The Peñablanca Flake Tools:
An Unchanging Technology?

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Abstract

Three caves were excavated in Peñablanca, northeastern Luzon in 2003. These caves yielded flake tools from earlier preceramic contexts (c. 25,000-3,500 BP) and later ceramic ones (c. 3,500-1,980 BP). Technological and use-wear analyses were conducted to test if there was any change in techniques of manufacture or use of the flake tools through time. The oldest flake assemblage in Callao cave (c. 25,000 BP) reveals a probable formal lithic technology with a predominance of blade-like flakes and two probable spear points. The Holocene assemblages indicate no significant changes in manufacturing techniques throughout the whole sequence, being based on a simple hard hammer percussion technique. Use-wear analysis also indicated no significant change, with flakes being utilised on hard and soft contact materials. This paper presents a scenario in which hunter-gatherer populations have coexisted during the past 3,500 years with agricultural populations living on the Cagayan Valley alluvial soils.

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Introduction

Studies of prehistoric human adaptation and culture rely heavily on stone tools for background data. Their durable characteristic makes them one of the few cultural materials to survive the test of time. Knowledge of how a stone tool was manufactured, used, and discarded may be useful to extrapolate past human behaviour.

In 2003, I excavated three cave sites in Peñablanca, Cagayan Province, Northeastern Philippines (Mijares 2005). The excavation is an attempt to understand the transition from Upper Paleolithic to Neolithic in Northern Luzon. The region contains a number of caves, most of which contain archaeological materials. Previous excavations by Thiel (1980), Ronquillo (1981), and myself (Mijares 2002) showed the widespread existence of two successive cultural units. In general, lower layers contain lithic implements, animal bones, and riverine shells, while the higher layers have the same kind of assemblage, with the addition of earthenware sherds. The stratigraphic distinction between two cultural deposits makes the Peñablanca caves promising for understanding the changes between the two periods. On the contrary, the open sites in the Cagayan Valley contain only Palaeolithic or Neolithic assemblages but not both in succession.

This paper will focus on flake tools, since the stone implements recovered from the cave sites are primarily flakes, rather than pebble or core tools. Previous lithic analyses in the area have not been able to discriminate between lower preceramic flakes and upper ceramic period flakes. This study will attempt to analyse the flake tools and compare them between sites and between the two archaeological periods. The aim of the lithic analysis is to search for any changes in manufacturing techniques and functions of the flakes through time.

The Archaeology of Peñablanca

The Peñablanca Caves are located within the Callao Limestone Formation, a 540-metre thick deposit, which is primarily composed of calcarenites (Durkee and Pederson 1961), in the foothills of the Sierra Madre in Northeastern Luzon (Figure 1). The Pinacanauan de Tuguegarao River, a tributary of the larger Cagayan River, dissects the Callao Formation into separate northern and southern sections.

In 1976 to 1977, archaeological exploration of caves in search of Palaeolithic sites in the Callao limestone formation was conducted by the

National Museum of the Philippines (Figure 2). Extensive explorations resulted in the identification of 43 caves and rockshelters containing archaeological materials on their surfaces (Ronquillo n.d.; Ronquillo and Santiago 1977).

Since then, a number of caves in the Callao limestone formation have been excavated between 1976 and 1982, and in 1999 (Figure 2). The caves excavated in the southern section were Rabel, Laurente, Alejandro Malanos, and Pedro Pagulayan (Henson 1977; Ronquillo 1981). In the northern section lie Arku, Musang, Lattu-Lattuc, Callao, and Minori caves (Cuevas 1980; Dalupan 1981; Mijares 2002; Thiel 1980, 1990a, 1990b). During 2003, I excavated Eme and Dalan Serkot Caves and re-excavated Callao Cave (Mijares 2005).

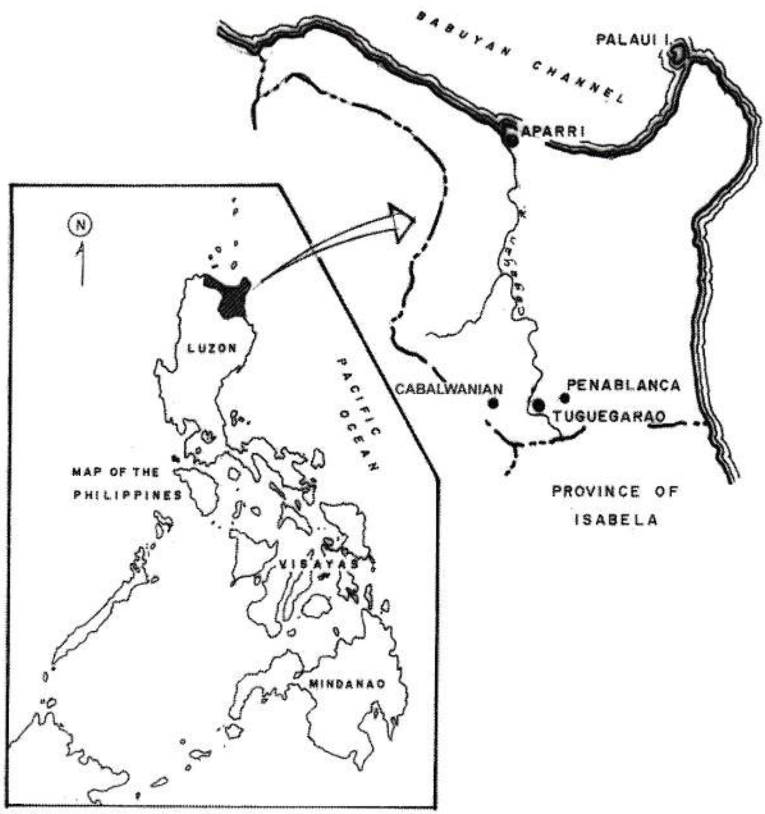

Figure 1. Site location map of Peñablanca

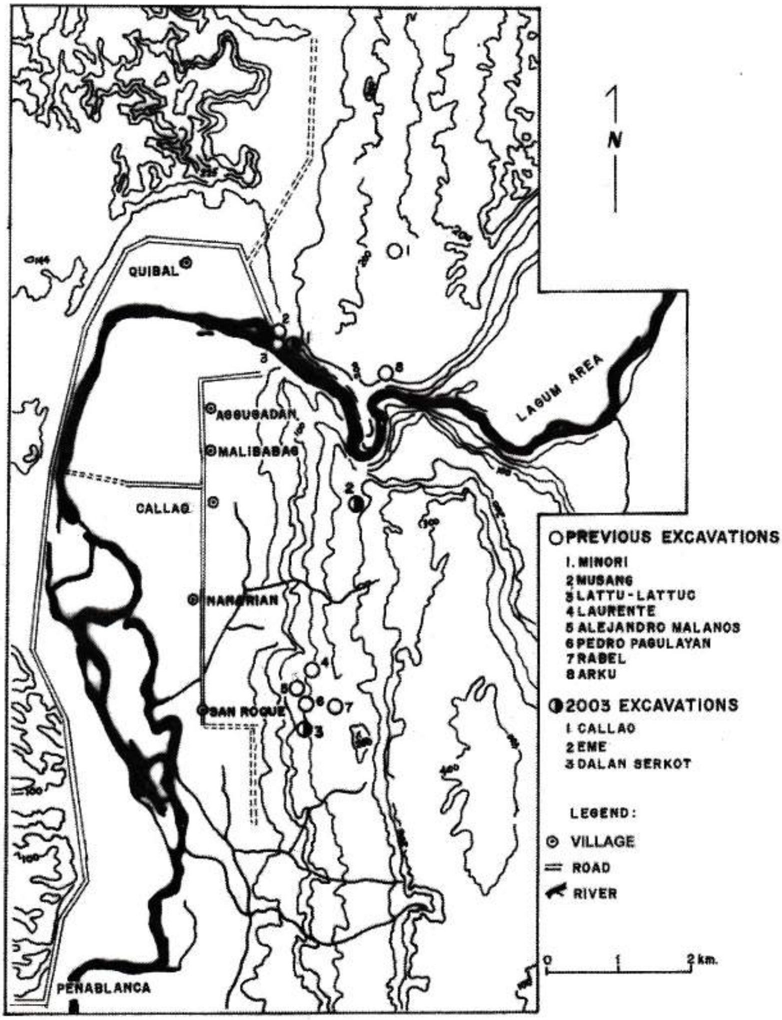

Figure 2. Excavated cave sites in Callao limestone formation

Eme Cave

The Eme Cave Complex is composed of three caves, under a good forest cover. The upper cultural layer is a compacted silty clay loam with earthenware sherds, flakes, lithic debris, riverine shells (*Thiara* sp.), and animal bones, the latter include many small bat bones recovered during sieving. The sherds are mostly of black finish, but there is also plain brown pottery. This layer has a charcoal radiocarbon date of 1980 ± 74 uncal. BP (Wk-14882).

The lower cultural layer is also a silty clay loam. Flakes of andesite, chert, and basalt, with lithic debris, were the only cultural materials recovered; there were no sherds. There is substantially more lithic debitage recovered from this layer than the layer above. Land snails and riverine shells, together with teeth of deer (*Cervus* sp) and pig (*Sus* sp.), were also recovered, as well as continuing quantities of bat bones. The charcoal radiocarbon date for this layer is 3569 ±52 uncal. BP (Wk-14883).

Callao Cave

Callao Cave was first excavated in 1979 to 1980 by a team lead by Maharlika Cuevas (Cuevas 1980). In 2003, two contiguous squares were opened next to the east wall inside the cave entrance. The cave deposits at Callao are generally undulating, so the excavation proceeded by removing natural layers in sequence. The upper cultural layer is a Neolithic deposit and contains shell beads, clay lingling-o earrings, brown, red-slipped and black earthenware sherds, chert and andesite flake tools, human bones and teeth, bat bones, and riverine and land snail shells.

A clay spindle whorl used to spin thick fibre was also recovered in this layer (see Cameron and Mijares 2006). Macrobotanical analysis on charred remains also shows a high occurrence of *Boehmeria* cf. *platanifolia* (Paz and Carlos 2005). This wild ramie is a relative of the Chinese white ramie (*Boehmeria nivea*). The spindle whorl might have been used to spin this wild ramie in the cave. Phytolith analysis for this layer shows high percentage of other arboreal types such as palms (Arecaceae) and bamboo (Bambusoid) (Parr 2005).

Four deer teeth, a wild boar tusk, and nine pig teeth were retrieved. This layer is dated to 3335 ± 34 uncal. BP (Wk-17010) by accelerated mass spectrometry (AMS) radiocarbon on charcoal.

There is a thick (40 centimetres) deposit devoid of cultural materials that separates the upper and lower cultural layers. This layer is an interbedded deposit of both cemented sand and very loose sand, which is of volcanic origin identified through energy dispersive x-ray analysis. Beneath it, the lower cultural layer appears at 130 centimetres below the surface, with chert flake tools and a probable hearth. Fragmentary burnt bones were recovered, but species identification was impossible except for the one that was identified as *Cervus* sp. An AMS radiocarbon date on charcoal for this layer is 25,968 ± 373 BP (Wk-14881).

Dalan Serkot Cave

Dalan Serkot Cave is located at the southern end of the limestone formation. Thick earthenware sherds, probably parts of burial jars, litter the current surface of the cave. The upper cultural layer contained earthenware sherds (red-slipped, black, and brown), human teeth and phalanges, human skull fragments, and a few chert and andesite flakes. Some black sherds have incised designs on their rims and carinations. Land snail shells, two deer teeth, and two pig teeth were also recovered. This layer is radiocarbon dated to 3530 ± 34 uncal. BP (AMS date Wk-15648) on charcoal.

In the lower cultural layer, no earthenware sherds were recovered but there was an increase in the number of chert and andesite flakes. A piece of charcoal attached to a chert flake from a depth of 70 centimetres below the surface yielded an AMS radiocarbon date of 6124 ± 48 uncal. BP (Wk-14879). Riverine gastropods were dominant in this layer. Faunal remains include three deer teeth and a pig tooth, plus small bones of bats and murids.

Flake Analysis in the Philippines

Flaked stone assemblages in Island Southeast Asia, particularly in the Philippines, are characterised by flakes and flake tools rather than by the pebble tools, which is characteristic of the mainland Palaeolithic and Hoabinhian industries (Bellwood 1997). The first attempt to conduct systematic analysis of stone artefacts in the Philippines was made by Robert Fox (1970) for the Tabon Cave assemblage. He published his preliminary analysis (Fox 1970) but passed away before he was able to publish his intended final report. The Tabon Cave lithic industry has a deep time depth, beginning around 50,000 BP and continuing until at least 9,000 BP. The flakes are of chert material and Fox classified them according to a simple typology of primary flakes, flake tools with evidence of utilisation, flake tools with retouch, unused lumps of chert, and waste flakes. He noted that "there was no basic change in the method-of-manufacture of the tools excavated from the first appearance of man in Tabon Cave until the final period of occupation; covering, as indicated, about 40,000 years" (Fox 1978: 64). Fox further stated that "there were no conscious attempts to shape the tools, no evidence of core preparation."

Most artefacts of the original collection that Fox was working on have been missing since his death (Pawlik and Ronquillo 2003). A re-excavation of

Tabon Cave was conducted in 2000 to 2001 and a new collection of excavated stone artefacts is now available for study. I have undertaken use-wear analysis as well as metrical measurements of these artefacts and have concluded that most of the flake tools had been used to work "hard" material, probably wood or bamboo (Mijares 2004:18-19).

In the early 1970s, Warren Peterson (1974) worked on the eastern coast of Northern Luzon at the site of Dimolit. Dimolit contained ceramics associated with flake tools. Peterson conducted low power microscopy using 8x–80x magnification. He noted that some of the flakes displayed an edge gloss, with two distinct types of distribution along their cutting edges. The first type was composed of a silica sheen that formed patches, lines, and streaks along the edge and flake scar ridge. The second was a heavy sheen found only along the edges. Peterson conducted tool-usage experiments to identify the reasons for the two different patterns using jasper flakes on different contact materials, particularly grass, bamboo, and rattan.

Musang Cave, according to Barbara Thiel (1980, 1990b), had a flaked lithic industry that dated from c. 12,000 to 4,000 BP. She conducted edge-wear analysis at 2x–20x magnification in order to infer function, concluding in her dissertation (Thiel 1980) that the flaked tools functioned as scrapers, spokeshaves, knives, grass-cutting blades, gravers, drills, and saws. She did not elaborate on how she was able to assess these functions in relation to particular edge-wear attributes.

Florante Henson (1978) next analysed the flaked lithic industry of Laurente Cave. He measured physical attributes of the artefacts and subjected the data to statistical procedures, such as analysis of variance and statistical inter-correlation, to support his hypothesis that there were no changes in lithic technology through time. Henson also used a microscope to infer possible tool use.

Wilfredo Ronquillo (1981)also worked on the lithic assemblage from Rabel Cave. To address the technological component of the analysis, he measured a number of flake physical attributes (Ronquillo 1981). In order to infer probable flake function, he used low power magnifications ranging from 10x-40x.

Continuing the tradition of analysing lithic assemblages from the Peñablanca Caves, I have more recently conducted morphological, technological, and use-wear analyses of flaked lithics from Minori Cave (Mijares 2001, 2002) by using experimental chert and andesite flakes on bamboo, rattan, and meat. The results of these experiments were then applied to the archaeological lithics from Minori Cave.

In the mid-1970s, Johan Kamminga (Davenport and Kamminga 2002) conducted a large series of stone tool-use experiments, mostly with chert and obsidian, among the Agtas of Peñablanca. The Agtas subsist primarily by hunting and gathering and some farming of swiddens along the Sierra Madre mountain in Northern Luzon (Griffin 1984). Kamminga employed these Agtas to use experimental flakes that he made on different materials and different activities. Recently, Daniel Davenport (2003) analysed these experimental flakes to characterise the different varieties of use-wear.

Methodology

The stone implements recovered from the three Peñablanca cave excavations described in this study were individually wrapped in bubble plastic wrap after excavation to avoid post-recovery damage. The flakes were cleaned by soaking them in a 10 percent HCl solution for 30 minutes (Levi-Sala 1996; Mijares 2002, 2004). The use of HCl is necessary as most flakes are coated with calcium carbonates. They were then soaked in soapy water, lightly brushed to remove sediment, rinsed with water, and air-dried.

The lithics were then sorted for further analysis. Flakes that had a good working edge, large enough to be held by the thumb and the index finger (Mijares 2004), were selected for analysis along lines similar to those used in the use-wear experiments cited above and applied to the Minori Cave lithics (Mijares 2001, 2002)[1].

The selected flakes were measured by using sliding and spreading calipers (Table 1) and a goniometer for measuring the edge angle. Length, width, thickness, weight, angle of working edge, and length of working edge were all recorded, as were nominal or non-metric attributes such as the raw material, type of flake termination, presence of cortex, and shape of the working edge (Mijares 2002).

[1] Readers are directed to these publications for details of the use-wear experiments.

Site	Ceramic Horizon		Preceramic Horizon	
	Measured	Use-wear	Measured	Use-wear
Eme	59	25	177	45
Callao	22	22	25	25
Dalan Serkot	16	16	21	21

Table 1. Number of flakes measured and subjected to use-wear analysis

The use-wear analysis combined the techniques of both Odell's low power microscopy (Odell and Odell-Vereecken 1980) and Vaughan's (1985) high power microscopy. An Olympus SZX–9 reflected light stereoscope with 6x-60x magnification was used for the low power microscopy and an Olympus BXFM reflected light microscope with 100x, 200x, and 500x magnifications for the high power microscopy.

The following attributes for each item were then recorded, when present (Mijares 2002):

1. Type of use scar termination, similar to flake terminations but smaller in scale, the main types visible under a low-power stereo-microscope being feather, hinge, step, and crescent break.
2. Degree of edge rounding is estimated as slight, intensive, or absent.
3. Presence of polish, identified according to the degree of light reflected from the surface under the low and high magnification stereo-microscopes as generic weak polish, smooth-pitted polish, and well-developed polish (Vaughan 1985).
4. Direction of striations on the working edge, identified as parallel, perpendicular, oblique, and irregular.
5. Hand kinematics, which can be either longitudinal (cutting, sawing) or transverse (scraping, whittling) (Semenov 1964), as inferred from the direction of the striations and the presence or absence of polishing on one or both faces.
6. Type of contact material, approximated according to the degrees of edge rounding, polish intensity, quantity of striations, and the type of edge-scarring. Contact

materials can be loosely identified into soft and hard categories. If no use-wear is found, the flake is considered unutilised.

Technological Analysis

The analysis of the lithics commenced with the physical measurements and identification of nominal attributes of the flakes. The selected materials were grouped separately according to whether they belonged to the lower preceramic context or the upper ceramic context in terms of cultural context. Eme Cave had the largest number of flakes analysed.

In order to make the comparisons across cultural layers and between cave sites, mean values were used in the data presentation (Figure 3). The mean values for length and width for the three sites, divided into preceramic and ceramic groups, range from 2.96-3.27 centimetres and 2.66-3.04 centimetres, respectively. For thickness, the mean values range from 0.81-1.05 centimetres, while the edge angle mean values range from 46- 50 degrees. Mean values for weight are from 6.26-9.31 grams. Working edge lengths (LWE in Figure 3) range from 4.28-6.65 centimetres. Based on a comparison of these mean values we can say that the differences between cultural contexts and sites are almost insignificant throughout.

The Callao Cave preceramic flakes, which are dated to the Late Pleistocene period, contained more blade-like flakes than the other, all-Holocene, assemblages discussed in this study. About 41 percent of the Callao Cave preceramic flakes have blade-like proportions (length being greater than twice the width). Two specimens are of particular interest: J3-7543 and J3-7491 (Figure 4). These have been further modified with a pointed distal end and a thinned proximal end, respectively. These specimens would have served well as arrow or spear points.

The lithics were all made either from volcanic rocks such as andesite (Plate 1) and basalt, or from sedimentary rocks, primarily chert. Andesite was the most common raw material in Eme Cave during both the preceramic and ceramic periods (Figure 5) with chert being marginally less common. In Callao Cave, chert was the only raw material used during the Upper Paleolithic period (c. 25,000 BP), and remained dominant during the ceramic period when it accounted for 63.4 percent, while andesite comprised the other 36.6 percent. At Dalan Serkot, andesite was the predominant material during the

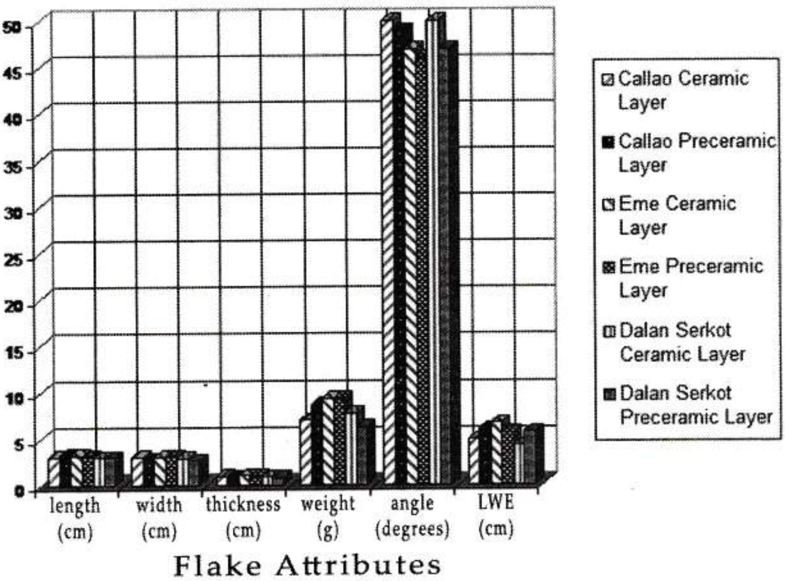

Figure 3. Comparative mean value of flake measurements

preceramic period, but became secondary to chert during the later ceramic period.

The remaining coverage of cortex was measured to estimate the stage of reduction of each implement. More than 60 percent of the flakes in all six lithic assemblages exhibit surviving cortex of over 50 percent or less of their dorsal surfaces. This shows that these flakes were used during relatively early stages in the reduction sequence (Andrefsky 1998).

Differentiating the chert materials from the Dalan Serkot preceramic layer with other materials showed a different result. Chert material from Dalan Serkot has about 60 percent of the flakes exhibiting no cortical surface, which could mean that they had undergone further reduction, or were made from preform cores. Preform cores or prepared cores had undergone reduction to remove cortical surface.

Flake termination and the shape of the working edge are two related attributes. Different flake terminations are produced according to the amount of energy applied to the striking platform and the follow-through motion of the knapper (Andrefsky 1998).

Most of the flakes analysed were predominantly feather terminated, pointing to the relatively high skill of the knappers who made them. Most of the assemblages are dominated by convex working edges except for the Callao ceramic layer and the Eme preceramic layer, both of which have more irregular shaped edges.

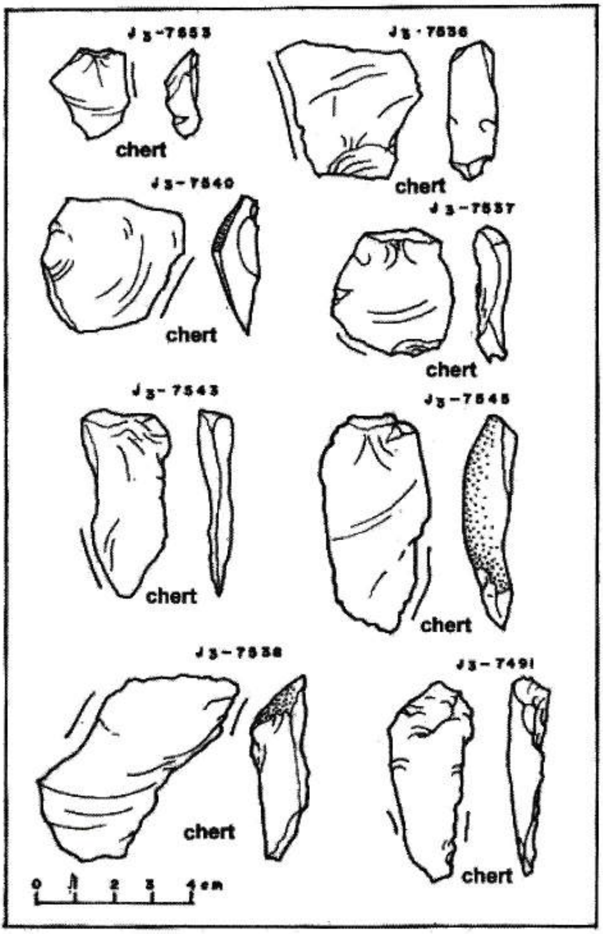

Figure 4. Callao preceramic layer flakes

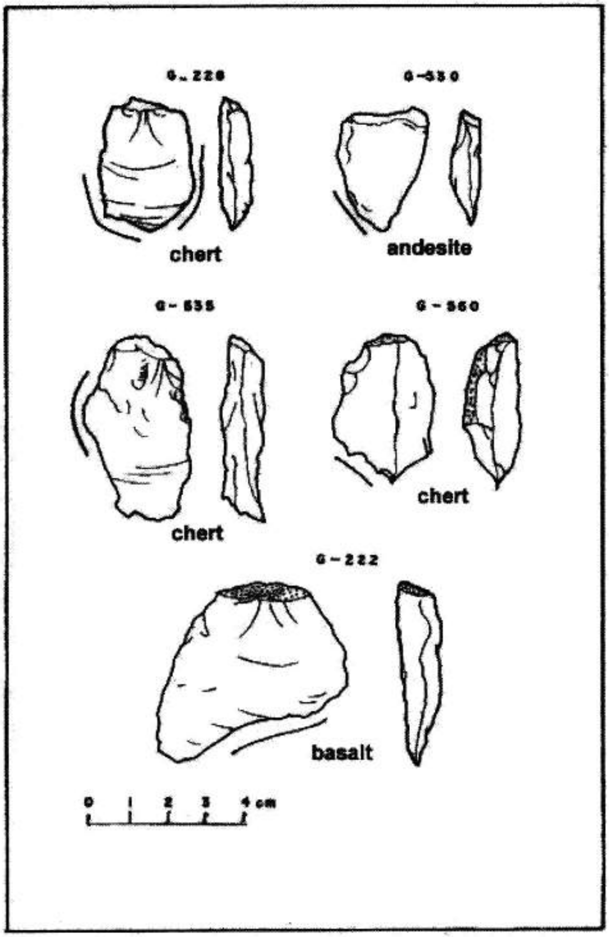

Figure 5. Eme ceramic layer flakes

Use-wear Analysis

Most edge scars caused by damage on the flakes have feather terminations (Plate 2), followed by hinge terminations (Plate 3), third with crescent breaks (Plate 4) and fourth step terminations. The majority of the flakes exhibit some level (slight to intensive) of rounding on the working edge.

High power microscopy identifies the extent of polishing and striation that develops when a flake is utilised. Longitudinal hand actions such as sawing and cutting produce striations parallel to the edge. On the other hand, transverse hand actions such as whittling and scraping produce striations perpendicular or at a high angle to the edge. The presence or absence of polish on one or both faces can also assist in the interpretation of usage, where longitudinal action will lead to polish on both faces, and transverse action will lead to polish on either just one surface, or on both but in unequal intensities (such as a combination of smooth-pitted and generic weak polishes). In this study, the terminology for polish follows Vaughan (1985:29-30):

1. generic weak polish (Plate 5)
2. smooth-pitted polish (Plates 6 and 7)
3. well-developed polish (Plate 8)

Polish was observed mostly on the internal surfaces, but at least 50 percent of the flakes in each assemblage also have polish on their external surfaces. Generic weak polish is the most commonly observed type on the internal surfaces, with the exception of flakes in the Callao and Eme ceramic layers, which have greater occurrences of smooth-pitted polish. A few flakes exhibit well-developed polish on the internal surfaces. Again, generic weak polish is the most common type of polish on the external surfaces, with the exception of flakes in the Callao and Dalan Serkot ceramic layers. The latter have greater occurrences of smooth-pitted polish.

Striations within the polished area of a flake are more difficult to see, and only a few flakes have been observed to have them. Most common are striations parallel and perpendicular to the working edge. Oblique striations were also observed. Except for the Callao Preceramic layer flakes, which have more scraping/whittling hand movement, the other assemblages have more cutting/sawing hand movement.

The combination of the four use-wear attributes can help in inferring the possible contact materials (Figure 6). Initially, they were assessed as either hard or soft materials. This conservative approach in identifying probable contact material, I believe, would limit hyperclaims that were done before. It also gives more bearing to the archaeological record of possible contact material. Hard contact materials could be wood, bamboo, or rattan. A typical flake used on a hard contact material will exhibit hinge, step, or crescent break scar terminations, with slight to intensive rounding and smooth-pitted to well-developed polish. It may or may not have visible striations.

Additional probable contact materials that were not part of the original experiment but were identified in the archaeological record are palm and wild ramie. In order to extract the fibre from a ramie plant, the bark of the stem must be stripped using a sharp knife (Chi-Lu 1969). A simple chert flake tool could do this job. Since wild ramie is a fibrous plant use-wear attributes would be similar to those of rattan with a typical smooth-pitted polish and hinge or step scar terminations.

Since no bone tools, or bones with obvious cut marks, were recovered from the three sites, the possibility that the flakes were used on bones is considered minimal.

Soft contact materials include meat, particularly from the locally hunted pigs and deer. Flakes used on soft contact materials will have typical feathered scar terminations, with slight rounding and generic weak polish.

Around half of each flake assemblage, except the Dalan Serkot ceramic layer flakes, was used on a hard contact material. Some flakes did not show any use-wear at all, despite having good potential working edges.

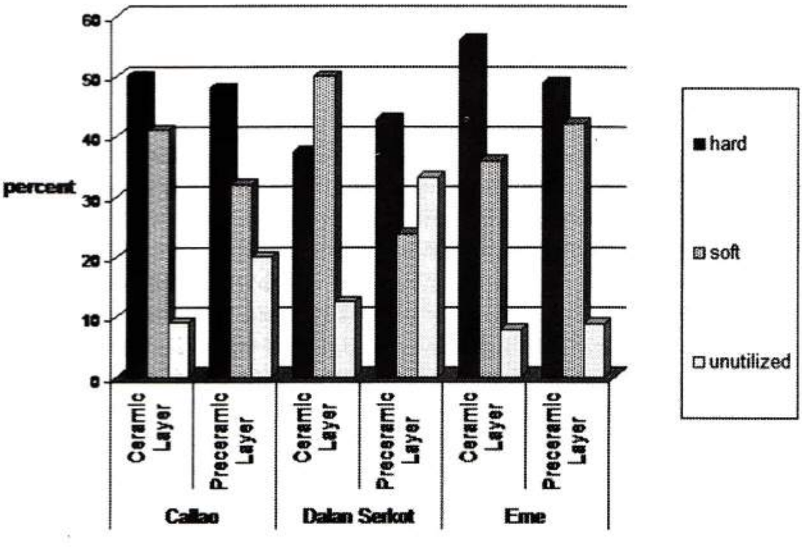

Figure 6. Comparative contact materials

Discussion

In general, the flake implements recovered from Callao, Eme, and Dalan Serkot caves show little change in form or use from the lower preceramic layers through the upper ceramic layers. Simple flakes were used from the last glacial maximum c. 25,000 years ago until at least 2,000 years ago.

The earliest lithic assemblage, at Callao Cave, was mainly manufactured from chert using simple percussion techniques. However, the recovery of more blade-like flakes in the preceramic period in Callao Cave could signify some variation in the lithic tradition through time. The possible evidence for a use of spear or arrow points from two blade-like flakes hints at a more formal lithic technology.

Unfortunately, we do not have evidence yet from the Philippines for stone points made with the prepared platform techniques reported by Glover (1977,1981) from late Pleistocene Leang Burung 2 in South Sulawesi, the bifacial techniques reported by Bellwood (1988) for the Tingkayu industry from Sabah, or the backing and serrating techniques used in the Holocene Toalian industry of South Sulawesi. Callao Cave is the only assemblage dating to c. 25,000 BP found so far in Luzon, and there is a big chronological gap from this time period to the next dated site of Musang Cave at c. 12,000 BP (Thiel 1990b). The Callao preceramic assemblage is also small, limiting our analysis and interpretation. We need to further verify this lithic technology in other cave sites of the same time period.

Around 12,000 BP, there was a change in Cagayan, both chert and volcanic rocks, particularly andesite, were used. The Pinacanauan de Tuguegarao River, which bisects the Callao Limestone Formation, carries many cobble-sized volcanic rocks from outcrops in the Sierra Madre. Most of the flakes, especially those of andesite, carry varying amounts of cortex. The cortical surface of each pebble was probably used as striking platform in producing these flakes. This can be seen because most flakes have cortical striking platforms. The addition of volcanic rocks might signal a diminishing access to chert raw material in the area.

All of the flakes from the three caves studied have no intentional retouch during this period (12,000-3,500 BP). This signifies that the preceramic Holocene people were not concerned with curating flakes, and they had sufficient raw material simply to knock off a new flake rather than retouch one that had become blunt or dull from usage. Though there are a few blade-like flakes from this period, they are very few and show no further modification. The more "formal" stone implements from the previous Late Pleistocene seemed to have discontinued, and a simpler, more expedient lithic technology persisted (Mijares 2002).

The same raw materials and the same simple hard hammer percussion technique persisted, even after the introduction of pottery from the Cagayan Valley about 3,500 years ago. At Eme Cave, flake tools were still associated with earthenware pottery at around 1,900 BP.

Use-wear analysis of flakes from the preceramic layers shows that about half were used on hard contact materials, possibly bamboo and/or rattan, which are ubiquitous in the region. These activities might have included the manufacture of spears, bamboo knives, and traps, or the making of mats. Some flakes were used in meat processing, as they exhibit soft contact use-wear attributes. Bones of pig (*Sus* sp.) and deer (*Cervus* sp.) were associated with the assemblages. This range of use-wear was also observed on the flakes recovered from the ceramic layers.

The flake tools from Peñablanca were manufactured using a simple percussion technique. The aim was to produce a good working edge that could be used for a number of tasks. There was no need to produce specialised tools and the simplicity and expediency of the technology made such flake tools adaptable in the tropical karst environment of the region.

The archaeological record of Southeast Asia reflects a mosaic of human adaptation to a rich and diverse region that contains many different ecological zones - alluvial plains, karst environments, rainforest, and coastlines. Modern humans in this region were already capable of crossing the sea by at least 30,000 BP, by which time they had populated non-land bridged islands such as Luzon, Talaud, and the Northern Moluccas. The lithic technology across both mainland and island Southeast Asia (including Luzon) during this period (25,000-10,000 BP) was based primarily on flake tools. The colonisation of these islands was probably related more to Late Pleistocene foragers, rather than to the predominantly Holocene "Hoabinhians."

There was a divergence between the mainland and island lithic technologies during the terminal Pleistocene and early Holocene periods, with the former becoming increasingly dominated by pebble tools (Hoabinhian), whereas the latter continued to produce flake tools.

Although Hoabinhian lithic technology (Tan 1997) was widespread on Mainland Southeast Asia (including Peninsular Malaysia) at around 9,000 to 6,000 BP, it never reached Luzon or elsewhere in Island Southeast Asia beyond Northern Sumatra. In Luzon, except for the Cabalwanian industry that has both pebble tools and flakes (Fox and Peralta 1974), there are generally few pebble tools recovered as compared to flake tools.

During the mid-Holocene, Southeast Asia experienced the introduction of new technologies and subsistence strategies. Farming systems were introduced, carried in part by spreading groups of people with their ancestral languages. The same phenomenon occurred in Luzon, particularly in the alluvial plains of the Cagayan Valley. Here, Austronesian migrants from Taiwan started to settle around 4,000 BP (Bellwood 1997). They brought with them a suite of cultural materials and economic systems. Alluvial plain sites in Luzon are mostly of Neolithic date and reveal no clear continuity from the preceramic sites closer to the edges of the valley. Most preceramic sites in the Cagayan Valley are on old alluvial platforms and are not associated with pottery.

In both Mainland and Island Southeast Asia, and in Luzon, hunting and gathering communities decrease in numbers to subsist today on the fringes of agricultural communities. They can sometimes live independently of the farming communities and maintain trading relationship with them, as long as competition for land and resources is not too overpowering (Headland 1986; Headland and Reid 1989; Peterson and Peterson 1977). Through such interaction, foraging communities were able to acquire pottery and other novelty items, as well as carbohydrate sources such as rice, from their farmer neighbours.

This phenomenon can be extended to the Neolithic period (c. 3,500-2,000 BP) as can be seen in Peñablanca cave sites. The continuity of simple flake technology from the preceramic period (6,500 BP) into the ceramic period (2,000 BP) in the cave sites points to non-replacement of hunting gathering groups by farming groups in the foothills of Sierra Madre. Instead, current data shows that these hunting gathering groups (probably ancestral to the modern Agta) maintained an interactive relationship with valley-bottom farmers, probably through an exchange of forest products and hunted meat in return for pottery and agricultural products.

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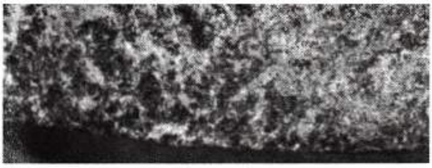

Plate 1. Callao Cave andesite flake (J-7295) at 10x, hinge scar termination with edge-rounding

Plate 2. Callao Cave chert flake (J3-7369) at 12x, feather scar termination

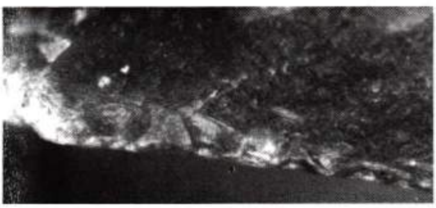

Plate 3. Eme Cave chert flake (G-378) at 20x, hinge scar termination

Plate 4. Eme Cave chert flake (G-441) at 16x, crescent breaks

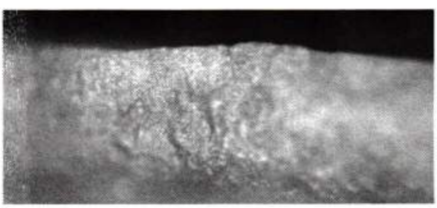

Plate 5. Dalan Serkot chert flake (I8-362) at 200x, generic weak polish

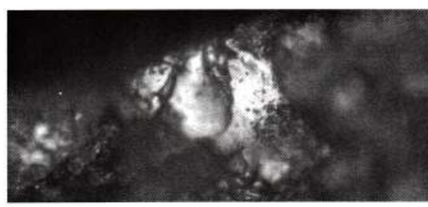

Plate 6. Eme Cave andesite flake (G-370) at 200x, smooth-pitted polish

Plate 7. Callao Cave chert flake (J3-7446) at 500x, smooth-pitted polish

Plate 8. Eme Cave chert Flake (G-246) at 200x, well-developed polish and parallel to the edge striations