

# Stone Tool Functions in the Preceramic Period at the Loma Atahualpa Site in Ecuador

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**Abstract:** The excavations at the Loma Atahualpa site (Atahualpa-66) in the Santa Elena Province of Ecuador were conducted by Russian, Ecuadorian, and Japanese archaeologists in 2017 and 2018. Three human burials were discovered approximately 100 cm below the ground surface, indicating that they probably originated from the Late Las Vegas culture of the preceramic period. This study aims to understand the technological and functional features of stone tools from the preceramic period at the Loma Atahualpa site. In addition, technological and functional changes between the Early-Middle Las Vegas and Early Valdivia cultures were examined in comparison to the materials already analyzed.

## 1. Introduction

Since the late 1950s, the earliest pottery has been attributed to the materials of the Early Formative Valdivia culture in coastal Ecuador. The Real Alto site, one of the most significant sites of the Valdivia culture, was excavated in the 1970s and 1980s. A series of field studies provided extensive and precise information on the evolution of small sites of early agriculturalists into huge settlements with artificial mounds and plazas and, later, into one of the earliest regional ceremonial centers in South America (Marcos 1988). Unfortunately, intensive expeditions of Valdivia culture sites were interrupted after the mid-1980s. Consequently, several important archaeological questions have remained unanswered for approximately 30 years.

In 2014, 2015, and 2017, new excavations of the Real Alto site were conducted by Russian, Ecuadorian, and Japanese archeologists (Popov et al. 2017). The main goal of their research was to discover the oldest cultural layer containing Valdivia I and San Pedro pottery in the early ceramic period. At last, the authors discovered the oldest non-ceramic culture at the Real Alto site, dated around 5,800 BP (6655-6563calBP). In addition, numerous lithic artifacts were unearthed and analyzed based on techno-typology and use-wear (Tabarev and Kanomata 2015, Kanomata et al. 2019b). The authors proposed the original model of the “Tropical package” for the transitional period from hunter-gatherers to

early agriculturalists in coastal Ecuador. Moreover, the new radiocarbon dates of Valdivia I and San Pedro potteries (n =5) could be attributed to 4640 to 4450BP (5470-4880calBP) (Tabarev et al. 2016, Kanomata et al. 2019b). In the case of the Santa Elena Peninsula, we suggest the existence of pre-Valdivia without pottery as well as Las Vegas with pottery. The next target was to understand the dates and features of the Late Las Vegas culture.

## 2. New Excavation at the Loma Atahualpa Site

A small test pit was excavated at the Loma Atahualpa site (Atahualpa-66) in Santa Elena Province in October 2017, in which a human burial was discovered 95cm below the ground surface. The burial was attributed to the preceramic period because this cultural level contains no pottery. Accelerator Mass Spectrometry (AMS) dates were obtained from the charcoal samples situated 80–100 cm below the ground surface (Table 1). A radiocarbon date near the burial indicated a preceramic age (5,340±30BP) and another, farther away from burial, yielded a younger age (3,280±30BP). Based upon these results, the burial can be attributed to the Late Las Vegas culture, and this site is deemed the most suitable target to achieve our research goal.

In 2018, the second excavation was directed by J. G. Marcos, A. N. Popov, and A. V. Tabarev. This project was

Tab.1 Radiocarbon dates at the Loma Atahualpa site. \*OxCal v.4.4.2 (Bronk Ramsey 2020) and Intcal 20

Lab Number	Sample	Sample Provenance	Material Type	Pre-treatment	Carbon recovery (%)	$\delta^{13}\text{C}$ (‰) (AMS)	Data with $\delta^{13}\text{C}$ Correction	
							Conventional $^{14}\text{C}$ Age (yrBP)	pMC (%)
IAAA-181070	1	level 5, burial 1, 80-100cm	Charred material	AaA	66	-25.44 ± 0.24	5,340 ± 30	51.44 ± 0.18
IAAA-181071	2	level 5, 80-100cm	Charred material	AaA	70	-26.93 ± 0.29	3,280 ± 30	66.48 ± 0.23
IAAA-190093	3	N103/E105, dark spot under shell mound burial 3, 100-120cm	Charred material	AaA	68	-26.43 ± 0.27	2,950 ± 30	69.31 ± 0.22

Lab Number	Data without $\delta^{13}\text{C}$ Correction		Age for Calibration (yrBP)	Calibrated Age (1 $\sigma$ )	Calibrated Age (2 $\sigma$ )
	Age (yrBP)	pMC (%)			
IAAA-181070	5,350 ± 30	51.39 ± 0.18	5,340 ± 27	6196calBP - 6172calBP (13.9%)*	6268calBP - 6245calBP (6.1%)*
				6149calBP - 6113calBP (22.0%)*	6205calBP - 6105calBP (47.5%)*
				6078calBP - 6058calBP (10.3%)*	6089calBP - 6001calBP (41.9%)*
				6050calBP - 6011calBP (22.1%)*	
IAAA-181071	3,310 ± 30	66.21 ± 0.22	3,279 ± 27	3556calBP - 3530calBP (21.3%)*	3567calBP - 3447calBP (95.4%)*
				3494calBP - 3454calBP (46.9%)*	
IAAA-190093	2,970 ± 20	69.1 ± 0.21	2,945 ± 25	3160calBP - 3069calBP (68.2%)	3205calBP - 3196calBP (1.3%)
					3176calBP - 3000calBP (94.1%)

\*OxCal v.4.4.2: Bronk Ramsey (2020) ; r5; Atomospheric data from Reimer et al. (2020)

conducted with the cooperation of Russian-Ecuadorian and Japanese archeologists. The area of the main unit (no.1) was 28 m<sup>2</sup> and accompanied by a trench (no.1, 4 m<sup>2</sup>) and five test pits (no.1-5, each 2 m<sup>2</sup>). The basic stratigraphy in the main unit comprised six layers as follows:

- 1<sup>st</sup>: Solid grayish sand (10-40cm depth).
- 2<sup>nd</sup>: Sandy loam of dark brown-greyish color (40-60cm depth).
- 3<sup>rd</sup>: Sandy loam of dark brown-greyish color with *Anadara* shells (60-80cm depth).
- 4<sup>th</sup>: Sandy loam of dark brown-greyish color (80-100cm depth).
- 5<sup>th</sup>: Sandy loam of dark brown-greyish color with *Anadara* shells (100-120cm depth).
- 6<sup>th</sup>: Solid yellow-brownish sand (deeper than 120cm) – sterile horizon.

Three burials were discovered in the lower levels of the main unit, situated approximately 100 cm below the ground surface. Burial no.2 was contained in the layer with shells (5th layer), which covered burials no.1 and 3. Burial no. 1 was discovered in the test pit in 2017. The closest charcoal of burial no. 3 was selected as a sample for radiocarbon determination. Unfortunately, the date measured by the AMS method, 2,950±30BP, was more recent than two dates attributed to the upper level (5<sup>th</sup> level). This suggests that the 6<sup>th</sup> layer was contaminated from the upper layers due to elements such as animal burrows or dry cracks under

the ground. Soil cracks identified on the sterile horizon at the bottom of the main unit may have contributed to this contamination.

A number of pottery fragments were recovered from the main unit. More than 95 % of the potteries were unearthed from a depth of 0-80 cm (levels 1-3). These are typologically attributed to the Late Valdivia, Machallilla, and Guangala-Manteña cultures. Therefore, the artifacts situated greater than 80 cm in depth can be attributed to the preceramic culture.

Because precise analysis of ceramics and lithic tools is in progress, the authors explain the characteristics of lithic tools in preceramic culture from the viewpoint of technology and function.

### 3. Technology

The authors selected 30 lithic tools from more than 3,000 materials (99% is represented by the by-products of percussion) and created the illustrations presented in Fig. 1, 2 and 3. These tools included denticulates (8), an end scraper (1), flakes (3), flakes with microflaking (3), notches (2), a notched scraper (1), retouched flakes (9), and scrapers (2) (Tab. 2) made from chalcedony (10), chert (16), jasper (2), and quartzite (2). The raw material composition indicates that artisans intentionally selected hard and silicified stones for manufacturing flake tools. The average

size of the flake tools was 37.4 mm long, 26.6 mm wide, and 12.1 mm thick. The average striking angle was 109.3°. Blank flakes were removed by direct knapping using hard stone hammers. The existence of a bipolar technique is unclear. Secondary retouch flake removals were performed using

the same method. Multiple circular cracks formed by hitting were observed on the surface of three flake tools (Fig. 13–4, 11, and 14–13 ). These traces indicate failures in knapping during secondary removals.

Tab.2 Attributes and use-wear of lithic tools at the Loma Atahualpa site in 2018

no.	square	depth	tool type	length (mm)	width (mm)	thickness	raw material	striking angle	used position	polish type	worked material	striation	operation	
1	N104-106 /E104	80-100 cm	retouched flake	37.3	22.1	8.7	chalcedony	120	dorsal/left/low	B? or D2?	wood, bone/antler	parallel	cut/saw	
2			retouched flake	27.8	36.2	11	jasper	119	-	-	-	-	-	
3			retouched flake	19	19.6	2.7	chert	-	ventral/left middle	-	-	-	vertical	whittle
4			denticulate	24.7	29.6	10.3	chert	-	-	-	-	-	-	-
5	N102-106 /E105		retouched flake	49.2	34.3	9.7	jasper	94	both/both/low	D2?	bone/antler ?	parallel	cut/saw	
6			flake with microflaking	46	54	9.5	chalcedony	91	dorsal/right/low, ventral/left/low	D2? or B?	wood, bone/antler	parallel	cut/saw	
7			notched scraper	66.9	27.8	20.7	chert	117	-	-	-	-	-	
8			notch	28.6	20.6	10.1	chert	-	-	-	-	-	-	
9			snapped flake	33.6	24.4	9.9	chert	-	-	-	-	-	-	
10	N102-106 /E101		retouched flake	25.4	11.7	7	chert	-	-	-	-	-	-	
11			denticulate	20	24.5	15.2	chert	-	-	-	-	-	-	
12			denticulate	31	24.7	17.4	chalcedony	-	ventral/notched edge	D1?	bone/antler ?	vertical	whittle	
13	N102-106 /E103		denticulate	26.4	17.5	12.4	chalcedony	127	-	-	-	-	-	
13(2)			end scraper	42	25.7	15.1	chert	126	ventral/notched edge	?	-	vertical	whittle	
14		notch	40.5	40.5	12.1	chalcedony	93	ventral/notched edge	B? or D2?	wood, bone/antler	parallel	cut/saw		
15		scraper	60.7	30.5	21.6	quartzite	-	-	-	-	-	-		
16		flake	48	17.4	7.7	quartzite	108	-	-	-	-	-		
17	flake	41.8	30.5	15.9	chalcedony	120	-	-	-	-	-			
18	N102-106 /E102	snapped flake with retouch	24.2	20.4	8	chert	-	-	-	-	-	-		
19		retouched flake	25.1	37.2	9.5	chalcedony	-	ventral/base	D1?	bone/antler ?	?	-		
20		denticulate	36.8	33.1	12.9	chalcedony	-	ventral/notched edge	D1, D2	bone/antler	vertical	whittle		
21		flake with microflaking	36.5	16.5	12.7	chert	133	-	-	-	-	-		
22	N102 /E106	100-110 cm	flake with microflaking	39.4	28.9	9.9	chert	105	dorsal/left, ventral/right	D2	bone/antler	parallel	cut/saw	
23			denticulate	45.7	42.7	24	chalcedony	90	dorsal/right, ventral/left	D2	bone/antler	parallel	cut/saw	
24			denticulate	39.2	29.2	19.2	chert	-	-	-	-	-	-	
25	denticulate		43.3	24.7	17.9	chert	100	ventral/notched edge	D1, D2	bone/antler	vertical	whittle		
26	N102 /E105		scraper	33.5	20.2	8.7	chert	103	dorsal/left, ventral/right	B? or D2?	wood, bone/antler	parallel	cut/saw	
27			retouched flake	35.3	18.1	6.7	chert	-	-	-	-	-	-	
28			flake	55.2	17.4	3.1	chalcedony	103	-	-	-	-	-	
29			retouched flake	39.9	17.2	13.2	chert	-	-	-	-	-	-	
30			burial no.2		axe	76.2	52.3	31.5	green madstone	-	-	-	-	-

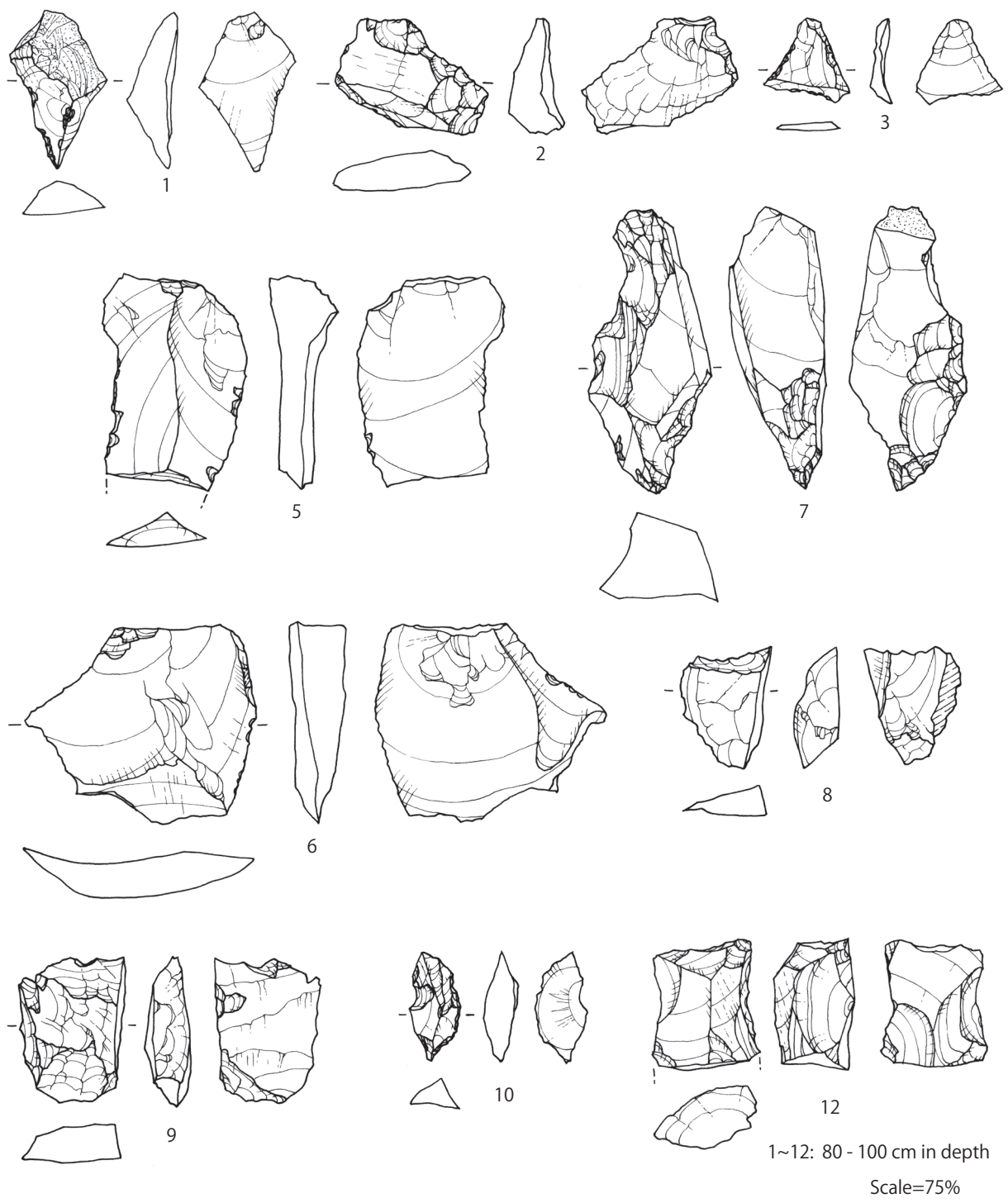


Fig.1 Lithic artifacts at the Loma Atahualpa site in 2018.

Based upon research conducted by the authors, these technological characteristics are common to the Las Vegas and Early Valdivia cultures (Tabarev and Kanomata 2015).

From a techno-typological point of view, it is difficult to distinguish which culture these lithic tools belong to.

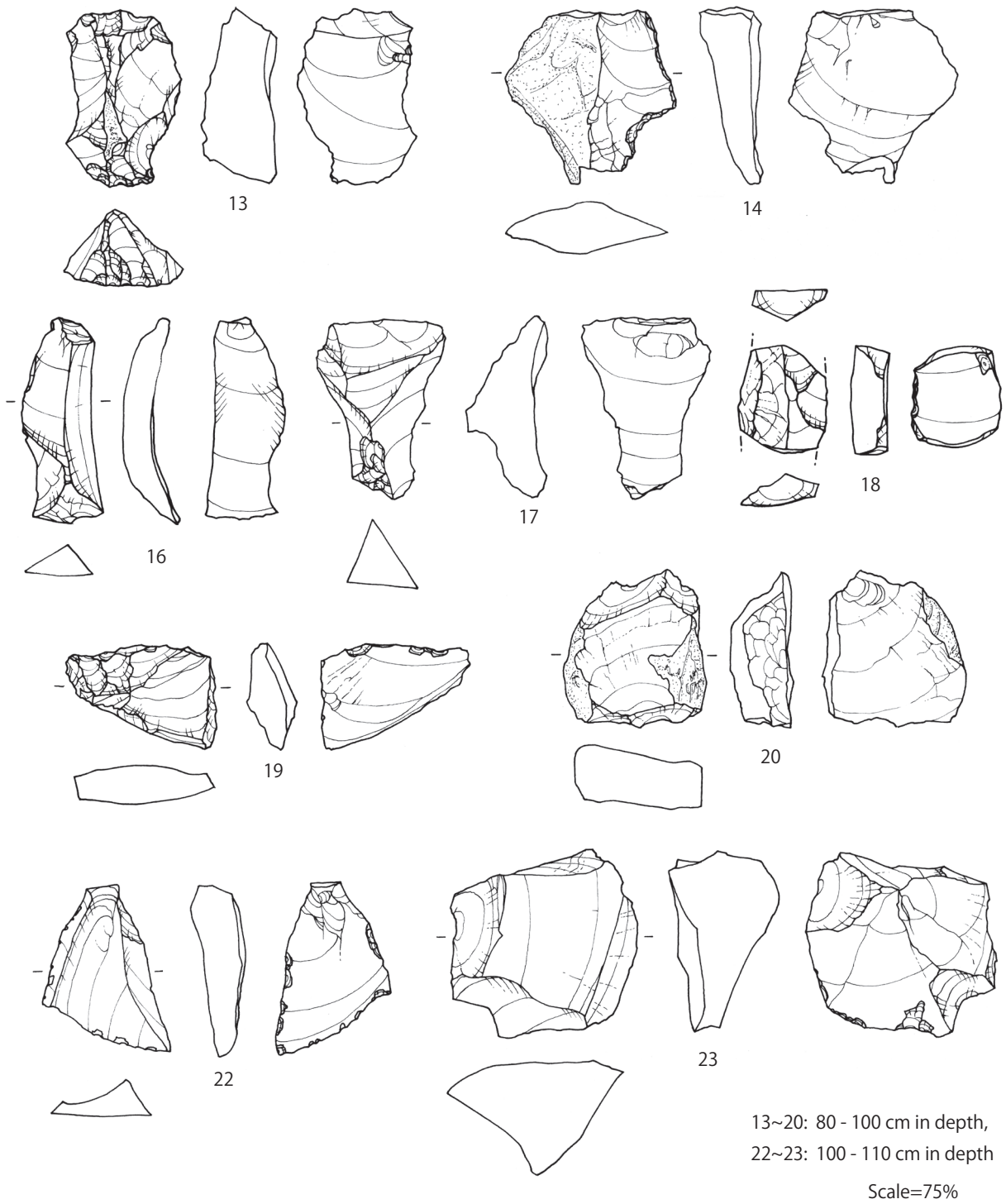


Fig.2 Lithic artifacts at the Loma Atahualpa site in 2018.

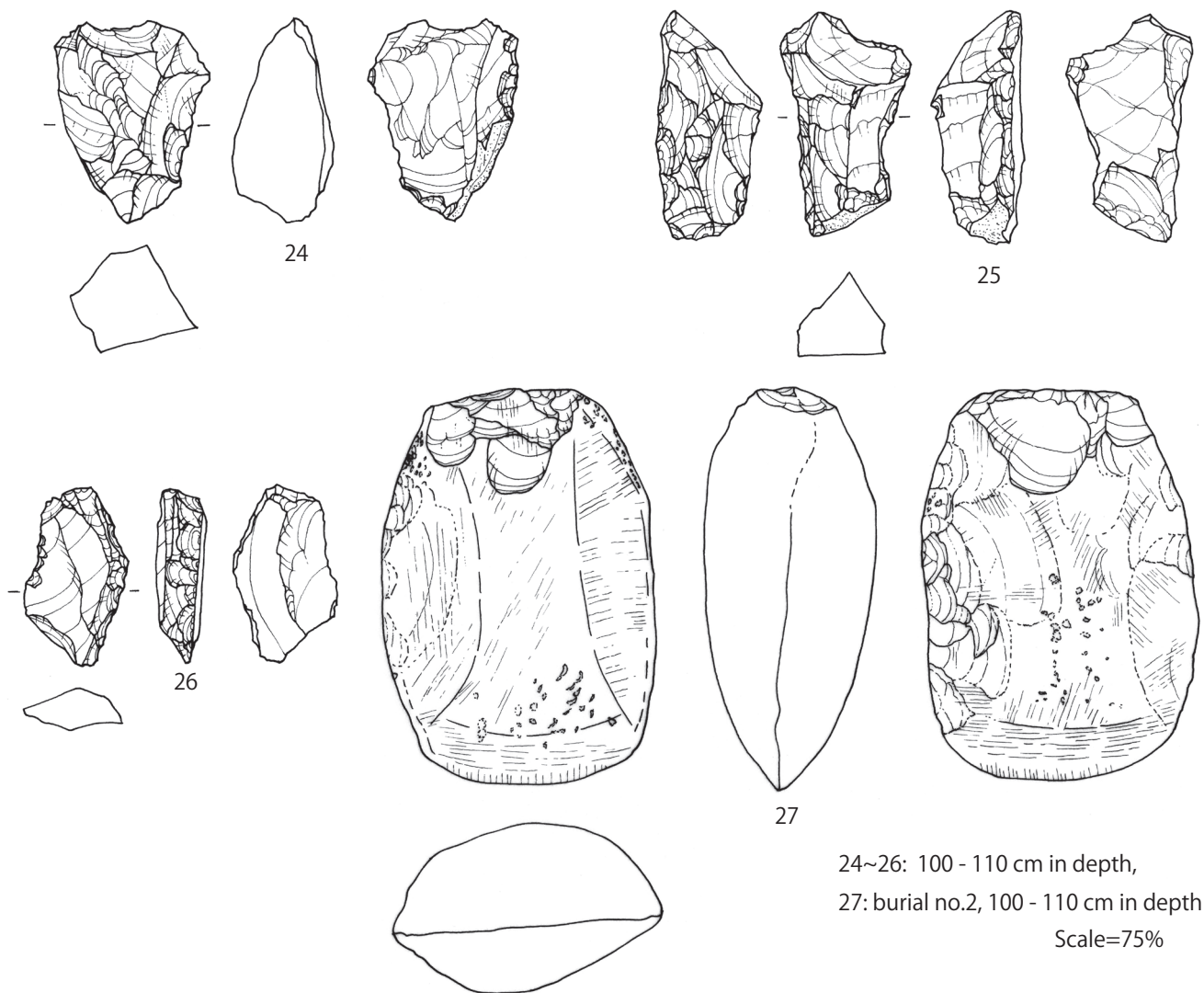


Fig.3 Lithic artifacts at the Loma Atahualpa site in 2018.

#### 4. Function

##### 1)Object

Object materials for use-wear analysis were unearthed from 80 to 100 cm (level 4) and 100 to 110 cm (level 5) below the ground surface. The vertical distribution of pottery and characteristics of lithic technology indicate that a cultural layer deeper than 80 cm from the surface would belong to the Late Las Vegas or Post Las Vegas period. Therefore, the objective of the use-wear analysis is to understand the function of stone tools in this period.

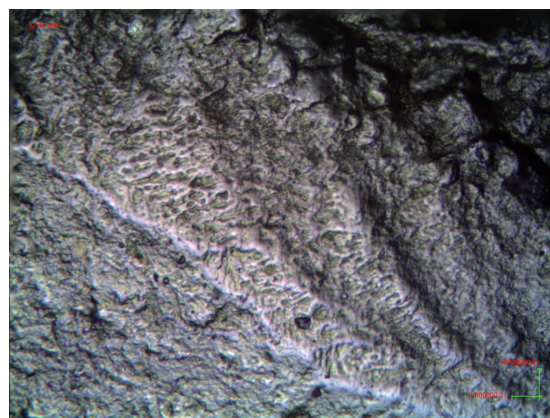
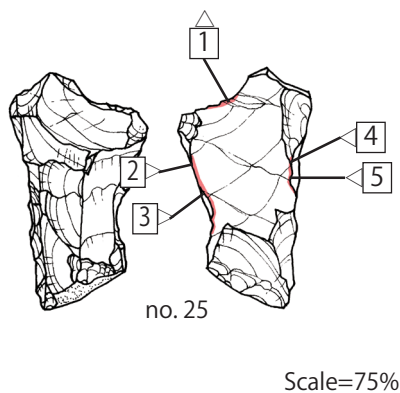
##### 2)Method

Use wear analyses were carried out by one of the authors

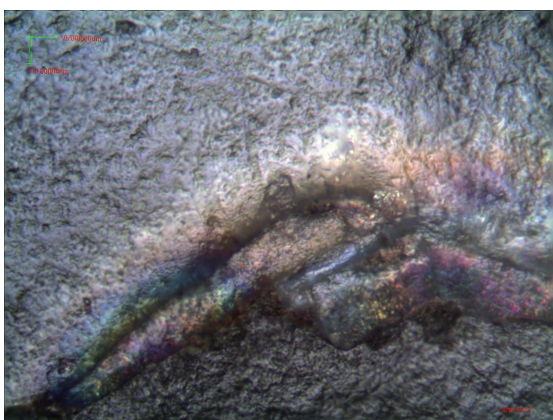
(Kanomata) at the Real Alto site from 2014 to 2017. The raw materials of the lithic tools recovered from the Real Alto and Loma Atahualpa sites included chalcedony, chert, and quartzite. Thus, the same methodology was applied in this analysis. As the authors excavated all of the materials in 2018, specific items were intentionally selected just after discovery and carefully washed. The authors observed lithic artifacts from 80 to 110 cm below the surface (levels 4 and 5) with the naked eye and tried to find stone tools that exhibited retouch, micro-flaking, and abrasion. Next, these materials were carefully examined under a metallurgical microscope (**OLYMPUS BH**). Microscopic photos were taken using a digital USB camera, and some of them were processed using image-composing software (**Helicon Focus**). Although

most lithic artifacts exhibited no apparent use-wear, four lithic tools with relatively obvious use-wear polishes and seven tools with unapparent use-wear were identified (Tab. 2). A microscope with magnification between 100× and 400×

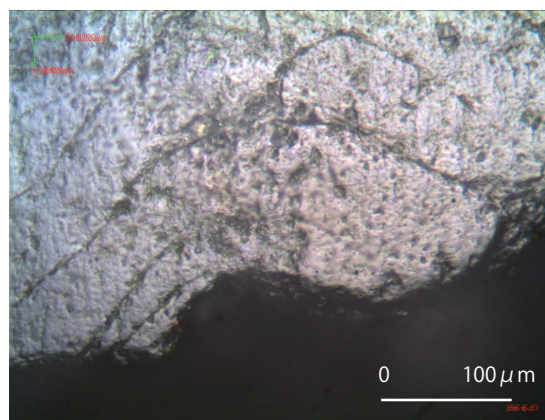
was used to classify micro-wear polishes. Systematic use-wear analysis was conducted using the “Keely method” (or the “high power approach”) to identify worked material and operation (Keely 1980, Akoshima 1989).



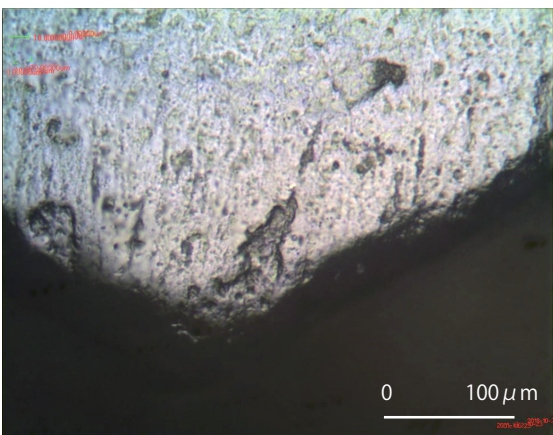
1 bone/antler polish and vertical striation (x200)



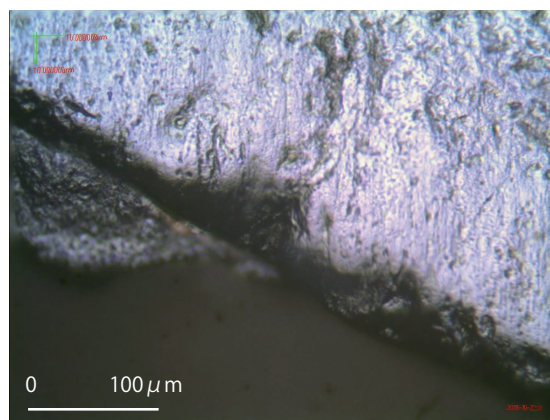
2 bone/antler polish and vertical striation (x200)



3 bone/antler polish and vertical striation (x200)



4 bone/antler polish and vertical striation (x200)



5 bone/antler polish and vertical striation (x200)

Fig.4 Use-wear on lithic artifacts at the Loma Atahualpa site in 2018.

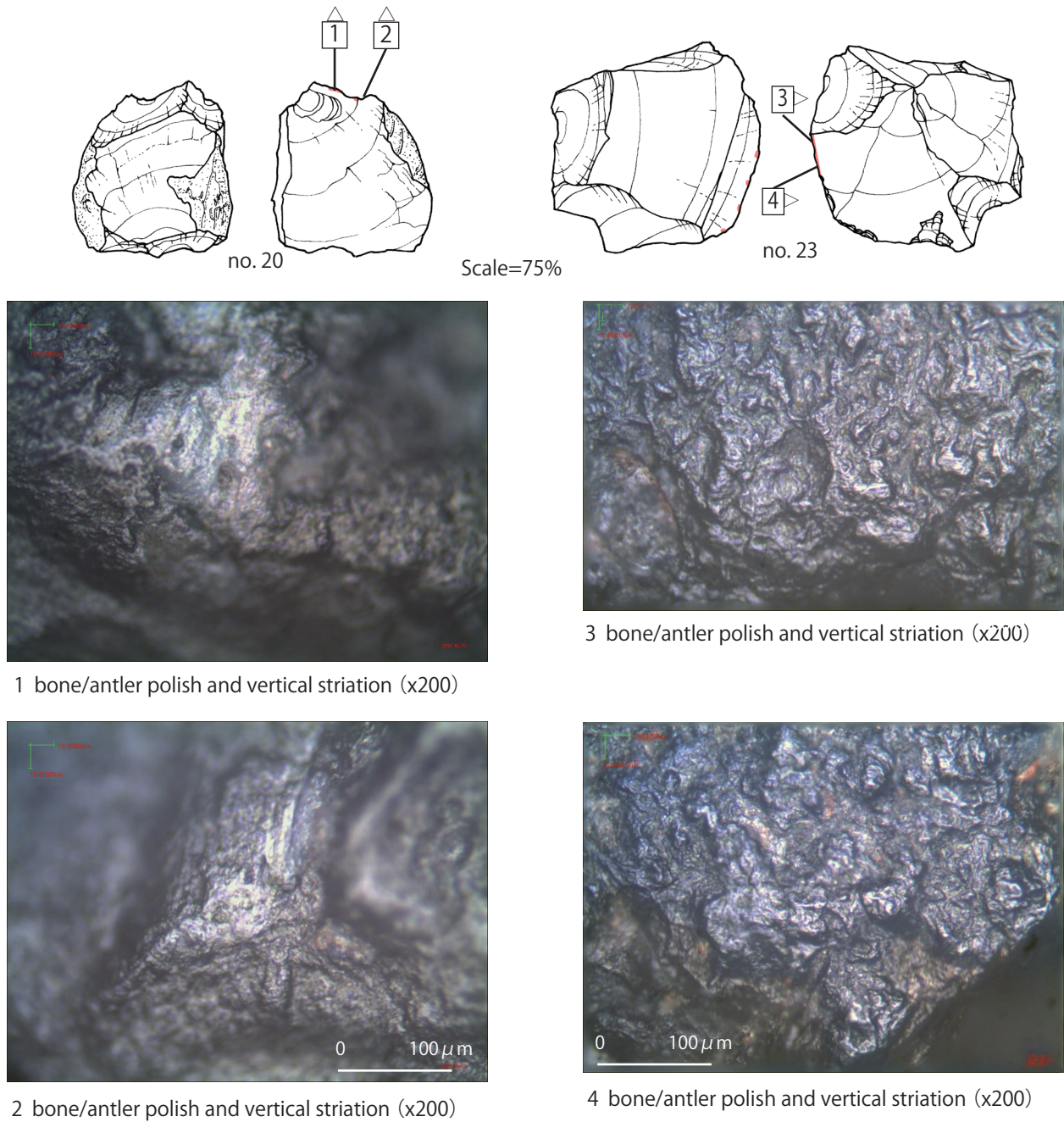


Fig.5 Use-wear on lithic artifacts at the Loma Atahualpa site in 2018.



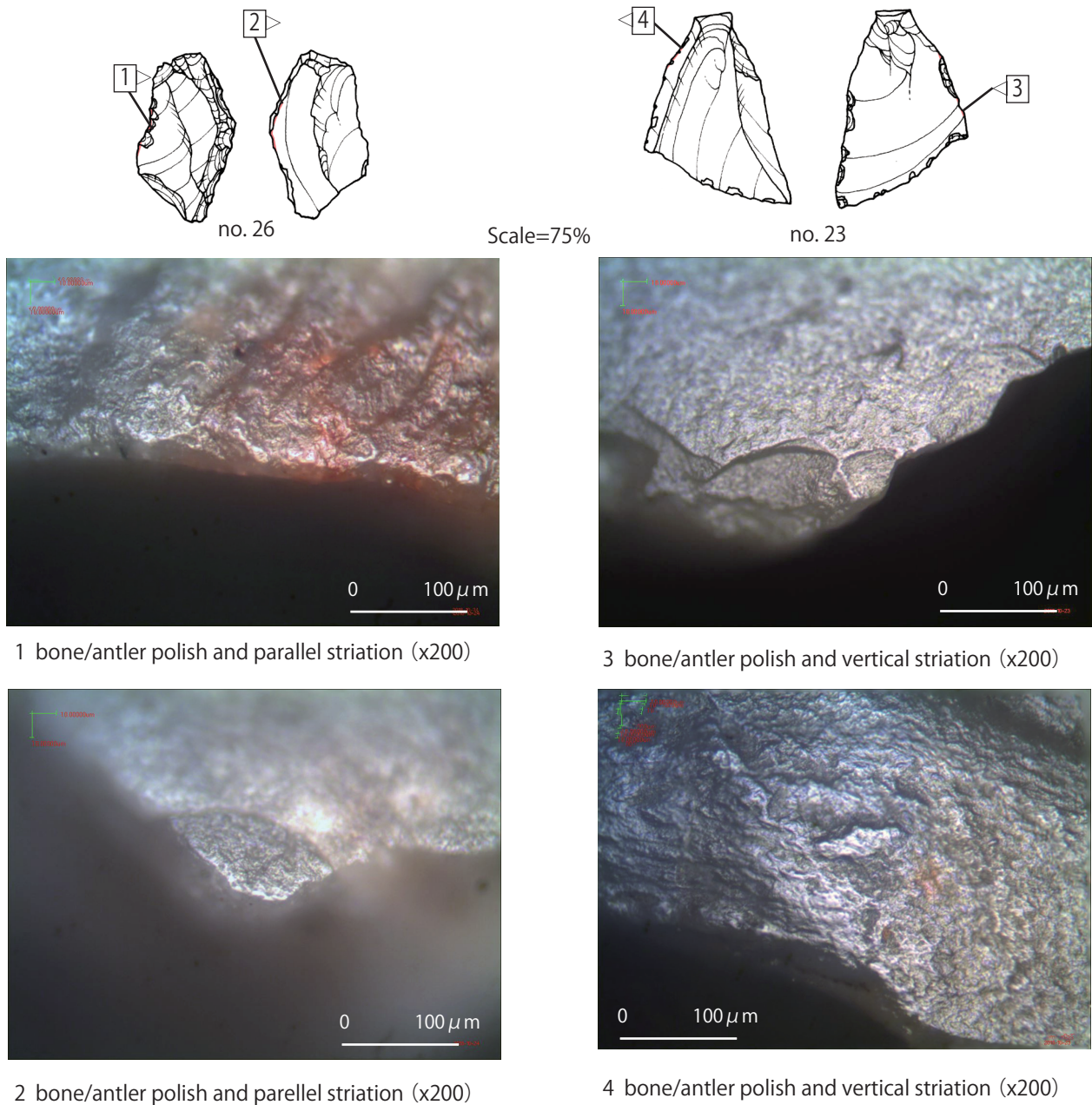


Fig.6 Use-wear on lithic artifacts at the Loma Atahualpa site in 2018.

### 3) Result

Denticulate no. 25 exhibited the most apparent use-wear pattern. This tool has three notched edges, with use-wear polishes formed at the central part of all edges (Fig.4). Polished surfaces with vertical striations exhibited characteristics of bone/antler use-wear pattern— a bright/flat surface, narrow/highly dense striations, and rounded edges. This means three independent use zones (IUZ: defined by Vaughan [1985a,]) for whittling bone/antler were recognized

on a lithic tool.

Notching and denticulate are related to whittling bone/antler. No. 20 exhibits a use-related polish with vertical striations on the center of the notched edge (Fig. 5–1 and 2). No. 12 shows the same traces on the notched edge at the distal end (Fig. 7–1 and 2 ).

The other tools were utilized for cutting/sawing activities. Edges that were not retouched were sharp enough to cut and saw relatively hard materials. The polished surface

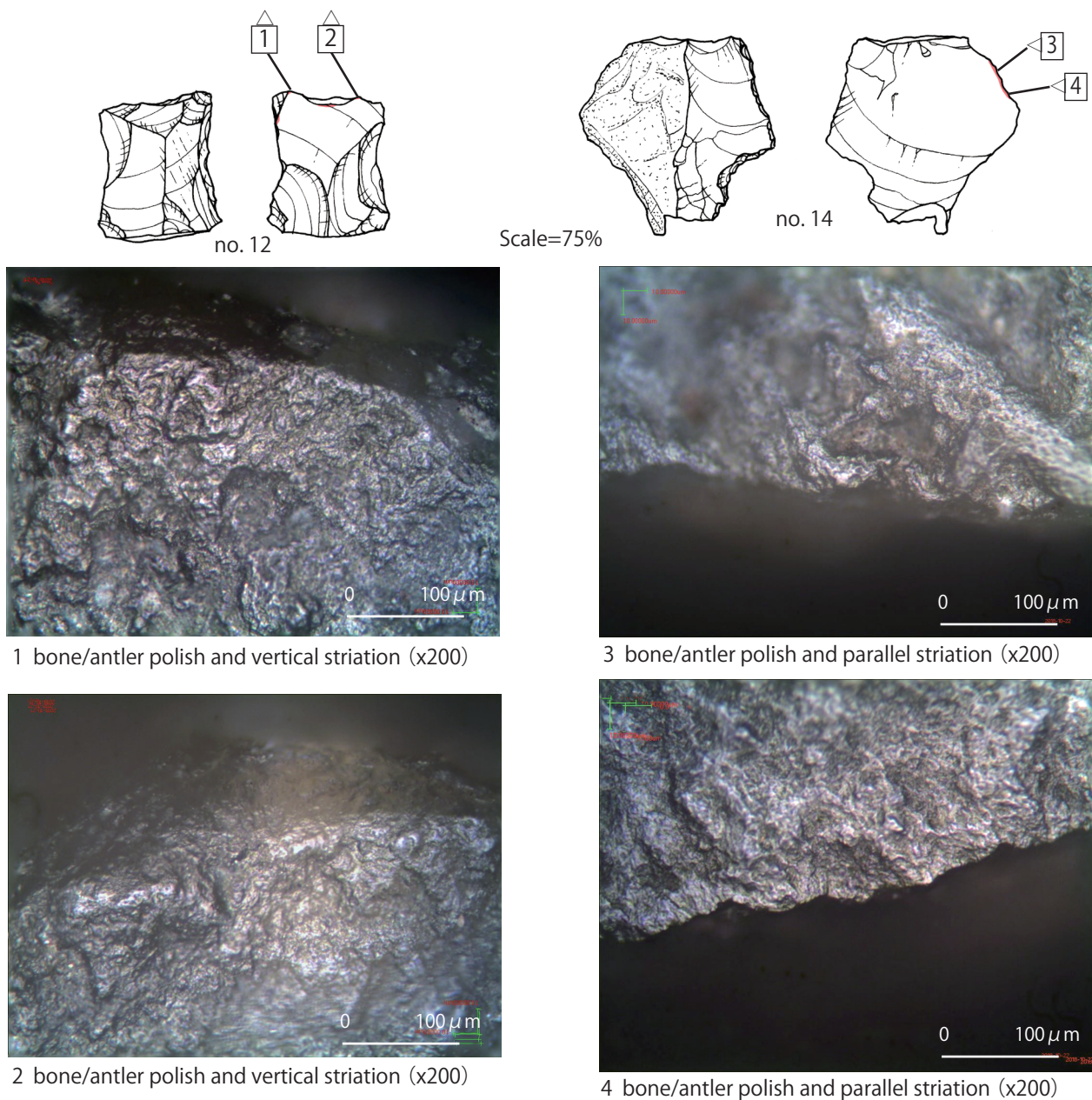


Fig.7 Use-wear on lithic artifacts at the Loma Atahualpa site in 2018.

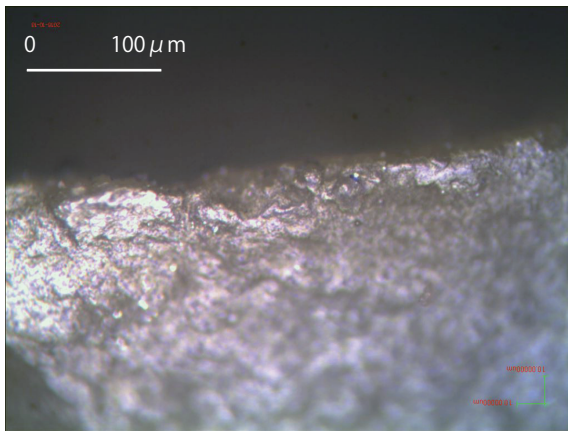
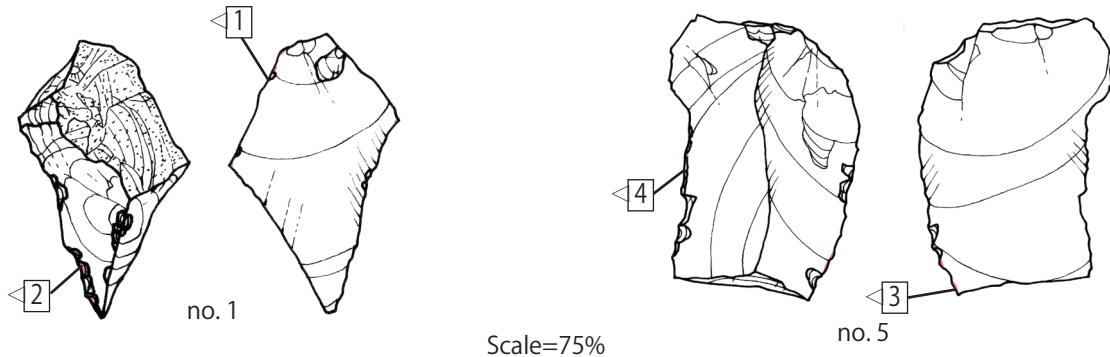
exhibits characteristics of cutting/sawing relatively hard materials such as wood and bone/antler (Fig. 5–3, 4, 6–3, 4, 7–3, 4, and 8 ). Although the development of the polish is not sufficient to classify worked material into wood or bone/

antler, the most probable worked material is bone/antler because there is no developed polish typical of working wood in this industry.

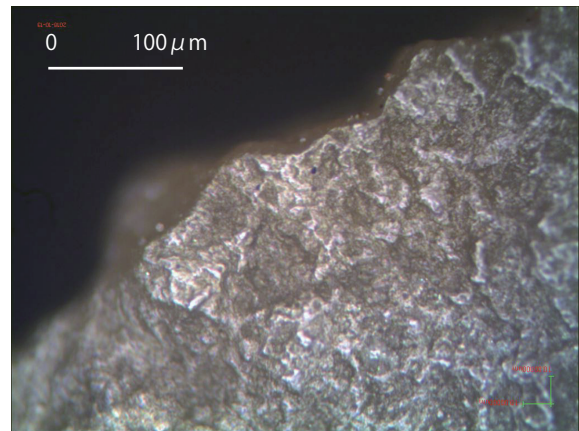
### 5. Polishing technology of the axe

Because an axe was discovered with burial no.2, it is important to know whether this axe was used. The axe was made of green mudstone with pecking, flaking, and polishing techniques. The author examined all the surfaces and edges of the axe not only to recognize use-wear but also to classify polishing technologies.

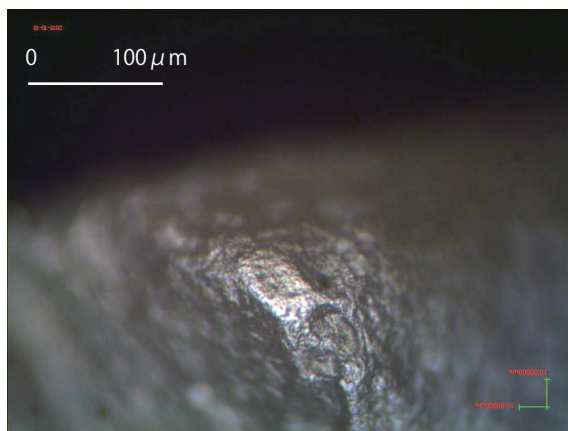
Removal of the face by knapping exhibits no striation in the area except for the ridge that contacted the polishing tool (Fig. 9-1 ). Pecking traces show overlapping pits without striation and polishing (Fig. 9-2). The polishing area indicates apparent and parallel striations with polish (Fig. 9-3 -6, 10-1 -6). The development of polish differs according to the degree of polishing activity. The brightest polish is shown in the central area of the axe. According



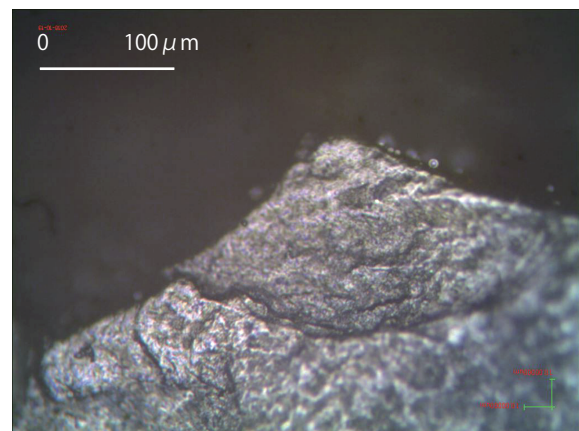
1 bone/antler polish and vertical striation (x200)



3 bone/antler polish and parallel striation (x200)



2 bone/antler polish and vertical striation (x200)



4 bone/antler polish and parallel striation (x200)

Fig.8 Use-wear on lithic artifacts at the Loma Atahualpa site in 2018.

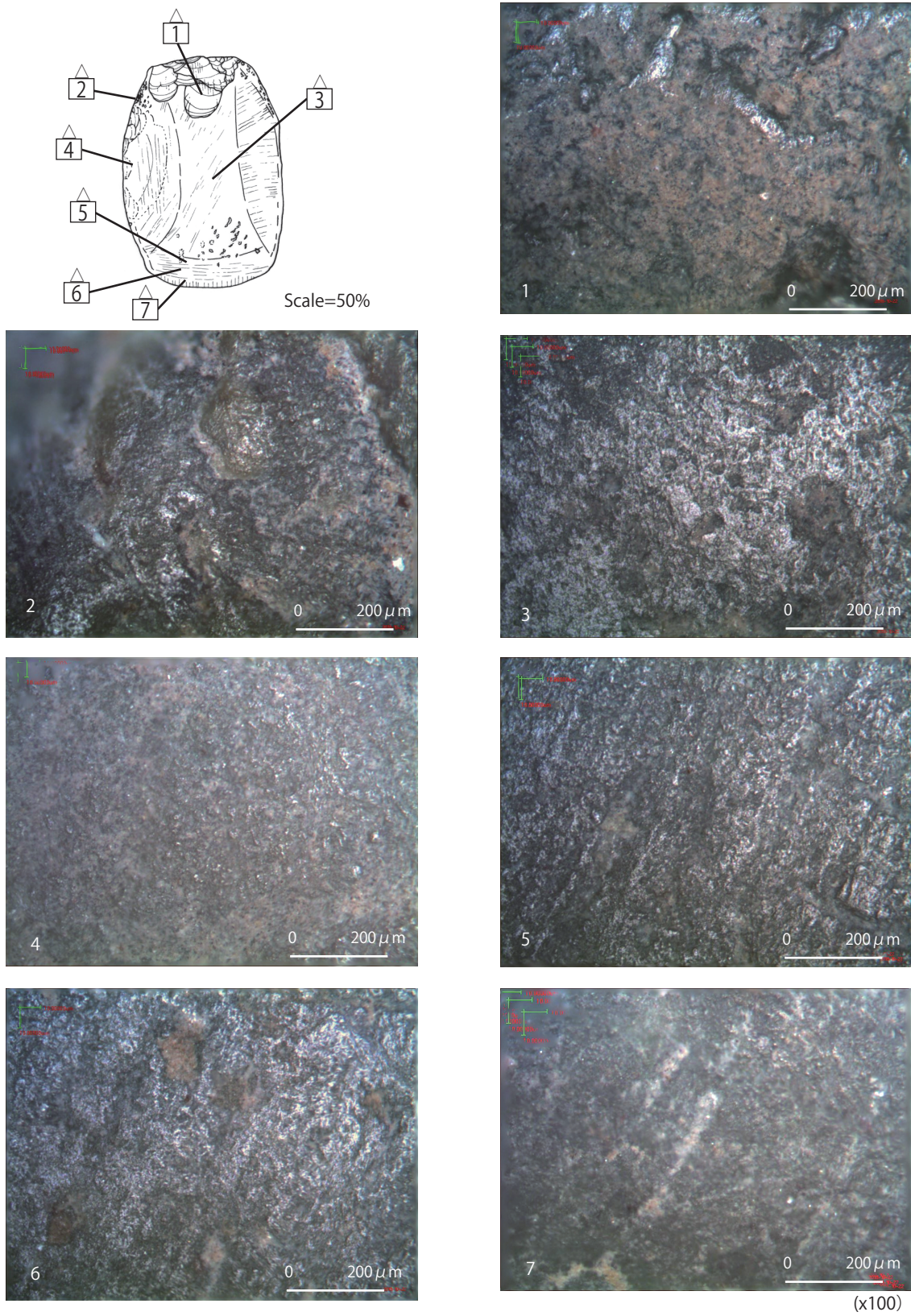


Fig.9 Polished surface and striations on the axe at the Loma Atahualpa site in 2018.

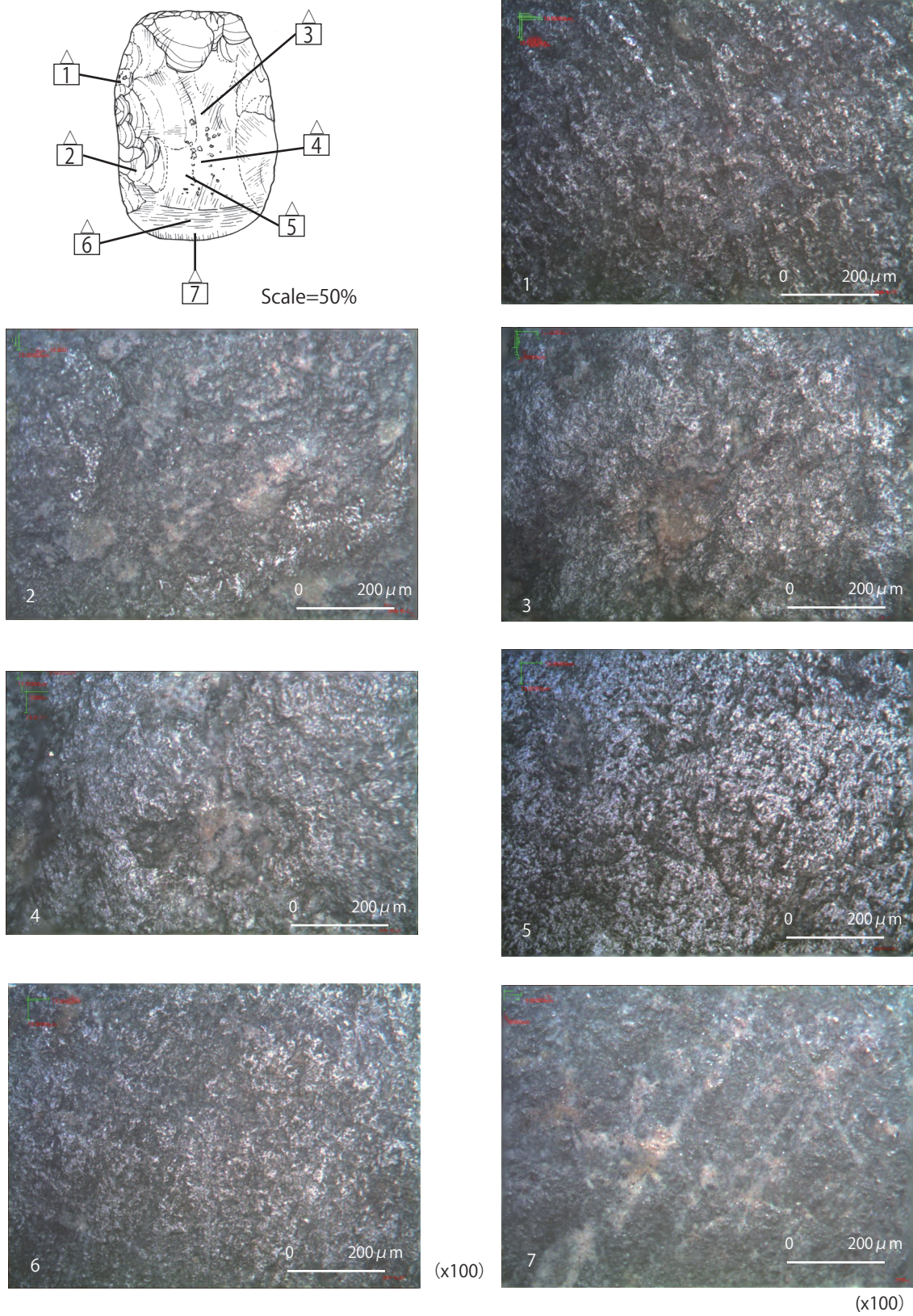


Fig.10 Polished surface and striations on the axe at the Loma Atahualpa site in 2018.

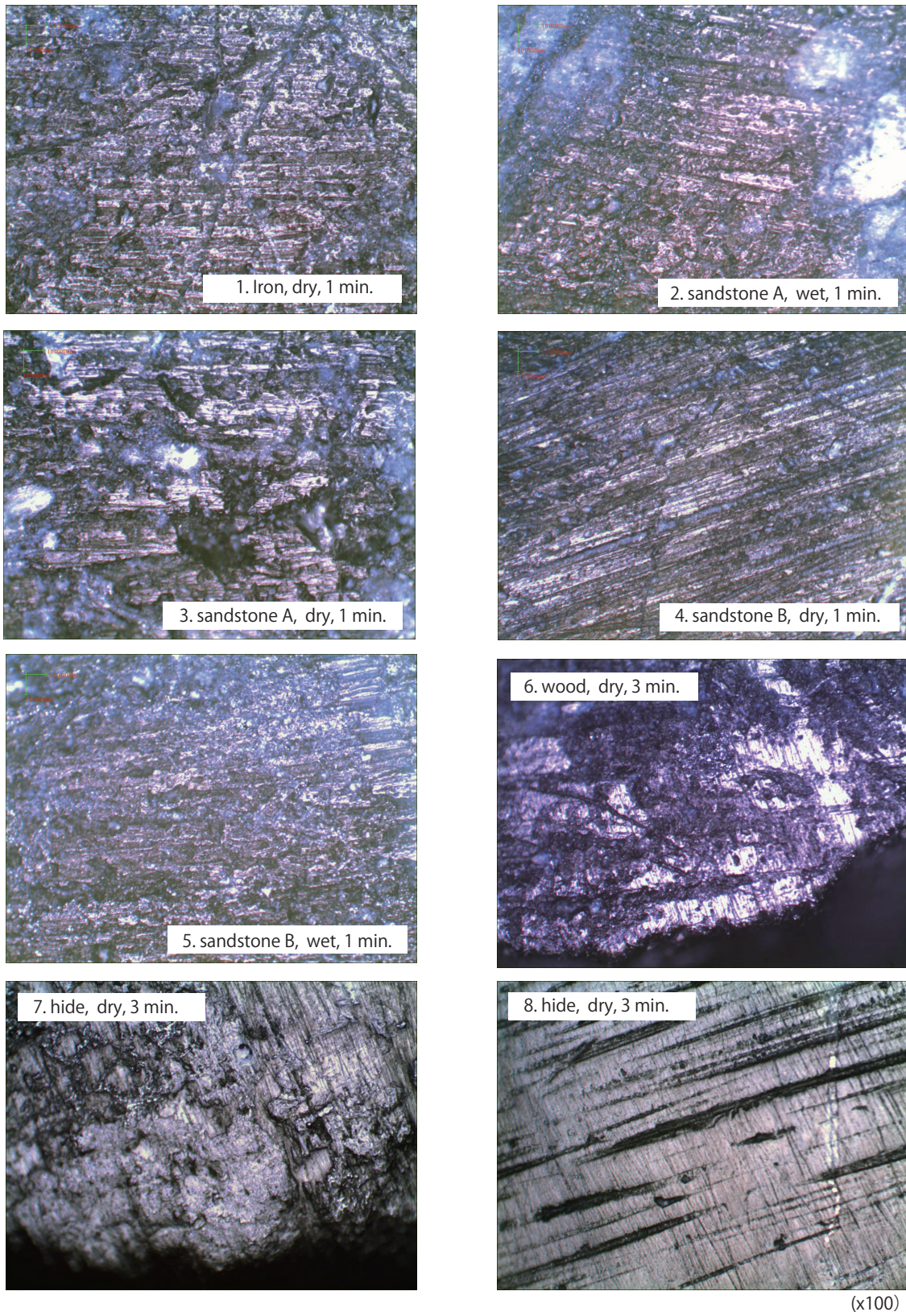


Fig.11 Polished surface and striations formed by experimentations.

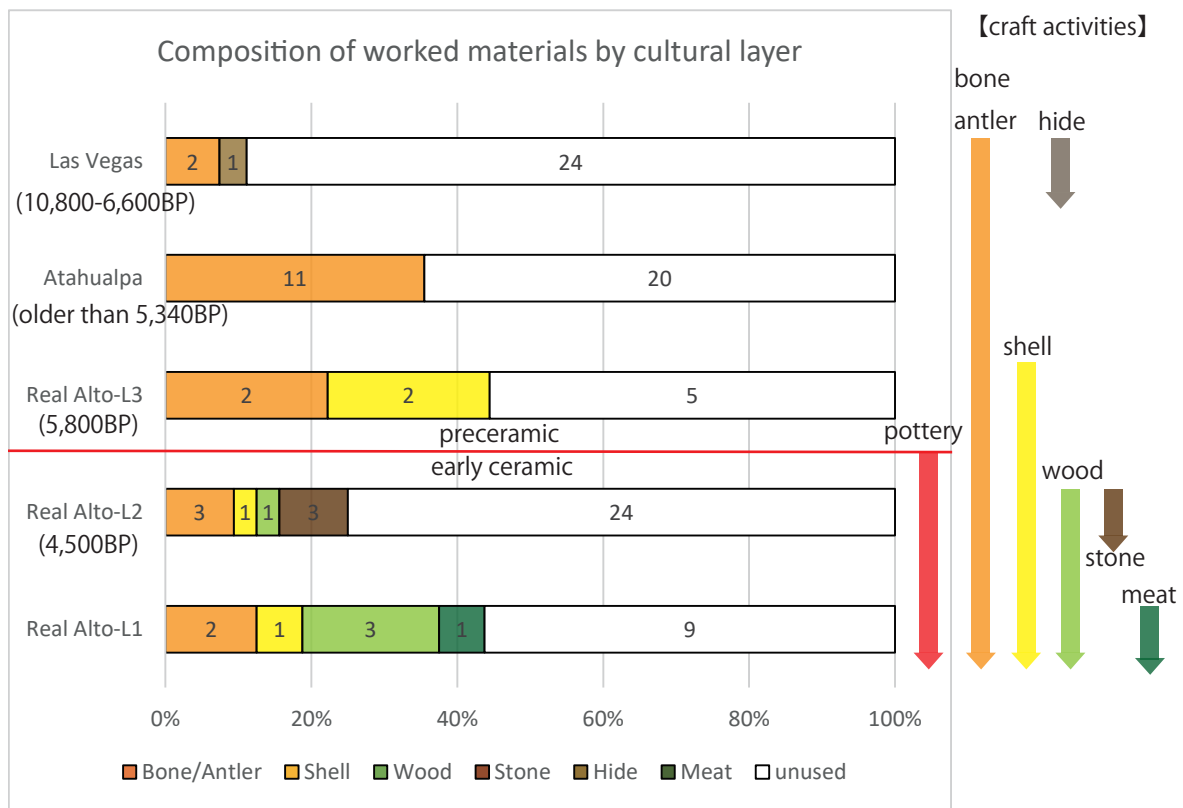


Fig. 12 Changes of lithic usage between Las Vegas and Early Valdivia cultures

to the experimentations, these traces are similar to those created by repetitive contact with sandstone under wet conditions (Fig.11-2 and 5). The supposed edge does not exhibit any polish despite the existence of apparent striations (Fig. 9–7 and 10–7). In general, soft materials, such as wood and hide, will produce a bright and rounded polish with narrow/sharp striations (Fig. 11–6, 7, and 8). In summary, it is highly probable that an unused or resharpened axe was buried with human body no. 2. The hafting trace is also unclear.

### 6. Summary and Further Prospects

Technological and functional research results were gradually accomplished by the authors at the Las Vegas OGSE-80 (Kanomata et al. 2014), Real Alto (Kanomata et al. 2014, Tabarev and Kanomata 2015, Kanomata et al. 2019a), and Loma Atahualpa sites. Because these materials belonged to the Early-Middle Las Vegas and Early Valdivia cultures, technological and functional changes could be examined chronologically. Twenty-seven lithic artifacts were analyzed using a microscope and three tools exhibiting use-

wear were identified at the OGSE-80 Las Vegas type site (Fig. 12). It was determined that two of them were used for bone/antler processing and the third for hide scraping. In the lower level of the Loma Atahualpa site, attributed to the Late Las Vegas culture, lithic tools were used for basic bone/antler processing. Tools recovered from the lowest level of the Real Alto site, also attributed to the Late Las Vegas culture, were used primarily for bone/antler and shell processing. These sites and cultural layers were commonly attributed to the preceramic period. In the Early Valdivia culture, various processing activities were identified at levels 2 and 1 at the Real Alto site. Wood and stone processing were identified in addition to bone/antler and shell workings. In addition, extensive use wear traces were created by the larger number of lithic tools. Thus, it can be inferred that various natural resources have been utilized for processing activities since the emergence of pottery. Such changes in lithic tool usage reflect developments in the social-economic structure, including a transition in subsistence from mobile hunter-gatherers to early agriculturists.

## ACKNOWLEDGEMENT

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和文要旨

# エクアドル・ロマ アタウアルパ遺跡の先土器時代における石器の機能

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## 1. はじめに

1950年代以降、最古の土器は、エクアドル沿岸の形成期・前期バルディビア文化の資料に属していた。バルディビア文化の最も重要な遺跡のひとつが、1970～80年代に発掘

されたレアルアルト遺跡である。一連のフィールド調査は、初期農耕民の小さな居住地から、人工的なマウンドや広場をもつ巨大な集落、そして後に南米最古の地域センターへ至る進化に関する多くの正確な情報をもたらした (Marcos 1988)。不運にも、バルディビア文化遺跡群の集中的な調査



は1980年代半ば以降中断した。そのため、幾つかの重要な考古学的な課題が30年近く未解答のまま残されている。

2014、2015、2017年に、ロシアとエクアドル、日本の考古学者によって、レアルアルト遺跡の新たな発掘が実施された (Popov et al 2017)。その第一の目的は、前期土器時代のバルディビア I やサンペドロ土器を含む最古の土器文化を発見することであった。そして、ついに筆者らはレアルアルト遺跡における最古の文化、約 5,800 BP (6655-6563calBP) の無土器文化を発見した。そこでは多数の石器が出土し、技術型式学と使用痕分析の観点で分析された (Tabarev and Kanomata 2015, Kanomata et al. 2019b)。筆者らは、エクアドル沿岸部の狩猟採集民から初期農耕民への移行期のために「トロピカルパッケージ」というオリジナルのモデルを提示した。さらに、バルディビア I やサンペドロ土器の新たな放射性炭素年代が 4640-4450BP (5470-4880calBP) と提示された (Tabarev et al 2016, Kanomata et al. 2019b)。サンタエレナ半島では、土器を伴うラスベガス文化と同様に、土器をもたない前バルディビア文化を指摘できた。したがって、次の標的は後期ラスベガス文化の正確な年代と特徴を理解するために選ばれた。

## 2. ロマアタウアルパ遺跡における新たな発掘

2017年10月、サンタエレナ州のロマアタウアルパ遺跡 (アタウアルパ66) で、小さな試掘区が掘られ、地表下95cmから埋葬人骨1体が発見された。文化層には土器が含まれないので、この埋葬は先土器時代に属したであろう。AMS年代は地表下80～100cmに位置する炭化物試料から得られた (Tab. 1)。埋葬近くの1点の放射性炭素年代は先土器時代の年代 (5,340±30BP) を示し、埋葬から少し離れたものはより新しい年代 (3,280±30BP) を示した。これらの結果によれば、埋葬はラスベガス文化に属し、この遺跡が我々の研究目的に最適の遺跡であることを示している。

2018年、J. G. マルコスと A. N. ポポフ、A. V. タバレフによって、第2次発掘調査が企画された。このプロジェクトは、ロシアとエクアドル、日本の考古学者の協力によって再び実践された。中央発掘区 (no.1) の面積は 28 m<sup>2</sup> であり、一つのトレンチ (no.1, 4 m<sup>2</sup>) と5つの試掘区 (no.1-5、各 2 m<sup>2</sup>) を伴う。中央発掘区の基本層序は、以下の6つの層で構成される。

- 1層：灰色がかかった固い砂 (深さ 10-40cm)
- 2層：暗褐色から暗灰色の砂質粘土 (深さ 40-60cm)
- 3層：アカガイを伴う暗褐色から暗灰色の砂質粘土 (深さ 60-80cm)
- 4層：暗褐色から暗灰色の砂質粘土 (深さ 80-100cm)
- 5層：アカガイを伴う暗褐色から暗灰色の砂質粘土 (深さ 100-120cm)
- 6層：黄色がかかった茶色の固い砂 (深さ 120cm 以下) 無遺物の基盤

3体の埋葬人骨が中央調査区の下層から発見された。それらは地表下100cm程に位置する。2号埋葬は、1・3号埋葬を覆う貝層に含まれていた。1号埋葬は2017年に試掘区から見つかったものである。3号埋葬に最も近い炭化物を放射性炭素年代のサンプルとして取り上げた。不運にも、AMS法で測定された年代は 2,950±30BP であり、より上位の2点の年代よりも新しかった。言い換えれば、放射性炭素年代測定の結果は、地表下の動物の巣穴や乾裂など、上層からのコンタミの存在を意味している。中央調査区底部の基盤層に認められる土壌亀裂は、コンタミの形成と関係するに違いない。

中央調査区では、たくさんの土器片が出土した。その95%以上は、地表下0～80cmから出土した。これらは、型式学的に後期バルディビアかマチャリーラ、ワンガラ-マンテーニャ文化に属する。したがって、80cm以下の遺物は、先土器時代に属すると考えられる。

現在、土器や石器に関する詳細な分析が進められているので、以下では、技術と機能の観点から先土器文化の石器の特徴を概説する。

## 3. 石器の技術

筆者らは3000点以上の資料 (その99%が剥離時の副産物) の中から30点の石器を抽出し、Fig.1～3に示す実測図を作成した。選ばれた資料は、鋸歯縁石器8点、エンドスクレイパー1点、剥片3点、微小剥離痕ある剥片3点、ノッチ2点、ノッチのあるスクレイパー1点、二次加工ある剥片9点、スクレイパー2点である (Tab. 2)。これらは、玉髓 (10点)、チャート (16点)、ジャスパー (2点)、石英 (2点) から作られる。この石材組成は、剥片石器の製作のために、製作者が意図的に硬くてケイ酸分に富んだ原石を選択したことを示している。剥片石器の平均的な法量は、長さ37.4mm、幅26.6mm、厚さ12.1mmである。剥離角の平均値は109.3°である。素材剥片の剥離は、ハードハンマーによる直接打撃によって行われ、両極剥離の存在は不明瞭である。二次加工は、同様な剥離法で行われる。打撃で生じた多くの円形のクラックが剥片石器の表面に観察される (Fig. 13-4, 11, 14-13)。これらの痕跡は、二次加工時の剥離の失敗を示している。

筆者らの研究に基づけば、これらの技術的特徴は、ラスベガス文化や前期バルディビア文化と共通する (Tabarev and Kanomata 2015)。技術型式学的な観点では、これらの石器がラスベガス文化と前期バルディビア文化のいずれに属するかを区別することは難しい。

## 4. 石器の機能

### 1) 対象

使用痕分析の対象資料は、地表下80～100cmと100～

110cmから出土している。土器の垂直分布と石器の技術的特徴は、地表下 80cm以下が先土器時代であることを示し、後期ラスベガスか後ラスベガス文化に属するだろう。したがって、使用痕分析の目的は、この時期の石器の機能を明らかにすることである。

## 2) 方法

筆者の一人（鹿又）によって、2014～2017年にリアルアルト遺跡の使用痕分析が実施された。リアルアルト遺跡の石器石材は、基本的に玉髓とチャート、石英であり、ロマアタウアルパ遺跡と同様である。したがって、同じ方法が本分析でも実践された。全ての遺物は、我々自身の手で2018年に発掘されたので、対象資料は発見直後に意識的に選択され、注意深く洗浄された。筆者らは、地表下 80～110cmの石器を肉眼で観察し、二次加工や微小剥離痕、摩滅がある石器を見つけようと試みた。その後、これらの資料が金属顕微鏡（OLYMPUS BH）を使って詳細に観察された。顕微鏡写真は USB カメラを使って撮影され、その一部は画像合成ソフト（Helicon Focus）によって加工された。ほとんどの資料には明瞭な使用痕が確認できなかったが、比較的明瞭な使用痕光沢が確認される石器 4 点と、不明瞭ながら使用痕が確認された石器 7 点が結果的に抽出された (Tab.2)。顕微鏡倍率は 100～400 倍が使われ、微小な使用痕光沢を分類するために用いられた。被加工物や操作方法を推定するために、システムティックな使用痕分析が「キーリーメソッド」や「高倍率法」を用いて行われた (Keely 1980, Akoshima 1989)。

## 3) 結果

最も明瞭な使用痕パターンが鋸歯縁石器 (no. 25) に認められた。この石器には 3 か所のノッチ状の刃部が認められ、使用痕光沢はこれら全ての刃部の中央に形成されている (Fig.4)。直交の線状痕をもつ光沢面は、明るく平坦な表面で、細く高密度の線状痕と丸い刃縁をもち、骨・角の使用パターンの特徴がある。つまり、骨角削りに用いられた 3 つの独立使用部位 (IUZ (Vaughan 1985a)) が 1 点の石器に認められる。ノッチと鋸歯縁石器は基本的に骨角削りと関係する。No.20 は直交の線状痕をもつポリッシュがノッチ状の刃部の中央に位置する (Fig.5-1, 2)。No. 12 は遠位端のノッチ状の刃縁に同様の痕跡をもつ (Fig.7-1, 2)。

他の石器は、切断行為に用いられた。二次加工のない使用刃部は、比較的硬い物質を切断するのに十分に鋭利である。使用痕光沢は木や骨角のような比較的硬質の資料の切断の特徴を示す (Fig. 5-3, 4, 6-3, 4, 7-3, 4, fig. 8)。ポリッシュの発達は、被加工物が木か骨角かを区別するには十分ではないが、本石器群には発達した木の使用痕がないため、おそらく被加工物は骨角であろう。

## 5. 石斧の研磨技術

石斧 1 点が 2 号埋葬に伴って発見されたので、その石斧が使用されたか否かを知ることは重要である。石斧は緑色泥岩製で敲打と剥離、研磨の技術によって製作された。筆者は使用痕を確認するためだけでなく、研磨技術を分類するために、石斧の表面と刃部を観察した。

打撃による剥離面は、研磨具と接触した稜線を除き、その範囲に線状痕がない (Fig.9-1)。敲打痕は線状痕や光沢のない重複するピットを呈している (Fig.9-2)。研磨された範囲は、光沢を伴って明瞭な平行の線状痕が認められる (Fig.9-3~6, 10-1~6)。光沢の発達は、研磨行為の程度によって異なる。最も明るい光沢は、石斧の中央部に認められる。実験によれば、これらの痕跡は砂岩製砥石との反復的な接触による痕跡に似ている (Fig.11-2, 5)。推定される刃部には、明瞭な線状痕があるにも関わらず、全く光沢がない (Fig. 9-7, 10-7)。一般に、木や皮のような柔らかい物体は、細く鋭い線状痕を伴った明るく丸みのある光沢を生じる (Fig. 11-6, 7, 8)。結論として、未使用または刃部再生された石斧が埋葬人骨 no.2 と共に埋納された可能性が高い。石斧には着柄痕も不明瞭であった。

## 6. 総括と展望

技術と機能に関する研究結果は筆者らによるラスベガス OGSE-80 遺跡 (Kanomata et al 2014) やリアルアルト遺跡 (Kanomata et al. 2014, Tabarev and Kanomata 2015, Kanomata et al. 2019a)、そして本論のロマアタウアルパ遺跡で徐々に蓄積されてきた。これらの資料は前～後期ラスベガス文化や前期バルディビア文化に属するため、技術と機能の変化が編年的に説明できる。ラスベガス文化の標識遺跡である OGSE-80 遺跡では、石器 27 点が顕微鏡を使って分析され、うち 3 点に使用痕が確認された (Fig. 12)。そのうち 2 点は骨角加工に、もう 1 点が皮なめしに用いられている。後期ラスベガス文化に属するロマアタウアルパ遺跡の下層では、石器が基本的に骨角加工に使用されている。後期ラスベガス文化に属するリアルアルト遺跡の最下層では、主に骨角と貝の加工に用いられている。これらの遺跡と文化層は共通して先土器時代に属する。前期バルディビア文化では、リアルアルト遺跡のレベル 1 と 2 で様々な加工活動が認められる。木と石の加工が骨角と貝の作業に加えられる。さらに、過度な使用痕がより多くの石器の上に生じている。したがって、土器の出現以降、様々な自然資源が工芸的活動に利用されるようになった。そのような石器使用の変化は、社会経済構造の変化を反映している。また、移動的な狩猟採集民から初期農耕民への生業の移行をも反映している。

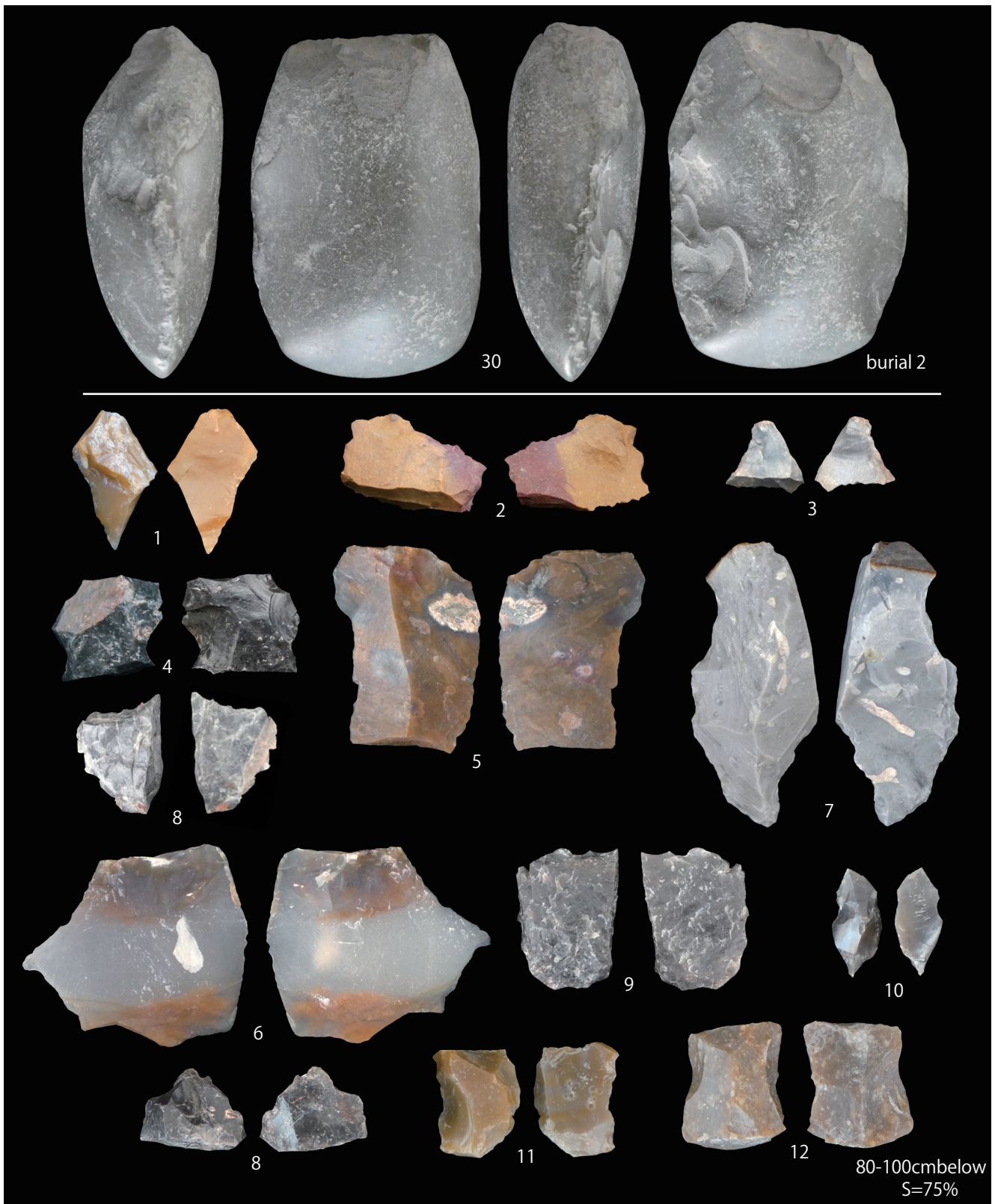


Fig.13 Lithic artifacts at the Loma Atahualpa site in 2018.

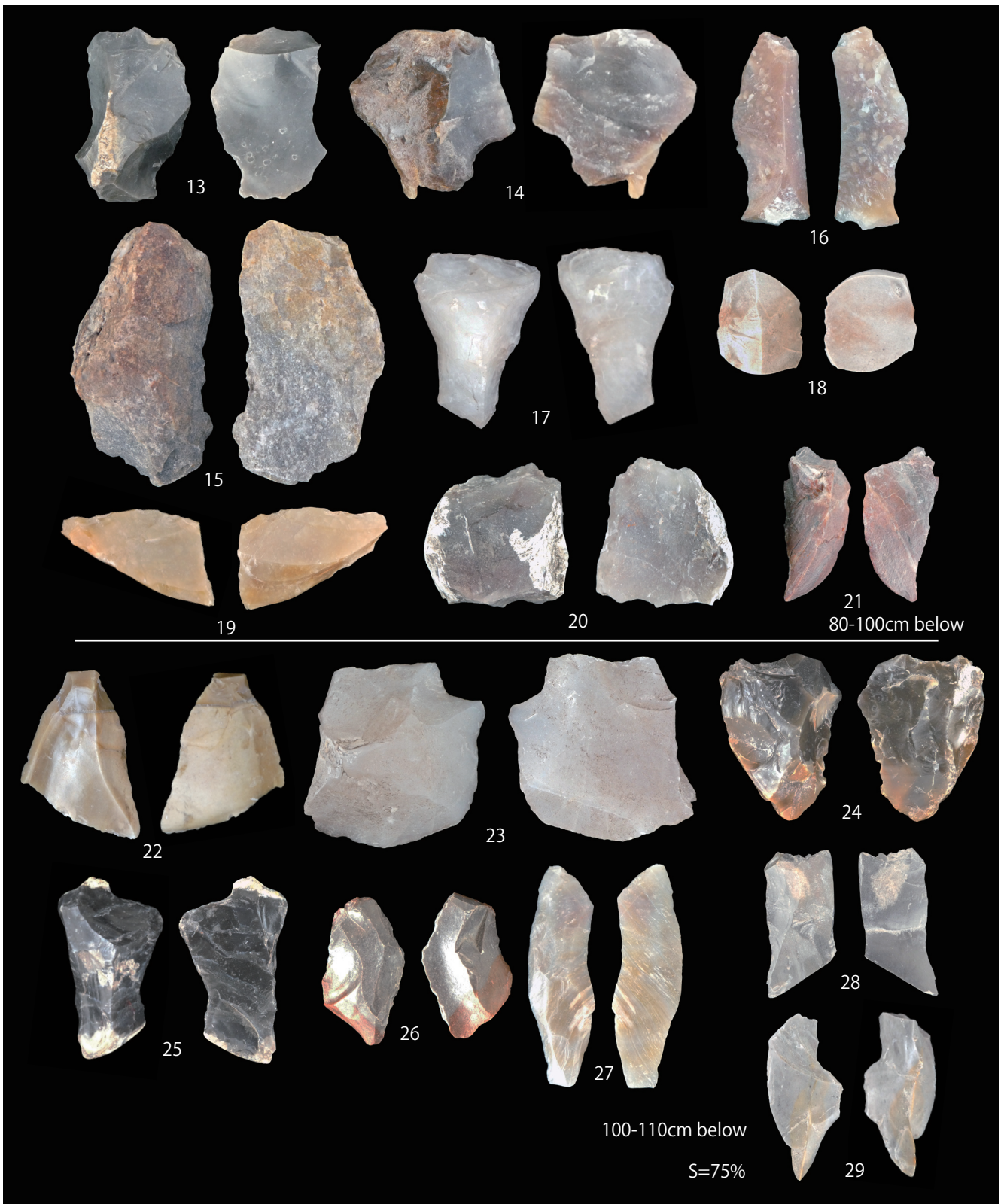


Fig.14 Lithic artifacts at Loma Atahualpa site in 2018.