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ORIGINAL PAPER

Lithic assemblage from the xiagachacunnanshan site, chaoyang city, liaoning province

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Abstract
In April, 2021, the School of Archaeology of Jilin University and the Liaoning Provincial Institute of Cultural Relics and Archaeology conducted a Paleolithic archaeological survey in Chaoyang City, Liaoning Province. The archaeological team traversed the three counties of Halaqinzuoyi Mongolian Autonomous County, Chaoyang County, and Beipiao City, and found more than 10 Paleolithic sites, among which the Xiagachacunnanshan site is one of them. Investigators found 33 stone artifacts at the Xiagachacunnanshan site, including cores, flakes, and tools. The raw materials of these stone artifacts is mainly quartz, quartz sandstone, and sandstone. According to the types of stone artifacts and pottery pieces collected, it is inferred that the stone industry of the site belongs to the small stone tool industry of the Late Paleolithic period, and the site should be dated from the Late Paleolithic to the Bronze Age.

Keywords Chaoyang City · Liaoning Province · Lithic · Xiagachacunnanshan site · Late Paleolithic period

1 Introduction

Liaoning 辽宁 Province is located in the southern part of Northeast China, with hills in the west, the Xialiaohe 西辽河 Plain in the middle, and mountains in the east. The terrain in Liaoning is diverse, rivers are widely distributed, and Quaternary sediments are widely distributed. In addition to the marine sedimentation, the river–lake sedimentation in the Liaohe Plain is particularly developed. In the distribution area of carbonate rocks, a large number of caves are found, and most Quaternary mammal fossils and Paleolithic sites in Liaoning Province are found here (Wei 1986). In the last century, several important Late Pleistocene sites were discovered in Chaoyang 朝阳 City, such as the Gezidong 鸽子洞 site in Kazuo 喀左 (Gezidong fa jue 1975), the Xibajianfang 西八间房 site in Lingyuan 凌源 (Liaoning Sheng bo wu guan 1973), and the Shenjiatai 沈家台 site in Jinxian 锦县 (Zhang 1981). A large number of Quaternary mammal fossils and stone artifacts have been unearthed at these sites, which provide abundant information for the division of the Quaternary strata, the study of mammal fossils, and the lithic industry in Liaoning.

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2 Location description

Chaoyang City is located in the west of Liaoning Province, and the Xiagachacunnanshan 下嘎岔村南山 site is located in Xiagacha 下嘎岔Village, Changbaoyingzi 长宝营子 Rural Area, Shuangta 双塔 District, Chaoyang City (41° 35 ′ 30.16 ″ E, 120° 30 ′ 53.61 ″ N) (Fig. 1: a). In April, 2021, investigators from the School of Archaeology of Jilin University and the Institute of Cultural Relics and Archaeology of Liaoning Province conducted archaeological investigations in three areas, namely, Halaqinzuoyi 喀喇沁左翼 Mongolian Autonomous County, Chaoyang County and Beipiao 北票 City, Chaoyang City, and found more than 10 sites and collected hundreds of stone artifacts. The Xiagachacunnanshan site is 685 m east of Donggou 东沟, 890 m west of Zhangjiawa 张家洼, and 830 m north of the Daling 大凌 River. There are mountains on the south side of the site, and the altitude of the highest peak is 510 m. Here, we report 33 stone artifacts collected from the Xiagachacunnanshan site in this investigation. According to the types of stone artifacts and

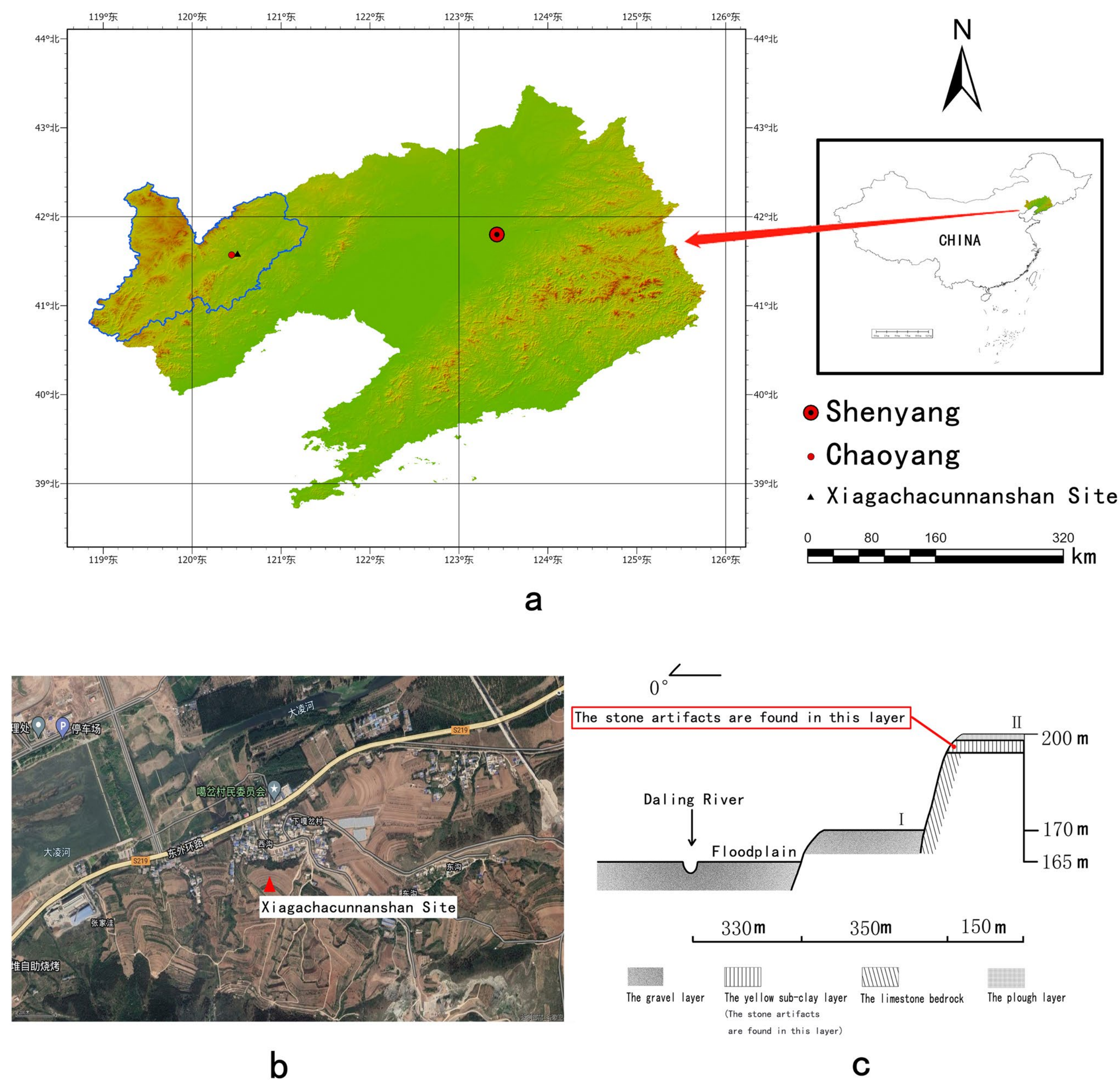

Fig. 1 a Location of the Xiagachacunnanshan site; b. Satellite image showing the site location; c. Profile of the Daling River valley

pottery pieces collected, it is inferred that the stone industry tradition of this site belongs to the small stone tool industry type of the Late Paleolithic period, and the site should dated from the Late Paleolithic to the Bronze Age.

The Daling River flows from southwest to northeast on the north side of the site. Because of modern dams, the water surface extends more than 500 m at its widest point, and the diara deposits are developed. The valley on the north side of the site is wide, and farmland is widely distributed. Stone artifacts are scattered on the second terrace, with a distribution area of about 2.5 ha (Fig. 1: b).

The Xiagachacunnanshan site is located on the second terrace on the south bank of the Daling River, at an altitude of 200 masl. The stone artifacts were all collected on the surface. Exposures show the stratigraphy of the site can be divided into three layers. The top layer is a gray-black plough layer with a thickness of 20–30 cm, and it contains pottery pieces. The middle layer is a 50–250 cm thick yellow sub-clay layer with loose soil, and stone artifacts have been found in this layer. The lowest layer is the limestone bedrock (Fig. 1c).

3 Lithic assemblage of the Xiagachacunnanshan site

From the Early to the Late Paleolithic period, stone materials were important resources for human survival and life. The quality and enrichment of raw materials can greatly affect the appearance of a stone tools industry, including stone tool-making technology and stone tool combinations, and then affect the production and lifestyle of ancient human (Binford 1979). The surface state of stone artifacts generally includes the gravel surface, weathered rock surface, joint surface, and flake scar, in which the two states of gravel surface and weathered rock surface can also reflect the prototype of raw materials, from which we can then infer their approximate sources (Inizan et al. 1999).

The raw materials of the stone artifacts from the Xiagachacunnanshan site are mainly quartz. Quartz is richly available raw material in this area, and its acquisition cost is low. It was used for producing cores, debitage, and tools, such as scrapers, denticulates, choppers and notches. Judging from a comparison of remaining cortex (gravel surface) on the stone artifacts with gravels found in the riverbed, the raw materials should derive from the riverbed of the nearby Daling River. On the one hand, this reflects that the ancient humans living in this area were proficient in the production mode and the processing mode of quartz artifacts. On the other hand, it shows that ancient people's the processing strategy was adapted to local conditions and developed using available resources.

A total of 33 stone artifacts were collected at the Xiagachacunnanshan site. In this paper, the classification of stone artifacts, in addition to cores, flakes, and chunks,

Fig. 2 The cores and flakes of the Xiagachacunnanshan site 1. Double-platform core (21CSXN: 6); 2. Three-platform core(21CSXN:2); 3.Fragment (21CSXN: 32); 4.Complete flake (21CSXN: 14); 5.Complete flake (21CSXN: 22); 6.Complete flake (21CSXN: 23); 7.Complete flake (21CSXN: 24)

includes three main categories of tools. The first category of tools is pounding tools, such as hammers, anvil, etc. The second category of tools is the utilized flakes, and the third category of tools are the retouched tool (Chen 2001). The stone artifacts found in this investigation are all produced by hammering/flaking, including cores, flakes, and retouched tools. Quartz is the main raw material.

Four stone cores were collected from the Xiagachacunnanshan site. Lengths range from 49.7 to 88.9 mm, with an average length of 66.2 mm. Widths range from 40.4 to 68.9 mm, with an average width of 51.2 mm. Thickness ranges from 30.2 mm to 46.2 mm, with an average thickness of 36.7 mm. The weight range is 76.4—395.2 g, and the average weight is 176.3 g. The raw materials are quartzite and quartz sandstone.

The cores can be divided into two types according to the number of platforms: double platform (n = 1) and multi-platform (n = 3) stone cores. Flaking technology is mainly simple, direct percussion. Although the cores found at the site feature a simple core-flake technology that is not as planned and predetermined as cores from Mousterian technology or blade-microblade technology, they still contain the debitage strategy of the knappers.

Core 21CSXN: 6 is 53.4 mm long, 45.8 mm wide, 30.7 mm thick, and weighs 80.7 g. The raw material is quartzite. The shape is approximately a quadrangular pyramid. There are two platforms, one natural platform and one scarred, and the remaining cortex area accounts for about 10% of the stone core surface area (Fig. 2 : 1).

Core 21CSXN: 2 is 88.9 mm long, 68.9 mm wide, 44.8 mm thick, and weighs 395.2 g. The raw material is gray quartzite, and it is nearly oval in shape, and the blank is a nearly oval pebble. The stone core has three platforms and three flaking surfaces. Judging from the surface, this core was also used as a hammerstone in the later stage of flaking (Fig. 2 : 2).

From the above description, we can conclude that the flaking of the stone cores at the Xiagachacunnanshan site has the following characteristics: firstly, the blank for the stone cores is generally an ovular, flat gravel, and the raw material is local, common quartzite.

Secondly, in this paper, the multi-platform core is identified as a high-efficiency stone core, while the single-platform core and double-platform core are identified as low-efficiency cores: since the majority of the stone cores at the Xiagachacunnanshan site are multi-platform stone cores, this shows that the core flaking efficiency at the Xiagachacunnanshan site is high. Although the simple stone core technology lacks strong planning and strategy, it still reflects the strategy of changing the platform frequently in order to obtain as many flake artifacts as possible at that time. In addition, the remaining cortex accounts for 40—60% of the whole stone core, which thus has the potential for continued flaking.

Table 1 Flake types and raw material

Identification number	Flake category	Raw material
21CSXN: 14	I1–1	quartz sandstone
21CSXN: 22	I2–2	quartzite
21CSXN: 23	I2–3	hornfels
21CSXN: 24	I1–2	hornfels
21CSXN: 25	I1–2	sandstone
21CSXN: 28	I1–2	quartzite
21CSXN: 30	II2–1	quartzite
21CSXN: 32	II2–1	quartzite
21CSXN: 33	II2–1	flint

Observation of the collected cores shows that the same cores can show various flaking concepts. This pattern of production reflects that the ancient human living in the site had no preferred choice and technical treatment for the flaking surface: as long as the length was moderate and the surface was regular, the stone could be used as a core. In addition, it also shows the cognition and flexible processing behavior of ancient human in regard to the platform and the angle of the platform.

Nine flakes were found at the Xiagachacunnanshan site (Fig. 2 : 3–7). According to the degree of integrity, flakes can be divided into complete flakes (N = 6) and fragments (N = 3). The complete flakes' lengths range is 33.3–73.8 mm, and the average length is 52.5 mm; their widths range 27.3–50.5 mm, with an average width of 36 mm; their thickness ranges 6.7–22.9 mm, with an average thickness of 16.2 mm; and their weight ranges 5.8–71 g, with an average weight of 32.6 g. Raw materials includes quartzite, hornfels, quartz sandstone, and flint (Table 1).

There are a total of 3 flake fragments, all of which are proximal fragments. Their lengths range 20–40 mm, with an average length of 29 mm. The width ranges 10.3–26.1 mm, with an average width of 18.9 mm. The thickness ranges 2.8–8.6 mm, with an average thickness of 5.4 mm. The weight ranges 0.6–7.9 g, with an average weight of 3.7.

2 chunks were found at the Xiagachacunnanshan site. They are irregular in shape, 42.2–59.1 mm long, with an average length of 50.7 mm; 29.3–29.5 mm wide, with an average width of 29.4 mm; 24.9–29.3 mm thick, with an average thickness of 27.1 mm; and weights of 38.3–44.7 g, with an average weight of 41.5 g. The raw material is sandstone.

There are 18 tools collected from the Xiagachacunnanshan site, accounting for nearly half of the total number of lithic artifacts. These tools include the each of the three

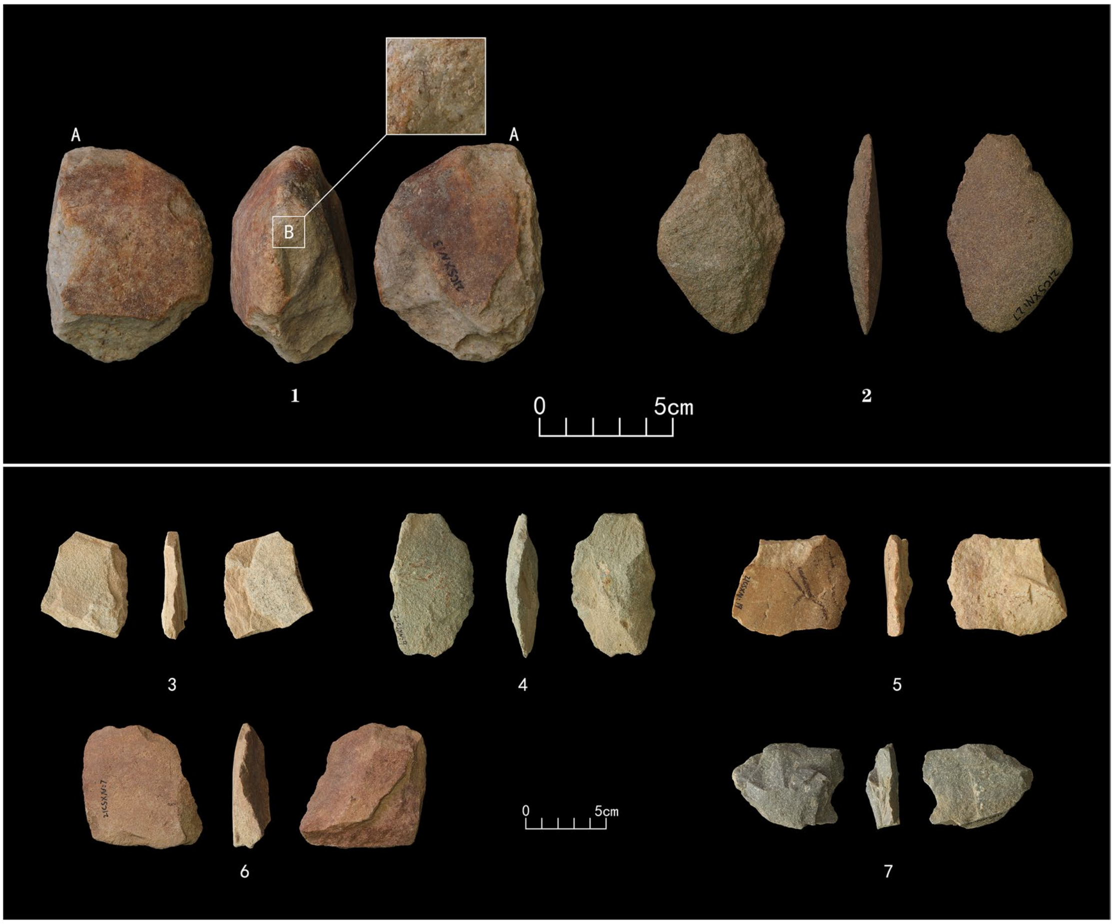

Fig. 3 The Tools of the Xiagachacunnanshan site. 1. Hammerstone (21CSXN: 3); 2.Used flake (21CSXN: 27); 3.Retouched tool (21CSXN:32); 4. Retouched tool (21CSXN:14); 5. Retouched tool (21CSXN:22); 6. Retouched tool (21CSXN:23); 7. Retouched tool (21CSXN:24)

categories of tools mentioned above: pounding tools, flakes, and retouched tools.

21CSXN: 3 is a hammerstone, 77.9 mm long, 59.2 mm wide, 46.2 mm thick, and weighing 248.3 g. The raw material is a quartz sandstone gravel. This hammerstone appears to be reformed from a wasted stone core. There are obvious striking pits at A and B (Fig. 3 : 1).

There are 6 used flakes. All of them are hammered stone flakes that are used directly without retouch.

21CSXN: 2 is 74.7 mm long, 47.3 mm wide, 12.4 mm thick and weighs 42.1 g. The raw material is sandstone. They are mostly on flake blanks. There are traces of use at the cutting edge (Fig. 3 : 2).

The retouched tools contain a very diverse set of tool types, including scrapers, a denticulate, a notch, and a chopper (Fig. 3 : 3–7). These tools are mostly on flake blanks and were modified through marginal retouch. Most pieces lack morphological standardization. Tools include scrapers, points, and a denticulate. They are mostly flake blanks and were made by hard hammering. According to the maximum length of the specimen (Wei and 卫奇. , 2001), the 18 tools found can be roughly divided into three grades: micro (less than 20 mm), small (more than 20 mm and less than 50 mm) and medium (more than 50 and less than 100 mm). These tools are all medium-sized tools, and the raw materials include sandstone, quartzite, and *xiuyan* 岫岩 jade, and the blanks are mostly flakes. Retouched is concentrated on the edge and handle, and the number of repairing scar layers is 1–2.

There is a total of 8 scrapers. Edge shapes include convex edges (n = 2) and straight edges (n = 6). The straight edge scarpers have lengths ranging 58.2–79.3 mm, and the average length is 67.99 mm; their width ranges 46.5–63.2 mm, and the average width is 52.9 mm; their thickness ranges 13.7–30.7 mm, with an average thickness of 20.5 mm; and their weight ranges, 48.7–137.8 g, with an average weight of 73.8 g. The processing parts are concentrated on the side, and the processing methods include direct and inverse. The edge length is 27.6–64.4 mm, the edge angle is 48°-65°, the repairing depth is deep, and the continuously-distributed scars are scalar.

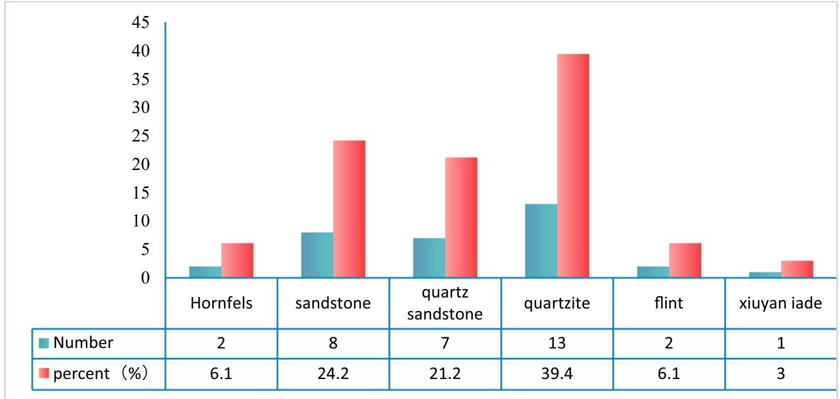

Fig. 4 Proportions of raw materials at the Xiagachacunnanshan site

The convex edges scrapers range is 56–87.9 mm in length, with an average length of 72 mm; their widths range 49.7–51.7 mm, with an average width of 50.7 mm; their thickness ranges 19.3–23.2 mm, with an average thickness of 21.3 mm; and their weight ranges 68.7–93.9 g, with an average weight of 81.3 g. They are all made on flakes. The edge lengths rang 46.2–72.5 mm; the edge angle is 56°-59°, the repairing depth is deep, and the continuously-distributed scars are scalar. In addition to the scraping tools, the repair tools also include one denticulate, one chopper, and one notch.

4 Conclusions

The Paleolithic materials of the Xiagachacunnanshan site include quartzite, quartz sandstone, sandstone, hornfels, xiuyan jade and flint. Among them, the amount of quartzite is the largest, accounting for 39.4% of the total raw materials. Sandstone is the second, accounting for 24.2%. Quartz sandstone accounts for 21.2%. Hornblende and flint each account for 6.1%. Xiuyan jade accounts for 3% (Fig. 4). Generally speaking, stone tools are mainly made of quartzite, sandstone and quartz sandstone, which are suitable for flaking and making tools. Judging from the cortex retained on the stone cores, the raw material should come from the floodplain of the Daling River.

Following Wei Qi's (2001) classification standard for lithic artifacts mentioned above, the largest stone artifacts at the Xiagachacunnanshan site is fall into the as medium-sized stone tools category, and these account for 75.8% of the total stone tools, while the small tool category accounts for about 24.2% of the total. There are no large stone tools (larger than 100 mm and less than 200 mm). It can be seen that the stone tools in this place are mainly medium-sized stone tools.

The Xiagachacunnanshan site is rich in stone tool types, including cores, flakes, chunks, fragments, hammerstons, utilized flakes, and the retouched tools. The proportion of retouched tools is the highest, accounting for about 33.3% of the total number of stone tools. Among these, scrapers are the most, accounting for about 81.8% of the three types of tools. There are few notches or choppers, each accounting for about 9.1% of the three types of tools. The number of flakes accounts for about 18.2% of the total number of stone tools, and there are fewer stone flakes, fragments and chunks, accounting for about 18.2%, 9.1% and 6.1% of the total, respectively. The number of cores accounts for about 12.1% of the total number of lithic artifacts, and the number of hammerstone is the least, accounting for about 3% of the total (Table 2).

The reduction technique of all of the cores, flakes and the blanks of the retouched tools at this site is hard hammer direct percussion. Most stone cores and flakes have cortex, and some tools also have cortex. The blanks of the retouched tools are all flakes. Tools are retouched by hammering, and most of the scars are scalar. The processing direction is mainly direct, followed by alternating, and inverse is rare. The overall retouch of tools exudes a style of simplistic and expedient processing.

The technical features of the tools include the following aspects: the raw material of the tools is mainly quartz, and no other raw materials are found. Tools are mainly made on flakes. The types of tools are all light-duty tools, including scraper, point, denticulate and drill, among which the scrapers are mainly single-edged, and only one of them is double-edged. The subtypes of the single-edge scraper (straight edge, convex edge, and concave edge) are not very different in function according to the shape of the edge, but are related to the shape of the blank.

The tool retouch technology is hard hammer, and the scars are mostly scales, with few parallel and sub-parallel scars. The vast majority of tools are only retouched on a single surface, which is mainly forward, followed by reverse. From the perspective of blank and retouching position, tools with flakes as the blank generally process the left or right side, followed by the proximal. Most tools have only one edge, and only a few specimens have two or more edges. The

Table 2 Stone tools, blanks, flakes, and types

Identification number	Category	Blank	Cortex	Number	Percent
21CSXN: 5	Chunks	Chunks	●	2	6.1%
21CSXN: 29			●		
21CSXN: 33	Fragments	Flakes		3	9.1%
21CSXN: 32					
21CSXN: 30			●		
21CSXN: 31	Used flakes	Flakes		6	18.2%
21CSXN: 27			●		
21CSXN: 15					
21CSXN: 26			●		
21CSXN: 11					
21CSXN: 21			●		
21CSXN: 28	Flake		●	6	18.2%
21CSXN: 25	Flake		●		
21CSXN: 24	Flake		●		
21CSXN: 14	Flake		●		
21CSXN: 23	Flake				
21CSXN: 22	Flake		●		
21CSXN: 20	Straight edges scarper	Flakes	●	11	33.3%
21CSXN: 19	denticulate		●		
21CSXN: 18	Straight edges scarper		●		
21CSXN: 17	Convex edges scarper		●		
21CSXN: 16	Straight edges scarper		●		
21CSXN: 13	Straight edges scarper		●		
21CSXN: 12	Straight edges scarper		●		
21CSXN: 10	Notch				
21CSXN: 9	Convex edges scarper		●		
21CSXN: 8	Straight edges scarper		●		
21CSXN: 7	Chopper		●		
21CSXN:6	Multifacial	Chunk	●	4	12.1%
21CSXN:4	Multifacial	Chunk	●		
21CSXN:1	Multifacial	Chunk	●		
21CSXN:2	Multifacial	Pebble	●		
21CSXN:3	Hammer	Core	●	1	3%

phenomenon of multi-use of one tool is not common, which indicates that the raw material is sufficient. The ratio of scar retouch area to tool surface area is low, which indicates that the degree of retouch on the tools is not high. The normal distribution of edge angle shows that the standardization of tool repair is low, and an expedient retouch strategy is the main one, while the proportion of finely retouched tools is extremely low.

The cutting edge, shape, and handle of retouched tools were processed and repaired, reflecting the purposeful and selective approach of humans at that time to produce tools that were more suitable for production and daily life based on the different raw materials available. By observing and analyzing the parts of the tool repair discovered at this site, the combination of repairing the cutting edge is dominant, accounting for 82.4% of the total number of retouched tools. The combination of directly using the sharp edges of flakes is very rare, accounting for only 17.6% of the total retouched tools (Table 2).

Because of the lack of stratigraphic accumulation sequence for systematic dating, we can only speculate on the age of the Xiagachacunnanshan site according to the comparative analysis of landform development and its related cultural characteristics with surrounding sites. All stone artifacts were made by hard hammer. There were no ground or polished stone objects found. There were also no cultural materials suitable for dating such as animal bones or carbonized plant materials discovered.

This site is situated on a second-level terrace on the south bank of the Daling River, close to the water source, making it suitable for human production activities. Based on the analysis of the lithic features of the site, it suggests that this site was a temporary settlement for ancient humans. The stone tools collected from the tillage layer and yellow subsoil layer, both of which were exposed on the surface of the second-level pedestal terrace at the Xiagachacunnanshan site were all collected at the surface. No coexisting fossils of mammals were found, but pottery was discovered. Thus, through a comparative analysis of lithic industry characteristics, this site was utilized from the Late Paleolithic period to the Bronze Age.

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Authors contribution Jiaxing Song performed the data analyses and wrote the manuscript.

Chunxue Wang helped perform the analysis with constructive discussions.

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Data availability Not applicable.

Code availability Not applicable.

Declarations

Conflict of interest The authors do not have any conflicts of interest to declare in regard to this manuscript.

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