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FLAKING STONE WITH WOODEN IMPLEMENTS

At Palliaike Cave in Southern Chile, stemless pressure flaked points made of basalt and varieties of siliceous stone (Period III) were found, but no bone compressors or percussors were discovered in association with the points. Since well-preserved bone was found in the cave, Dr. Junius Bird became curious to determine what implements and techniques were used in their manufacture. He wondered if, like certain Australian Aboriginies, these people could have used wooden implements so, at his suggestion, I decided to try replication with wooden flakers.

Dr. Bird generously provided seven examples of the points as well as a variety of Calafate hardwood (Berberis buxifolia) and a small supply of native coarse-grained basalt. The pressure technique of the points could not be called "classic" or "extremely refined", but flake detachment does show planning and control, making the writer eager to accept the challenge of replication with wooden implements. It may be difficult to visualize the shaping and forming of lithic materials - which are harder than steel - by means of a wooden tool, but it can be done. Perhaps we find it difficult to reconcile the use of a wooden flaker because it is common in New World sites to find compressors of antler, bone, ivory and other non-perishables which are resistant to decay; but have we stopped to consider that wood, because of its perishable nature, could go unrecorded as material used for flaking stone? We know that wooden pressure tools are used in the Kimberley region of Western Australia, for this has been observed by A.P. Elkin, ("Pressure Flaking in Northern Kimberley", Man, 130 p.p. 110-113) Norman Tindale ("Aboriginal Australian" 1963 p.p. 25-46 and personal communication) and others. There is also a possibility that wood was used as a pressure tip in Mexico for making blades by pressure. (Crabtree, "Mesoamerican Polyhedral Cores and Prismatic Blades" American Antiquity 33:4 p.p. 446-451). As this paper will demonstrate, pressure-flaking with wooden implements must be considered by archaeologists on some occasions as an alternative to flaking with bone or antler pressers.

After experiments with the Australian method and other wooden flaker techniques, I would suggest that the geographic range of the wooden pressure flaker technique should not be confined to Australia. These experiments involved only the replication of flake character and no attempt was made to duplicate for or size of the artifact. Indeed, the initial attempts with wooden implements were very discouraging and had to be confined to duplication of flake character alone. Replication of flake scars is the real challenge and duplication of form is no problem. As the experiments progressed, interest became keener, muscle response improved, holding became more comfortable, and the results more gratfying. Certainly, more prolonged experiments would improve one's technique with the wooden flaker.

Experiments in pressure flaking with a replica of the Australian wooden flaker were limited and resulted in only moderate success. This was due, in part, to the fact that the Australian tool is longer than the bone flaker with the holding method completely reversed from my normal manner of holding the compressor, and also because pressure is applied by thrusting away from the body. Initially, I found the technique awkward and concluded a longer training period was necessary. The first experiments resulted in imitations of the Australian points, but I did not feel they were duplications. Further experiments using an actual Kimberley Aboriginie hardwood pressure flaker loan by the American Museum of Natural History proved more successful, with the results closely similar to the Australian points.

One peculiarity of Kimberley points is the steep bifacial marginal retouch on the base. This feature was duplicated by pressing straight down in removing a row of flakes, then turning the point over and repeating this process on the other face. All flaking on Kimberley points was done on an anvil of wood or a padded stone following the traditional Aboriginal method.*

The Palliaike experiment was not as awkward; it progressed much faster and was successful. It involved pressing toward the worker - much more parallel to my normal pressure technique - and I feel that both the technique and the points were replicated.

* A collection of 15 ethnographic Kimberley points from Australia was loaned for this project by the American Museum of Natural History, New York.

LITHIC MATERIALS:

Isotrophic minerals selected for the experiments of fracturing and shaping stone with wooden flakers and billets ranged in texture from coarse-grained basalt to vitrious obsidian. Non-homogeneous materials and those having apparent planes of weakness and obvious imperfections were discarded. (Flintworker's Raw Materials, Tebiwa, 10:1)

The most granular material used was a basalt from the Magellan Straits and some from Southern Idaho. The Palliaike artifacts were made of basalt superior to the experimental material which was much too granular and tenacious to respond well to the wooden pressure flaker. Therefore, in an effort to duplicate the quality of the Palliaike artifacts, some of the basalt was thermal treated before flaking. One specimen was retained unaltered for control and comparison. The alteration consisted of placing the natural basalt in an oven and - over a period of twelve hours - gradually bringing the temperature to 500°F; then the oven was turned off and the stone allowed to cool undisturbed for approximately twelve hours. This considerably improved the quality of the basalt but still the texture did not approximate that of the Palliaike artifacts. Possibly, further experiments with a higher temperature and a longer cooling period would alter the material to a duplicate texture. However, lacking a sufficient amount of the Chile material, further experiments could not be made. The alteration was merely an attempt to replicate texture and does not indicate or infer the use of thermal treatment at the Palliaike Cave.

Because the basalt supply was limited, porcelain was substituted, for it has a similar texture and behaves and responds in much the same manner. Both altered and unaltered silica minerals were also used and it was noted that the heating process greatly improved the flaking quality of the silica. Of course, the more vitreous obsidian from Oregon and Mexico did not require alteration.

HAMMERSTONES AND BILLETS:

A hammerstone of medium density weighing approximately one and one-half pounds was used to serve a two-fold purpose - i.e., to detach usable flakes from the core and to make the preliminary roughout of the core tool. But an antler or wooden billet was used for the preforming stage.

To expand the experiment with wooden implements, a billet of ironwood from Southern Arizona was used for the percussion modification for, unlike the stone percussor, the hardwood billet will detach flakes without shattering the objective piece. When the blow is struck with a wooden billet, the lateral margins of the artifact penetrate the wood and a flake is detached without the shattering effect. Depth of penetration of the artifact's edge into the wooden percussor determines the width of the platform, for it detaches a part of the margin along with the flake. Billet-struck flakes often have a lip on the ventral side near the platform and very little definition of the bulb of force. But it should be pointed out that the wooden billet is practically worthless for the preliminary stages of stone flaking - i.e., reduction of large natural material to a usable form; making large usable flakes; making handaxes; large uniface or biface implements; and for blademaking. A hammerstone is considerably more suitable for these stages.

The working end of the wood billet is rounded so that only the arc-like convex end will contact the edge of the artifact. This gives the worker greater striking margin for the wood billet with a rounded end does not require the accuracy of the hammerstone. Also, the hammerstone will shatter unprepared edges whereas the billet will not. Therefore, the billet also allows the worker a greater latitude when delivering blows on the unprepared perimeter of the artifact. Flakes detached from the obscure side of the artifact form ridges on each side of the slightly concave flake scar. These ridges thicken that part of the artifact and, consequently, the ridge part of the lateral margin (edge) is stronger and will withstand more force than the concave parts of the artifact. When the wooden billet delivers repeated blows on the ridge part of the lateral margin, small flakes will naturally be removed from each side of the ridge. This is because the concave part of the edge is relatively weak in comparison to the part of the edge bearing the ridge. In turn, the removal of these small flakes forms a projection on the edge which is in alignment with the ridge. The projection will act as a platform and receive the major amount of the billet force and detach a long skimming flake. The novice experimenter may be unaware of creating this projection, become discouraged when the flake does not detach, and increase the velocity of his blows. Ultimately his wood billet will detach a good flake but this will be due to the created platform, not the increased blow velocity. The exterior surface of a core is always an important factor in controlling the form of the flake. When ridges are present on the core surface they can always be used to advantage to guide and control the flake or blade detachment.

The billet technique does not require the skill and accuracy of the hammerstone and, therefore, it offers considerable advantage to the novice experimenter for successful flake detachment when he is unaware of other related factors. As a result, the less seasoned knapper has often misinterpreted and cited this as being the technique used by aboriginal people when often there is no evidence to substantiate this conclusion. The character of the flakes and their skars must always be described, defined and evaluated before the manufacturing tool can be determined and the technique interpreted.

M. Coutier discovered that when he struck blows on the side of a piece of flint with a rounded piece of wood he could detach thin, flat flakes with flat bulbs of applied force - called the "wooden hammer" technique. (Adams Ancestors, L.S.B. Leakey, 1960) If Coutier was aware of the stone penetrating the wooden billet; the unwitting creating of the platform projection; and the use of ridges to guide the flakes, he did not make reference to it. So, unfortunately, this has led to the conclusion that all thin, flat flakes with diffused bulbs are, therefore, detached with a wooden billet. This is not always true.

The wooden billet can be used successfully for some techniques after preliminary work has been accomplished with percussors of denser materials. The hardwood billet does, however, have a definite and useful place in stone flaking but, aboriginally, it may not have had the wide-spread use interpreted by some archaeologists. Final conclusions of the knapping instrument used in manufacture can only be determined after an evaluation of a comparatively large population of flakes and artifacts.

PREFORMING:

The involved process of preforming is not explained here because it has been adequately described in detail in "A Stoneworker's Approach to Analyzing and Replicating the Lindenmeier Folsom" (Tebiwa, 9:1) The proper use of a wooden percussor is covered in the text under "Percussion Tools".

This paper is primarily concerned with the use of wooden pressure flakers. However, it is well to note that when a wooden flaker - rather than one of bone, antler, or metal - is used in preffure flaking, the last stage of preforming must be done with considerable care. The surface of the preform should be left as regular as possible, for it is difficult to remove step or hinge fractures left by careless percussion preforming when the worker is using a wooden flaker.

If the worker employs the core tool technique he can use either a hammerstone; antler, bone, or wood billet; or a punch and direct or indirect percussion to remove all surplus material from the mass until it is preformed into the proper form. But for the final forming, thinning, and sharpening, the wooden flaker and pressure technique is used.

A simpler method is to obtain blanks by using a hammerstone and percussion to detach simple flakes from the core and thereby eliminate the preforming stage. Flakes intended for bifacial points are designed to be straigh with the distal end pointed and feather and, of necessity, must be slightly larger and thicker than the intended artifact. All flakes detached from the core may not have these requisites, so the worker selects only those which are suitable for pressure work and discards the other flakes or uses them for other purposes.

WOODEN PRESSURE FLAKER:

Properly used, wooden pressure tools make fine compressors. Selected hardwoods have sufficient strength to transmit the force necessary to exceed the elastic limit of the lithic material and induce fracture. When the stone reaches its elastic limit, shear stresses are induced, fracture occurs, and a flake is detached. After much trial and error, it was determined that a wooden flaker with a sharp pointed working end would not tolerate the pressing strain and would either split or break. But when a shaft of selected hard wood from 8 inches to 2 feet long and three quarters of an inch in diameter was fashioned with a blunt working end, it was strong enough to withstand and transmit sufficient force to fracture the material. But wood must be carefully selected for flakers; - it must be sufficiently hard to prevent too deep a penetration of the lithic material into the tip of the wooden flaker and tough or fiberous enough to prevent splitting. Highly resinous woods which are too hard (such as ironwood) were found to be too brittle and would break. Ironwood is good for wood billets but does not work as a compressor. Coarse-grained wood will split before a flake can be removed. The worker should experiment with various types of wood until he finds a satisfactory billet or pressure flaker. At this time, the writer has not had a sufficient variety of woods to express a preference. However, experiments reveal that the Calafate wood - a species of barberry which grows in the grasslands near Fells Cave - is a satisfactory tool for pressure work. Dr. Junius Bird generously provided four pieces of Calafate; and the writer gathered some Manzanita from Arizona and found both satisfactory for pressure flakers. Other woods were also tried, but none were equal to the Calafate and Manzanita. I hope in the future to obtain some

Australian hardwoods for further experiments.

Having become accustomed to flakers of bone, antler, and metal, it was necessary to modify the holding method and vary the application of pressure with the wooden implement. The tips of bone, antler, and metal flakers will withstand more downward pressure than the wooden tool. They also allow greater control and "feel" of flake detachment and the worker can remove long narrow curved parallel flakes from one lateral margin to the other. This was not accomplished in this experiment with the wooden flaker, but it is not rejected for it may have been due to the brevity of the experiment. The coordination and rhythms of muscular motor habits become ingrained in the worker who has used bone, ivory and metal flakers for years and changing to tools of wood; a new technique; and a different "feel", made response difficult. It was necessary to attempt a variety of diverse approaches in order to overcome some of the difficulties encountered. The wooden pressure tool would slip, the tip would break, the wood was insecure and would yield when pressed against the margin of the artifact, and "feel" was limited. "Feel" has little meaning to the novice, but when one has pressure flaked with bone, metal, or antler which adheres to the platform of the artifact, he is accustomed to feeling the flake part from the piece being worked. Pressure tools must be kept in alignment and the flake pressed off across the face of the artifact to delete small step fractures or irregular areas. The wooden pressure flaker experiment was limited to a few weeks whereas years of working with bone and antler compressors have disciplined my muscle responses to adjust to harder flakers. Given more time to become familiar with the wooden flaker, I feel it could be as efficient as the harder tool and its use expanded to include diverse techniques.

If the tip of the wooden pressure flaker is rounded to resemble the end of a broom or mop handle, one can apply considerable pressure without the flaker breaking. As work proceeds, the tip of the compressor is rotated to expose new surfaces, retain the rounded shape, and regularize the wear pattern. If the tip becomes fiberous, it can be rubbed on an abrasive stone to expose a new hard surface.

New pressing techniques had to be devised to use the bluntly rounded wooden tip. The blunt end contacts a wider part of the artifact's edge and detaches flakes with wider proximal ends than when a harder pressure tool is used. With the wooden flaker, the worker uses a thrusting motion in a straight line toward the edge and then presses away from the artifact to detach a flake. The wooden flaker is firmly seated on a slightly beveled platform and then thrust downward and away in a simultaneous motion; snapping, rather than pressing off a flake. If basalt or other coarse-textured materials are being worked, considerable more force is necessary to detach flakes. If the downward and outward forces are not coordinated, the snapping method may break the flakes off short and terminate the end in a step fracture rather than the desired feathered edge.

HOLDING:

The method of holding the wooden pressure tool is quite different than when antler or other hard flakers are used because the harder tool will tolerate more downward pressure at its tip. When wood is used, the artifact being pressure flaked must be firmly supported. This can be either with a padded anvil stone or, if hand-held, the artifact can be held in the left hand with its lateral margins horizontal and the back of the hand solidly supported against the inside of the left thigh. The worker sits on a low seat and holds the wooden flaker as close as possible to the tip in order to increase the leverage. If the pressure tool is longer (about two feet), the distal end can be rested against the right ribs and kept in alignment with the forearm of the right hand. This enables the worker to use the forearm and shoulders to increase the vertical pressing force. The low seat raises the left thigh above the posterior, thus permitting pressure to be applied on the vertical edge of the artifact perpendicular to its longitudinal axis. The position of the Australian Aborigine worker differs somewhat since he is accustomed to sitting on the ground.

The wooden flaker is placed on the margin of the artifact and controlled pressure applied inwards in alignment with the proposed flake. As the pressing force increases, an outward force is imparted causing the flake to detach from the artifact. Examination of aboriginal flake scars and those made experimentally reveal that pressure was applied in the same direction. The technique is different than when using antler or bone flakers which are held at an angle to the margin with the force directed at right angles to the long axis of the pressure tool.

The wooden flaker technique and the change of applied pressure requires the worker to use a different set of muscular motor habits and, in the beginning, will form either blisters or calluses on the right hand. After a few attempts, a blister formed at the base between the first and second fingers until I became accustomed to the change in technique. It requires about three weeks of intermittant practice before the right hand is really comfortable and tolerates the tool without the bruising. Perhaps the shaft of the pressure tool could be served with fiber or sinew to make it more comfortable and to prevent slippage.

PRESSURE FLAKING:

Preforming by direct percussion leaves fairly large rnadomly spaced flake scars, creating crests and hollows which must be removed by pressure to make the artifact symmetrical and regular. A platform is established by making a bevel on the edge in alignment with the ridge to be removed. The bevel is made by pressing the wooden flaker at right angles to the margin to detach small flakes and to slant the edge toward the face being flaked. The tip of the pressure tool is then seated firmly on the platform and the worker presses first inward and then outward, detaching a flake which, in turn, removes the ridge. When the major ridges are removed, the piece is ready for the next stage of final pressure flaking.

When the artifact is to be pressure flaked bifacially, the worker has a choice of techniques, but the following two are suggested: (1) Pressure flake one-half of the face from one margin and then one-half of the opposite face from the same margin. After one margin is worked, we have an artifact flaked from one margin and on one-half of both faces. The technique must be repeated from the opposite margin to complete the artifact, but now the detached flakes must meet and terminate at the median line to intersect flakes removed from the opposite margin. (2) One-half of one face can be pressure flaked from one margin then the piece turned and the same face flaked from the opposite margin, having the flakes meet and terminate at the median line. We now have a unifacially flaked artifact so the technique must be repeated on the opposite face to complete the artifact.

The edge of one margin is beveled on one face which removes the overhang left by previous bulbar scars. Then a more pronounced bevel is made on the same margin but on the opposite face and this bevel is used as a platform area for the pressure retouch. To remove the second series of flakes from the same margin but the opposite face, the edge must again be beveled in the same manner as previously described. However, now the bevel is on the face to be flaked. After the second bevel is made, the artifact is held in the left hand with the first beveled side resting on the palm and the second beveled side visible to the worker and this bevel serves as a platform to detach flakes on the obscure side. A series of flakes is removed along the margin beginning at either the base or tip of the artifact, depending on the worker's preference. If work is started at the tip, flakes become increasingly larger as the worker nears the base; if flaking starts at the base, flakes become increasingly smaller as the work approaches the tip. Flakes progress along the margin toward the base or tip until all of the beveled margin is removed.

When flaking is started on the margin - whether at the base or tip - a short flake with the bevel adhering is removed to establish a ridge. This and subsequent flakes become increasingly long and all flakes terminate at the median line of the long axis. After each flake is detached, the tip of the pressure tool is again seated on the beveled edge and flaking is spaced to allow the platform part of the second flake to intersect the sharp edge left by removal of the bevel of the preceding flake.

The wooden flaker does not crush the edge. Consequently, it will detach a flake with a broad and diffused bulb of force rather than one that is deep. Flaking progresses toward either the base or tip (depending on where the worker starts) along the margin until all beveling is removed. Due to the blunt, thick end of the wooden tool, the spacing interval between flakes is broader than when an antler pressure tool is used. The worker intentionally spaces the flakes so that each subsequent flake scar will intersect the last scar and form a straight sharp edge. When pressure flaking is complete, the wooden flaker leaves edges which are uncrushed and quite sharp. Flaking is continued until both faces and both margins are flaked.

The wooden flaker is not suitable for removing long, narrow, curved, or parallel flakes and is inadequate as a notching tool; but it could be used for making a shouldered or stemmed point.

CONCLUSIONS:

Two of the seven Palliaike points show better quality workmanship than the other five. This appears to be because a material superior to basalt was used rather than the result of greater skill. All seven examples show surface smoothing to a varying degree. The bifacial smoothing could be either intentional abrading by the worker or unintentional smoothing by function. Without the aid of considerable magnification and further experiment, it is difficult to pass final judgement. If these points were hafted, then it would seem that the bifacial basal smoothing could not be the result of function. Hafting could be accomplished by using resins and adhesives to affix the base of the point to a wooden shaft, as shown by the Kimberley Aborigines. Many Clovis points from Western North America are smoothed to an even greater degree - for example those found at the Simons site in Idaho. Some points show the detachment of short flakes terminating in step fractures. But this may be because the Palliaike points were made of basalt and this is very difficult material to work; or because the worker was less skilled; or because the wooden flaker was inadequate to overcome the coarse-grained material. All of the Palliaike points are thick in relation to their width, making them resistant to breakage. However, since only one point in the collection (1755c) shows an attempt at basal thinning, this could be due to the worker's to control the coarse-grained basalt which is difficult to thin with a wooden flaker; or simply because he wanted the point thick for a particular function.

Palliaike Cave points and replicas which were pressure flaked with a wooden compressor have flake scars with certain comparable characteristics. The wooden tool distributes the force over a wider area than when bone or antler tools are used and it produces flake scars with a diffused bulb. It also removes a part of the lateral margin with the flake, leaving a distinctive edge. This is due to the spacing of the final series of pressure flakes, leaving the margin with a serrated appearance. However, this is coincidental, for the serrating technique was not employed.

The wooden compressor can be used by a less skilled worker to produce a sharp edge on a stone tool. The wider, blunter tip of the wooden tool narrowed the margin of the worker's visibility for seating the tool on the edge. For me, the wooden flaker required more foot pounds of pressure than is needed with a harder compressor. I did not find the wooden flaker suitable for detaching long, narrow, curved, or parallel flakes; but I do not reject the possibility, pending further experiment. The wooden flaker will not withstand the amount of downward pressure that a bone, antler or metal tip will tolerate. It also limits the worker's muscular reaction, "feel", and control of the lithic material's response.

The wooden billet does not shatter the objective piece, and a less skilled worker can successfully detach flakes without understanding a more spphisticated technique. However, I feel this has resulted in some erroneous conclusions of billet technique manufacture without a complete analysis and evaluation of the flakes and scars.

There are no horned or antlered mammals among the native fauna of Australia, while, on the other hand, the Australian continent possesses a wide variety of acacia and eucalyptus hardwoods. Thus the Kimberley Aborigines, while they lacked perhaps the ideal material for pressure flakers, possessed an alternative which was almost as good. Familiarity by this experimenter with bone pressure-flakers suggests that the Australian hardwoods may have been better than bone. Might a similar kind of ecological interpretation apply in the case of the ancient inhabitants of Palliaike Cave and contemporary sites?

Only in Period III of this region is there an absence of bone pressure flakers. In the subsequent period guanaco bone pressure-flaking tools occur in a ratio of one to every fifteen stone projectile points or knives. In contrast, in Period III several hundred stone points occurred while no bone flakers were found. Since there is no evidence for any ecological or fannal changes at this point in the Palliaike sequence, it must be concluded that the probably introduction of wooden pressure flakers in extreme southern South America would be the result of cultural rather than ecological factors.

After working with the wooden flaker and producing some acceptable replicas with characteristics similar to aboriginal flake scars, I believe it is entirely possible that the Period III Palliaike points were pressure flaked with a wooden tool.

Palliaike Points:

1754a

One face bears the original percussion flake scars, the other face has had pressure flakes removed from both margins which terminate in step fractures before the flakes reach the median line. The basalt is coarse-textured, which probably accounts for the failure of the flakes to meet in the center. It is interesting to note that the percussion side of the point has evidence of slight smoothing as well as remnants of the original margin before pressure flaking.

1755A

Material is greenish gray on fresh flake near the tip of the point and allows the passage of light at the thin edges. It is fine-grained and this texture permitted the worker to do superior flaking. The material is not identifiable but seems to be other than basalt. The last series of pressure flakes slant toward the base and were removed from opposite faces and opposite margins.

1755b

Material is a medium fine-grained basalt with smoothing on both faces. One face is free of step fractures with good feathered terminations. The other face has a few step fractures. Flake scars are at right angles to the lateral margins. Last series of flakes removed from opposite faces and opposite margins.

1754b

Material is medium fine-grained basalt with slight smoothing on both faces. At the base is a remnant of the outside of a water-worn cobble and shows that this point was made from a flake using the cobble cortex as a platform rather than a prepared platform. One face bears the original percussion flake scar. Pressure flakes are short and many terminate in step fractures rather than feathering. Both faces show signs of smoothing.

1755c

Material is medium fine-grained basalt with slight smoothing on both faces. One side of the base has had several longitudinal parallel flake scars, an attempt at basal thinning. Several short step fractures along both margins and both faces which appear to be the result of flaking during manufacture rather than function. ~~All points are rather thick in relation to their width making them resistant to breakage.~~

1755d

Material is medium fine-grained basalt with smoothing on both faces. There are several step fractures on one face and the opposite face shows diagonal parallel pressure flakes directed toward the base. The tip of the point is sharp and made with considerable skill - flakes being directed away from the worker; or it could have been made by a left-handed person.

1754c

Material is similar to point 1755a only slightly darker and showing light transmission on thin margins. Quality of the material reflects the quality of workmanship. Base of the point is thicker than the other points and is beveled. The point appears to have been re-sharpened at least once. The last series of pressure flakes were removed unilaterally and unifacially. The most recent flaking shows a gloss on both the flake crests and the edges while the older flaked surface on both faces shows more smoothing than the last retouch. The tip of the point was snapped from force directed from the numbered face at right angles to the transverse axis. The point appears to have been abandoned or lost after the tip was broken.

<u>EXPERIMENTAL REPLICAS:</u> 1 to 16

1. Natural basalt from Southern Chile. Flake has no bulb of force and was made by a smashing force that caused the cone of force to split. The blow was delivered directly into the cobble and not at an angle. Had the blow been delivered at an angle, the bulb would have been present and, in turn, would show the cone's plane of fracture and the direction of force calculated.

2. Basalt from Chile which has been thermal treated. Only the burin breaks at the corners reveal the texture change. The original surface still retains the natural texture. After the thermal treatment, the material is considerably more vitreous.

3. Treated basalt from Chile. A series of flakes have been removed from one margin and one face by using a wooden pressure tool (Calafate) which is also from Chile. Note the sharp edges and diffused bulbs of pressure. Flake is made the same way as No. 1 and has no bulb of force. Both faces show the termination of large flake scars. The absence of pronounced rippling show the stiffness of the material.

4. Example of bifacial flaking by both direct percussion and pressure on untreated material. The piece was then heated and an abortive attempt was made to remove large hinge fractures.

5. Preform of heated basalt using direct percussion by using a hammerstone. Lacks symmetry and has irregular margins.

6. Point finished by using a Calafate wooden pressure tool. Material is treated basalt. Flake crests are not smoothed. Note uncrushed margin and the shallow bulbs of pressure.

7. Example of a point to show change of texture due to heating. The basal part of the point retains the original texture. Point was flaked by wooden pressure tool. Material from North Central Nevada.

8. Point of heated Northern Nevada material. Pressure flaked with a wooden flaker of Manzanita wood. Edges were reflaked to make regular.

9. Coarse-textured material from Yermo, California. Pressure flaked by using wooden pressure tool.

10. Material is white porcelain - texture resembling that of basalt. Calafate wood was used as a pressure tool. Edges compare to points from Palliaike Cave.

11. Material is white porcelain. One edge and one margin show regular flake scars with bulbar area typical of the use of wooden pressure tools.

12. Material is white porcelain. Lateral margins were left irregular to show edge character of using wooden pressure tools. Original edge is removed with the flake.

13. Material is obsidian from Glass Butte, Oregon. One face shows that, with practice, the vitreous material can be worked to detach a flake from one margin to the other using wooden pressure tools.

14. Material is obsidian from Mexico. Pressure flaked with small pressure tools of Calafate wood. Work was continued until the tools split.

15. Peacock obsidian from Mexico. Shows thinning attempts on vitreous material with wooden pressure tools.

16. Peacock obsidian from Mexico. Note Longitudinal flake removed from the base of the artifact for the purpose of thinning. Done by hand-held pressure using a wooden pressure tool.

17. Broken tip of large calafate wood flaker. Tip of flaker has been re-pointed and more rounded than original.