THE EXPEDIENCY OF ANDESITE FLAKE TOOLS

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ABSTRACT

The predominance of a simple lithic technology in Southeast Asia during the Late Pleistocene until Early Holocene Periods has long evoked the interest of archaeologists. Two plausible hypotheses have been presented. The first involves the availability in Southeast Asia of wooden materials such as bamboo, which can easily be shaped into tools. The second concerns the predominance of coarse–grained raw materials (e.g., andesite), which are difficult to shape into formal tools. In order to test these hypotheses a two-stage approach was undertaken. An experimental study using andesite and chert flakes on bamboo, rattan and meat was conducted to identify probable microwear traces. The second stage involved microwear analysis of prehistoric andesite flakes from Minori Cave (Luzon). The experimental study showed that microwear analysis could be conducted on andesite flake tools. Microwear analysis showed that some of the prehistoric andesite flakes were in fact used on hard contact materials, possibly bamboo.

Introduction

The Southeast Asian stone tool tradition can be generally categorized as an expedient technology, namely tools made to perform tasks immediately at hand. "Expediency refers to minimized technological effort under conditions where time and place of use are highly predictable" (Nelson 1991:64). "Under such conditions one need only be concerned with design characteristics which facilitate a *specific*, *known* and *immediate* task; therefore, tool design may be quite specific or limited, in response to '*short term*' considerations" (Binford 1983:283 emphasis in original).

The reasons why a simple stone technology persisted in most of Southeast Asia with the exception of a few sites remain to be shown (Movius 1944, 1948). One plausible argument for the persistence of this simple stone technology in Southeast Asia is the availability of wooden materials such as bamboo, which can easily be sharpened using simple flaked tools (Pope 1989; Schick and Toth 1994; Reynolds 1993). Unfortunately, these organic materials do not preserve well in the archaeological record, so the hypothesis has been difficult to test until now.

Another probable reason for the ubiquity and persistence expedient technology is the availability of raw materials. Generally, fine-grained materials, such as chert (SiO_2), were preferred in making formal stone tools. Medium-grained materials such as quartzite and volcanic rocks are not very suitable for producing bifaces, although they can be excellent materials for making simple flake tools. "Lowquality raw material tends to be manufactured into informal-tool design" (Andrefsky 1994:31)

In the Philippines, the flake and blade-flake technology persisted from the late Pleistocene until the mid-Holocene period (c.4000 BP). It differs from its contemporary in the mainland Southeast Asia, where a developed pebble- and flake-tool industry- generally called "Hoabinhian"- dominated. But both traditions would still be classified as expedient technologies.

Understanding the reasons why the stone tool tradition in Southeast Asia remained relatively unchanged for thousands of years is an objective of this paper. In the Philippines, the flake tool tradition had persisted since 30,000 years ago up to the time when agriculture and ceramics were introduced around 6000 BP or later.

The subject of this research is Minori Cave in the Cagayan Valley, Northern Luzon (Figure 1). This cave was first excavated in 1981 and yielded a number of andesite and chert flake tools with accompanying faunal remains. In 1999, the site was re-excavated by this writer. Two cultural layers were identified. A radiocarbon determination on a charcoal sample provided a date of 4590 +/- 50 BP. This effectively dated the uppermost Cultural Layer (II), which contained both flake tools and ceramics. Underlying Cultural Layer I contains an assemblage of archaeological materials including stone tools, but no ceramics. Cultural Layer I, by analogy with a similar assemblage at nearby Musang Cave (Thiel 1990), would be approximately 12,000 years old.

Analytical Approaches

The study took a two-stage approach. First an experimental study was conducted to establish the possible presence of microwear traces both on andesite and chert flakes used on bamboo, rattan and meat. The second stage was to conduct microwear analysis on flakes from Minori Cave itself and to determine whether the andesite flakes were used on hard contact materials such as bamboo.

Microwear analysis conducted on both experimental and prehistoric sample in turn consisted of two steps each. First was the use of a using hand lens (10x) and low-power microscopy (50x) to identify edge-rounding and use-scar terminations such as:

Feather Termination- a flake which terminates in an edge with minimal margin.

Step Termination- A flake or flake scar that terminates abruptly in a right angle creating a "step-like" breakage.

Hinge Termination- A hinge fracture meets the surface at a steep angle creating a rounded breakage.

Crecent break- are half-moon shape breakage which has about 90^0 angle from either surface.

The second step was the use of 200x microscopic magnification. An Olympus BX30M Metallurgical Microscope (Figure 2) with incidentlight was used in the analysis to identify possible striations and polish. The identification of polish was based on Vaughan's (1985: 29-30) development of polishes;

Generic weak polish is a dull polish, which is, nonetheless, somewhat brighter than the natural reflective background of the flint, yet definitely less reflective than a well-developed polish on the same surface.

Smooth-pitted polish- Individual small polish components, with more or less smooth surfaces, form on the higher points of the microtopography of the generic weak polish contact area. Since the components are incompletely linked, numerous darker interstitial spaces are left between the components (pits).

Well-developed polish- Further linkage of the polish components and the formation of diagnostic surface features on the polish surface occurred in the area of greatest contact on the flint edges. This polish is further classified based on worked material, such as bone polish, antler polish, wood polish, etc.

The combination of microwear attributes were used to identify probable contact material. If no microwear traces were found, a flake is identified as unutilized. Contact material is either soft or hard. Identification of highly specific contact materials that Keeley (1980) and Vaughan (1985) claimed to do in their studies was not attempted in this research. The identification of specific contact material is very subjective, due to the potential overlapping of microwear traces. As Vaughan (1985:46) himself stated, "there are certain zones of overlap between various use-wear polishes which can result in certain ambiguities." The polishes in their developed form may overlap between bone, antler and wood substrates.

The approaches taken in this study would then help determine if the prehistoric andesite flakes from Minori Cave were utilized or not. Microwear analysis would further enhance functional identification, since the probable contact material can be approximated.

Experimental Module

In order to establish a reference database for possible microwear traces on the flake tools, experiments were conducted with different contact materials similar to those available in the area during prehistoric times.

One possible use of stone flake tools was in the production of wooden implements used either as spears or digging implements. The Southeast Asian region, specifically the area of Minori Cave, is rich in bamboo and rattan, which can be shaped to serve as such implements. Thus, andesite and chert flakes were used in my experiments to do a number of activities such whittling, scraping, chopping, cutting or sawing bamboo and rattan (Figures 3 and 4).

Since Elenita De Vera's (1983) analysis of the faunal remains from Minori Cave identified deer (Cervus sp.) and pig (Sus sp.) in the assemblage, a few flakes of andesite and chert were used in cutting deer and pig meat. Eleven andesite and six chert flakes were prepared for the experiment and their morphological features had been measured. The type of activity (i.e., sawing, cutting, slicing, chopping, scraping, or whittling) done on each material, the duration of time used, and the number of strokes were all documented (Table 1)

Table 1. Activity Conducted by Contact Material Type

Code	Activity	Contact Material	# of Stokes	Use Duration
AX1	Chopping	Bamboo/Rattan	1500	16 min
AX2	Whittling	Rattan	2000	32 min
AX3	Slicing	Bamboo	2200	58 min
AX4	Whittling	Bamboo	2000	35 min
AX5	Slicing	Rattan	2000	36 min
AX6	Cutting	Deer Meat	1000	38 min
AX7	Sawing	Bamboo	3000	35 min
AX8	Cutting	Pig Meat	1100	30 min
AX9	Scraping	Rattan	2000	28 min
AX10	Sawing	Rattan	2500	35 min
AX11	Scraping	Bamboo	2000	30 min
CX1	Slicing	Bamboo	1500	35 min
CX2	Slicing	Rattan	2000	31 min
CX3	Whittling	Bamboo	1500	25 min
CX4	Cutting	Deer Meat	1000	35 min
CX5	Cutting	Pig Meat	1000	22 min
CX6	Whittling	Rattan	2000	33 min

*__AX__= Experimental andesite flake **CX**= Experimental chert flake

Comparing the efficiency of andesite with chert flakes, based on these experiments, the former tend to get crescent breaks on the edge, a fact which dulls the flakes faster. Chert flakes, on the other hand, could maintain their sharp edge much longer.

Chert could also be easily analyzed using microscopic techniques, due to its relatively flat surfaces and very fine-grained texture. Microwear analysis of andesite material is tedious, but possible. The coarse-grained texture of andesite, coupled with its crystal inclusions, makes identification of polish very difficult. The rough microtopography of andesite makes focusing and scanning with a stereomicroscope very difficult and time-consuming. Nonetheless, microwear analysis can be performed on andesite flake tools.

Evidence of microwear on andesite flakes can be seen at 200x magnification through the striations and polish produced on ferromagnesian minerals such as hornblende. The directions of the striations mostly conform to the kinematic motion of use (Figure 5). Bamboo material tends to produce more microwear damage than rattan. Both of the well-developed polishes seen in chert flakes (CX1 and CX3) were produced by use on bamboo. Sawing bamboo made one of the smooth-pitted polishes observed on an andesite flake (AX7).

Rattan, which seems to be the softer of the two woods, produced both generic weak and smooth-pitted polishes in chert flakes. The other andesite flake (AX10) with polish was used in sawing rattan (Figure 6).

Both bamboo and rattan produced mostly crescent breaks and step terminations in terms of micro-chipping. Cutting meat (venison and pork) tends to produce feather terminations in micro-chipping.

Of the two kinematic motions, the longitudinal motion (particularly sawing) tends to produce more microwear traces. No polish was observed on the andesite flakes used in transverse motion, while one chert flake so used has a generic weak polish. The other chert flake with a well-developed polish was used on bamboo.

Based on these experiments on andesite flakes, it is concluded that microwear analysis can be performed on this material. Bamboo and rattan as contact materials produced microwear traces like those of other hard materials. However, specific microwear signatures of these contact materials remain to be identified.

Analysis of Minori Cave Andesite Flakes

A sample of 100 pieces or twenty percent of the total andesite flakes from Minori Cave, Chamber D were subjected to individual flake analysis. Of the 100 flakes, 42 flakes are from the 1999 excavation and 58 from the 1981 excavation.

Andesite is an extrusive igneous rock in the diorite family. It frequently has a porphyritic texture, though an aphanitic texture is also common. Phenocrysts of tabular plagioclase, plates of mica or biotite, and prisms of hornblende or augite can easily be seen (Figure 7). The ground mass is also composed of the same minerals, plus pyroxene (Bishop et al 1999). There are andesites that contain quartz, but if quartz is present it is less than 10 percent of the total composition. The amount of quartz distinguishes andesite from rhyolite, which has at least 10 percent quartz.

Hand lens (10x) and a 50x stereomicroscope magnification were used to determine scar termination (Figure 8) and presence of edge rounding (Figure 9). At this range of magnification, the feather scar termination is the most abundant type, representing 44 percent of the sample. Hinge and step terminations are almost equal, with 16 and 10 percent of the sample, respectively. Only 5 pieces of the flakes exhibited crescent break terminations, while 25 percent of the sample andesite flakes has no recognizable scar termination.

Almost three-fourths (73%) of the total andesite flake sample exhibited some degree of edge rounding. Of this group, two flakes exhibited extensive rounding visible to the unaided eye. Twenty-seven percent of the andesite flake sample has no edge rounding.

The second level of microwear analysis utilized a magnification of 200x to determine the presence of polishes and striations. The same microscope used in the experimental study was used in the analysis. The identification of polishes and striations was based on the previously described experimental study. In the experimental study, polishes and striations were primarily found on ferromagnesian mineral phenocrysts (e.g., hornblende, Figure 10), because the experimental flakes were of the dark gray-colored andesite. The Minori

Cave andesite flake samples have a more diverse range of color, from grayish-white to dark gray or greenish gray (Figure 11). The lighter color andesite contains fewer ferromagnesian minerals and may contain some quartz. For this variety of andesite, polish and striations can be found on some quartz phenocrysts (Figure 12). Traces of polish and striations could also be found in the ground mass, particularly on pyroxene (Figure 13).

Of the 100 flakes andesite sample from Minori Cave, 38 flakes exhibited polish. Most of them (33%) exhibited smooth-pitted polish, but four flakes have a well-developed polish and one has a generic-weak polish.

One quarter of the total andesite flake sample has identifiable striations. Striations parallel to the edge are the most dominant type (n=13), indicating that the flakes were used in a longitudinal motion. Transverse motion, as represented by striations perpendicular to the edge, was present on only eight. Four flakes have striations oblique to the edge. The majority of the andesite flake sample has no visible striations, however. Although some flakes have polish on them, striations cannot be seen at 200x magnification; a higher magnification might reveal striations.

The probable contact materials on which the andesite flakes from Minori Cave were used were determined by using both levels of microwear analysis. The combination scar termination type, edge-rounding, polish and striations can be used to assess whether the flake was used on a hard or soft contact material. Andesite flakes that have a feather scar termination and rounding with no polish or visible striations, were assessed to have been used on soft contact materials, such as meat. Those flakes with step, hinge and crescent breaks scar terminations, rounding and polish, with or without striations, were determined to have been used on hard contact materials such as wood or bamboo. Flakes that do not exhibit any of these four attributes were considered to be unutilized flakes.

There are 26 andesite flakes from the Minori Cave sample that have been determined to be unutilized. Equal numbers of andesite flakes were identified to have been used on soft (n=37) or hard (n=37) material.

The experimental study shows that microwear analysis can in fact be performed on andesite flakes. Low-power microscopy can be used to identify flake scar termination and edge-rounding. High-power magnification can be used to identify polish and striations. At 200x or higher, one can see polish on ferromagnesian minerals, such as hornblende and pyroxene.

Hornblende ($Ca_2(Mg,Fe^{2+})4(Al,Fe^{3+})Si_7Al)_{22}(OH)_2$) and pyroxene ($X_2Si_2O_6$) minerals are silicates. Being silicates, they seem to behave similarly to chert (SiO_2) in forming polish and striations. Polish can also be seen on quartz, which undergoes a process of rounding as polish and striations are formed.

Using the four attributes of microwear (i.e., scar termination, rounding, striation and polish), one can determine probable contact materials. Bamboo and rattan produced hard-contact microwear traces.

The microwear analysis of Minori Cave andesite flakes shows that most of the andesite flakes were utilized, and that a number of andesite flakes were used on a hard contact material.

Conclusions

This study cannot categorically state that the Minori Cave andesite flakes were used specifically on bamboo and rattan materials. However, based on the results of the microwear analysis, we can say that these flakes were used on hard contact materials. Since bamboo and rattan are ubiquitous to the region, there is a high probability that the flake tools were used on them.

This study has proven that the andesite flakes were functionally tools, although they may not have been as efficient as chert flakes. They were utilized on different contact materials. Coarse-grained materials such as andesite may not be the best materials to make formal tools, but they are good enough to make simple flake tools. The lack of precise control over the direction of fracturing makes it difficult to form a coarse-grained material into a formal tool. It also requires strong blows to detach a flake, which adds to the difficulty of control. The removals is often thick, creating deep negatives or scars.

Going back to the two hypotheses on the persistence of a simple lithic technology in Southeast Asia in particular, this study adds credence to the functional hypotheses. Stone tools, made from both fine- and coarse-grained materials, were probably manufactured as maintenance tools to work on bamboo and rattan. There was no need to develop a more formal stone tool technology, since this level of technology is sufficient for the prehistoric people to exploit their environment over a long span of time.

An expedient lithic technology thus persisted in Minori Cave in Northern Luzon (Philippines), as in the rest of the Southeast Asian region. The expediency of the industries is, however, not due to cultural stagnation, but is an appropriate cultural adaptation by prehistoric people to their environment and its resources.

From the results of this study, I argue that Philippine as well as Southeast Asian archaeologists can no longer dismiss or relegate coarse-grained lithic implements to the background of their research. Prehistoric people used and exploited the materials available to them. If coarse-grained stones such as andesite were the materials most available to them, they would utilize these stones to perform the needed tasks. Every lithic implement that is recovered from archaeological context has the potential to add knowledge to our understanding of the past.

This study also shows the importance of conducting microwear analysis on lithic implements recovered from sites in the Philippines, as well as in other parts of Southeast Asia. Although the previous approach of assessing if the stone tool was utilized through macroscopic edge-wear analysis is still relevant, microwear analysis could push functional identification to a new level. Chert materials could easily be studied using high-power microscopy but microwear is particularly relevant when analyzing coarse-grained lithic implements, where possible wear traces can only be seen at 200x magnification.

Since this study has shown that microwear analysis can be conducted on andesite materials, it can also be applied to other coarse-grained materials such as rhyolite and quartzite. The range of lithic raw materials, which can be analyzed using this approach, has thus been expanded.

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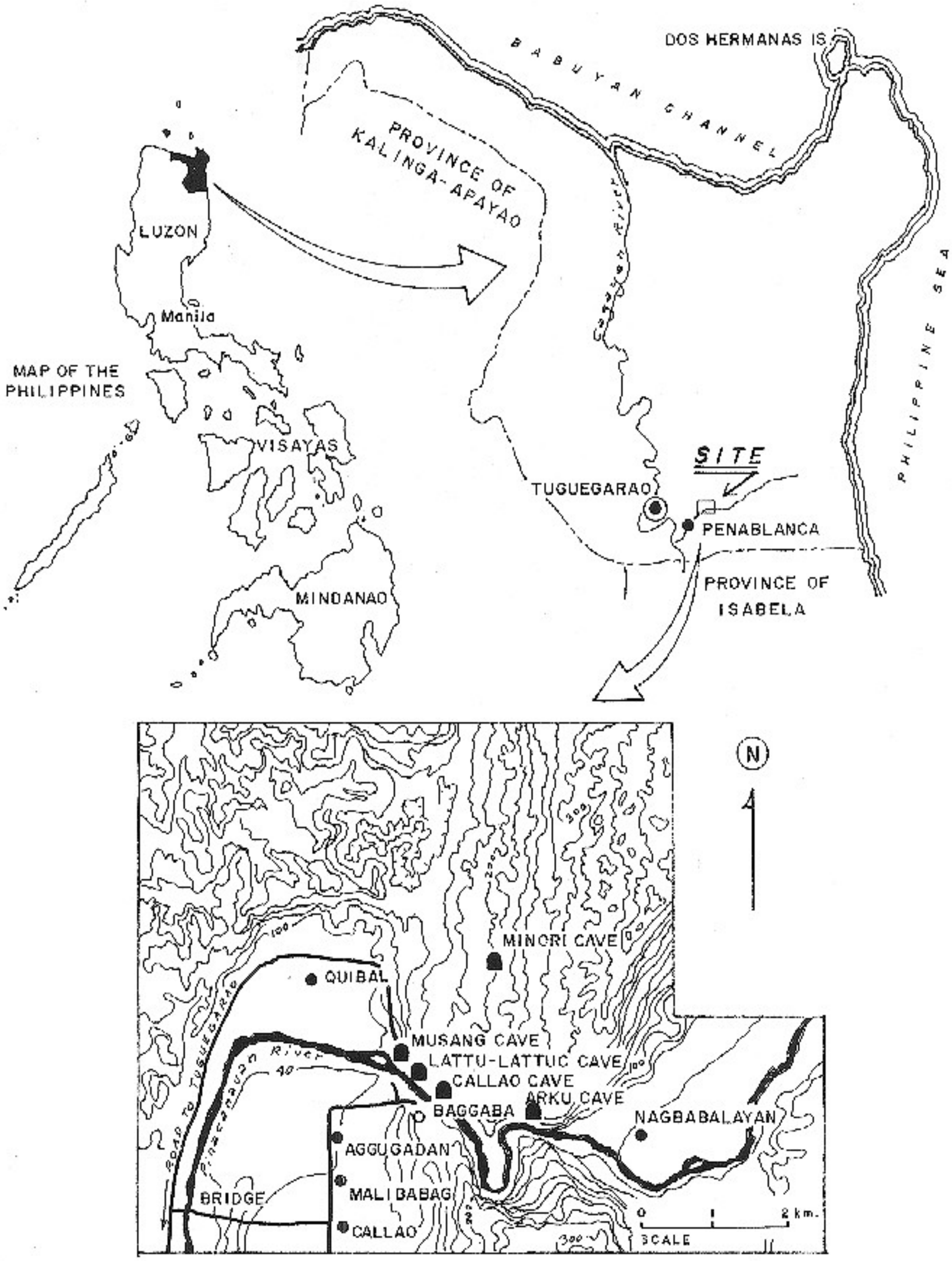

LOCATION MAP OF MINORI CAVE, PENABLANCA, CAGAYAN

Figure 1

Figure 2. BX30M Metallurgical Microscope

Figure 3. Chopping bamboo with an andesite flake

Figure 4. Cutting meat with a chert flake.

Figure 5. Striations on an andesite flake used on chopping bamboo (200x)

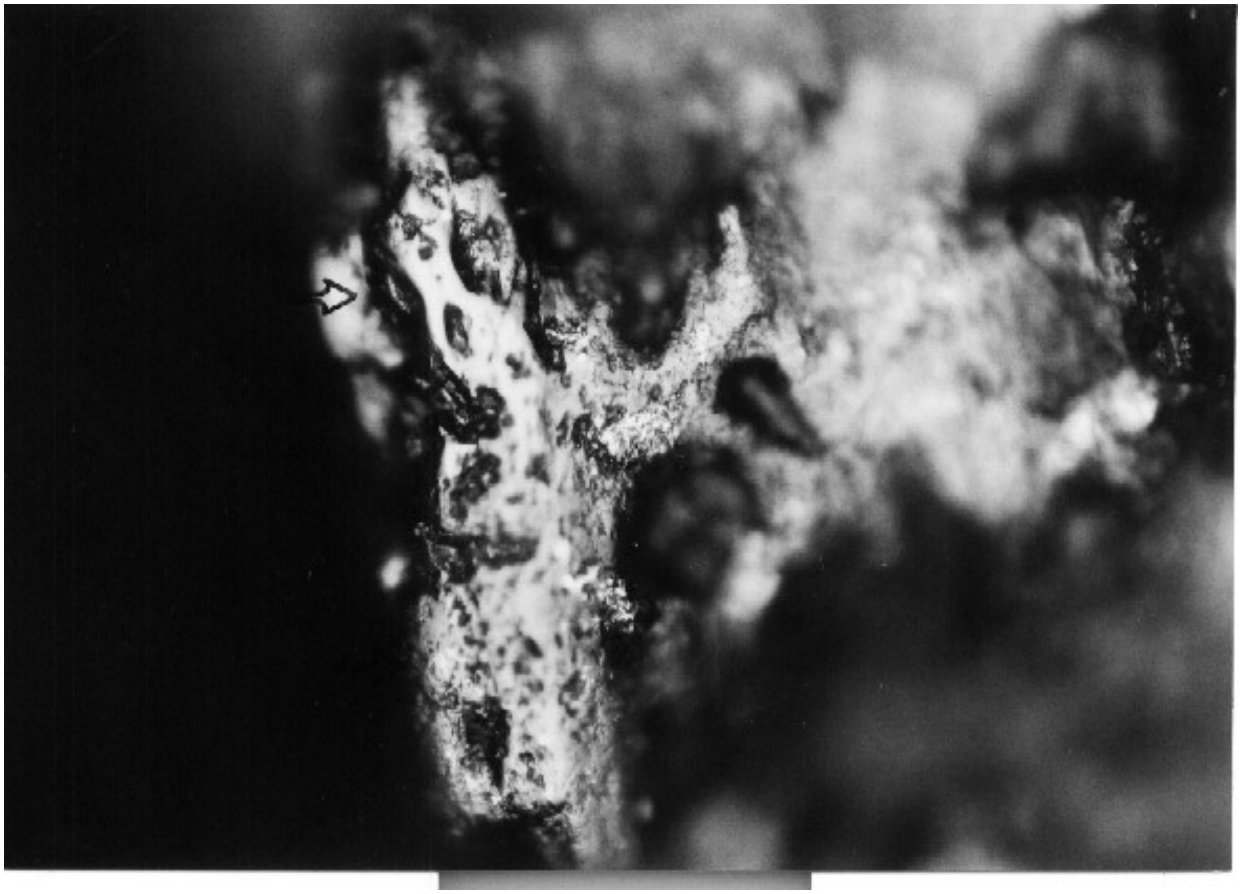

Figure 6. Smooth-pitted polish on hornblend mineral (200 x)

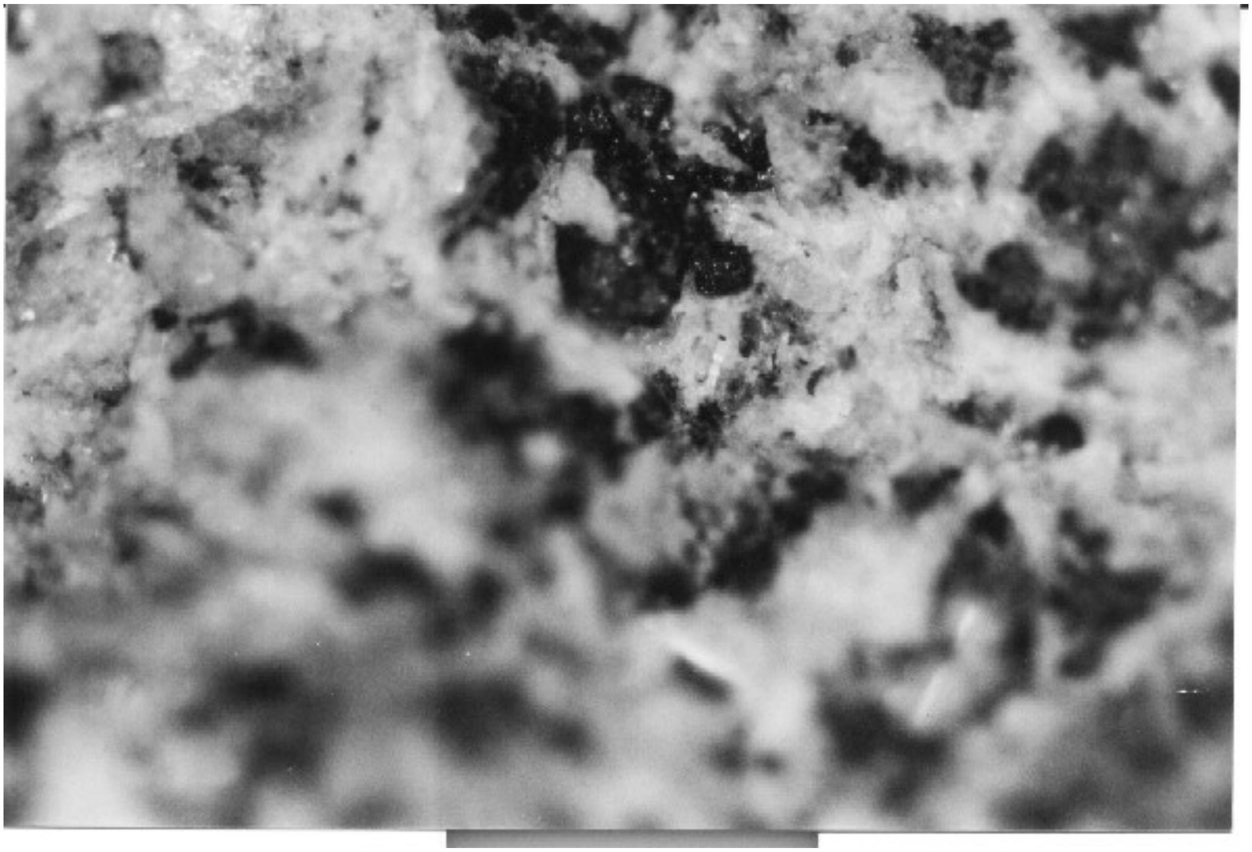

Figure 7. Unpolished ferromagnesian (dark) and pyroxene (light) minerals (200x).

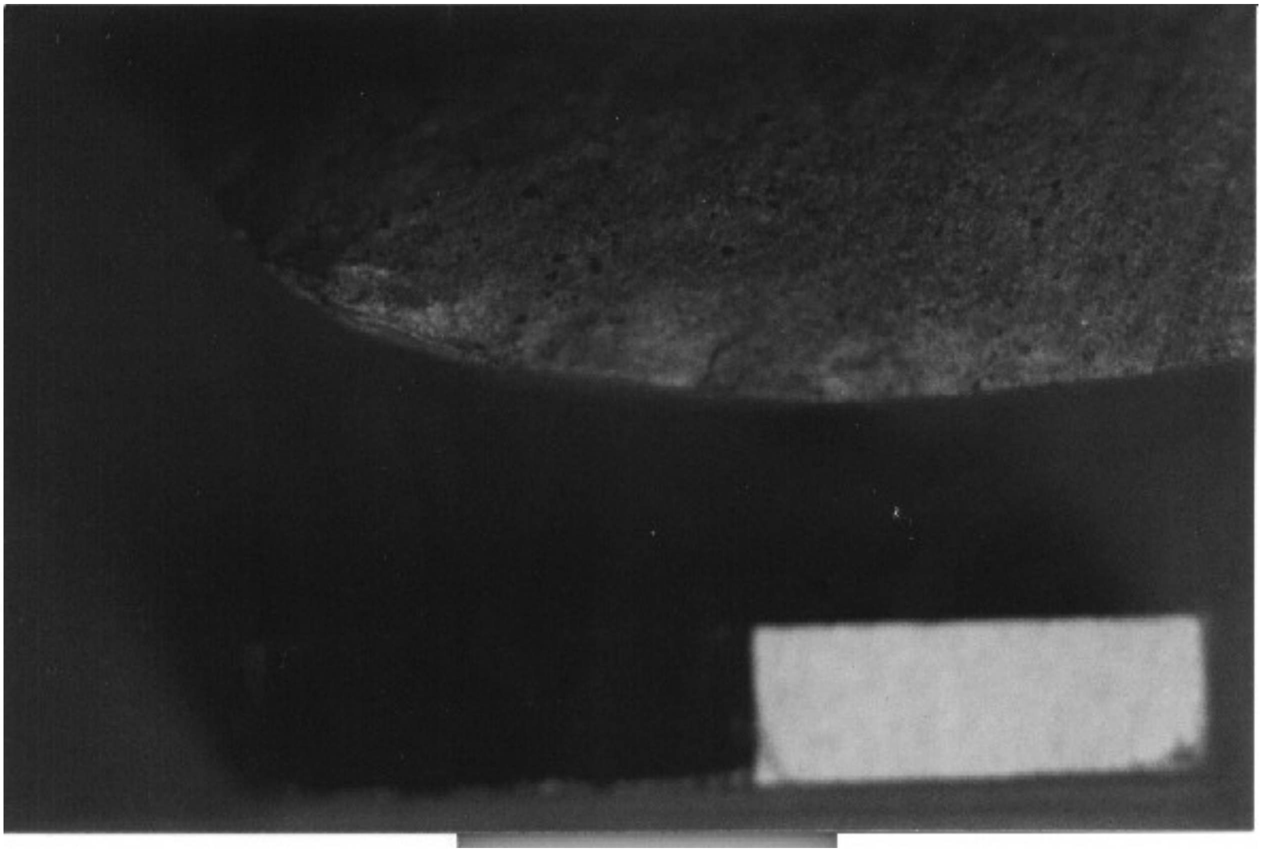

Figure 8. Edge scar termination on an andesite flake

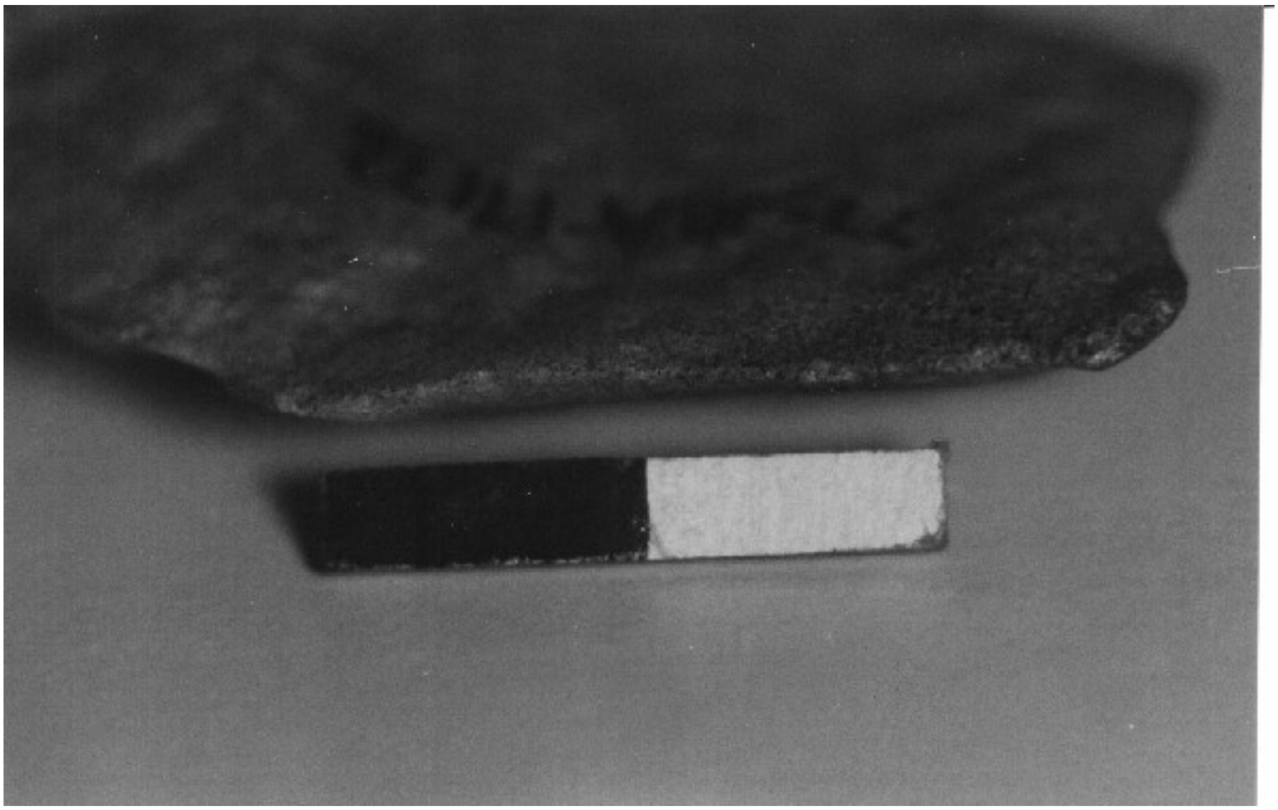

Figure 9. Edge rounding on andesite flake

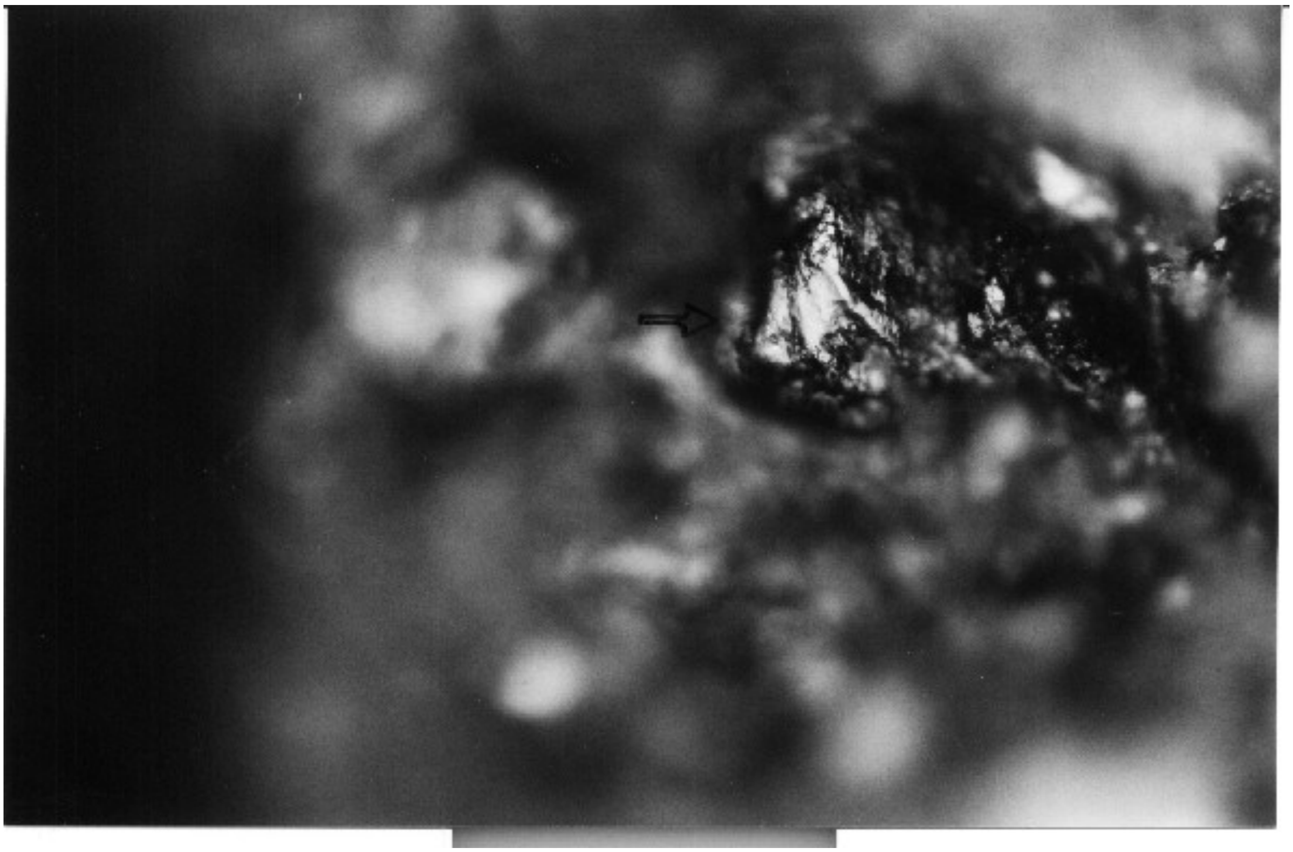

Figure 10 Polish on hornblende mineral.

Figure 11. Minori Cave andesite flakes of lighter (above) and (darker)below varieties.

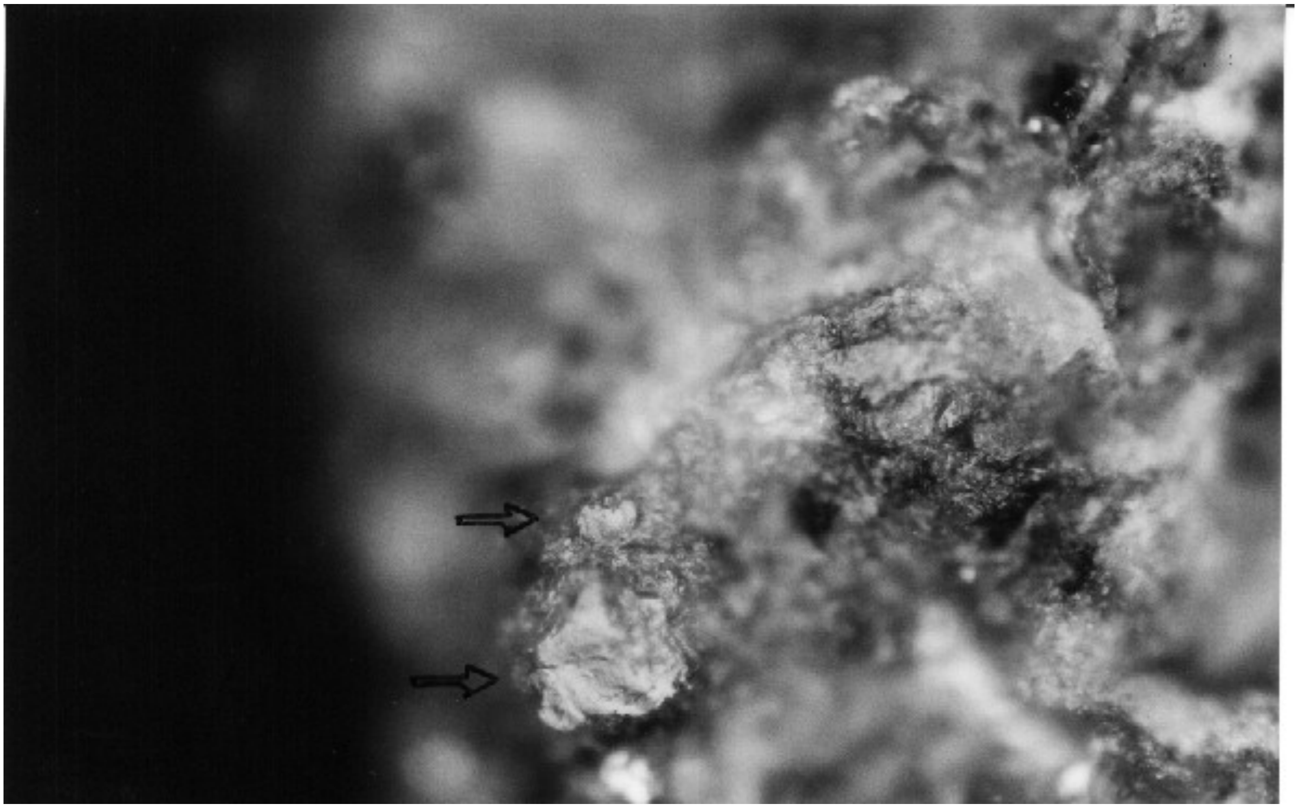

Figure 12 Polish found on quartz phenocyrsts (200x)

Figure 13 Polish on pyroxene minerals (200x)