MODIFIED LITHIC SPECIMENS FROM LOWER MEMBER B OF THE MANIX TYPE SECTION, CENTRAL MOJAVE DESERT, CALIFORNIA

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ABSTRACT

Twenty-two modified lithic specimens, interpreted here as artifactual, have been recovered more than 5 m below the 185,000±15,000 ybp Long Canyon tephra (volcanic ash) in the Manix Formation of the central Mojave Desert. The specimens, all of siliceous lithologies, exhibit technically significant attributes including bulbs of percussion, force lines, unifacial flaking, and alternate bifacial flaking, as well as evidence of step and hinge flaking. All were recovered from the eroded surface of Lower Member B, a depositional unit of deltaic sands and gravels. All of the artifacts exhibit fluvial abrasion similar to that on non-artifactual clasts. The Manix Formation, a complex sequence of interdigitating lacustrine, fluvial, and alluvial sediments in the lower Mojave Valley, is of middle and late Pleistocene age. It contains the numerous and varied sediments of the Mojave River and its deltas, pluvial Lake Manix, and local alluviation. The investigation reported was conducted under permit from the Bureau of Land Management. It was limited to those sediments which are topographically lower than the laterally-extensive Long Canyon ash, a tephra originally erupted from the Kern Plateau in the southern Sierra Nevada.

This paper reports the recovery of 22 lithic artifacts from the eroded surface of a major depositional unit of the Manix Formation (Jefferson 1968, 1985) in the lower Mojave Valley in the central Mojave Desert of California. The artifacts were recovered more than 5 m topographically below the 185,000±15,000 ybp Long Canyon tephra (Bacon and Duffield 1981), a laterally-extensive chronometric horizon in the Manix Type Section. The artifacts are all of siliceous lithologies, primarily chalcedony and jasper. They exhibit technically significant attributes including bulbs of percussion, force lines, unifacial flaking, and alternate bifacial flaking, as well as evidence of step and hinge flaking. All of the specimens exhibit fluvial abrasion similar to that exhibited on non-artifactual clasts in the deltaic deposit. The overall Manix Formation is a complex sequence of interdigitating lacustrine, fluvial, and alluvial sediments of middle and late Pleistocene age. It contains the numerous and varied sediments of the Mojave River and its deltas, pluvial Lake Manix, and sediments derived from local alluviation. The investigation reported here, conducted in accord with a permit from the Bureau of Land Management, was limited to sediments topographically lower than the Long Canyon ash, a tephra originally erupted from the Kern Plateau in the southern Sierra Nevada (Bacon and Duffield 1981).

The following text addresses first site setting, principally through synoptic overviews of the area's stratigraphy and depositional history. Secondly, the characteristics of the artifactual specimens are discussed in the context of the artifact/geofact debate which has attended most discussions of early lithic assemblages in the New World. While this discussion may appear to be a major digression from the subject at hand, I present it here as a rudimentary epistemological context for assessing lithic artifacts. Within this context, it is postulated that the Bassett Point specimens are artifactual, not geofactual.

MANIX FORMATION STRATIGRAPHY

The Manix Formation initially described by Jefferson (1968, 1985) has been examined as part of a geoarchaeological investigation to assess its potential to yield archaeological evidence (Budinger 1992, 1996). The fine-scale stratigraphy of the upper 15 m of the Manix Formation at Bassett Point (SW1/4 Section 10, T.10N., R.4E., San Bernardino Base Line and Meridian) was described. Four types of depositional units were recognized: shallow lake deposits, deep lake deposits, deltaic deposits, and alluvial deposits. Shallow-lake deposits consist of silts and clays with a few sandy layers. The clays are often platy and blocky. Sandy zones are sometimes reddened due to the oxidation of ferrous minerals. Deep-lake deposits typically consist of indurated silts and clays. Claystones are typically blocky and massive, and sometimes mottled as a result of differential oxidation. Soft, platy, clay layers are locally interbedded with indurated, fissile layers. The few layers of fine sand which occur are sometimes oxidized. Deltaic deposits consist of coarsening-upward sequences of fine to coarse sands. Alluvial deposits consist of fine to coarse sands, as well as pea gravels, pebbles, and cobbles.

The basic stratigraphic units of the Manix Formation, from top to bottom, are Member D, Upper Member C, Upper Member B, Middle Member C, Lower Member B, and Member A.

<u>Member D</u>

Member D consists of deltaic deposits of arkosic sands with a few conglomerate lenses. The modern surface is a lag deposit winnowed by aeolian processes. A soil with secondary carbonates is present. Freshwater mussel shells (*Anodonta californiensis*) are found at seven distinct levels. The uppermost shell layer has been radiocarbon dated to approximately 18,100 yrs BP (Meek 1999).

Uranium-thorium dating of fossil bones recovered from depths between 2 and 3.8 m has provided additional chronometric control. Th-230 decay series dates of 47,000±2,000 b.p., 51,000±2,500 b.p., and 60,300±2,000 b.p. were determined for a mammoth (*Mammuthus* sp.) femur, a llama (*Hemiauchenia* sp.) femur, and an unidentified mammal bone element, respectively (Bischoff, written communication, 1988).

<u>Upper Member C</u>

Member C is composed primarily of lacustrine silts and clays and is thought to be temporally correlative with Marine Oxygen-Isotope Stages 4 though 6, covering the timespan from 58,000 to 188,000 years ago. At a depth of 8.91 m (and 28.6 cm above the base of Upper Member C) is a 7.6 cm (3 in) thick layer of air-fall tephra. The chemical composition of the ash is nearly identical to the rhyolitic glass of Long Canyon in the Kern Plateau of the southern Sierra Nevada (Bacon and Duffield 1981; Izett 1981; Sarna-Wojcicki *et al.* 1984). The sanidine of the Long Canyon rhyolite has been dated to 185,000_15,000 years b.p. by the potassium-argon method (Izett 1981).

Bischoff (1987) dated a camel (*Camelops* sp.) humerus to 68,000 _ 4,000 b.p. by Th-230 and 87,200 _ 17,000 b.p. by Pa-231. A camel scapula recovered 1.5 m above the 185,000_ 15,000 b.p. volcanic was dated to 183,000 _ 12,000 b.p. by the Th-230 method and >140,000 years by the Pa-231 technique (Bischoff 1987). Even though the dates were not concordant, there was no reason to reject them.

<u>Upper Member B</u>

Member B consists of alluvial sediments derived from the northwest; it is sub-divided into upper and lower units. Upper Member B consists of moderately to poorly sorted tan, medium to coarse arkosic sands, with lenses of gravel conglomerate.

<u>Middle Member C</u>

Middle Member C underlies Upper Member B and consists of 4.56 m of deep lake sediments, including silts, silty clays, and clays with stringers of very fine sand. Some of the clays are oxidized, but there are no carbonates or soil horizons indicative of long-term weathering. In those places where Middle Member C interdigitates with Member A or overlies Lower Member B, there is a 50 to 100 cm thick layer of moderately- to well-sorted oxidized arkosic sand. These sands often rest directly atop layers of lithoid tufa-encrusted clasts. Based on an assumption that high-latitude glacials correlate with mid-latitude pluvials, Jefferson (1985) believes Middle Member C to be correlative with Oxygen-Isotope stage 8, covering the time-span from 244,000 to 279,000 years ago.

Lower Member B

Lower Member B consists of arkosic sands and interbedded conglomerates ranging from gravel- to cobble-size, thinly bedded silty sands, and micaceous claystones. Moderately- to well-sorted, coarse, arkosic sands found near the top of Lower Member B contain cobbles covered with tufa believed to be correlated with Marine Oxygen-Isotope Stage 12. The lowest portion of Member B, a stratum of thinly bedded silty sands, was found to have a normal magnetic polarity (Jefferson 1985), suggesting an age younger than the Brunhes-Matuyama magnetic reversal event 730,000 years ago.

The upper portion of Lower Member B is believed by Jefferson to be correlative with Marine Oxygen-Isotope Stage 9 (334,000 to 347,000 b.p.). The basal portion of Lower Member B is thought to correlate with Marine Oxygen-Isotope Stage 14 (475,000 to 505,000 years ago). A horse (*Equus* sp.) ulna recovered 9 m above the base of Lower Member B proved to be too old to be dated by the uranium-thorium technique (i.e., >350,000 b.p.) (Bischoff 1988).

Member A

Member A is a conglomerate of cobble- to boulder-size andesitic igneous and metamorphic clasts, derived from the Cady Mountains and interbedded sandstones (Jefferson 1968, 1985). The uppermost portion of Member A locally interdigitates with Members B and C.

DEPOSITIONAL HISTORY

The Manix beds represent at least 500,000 years of depositional history. Member A, lowest in the sequence, is a conglomerate of volcanic and metavolcanic rocks and sands which were probably shed rapidly under torrential conditions from the Cady Mountains on the south side of the basin.

The fluvial sands and conglomerates of the subsequent Member B are rich in granodioritic clasts which were shed from the north, presumably from old alluvial deposits southeast of Alvord Mountain (Byers 1960; Jefferson 1985).

Under positive water budget conditions, the Afton sub-basin impounded the flow of the ancestral Mojave River, forming Lake Manix. As the water level rose, lacustrine sediments of lower Member C interdigitated with and prograded over the alluvial deposits of Members A and B (Jefferson 1985). The earliest lacustrine sediments were deposited probably during Marine Oxygen-Isotope stage 8, 279,000 to 244,000 years ago.

Xeric conditions during Marine Oxygen-Isotope Stage 7 caused the early stand of Lake Manix to contract; there is no evidence that the lake became saline or was reduced to a playa. Some of the lacustrine clay layers were slightly oxidized, presumably due to sub-aerial exposure. Fluvial sands were subsequently deposited over the lacustrine deposits of lower Member C and the sands and gravels of upper Member B were transported into the basin from the north.

A second major episode of lacustrine transgressions began approximately 190,000 years ago (Jefferson 1985). Overall, this thick lacustrine sequence is thought to date to Marine Oxygen-Isotope Stages 6 through 4, or approximately 188,000 to 58,000 years ago.

Late in the Pleistocene, deposition of deltaic sediments by the Mojave River (Member D of the Manix Formation) served to constrain the lake to the central and eastern portion of the Manix basin. During this period, the lake had two stands (Meek 1990). These were between 31,000 and 29,000 years B.P., and 21,000 and 18,000 years B.P. (Meek 1990). The lake drained, probably catastrophically, about 18,000 years ago (Meek 1990) as a result of the downcutting of Afton Canyon. Water from the draining lake filled the Lake Mojave basin, approximately 32 km to the east-northeast.

The cutting of Afton Canyon lowered the local base-level by approximately 120 m (394 ft) (Meek

1990). This entrenched the Mojave River close to its present course and initiated the erosional dissection of the Manix Formation beds in the vicinity of an entrenched meander (informally known as the "Big Bend"). It was this dissection which exposed the Manix beds in the Bassett Point area.

Bassett Point Artifacts

A unifacially-flaked chalcedony specimen was discovered *in situ* in the deltaic sands and gravels of Lower Member B. It was found at a depth of 13.7 m from the top of the section. It has a prominent bulb of force and distinct compression rings. Both of these attributes are diagnostic of human craftsmanship (Phagan 1976; Patterson 1983). Force lines radiating from the point of percussion are evident. The dorsal surface of the specimen exhibits evidence of a hinge flake removal and a step termination. Hinge flaking and step flaking are also indications of human manufacture (Patterson 1983). The dorsal surface of the specimen exhibits irregular edge flaking. This specimen was the largest siliceous clast observed in the layer. A possible source area for the chalcedony would be the eastern Calico Mountains and outcrops in the vicinity of the Calico Site, 16 km (10 mi) to the west.

This first artifact was found 5 m below the Long Canyon ash (Bacon and Duffield 1981; Izett 1981; Sarna-Wojcicki *et al.* 1984) which has been dated to 185,000_15,000 b.p. It is postulated that the artifact was deposited at least 230,000to 240,000 years ago, during the climatic transition from Marine Oxygen-Isotope Stage 7 to Oxygen-Isotope Stage 6.

That first artifact was found in October 1987. Investigation of the Manix beds began again in October 1998 under permit from the Bureau of Land Management. To date, 21 additional specimens have been recovered from the eroded surface of Lower Member B which exhibit enough evidence to be classified as artifacts. All have been recovered from locations which are at least 5 m topographically below the Long Canyon ash.

The Bassett Point artifacts are judged to be artifactual because individual specimens are seen to possess distinct bulbs of percussion, bulb scars, undulating ripple lines concentric to the point of percussion, and partial crushing of striking platforms. Several specimens exhibit distinct unifacial retouch. Some specimens exhibit bifacial retouch with similarity of flake size, shape and direction. Especially significant is the specimen which displays methodical alternate bifacial flaking. Edge retouch is generally restricted in distribution and often occurs in fortuitously-shaped natural concavities.

ARTIFACT-GEOFACT ISSUES

Much of the skepticism regarding claims of early stone tools stems from an assumption that if nature breaks enough rock eventually specimens resembling artifacts will be produced. This is an unconfirmed assumption. Elaborate scenarios of how natural processes *might* mimic anthropogenic flaking, coupled with "conclusions" that certain assemblages display characteristics of those hypothetical processes are totally vacuous (see, for example, Haynes 1973).

As Dr. George Carter noted in his book, *Earlier Than You Think*: "The biggest myth in American archaeology is that nature breaks rocks by percussion and pressure with considerable frequency and that this breakage reproduces human work" (Carter 1980:96). This paradigm has certainly been applied vigorously to considerations of the Calico specimens. Dr. C. Vance Haynes, perhaps the most outspoken of the Calico critics, outlined his thinking on this issue in his 1973 paper, "The Calico Site: Artifacts or Geofacts?" In that article, Haynes described a scenario involving rock fracturing mechanisms such as outcrop splitting by tectonic stresses and weather fracturing, rock on rock percussion in streams and mudflows, pressure retouch of buried cobbles, and cycles of erosional and re-depositional processes which could produce successive generations of flake removals as well as separation of flakes from parent cores. Haynes concluded that in an alluvial fan building situation such as existed at the Calico Site during Pleistocene times, "_ there are innumerable possibilities for flakes and flake scars to be produced that are indistinguishable from those produced by primitive man" (Haynes 1973). I would submit that the mechanisms cited by Haynes are not operative in general for the production of frequent and significant artifact-like fracturing.

Experimental and quantitative field studies undertaken by P.H. Kuenen (1956), S.A. Schumm and M.A. Stevens (1973) and field observations by G.F. Carter and H.L. Minshall (Carter 1980:102-103)and others indicate that the movement of rocks in streams is *not* able to break unweathered hard rocks by percussion. Stream transport abrades and rounds rocks quickly; it does not dislodge artifact-like flakes. The gist of Kuenen's literature review and his experiments is that nature does not exert forces in streams capable of breaking unweathered stones and in fact exerts only about 10 percent of the needed force. If stream tumbling can only generate 10% of the force necessary for percussion flaking, the forces involved in mudflows in which viscosity is reducing impact energy must certainly be less.

Oakley (1961:11) has stated that, "...under exceptional conditions, naturally flaked stone will occur which, if seen out of geologic context, might be mistaken for artifacts." However widespread such contentions, are they remain essentially undocumented. The only environmental context actually known to produce significant amounts of percussive flaking (and occasional pseudo-artifacts) is high-energy storm conditions on rocky beaches (Oakley 1961:11). The oft-heard claim that stream transport can create artifact-like objects has never been documented. If streams were capable of producing pseudo-artifacts, dry streambeds would be littered with such artifacts. They are not. Streams tend to quickly abraid and round lithic clasts, they do not tend to sharpen them through percussion flaking.

The identification of lithic manufacturing is best done through analyses of flake attributes rather than core attributes (Patterson 1983:299). Core attributes are often difficult to identify unambiguously. A variety of flake attributes can be identified: The bulb of force is the bulbous semi-spherical potion of the proximal end of the ventral face of a flake caused by the large initial energy oscillation induced by the application of force to a platform. Whether a bulb of force is prominent or diffuse depends largely on percussor hardness, relative direction of force application, and the size of the contact area a percussor has on the core (Phagan 1976:96; Sollberger 1981; Patterson 1982). While there are exceptions, most force bulbs created by hard hammer flaking are prominent, while those from soft hammer work are diffuse.

It has been demonstrated experimentally that flake assemblages produced by percussion have high percentages of prominent force bulbs (Sollberger and Patterson 1976) whereas assemblages produced by pressure do not (Sollberger and Patterson 1980). The presence of a prominent force bulb, therefore, is a key attribute in identifying percussion flaking. Oakley (1961:11) has noted that those energetic beach conditions, which do fracture rocks, usually produce flakes with, "...flatter and more diffuse bulbs of percussion than those produced by purposeful blows." The important difference here is that during lithic reduction flintknappers hold cores relatively fixed and deliver quick, sharp, targeted percussive blows. In nature, a rock being broken by percussion is usually not held.

Concentric rings of compression are undulations in the surface topography of the ventral face of a flake created as the initial energy wave travels through the lithic material in successively smaller oscillations.

The presence of erraillure scars (bulb scars) is indicative of human craftsmanship. Such scars have never been documented on naturally fractured rocks. The late Françoise Bordes, a prominent lithic technician, regarded erraillure scars as one attribute diagnostic of man's work alone.

If a flintknappers finds that a satisfactory striking platform does not exist on a core that he is working, he prepares one in order to have a suitable surface from which a desired type of flake can be removed. Such prepared striking platforms can be either single or multiple faceted. The key point, however, is that there is usually little if any remaining cortex on platforms prepared by man. Nature, on the other hand, is more likely to use corticated platforms on a more consistent basis, because nature is likely to remove isolated flakes from the outside surfaces of rocks. Evidence of a striking platform preparation is a good indicator of manufacturing by man, not natural breakage by nature.

Fortuitous fracturing by natural forces is essentially random. Nature is not likely to remove several flakes in a series from a single portion of a core. In contrast, flintknappers are likely to remove several flakes from a core through selective exploitation of striking platforms. Such removal of several flakes from a core face will produce attributes on the dorsal faces of flakes. Man-struck flakes are much more likely to have multiple flake scars on dorsal surfaces indicating prior flake removals from the core. Such dorsal scars will be of the same apparent age with no apparent differences in surface weathering suggestive of removals at different points in time. Nature, on the other hand, might randomly remove flakes from the same core over a long period of time and such scars would exhibit different weathering characteristics.

Hoofed animals and man can cause edge damage on lithic flakes by trampling. Patterson (1983:303) has noted that natural and fortuitous edge damage, "... mostly consists of short, steep, uneven facets that usually occur in a random bifacial manner." It is difficult to visualize how random forces could create uniform, unidirectional retouch along several centimeters of a flake edge. The few examples of fortuitous unifacial edge damage that have been reported display no uniformity of pattern. Some scholars have proposed that unidirectional flow of materials such as occurs in streams and in hill slope coluviation can produce natural unifacial flaking. However, when such items are examined closely it has been found that unifacial edge damage is limited to abrasion and only short steep transverse flake scars (Patterson 1983:304). While this type of edge damage might be confused for wear patterns, it usually does not have the uniform parallel scar patterns which are seen on unifacial tools.

Natural forces can under high energetic conditions generate bidirectionally flaked objects. However, natural forces usually act randomly and as a consequence produce amorphous shapes. The ultimate product of repeated applications of natural force is rounding, not patterned bifacial flaking. Bifacial edge retouch can be distinguished from natural bi-directional edge damage by the uniformity of flake size, shape and placement. Natural forces seldom produce bifacially retouched edge segments that are both long and sharp. Instead, natural fracturing produces rather blunt, rounded, bifacial edges because such forces tend to create steep transverse fractures. The reason for this is that in nature rocks are usually free to move or are only loosely held by surrounding matrix. Randomly applied forces therefore tend to impact at very oblique angles to the edge of a core or flake and fracturing occurs transversely across edges in the direction of least mass resistance (Patterson 1983:304).

The consideration of lithic assemblages of unknown origin must be made on the basis of diagnostic attributes. It is only in this way that the artifactual or geofactual character can be determined objectively. It is of little scientific value to simply proclaim that a lithic specimen does or does not look like it is man-made without explicitly stating the reasons for the conclusion. I believe those studies of suites of diagnostic attributes, rather than studies which focus on single variables. provide the most powerful tools for distinguishing the work of man from the work of nature.

<u>Flake Scar Angle Studies</u>

One example of a restricted-scope, singe variable study is that of Dr. Louis Payen (Payen 1982). I believe it useful to briefly examine Payen's work, because it and Haynes' 1973 paper are the *only* major references cited by skeptics of the Calico evidence.

Payen claims to be searching for a simple, single trait, objective procedure for distinguishing fortuitously broken rocks from artifacts. The trait he has chosen to study is the flake scar angle, i.e., the angle that exists between the striking platform and the adjacent flake scar.

Angle studies of the genre were pioneered by Alfred Barnes (Barnes 1939) and Hazzeldine

Warren (Warren 1914). Dr. Barnes studied what he termed the "angle platform scar," that is to say, the, "_dihedral angle formed by the intersection on the surface on which the blow was struck or the pressure applied and the surface of the scar left by the flake removed. It is measured on flaked tools" (Barnes 1939:112). Regarding methodology, Barnes only states, "the angles were measured with a simple form of goniometer reading in degrees" (Barnes 1939:112). In other words, Barnes is considering the angle between the platform and the flake scar, and he is applying a straight edge goniometer to a concave surface and feels that he can legitimately distinguish a single angle for such juxtaposition.

Barnes does not formulate one or more testable hypotheses; he measures angles first and then deduces later. He considers 5,200 angle platform scars on lithic specimens which he has pre-selected as eoliths, natural fractures, and unquestioned artifacts. He measures 3 or 4 angles per specimen. He does not indicate how he selects the angles to be measured other than to say that he does not consider scars less than 1 cm. in length. He does indicate that he measures in the middle of the scar and considers the first centimeter along the long axis of the flake; " _in this way the change in curvature along the axis of length in many flakes is avoided" (Barnes 1939:112). Barnes seems to be unconcerned with the obvious fact that different artifact types have different edge angles to facilitate different functional capabilities. He does not designate the types of artifacts studied and one therefore suspects that he selected a skewed sample.

Barnes proceeds with his study by comparing the "frequency per cent" of obtuse angles in his three categories. Please note that he does not present a case based on actual angle readings but rather one based on whether angles are obtuse or not. Yes or no. He finds that among his pre-selected eolith categories 72% have obtuse angles, that 75% of the "natural fracture" categories have obtuse angles, and that only 18% of the "human worked" categories have obtuse angles. Barnes concludes by announcing a single diagnostic criterion: "The flaked tools of an industry_may be considered to be of human origin if not more than 25% of the angles' scar-platforms are obtuse (90_ and over)" (Barnes 1939:111).

Payen, in his study, equates Barnes' "angle scar platform" with the "beta angle" used in contemporary lithic studies, by Wilson (Wilson 1970). Payen then attempts to test the Barnes criterion by taking more than 14,000 measurements on 54 sample collections of controlled (artifact) and uncontrolled (geofact) collections and finds there is a, "statistically significant difference_which suggests that the Barnes test doesn't indeed distinguish between populations of conscious and fortuitous flaking" (Payen 1982:197). Having accepted the criterion and methodology of Barnes, Payen proceeds to apply the test to the Calico specimens and finds that, "_the alleged tools from the Yermo deposit_fall within the range of the uncontrolled fracture series" (Taylor and Payen 1979:273).

There are numerous problems with the research design, methodology, statistical analysis, and conclusions in the Payen study and in the earlier study by Barnes. Payen is not measuring angles which are comparable to those measured by Barnes. Barnes states that,

> "only those angles are measured which show on one side or the other the pit of percussion or pressure, for it is only in this way that one can be sure that the surface of origin has remained intact and has not been replaced by a flake scar starting from some other point. The measurement is made at the center of the pit for a distance of about 1 cm. along the axis of the flake; in this way the change in curvature shown along the axis of length in many flakes is avoided. The measures are confined to flake scars not less than about 1 cm. in length" (Barnes 1939:112).

I read Barnes' "pit of percussion" to be the negative bulb of percussion. It appears that Barnes is starting his consideration at the center of the negative bulb of percussion and setting his swing arm goniometer over the next centimeter of the flake scar face. There are problems here. In many cases the next centimeter from the center of the negative bulb is still within the hollow of that negative bulb. As a knapper, I have often struck flakes which have large bulbs, say more than 5 cm. In such a case, Barnes' angle would be physically impossible to measure. The swing arm would be resting in space above the hollow of that negative bulb. Was there a bias in Barnes' study toward measuring only small flake scars with small negative bulb scars?

Payen evidently did not use the, "one centimeter beyond the center of the negative bulb," rule but rather attempted to find a fairly flat surface below that hollow. The trouble here is that flake scars are rarely flat. They are often curved, and superimposed on that curvature are the peaks and valleys of the concentric compression rings. Where is the correct flat surface upon which to rest the swing arm of the goniometer?

Dr. Jeanne Binning, a colleague of Dr. Payen, states in an unpublished manuscript that Payen measured *all flake angles* evidenced on each of the prime Calico tools (Binning nd:14). I could not find this so clearly stated in Payen's publications. If this is the case, it is quite possible that Payen was often confusing subsequent flake scars for striking platforms. The point here is that often, especially with bifacial tools, flaking from the other side eliminates the platform areas for flakes on one side. The angles produced by the intersections of two flake scars are certainly different than angles between platforms and flake scars.

As Barnes did before him, Payen pre-selects certain artifactual specimens as being representative of the total range of angles indicative of human workmanship. Again I suspect a bias. I do not believe that the specimens studied necessarily reflected the total range of lithic reduction strategies and craftsmen competencies. I believe, therefore, that even if the techniques employed by Barnes and Payen were useful (and I'm not suggesting they are) the biased initial sampling would introduce a certain element of circularity into the later comparisons. In my view it comes down to a situation something like this: I will pre-select the "n" specimens as being definite artifacts because I think they are artifacts and all my colleagues think they are artifacts. I'll measure all the angles I can find on these specimens (ignoring, of course, the obvious methodological problems of using a swing arm goniometer on curved surfaces) and then I'll use the mean values and ranges of the angles I determine as being indicative of the range for artifacts *sinsu lato*, that is to say, artifacts in general, any time, any place, any knapping proficiency, any lithic tradition.

Having made his measurements on selected Calico specimens, Payen compares the mean angle values for those Calico specimens with the mean angle values for his pre-selected controlled and uncontrolled fracture series. He finds that, "Statistically, there is no significant difference between the sample of alleged tools and the uncontrolled fracture series" (Payen 1982:200). I do not believe that Payen's own data (all other considerations aside for the moment) allow for that conclusion.

In brief Payen's data are (Payen 1982:194, 197, 200):

- For controlled fracture (pre-selected artifacts): angles range from 31° to 136° for 7,375 angles measured. The weighted mean angle = 72° with a standard deviation of 13°.

- For uncontrolled fracture: angles range from 30° to 156° for 7,057 angles measured. The weighted mean angle is 88° with a standard deviation of 17°.

- For Calico Prime Tools: angles range from 70° to 105° for 593 angles measured. The weighted mean angle is 88° with a standard deviation of 17°.

It should be pointed out that in both his controlled and uncontrolled fracture series Payen calculates his weighted means over a wide variety of rock types (basalt, obsidian, flint, chert, quartzite, rhyolite, chalcedony, etc.). To compare the flake scar angles on the Calico tools, which are almost all fashioned of chalcedony, with a weighted mean derived from such a mixture of lithologies is not appropriate. All other criticisms aside for the moment, this averaging over a considerable variety of lithologies is a major defect in the Payen study.

The greatest problem with the Payen study, however, is that his stated conclusion simply does not follow from his data. His controlled and uncontrolled fracture series are not distinct populations. The difference between the weighted means (i.e., 72° and 88°, a difference of 16°) is smaller than the larger of the two standard deviations (i.e., 17° for the uncontrolled fracture). When one compares the Calico Prime Tool weighted mean angles with either the controlled or uncontrolled fracture series the same observation can be made: the differences between the weighted means is smaller than the standard deviations. The application of Student's 't' test bears this out. Payen is simply not dealing with statistically distinct populations, even though he claims that he is. Neither he, nor Barnes before him, has established a single trait criterion for distinguishing artifacts from geofacts.

The Payen and Barnes studies were misdirected in that they addressed the wrong angles. When assessing a lithic core for the removal of a flake, a knapper must find a geometric situation in which the angle between the possible striking platform and the next adjacent surface is less than 90_. Only with such juxtaposition will he be able consistently to remove flakes with control. Once the flake is removed from the core, that acute angle is the angle between the platform and the *dorsal face.* What Payen has studied is the angle between the platform and the *ventral face* (or its equivalent back on the core or finished tool). This platform to ventral surface is a dependent variable, a product angle (Patterson 1982, 1983). The important angle is on the other side of the flake. There the platform to dorsal surface angle is the independent variable. That is where attention should be focused to determine if one is dealing with artifacts or not. *All* of the technical flakes from the Calico Site which have been examined thus far, have platform to dorsal surface angles of less than 90_.

While claiming to provide an objective test it appears after scrutiny that Dr. Payen's research design, methodology, analysis, and conclusion rest largely on subjectivity. His conclusion that the Calico specimens are not artifacts can not be drawn unambiguously from his own data. In short, Dr. Payen's study is not the major detraction to the Calico evidence that some reviewers would have you believe.

What then are the necessary and sufficient, objective and testable criteria, which can be employed to determine whether a particular lithic collection is indeed the result of man's craftsmanship? Leland Patterson is developing one very productive approach (Patterson 1983). This approach focuses on quantifiable definitive morphological characteristics and technological attributes. The attributes considered include the presence or absence of force bulbs, bulb scars, and ripple lines; the condition of the striking platform, whether intact, crushed or missing; the angle of the striking platform; and the striking platform type, whether single or multiple faceted, or with remaining cortex. Also examined is the dorsal face of the striking platform for the presence or absence of small facets and number of major facets on the dorsal surface. Flake size in terms of square millimeters and flake thickness is also recorded. Finally, the flake is categorized as to type, whether primary (with cortex on entire dorsal surface), secondary (with cortex on part of the dorsal surface), or interior.

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