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# THE NANCHOC LITHIC TRADITION OF NORTHERN PERU: MICROSCOPIC USE-WEAR ANALYSIS

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## Introduction

The Nanchoc Lithic Tradition (NLT) is a Middle Preceramic Period unifacial lithic industry of the upper Zaña Valley, northern Peru (Figure 1). It is one of several known unifacial lithic industries of northern Peru and Ecuador (Malpass 1983; Stothert 1974, 1985, 1988; Richardson 1969, 1978, 1981). The NLT is associated with the Las Pircas Phase (ca. 8500-6000 B.P.) Nanchoc Culture, a people who maintained a localized permanence or semi-sedentism at dispersed homesteads in the valley side canyons (*quebradas*) and alluvial fans (Dillehay *et al.* 1997). The dispersed homesteads contain single *quincha* (cane) huts, small above-ground stone storage structures, and furrowed areas that may represent garden plots.

There are also specialized mortuary sites (Rossen 1991:580-599) and cut-bone burials with evidence of possible cannibalism (Verano 1994). The Nanchoc people practiced a broad-spectrum economy that probably included incipient horticulture (Rossen *et al.* 1996). The small, dispersed habitations were integrated by at least one small public site, the Nanchoc Mounds site, where calcite leaching (perhaps associated with coca use) occurred (Dillehay and Netherly 1983; Dillehay *et al.* 1989, 1997).

The NLT, the lithics of the Nanchoc Culture, have been exhaustively studied and described from the various perspectives of attribute-variables, stages of reduction, local and exotic material types, edge angles, and tool angles (the tool body angle apart from the edge) (Rossen 1998). Debitage, the waste flake by-products of tool production, was analyzed for its striking platforms and length-to-width ratios. All these analyses together led to a description of the NLT as a unifacial industry with relative morphological stability and consistency, particularly in terms of formal tool types and attributes, though not standardized in the sense of containing extremely exact replication of tools and edges (Laville *et al.* 1980; Rossen 1998).

The results of the various lithic analyses were reported in detail in the previous issue of *Andean Past* (Rossen 1998). The NLT contains traits of both expedient and curated lithic industries, including a high percentage of expedient briefly-utilized flakes and a series of well-made, curated, heavily-used, non-marginal, edge-trimmed tool types (Table 1, Figure 2). Raw material types indicate that the industry is heavily localized, that is, overwhelmingly (98.9%) based on locally available material types such as basalt, andesite, tuff, rhyolite, and diorite. The small remaining percentage of exotic materials, mostly silexes and crystalline quartz, probably represent sporadic, low-level contacts with coastal and highland regions.

One important issue involving the NLT is its comparison with other unifacial industries of the north-central Andes and Panama. These industries, including Chiriqui (Panama), Las Vegas, Sangay, and Cubilán (Ecuador), and Siches and

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Mongoncillo (Peru) have been grouped together as a single "unifacial complex" of industries (Correal 1989; Linares and Ranere 1980; Malpass 1983; Porras 1988; Ranere 1978; Richardson 1969; Stothert 1974, 1988). Several of the named industries appear to be associated with preceramic dates ranging from 9000-5000 B.P. and with woodworking and diverse, generalized economies. A few are associated at least partly with horticultural economies (Pearsall 1994; Piperno 1990; Richardson 1969: 115; Stothert 1988).

*Table 1: Formal tool types and frequencies of the Nanchoc Lithic Tradition*

| *Type description* | *Type* * | *Frequency* | % |
|---|---|---|---|
| large quadrilateral | 1 | 25 | 1.0 |
| medium quadrilateral | 2 | 148 | 5.7 |
| small quadrilateral | 3 | 70 | 2.7 |
| large semi-lunar | 4 | 28 | 1.1 |
| medium semi-lunar | 5 | 120 | 4.6 |
| small semi-lunar | 6 | 82 | 3.2 |
| thick semi-lunar | 7 | 57 | 2.2 |
| multi-faceted pointed | 8 | 4 | .2 |
| non-faceted pointed | 9 | 8 | .3 |
| core tools | 10 | 8 | .3 |
| pentagonal | 12 | 131 | 5.1 |
| incurved | 13 | 86 | 3.3 |
| utilized unmodified | 14 | 1,266 | 49.0 |
| blocky | 15 | 284 | 11.0 |
| elongated rectangular | 16 | 28 | 1.1 |
| large pentagonal | 17 | 13 | .5 |
| small triangular | 18 | 15 | .6 |
| medium triangular | 19 | 31 | 1.2 |
| large triangular | 20 | 5 | .2 |
| amorphous 1 | 21 | 66 | 2.6 |
| amorphous 2 | 25 | 10 | .4 |
| small elongated | 26 | 96 | 3.7 |
| biface | 27 | 1 | .0 |
| | *Total* | 2,582 | 100.0 |

* *Type numbers are not continuous; some types were consolidated for purposes of analysis.*

Despite the superficial similarities, analysis revealed important differences between the NLT and these industries. These involve stage of reduction, tool morphology (especially trimming and shaping), and relative morphological stability and standardization of the industries. Specifically, the NLT is distinguishable from most other unifacial industries on the basis of its well-made formal tool types with removed dorsal ridges and non-marginally trimmed edges (Figure 2). We concluded that each unifacial industry should be considered independently for its own attributes, characteristics, and economic associations instead of being lumped together (Rossen 1998; Rossen and Dillehay 1999:126-131). Furthermore, we feel that the importance of unifacial industries in cultural evolution and the corresponding development of plant-oriented economies has been underestimated.

The specific purpose of this article is to present in detail the microscopic use-wear analysis that was conducted on selected lithic artifacts. There are several reasons we choose to publish this specialized analysis. Microscopic use-wear analysis can provide crucial information on the scope and variety of lithic tool use (Keely 1974, 1980; Odell and Odell-Vereeken 1980; Semenov 1964; Shea 1987; Sussman 1988; Vaughn 1985). Furthermore, use-wear analysis may be instrumental in cross-checking and reinforcing more traditional modes of lithic analysis. Despite these obvious benefits, very little detailed use-wear analysis has been conducted on unifacial collections (for an exception see Nieuwenhuis 1998), although work has been published on bifacial industries (Aldenderfer 1998; Lurie 1983; Vaughan 1995). Some important case studies, for various reasons, lack microscopic use-wear studies. A notable case involves the Paiján lithic studies published on early and middle Preceramic sites from the north coast of Peru (Chauchat 1975, 1978, 1988; Chauchat *et al.* 1992; Uceda 1986, 1987). Most Paiján lithics, dominated by stemmed points, side and endscrapers, and long bifacial "Chivateros" cores have come from surface collections with poor contexts, which precluded meaningful use-wear studies. The Paiján studies thus were forced to focus solely on a narrowly-defined morphological analysis.

Our interest in microscopic use- wear analysis stems from Dillehay's work on the Late Pleistocene bifacial and split pebble lithics from Chile's

Monte Verde site. These date to approximately 12,500 B.P. In that study, use-wear analysis revealed an industry that was remarkably varied in use despite its deceptive morphological simplicity (Dillehay 1997).

Microscopic use-wear analysis of the NLT was central to the development of a multi-dimensional approach to analyzing the lithics (*sensu* Dillehay 1997). Specifically, use-wear analysis complemented the reduction sequencing, formal typology, and contextual-spatial analyses. In this analysis, a sample of lithics from three interrelated sites in the Quebrada de Las Pircas (CA09-27, CA09-28, CA09-52) is considered (Figure 3). We present the details of the use-wear analysis with three goals. First, we wish to complete the documentation of the NLT, which we believe to be a significant Middle Preceramic lithic tradition. Second, we wish to discuss the methodological and conceptual issues surrounding the implementation of use-wear analysis and its integration with other forms of lithic analysis. Third, we hope to encourage a wider implementation of use-wear analysis as a standard part of the documentation of South American lithic traditions. Readers well-versed in the methods and results of microscopic use-wear studies on fine-grain chert assemblages, which normally render clearer, diagnostic use traces and patterning than medium-to- large grain basalt and andesite assemblages, may be disappointed by some of the non-diagnostic and ambiguous results and patterning presented below. Yet, this is the nature of use-wear studies on multipurpose, expedient tool assemblages produced on large grain raw materials. Distinctive use-wear and residues (plant, bone, hide, etc.) were observed on enough lithics in this sample, however, to provide important insights into the NLT.

## Microscopic use-wear analysis

The analysis techniques of use-wear traces on stone tools adapted for this study are essentially those developed and described by Keeley (1980; Odell 1981). This section briefly describes the method of specimen preparation and microscopy. This is followed by the first author's experimentally produced collection used for comparative purposes in identification of wear polishes on the archeological specimens examined. (For a more detailed and comprehensive assessment of the methods employed in this type of use-wear, see Dillehay 1997.) The reader should also consult Richard's (1988) study of microwear patterns on experimental basalt tools, because it was very similar in techniques and results to the experimental tests that Dillehay conducted on basalts and andesites sites from Peru and Chile.

### *Preparation of specimens and microscopy*

Edge damage, linear striations and polish are features intrinsic to the utilized area of the implement. It is critically important to remove organic and inorganic residues from the implement prior to microwear analysis, because these residues may be confused with use-wear, or may obscure use-wear traces. Obviously, this must be done with caution because residues resulting from implement use may still adhere to the surface of the specimen and these may provide valuable data on utilization. Distinguishing cultural from natural residues usually is an easy task. The former are often embedded in microcracks and fissures and are exotic plants and materials. Cultural residues are often recovered only on the worked or used edge while naturally adhering residues usually occur on all areas of the stone in question (Dillehay 1997). Thus, it is important to inspect each artifact carefully prior to chemical and other cleaning. After this inspection, the following procedures were used to clean the artifacts.

Artifact edges first were inspected under both high and low-power microscopes to detect

potential residue areas. Artifacts exhibiting such areas were subjected to a special residue extraction method (Barton *et al.* 1998; Dillehay 1997; Fullagar *et al.* 1996). Artifacts were then very lightly scrubbed with a fine-hair brush in diluted ammonia-based cleaner. In this case, Top Job brand liquid cleaner was used. This removed most of the grease that had accumulated on specimens as a result of handling. The artifact was dried and once again examined for traces of residues. The artifact was then subjected to a 15 minute bath in 15% hydrochloric acid (HCl) to remove inorganic residues. After removal from the bath, the specimen was thoroughly washed in warm water. A second bath of similar duration in 15% potassium hydroxide (KOH) solution was followed by a light washing in warm water. Once the specimens were thoroughly dried, microscopic examination continued. All specimens were examined under a stereoscopic microscopic at 15-30 magnifications and general note of edge damage characteristics were made. Then the edges were scanned under the light microscope at 50, 100, 200, and 400 magnifications. Most polish which is substantial enough for interpretation was revealed as bright spots at magnifications less than 15x. However, resolution of particular characteristics of polish and linear features was usually only possible at higher magnifications, often using a scanning electron microscope.

The microscopes used in this study were the Swift Stereo zoom stereomicroscope, the Olympus BM1, and a Hitachi scanning electron scope. The Olympus is equipped with incident light for viewing opaque materials. This attachment is critical in order to sufficiently illuminate the specimen for study. Identifications of use-wear traces observed during microscopy were compared with experimentally produced polishes of known origin on materials similar to the archeological specimens under investigation. For comparative analyses, local basalts, tonalities, andesites, and cherts were used to prepare a comparative collection. Additional experience with basalts, andesites, and granites from southern Chile was also incorporated.

*The comparative collection*

Initially, hand-held flakes of local basalt, andesite and chert were used to scrape, cut, adze, gouge, and drill wood, bone, leather, meat, and antler, in several operations (for 25, 50, 100, 150 strokes, and so on). These and other specimens were used as training aids for the lead author. Later, a more extensive comparative collection was prepared by the authors using different lithic raw materials on fresh cow bone, including scraping sueded cow hide leather, cutting and adzing soft and dry wood, and working a wide variety of plant material. In this way, a wide range of activities and material types was replicated while at the same time, certain variables such as angle of work, stroke length, speed, and pressure were controlled. In all, 75 experimental specimens made of local basalts, andesites, and other stone types from the north coast of Peru were prepared.

*Microwear analysis skills test*

In order to provide an assessment of the ability to correctly interpret work action and material worked and to clarify limitations in the ability to interpret use-wear, a blind skills test was developed by Michael B. Collins and taken by the first author. The tools (n=35) were made from local lithic raw materials that occur in the study area. The specimens were used in a variety of ways (i.e., whittling, cutting, scraping, digging, etc.) on a variety of materials. The tools were then cleaned as specified above.

After characteristics of edge damage and polish were recorded for each specimen, the area(s) utilized, the work action indicated, and the work material interpreted were then used to construct an overall assessment of tool use. The results of the blind skills test were compared to the actual description of use prepared by Collins and to published skills test results (Keeley 1980; Odell and Odell-Verreken 1980; Richards 1988). The results are shown in Table 2:

*Table 2: Results of blind skills test*

| *Analyst* | *Used part of tool* | *Work action* | *Material worked* |
|---|---|---|---|
| Dillehay (n=35) | 88.5% | 63.8% | 51.2% |
| Keeley (n=16) | 87.5% | 75.0% | 62.5% |
| Odell (n=46) | 82.6% | 67.7% | 39.1% |
| Richards (n=30) | 95.0% | 90.0% | 40.0% |

The used portion of a tool was usually easily identified as suggested by Dillehay's score as well as by the other skills tests. Mistakes usually result from poorly formed evidence for use, either through use on very soft materials or very short duration of use. Work action may be inferred with more confidence by each analyst than can worked material. This is particularly evident in the tests reported by Keeley (1980), Odell and Odell-Vereeken (1980), and Richards (1988). The score by the first author may be at least partially attributed to quality of the materials from which specimens were made. Many specimens analyzed were made from andesites and basalts with large-to-medium grain size. These stones do not "behave" as predictably under work stress conditions as would be desired. Edges often tend to erode and crumble rather than flake as may be expected in cherts with finer texture. Because much of the inference of work action is based on patterns observed in microscarring, this factor accounts for some of the mistakes.

Specific work material was the most difficult attribute to identify. When the polish is extensive and well-formed, the difficulties are decreased considerably. However, as noted above, certain polishes are quite similar to one another. Bone and antler polish were not distinguishable from each other by the first author. Bone-antler polish may look very much like wood polish, unless the wood polish is well-formed. Meat and fresh hide polish are very difficult to distinguish from one another and are both almost impossible to recognize in lieu of other polishes, which may be correlated with the specific activity such as butchering. Soft vegetal materials did not produce pronounced polish, presumably as a result of low silica content in temperate and arid zone plants.

While numerous clues to the specific use of a specimen are provided through physically observable phenomena, interpretation is a matter of assembling these into a logical framework. Committing to an interpretation of one edge can produce mistakes on another work area of the same tool. This problem was obvious in several examples of the skills test in which an intentionally crumbled edge was interpreted as use damaged and minor damage on the opposing edge was therefore interpreted as the result of prehension when, in fact, it had also resulted from use.

Space does not allow for a detail discussion of the results of the skills test. Several major concerns were derived, however. First, bone and antler polish appear so similar on experimental stone artifacts examined that no distinction was made between the two. Second, bone-antler and wood polishes were hard to distinguish in the incipient stages of polish formation, at least on the lithic materials used in this study. Third, while some clear distinctions between soil and dry hide polishes were evident in the experimental specimens, the distinctions were much less clear in the archeological specimens. Fourth, many polishes are difficult to detect in the absence of other indications of butchering such as bone polish or edge damage.

## Analysis description and parameters

Microscopic use-wear examination involves the recording of a variety of attributes, which may then in combination be judged to generally fit into a particular material use (that is, used on soft, medium, or hard material) and action (scraping, slicing, chopping, etc.). To summarize the analysis (Table 3), first the **curve** of the tool edge was coded into one of nine classes, from incurvate to straight to excurvate. **Edge dam-**

**age** was estimated as the type and degree of crushing, smoothing and abrasion present on the edge. **Crystal location** was estimated as the provenience of prominent crystals as opposed to aggregates of less prominent crystals along the edge. Estimating crystal location involves the determination of whether crystals are found isolated, clustered, flattened, rounded and/or elevated in various possible combinations. **Scar type** and **scar distribution** are the two primary attributes of low magnification edge damage. Scar type codes scars in terms of various types of scalar, step, and half-moon edge fractures. Scar distribution documents how even, sporadic, and closely or widely spaced the scars are. **Linear features** and **linear direction** are the two primary attributes of striations. The linear features category documents whether striae and scratches are found in conjunction with abrasion tracks and/or polish. Linear direction documents whether striae are perpendicular or parallel to the use-edge, or whether there is a random pattern.

**Striae type**, whether short or long, narrow or wide, or oblique, and **striae number** were also documented when striations were present. Striae may be caused by either cultural use or natural processes. Evaluation of striae thus depends heavily on their association with edge damage, polish or residues.

The two attributes of high-magnification analysis are **polish location** and **polish type**. Polish location documents how broadly distributed along the edge and how far from the edge into the tool interior the polish extends. Polish type documents whether the polish is smeared or pitted, homogeneous or uneven, and bright or dull. The last two attributes, **estimated material worked** and **action**, are based on a combination of all previously-listed observations. Estimated material use documents whether the edge damage, linear features, and polish, considering not only types of each attribute but combined presence/ absence of all attributes, can be placed into a general use-wear category of hard, medium, or soft material.

*Table 3: Attributes and observed features of microscopic use-wear analysis*

| *Attribute* | | *Observed feature(s)* |
|---|---|---|
| 1 | Curve | Use edge configuration |
| 2 | Edge rounding | Crushing, smoothing, abrasion |
| 3 | Crystal location | Prominence and aggregation of crystals |
| 4 | Scar type | Shape and size of low-magnification fractures |
| 5 | Scar distribution | Distribution of low-magnification fractures |
| 6 | Linear features | Conjunction of striae with abrasion tracks, polish |
| 7 | Linear direction | Relation of striae to edge-use directionality |
| 8 | Striae type | Length, width, and obliqueness of striae |
| 9 | Striae number | ---------- |
| 10 | Polish location | Concentration and distribution of polish |
| 11 | Polish type | Relative brightness and homogeneity, amount of pitting present |
| *Summary attributes:* | | |
| 12 | Estimated material use | Tool used on hard, medium or soft material; sometimes more specific assessment possible |
| 13 | Action | Type of work and/or working motion employed with tool |

Sometimes the evidence is convincing enough to discern specific material use, as on bone, hide, or soft plant tissue. Action is an estimation of the type of work performed with a tool, such as slicing, cutting, scraping, boring or chopping. Finally, 24 of 91 (26.4%) edges contained actual residues on their edges, en-

hancing interpretations based on edge damage, striations, and polish.

A total of 78 lithic specimens with a total of 91 use aspects were selected for micro-wear analysis. A summary of the microscopic analysis of each stone appears in Table 4.

*Table 4: Summary of the microscopic use-wear analysis*

| *Site No.* | *Lithic No.* | *Material type* | *Tool Type* | *Observations* |
|---|---|---|---|---|
| CA09-27- | 16 | tuff | 14 | Edge-crushing; plant fibers, white, red residue. |
| CA09-27- | 57 | rhyolite | 13 | Elongated nicking, step and deep scalar fractures; very bright diffuse flattened domed unpitted polish; burned and unburned plant fibers. |
| CA09-27- | 68 | crystalline quartz | 12 | Edge crushing, nicking; wide perpendicular striations; scraping hide. |
| CA09-27- | 79 | basalt | 6 | No use evident. |
| CA09-27- | 137 | diorite | 3 | Dull, flat, heavily smeared polish with micropits; dirty hide or dry bone; black fibrous residue. |
| CA09-27- | 189 | tuff | 12 | Elongated step fractures; pit-like diffuse polish; fresh hide. |
| CA09-27- | 221 | andesite | 26 | No use evident. |
| CA09-27- | 460 | tuff | 15 | Sharp edges; high ridges with bright polish; plant scraping. |
| CA09-27- | 482 | granite | 10 | Smeared, homogeneous bright polish; oxidation rubbed off; step fractures and crushing; many burned plant fibers; slicing, cutting, chopping. |
| CA09-27- | 490 | tuff | 16 | Edge nicking, step and half-moon fractures; nondescript polish; plant fibers. |
| CA09-27- | 569 | basalt | 15 | 2 use-edges; both long half-moons; homogeneous bright flattened polish; meat/hide. |
| CA09-27- | 593 | basalt | 12 | 3 use-edges; 2 with step, scalar, half-moon fractures; transverse striae; smooth bright polish; soft wood; 1 with semi-bright pitted even polish; meat/hide. |
| CA09-27- | 741 | rhyolite | 15 | No use evident. |
| CA09-27- | 744 | basalt | 19 | 2 use edges; 1 with sub-parallel striae; homogeneous bright flattened polish; medium-to-hard; haft, 1 with step, scalar, half-moon fractures; sub-parallel abrasions; pitted irregular polish; indeterminate use and action. |
| CA09-27- | 828 | basalt | 7 | White residue; no use evident. |
| CA09-27- | 901 | tuff | 21 | No use evident. |
| CA09-27- | 1031 | silex-coffee | 6 | Semi-bright, flattened, smeared, unpitted polish; perpendicular + long thin diagonal striae; soft-to-medium material, fresh hide? |
| CA09-27- | 1048 | rhyolite | 17 | Large, deep, half-moon fractures; very dull, heavily flattened pitted polish; parallel striae; cutting burned bone. |
| CA09-27- | 1054 | basalt | 10 | Use on 6 edges of 2 types; 1: extensive grain loss; long scalar fractures; plant fibers; scraping plants; 2: many step fractures; white residue, chopping hard-to-medium material. |
| CA09-27- | 1171 | tuff | 7 | Long uneven half-moon fractures; extensive edge rounding; slight polish; plant fibers; slicing. |
| CA09-27- | 1179 | basalt | 21 | 2 edges, both grain loss; non-descript polish; indeterminate action and use. |
| CA09-27- | 1222 | basalt | 14 | Semi-bright pitted even polish; burned plant fibers; soft wood slicing/cutting. |
| CA09-27- | 1231 | basalt | 12 | Sporadic grain loss; bright, pitted, even polish; cutting meat/hide. |
| CA09-27- | 1303 | basalt | 2 | No use evident. |
| CA09-27- | 1309 | diorite | 14 | Diffuse semi-bright polish; dried soft plants. |
| CA09-27- | 1320 | basalt | – | Large, stepped, half-moon fractures; hard scraping. |
| CA09-27- | 1393 | diorite | 5 | Long deep step fractures; very bright, even, domed polish; sawing bone. |
| CA09-27- | 1394 | rhyolite | 25 | 2 use-edges; 1: scalar and step fractures; non-descript polish; plant fibers; slicing soft material; 2: heavy crushing on tip; punching medium-to-hard material. |

*Table 4 (continued): Summary of the microscopic use-wear analysis*

| Site No. | Lithic No. | Material type | Tool type | Observations |
|---|---|---|---|---|
| CA09-27- | 1447 | silex-grey | 4 | No use evident. |
| CA09-27- | 1467 | tuff | 10 | Edge crushing; small, deep, scalar fractures; plant fibers; chopping soft-medium material. |
| CA09-27- | 1533 | tuff | 21 | No use evident. |
| CA09-27- | 1535 | andesite | 2 | Long scalar and step fractures; non-descript polish; burned and unburned plant fibers; slicing/cutting soft plants. |
| CA09-27- | 1575 | silex-black | 8 | Crushing on point; non-descript polish; perforating. |
| CA09-27- | 1649 | tuff | – | Light, diffuse polish; plant fibers; indeterminate use and action. |
| CA09-28- | 133 | basalt | 14 | Slight grain loss; non-descript polish; burned and unburned plant fibers; slicing soft plants. |
| CA09-28- | 237 | rhyolite | 6 | Long step and shallow half-moon fractures; non-descript polish; plant fibers; soft material. |
| CA09-28- | 259 | rhyolite | 7 | Elongated scalar fractures; elevated crystals; spotty, flattened, micropitted polish; burned plant fibers; sawing soft plants. |
| CA09-28- | 273 | basalt | 1 | Small scalar and half-moon fractures; light hummocked polish; slicing/cutting soft plants. |
| CA09-28- | 289 | rhyolite | 6 | Sharp edge; red residue; indeterminate action. |
| CA09-28- | 298 | andesite | 16 | 2 use-edges; 1: step fractures; slicing medium-to-hard material; 2: semi-bright pitted even polish; indeterminate. |
| CA09-28- | 318 | diorite | 6 | No use evident. |
| CA09-28- | 428 | andesite | 17 | Short narrow square-corner scalar fractures; too much oxidation on edge to read. |
| CA09-28- | 464 | basalt | 14 | Bright flat polish; soft plants. |
| CA09-28- | 548 | tuff | 14 | No use evident. |
| CA09-28- | 554 | basalt | 7 | Large scalar and step fractures; high points crushed; non-descript polish; indeterminate. |
| CA09-28- | 584 | tuff | 13 | Unable to read due to sun-bleached oxidation. |
| CA09-28- | 589 | basalt | – | No use evident. |
| CA09-28- | 612 | basalt | 15 | Use-edge broken off. |
| CA09-28- | 634 | diorite | 16 | Bright polish; burned plant fibers; soft material. |
| CA09-28- | 650 | rhyolite | 15 | No use evident. |
| CA09-28- | 651 | rhyolite | 13 | Abrasion tracks, probably trampled; no use evident. |
| CA09-28- | 680 | basalt | 4 | Few half-moon fractures; red residue; unknown material. |
| CA09-28- | 687 | andesite | 9 | 2 use-edges; 1: bright, flattened, homogeneous polish; cutting fresh bone; 2: semi-bright, pitted, even polish; hafting. |
| CA09-28- | 735 | tuff | 4 | 2 use-edges; 1: step and half-moon fractures; edge crushing; fracture cleavages; perpendicular and diagonal striae transverse to edge; heavily pitted bright flattened polish; 2: same without striae or polish; sawing hard-med (hide or wood?). |
| CA09-28- | 786 | basalt | 7 | Sporadic grain loss; bright, irregular, uneven, pitted polish; scraping soft plants. |
| CA09-28- | 805 | basalt | 17 | 3 use-edges; 1: scalar and step fractures; short, oblique, wide striae; smeared, homogeneous, bright polish; hafting; 2: small flattened grains with crossing striae; wood hafting; 3: bright pitted uneven polish; slicing plants. |
| CA09-28- | 826 | rhyolite | 12 | No use evident. |
| CA09-28- | 863 | basalt | 17 | Shallow half-moon fractures; small scalar and step fractures; non-descript polish; slicing/cutting (light chopping) soft plants. |
| CA09-28- | 870 | diorite | 2 | Crushed crystals, trampled, no use evident. |
| CA09-28- | 878 | rhyolite | 12 | Diffuse polish; indeterminate. |
| CA09-28- | 890 | basalt | 12 | No use evident. |

*Table 4 (continued): Summary of the microscopic use-wear analysis*

| Site No. | Lithic No. | Material type | Tool type | Observations |
|---|---|---|---|---|
| CA09-52- | 16 | tuff | – | Slight grain loss; no use evident. |
| CA09-52- | 26 | quartz crystal | – | Rounded tip on faceted quarts crystal; long deep rounded scalar fractures; hard boring. |
| CA09-52- | 80 | basalt | 13 | Slight grain loss; non-descript polish; burned and unburned plant fibers; slicing soft plants. |
| CA09-52- | 249 | diorite | 13 | Long, shallow, scalar and step fractures; semi-bright, flattened, nondescript polish; black residue; very soft material. |
| CA09-52- | 250 | basalt | 14 | Abrasion tracks within flattened, pitted polish; slicing/cutting hard-med material; non-plant. |
| CA09-52- | 322 | silex-coffee | 14 | Deep scalar fractures; dull, pitted polish with irregular bright spots; soft-to-medium; hide scraper. |
| CA09-52- | 334 | tuff | 26 | Step fractures; heavy, bright, domed, smooth, homogeneous, unpitted polish on dorsal side; plant fibers; slicing soft plants. |
| CA09-52- | 395 | basalt | 16 | 2 use-edges; 1: long scalar and step fractures; nondescript polish; soft material; plants? 2: long, narrow, square-corner, scalar fractures; semi-bright, pitted, even polish; cutting fresh, greasy meat. |
| CA09-52- | 420 | tuff | 15 | Edge rounded, nicked; sporadic grain loss; nondescript polish; indeterminate. |
| CA09-52- | 426 | tuff | 14 | Scraped, crushed, flattened high spots; trampled; no use evident. |
| CA09-52- | 439 | basalt | 15 | Few half-moon and step fractures; indeterminate. |
| CA09-52- | 555 | silex-black | 15 | 2 use-edges; 1: sporadic grain loss; semi-bright. clean polish; slicing soft plants; 2: deep scalar fractures; some polish; heavy sawing; soft plants. |
| CA09-52- | 608 | quartzite | 14 | Sharp, jagged edges; edge crushing; too much reflection off edge to read; indeterminate. |
| CA09-52- | 727 | tuff | 12 | Elongated scalar fractures; longitudinal striae sub-parallel to edge; semi-bright, pitted, even polish; slicing medium-to-hard material. |
| CA09-52- | 748 | tuff | 14 | Unable to read due to bright water sheen and heavy oxidation; indeterminate. |
| CA09-52- | 1075 | basalt | 9 | 2 use-edges; 1: bright, flattened, homogeneous polish; hide/meat; 2: short striae; even polish; hafting. |

In considering Table 4, it is important to remember that it merely depicts a partial summary of fractures, polish, residue, etc. observed on each specimen edge. As such, the table is useful to illustrate (1) the variety of use-wear attribute combinations present in the collection, and (2) the complexity of determining or leaving undetermined estimated material use and action. According to Dillehay and others such as Vaughn (1985), there are no shortcuts in this type of time-consuming analysis and it is hoped that Table 4 adequately illustrates this point. Figures 4 to 9 depict examples of edge damage, polish, and residues, photographed at relatively low magnifications of 30 to 40x. These photos are only meant to illustrate a few cases of the attributes that were microscopically examined, because diagnosis of polish and edge damage often involve their examination under much higher magnifications (from 400Xto 2000X). For the purposes of this discussion, the summary attributes of estimated material use and action will be discussed in conjunction with tool type, raw material type, and residues.

The small sample represents only 3.2% of all tools and utilized flakes from the three excavation sites. Specimens for analysis were selected unsystematically during the process of typological analysis. An effort was made to proportionally represent the three sites and most of the formal tool types in the sample. Because the highest frequency of formal edge-trimmed tools was recovered from site CA09-27, 45.1% of the examined specimen edges were from that site. Similarly, fewer edges (20.9%) were examined from site CA09-52 because that site was dominated by Type 14 unmodified utilized flakes. In

terms of raw material types, the use-wear sample is generally representative of both major and minor types in the lithic assemblage (Tables 5 and 6). For example, the percentage of basalt edges selected (44.0%) is quite similar to the percentage present in the entire assemblage (46.5%). Rhyolite is slightly over-represented in this sample, while rhyolite diorite and andesite are under-represented.

Limestone was excluded because use-wear is extremely difficult to read on the often chalky, exfoliated surfaces of this material. A few silex and quartz specimens were examined to estimate the use of special, exotic materials.

*Table 5: Raw material types and frequencies of the Nanchoc Lithic Tradition)*

| | Material | Color | Mat. Code¶ | Frequency | Percent |
|---|---|---|---|---|---|
| | basalt | black | 1 | 16,520 | 46.5 |
| | quartzite | violet | 2 | 353 | 1.0 |
| | andesite | gray | 3 | 2,658 | 7.5 |
| * | silex | banded | 4 | 41 | .1 |
| * | silex | cream | 5 | 25 | .1 |
| * | silex | coffee | 6 | 13 | .0 |
| * | silex | dark green | 7 | 70 | .2 |
| | limestone | off-white | 8 | 2,788 | 7.8 |
| * | silex | general | 9 | 3 | .0 |
| | rhyolite | banded | 10 | 2,298 | 6.5 |
| | quartz | milky | 11 | 88 | .2 |
| * | quartz | crystalline | 12 | 50 | .1 |
| * | quartz | crystal | 13 | 2 | .0 |
| * | quartz | variously colored | 14 | 48 | .1 |
| * | chalcedony | white | 15 | 24 | .1 |
| * | silex | black | 16 | 67 | .2 |
| * | silex | black with coffee | 17 | 1 | .0 |
| | granite | gray | 18 | 104 | .3 |
| | tuff | gray, veined | 19 | 4,572 | 12.9 |
| * | jasper | black with red | 20 | 33 | .1 |
| * | silex | gray | 21 | 35 | .1 |
| | diorite | cream, off-white | 22 | 5,576 | 15.7 |
| | granite | green | 23 | 1 | .0 |
| | basalt | black, white flecks | 24 | 7 | .0 |
| * | quartz | amber | 25 | 3 | .0 |
| * | silex | gray, red streaks | 26 | 11 | .0 |
| | copper ore | dark green | 28 | 126 | .4 |
| * | jasper | cream, black and red | 29 | 16 | .0 |
| * | silex | dark pink, violet | 30 | 1 | .0 |
| * | mica | silver | 31 | 1 | .0 |
| * | silex | maroon | 32 | 3 | .0 |
| * | silex | black and yellow | 33 | 1 | .0 |
| | ** denotes material type considered exotic* | | *Total* | *35,537* | *100.0* |

¶ Material codes are not continuous; Type 27, "unworked petrified wood [?]" was not included in the analysis.

*Note that this table supersedes previous versions.*

*Table 6: Raw material types of the lithic tool sample analyzed for microscopic use-wear*

| Material | Code | Frequency | Percent |
|---|---|---|---|
| basalt | 1 | 40 | 44.0 |
| quartzite | 2 | 1 | 1.1 |
| andesite | 3 | 3 | 3.3 |
| silex-coffee | 6 | 2 | 2.2 |
| rhyolite | 10 | 12 | 13.2 |
| quartz crystal. | 12 | 1 | 1.1 |
| quartz crystal | 13 | 1 | 1.1 |
| silex-black | 16 | 3 | 3.3 |
| granite | 18 | 1 | 1.1 |
| tuff | 19 | 19 | 20.9 |
| silex-gray | 21 | 1 | 1.1 |
| diorite | 22 | 7 | 7.7 |
| | *Total* | *91* | *100.0* |

*Material use, action, and residues*

As a total assemblage, estimated material use for microscopically analyzed lithics shows the dominance of tools used on vegetal materials, probably wood and soft plants (Table 7). The specific "soft plant" and less specific "soft" category (that may also include very soft hide) together comprise 25.3% (n=23) of the edges. Only the "medium-to-hard" category, most likely representing woodworking, has a frequency representation close to the soft categories, with 13.2% (n=12). The remaining specimen edges are split between low frequencies of "soft-to-medium" (n=5), meat/hide (n=4), soft wood (n=3), soil (n=3), bone (n=3), fresh meat (n=l), "hard" (representing bone or hard wood) (n=l), and "unknown substance" (n=2). More than a third of the edges (n=34) were categorized as indeterminate or without use-wear. This last reflects several conditions, including (1) the complexity of use-wear analysis, (2) the special conditions required to produce use-wear, (3) the probable existence of multi-functional tools in the sample, and (4) the loss of use-wear through edge breakage and retouch. Despite these problems, the predominance of estimated plant and wood use-wear on these edges is in agreement with (1) the typological analysis of the NLT, (2) the substantial presence of grinding stones at these sites (Rossen 1991), and (3) the typological observations of other researchers who have discussed unifacial lithic industries (Malpass 1983; Ranere 1978; Richardson 1969; Stothert 1974). Simultaneously, Table 7 demonstrates that despite the dominance of plant and wood oriented activities, a broad spectrum of other activities is also represented.

*Table 7: Determinations of estimated material use from the use-wear analysis*

| Site | CA 09-27 | CA 09-28 | CA 09-52 | Total |
|---|---|---|---|---|
| soft plant | 8 | 5 | 2 | 15 |
| medium-to-hard | 6 | 2 | 4 | 12 |
| soft | 2 | 3 | 3 | 8 |
| soft-to-medium | 3 | 1 | 1 | 5 |
| meat/hide | 2 | 1 | 1 | 4 |
| soft wood | 3 | 0 | 0 | 3 |
| soil | 0 | 2 | 1 | 3 |
| bone | 2 | 1 | 0 | 3 |
| fresh meat | 0 | 0 | 1 | 1 |
| hard | 1 | 0 | 0 | 1 |
| unknown substance | 1 | 1 | 0 | 2 |
| indeterminate/ not used | 13 | 15 | 6 | 34 |
| *Total* | *41* | *31* | *19* | *91* |

In terms of action, the dominance of plant-oriented activities is again evident in the relatively high frequency of cutting specimens, which constitute 22.6% (n=21) of the specimen edges (Table 8).

Plant cutting may refer to a variety of activities ranging from wild plant exploitation and processing to garden plot clearing, plant harvesting, and production of wooden tools. Other harder materials such as hard wood and bone may also have been cut. Second in terms of percentage and frequency is scraping, which may represent various materials, with 12.1% (n=11) of edge specimens. Low frequencies of sawing (n=4), boring (n=3), chopping (n=2) hafting (n=2), and scoring (n=2) again display the variety of activities represented in the assemblage.

*Table 8: Determinations of action from the use-wear analysis*

| Site | CA 09-27 | CA 09-28 | CA 09-52 | Total |
|---|---|---|---|---|
| slicing/cutting | 9 | 6 | 6 | 21 |
| scraping | 8 | 2 | 1 | 11 |
| sawing | 1 | 2 | 1 | 4 |
| boring | 2 | 0 | 1 | 3 |
| chopping | 2 | 0 | 0 | 2 |
| hafting | 1 | 1 | 0 | 2 |
| scoring | 2 | 0 | 0 | 2 |
| indeterminate/ not used | 16 | 20 | 10 | 46 |
| *Total* | *41* | *31* | *19* | *91* |

The third general microscopic category is residues. Archaeological residues were found only on edges prior to cleaning, with 27.5% (n=25) of the specimen edges having observable residues as possible direct evidence of their use (Table 9). Residues were located in fissures and cleavages and not on open surfaces, and thus fortuitous associations are highly unlikely. Plant/wood fibers were present, either alone, or in combination with another residue, on 19 edges (Figures 8 and 9). At high magnifications of 400x to 2000x the plant cells were observable on several of these specimens. Reconfirmed is the importance of plant and wood-related activities at these sites. In addition, other substances were found on use-edges in low frequencies. A white substance, probably calcite, was present on five edges, and four of the five specimens came from site CA09-27. These specimens fizzed along their edges when placed in acid baths, a chemical reaction typical of calcite. The importance of specialized calcite processing at the Nanchoc Mounds site (CA09-04) has been previously discussed (Dillehay and Netherly 1983; Netherly and Dillehay 1985; Dillehay *et al.* 1989). In contrast to the large chunks of calcite recovered at site CA09-04, only a few tiny fragments of calcite were recovered from sites CA09-27 and CA09-28. Thus, though only present in relatively miniscule amounts at these sites, the possible presence of calcite on a small number of use-edges suggests that the material may have also been utilized in less specialized residential contexts, possibly as either a nutritional supplement (Antuñez de Mayolo 1981:87-88; Baker and Mazess 1963) or as an additive for chewing coca leaf. The presence of calcite further relates these sites and the Nanchoc Mounds together into the same cultural tradition. A bright red substance was found on three edges. Two of these specimens were recovered from site CA09-28, where red-stained ground stone was also recovered. This material is possibly red ochre, although no chemical tests could confirm this. A black substance that may be tar was present on two use-edges including one hafted edge. One obvious use of tar would be in hafting tools to wooden handles, and the presence of hafting polish on two specimens indicates that at least a few unifacial tools were hafted.

*Table 9: Fibers and residues from lithic tool edges*

| Site | CA 09-27 | CA 09-28 | CA 09-52 | Total |
|---|---|---|---|---|
| plant fibers | 8 | 4 | 3 | 15 |
| plant fibers + white substance | 2 | 1 | 0 | 3 |
| red substance (ochre?) | 0 | 2 | 0 | 2 |
| black substance (tar?) | 1 | 0 | 1 | 2 |
| white substance (calcite?) | 1 | 0 | 0 | 1 |
| white + red substances | 1 | 0 | 0 | 1 |
| plant fibers + possible silica | 1 | 0 | 0 | 1 |
| no residue | 27 | 24 | 15 | 66 |
| *Total* | *41* | *31* | *19* | *91* |

## Typological/microscopic attribute cross-tabulations

Crosstabulations between microscopic use-wear attributes and typological attributes were useful in relating microscopic data to the typological analysis (Tables 10 to 14). The formal tool typology has been published in detail elsewhere (Rossen 1998). The crosstabulations demonstrate that there is no simple formula for understanding tools and tasks, but instead tool

use involved a complex combination of considerations including tool type, edge angle, raw material type, action, and material being worked. Because of the many tool types present in the NLT, the microscopic analysis could only include a few specimens of each type. The sample was further diminished by the fact that if an attribute was not recorded for a specimen, it was dropped from the crosstabulation. Even when crosstabulations involved fewer categories and greater frequencies, as with raw material type, the overall small sample of microscopically examined edges allows some tentative conclusions. Despite the limitations, some interesting patterns are worth discussing and suggestions may be made concerning the complex interplay of various tool use factors.

Cross-tabulation of raw material type with action and estimated material use suggests that there existed certain material preferences for particular actions but not for use on particular materials (Tables 10 and 11) . Common basalt appears to have been heavily favored for cutting action, as indicated by the presence of 12 such specimens in the microscopically-analyzed sample. In terms of estimated material use, however, basalt was used on the entire range of materials. Conversely, finer-grained materials such as local rhyolite and exotic silex (or chert) were preferred for boring and sawing tasks, again on a wide range of materials.

Crosstabulations of tool type with action, estimated material use, and residue indicate that, from strictly typological data, both specialized and generalized tools are present in the NLT (Tables 12 to 14). Type 14 unmodified flakes are associated with four different actions and five different estimated material uses (excluding the indeterminate and unknown categories). This suggests the wide variety of uses these untrimmed flakes had, and reinforces their previous categorization as expedient.

Specific edge-trimmed tool types may be identified as either generalized or specialized in terms of microscopic use-wear. Type 7 (thick semilunar) tools appear to be specialized in estimated material use, but generalized in terms of action. All three Type 7 specimens with determined use-edges displayed some evidence of plant polish, and two specimens had plant fiber residues, while a third had the white substance on its edge. However, action of these same specimens varied, with one each showing signs of sawing, scraping, and cutting. Conversely, Type 12 (pentagonal) tools appear to be generalized in estimated material use but specialized in action. The five Type 12 specimens for which action could be determined were placed into only two categories, cutting (n=3) and scraping (n=2), but action for this type varied from medium-to-hard (n=2) to meat/hide (n=1) and soft wood (n=1).

Larger pentagonal forms, Type 17, follow the same general pattern as their smaller counterparts, with two of three determined action specimens having been used for cutting (an additional edge on one was used for scoring). Estimated material uses for Type 17 tools vary greatly, with bone (n=1), soil (n=2), soft (n=1) and soft-to-medium (n=1), all represented. Type 16 elongated rectangular forms are similar in microscopic pattern to pentagonal forms. All three specimens from which action could be determined were for cutting or scraping, while material use was extremely variable, with soft plant (n=1), meat/hide (n=1), fresh meat (n=1) soft (n=1), and hard-medium (n=1) represented.

The above examples serve to illustrate some problems in categorizing a tool type as expedient or curated, generalized or specialized, or in utilizing any conceptual dichotomy at all. Tools may fit one descriptive category for one area of analysis and another category for other attributes. In the case of the NLT, it is possible, though far from conclusively demonstrated, that semilunar forms were designed primarily for a variety of activities involving plants, while pentagonal and rectangular forms were designed specifically for scraping and cutting on a variety of materials.

*Table 10: Cross-tabulation of raw material type and action*

| MATERIAL | | ACTION: sawing 2 | boring 3 | chopping 4 | scraping 5 | slicing/ cutting 6 | hafting 8 | undet. 9 | scoring 13 | Row % Total |
|---|---|---|---|---|---|---|---|---|---|---|
| basalt | 1 | | | 1<br>3.6 | 4<br>14.3 | 12<br>42.9 | 2<br>7.1 | 8<br>28.6 | 1<br>3.6 | 28<br>43.8 |
| quartzite | 2 | | | | | | | 1<br>100.0 | | 1<br>1.6 |
| andesite | 3 | | | | | 2<br>66.7 | | 1<br>33.3 | | 3<br>4.7 |
| silex-coffee | 6 | | | | 2<br>100.0 | | | | | 2<br>3.1 |
| rhyolite | 10 | 1<br>12.5 | 1<br>12.5 | | 1<br>12.5 | 1<br>12.5 | | 3<br>37.5 | 1<br>12.5 | 8<br>12.5 |
| quartz-cryst.. | 12 | | | | 1<br>100.0 | | | | | 1<br>1.6 |
| quartz crystal | 13 | | 1<br>100.0 | | | | | | | 1<br>1.6 |
| silex-black | 16 | 1<br>33.3 | 1<br>33.3 | | | 1<br>33.3 | | | | 3<br>4.7 |
| granite | 18 | | | | | 1<br>100.0 | | | | 1<br>1.6 |
| tuff | 19 | 1<br>9.1 | | 1<br>9.1 | 2<br>18.2 | 4<br>36.4 | | 3<br>27.3 | | 11<br>17.2 |
| diorite | 22 | 1<br>20.0 | | | 1<br>20.0 | | | 3<br>60.0 | | 5<br>7.8 |
| | Column<br>% Total | 4<br>6.35 | 3<br>4.7 | 2<br>3.1 | 11<br>17.2 | 21<br>32.8 | 2<br>3.1 | 19<br>29.7 | 2<br>3.1 | 64<br>100.0 |

*Note: Significant values are marked by a box.*

*Table 11: Cross-tabulation of raw material type and estimated material use*

MATERIAL USE

| Raw Material | | Bone | Soft plant | Soft wood | Soil | Meat / hide | Fresh meat | Soft | Soft Med | Hard Med | Hard | Indet. | Not known | Row % Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basalt | 1 | 1<br>3.0 | 6<br>18.2 | 3<br>9.1 | 3<br>9.1 | 3<br>9.1 | 1<br>3.0 | 3<br>9.1 | 1<br>3.0 | 5<br>15.2 | 1<br>3.0 | 5<br>15.2 | 1<br>3.0 | 33<br>48.5% |
| Quartzite | 2 | | | | | | | | | | | 1<br>100.0 | | 1<br>1.5% |
| Andesite | 3 | | 1<br>33.3 | | | 1<br>33.3 | | | | 1<br>33.3 | | | | 3<br>4.4% |
| Silex-coffee | 6 | | | | | | | | 2<br>100.0 | | | | | 2<br>2.9% |
| Rhyolite | 10 | 1<br>12.5 | 2<br>25.0 | | | | | 2<br>25.0 | | 1<br>12.5 | | 2<br>25.0 | | 8<br>11.8% |
| Quartz-cryst. | 12 | | | | | | | | | 1<br>100.0 | | | | 1<br>1.5% |
| Quartz crystal | 13 | | | | | | | | | 1<br>100.0 | | | | 1<br>1.5% |
| Silex-black | 16 | | | | | | | 2<br>66.7 | 1<br>33.3 | | | | | 3<br>4.4% |
| Granite | 18 | | 1<br>100.0 | | | | | | | | | | | 1<br>1.5% |
| Tuff | 19 | | 4<br>36.4 | | | | | | 1<br>9.1 | 3<br>27.3 | | 2<br>18.2 | 1<br>9.1 | 11<br>16.2% |
| Diorite | 22 | 1<br>25.0 | 1<br>25.0 | | | | | 1<br>25.0 | | | | 1<br>25.0 | | |
| | Column % Total | 3<br>4.4% | 15<br>22.1% | 3<br>4.4% | 3<br>4.4% | 4<br>5.9% | 1<br>1.5% | 8<br>11.8% | 5<br>7.4% | 12<br>17.6% | 1<br>1.5% | 11<br>16.2% | 2<br>2.9% | 68<br>100.0% |

*Table 12: Cross-tabulation of formal tool types and action*

| TOOL TYPE | | ACTION: *sawing* | *boring* | *chopping* | *scraping* | *slicing/ cutting* | *hafting* | *undet.* | *scoring* | *Row* |
|---|---|---|---|---|---|---|---|---|---|---|
| large quadrilateral | 1 | | | | | 1 | | | | 1 |
| medium quadrilateral | 2 | | | | | 1 | | | | 1 |
| small quadrilateral | 3 | | | | | | | 1 | | 1 |
| large semilunar | 4 | 1 | | | | | | 1 | | 2 |
| medium semilunar | 5 | 1 | | | | | | | | 1 |
| small semilunar | 6 | | | | 1 | | | 2 | | 3 |
| thick semilunar | 7 | 1 | | | 1 | 1 | | 1 | | 4 |
| multi-point | 8 | | 1 | | | | | | | 1 |
| point | 9 | | | | | 1 | 1 | 1 | | 3 |
| core tool | 10 | | | 1 | | 1 | | | | 2 |
| pentagonal | 12 | | | | 2 | 3 | | 1 | | 6 |
| incurved | 13 | | | | 1 | 1 | | 1 | | 3 |
| unmodified | 14 | | 1 | | 2 | 3 | | 3 | | 9 |
| blocky | 15 | 1 | | | 1 | 2 | | | | 4 |
| elongated rectangular | 16 | | | | 1 | 2 | | 2 | | 5 |
| large pentagon | 17 | | | | | 2 | | 1 | 1 | 4 |
| medium triangular | 19 | | | | | | 1 | | | 1 |
| amorphous1 | 21 | | | | | | | 1 | | 1 |
| amorphous2 | 25 | | | | | 1 | | | | 1 |
| long handled | 26 | | | | | 1 | | 1 | | 2 |
| *Column* | | 4 | 2 | 1 | 9 | 20 | 2 | 16 | 1 | 56 |
| *% Total* | | 7.1% | 3.6% | 1.8% | 16.1% | 35.7% | 3.6% | 28.6% | 3.6% | 100.0% |

*Note: This table supersedes previous versions. Significant values are marked by boxes.*

*Table 13: Cross-tabulation of formal tool types and estimated material use*

| TOOL TYPE | | ESTIMATED MATERIAL USE: Bone | Soft plant | Soft wood | Soil | Meat/ hide | Fresh meat | Soft | Soft, med | Hard, med | Indet. | Not known | Row Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| large quadrilateral | 1 | | 1 | | | | | | | | | | 1 |
| medium quadrilateral | 2 | | 1 | | | | | | | | | | 1 |
| large semilunar | 4 | | | | | | | | | 2 | | 1 | 3 |
| medium semilunar | 5 | 1 | | | | | | | | | | | 1 |
| small semilunar | 6 | | | | | | | 1 | 1 | | 1 | | 3 |
| thick semilunar | 7 | | 3 | | | | | | | | 1 | | 4 |
| multi point | 8 | | | | | | | | 1 | | | | 1 |
| point | 9 | 1 | | | 1 | 1 | | | | 1 | | | 4 |
| core tools | 10 | | 2 | | | | | | | | 1 | | 3 |
| pentagonal | 12 | | | 1 | | 1 | | | | 2 | 2 | | 6 |
| incurved | 13 | | 2 | | | | | | | | 1 | | 3 |
| unmodified | 14 | | 1 | 1 | | | | 2 | 1 | 2 | 1 | 1 | 9 |
| blocky | 15 | | 1 | | | | | 2 | | 1 | | | 4 |
| elongated rect | 16 | | 1 | | | 1 | 1 | 1 | | 1 | 1 | | 6 |
| large pentagonal | 17 | 1 | | | 2 | | | 1 | 1 | | 1 | | 6 |
| med triang | 19 | | | | | | | | | 1 | | | 1 |
| amorphous1 | 21 | | | | | | | | | | 1 | | 1 |
| amorphous2 | 25 | | | | | | | 1 | | | | | 1 |
| long handled | 26 | | 2 | | | | | | | | | | 2 |
| Column | | 3 | 14 | 2 | 3 | 3 | 1 | 8 | 5 | 10 | 9 | 2 | 60 |
| % Total | | 5.0% | 23.3% | 3.3% | 5.0% | 5.0% | 1.7% | 13.3% | 8.3% | 16.7% | 15.0% | 3.3% | 100.0% |

*Table 14: Cross-tabulation of formal tool types and residues*

| TOOL TYPE | | RESIDUE: plant fibers | white material (calcite) | white + red | red material (ochre?) | black material (tar?) | fibers + white | fibers + silica | Row % Total |
|---|---|---|---|---|---|---|---|---|---|
| medium quadrilateral | 2 | 1 | | | | | | | 1 4.2% |
| small quadrilateral | 3 | | | | | 1 | | | 1 4.2% |
| large quadrilateral | 4 | | | | 1 | | | | 1 4.2% |
| small semilunar | 6 | 1 | | | 1 | | | | 2 8.3% |
| thick semilunar | 7 | 1 | 1 | | | | | 1 | 3 12.5% |
| core tools | 10 | 2 | | | | | 1 | | 3 12.5% |
| incurved | 13 | 2 | | | | 1 | | | 3 12.5% |
| unmodified | 14 | 2 | | 1 | | | | | 3 12.5% |
| blocky | 15 | 1 | | | | | | | 1 4.2% |
| elongated rectangular | 16 | 2 | | | | | | | 2 8.3% |
| large pentagonal | 17 | | | | | | 1 | | 1 4.2% |
| amorphous2 | 25 | 1 | | | | | | | 1 4.2% |
| long handled | 26 | 2 | | | | | | | 2 8.3% |
| Column %Total | | 15 62.5% | 1 4.2% | 1 4.2% | 2 8.3% | 2 8.3% | 2 8.3% | 1 4.2% | 24 100.0% |

*Inter-analysis results*

A comparison of microscopic use-wear data (including estimated material use, action, and residue evidence together) with typological data and characterizations highlights areas of agreement and disagreement between different forms of analysis. The reason for making this comparison, summarized in Table 15, is not to decide whether one form of analysis is superior to another or whether mistakes were made in analysis. Rather, this comparison allows certain research assumptions to be examined, and brings forward areas of greater and lesser certainty and ambiguity within the data. It is worth repeating that these different analysis forms are here considered complementary, in that they together form a more effective, multi-dimensional approach than either approach can offer alone. Agreement between typological and microscopic analysis was classified in Table 15 as good, fair, or poor. Good agreement means that the two forms of analysis leave little doubt as to the function(s) of the tool type in question (Dillehay 1997). Fair agreement means that relatively minor disagreements are the product

of differing terminology and, despite this, the tool is well-understood in terms of function and use. Poor agreement means that substantial differences were found in the results of the two analyses, and the meaning of these differences will be discussed below.

This system was modified from a similar analysis comparison developed by Dillehay for use with the Monte Verde lithic collections from southern Chile.

*Table 15: Summary of interanalysis agreement of tool functions*

| Tool type | Form | Action | | Material use | | Agreement |
|---|---|---|---|---|---|---|
| | | typo | micro | typo | micro | |
| 1 | large quadrilateral | slice/cut | slice/cut | – | soft plant | good |
| 2 | medium quadrilateral | slice/cut | slice/cut | – | soft plant | good |
| 3 | small quadrilateral | slice/cut | indeterminate | – | – | – |
| 4 | large semi-lunar | slice/cut | sawing | – | med.-to-hard | fair |
| 5 | medium semi-lunar | slice/cut | sawing | – | bone | fair |
| 6 | small semi-lunar | slice/cut | scraping | – | soft, soft-med. | poor |
| 7 | thick semi-lunar | cutting | various | – | soft plant | poor |
| 8 | burin multi | boring | boring | – | soft-to-med. | good |
| 9 | burin simple | boring | slice/cut | – | various | poor |
| 10 | large core | scraping/ planing, hoeing | various | – | soft plant | good |
| 12 | pentagonal | slice/cut | slice/cut, scraping | – | various | good |
| 13 | incurved | planing | slice/cut, scraping | wood | soft plant | fair |
| 14 | unmodified util | slice/cut | various | – | various | fair |
| 15 | blocky | scraping/ planing | various | wood | various | good |
| 16 | thick rectangular | cutting | slice/cut, scraping | wood | various | good |
| 17 | thick pentagonal | cutting | slice/cut | – | various | – |
| 18 | small triangular | slice/cut | – | – | – | – |
| 19 | medium triangular | slice/cut | (hafted) | – | med.-to-hard | – |
| 20 | large triangular | slice/cut | – | – | – | – |
| 21 | amorphous 1 | – | indeterminate | – | indeterminate | – |
| 25 | amorphous 2 | – | slice/cut | – | soft | – |
| 26 | large handled | scraping/ planing | slice/cut | wood | soft wood | fair |

In considering the ramifications of Table 15, it is important to remember the small sample of microscopic analysis specimens, with tools characterized for the sake of general discussion based on only one to five specimens per type. With this major caveat, it is thus encouraging that seven tool types were classified as having good agreement, six as having fair agreement, and only three as having poor agreement between the two forms of analysis. In several cases, the microscopic use-wear analysis confirmed the categorizations made from typological data. Quadrilateral forms with low edge angles, such as Types 1 and 2, were confirmed as plant cutters. The Type 8 faceted burin-like pointed form was indeed used for boring. The characterizations of Types 12 and 17, both pentagonal forms with medium edge angle modes and trends, as general purpose plant cutters were well-established by analysis agreement.

In examining tools with fair agreement between analyses, some differences in terminology may be discussed that do not represent substantial differences in analysis results. Types 4 and 5, both semilunar forms with medium edge angles, were characterized as cutting through typology, and sawing through microscopic analysis. It is easy to see that a cutting motion with these long concave use-edges would easily grade into a sawing motion, and larger specimens, in particular, would tend to be used for heavier jobs employing more of a sawing action. Type 13 incurved edge tools were characterized as planers through typology, and cutting and scraping tools through microscopic analysis. In this case, the terminology used in microscopic analysis is more logical, in that these relatively small, incurved or notched use-edges would not be used per se for heavy wood planing of a flat surface, but more for shaving smaller pieces such as shafts, involving a motion closer to scraping. Also in the Type 13 case, the difference between wood versus soft plant material use is considered minor, as soft wood carving could produce exactly the type of polish found on these specimens.

Last in the category of fair agreement is Type 26, the long- handled, short use-edge tools that were specifically related to site CA09-52 by spatial analysis. Again, disagreement is minor because both analyses agree that these were woodworking tools. Type 26 tools were typologically classified as scrapers and planers because of their relatively high edge angles. However, the microscopic observation that these tools were used in cutting despite the high angles is acceptable because heavy cutting of plants fits well with the garden plot interpretation of site CA09- 52 where these specimens were primarily recovered. That is, plant cutting in a garden context would be expected to involve heavier tools with higher edge angles than plant manipulation associated with food preparation in a domestic context involving smaller tools with lower edge angles. Again, these higher edge-angle tools may have alternatively been used for cutting wild plants, but this would not explain why these tools were concentrated at a site (CA09-52) without evidence of a dwelling or substantial artifact concentrations.

Two of the three cases of poor interanalysis agreement were the result of a faulty assumption within the typological analysis. It was typologically assumed that Type 9 unfaceted pointed tools and Type 14 unmodified utilized flakes could be placed within specific action types. Type 9 specimens are sometimes called denticulates in other South American unifacial industries (Richardson 1969), and in the NLT were considered less formal versions of the Type 8 faceted, pointed form. Instead, the pointed edges were unused, while other long straight edges exhibited evidence of use-wear. This pinpoints another important difference between the NLT and other unifacial industries such as Siches where pointed tools are considered extremely important, or it suggests that the importance of denticulate forms in other unifacial industries has been overemphasized or mistaken outright.

In the case of the large Type 14 category of unmodified flakes, the typological assumption that these were light cutters was based on their relatively small sizes and very low edge angles. It appears, instead, that these expedient flakes were utilized for a wide spectrum of purposes when well-made non-marginal edge-trimmed tools were unavailable or not worth the effort to produce. In the case of Type 14, the disagreement between analyses does not change but clarifies one aspect of the dichotomy of expedient and curated tools in the NLT.

The third case of poor interanalysis agreement is that of Type 7 thick semi-lunar forms. Type 7 specimens were typologically classified as cutting tools because of the combination of their relatively large size and very low edge-angle mode and trend. Their distinctiveness in terms of relative standardization and easy recognition also fostered the idea that these tools had a relatively specific function. However, microscopic analysis suggested that these assumptions

were false, and that, though specific to plants, the Type 7 tool was utilized in a variety of actions. As mentioned above, this tool type in final consideration cannot be classified as either generalized or specialized. Its classification as a curated tool type, however, appears to be correct, based on the heavy use-wear found on 3 of 4 microscopically analyzed specimens.

## Conclusions

The microscopic use-wear study of the NLT, despite being conducted on a small sample of the total lithics assemblage, achieved its goals. The analysis crosschecked the typological data, finding many points of agreement and allowing clarifications to be made where there were interanalysis disagreements. The polish and residue evidence provided invaluable direct evidence of tool use and reemphasized the primacy of plant and wood- related activities. The variability present within the NLT was further underscored by the variety of both generalized and specialized tools present, and even the presence of certain tool types that were generalized in one category and specialized in another (*i.e.*, action versus estimated material use). Lastly, the microscopic analysis added further detail to the intersite activity differences that have been repeatedly observed thus far. The limitation of the study was the small size of the sample (91 use edges), which only allowed a few examples of each tool type to be examined. In its entirety, the multidimensional lithics analysis provided a complete documentation of the NLT which could not have been achieved from any one perspective (such as morphological analysis) alone. As the most numerous artifact assemblage in the Nanchoc sites, a complete lithic analysis including use-wear analysis is essential for providing a basic framework of site activities, against which site structures, features, and a variety of smaller non-lithic assemblages were juxtaposed and compared (Dillehay *et al.* 1997; Rossen 1991). The ultimate definition of the Middle Preceramic Nanchoc Culture as a locally permanent, plant-oriented society in the early stages of cultural intensification depends on the foundation of a complete and multidimensional lithic analysis.

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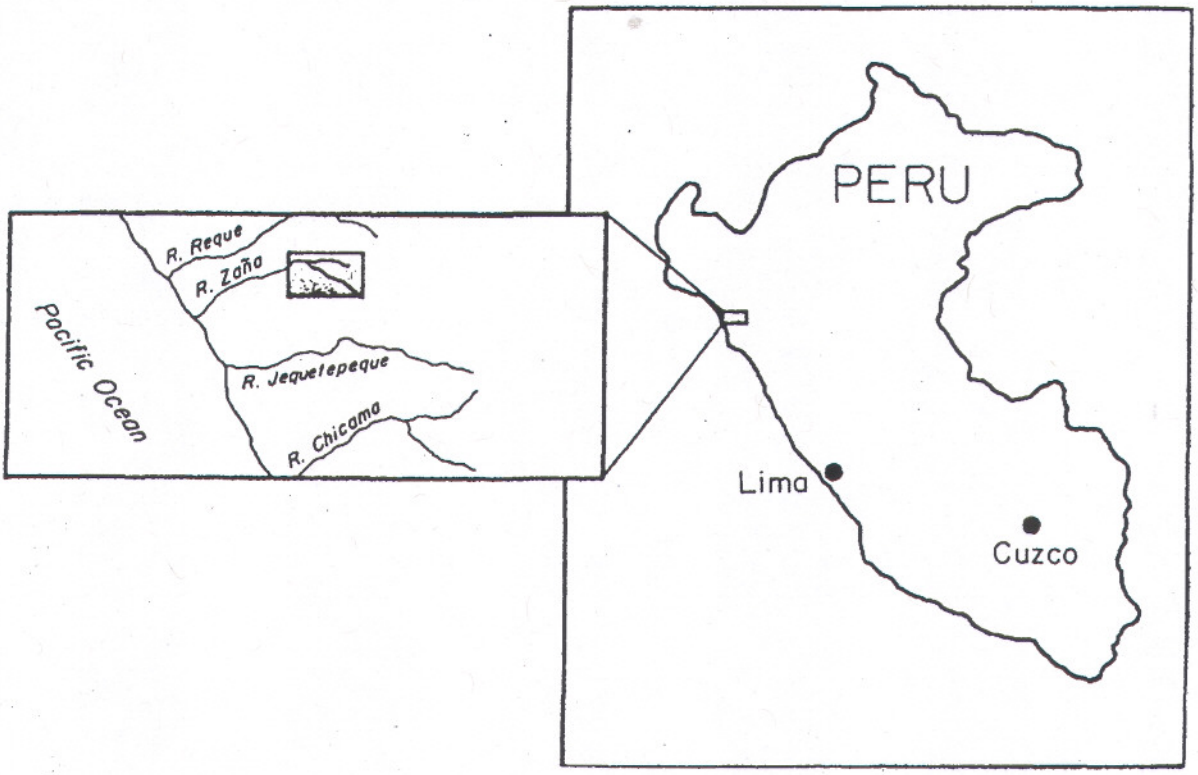


Figure 1. Location of the upper Zaña Valley, northern Peru (from Rossen 1998: figure 1).

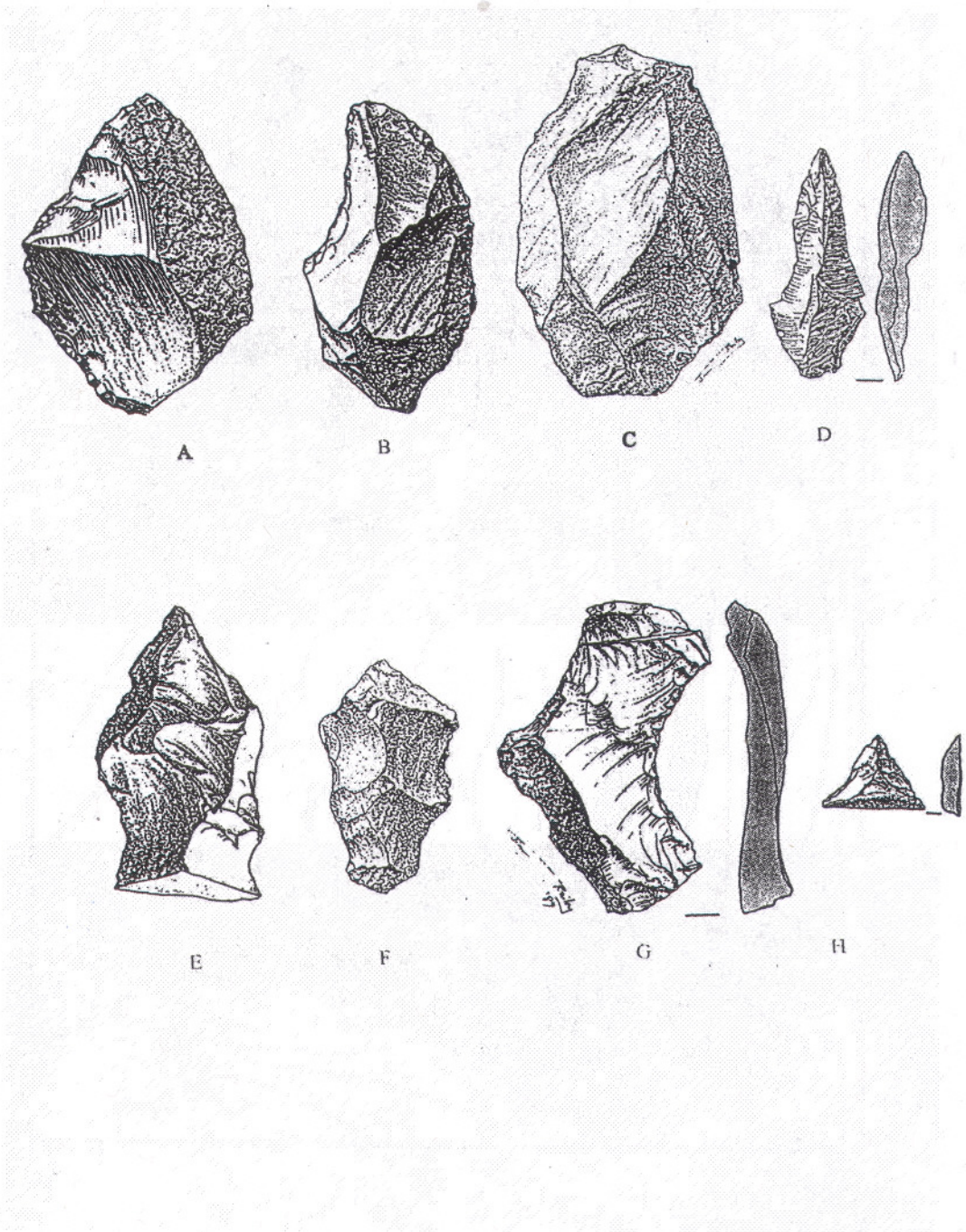


Figure 2. Representative formal secondary flake tool types of the Nanchoc Lithic tradition: A, Type 1 large quadrilateral tools; B, Type 4 large semi-lunar tools; C, Type 7 thick semi-lunar tools; D, Type 8 multifaceted pointed tools; E, F, Type 12 pentagonal tools; G, Type 13 incurved or notched tools; H Type 18 small triangular tools (actual size). *Illustrations by Jimmy A. Railey after Rossen 1998: figures 9, 10, figure 11, figure 14, figure 15.*

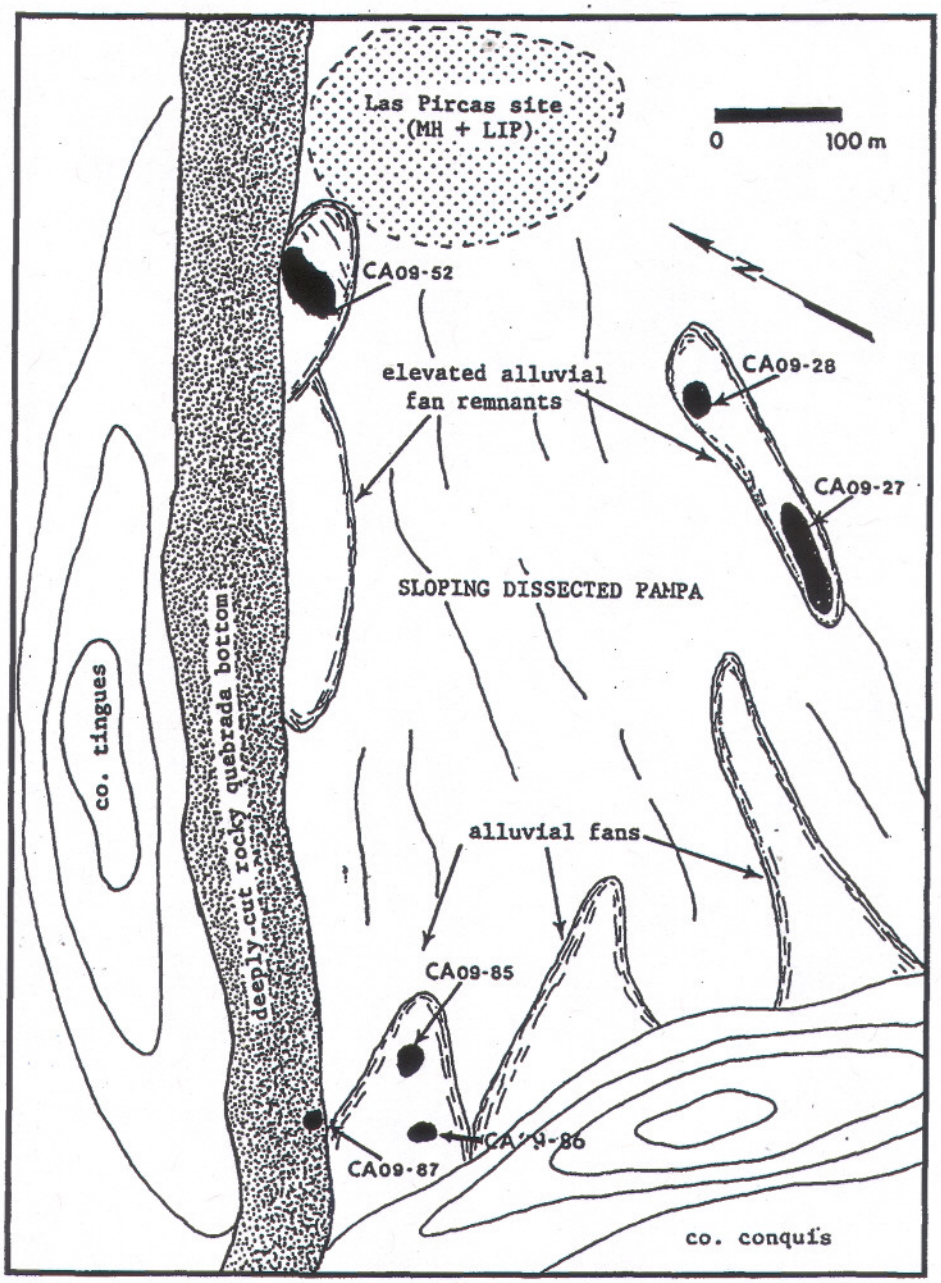


Figure 3. Locations of excavated Middle Preceramic sites in the Quebrada de Las Pircas, near Nanchoc, Peru (from Rossen 1998: figure 5).

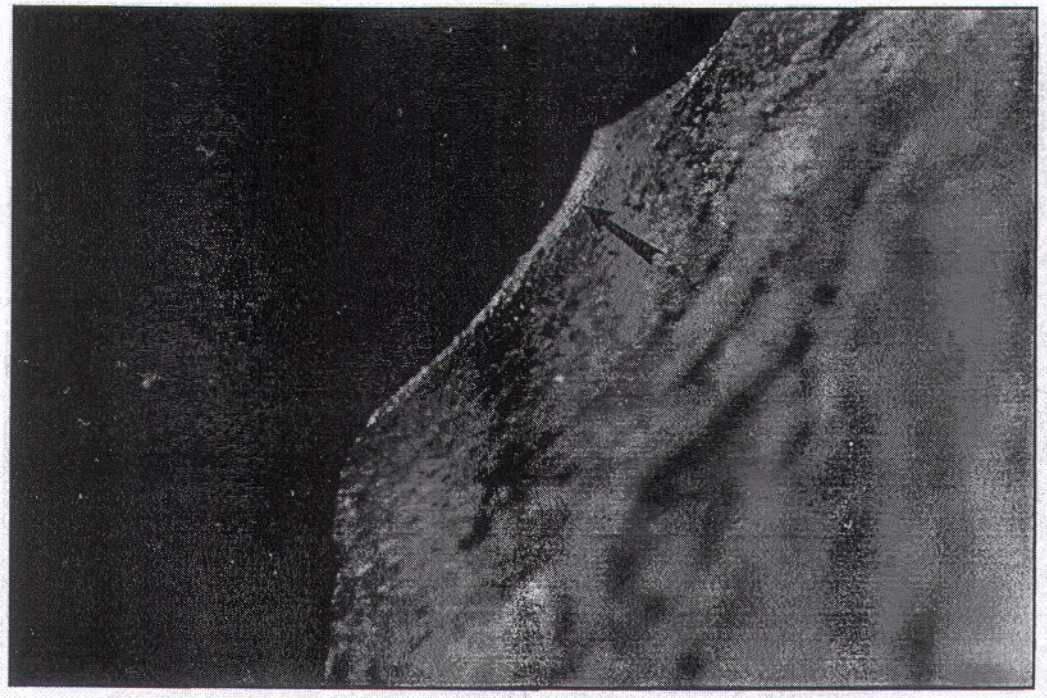

Figure 4. Plant polish on tool edge (40X).

Figure 5. Bone polish on tool edge (40X). Note the pitted rough edge with grain loss and edge attrition.

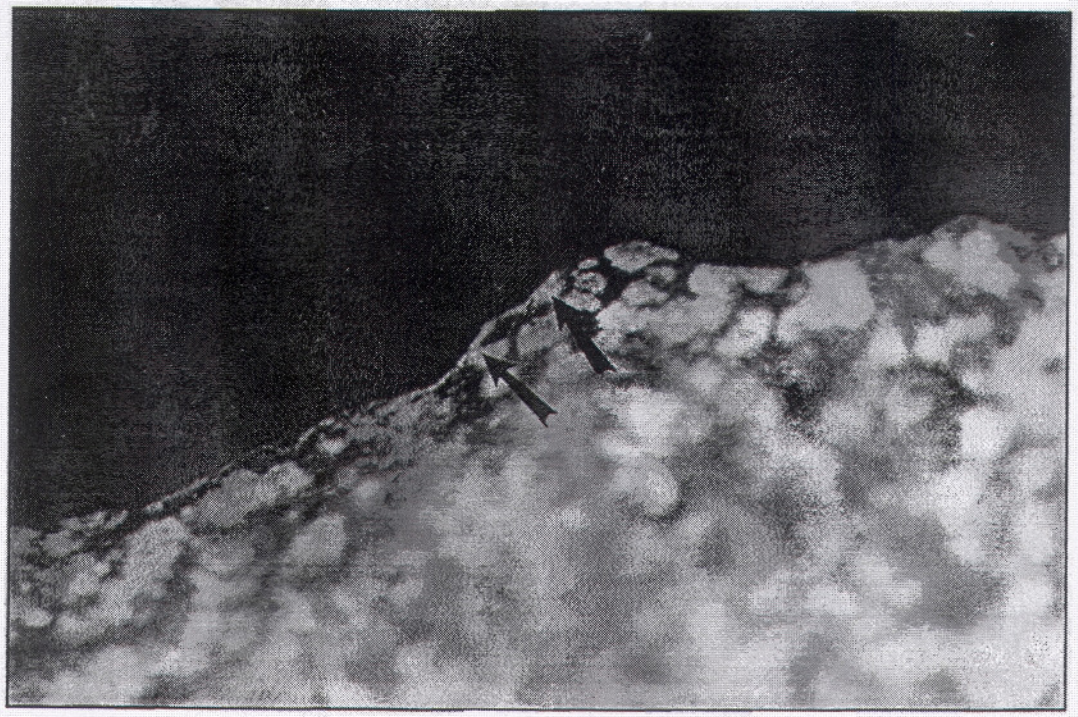

Figure 6. Scalar and half- moon fractures on tool edge, along with polish streaks (40X).

Figure 7. Crushing and polishing on point of tool (40X).

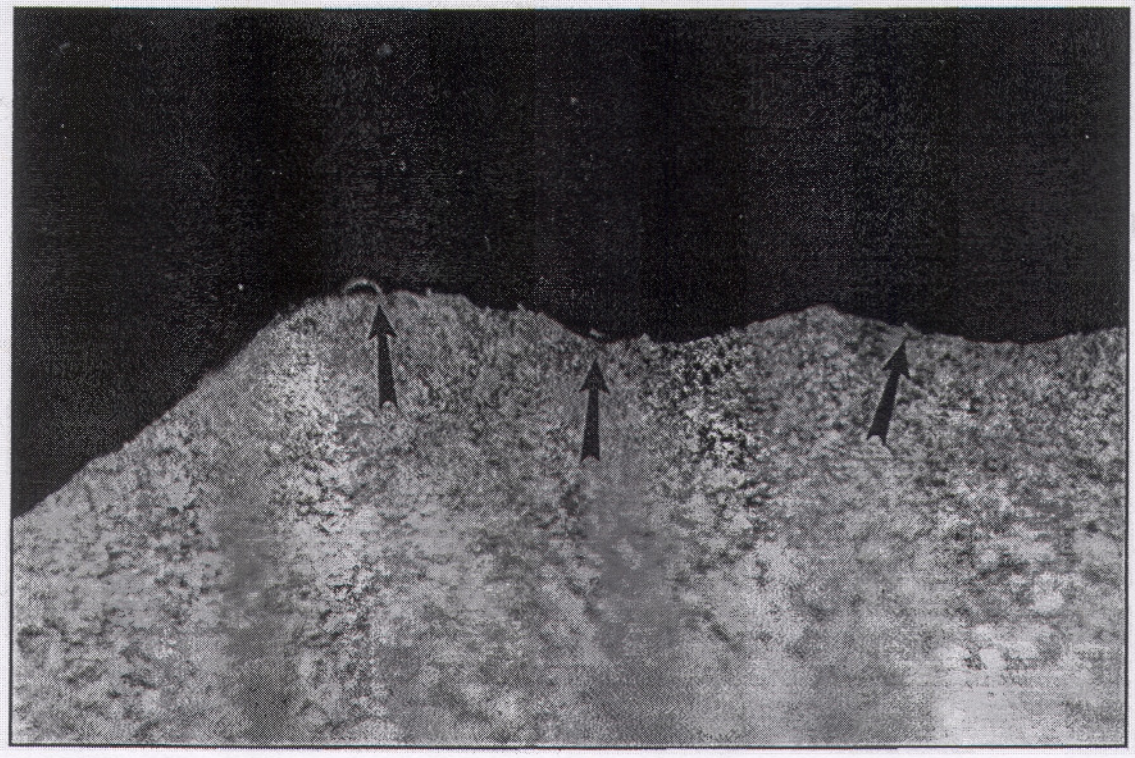

Figure 8. Plant fibers associated with semi-bright sheen and smooth grainy plant polish. From Rossen and Dillehay 1999:131 (40X).

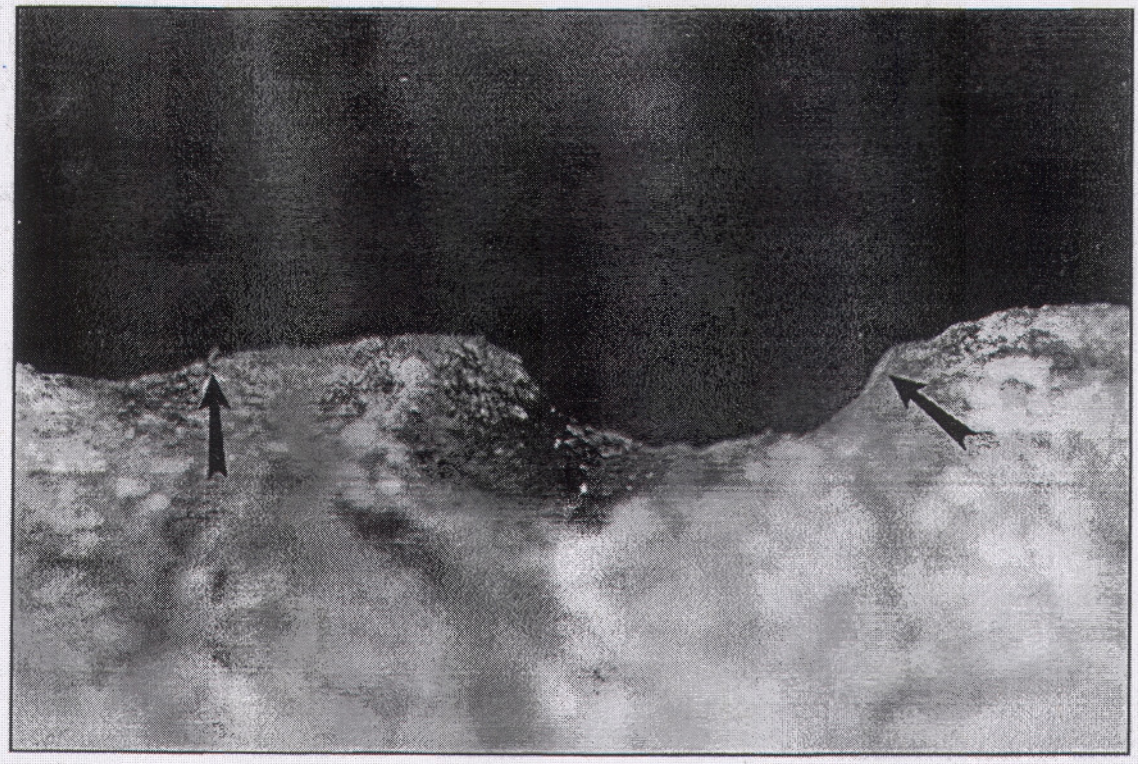

Figure 9. Plant fibers and dull, flat, pitted, smeared hide polish (40X).