. C710 (Liangshan and Chengdu 2009: Figures 124.5-6); *potential spearhead*: 17. DDP4.24 (Zhou Zhiqing 2011: Figure 7.6); **processing tools**: *chopper*: 18. XQG3.6 (Chengdu, Liangshan Zhou, and Xichang Shi 2009: Figure 17.2); *grinding slabs*: 19. XLZ1.83 (Lizhou yi zhi 1980a: Figure 7.17), 20. XMIH1.4 (Liangshan, Chengdu, and Xichang Shi 2006: Figure 6.1); *handstone*: 21. HLJM1.32 (Chengdu, Liangshan Zhou, and Huili Xian 2009: Fig. 16.4); *pestle*: 22. XQG3.46 (Chengdu, Liangshan Zhou, and Xichang Shi 2008: Fig. 15.5); *grinding roller*: 23. HML0.3 (Chengdu, Huili Xian, and Sichuan 2010: Fig. 12.2); *hammer stone*: 24. XYG0.10 (Liu Shixu 1981: Fig. 1.3); *perforator/drill*: 25. XLZ1.65 (Lizhou yi zhi 1980a: Fig. 7.13).

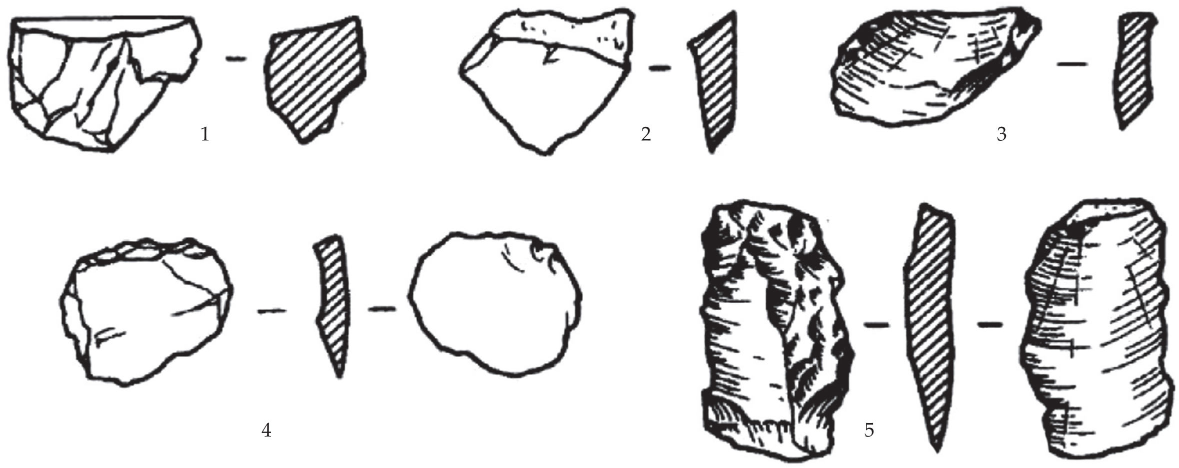

Figure 14. Microliths DWT3.103–107, microlithic cores (1–2), scrapers (3–8) (Sichuan Sheng and Liangshan 2006: Fig. 13).

Table 2. Number of stone tools by type throughout all sites.

Object type	Number	SUM	Object type	Number	SUM
Woodworking tools		521	Percussion tools		155
Axes	231		Pestle	22	
Adzes	194		Hammerstones	50	
Chisel	96		Chopper	83	
Agricultural tools		212	Grinding tools		65
Perforated knives	99		Grinding slabs	27	
Other knives	96		Grinding roller	13	
Shovels	13		Handstones	25	
Plows	2		Half-products and fragments		163
Ring stones	2		Half-products	78	
Fishing and hunting tools		86	Cores	14	
Net weights	28		Flaked fragments	14	
Arrowheads	56		Polished fragments	57	
Spearheads	2		Decorative items		28
Clothes production tools		40	Stone balls	5	
Spindle whorls	20		Stone squares	2	
Needles	13		Pearls	4	
Borer	7		Bracelets	17	
Flake tools		149	Bronze molds		2
Scraper	71				
Flakes	57				
Microliths	21		SUM	1341	1341

Table 3. Number of stone tools by type group by absolute number and percentage, referring to the number of objects (left) and to the number of sites of occurrence (right)

Object number			Site number		
Type group	Number	Percentage	Type group	Number	Percentage
Woodworking tools	521	38.9	Woodworking tools	114	37.0
Agricultural tools	212	15.8	Agricultural tools	58	18.8
Half-products and flakes	163	12.2	Half-products and flakes	34	11.0
Percussion tools	155	11.6	Percussion tools	34	11.0
Flake tools	149	11.1	Flake tools	21	6.8
Fishing and hunting tools	86	6.4	Fishing and hunting tools	35	11.4
Grinding tools	65	4.8	Grinding tools	33	10.7
Clothes production tools	40	3.0	Clothes production tools	17	5.5
Decorative items	28	2.1	Decorative items	11	3.6
Bronze molds	2	0.1	Bronze molds	1	0.3
SUM	1341	100.0	SUM	308	100.0

long and rather flat with a thin blade. Chisels vary widely in size, the smallest measuring only 5.2 × 1.1 cm, the largest 27.2 × 2.9 cm, but most specimens range around 6–12 cm in length. They were mostly made of slate, fine igneous rock, serpentinite, very rarely high-polished chert or nephrite, and sometimes tough forms of sedimentary rock.

As no microscopic observations were possible, it is not possible to know at which angle these three kinds of tools were hafted or if they have indeed all been used for woodworking. The heavy axes would be ideal for chopping wood, while the significantly narrower adzes are good for slicing wood or similar material at an acute angle, and small chisels could have been employed for further refining the form. Some of the small broad blades usually identified as adzes might have been attached to the end of a digging stick as used by modern groups practicing slash-and-burn agriculture (Mazoyer and Roudart 2006: 11, Figure 3.3).

5.3 Agricultural tools

Tools possibly used in an agricultural context are plows, shovels, ring-stones, and certain types of knives. The plows are large, coarse, and fall into two varieties: specimens with a thickened top and pointed bottom, and tools of upright rhombic form. The objects from Huili Fenjiwan identified as shovels, are flaked and only partially polished objects of igneous rock or tough limestone of 9–14 cm × 6–8 cm × 3 cm. They are rectangular or square in shape, and have a slightly curved or straight single-sided blade. Overall, they are difficult to distinguish from half-finished large adzes or axes; their identification as shovels is thus problematic.

Another group of objects possibly associated with agriculture are ring-shaped round or oval sandstone implements that have generally been interpreted as net-weights, but might actually be ring-stones used as digging-sticks. Their size, the material choice of sandstone instead of more hardwearing material, and the lack of random percussion damage common to net-weights affirm this interpretation.

Knives appear at many sites in great numbers. Nearly all specimens show striation along the blade and sometimes traces of sickle-gloss, indicating a use as harvesting-tools, possibly for cutting rice-straw or other grassy plants. Nearly identical knives have been found over all of East Asia, many of them with clear evidence of sickle gloss, while similar knives are used for rice agriculture by present-day groups in Southeast Asia.[16] It is therefore reasonable to

16. For further material on Southwest China see Luo Erhu 2000; for examples from Longshan sites see An 1955 and 1980; for examples from Korea see Choe 1982 and Chon 1992; for the Japanese material see Ishige 1968; for examples of the modern-day usage of similar knives see Ishige 1968, Luo 2000, and Yin 2001 and 2009.

assume that the knives from the Liangshan region were used for harvesting as well, be it of wild or domesticated plants. It remains unclear if they were exclusively used for harvesting rice, as many scholars suggest (e.g., An 1955; Luo 2000), or for sorghum or millet, as Okladnikov and Michael (1965: 121) and Leroi-Gourhan (1946: 306) believe. Furthermore, the same knife may have been used for a number of functions including harvesting, animal butchering, and various daily functions. The assignation as special-purpose harvesting tools is therefore by no means clear. Most knives are perforated in the middle close to the rim, usually with two holes that are aligned parallel to the rim and perforated from both sides. A string drawn through these holes and attached around the wrist of the user would have allowed for a secure grip in cutting. Un-perforated knives make up 20% of the knife assemblage, and they tend to be somewhat smaller in size and more coarsely made then the perforated specimens. They are usually long-oval, oval to rectangular, or more rarely D-shaped in form. All knives are thin, well-polished, and measure on average 11× 4 cm. Most specimens are made of fine grey slate; only a few specimens consist of fine igneous rock or metamorphosed shale or slate.

5.4 Implements for fishing and hunting

The main indicator for fishing is the presence of net-weights: oval flat cobbles with indentations pecked into the middle of both long-sides, giving them a kidney shape. They are very smooth, probably made from river cobbles that did not require any polishing, and they roughly fall into two size classes (5–7 × 3–5 cm, and 11–14.5 × 7–9 cm). The objects all show striations around the middle and percussion damage over the entire object consistent with the function of net-weights. The material chosen tends to be tough igneous rock, limestone, or sedimentary rock with a high silica content, which can withstand such treatment.

For arrowheads, fine slate is the preferred raw material type, while fine igneous rock is only rarely used. Arrowheads fall into two main types, lanceolate and staff-shaped, the former having either a straight, concave, convex, or sharply triangular indented base. The arrowheads vary in size with a length of 2.1–8.6 cm (mean: 4.7 cm), and a width of 0.7–1.7 cm (mean: 1.3 cm). Most arrowheads are elongated with a narrow edge angle. Several specimens show striation (probably remains of the production process or signs of re-sharpening); others have broken bases or tips, likely caused by the impact of hitting a target. Large coarse points were reported only from Dechang Dongjiapo. They are chipped, lanceolate in form with a straight base and pointed tip, measuring around 6.8 × 3.5 × 0.8 cm. The excavation report calls them spearheads, but they might just as well be half-products of other objects (Zhou Zhiqing 2011).

5.5 Processing tools

Stone tools that can be associated with food processing comprise roughly-flaked choppers, scrapers, and different kinds of grinding equipment. Scrapers are usually small (2.5–6.3 × 2.2–6 × 1.3 cm), have a triangular cross-section, a thin convex single-sided blade, and tend to be a little longer than wide. They are usually made of igneous rock or more rarely of coarse serpentinite. Choppers are made of the same material but they are much bigger, length and width both ranging around 7–12 cm, leading to a square or round form. They are usually rather thick (3.4–5 cm), thus providing enough weight for crushing material, but there are also a few particularly small (4 × 3 cm) and some very large specimens (17.4 × 17.4 cm), indicating a variety of targets and/or grades of grinding and crushing.

Some microliths have likewise been identified as choppers or scrapers, but they are very different in size, form, and material. Microliths, mostly made of quartzite and in one case of obsidian, have been reported from only five sites (Dechang Maojiakan, Wangjiatian, Huili Yangjia Wuji, Renhe Gonghe and Huilongwa). Four objects of oval to rectangular form with large numbers of flake scars on the surface are likely small cores. Four others, triangular or rectangular in shape and with one curved or straight working edge, are probably scrapers, while the function of the other objects is less clear: these items are mostly irregular-oval, rectangular, or triangular in shape, and have a thin, sharp working edge that is either curved or straight, making good scrapers or cutters respectively. These tools might have been used in a variety of functions ranging from food processing to hide cutting.

Grinding tools (including grinding slabs, grinding rods, and handstones) have been reported from a large number of sites. Most of them are made of sandstone, more rarely igneous rock, granite, gneiss, or in one case slate. The grinding slabs are usually rather large (10–28 × 4–20 × 2–5 cm), rectangular or more rarely trapezoidal or oval in shape, with a flat base, and a rectangular cross-section. The sides are often not worked, while the top shows a clear indentation, hollowed out by repetitive grinding. The grinding rollers are either long-oval with a round cross-section or tongue-shaped with a rectangular cross-section (12–18 cm long, 2–4 cm max. width). The second type would therefore be more correctly addressed as grinding stick, as the motion cannot have been a rolling but more a sliding one. Handstones are oval, round, or rectangular with rounded corners, and consist of sandstone ground down on the sides. These objects are all flat and fairly homogenous in size (around 12 × 7 × 2.2–5.2 cm).

In addition to grinding equipment, there are various kinds of pounding tools, namely pestles and hammerstones. The pestles measure around 14 × 5 × 3 cm, are long-oval, with a round or oval cross-section, and have one rounded thinner or two thickened ends. Objects clearly identifiable as hammerstones vary considerably in dimension (max. 17 × 9 × 6 cm, min. 5.8 × 3.8 × 2.5 cm), probably depending on the intended target. Most hammerstones are oval, with a round or flattened cross-section. Unique is a group of objects from Xichang Lizhou: they have the shape of modern-day hammers with middle perforation. All types of hammerstones are made of igneous rock, sandstone, limestone, or other heavy sedimentary rock that does not break easily and allows considerable force in striking.

Lacking microscopic and residue analysis, it is not possible to ascertain what was processed with the grinding and pounding equipment. Ethnographic research suggests that plant processing is the most common function of grinding equipment, and it is often assumed that the objects served to grind grains into flour; however, for various pre-Neolithic and early Neolithic sites throughout China it has been shown that the grinding stones were mostly used to remove shells from nuts and process acorns (Liu et al. 2010). Considering that pine and other nut trees are abundant in Southwest China, the grinding stones might well have been used to process them, but grain and other food items may have been ground as well. Furthermore, small grinding tools may have been used in tool production.

5.6 Production tools

Of the tools mentioned above, hammerstones, scrapers, choppers, and knives might have been employed in non food-related production activities, such as tool-production, building, or hide-processing. Tools clearly associated with the production of clothes are spindle whorls and needles; borers and saws might have served in tool production as well. Only two molds have so far been found, both at Huili Washitian, made from fine-ground sandstone and meant to produce metal arrowheads in one and a halberd in the other case. Saw-like objects were only found at Xichang Lizhou, all of them flat, square, thin sandstone objects with a single perforation in the upper right-hand corner. They could have served as small knives or other kinds of cutting tools, or they may have been used in smoothing the surface of ceramics.

Furthermore, there are a number of plump, coarsely-flaked borers made of igneous rock or serpentinite. They are leaf-shaped or bi-pointed and measure 8–12 × 3–4 cm. One long thin stone needle is made of slate as well, but most needles are made of bone. The spindle whorls are flat, disk-shaped, middle-perforated objects usually made of fine-polished slate, sandstone, limestone, or some other kind of sedimentary rock. Most have a diameter of 5–7 cm, while a few measure as little as 3 cm or as much as 10 cm. The inner diameter varies accordingly (0.5–2.3 cm), but they are all similarly thin (0.3–0.6 cm) and flat with slightly convex sides.

Larger flakes made of igneous rock have been mentioned at three sites: Dechang Maojiakan, Huili Yangjia Wuji, and Renhe Huilongwa. Information on forms and sizes is available for 21 flakes from Maojiakan; all of them have much cortex on one side and no signs of retouch or usage, indicating that they were surface-removal flakes in the process of stone-tool production rather than tools in their own right. These objects were associated with some cores, half-products, a large number of unspecified fragments, some of quartzite, many of igneous rock and slate, and half-products of knives, and they show on-site stone-tool production.

5.7 Other items

Apart from stone objects serving as tools, there are also a small number of lithics of decorative or ritual function. They include arm rings from Yongsheng Duizi 堆子 made of white or yellowish highly-polished nephrite, and a small drum-shaped object with a half-finished perforation from Xichang Lizhou, probably a bead half-product. The same site also revealed a sandstone ball of unclear function. Similar balls of 3–5 cm diameter were found at Dechang Dongjiapo and Huili Dongzui. Huili Liantang furthermore furnished two stone-squares (2.5 × 2.5 × 0.2 cm) made of fine grey slate with lines incised in them. They may have had a decorative or talismanic function.

6. Settlement Distributions and Features

6.1 Statistics and spatial analysis

In order to explore the distribution of the settlement sites in relation to the surrounding environment, I conduct spatial analyses on both the settlement sites and a set of 600 computer-generated random points, using ArcGIS to assess elevation, slope, aspect (i.e., orientation of the slope), and distance to the nearest river. In a second step, I export the results into SPSS to conduct statistical analyses. Aside from exploratory data analysis through descriptive statistics, histograms, and pie-charts, I use the Kolmogorov-Smirnov test to compare the two populations (i.e., the actual data and the random points), as well as various sub-groups of the actual data. I also combine information on the relative frequency of the various functional object types in any given assemblage with information on site size, structure, and location to determine site function. The result is an examination of the distribution of object types and site function in relation to geographic preconditions such as elevation, slope, and soil quality.

6.2 Nature and distribution of the sites

In elevation, nearly all sites range between 900 and 2,100 m, half of them around 1,400–1,900 m, and only very few are located at higher elevations of up to 3,100 m (Figure 15). The high-elevation sites are mainly located in areas with an especially high average elevation such as the mountainous parts of the northeast and the northwest, where the average elevation is around 2,300 m. The choice of site location therefore has to be judged locally and not in reference to absolute elevation numbers.

Most sites were found close to a river, but slightly raised above the water, usually on a terrace leaning against a mountain. In most cases, the ground is level or only slightly sloped (slope values of 8.73% for sites vs. 21.37% for non-sites; Figure 16; Plate Ⅴ: 2); only the site of Puge Wadaluo is located on a very steep hill. No preference for slopes oriented in a specific direction could be identified. Hilltops with no guarding mountain slope in the background were rarely chosen as settlement locations, and only ten sites were found in the immediate alluvial fan of a river (Table 3). However, as modern-day settlements are largely located within the alluvial fan as well, recent human activity might have destroyed evidence to the contrary. Furthermore, the Anning River has constantly shifted, and many smaller rivers are seasonal, changing course with nearly every rainy season. Such activity has likely destroyed sites formerly located close-by; however, the unpredictability of the exact location of the river courses would have been a good reason to choose an elevated spot in order to provide some protection against flooding, and that is indeed where most settlements have been found.

What is more difficult to determine is the preference for specific soil types and surface covers, as the available soil and vegetation maps for Southwest China are rather imprecise. All evaluations therefore have to remain fairly general. Judging from the available maps (Chengdu di tu 2010; Sichuan Sheng ce hui ju 1981; Sichuan Sheng di zhi 1991), the majority of settlements are located on the fertile yellow or grey-brown alluvial soil in the lacustrine basins, especially along the upper and middle reaches of the Anning River where at present rice paddies are located. The Yanyuan Basin has similar deposits but only a small number of settlement sites are known from this sub-region, likely because it is far-away from present-day research centers and suffers of poor infrastructure. A significant number of settlements are located on the drab red soil along the lower Anning River and other rivers in the southern part of the research area. Nowadays, these places are covered with agricultural fields. Only very few settlements can be found in the mountains of the hinterland on less fertile purple soils, e.g., in Zhaojue, Meigu, and Huidong Counties in the east. The valleys of Huili and Yongsheng Counties in the south are characterized by red and para-red soils, but these patches of fertile soil are surrounded by steep areas less well suited for agriculture that have so far yielded few settlement remains. Overall, settlement sites thus tend to be located in areas that are favorable for agriculture, but some can also be found in the high mountains, on steep slopes, or in forested regions not suited for extensive planting of crops, where inhabitants necessarily pursued different forms of subsistence or used these places only temporarily.

Access to natural resources is another factor that might have influenced settlement location choice. The available maps are too imprecise to allow for exact correlations (Sichuan Sheng and Zhongguo 1990), but it is clear that Huili and Panzhihua have especially rich metal deposits. Interestingly, sites in the vicinity of Huili and Panzhihua have been found on less fertile soil. The salt of Yanyuan likewise may have drawn people to this inaccessible high-altitude plateau (Hein 2014b). So far, no early salt-production sites have been found, but a first survey has shown that the local salt was probably exploited during the Han Dynasty (206 BC–AD 220) or earlier (Zhou and Jiang 2011).

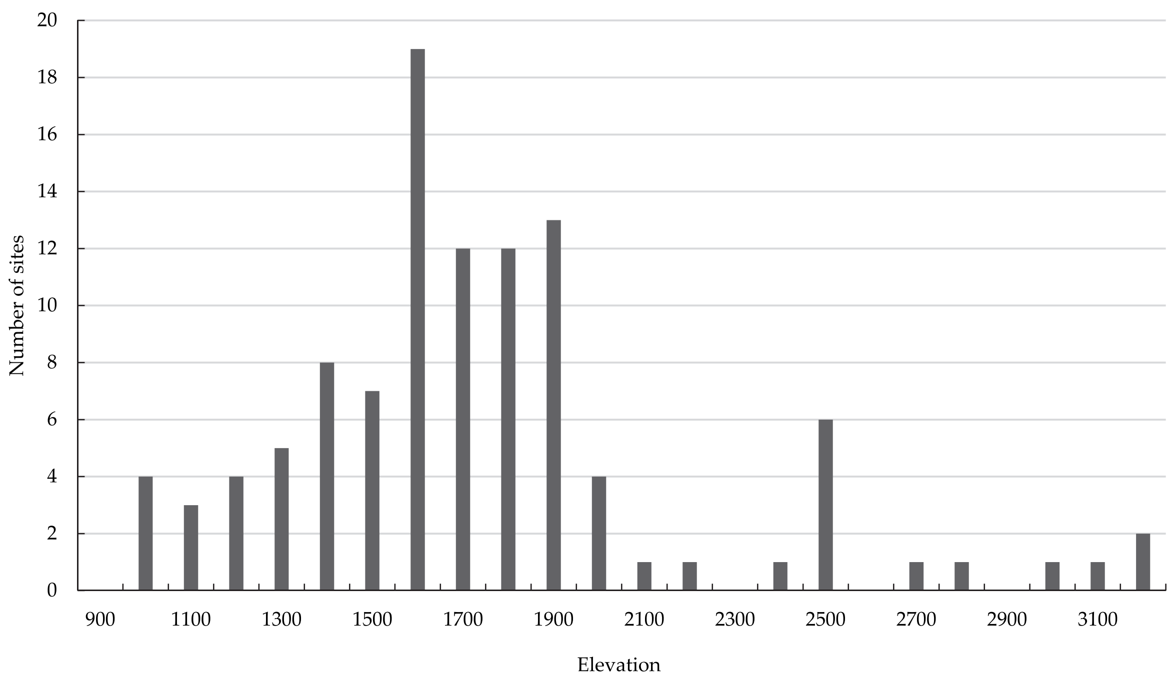

Figure 15. Elevation of settlement sites in the research area (n=106).

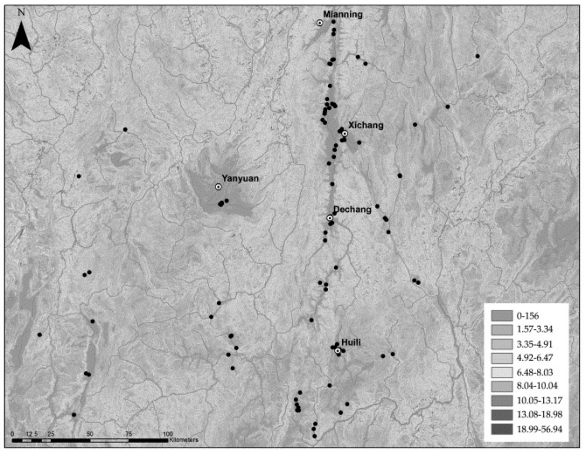

Figure 16. Distribution of settlement sites in relation to slope.

There are 80 open-air sites, 3 cave sites, and one site that combine a cave site with an open settlement. All of the cave sites are located in the southwestern mountains. Site-size estimates are available for 84 sites, and they range widely from 13 m^2 to 32 ha among all sites, and from 1,400 m^2 to over 13 ha among excavated sites. Statistical evaluations provide a much dispersed picture, but a few general trends are discernible: 30–50% of the sites are 0.1–0.5 ha in size, 20% of all sites measure 1.1–5 ha, and only four of the excavated sites are considerably larger (7–13 ha). Two of the unexcavated sites are even estimated to have been considerably larger, 16 ha and 32 ha respectively. What these sizes mean in terms of population size or settlement pattern is unclear. Worldwide and even within China, the size of prehistoric settlements varies widely between different areas and time periods, but it is safe to say that the sites in the Liangshan region are very small.[17] Given the shallow layering and the lack of larger constructions, prehistoric mobile and semi-mobile communities in Southwest Asia and other places are a parallel worth considering: such sites are mostly below 0.2 ha in size, with some larger settlements measuring between 0.2 and 0.5 ha, and the largest reaching 1–1.5 ha (Fletcher 1986). This shows that the interpretation of site size is not only connected to issues of population size but also subsistence and social structure, problems which require further investigation into site structure and object assemblage.

6.3 Settlement structure and building features

As most excavations conducted so far are rather limited in extent and intensity, not much is known about settlement structure. Building remains are known from eight sites, ash pits have been observed at 19 sites, and pottery kilns were reported from two sites (Table 3). Most houses are rectangular and very small (2–3 × 1–2 m), suggesting that they were used at most as temporary shelters, workshops, or for small-scale storage but not as long-term living quarters for larger groups. Three different construction types can be identified: (1) semi-subterranean houses with two posts in the middle or along the sides (at Dechang Dongjiapo and Yongsheng Duizi); (2) buildings whose walls were sunken into trenches, with or without supporting posts (at Dechang Dongjiapo, Huili Dongzui, Xichang Mimilang and Qimugou); and (3) features lined by rows of post holes and wattle-and-daub construction (at Huili Dongzui, Xichang Henglanshan, Ma'anshan, and Wangjiaping 汪家坪). The internal organization of the houses is unknown, but the presence of ash, charcoal, red-baked earth, and ceramic sherds suggests a function as living quarters or workshops with facilities for heating and/or cooking.

Most refuse pits within the sites contain heavily-fragmented ceramic sherds, mainly jars of various sizes, as well as bowls and more rarely spouted ewers. Eleven pits at five sites held polished stone tools, including axes, adzes, arrowheads, chisel, grinding slabs, and knives, as well as flaked scrapers and half-products (at Dechang Maojiakan and Wangjiatian, Huili Dongzui, Xichang Ma'anshan, and Mimilang). The walls of nine round and oval pits at the site of Xichang Lizhou were burned grey to a depth of 1–2 cm, indicating a short burning period at relatively low temperatures. In addition, they were filled with stones blackened and partially cracked by fire, as well as ash and charcoal. A kiln consisting of a fire pit and a fire corridor observed at the same site contained similar material. It is therefore likely that these pits were used for firing ceramics as well. The temperatures reached cannot have been very high, and

17. The large prehistoric walled settlements of the Chengdu Plain range around 11–60 ha in size (Wang 2003).

indeed the ceramics found in the graves and settlement layers at Lizhou are coarse, hand-thrown, sand-tempered, and low-fired. Pottery kilns have not been reported from any other sites, and other production facilities are equally rare. All features associated with metal working are from the post-Han period and show Han cultural influence. Metal technology thus likely did not develop locally but was adopted from the outside.

7. Discussion: Resource Availability, Site Function, and Location Choice

7.1 Raw material choice and availability

Throughout all assemblages, various kinds of igneous rock are the most common type of lithic raw material used in the production of nearly all stone-tool types (Tables 6–9; Figures 17–19; Plate Ⅷ: 2, 3). It was preferably employed for axes, but also adzes and coarse percussion tools, for which this material is well-suited. Serpentinite is often used for high-polished adzes; however, serpentinite does not occur in the Liangshan region itself, but only further north, on the northwestern rim of the Chengdu Plain and on the border to Tibet. Fine dark-grey slate only occurs along the Anning River and on the southern rim of the Yanyuan Basin. Nevertheless, this raw material was widely used for making knives in all parts of the Liangshan region, indicating the existence of a regional exchange network.

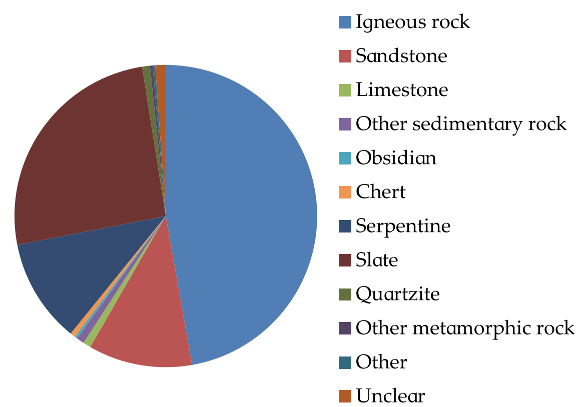

Figure 17. Relative and absolute numbers of main stone material types employed in tool production.

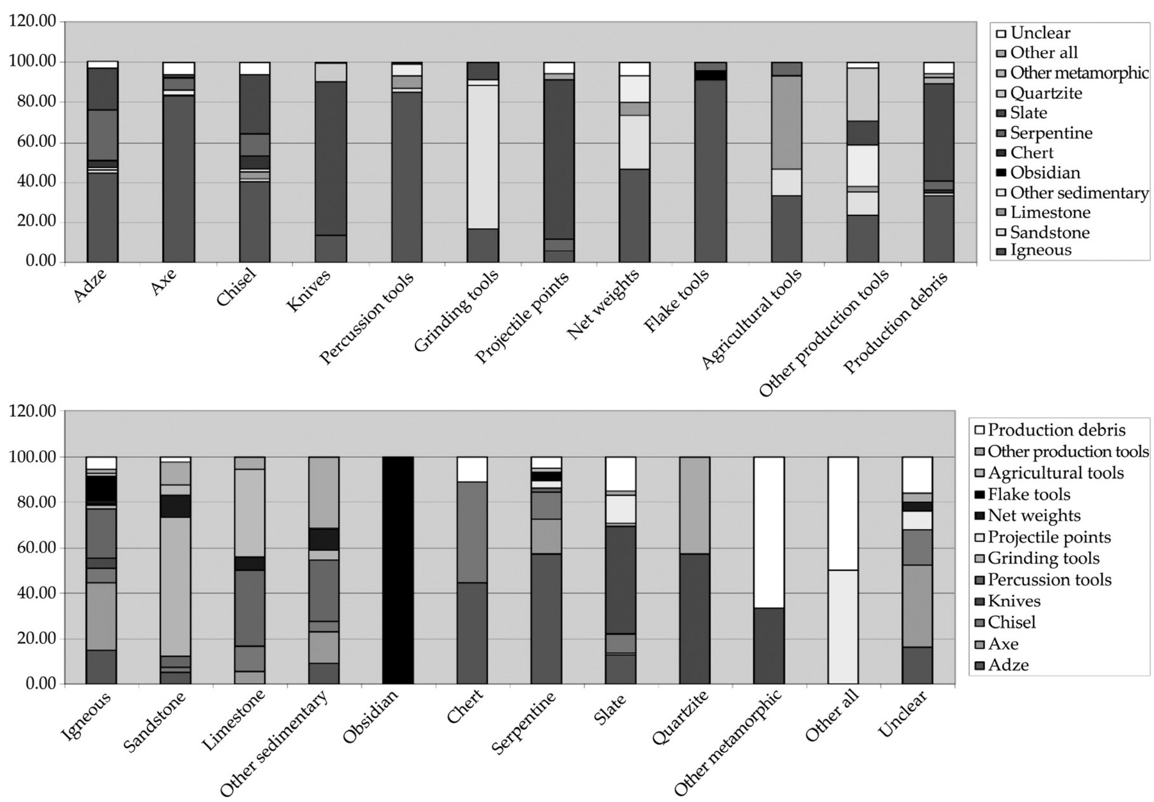

Figure 18. Raw material used for the main tool types in percentages.

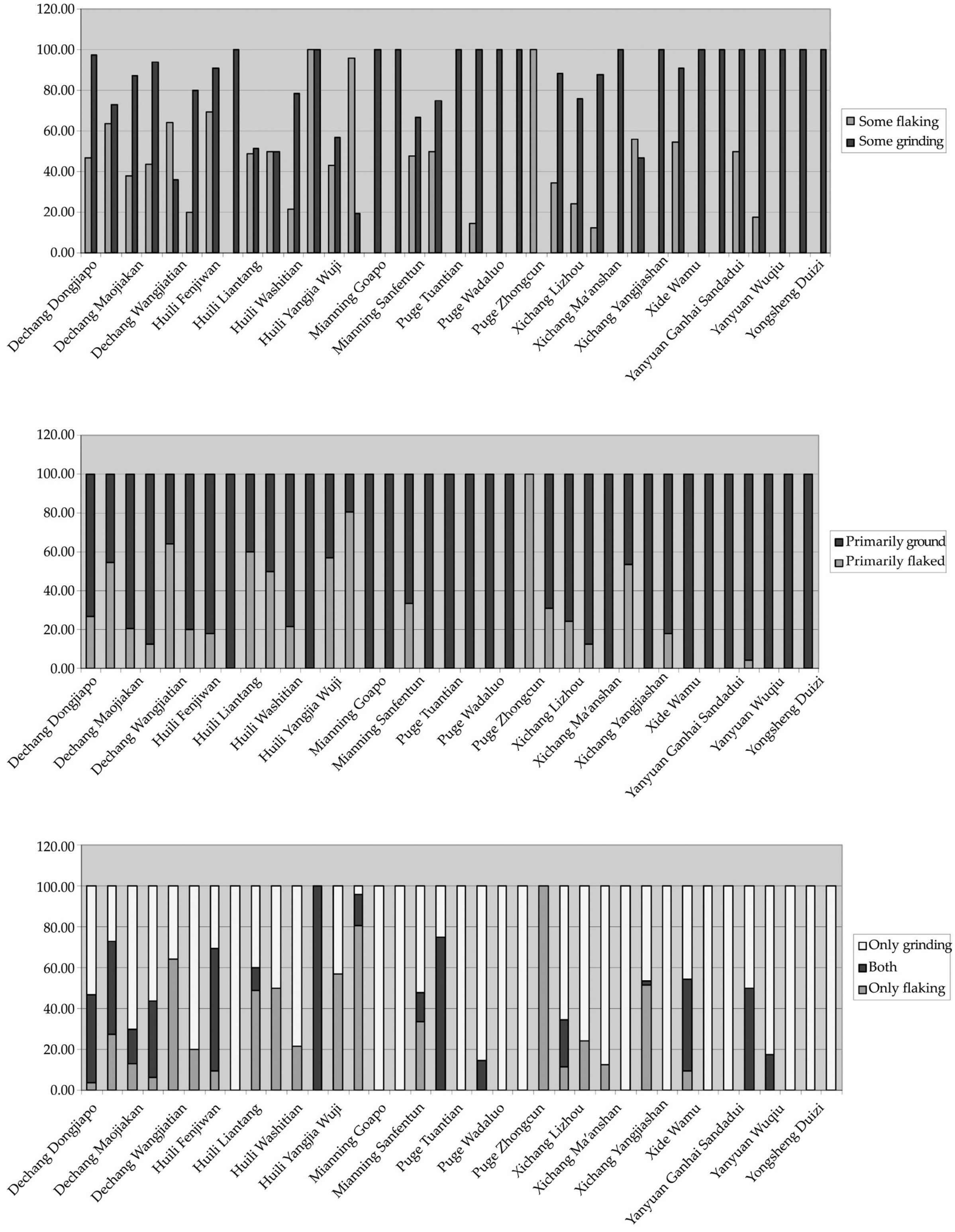

Figure 19. Main production techniques by site.

All of these stone materials are best worked through grinding, but they were also employed in producing flake tools and coarsely chipped core tools. As high-grade flakeable material is not widely available in the Liangshan region, the usage of less ideal but more common material such as igneous or even sedimentary rocks is not surprising. By contrast, the large amount of high-quality knives found in settlement context is closely linked with the availability of fine slate in the northeastern mountains. Materials such as obsidian and chert, which are ideally suited for flaked stone tools, are only rarely employed, probably because it was locally not readily available.[18] Other rarely used materials are quartz, quartzite, and nephrite. There are large deposits of quartz diorite in the south, but nephrite was likely imported, as was chert.

Table 4. Relative and absolute numbers of main stone material types employed in tool production

	Object number	Percentage
Igneous rock	390	48.15
Sandstone	41	5.06
Limestone	18	2.22
Other sedimentary rock	19	2.35
Obsidian	2	0.25
Chert	9	1.11
Serpentine	58	7.16
Slate	223	27.53
Quartzite	21	2.59
Other metamorphic rock	3	0.37
Other material	2	0.25
Unclear	24	2.96
SUM	810	100.00

7.2 Production techniques and their spatial distribution

The majority of stone tools were worked by grinding (64%), about one fifth were only flaked (18.5%), and 17.5% were both ground and flaked. However, these proportions differ significantly by site, indicating differences in site function and/or date. For a few sites, the number of primarily flaked tools is significantly higher. For other sites, the percentages are about even. However, at most sites ground tools are in the majority (Figure 19). Another factor that can be used to classify the stone tools in relation to production is the amount of work applied to them (Figure 20). At most sites finely worked tools dominate, while at others the lithic assemblage is very coarse, and a number of sites had an assemblage about evenly composed of fine, medium, and coarsely-worked objects.

The most highly polished assemblages were found in Puge, Yanyuan, and Yongsheng, i.e., in the most mountainous part of the research area. Nearly all coarser assemblages come from Dechang and Huili, where some of the earliest sites were observed. The material from Xichang has a high percentage of finely ground tools, intermingled with some coarser specimens. With the exception of Dechang Maojiakan and Wangjiatian, all flakes and microliths were found in Huili and Panzhihua in the south, but their number is very small, with all 151 object coming from only seven sites (three of them cave sites), most of them dating to the Paleolithic or early Neolithic. Indeed, flakes and microliths occur nearly exclusively in the southern part of the research area, indicating sub-regional differentiation.

7.3 Object assemblages, environmental preconditions, and economic implications

As practical experiments have shown, cutting hard or soft wood with ground stone tools can go quickly, while it is nearly impossible to cut hardwood and time-consuming to cut softwood with chipped stone tools (Boydston 1989, esp. Tables 8.2–8.3 and 74 ff.). As Boydston (1989: 74) has shown in a cost-benefit analysis, in woodworking chipped stone tools are low in cost (i.e., time and effort for production) and benefit, while both cost and benefit for ground stone tools are high. The choice of ground or flaked tools would thus have depended on the amount of forest and the kind of wood to be cleared, patterns of mobility, relative importance of agriculture in the subsistence scheme, and availability of suitable raw material.

18. Obsidian was reported from Dechang Maojiakan, chert from Dechang Wangjiaping, Huili Fenjiwan, Liantang, Xiao'aozi 小凹子 and Yongsheng Duizi. Small fragments of obsidian were found at a number of sites in Sichuan, but as they are only rarely shaped into tools, these fragments are usually not reported (personal communication Jiang Zhanghua). There are no known obsidian sources in any part of Southwest China, but considering the active fault zones and volcanic deposits, there could be smaller obsidian occurrences already exhausted in the past.

Table 5. Raw material used for the main tool types in percentage of each tool type

	Igneous rock	Sandstone	Limestone	Other sedimentary	Obsidian	Chert	Serpentine	Slate	Quartzite	Other metamorphic	Other all	Unclear	SUM
Adze	44.62	1.54	0.00	1.54	0.00	3.08	25.38	20.77	0.00	0.00	0.00	3.08	100
Axe	83.10	0.00	0.70	2.11	0.00	0.00	6.34	1.41	0.00	0.00	0.00	6.34	100
Chisel	40.32	1.61	3.23	1.61	0.00	6.45	11.29	29.03	0.00	0.00	0.00	6.45	100
Knives	13.64	0.00	0.00	0.00	0.00	0.00	0.00	76.52	9.09	0.76	0.00	0.00	100
Percussion tools	85.00	2.00	6.00	6.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	100
Grinding tools	17.14	71.43	0.00	2.86	0.00	0.00	0.00	8.57	0.00	0.00	0.00	0.00	100
Projectile points	5.88	0.00	0.00	0.00	0.00	0.00	5.88	79.41	0.00	0.00	2.94	5.88	100
Net weights	46.67	26.67	6.67	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	100
Flake tools	91.11	0.00	0.00	0.00	4.44	0.00	4.44	0.00	0.00	0.00	0.00	0.00	100
Agricultural tools	33.33	13.33	46.67	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	100
Other production tools	23.53	11.76	2.94	20.59	0.00	0.00	0.00	11.76	26.47	0.00	0.00	2.94	100
Production debris	33.33	1.52	0.00	0.00	0.00	1.52	4.55	48.48	0.00	3.03	1.52	6.06	100
SUM	48.77	5.06	2.22	2.72	0.25	1.11	7.16	26.42	2.59	0.37	0.25	3.09	100

Table 6. Raw material used for the main tool types in percentage of raw material type

	Igneous rock	Sandstone	Limestone	Other sedimentary	Obsidian	Chert	Serpentine	Slate	Quartzite	Other metamorphic	Other all	Unclear	SUM
Adze	14.68	4.88	0.00	9.09	0.00	44.44	56.90	12.62	0.00	0.00	0.00	16.00	16.05
Axe	29.87	0.00	5.56	13.64	0.00	0.00	15.52	0.93	0.00	0.00	0.00	36.00	17.53
Chisel	6.33	2.44	11.11	4.55	0.00	44.44	12.07	8.41	0.00	0.00	0.00	16.00	7.65
Knives	4.56	0.00	0.00	0.00	0.00	0.00	0.00	47.20	57.14	33.33	0.00	0.00	16.30
Percussion tools	21.52	4.88	33.33	27.27	0.00	0.00	1.72	0.00	0.00	0.00	0.00	0.00	12.35
Grinding tools	1.52	60.98	0.00	4.55	0.00	0.00	0.00	1.40	0.00	0.00	0.00	0.00	4.32
Projectile points	0.51	0.00	0.00	0.00	0.00	0.00	3.45	12.62	0.00	0.00	50.00	8.00	4.20
Net weights	1.77	9.76	5.56	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	1.85
Flake tools	10.38	0.00	0.00	0.00	100.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00	5.56
Agricultural tools	1.27	4.88	38.89	0.00	0.00	0.00	1.72	0.00	0.00	0.00	0.00	0.00	1.85
Other production tools	2.03	9.76	5.56	31.82	0.00	0.00	0.00	1.87	42.86	0.00	0.00	4.00	4.20
Production debris	5.57	2.44	0.00	0.00	0.00	11.11	5.17	14.95	0.00	66.67	50.00	16.00	8.15
SUM	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 7. Raw material used for the main tool types in absolute numbers.

	Igneous rock	Sandstone	Limestone	Other sedimentary	Obsidian	Chert	Serpentine	Slate	Quartzite	Other metamorphic	Other all	Unclear	SUM
Adze	58	2	0	2	0	4	33	27	0	0	0	4	130
Axe	118	0	1	3	0	0	9	2	0	0	0	9	142
Chisel	25	1	2	1	0	4	7	18	0	0	0	4	62
Knives	18	0	0	0	0	0	0	101	12	1	0	0	132
Percussion tools	85	2	6	6	0	0	1	0	0	0	0	0	100
Grinding tools	6	25	0	1	0	0	0	3	0	0	0	0	35
Projectile points	2	0	0	0	0	0	2	27	0	0	1	2	34
Net weights	7	4	1	2	0	0	0	0	0	0	0	1	15
Flake tools	41	0	0	0	2	0	2	0	0	0	0	0	45
Agricultural tools	5	2	7	0	0	0	1	0	0	0	0	0	15
Other production tools	8	4	1	7	0	0	0	4	9	0	0	1	34
Production debris	22	1	0	0	0	1	3	32		2	1	4	66
SUM	395	41	18	22	2	9	58	214	21	3	2	25	810

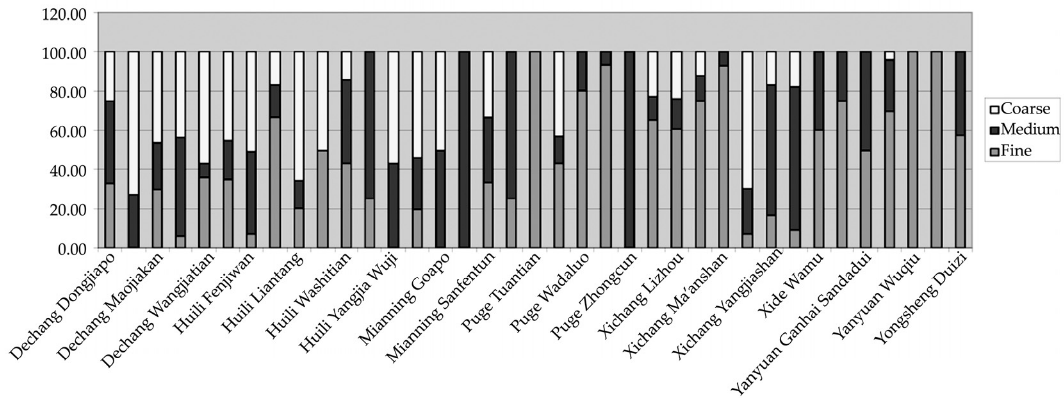

Figure 20. Degree of refinement in tool production by site.

All microliths recorded in this study were retrieved from five sites in Huili, Panzhihua, and Dechang in the southern part of the research area, one of them a cave site devoid of pottery remains (Renhe Huilongwa). Most caves in the research area revealed coarse chipped stone and bone tools, and large numbers of animal bones, but no pottery and only rarely microliths. All cave sites are located in close vicinity of the Jinsha River on drab red soil of medium to poor quality that was probably forested in the past. Three out of four cave sites are positioned on steep slopes at high elevations, making them good lookouts but not easily accessible. Only Xiqu Yanwan is located at a lower elevation in the alluvial fan of a river where the soil is more fertile than that in the surrounding mountains. This site combines open-air space with a cave and its assemblage combines chipped stone tools with ceramics; its inhabitants therefore likely practiced a more settled way of life, combined with a certain amount of agricultural activity. The other cave sites are more likely to have been occupied by hunter-gatherers or used as hunting stations by groups practicing a mixed mode of subsistence.

The open-air site of Huili Yangjia Wuji is characterized by a coarse, exclusively flaked stone assemblage just like most cave sites, and might have been a special-purpose site (i.e. for tool production, hunting, or as a seasonal camp). The same holds true for the open-air site of Renhe Gonghe which furnished both microliths and a small number of coarse pottery sherds but is located in the same region and kind of environment as the cave sites.

The two sites in Dechang that furnished microliths are rather different in character: Dechang Maojiakan revealed a large number of coarse ceramic sherds as well as stone tools. The lithic assemblage consists mainly of flakes and scrapers, but some polished woodworking tools, knives, arrowheads, and percussion tools have also been found, indicating a mixed subsistence but with heavy reliance on hunting and gathering. The flaked stone-tool assemblage of Dechang Wangjiatian is similar in character, but the range of ground-stone tool types is much more limited, consisting only of un-perforated knives and grinding tools, but no woodworking or agricultural tools or arrowheads. The ceramic assemblage is also different, comprising fine ware in the form of spindle whorls and handled jars with decorations usually associated with later-period megalithic graves (Sichuan Sheng, Liangshan, and Xichang Shi 2006a). The discrepancies between the assemblages thus seem to be related to differences in subsistence as well as date and cultural affiliation. The presence of microliths alone therefore does not prove an early date or an economy solely reliant on hunting and gathering.

Rather coarse stone-tool assemblages of grinding and percussion tools as well as projectile points are also characteristic of most settlement sites in Huili in the southeast. Most of these sites do not contain microliths; also perforated knives or other agricultural tools, spindle whorls, and fine ware are lacking. Nevertheless, most revealed woodworking tools, indicating that forest clearing usually associated with early agriculture or shifting cultivation. As Mazoyer and Roudart (2006: 103) have pointed out, polished stone axes are very effective at cutting shrubs and trees, but without further tools to work the soil or mow grass except for hand-held knives, it would be difficult to maintain a cleared area. Early agriculturalists with an assemblage similar to the one under analysis here would thus be prone to shifting cultivation (Pelzer 1978); however, the stone assemblage that Mazoyer and Roudart have in mind consists of highly polished woodworking tools, which are highly effective for felling trees and working wood. The tools in the research area are much coarser and further research (including paleobotanical work) are needed to decide if shifting cultivation was practiced here in the past.

Especially noteworthy is Huili Houzidong, which produced large amounts of flaked tools, mainly coarse axes and a few adzes, choppers, scrapers, and grinding equipment, but associated with polished fine ware. The site is located on a second-level terrace at low elevation (ca. 1,000 m asl.). Most other settlement sites in Huili are at higher elevation, further away from rivers, while Houzidong is particularly close to the Jinsha River, a main contact route in the area. The peculiar assemblage might therefore be the result of contact with a foreign group reaching this sub-region through the Jinsha River (Hein 2014a).

Qimugou is one of the few sites in Xichang in the center of the Anning River valley noted for the presence of flaked choppers and scrapers, both in early and later layers, but associated with perforated knives indicating agricultural activities. Otherwise, the material from earlier and later layers differs significantly: in the earlier layers, coarse sand-tempered flat-bottomed ceramics predominate, but in the later layers fine grey pottery emerges and the stone tool assemblage becomes more versatile, also containing woodworking tools, grinding equipment, and net weights. The assemblage from early Qimugou is rather similar to that from Xichang Henglanshan, early Yingpanshan, and Ma'anshan. Furthermore the ceramic assemblage from Xichang Lizhou bears some resemblance to the objects from these sites, but the lithic assemblage contains a particularly large number of double-perforated knives and well-polished woodworking tools, as well as spindle whorls and borers, indicating forest-clearing activities as well as agriculture and weaving, showing a clear development over time (Table 1).

Late Qimugou and Xichang Yingpanshan both yielded net-weights, an object type that was reported from 11 sites in various parts of the research area, mostly in large numbers, indicating a strong reliance on river resources in these particular sites. All of them are located on terraces or mountain slopes, i.e. at elevated locations in close vicinity to river courses and lakes, making them ideal locations for a fishing-based subsistence. It is not clear, however, if these sites were used year-round or if some of them were only a temporary convenience.

At two sites, net-weights were coupled with projectile points (Dechang Dongjiapo and Yanyuan Jiaodingshan), but these sites additionally held considerable numbers of woodworking tools and some perforated knives, indicating a mixed economy. Projectile points were also found at 21 other sites, showing at least a partial subsistence from hunting. Interestingly, nearly all sites in Puge contain projectile points, always associated with woodworking tools and non-perforated knives, but no grinding equipment or agricultural tools, indicating subsistence more heavily reliant on hunting than agriculture. To this day, large parts of Puge are covered by forest, and the region is rather mountainous with little even ground suitable for agriculture. Most other sites with considerable numbers of projectile points are likewise located in the western mountains, i.e., the foothills of southern Huili, Xide, and Meigu, where agricultural soil is scarce. A mixed economy relying heavily on hunting is thus a natural choice. Nevertheless, while the pottery of all sites in Puge is rather homogenous, it is rather different from assemblages in neighboring areas, indicating a local cultural group.

While hunting and fishing equipment is easy to identify, tools with primary agricultural function are more difficult to pinpoint. Potential plows are only reported from Dechang Dongjiapo and Wangjiaping, ring stones from Xichang Lizhou and Henglanshan, and potential shovels from Huili Fenjiwan, but the latter could also have been used in activities other than agriculture, if they were shovels at all. The same is true for perforated knives, which have been reported from only 22 sites (21%). Only the crescent-shaped specimens, sometimes referred to as sickles, are very clearly identifiable as harvesting tools, but they only appear at a few sites (Dechang Dongjiapo, Mianning Sanfentun, Puge Xiaoxingchang 小型场, and Yongsheng Duizi), and always in association with projectile points, showing a mixed economy.

Lithic half-products and cores have been found at many sites in connection with a wide range of finished tools and ceramics, indicating that tool production mostly did not take place at purpose made sites but at normal settlements. The only exception is Huidong Dashanbao 大山包, which mainly held debris from stone tool production but hardly any finished products, identifying it as a potential stone-working site. Another potential special-purpose site is the Qin-period site of Washitian, the only site in Huili with an exclusively finely-ground lithic assemblage. Washitian furthermore furnished several bronze weapons and two stone molds indicating bronze smelting activities. The other stone tools found here (choppers, needles, borers) might have been employed in production activities as well. Huili is particularly rich in copper and other metal sources, though early metal extraction or production sites have not been reported. The only other bronze find from a settlement site is a bronze bracelet from Xichang Qimugou, but to date no evidence of local metal working could be identified.

8. Conclusion: Results and Suggestions for Future Research

From the analyses conducted above it has become clear that the archaeological material from the research area varies greatly by sub-region; additionally, chronological developments and differences in site function lead to inter-regional diversification. Overall, the differences in material culture correspond very nicely with the differences between the ecological sub-regions defined above. At the same time, the center of development shifts over time and there is an increase in intra- and inter-regional diversity but also inter-community connection.

The south with its early microlithic assemblages in cave sites combined with the presence of resources ideal for a hunter-gatherer life style was likely settled the earliest. Throughout all of its history, especially the southeast shows many particularities in lithic and ceramic assemblages that are closely related to neighboring parts of Yunnan but rather different from other parts of the Liangshan region. The local prehistoric communities seem to have gone through a three-stage development from early semi-permanent living with a hunter-gatherer or mixed form of economy, to settled, agricultural living, and finally to the emergence of special-purpose sites for metal production during the late Han period or possibly earlier. The fertile river valleys and rich natural resources of the southeast are indeed ideal both for agriculture and hunting and gathering, but at the same time its self-sufficiency and the high mountains and the wild rivers enclosing it on all sides likely prevented its early integration into long-distance contacts as they characterize the development and economy of the Anning River valley. Only with the advent of metal production does the Southeast seem to become more connected to other regions, likely due to the availability of considerable metal resources in Huili. Especially special-purpose sites such as Huili Washitian were likely integrated into long-distance exchange systems; however, further research on early metallurgy in the Liangshan region is needed to understand the development of local metal production.

The fertile valley of the Anning River was likely settled somewhat later than the southeast but saw a long series of cultural developments, some local, others triggered by outside influences. The major local developments seem to originate from its central area during the mid-3rd millennium BC; at that time, the inhabitants of various sites in Xichang shared a similar ceramic repertoire, but the lithic assemblages indicate differences in subsistence practices, some of them due to difference in settlement location, others based on cultural choices. The inhabitants of Xichang Henglanshan, which is located on a piece of land not ideal for agriculture, seem to have relied on a mixed economy of hunting and small-scale agriculture; Lizhou, by contrast, is located on fertile ground and the stone tool assemblage indicates forest clearing, extensive agricultural activities, and weaving, but no hunting or fishing. All layers at Yingpanshan, although located on soil suitable for agriculture, contain considerable numbers of net weights and grinding equipment showing a strong reliance on fishing and probably gathering of wild plants and grains rather than systematic agricultural activities. The ceramic assemblage of all three sites is nevertheless nearly identical. As all of these settlements have shallow layers and were likely occupied only over a short period of time, it is possible that the same community occupied all three sites, moving from one to the other either in seasonal cycles or after a number of years without returning. Another possible explanation is that the sites were inhabited by different communities or subgroups of the same community who were in constant contact, exchanging food supplies won through different economic practices.

By contrast, the earliest assemblages of the southern and the northern parts of the Anning River valley point to hunter-gatherer or mixed subsistence, and the earliest ceramics differ in form from what can be seen in the center. Later, the ceramic assemblages of sites throughout the Anning River valley become increasingly homogenous and most groups take on agriculture, but the inhabitants of the mountains in the north still practice a mixed subsistence as is suitable for the local environment. The mountains of the northeast immediately adjacent to the Anning River valley (i.e., Puge, Xide, Yuexi) remain considerably more distinct, both culturally and economically. The sites here show unique material assemblages pointing to the presence of local cultural groups strongly relying on hunting and to a lesser extent fishing as befits the forested mountains of the area. Even when the custom of building megalithic graves reaches the eastern mountains during the 6^{th} or 5^{th} c. BC, the mode of subsistence does not change and the graves take on particular local forms. At this point, the sites in the Anning River valley reflect an agricultural and probably settled mode of living involving the planting of rice and other cereals, often supplemented by hunting and in some places fishing.

Moving even further northeast into Zhaojue, Meigu, and Leibo, which have both high mountains and high-altitude river valleys allowing for the planting of cold-resistant crops, the situation is again different. So far, not much settlement material has been found here, but the known sites show ceramics rather different from those in other parts of the Liangshan region, while the tool assemblages indicate a mixed economy, a reasonable choice in the cold mountains. Nevertheless, settlement remains were reported mostly from the river valleys on flat, arable soil, while in the southwest both valleys and mountains were inhabited.

The southwest comprises several different environments allowing for a variety of subsistence systems. The large storage jars, sickle-shaped stone knives, axes, and spindle whorls found in Yongsheng reflect a settled, agricultural mode of living. The sites here are all located on flat ground with fertile soil ideal for agriculture; Ninglang and Yanyuan, on the other hand, are covered by mountains and high-altitude plateaus asking for a mixed economy. The Yanyuan Basin has ample flat and relatively fertile land, but a dry and cold climate allowing only for a limited range of agriculture; not surprisingly, the local settlement sites yield stone arrowheads, net weights, and woodworking tools combined with few perforated knives. Some graves furthermore contain horse bones and gear together with metal weapons reflecting an emphasis on combative activities and horse riding. Overall, Yanyuan and Ninglang were probably characterized by a mixed or pastoral economy, practiced by societies having a combative streak, whereas for the people living in Yongsheng agriculture held the highest importance. It is also interesting to note that some sites in Yongsheng date as early as the early 2nd millennium BC, while finds from the high-altitude parts of the Southwest date considerably later (likely early to mid-1st millennium BC and later). This region may thus have been settled relatively late, as may have the utmost northeast; however, in both sub-regions archaeological research is lacking and further work is needed to reconstruct the settlement history of both sub-regions.

Overall, there are thus remarkable discrepancies in archaeological assemblages between the four cultural-geographical sub-regions identified above. The choice of a largely agricultural mode of subsistence in the fertile Anning River valley with its mild climate or in the lush valleys of central Yongsheng is natural; the same applies to the economy based on hunting in the forested mountains of Puge and to the mixed economy practiced both in the cold and forbidding mountains in the utmost northeast and in the species-rich and fertile southeast, in the former case to mitigate risk, in the latter to take advantage of the local abundance of resources. The emergence of a society defining itself through armed combat and horse-riding as seen in Yanyuan, however, as opposed to groups seemingly focused on domestic affairs as seen in neighboring Yongsheng, cannot simply be explained by environmental preconditions. As I have argued elsewhere (Hein 2014b), the availability of considerable salt resources—and restricted access to this source of wealth—may have led to the development of a competitive society dominated by a local elite that justified its privilege through their skills in armed combat. This serves to show that economic practices are not only related to environmental circumstances but also have to be seen in their social context.

Furthermore, single sites cannot be evaluated on their own but always have to be seen in their local and regional context. Particularly special-purpose sites serving for stone tool or metal production, or sites with highly specialized subsistence systems were likely integrated into an exchange network. The employment of fine slate throughout the entire Liangshan region, a material limited in natural occurrence to parts of the Anning River valley and the Yanyuan Basin, shows the existence of a regional exchange network of stone raw material. The use of stone material types (e.g., serpentinite) not occurring locally, shows that exchange networks reached beyond the immediate Liangshan region. Indeed, the great variability of the local environment leaves a limited range of options for the inhabitants: either they relocate on a regular basis, exploiting the environment in various ways depending on the season and their individual location, or each group or sub-group can specialize in a specific form of food procurement or raw-material extraction and obtain through exchange what they are missing.

The archaeological evidence from the Liangshan region indicates that throughout most of the prehistoric period both solutions were combined. The prevalence of large storage containers in the ceramic assemblage of many settlement sites in the Anning River valley indicates that their inhabitants probably did not relocate on a regular basis, and the associated tool assemblages reflects a primary (but not sole) reliance on agriculture. Most sites outside of the main river valleys, on the other hand, show signs of mixed subsistence patterns, definitely the most sensible strategy in this highly-varied environment. The presence of a wide range of edible nuts and other plants, as well as of a rich fauna, make it very likely that early inhabitants of the region relied on a mixed subsistence, which would have been less arduous to maintain while at the same time protecting them from famine. The varied environment furthermore requires sub-regional diversification in subsistence practices and at the same time promotes contact and cooperation between groups inhabiting adjacent niche environments.

Because of the limited thickness and the small number of cultural layers at most sites throughout the Liangshan region, several authors have suggested that some form of shifting cultivation, possibly slash-and-burn agriculture, was commonly practiced (Liu and Wang 2007). This would explain the scarcity of tools for tilling the ground; a digging stick and implements for harvesting suffice for shifting cultivation. Shifting cultivation was very common in the mountainous parts of the Liangshan region until the 1960s and is still being practiced in parts of Yunnan and adjacent areas of Southeast Asia with similar geomorphological preconditions (e.g. Spencer 1966, Yin 2001), but further research is needed to ascertain if it was also practiced in the past.

Overall, many different factors—location and geography, subsistence and material availability, culture and chronology—come together to build a complex picture of human-environment and inter- and intra-group interaction that has thus far not been sufficiently understood. Future survey work will help to understand past settlement patterns, while systematic collection of archaeobotanical and archaeozoological material during excavation is absolutely crucial to improve our understanding of past subsistence practices, and paleoenvironmental preconditions.

The same material can also be used to obtain absolute dates and help to reconstruct the chronological sequence of the Liangshan region. Additionally, excavators have to pay particular attention to charcoal remains as indicators for large-scale burning for forest clearing in connection with shifting agriculture, if that was indeed a common practice. These questions can be starting points for many future projects, in which use-wear and residue-analyses of ceramics and stone tools should play a part as well.

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Appendix 1. Settlement sites and state of preservation and research.

No.	ID	Name	Name Chinese	Preservation	Excavation	Publication state	Data source(s)
Liangshan Prefecture, Sichuan Province 四川省凉山彝族自治州							
1	DDS	Dechang Dashipai (also: Chayuancun)	德昌县大石排（茶园村）	Good	Unexcavated	Listed	Zhongguo wen wu ju 2009; data collection
2	DDP	Dechang Dongjiapo (also: Guanshanba)	德昌县董家坡（观山坝）	Good	Excavated	Well-published	Zhou Zhiqing 2011; data collection
3	DHZ	Dechang Hezui	德昌县何嘴	Good	Unexcavated	Listed	Liu Hong 2009
4	DMB	Dechang Maojiaba	德昌县毛家坝	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
5	DMK	Dechang Maojiakan	德昌县毛家坎	Poor	Excavated	Well-published	Sichuan Sheng and Liangshan 2007; data collection
6	DWP	Dechang Wangjiaping	德昌县汪家坪	Good	Test pits	Well-published	Chengdu Shi, Liangshan Zhou, and Dechang Xian 2009
7	DWT	Dechang Wangjiatian	德昌县王家田	Good	Excavated	Limited information	Sichuan Sheng and Liangshan 2006; data collection
8	HDS	Huidong Dashanbao	会东县大山包	Good	Unexcavated	Listed	Guo jia wen wu ju 2009; data collection
9	HLW	Huidong Liujiawan	会东县刘家湾	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
10	HDG	Huili Dachonggou	会理县大冲沟	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
11	HDZ	Huili Dazhaizi	会理县大寨子	Fair	Unexcavated	Unpublished	personal communication Liu Hong
12	HDJ	Huili Dongzui	会理县东咀	Fair	Excavated	Well-published	Chengdu, Liangshan Zhou, and Huili Xian 2008; data collection
13	HFJ	Huili Fenjiwan	会理县粪箕湾	Fair	Test pits	Limited information	Huili Xian, Liangshan, and Sichuan Sheng 2004; data collection
14	HGS	Huili Guantianshan & Yingpanshan	会理县观田山英盘山采集点	Good	Unexcavated	Well-published	Sichuan Sheng, Liangshan, and Huili Xian 2009
15	HHW	Huili Hewanwan	会理县河湾湾	Good	Unexcavated	Mentioned	Tang Xiang 1992
16	HZD	Huili Houzidong	会理县猴子洞	Poor	Test pits	Well-published	Sichuan Sheng, Liangshan, and Huili Xian 2009; data collection

Continued

No.	ID	Name	Name Chinese	Preservation	Excavation	Publication state	Data source(s)
17	HJM	Huili Jinmei	会理县金梅	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
18	HKP	Huili Kangzipo	会理县康子坡	Good	Unexcavated	Unpublished	data collection
19	HLT	Huili Liantang	会理县莲塘	Fair	Unexcavated	Listed	Tang Xiang 1992; data collection
20	HQB	Huili Qiaoba	会理县乔坝	Good	Unexcavated	Unpublished	personal communication Liu Hong
21	HRJ	Huili Raojiadi	会理县饶家地	Fair	Unexcavated	Unpublished	data collection
22	HSJ	Huili Shenjiafen	会理县沈家坟	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
23	HTJ	Huili Tangjiaba	会理县唐家坝	Good	Unexcavated	Mentioned	Tang Xiang 1992
24	HTC	Huili Tianbacun	会理县田坝村	Poor	Unexcavated	Well-published	Sichuan Sheng, Liangshan, and Huili Xian 2009
25	HWT	Huili Washitian	会理县瓦石田	Poor	Test pits	Well-published	Tao and Zhaodian 1981; data collection
26	HXA	Huili Xiao'aozi	会理县小凹子	Fair	Unexcavated	Listed	Guo jia wen wu ju 2009; data collection
27	HYW	Huili Yangjia Wuji	会理县杨家屋基	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
28	HYB	Huili Yuanbaoshan	会理县元宝山	Fair	Unexcavated	Listed	Guo jia wen wu ju 2009; data collection
29	MWG	Meigu Wagujue	美姑县瓦姑觉	Good	Unexcavated	Listed	Sichuan Sheng, Liangshan, and Xichang Shi 2006a
30	MGP	Mianning Gaopo	冕宁县高坡	Fair	Test pits	Unpublished	data collection
31	MGW	Mianning Gaopo Wanwan	冕宁县高坡湾	Very poor	Unexcavated	Listed	Liu Hong 2009, Guojia wen wu ju 2009; data collection
32	MHJ	Mianning Hujiacui	冕宁县胡家嘴	Good	Test pits	Listed	Liu Hong 2009; data collection
33	MMS	Mianning Miaoshan	冕宁县庙山	Good	Unexcavated	Listed	Liu Hong 2009, Guojia wen wu ju 2009; data collection
34	MST	Mianning Sanfentun	冕宁县三分屯	Fair	Test pits	Well-published	Liangshan and Mianning Xian 2006; data collection
35	MWJ	Mianning Wenjiatun	冕宁县文家屯	Good	Unexcavated	Listed	Liu Hong 2009
36	MZJ	Mianning Zhaojiawan	冕宁县赵家湾	Fair	Excavated	Listed	Chengdu Shi, Liangshan, and Mianning Xian 2012; data collection

Continued

No.	ID	Name	Name Chinese	Preservation	Excavation	Publication state	Data source(s)
37	NHG	Ningnan Heinigou	宁南县黑泥沟	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
38	NTW	Ningnan Tangjiawan	宁南县唐家湾	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
39	PKL	Puge Kangli	普格县康利	Good	Unexcavated	Unpublished	data collection
40	PTB	Puge Tianba	普格县田坝	Good	Unexcavated	Listed	Liangshan and Puge Xian 1982
41	PTT	Puge Tuantian	普格县团田	Good	Unexcavated	Listed	Liangshan and Puge Xian 1982
42	PWL	Puge Wadaluo	普格县瓦打洛	Destroyed	Test pits	Well-published	Liangshan yi zu 1983a; data collection
43	PXC	Puge Xiaoxingchang	普格县小兴场	Destroyed	Test pits	Well-published	Liangshan and Puge Xian 1982 and 1987; data collection
44	PZC	Puge Zhongcun	普格县中村	Good	Unexcavated	Listed	Liangshan and Puge Xian 1982
45	XBB	Xichang Bahe Baozi	西昌县坝河堡子	Poor	Test pits	Well-published	Sichuan Sheng and Anning he 1976; Xichang et al. 1978; Sichuan Sheng, Liangshan, and Xichang Shi 2006a; Liu Hong 2009; data collection
46	XBT	Xichang Bengtukan	西昌县崩土坎	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
47	XDL	Xichang Damaliu	西昌县大麻柳	Good	Unexcavated	Well-published	Guo jia wen wu ju 2009
48	XDN	Xichang Daniba	西昌县大泥坝	Destroyed	Unexcavated	Listed	Liu Hong 2009
49	XDY	Xichang Dayangdui	西昌县大洋堆	Good	Excavated	Limited information	Xichang Shi, Sichuan Sheng, and Liang-shan 2004; Sichuan Sheng, Liangshan, and Xichang Shi 2006a; data collection
50	XDP	Xichang Dongping	西昌县东坪	Good	Excavated	Well-published	Jiang Xianjie 1994; Sichuan Sheng, Liang-shan, and Xichang Shi 2006
51	XDM	Xichang Dongyuemiao	西昌县东岳庙	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
52	XGJ	Xichang Guanjiashan	西昌县官家山	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
53	XGS	Xichang Guanshan	西昌县关山	Good	Excavated	Limited information	Liangshan Yizu 1983a; Sichuan Sheng, Liangshan, and Xichang Shi 2006a
54	XHS	Xichang Henglanshan	西昌县横栏山	Fair	Excavated	Well-published	Xichang Shi 1998; Chengdu, Liangshan, and Xichang Shi 2006; data collection

Continued

No.	ID	Name	Name Chinese	Preservation	Excavation	Publication state	Data source(s)
55	XJB	Xichang Jiangjiabao	西昌县蒋家包	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
56	XLZ	Xichang Lizhou	西昌县礼州	Poor	Excavated	Limited information	Lizhou 1980a and 1980b; data collection
57	XMS	Xichang Ma'anshan	西昌县马鞍山	Good	Test pits	Well-published	Chengdu, Liangshan, and Xichang Shi 2007a; data collection
58	XMH	Xichang Mahuangkan	西昌县蚂蟥坎	Destroyed	Unexcavated	Listed	Liu Hong 2009
59	XML	Xichang Maliucun (Zhaoshanbei)	西昌县麻柳村（赵山碑）	Very poor	Test pits	Limited information	Sichuan Sheng, Liangshan, and Xichang Shi 2006a and 2006b; data collection
60	XMI	Xichang Mimilang	西昌县咪咪啷	Poor	Test pits	Well-published	Liangshan, Chengdu, and Xichang 2006; Sichuan Sheng, Liangshan, and Xichang Shi 2006a; data collection
61	XQG	Xichang Qimugou	西昌县桤木沟	Fair	Excavated	Well-published	Chengdu, Liangshan, and Xichang 2008; Sichuan Sheng, Liangshan, and Xichang Shi 2006a and 2006c; Chengdu, Liangshan Zhou, and Xichang Shi 2009; data collection
62	XJJ	Xichang Qujia Laokan	西昌县瞿家老坎	Good	Unexcavated	Listed	Liu Hong 2009
63	XSH	Xichang Sanhe	西昌县三和	Good	Unexcavated	Listed	Liu Hong 2009
64	XST	Xichang Shantou	西昌县山头	Good	Unexcavated	Listed	Liu Hong 2009
65	XSK	Xichang Shaojia Gaokan	西昌县肖家高坎	Destroyed	Unexcavated	Listed	Liu Hong 2009
66	XTS	Xichang Tanshan	西昌县坛山	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
67	XTE	Xichang Tu'ershan	西昌县兔儿山	Destroyed	Unexcavated	Listed	Liu Hong 2009
68	XTB	Xichang Tuanshanbao	西昌县团山包	Good	Unexcavated	Listed	Liu Hong 2009; Guojia wen wu ju 2009
69	XXH	Xichang Xiaohuashan	西昌县小华山	Poor	Test pits	Limited information	Liangshan Yizu 1990; Sichuan Sheng, Liangshan, and Xichang Shi 2006a
70	XXG	Xichang Xiaojia Gaokan	西昌县肖家高坎	Good	Unexcavated	Listed	Xichang di qu 1978d; Liangshan Yizu 1983b; Sichuan Sheng, Liangshan, and Xichang Shi 2006a; data collection

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No.	ID	Name	Name Chinese	Preservation	Excavation	Publication state	Data source(s)
71	XYG	Xichang Yangjiashan	西昌县杨家山	Very poor	Excavated	Limited information	Liu Shixu 1981; Liangshan Yizu 1987a
72	XYS	Xichang Yangshanpo	西昌县羊山坡	Destroyed	Unexcavated	Listed	Liu Hong 2009
73	XYP	Xichang Yingpanshan	西昌县营盘山	Good	Test pits	Well-published	Chengdu, Liangshan, and Xichang Shi 2007a; data collection
74	XZJ	Xichang Zengjiabao	西昌县曾家堡	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
75	XZP	Xichang Zhongguanpo	西昌县钟官坡	Destroyed	Unexcavated	Listed	Liu Hong 2009
76	XZS	Xichang Zhongjia Shanzui	西昌县钟家山嘴	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
77	XWD	Xide Wadegu (also: Sihe)	喜德县瓦得（四合）	Good	Unexcavated	Listed	Wang Hengjie 1979
78	XWM	Xide Wamu	喜德县瓦木	Good	Unexcavated	Listed	Wang Hengjie 1979
79	YGH	Yanyuan Ganhai Sandadui	盐源县干海三大队	Destroyed	Unexcavated	Unpublished	data collection
80	YJD	Yanyuan Jiaodingshan	盐源县娇顶山	Poor	Test pits	Limited information	Sichuan and Sichuan 1984
81	YWQ	Yanyuan Wuqiu	盐源县乌丘	Destroyed	Test pits	Limited information	Xichang Diqu 1978a
82	YXG	Yanyuan Xiaoguan Liangzi	盐源县小官梁子	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
83	YXF	Yanyuan Xifan	盐源县西蕃	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
84	YYN	Yanyuan Yingpanshan (North)	盐源县营盘山（北区）	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
85	YYS	Yanyuan Yingpanshan (South)	盐源县营盘山（南区）	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
86	ZHB	Zhaojue Hebo	昭觉县合波	Poor	Unexcavated	Unpublished	personal communication Liu Hong
Panzhihua City, Sichuan Province 四川省攀枝花市							
87	MHB	Miyi Hejiaba	米易县何家坝	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
88	MLG	Miyi Lianhua Gongshe	米易县莲花公社	Destroyed	Unexcavated	Unpublished	data collection
89	MYJ	Miyi Yuanjiabao	米易县袁家堡	Good	Unexcavated	Listed	Guo jia wen wu ju 2009

Continued

No.	ID	Name	Name Chinese	Preservation	Excavation	Publication state	Data source(s)
90	MZS	Miyi Zhaizishan	米易县寨子山	Destroyed	Unexcavated	Listed	Liu Hong 2009
91	PGH	Renhe Gonghe	仁和区共和	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
92	PHD	Renhe Huilongwan Cave	仁和区回笼湾洞穴	Good	Test pits	Well-published	Guo jia wen wu ju 2009
93	PXW	Renhe Xiawan	仁和区下湾	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
94	PXP	Renhe Xicaoping	仁和区席草坪	Good	Test pits	Listed	Guo jia wen wu ju 2009
95	PYJ	Renhe Yangjiashan (also: Dashibao)	仁和区杨家山（命大石包）	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
96	PYW	Xiqu Yanwan (Dashibao)	西区岩灣（大石包）	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
97	YXL	Yanbian Xinlin	盐边县新林	Good	Unexcavated	Listed	Guo jia wen wu ju 2009
98	YYW	Yanbian Yumen Wanxiao	盐边县鱼门完小	Good	Test pits	Limited information	Guo jia wen wu ju 2009; Dukou Shi wen wu 1968
Yunnan Province 云南省							
99	YJY	Ninglang Jinyangcun	宁蒗县金杨村	Good	Unexcavated	Listed	Guo jia and Yunnan Sheng 2001
100	YKJ	Ninglang Kaijicun	宁蒗县开基村	Good	Unexcavated	Listed	Guo jia and Yunnan Sheng 2001
101	YPJ	Ninglang Pijiangcun	宁蒗县皮匠村	Good	Unexcavated	Listed	Guo jia and Yunnan Sheng 2001
102	YDZ	Yongsheng Duizi	永胜县堆子	Good	Excavated	Unpublished	Yunnan Sheng, Lijiang Shi, and Lijiang Shi 2010; data collection
103	YHC	Yongsheng Haiyancun	永胜县海沿村	Good	Unexcavated	Listed	Guo jia and Yunnan Sheng 2001
104	YLJ	Yongsheng Lujiajie	永胜县陆家界	Good	Unexcavated	Listed	Guo jia and Yunnan Sheng 2001
105	YSK	Yongsheng Sankuaishi	永胜县三块石	Good	Unexcavated	Listed	Guo jia and Yunnan Sheng 2001
106	YTY	Yongsheng Taoyingcun	永胜县陶营村	Good	Unexcavated	Listed	Guo jia and Yunnan Sheng 2001

Appendix 2. Site location and morphology

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
1	Dechang Dashipai	1,379	On alluvial fan	27,347	1	0.5					Very close to river
2	Dechang Dongjiapo	1,372	Second-level terrace, level	71,171	4	1.0	0.5	0.1	1	4	Overlooking surrounding area, close to river
3	Dechang Hezui	1,476	River valley, level	20,000	1	0.4					Very close to river
4	Dechang Maojiaba	1,619	Second-level terrace, level	75,000	6	1.0					Overlooking surrounding area, close to river
5	Dechang Maojiakan	1,378	Second-level terrace, sloped		5	1.4	0.5	0.2		4	Leaning against mountain, facing river
6	Dechang Wangjiaping	1,445	Second-level terrace, sloped	2,000	3	0.6	0.3	0.1	1	2	Leaning against mountain, facing river
7	Dechang Wangjiatian	1,185	Second-level terrace, level	2,100	3	1.0	0.4	0.2		3	Leaning against mountain, overlooking river
8	Huidong Dashanbao	1,791	Foothills, sloped	2,000							
9	Huidong Liujiawan	1,653	Foothills, sloped	1,200	1	0.5					
10	Huili Dachonggou	1,809	Mountain slope	18,000							
11	Huili Dazhaizi	1,815	On terrace, level	5,958							Overlooking surrounding area, very close to river
12	Huili Dongzui	1,776	First-level terrace, level	22,000	5	1.1	0.4	0.1	2	5	Close to intersection of two rivers, on mountain slope, overlooking river
13	Huili Fenjiwan	2,600	Mountain slope	4,000	1	1.0				4	
14	Huili Guantianshan/ Yingpanshan	1,840	Foothills, sloped	3,000	1	0.5					

Continued

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
16	Huili Houzidong	982	Second-level terrace, level	2,500						1	
17	Huili Jinmei	1,805	First-level terrace, level	2,000							
18	Huili Kangzipo	1,908	Foothills, sloped								
19	Huili Liantang	2,005	Foothills, sloped	17,000	4	1.0	0.3	0.2			
20	Huili Qiaoba	1,822	First-level terrace, level	157,500							Overlooking surrounding area, very close to river
21	Huili Raojiadi	1,796	On terrace, level	5,300							Close to river
22	Huili Shenjiafen	1,956	On hill-top	1,000							
23	Huili Tangjiaba	1,814	On terrace, level		1	0.4					Overlooking surrounding area, very close to river
24	Huili Tianbacun	986	First-level terrace, level	1,860							Close to river
25	Huili Washitian	992	Second-level terrace, level	1,860							Overlooking surrounding area, very close to river
26	Huili Xiao'aozi	1,794	On alluvial fan	32,000							Very close to river, in river valley between mountains
27	Huili Yangjia Wuji	1,800	On hill-top	1,000							On shallow hill, overlooking the area
28	Huili Yuanbaoshan	1,298	On mountain slope	8,000							
29	Meigu Wagujue	1,960	Second-level terrace, level	320,000	4	1.7	0.6	0.1			

Continued

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
30	Mianning Gaopo	1,740	First-level terrace, level	5,600							overlooking surrounding area, close to river
31	Mianning Gaopo Wanwan	1,722	First-level terrace, level	6,000	3	0.6	0.3	0.1			overlooking surrounding area, close to river
32	Mianning Hujiacui	1,659	On alluvial fan	40,000	2	1.1					very close to river
33	Mianning Miaoshan	1,633	First-level terrace, level	6,000	7	2.4	1.0	0.1			
34	Mianning Sanfentun	1,766	First-level terrace, level	44,100							overlooking surrounding area
35	Mianning Wenjiatun	1,632	On alluvial fan	150	3	0.7	0.3	0.1			very close to river
36	Mianning Zhaojiawan	1,643	On alluvial fan	8,800	6	1.5	0.3	0.1			
37	Ningnan Heinigou	1,038	Third-level terrace, level	13,000	3	1.0	0.5	0.2			very close to river, leaning against mountain
38	Ningnan Tangjiawan	999	Second-level terrace, level	131,100							overlooking surrounding area, leaning against mountain, facing river
39	Puge Kangli	1,323	First-level terrace, level								facing the river, leaning against mountains
40	Puge Tianba	1,195	Second-level terrace, level	2,000							very close to river
41	Puge Tuantian	1,257	Foothills, sloped	10,000	2	2.0	1.5	0.2		1	facing the river, leaning against mountains, close to river intersection
42	Puge Wadaluo	1,773	First-level terrace, sloped	131,400							facing river, leaning against mountain, steep ground

Continued

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
43	Puge Xiaoxingchang	1,857	Secondl-level terrace, sloped	50,000							in narrow river valley, surrounded by mountains, close to river
44	Puge Zhongcun	1,373	Third-level terrace, level	30,000	1	0.5					overlooking surrounding area, leaning against mountain, facing river
45	Xichang Bahe Baozi	1,612	Second-level terrace, sloped	2,000							leaning against mountain, facing river
46	Xichang Bengtukan	1,489	Second-level terrace, sloped	20,000	1	0.6					leaning against mountain, facing river
47	Xichang Damaliu	1,771	Second-level terrace, sloped	12,000	1	0.6					
48	Xichang Daniba	1,513	On alluvial fan	2,000	6	3.1	0.8	0.1			
49	Xichang Dayangdui	1,494	First-level terrace, level	9,600	3	1.7	0.3	0.1			overlooking surrounding area, close to river
51	Xichang Dongyuemiao	1,500	Second-level terrace, level	300	1	0.7					close to river
52	Xichang Guanjiashan	1,775	On hill-top	1,400	1	0.7					
53	Xichang Guanshan	1,601	On hill-top	1,400	1	0.7					
54	Xichang Henglanshan	1,641	On terrace, sloped	2,933	4	1.0	0.4	0.3	2	3	leaning against mountain, facing the river
55	Xichang Jiangjiabao	1,591	On terrace, level		1						
56	Xichang Lizhou	1,621	Third-level terrace, level	7,000	4	1.9	0.8	0.2			Leaning against mountain, facing the river
57	Xichang Ma'anshan	1,519	On terrace, sloped	100,000	8	4.0	1.5	0.1	1	6	Leaning against mountain, facing the river

Continued

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
58	Xichang Mahuangkan	1,922	On terrace, level								
60	Xichang Mimilang	1,560	Second-level terrace, sloped	48,000	5	1.8	0.6	0.2	3	1	Overlooking surrounding area, close to river, creeks near-by
61	Xichang Qimugou	1,565	Second-level terrace, sloped	13,000	5	1.8	0.4	0.1	1	3	Leaning against mountain, facing river
62	Xichang Qujia Laokan	1,511	On terrace, level	24,000							
63	Xichang Sanhe	1,575	On terrace, level	2,500							
64	Xichang Shantou	1,482	On alluvial fan	5,000	1	0.6					Very close to river
65	Xichang Shaojia Gaokan	1,547	On terrace, level	4,800	1	0.8					
66	Xichang Tanshan	1,594	On hill-top	20,000	1	1.0					
67	Xichang Tu'ershan	1,522	Mountain slope	500	1	0.2					
68	Xichang Tuanshanbao	1,595	Mountain slope	3,000	1	0.6					
69	Xichang Xiaohuashan	1,659	Mountain slope	3,600	1	1.0					
70	Xichang Xiaojia Gaokan	1,555	First-level terrace, level	4,800	1	0.8					
71	Xichang Yangjiashan	1,789	Mountain slope	2,000	3	3.9	1.5	0.2			Very close to lake and river
72	Xichang Yangshanpo	1,536	On alluvial fan	3,000	1	0.6					
73	Xichang Yingpanshan	1,547	Second-level terrace, sloped	2,000	6	0.2	0.8	0.1			Leaning against mountain, facing the river
74	Xichang Zengjiabao	1,555	First-level terrace, level	10,000	1	0.6					Close to river

Continued

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
75	Xichang Zhongguanpo	1,592	On mountain slope	4,000	1	0.9					
76	Xichang Zhongjia Shanzui	1,554	On alluvial fan	8,000	1	0.5					
77	Xide Wadegu	1,809	On terrace, level	25,000	1	0.3				1	Very close to river
78	Xide Wamu	1,830	Secondl-level terrace, level	20,000	1	0.3					Overlooking surrounding area, in very mountainous area
79	Yanyuan Ganhai Sandadui	2,376	On terrace, level								Overlooking surrounding area, in wide plain in between mountains, river in short distance
80	Yanyuan Jiaodingshan	2,390	Mountain slope	50,000						3	Leaning against mountain, facing river
81	Yanyuan Wuqiu	2,350	On terrace, level								Overlooking surrounding area, in wide plain in between mountains, river in short distance
82	Yanyuan Xiaoguan Liangzi	2,398	On hill-top	25,000	1	0.5					Overlooking surrounding area
83	Yanyuan Xifan	3,006	First-level terrace, level	20,000	1	0.8				3	Leaning against mountain, facing river
84	Yanyuan Yingpanshan (North)	2,341	On terrace, level	4,000							Overlooking surrounding area, in wide plain in between mountains, river in short distance

Continued

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
85	Yanyuan Yingpanshan (South)	2,380	On terrace, level	7,200							Overlooking surrounding area, in wide plain in between mountains, river in short distance
86	Zhaojue Hebo	1,897	Foothills, sloped	2,000							
87	Miyi Hejiaba	1,170	Third-level terrace, level	10,000	1	1.5					Close to intersection of two rivers
88	Miyi Lianhua Gongshe	1,239	Third-level terrace, level								
89	Miyi Yuanjiabao	1,085	Mountain slope	5,000	1	0.5					
90	Miyi Zhaizishan	1,844	Mountain slope								
91	Renhe Gonghe	1,370	Second-level terrace, level	3,000	1	0.5					Close to river
92	Renhe Huilongwa Cave	1,167	Mountain slope	35	1	2.0					In cave, close to river
93	Renhe Xiawan	1,387	Second-level terrace, level	1,000							Close to intersection of two rivers
94	Renhe Xicaoping	1,511	Mountain slope		1	1.5					In cave, close to river
95	Renhe Yangjiashan	1,341	Mountain slope	20							
96	Xiqu Yanwan	1,070	Mountain slope	220							Open-site and cave settlement, close to river
97	Yanbian Xinlin	1,252	Second-level terrace, level								
98	Yanbian Yumen Wanxiao	1,479	First-level terrace, level								Close to river

Continued

No.	Name	Elevation m asl.	Morphology	Area (m^2)	Number layers	Thickness cultural deposit	Thickness layers min.	Thickness layers max.	Buildings	Pits	Description location
99	Ninglang Jinyangcun	2,880	On terrace, level								
100	Ninglang Kaijicun	3,775	On terrace, level								
101	Ninglang Pijiangcun	2,954	On terrace, level								
102	Yongsheng Duizi	1,203	First-level terrace, level		4	1.0	0.5	0.4	18	30	Very close to river and lake
103	Yongsheng Hai-yancun	1,519	Mountain slope	5,000	2	1.5					Very close to river, in river valley
104	Yongsheng Lujiajie	1,609	Mountain slope								
105	Yongsheng Sankuai-shi	1,876	Mountain slope								
106	Yongsheng Tao-yingcun	2,676	Mountain slope								In cave, close to river

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