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GRINDING AND SMOOTHING OF STONE ARTIFACTS

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To arrive at a comprehensive evaluation of the diagnostic features of stone implements, the analyst should be capable of separating the diverse implications of grinding and attrition on stone artifacts. Some grinding and wear is the result of the manufacturing process but, generally, it represents a later modification. For example, some Neolithic implements were formed and shaped by grinding and abrading surfaces. On the other hand, we find unifacially and bifacially flaked stone artifacts which are often made more even by grinding or polishing the surfaces. This is not a forming action but, rather, a means of making the artifacts smoother perhaps for easier penetration, withdrawal and cutting of a hunted mammal.

Both intentional and unintentional surface attrition is a possible diagnostic feature which may be useful when correctly evaluating flaked stone implements. Intentional attrition can be a diagnostic trait related to the manufacturing technique. Unintentional wear can aid in determining the function of a tool or may permit the identification of natural causes. I know of no publication which has described this particular attribute but it can be a valuable key to the manufacturing process or functional hypothesis. Recently there has been considerable interest in the study of functional wear on the edges of tools which appear to be the wear pattern resulting from continual use. This would be an example of attrition resulting from function on the working part used to perform a specific task.

The primary emphasis of this paper is a discussion of the main types of wear found on stone implements. It also describes some of the diagnostic characters such as striations which the student must be aware of in analyzing these items. There are three main processes discussed by which stone implements can become worn: intentional, unintentional, and natural. There are three types of intentional wear: (1) the smoothing and rounding of bases to prevent the severing of lashings and to aid in hafting; (2) the abrading of platform surfaces to strengthen the area of applied force and aids in flake and blade removal; and (3) the grinding and polishing of one or two faces to reduce friction and drag to allow for repeated deep cutting. There are also three types of unintentional wear: (1) the wear on the acute edge angles of stone implements due to function, which tends to remove particles from the working surface and to create a ground or polished surface; (2) the functional use of obtuse angles, which creates a similar effect; and (3) the transportation of unhafted artifacts, which creates facets on all high surfaces. The final type is natural wear which is not man made, but nevertheless must be considered. It is due to the natural action of the elements. The striations chiefly associated are generally multidirectional and have a circular pattern; however, there are some unidirectional striations which are parallel or subparallel. Unintentional wear striations conform to the manner in which the tool was used. They are generally uniform and start at the working edge and are oriented in the direction of tool use. The associated striations are generally random and minus pattern or direction. These can be difficult to distinguish from the other types of striations.

Before proceeding with the discussion, it is appropriate to define a limited number of terms. Such terms as attrition, grinding, striations, and polish are the most important in this connection; their definition here is chiefly applicable to this paper. Attrition is the process of wearing away or grinding down a surface by the use of friction. Grinding is one type of attrition indicative of the use of an abrasive such as grit, or solids such as a whetstone or a grinding stone. This technique usually leaves a rounded edge which has a slightly rough texture. It is a dual-purpose technique which weakens a plane surface and strengthens a rounded one. Striations may be viewed as small scratches which result from the use of an abrasive material. They can be either intentional, as in grinding, or they may be unintentional, resulting from function. Polish is a smoothing process in which one uses progressively finer abrasives; it is also a strengthening procedure. Polish may be produced intentionally, as in the smoothing of a face to reduce drag; or it may be unintentionally produced, as a result of function. It leaves a smooth surface which often reflects light and may appear shiny. A special note must be made concerning polish. We know from lapidary processes that polish is not necessarily a type of attrition; rather, it is a form of molecular flow involving the surface molecules of the material. The molecular flow tends to smooth the surface but cannot fill up a scratch. This flow creates a thin layer which is harder and smoother than the natural surface.

Abrasion, grinding and polishing on the basal margins of projectile points have been observed and described in various texts as a technique for preparing platforms prior to flaking. It has also been noted that grinding is evident and perhaps even limited to the surfaces and basal portions of Clovis points and other Paleo-Indian projectile points of the New World while the grinding and abrasion of platforms on blade cores generally has a universal distribution. However, intentional abrasions of flaked surfaces has remained unnoticed or overlooked and little is known of the extent and distribution in time and space of this smoothing process and purpose.

Abrading the platform surface aids the stoneworker in detaching flakes and blades because it strengthens the area where force is applied thereby preventing crushing of the platform which would result in only a partial removal of the flake or blade. The smoothing and rounding of the acute edge of the proximal end of the projectile was, undoubtedly, done to prevent severing the lashings or servings when the stone tool was inserted and affixed to the shaft. Intentional abrasion was quite common among the Paleo-Indians due to their advanced technique of precision platform preparation and the possible use of their implements as thrusting spears. The stoneworker seldom, if ever, ground the basal portion of the artifact classified as an arrowhead because he realized it would not survive more than one flight without breaking. However, an exception is the Hopewell beveled notched points which were used repeatedly as knives. These show polishing at the hafted part which was apparently affixed to handles with lashings. We can hypothesize then that we can separate projectile points and thrusting spears intended for continuous and repeated use by the grinding or lack of grinding on the basal portion. Those intended for hafting and sustained and repeated use would be intentionally ground at the basal portion—those intended for a one-shot kill would lack this basal grinding and polish.

Surface attrition of one face (uniface) and two faces (biface) is sometimes overlooked by the analyst as one of the diagnostic traits of prehistoric man and, therefore, not included or described in reports. However, this can be a pertinent diagnostic feature. The ground and polished faces I have observed in collections have generally been on Paleo-Indian artifacts and apepar to be an intentional smoothing of the surfaces rather than the result of function. Recently, Gene Titmus recovered a chalcedony knife in mint condition which was worked with parallel diagonal flaking and exhibited superior skill and exquisite workmanship. This was a surface find from the Shoshone Basin in South-central Idaho. This knife-like ovate is approximately 12 cm. long, 5 cm. wide and 4 mm. thick with very sharp margins. The ridges of the flake scare on each face have been ground and polished with accuracy and precision. When the surface is prepared by this smoothing process, friction and drag are substantially reduced thereby allowing repeated deep cutting action with a minimum of effort. When deep penetration is desired—whether the implement is used as a knife or thrusting spear—the smooth surfaces of both faces facilitate the cutting or thrusting. The spectacular Clovis points from the Simon site in Idaho (Butler, 1963) are superb examples of intentional surface smoothing. They are designed for killing large game animals by the deep penetration of thrusting spears. It is unlikely that they were affixed to a foreshaft and propelled by the throwing stick or atlatl. It is even possible that the Simon points were used for butchering in which case the surface smoothing would make the job easier. Once a spear is thrown or cast the hunter is weaponless and unless the projectile scores a fatal hit the stone point will be fractured. This manner of killing would require a backup supply of spears to accomplish the kill. It would seem unlikely that a single throw or cast of the spear would result in the instant kill of an animal as large as some of the extinct bison or elephant. However, a shorter spear fitted with the classic Simon polished fluted point is ideal for repetitious deep thrusting of the spear at closer proximity and should have resulted in a quicker kill. A skillful hunter could have used this type of thrusting implement indefinitely bearring accidental breakage from mishandling or the tip striking bone. When one considers the manufacturing skill and meticulous precision necessary to produce this fluted biface with ground surfaces it seems evident that it was intended for a thrusting spear and not a projectile. The steps involved in arriving at the end product include many stages of manufacture plus grinding and polishing, indicating that the worker was trying to produce an implement which might endure through many kills.

It was not an easy task to secure the proper abrasive media, which must be of the hardness of seven on the Moh's scale, for rubbing and lapping the stone. Abrasive materials having a hardness of eight or nine are usually found in metamorphic rocks, or in stream gravels derived from such rocks. Garnet is probably the most common. Corundums are harder than garnet but have a limited distribution. The Columbia River Plateau has a predominance of extrusive basalts which are geologically comparatively recent. This restricts the exposures of metamorphic rocks and consequently limits the ready availability of adequate abrasive materials in this area. It was undoubtedly more difficult to obtain good abrasive materials than to secure the proper stone for the artifacts. I know of only one archaeological source of abrasive materials in situ—this is a piece of mica shist containing garnet crystals which was excavated by Dr. Marie Wormington at Kersey, Colorado—an Agate Basin butchering site. The artifacts at this site bore evidence of grinding and smoothing at the basal parts but I do not recall a smoothing of the faces. However, a re-examination of the artifacts may reveal that the points were designed for repetitious use or to serve the dual purpose of knives for butchering or tips for spears.

Unintentional or functional attrition, as opposed to intentional grinding and smoothing, should be considered before making a final appraisal of a collection. It is common to find in collections large pointed bifaces which apepar to have functioned as hafted digging or planting tools showing attrition on both margins and both faces apparently the result of repeated thrusting into the soil. Silica sand and grit has an abrasive and burnishing action on stone artifacts. Flints and siliceous materials used to make artifacts are approximately the same hardness as quartz sand and the abrasive action is very slow compared to the worker intentionally grinding with an abrasive material harder than quartz. Also the character of functional abrasion is quite different than intentional smoothing. Striations resulting from functional alteration start at the working end and are directed toward the base in one direction and the leeward side of any protrusions will not be altered by abrasive action. Details of functional polish and attrition of implements other than projectile points should be noted and compared in order to form a basis for intended function. Corn polish or silica deposits acquired from reaping grain, grasses or other vegetable materials having a high silica content are not to be confused with wearing away attrition and intentional abrasion. As opposed to these functional wear patterns, intentional smoothing is done from both directions or by a rotary motion and will have corresponding striations. The margins are not affected by intentional surface smoothing.

The unintentional wear and functional attrition found on scrapers, adzes and their flakes, hoes and other cutting tools having acute angle margins should be the subject of a separate study. This study is not included here for it is complex and should contain an explanation of how the tools were held, hafted, used, and the tasks performed on specific materials.

We also find unintentional abrasion on the faces of elongated bifaces which have the appearance of knives or spearpoints and this wear could easily be confused with the intentional smoothing of thrusting spears and knives. Another paper, "The Obtuse Angle as a Functional Edge" (Crabtree, 1973) explains how some implements were used as files, hones and rasps. This paper also explains how the surface of a biface is characterized by a series of flake scars directed inward from both margins to and across the median line. These ridges made an adequate rasp-like implement to use as a forming tool when working on hard resistant materials. When they are continually used on a hard surface, such as jade, the ridges will become rounded and smoothed until they resemble intentionally ground and smoothed bifaces predesigned by the worker to reduce friction and drag. This planing action was also applied by prehistoric man to the ridges on cores.

When one evaluates artifacts to determine intentional grinding due to facial smoothing or unintentional attrition due to functional processes, one should also consider friction due to natural causes. One perplexing example owing to the lack of provenience is the group of unhalfted artifacts which has been transported long distances and the specimens have become burnished and abraded on all surfaces as a result of rubbing together in the carrier's yielding pouch. When they are carried unprotected in the leather pouch, the continuous movement acts as an abrasive on all surfaces and, therefore, the attrition will be more pronounced on the margins and ridges of the flake scars. The artifacts may be made of stone of similar hardness but the surfaces will still become burnished and worn from such movement. This type of wear is more characteristic of blanks, preforms and unhafted artifacts. The large ovate bifaces from the Simon Clovis site bear these characteristic marks. This does not apply to finished projectile points which exhibit intentional smoothing.

I have noted examples of surface smoothing and polishing on projectile points and broken sections which are superb examples of flaking but which were out of context with associated artifacts. I have often found these worked pieces on the surface of comparatively recent Indian campsites in association with arrowpoints. The arrowpoints were made from simple flakes entirely by the pressure technique exhibiting random flaking by an inferior knapping technique. Many were curved on the ventral side with a minimum amount of flaking on that side. Those recent points show a lack of skill and the impatience of the worker cannot be compared to the parallel flaking on the precision pieces found in apparent association on the surface of the ground. These sophisticated pieces were perhaps held in esteem by a later owner because of their aesthtic value or perhaps were fetishes of the medicine man. Since their workmanship is discordant with the arrowpoints associated with the campsite, it is possible to assume that they were transported a considerable distance and were unintentionally smoothed and polished by the movement during travel.

Unintentional and natural attrition can also be the result of action of the elements, as in the case of ventifacts. Another example of natural abrasion of lithic tools are those found in association with the abrasive sands of beaches, seas and lakes. The turbulence and movement of sandy sediments and water in suspended loads, bed loads and boiling springs can induce a polish on artifacts found under these conditions. These are only a few factors to be considered when making a final evaluation of abraded flaked stone artifacts.

It is not easy for the student who has not worked stone to differentiate between intentional, unintentional and natural abrasion. However, there are a few clues which can help his analysis. Intentional grinding and smoothing are generally obtained by a rotary motion so that the striations will be multi-directional. If the worker grinds in a back and forth motion then the striations will be parallel or sub-parallel. The margins are not affected by intentional grinding.

Unintentional functional attrition will leave striations on the stone which will conform with the manner in which the tool was used. Striations will be more consistently uniform as opposed to the rotary motion of the intentional grinding. Also the margins will generally show abrasion. Natural abrasion and polish will be random and minus pattern or sustained direction. Since the possibilities for producing wear on artifacts are very great it is wise to test hypotheses about the causes of wear by carrying out experimental work designed to replicate manufacturing and use processes.

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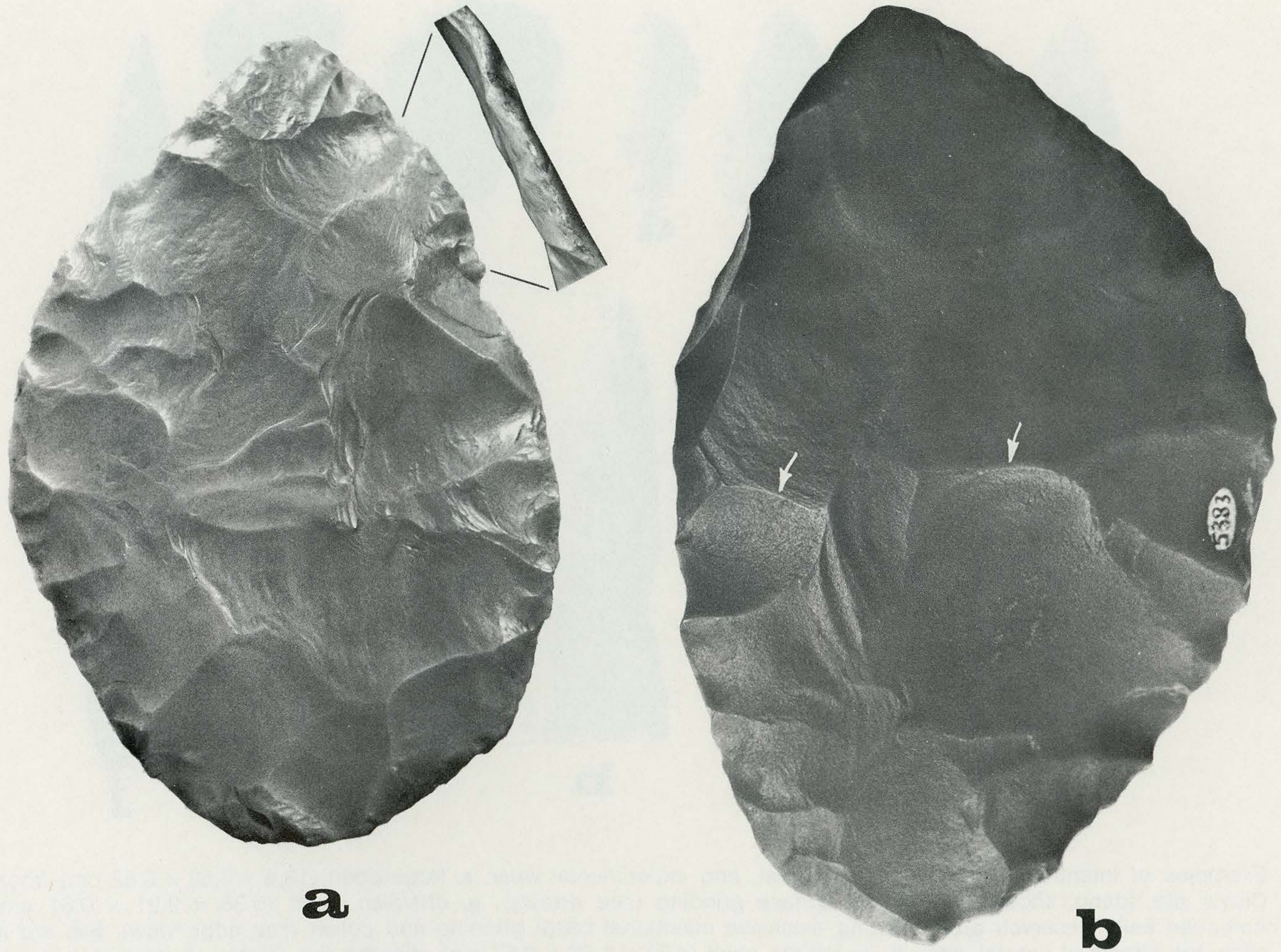

Fig. 1. Examples of intentional and unintentional wear. **a,** large biface (20.5 x 13.3 x 1.3 cm) from the Simon Clovis site, Idaho, showing intentional edge grinding (see edge view) used to enhance manufacture. **b,** large biface (15.6 x 10.0 x 1.7 cm) from the Simon Clovis site, Idaho, showing unintentional surface wear possibly the result of transport (note flake ridges on the center left [see arrow] of the biface are clear and sharp while the ridges near the center [see arrows] are smooth and rounded due to wear.)

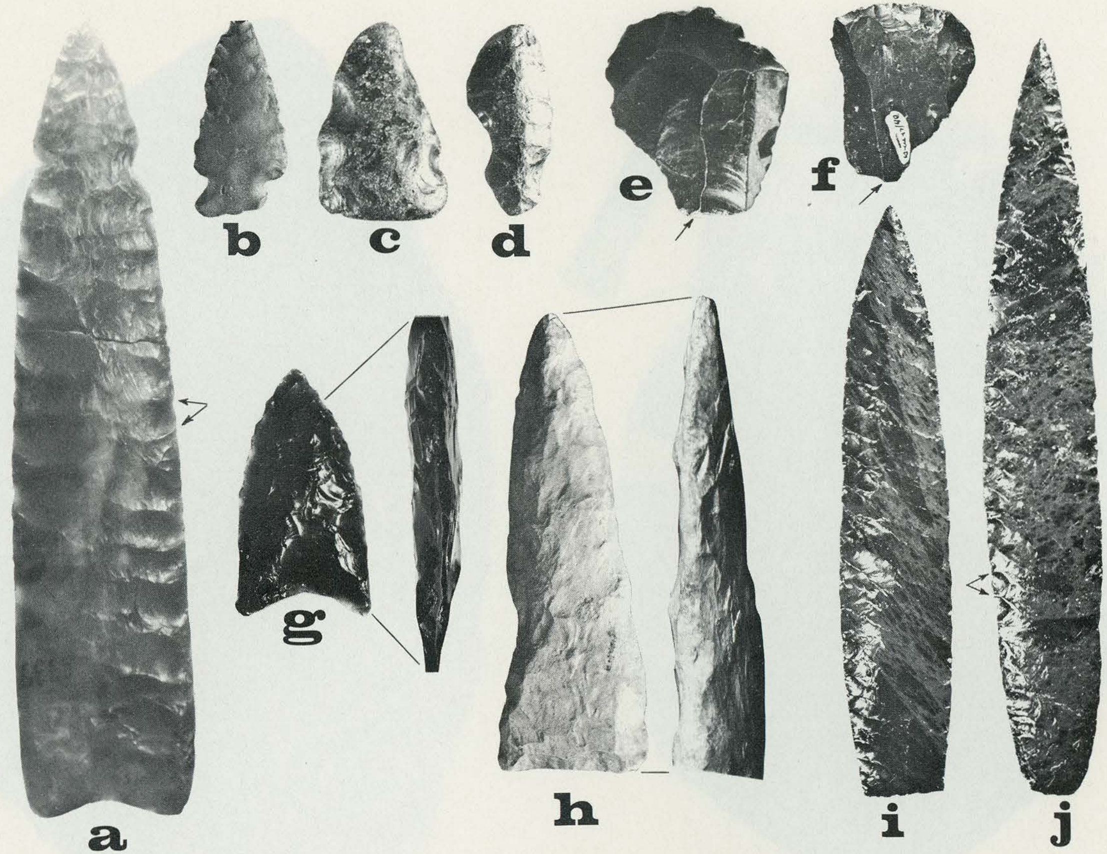

Fig. 2. Examples of intentional, unintentional, natural, and experimental wear. **a,** large point (18.4 x 3.82 x 0.82 cm) from the Simon Clovis site, Idaho, showing intentional surface grinding (see arrows). **g,** obsidian point (5.38 x 2.91 x 0.61 cm) from the American Falls Reservoir area showing extensive intentional basal grinding and polish (see edge view). **b-d,** are items which show the effects of natural wear. **b,** ignimbrite point (4.35 x 1.96 x 0.57 cm) showing the effects of stream erosion. **c,** obsidian point tip fragment (3.38 x 2.13 x 0.82 cm) and **d,** obsidian point fragment (4.17 x 1.79 x 0.83) both showing the effects of beach erosion on a lake. **e,f,h,** are items which show unintentional wear due to function. **h,** tan chert biface fragment (10.44 x 3.58 x 0.99 cm) showing heavy acute edge angle wear (see edge view). **e,** flake (4.73 x 3.74 x 0.89 cm) and **f,** flake (4.45 x 3.68 x 0.66 cm) both showing obtuse angle wear. **i-j,** are items produced experimentally by Don Crabtree to illustrate the surface differences between an unground face and a ground face. **i,** lanceolate point (16.3 x 3.0 x 1.08 cm) with unground face and **j,** a lanceolate point (20.9 x 3.15 x 1.09 cm) with highly ground and polised face (see arrows).