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PREHISTORIC MANUFACTURING SITES AT NORTH AMERICAN STONE QUARRIES

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A THESIS

Presented to the Department of Anthropology
and the Graduate School of the University of Oregon
in partial fulfillment
of the requirements for the degree of
Master of Arts

August 1966

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INTRODUCTION

In reconstructing the prehistoric cultures of North America, archaeologists are forced to rely heavily on the study of stone artifacts since these are often the only remaining traces of these cultures. Although much work has been done on many phases of the study of these artifacts and the methods used to manufacture them, one very important problem has been studied very little--the processes involved in the initial working of the material at its source. Many problems have been left unanswered or inadequately answered by previous studies on this subject. Among these are such questions as: What stone-working processes were carried on at quarries? Were finished tools manufactured at quarries and if so, were they used there? What effect, if any, did the natural characteristics of the quarry and surrounding areas have on the manufacturing processes carried on there? This study is an attempt to answer these questions and to devise a method for future studies of stone manufacturing sites at North American quarries.

An examination of the literature on such sites reveals a remarkable homogeneity in the types of material found. An attempt will be made in this study, using archaeological and ethnographic literature on this subject as a base, to set up a model classification that would be adequate for the description and study of material from these sites. The classification will then be tested to see how much, if any, it must be modified after an examination of a number of quarries of one particular type of rock. A further test will be given to the classification by using it in a careful study of a particular quarry.

Although the major portion of this study deals with obsidian quarries, many other types of stone have been used for the manufacture of tools by chipping or flaking. The type of stone employed undoubtedly had an effect on the methods used in the quarrying itself, and on the quality of the tools that could be made, but it apparently did not have a great deal of effect on the initial manufacturing processes that were carried on at the quarries. The way in which stone was utilized by a particular group was also affected by the distance that had to be traversed to the sources and the difficulties involved in extraction. It would seem likely that the most sought after rocks were those that were brittle and had a homogeneous composition so that the direction of fracture could be controlled easily. When possible, the majority of Indians in North America generally used high quality obsidian, flint, chert, or an equivalent.

When these substances were difficult or impossible to obtain, however, other rocks were used, some of the more common being called agate, agatized (petrified) wood, argillite, basalt, chalcedony, hematite, jasper, lignite, limestone, novaculite, opal, quartz, quartzite, rhyolite, sandstone, slate and shale (Ball 1941: 2; Bordes 1947: 2-3; Bryan and Tuohy 1960; Heizer and Treganza 1944: 342-343; Hodge 1907: 83, 233, 628, 864-867; 1910: 87, 102, 337-338, 391; Holmes 1919: 157; Lincoln 1924: 8; Mewhinney 1957: 25; Oakley 1959: 27-35). Many of these terms overlap and many are inaccurately used in the literature (particularly "flint"). Often terms are split to encompass smaller categories as, for example, quartz can be divided into "rose quartz," "smokey quartz," etc. (Heizer and Treganza 1944: 342-343).

These smaller groupings may well involve distinctions important to the users. For example, the Pomo Indians at Clear Lake, California, distinguished two kinds of obsidian. One type, which was easier to flake, was called bati xaga (arrow obsidian), and the other, which was harder and better for cutting implements was called dupa xaga (to-cut obsidian) (Loeb 1926: 179).

The actual processes of quarrying--the removal of the stone from its matrix--is not examined here. Rather, this study is concerned with the stone-working done at North American quarries, for it is this which produced the major part of the cultural debris found at these sites.

Specifically, Chapter II of this paper is concerned with the setting up of an adequate classification of the cultural debris found at quarry manufacturing sites. Although obsidian quarries are the main concern of the bulk of this study, this classification is based on ethnographic and archaeological information on all sorts of quarries. This chapter also includes a discussion of some previous theories that have been advanced to explain the material found at these sites.

Chapter III is a presentation of descriptions and discussions of various obsidian quarries from Mexico to Yellowstone National Park to give some idea of the similarities and the range of variation that can be found in the material from quarries of a single material. This chapter serves as a test for the adequacy of the classification that was set up in Chapter II, and provides comparative data for the description of the obsidian quarry in Chapter IV.

The next chapter is a description and analysis of an obsidian quarry near Riley, Oregon. More than one hundred worked artifacts and nearly ten thousand flakes and other pieces were examined to form the basis for the discussion of this site. The study of this site will further test the adequacy of the classification presented in Chapter II and will also test any inferences that might be made about obsidian quarries in general after an examination of the information on the sites in Chapter III.

The final chapter is devoted to conclusions.

CHAPTER II

MANUFACTURING SITES AT QUARRIES

Any discussion of the investigation of manufacturing sites at quarries should begin with mention of W. H. Holmes, a man whose work and publications on quarries have, for more than fifty years, greatly influenced thought on this subject. Holmes has visited and described various types of quarry sites in a number of North American locations from the east coast of the United States to Mexico. The quantity of his publications and the extent of his observations of quarry sites far exceed those of anyone else.

In describing these sites, Holmes was primarily concerned with the extent and depth of the deposits and the probable manner in which the rock was extracted. The maps, illustrations and diagrams in his works are always of high quality. His illustrations and descriptions, however, rarely treat cores, the faceted, non-utilizable remains of flaked rocks, unless they are very specialized, such as the Mexican blade cores, and usually gloss over a description of the flakes, certainly the most numerous pieces at these sites. Holmes felt that the only form of artifact made at quarry sites was a bifacial, leaf-shaped "blank" which was carried off and later worked into knives or projectile points (Holmes 1890: 13, 25; 1894: 13-14; 1919: 162, 165). Although he believed that many selected chips and fragments must have been carried away from the quarries to be utilized elsewhere as implements or for the making of implements, he found no evidence that any implements, large or small, were finished at the site. Any finished artifacts found at such a site, Holmes felt, were there by accident.

With very few exceptions, these ideas have been the basis for quarry descriptions during the past fifty or sixty years. One of these exceptions was an article entitled "Flint Quarries - the Sources of Tools and, at the Same Time, the Factories of the American Indian," written in 1950 by Kirk Bryan. Bryan thought that many of the so-called "blanks" and "rejects" found at quarry manufacturing sites were actually useable tools, mainly axes, and that they were used there. He also felt that many flint quarries were not only sources for export, but were "also industrial sites or factories to which materials such as wood and bone were brought to be worked in the presence of abundant tools" (Bryan 1950: 3). He then describes finds from three well-known quarries to support his statements.

Most of Bryan's ideas are probably correct, for chipped stone tools can be found in many quarry sites (for example, see Bryan and Tuohy 1960: 506). Some of the pieces that Bryan describes as "utilized flakes," however, do not seem to have been utilized at all (for example, see Bryan 1950: 9, fig. 2), but more likely were chipped by natural action. Also, his assertion that the quarry bifaces were often used as axes is not supported by ethnographic evidence, although his inferences, based on experimental work, are interesting. The major breakthrough that Bryan made is the realization that actual "tools" as well as "blanks" were made, used and can be found at quarry manufacturing sites.

Ethnographic Data

The ethnographic evidence concerning the working of quarries and on the chipping and flaking of rocks is quite limited. Quarrying and chipping were probably done in a generally similar manner by the various Indian groups of North America. This seems likely because of the great similarities in quarry sites all over the continent and the fact that even the Indians of Tierra del Fuego made their arrow and spear points in the same general forms and by the same processes as the North American Indians (Catlin 1867: 299-300).

The paucity of relevant ethnographic information is probably due to two major factors: First of all, the use of metal and firearms spread very rapidly and quickly replaced the use of stone for tools and weapons. Secondly, and less certainly, many of the Indian tribes reputedly kept as "a profound secret" the methods by which they worked stone into tools and weapons (Catlin 1867: 187).

The major tools used in the initial processes of manufacture were various types of rounded hammerstones, although hafted bifacially worked pieces may have been used for some types of rock (see Catlin 1876: Vol. II, Pl. 270). The hammerstones were usually rudely shaped and were often hafted in a twisted withe which formed a handle (Catlin 1876: 188; Powell 1895: 2; Ross 1959: Pl. 141).

Once the initial breaking of the stone was accomplished, further roughing out of the tools or preparation of flakes could be done in one of three major ways. The first, which was observed among the Shoshone, consists of the flaking of a rock fragment by holding it in one hand, which was protected by a piece of untanned elk skin, and striking it with a small stone hammer held in the other hand (Powell 1895: 2).

A second method, which was used by the Yahi Indians of California, and probably by many other groups, was demonstrated by Ishi and consists of placing one end of a blunted bone tool on a rock fragment and striking the other end with a hammerstone. This results in the detaching of a large piece without shattering the whole fragment (T. Kroeber 1961: 182-183). This was a fairly dangerous operation because of the possibility of flakes flying into the knapper's eyes. It also required great skill, and therefore was often done by specialists (Catlin 1867: 188; Gifford 1960: 239; T. Kroeber 1961: 183; Loeb 1926: 179; Sellers 1885: 874-875).

A third method was described by George Catlin to George Ercol Sellers. By this method, after the initial breaking of the rocks was accomplished, "good flakes could be split from their clean fractured surface by what Mr. Catlin called impulsive pressure" (Sellers 1885: 874). This was accomplished by the use of a long shaft or stick two to three inches in diameter and from thirty inches to four feet long depending on how it was used. These shafts were usually pointed with bone or horn tips which had been worked to either a blunt or gently rounded end. After being slightly worked to prepare a platform to keep the tool from slipping, the stone was either held in place by embedding it in hard earth, holding it between the feet or securing it "between two pieces or strips of wood like the jaws of a vise, bound together by cords or thongs of rawhide" (Sellers 1885: 874). The tip of the flaking tool was placed on the prepared platform of the stone fragment, and pressure was applied to the tool to produce a flake. When additional pressure was needed, heavy stones were tied to the tool. If this did not produce enough pressure to disengage the desired type of flake, a variation of the flaking tool was used in which the shaft of the tool had on it the remains of a branch forming a crotch. While one workman delivered a pressure thrust to the top of the tool, another workman would deliver a blow into the crotch of the shaft using a large stone.

Archaeological evidence points to the conclusion that very careful shaping of implements was not done at the quarry site, but back at the living site, since even fragments of finely worked artifacts are rarely found at quarry sites.

There is some evidence that indicates that occasionally a camp would be set up near to (or sometimes at a considerable distance from) a quarry for the sole purpose of manufacturing stone tools (for example see Breton 1905: 265; Cole and Rice 1965: 12). It may be this sort of site that is pictured in a painting by George Catlin (see Ross 1959: Pl. 141). If this type of camp were used, the "roughing out" of tools might be done at the camp rather than at the quarry. The only operation that would be carried on at the source of supply would be the selection of materials.

Archaeological Data

The material usually found at quarry sites can be put into four major categories: (1) hammerstones; (2) cores; (3) flakes; (4) roughly unifacially or bifacially worked pieces. Only in very rare cases are any of the more perishable tools such as digging sticks or antler flakers found (for examples of such cases, see Holmes 1919: 193; Sellers 1885: 877).

Hammerstones

This category includes every type of stone implement that is used to strike off flakes, whether it is used to strike directly on the material to be flaked or used indirectly with a bone or antler punch. It also includes stones that have been used as anvils, although it is difficult, if not impossible, to tell if a rock has been used as an anvil rather than as a hammer unless it is very large or has some other characteristic that rules out its being used as a hammerstone.

Hammerstones usually show definite signs of battering on at least part of their surface, and occur in a great range of sites. It is not the violence with which a rock is struck that determines the size and characteristics of the flake removed, but rather it is the mass of the hammerstone. Very violent blows with a small hammerstone still only give small flakes, while a relatively moderate blow with a heavy hammerstone will detach a large flake (Bordes 1947: 6). Thus to remove a large, long flake as, for instance, was necessary to make a large ceremonial knife such as those used by the Indians of Northwestern California, a fairly heavy stone had to be used (see Holmes 1919: 217, Fig. 93).

Hammerstones were usually rounded, but when these were not easily made or available naturally, other types were used (for example, see Holmes 1919: 190; Phillips 1900: 47-49). In most cases, naturally rounded pebbles of durable material were used as hammerstones (see Catlin 1867: 188; Farmer 1937: 8-9;

Holmes 1894: Pl. XI; 1900: 412; 1919: 168, 180, 285, 286; Mewhinney 1957: 39), but often they were shaped and grooved for hafting (for example, see Holmes 1919: 237, 261, 272, 332). It is also likely that hammerstones were sometimes used as anvils (Holmes 1919: 301).

Judging from this information, the classification of hammerstones should probably be according to the following criteria: (1) weight (both absolute and relative to other hammerstones at the same site); (2) material (its adequacy for use as a hammerstone and its source); (3) special working (such as shaping or grooving); (4) location and extent of use marks; (5) shape.

Cores

For most purposes, cores can be split into two main divisions, the first including cores that appear to have been shaped before the removal of a flake and the second including all other cores. Sub-divisions could be made for special features as on cores which have had flakes struck from a single striking platform as is done on conical blade-cores.

If a special use can be demonstrated for flakes struck from a particular type of core, it is good reason for putting the core in a separate division. For example, at several sites in Mexico (see below, pages 19-23), conical cores can be placed into a separate division because of the probability that they were rejects of the type of core that was used to make the famous Aztec "razor" blades. Both blades and "exhausted" cores have been found in Aztec living sites (see Breton 1905; Holmes 1900; 1919: 214-227; MacCurdy 1900). If, however, there is no evidence of the use of blades such as these among the people who worked the quarry or among those with whom they traded, there is no good reason for placing conical cores in a separate division. The reason for placing the Mexican blade-cores in a separate category is that they were prepared so that a tool of a particular design was removed and no further working was necessary.

Flakes

As mentioned above, the most numerous pieces at a quarry manufacturing site are flakes. It is probable that these were used by the Indians of North America both as cutting or scraping tools and as blanks for the manufacture of arrowpoints, drills and other small artifacts. Certainly it is easier to flake an arrowpoint from a small, thin flake than from a leaf-shaped blank (for example see Mewhinney 1957: 42), as some have suggested (Cushing 1895: 317-318; Hodge 1910: 337, 639). The use of flakes as blanks might also explain the various shapes of flakes and flake scars on cores that are found at quarry sites. Long, thin flakes are the best blanks for long, thin tools just as short, thick flakes are the best blanks for short, thick tools. The conical cores found at many quarry sites are probably only the remains of the removal of flakes to be used as blanks to manufacture long, thin tools. They are not, by themselves, evidence of the manufacture of specially shaped blades used as finished tools such as is usually implied by reference to blade-core industries.

Many of the flakes that can be found at quarry sites show signs of having been worked. Many others show signs of having been used. Holmes describes a few scraper-like objects that were found at the Guajolote Estate quarry in Mexico and were made by "taking a long, thick flake with one smooth, concave side, and removing a few chips around the convex margins of the wider and, giving a scraping edge" (Holmes 1900: 415). Worked or utilized flakes have been found by Kirk Bryan at the Spanish Diggings in Oklahoma, at the Alibates Quarry in Texas and at the Cerro Pederal Quarry in New Mexico (Bryan 1950: 8-18). Worked flakes have also been found by Cole and Lee at a quarry in Crook County, Oregon (Cole 1963: 3) and by Cole and Rice in Sumpter Valley, Oregon (Cole and Rice 1965: 8-9).

Bryan felt that quarries were industrial establishments or factories. He thought that "materials such as wood, bone or horn were brought to the site and in their fabrication the inumerable utilized flakes, blocks, scrapers and other irregular forms were used and discarded" (Bryan 1950: 21). This theory is very appealing, but unfortunately is not supported by ethnographic data. A much more convincing explanation is given by Holmes (1919: 221, 225), to the effect that these utilized flakes and scrapers were "employed in shaping and sharpening the wood and antler tools required in the quarry-shop work."

It would seem desirable, therefore, to classify flakes using the following features: (1) signs of secondary working; (2) definite signs of use; (3) indications of having been struck from a prepared core, whether this is a turtleneck core or simply an unwanted "blank" or other worked piece; (4) indications of not having been made by this method; (5) traces of cortex (the more flakes that are found with cortex on them, the greater is the likelihood that the manufacturing site was at or near a quarry); (6) existence of at least one good cutting or scraping edge; (7) absence of such an edge; (8) size. One particular flake could, of course, have several of these features.

Worked Pieces

At most quarry sites, large numbers of rough, unifacially and bifacially worked pieces have been found. The most common form is a hand-size, leaf-shaped biface which is usually broken. Although these are often called "blades" in the literature, that term will not be used for these pieces in this study. Holmes (1919: 167) felt that it was a "well-established fact that the thin leaf blade was the almost exclusive designed product of the quarry shops and the parent of the several specialized forms." The roughing out of the "blade," according to Holmes, was done at the quarry, while any further specialization was done elsewhere. He also referred to these leaf-shaped bifaces as "blanks" and felt that any that were found at quarry sites were rejects since they were not carried away by the Indians.

Bryan (1950) felt that although the thin bifaces may have been blanks, the thicker but similar forms were probably axe blades. This use would explain the fact that so many are found broken across the long axis (see Bryan 1950: 23).

It is possible that some of the bifaces were hafted for use as quarry tools, either as axes or as digging implements (see Catlin 1876: Vol. II, Pl. 270; Phillips 1900: 46-47). It is also possible that many of these larger worked pieces were used for adzing wood or bone (see the photograph of Ishi adzing Juniper wood for a bow in Kroeber 1961).

The great variety of worked forms that are found at some quarry sites certainly justify more than the one category of "rejects" that has been used by most writers on the subject. The description of the pieces probably should include size, shape, thickness and any signs of shaping or utilization.

CHAPTER III

OBSIDIAN QUARRIES

For manufacturing tools by chipping or flaking, obsidian is the best material possible because its quality of extreme homogeneity allows the knapper and high degree of control over its fracturing. Its only disadvantage is its great fragility (Bordes 1947: 3; Goodman 1944: 303-306). Obsidian, a volcanic glass, is usually found either in massive deposits or in nodule form and on the surface, underground or both. Most North American obsidian quarries are located on the western part of the continent, and are especially numerous in Southern Oregon, Northern California, and in Middle America (Ball 1941: 52; Heizer and Treganza 1944: 303-306; Hodge 1910: 102; Holmes 1919: 214). Obsidian is usually black, but some types are brown, red, green, mottled, streaked, translucent or sometimes even transparent (Forbes n.d.: 41-43; Hodge 1910: 102; Randolph 1935: 11-12, 26-27). Tools made from one of these impure varieties of obsidian are often greatly valued because of the rarity of the material, its beauty, and the difficulties involved in working it (Kroeber 1905: 690).

Mexico

Probably the best known obsidian quarries are those in Mexico. In the state of Hidalgo, twenty miles northeast of Pachuca, is the Guajolote estate quarry which has been well known for a long period of time (Ball 1941: 53, 55; Breton 1902: 264; Holmes 1900: 407). This quarry is characterized by alternating depressions and mounds of debris and obsidian. The pits and depressions, which are probably the remains of trenches three to six feet wide and up to twenty feet deep, are the ancient mines dug to reach the mass deposits of obsidian, while the hillocks are the heaps and ridges of debris thrown out from them (Ball 1941: 55; Holmes 1900: 408). The workings cover hundreds of acres and appear to have been worked vigorously for centuries (Holmes 1900: 409; 1919: 217). Where an extensively operated mine can been seen in isolation, "the ridges of debris usually encircle the pit on three sides, and extend outward on the fourth side, in a rough way like the arms of the letter V ..." (Holmes 1900: 411).

The only mining implements found at this site were hammerstones. The larger ones, which were four or five inches in diameter and somewhat discoidal, were probably used in the initial breaking of the obsidian. The smaller ones, also often discoidal, "must have been used in the hand simply, or with a light haft attached, in the work of breaking the fragments and trimming them down to the desired contour" (Holmes 1900: 412;

1919: 218, 220). The well known Mexican blade-cores are not found in the quarry manufacturing sites. The blades struck from these cores were much too delicate to be transported, so the cores were only roughed out at the quarry. Cores which were roughed out but presumably not considered adequate enough to take along have been found at the Guajolote estate quarry by Holmes (1900: 413; 1919: 220, 222).

Although Holmes in other places (see above, pages 5-6) stated that a bifacial "blank" was the only type of artifact found at quarry sites, he found at this site a number of scraper-like artifacts which he felt were either rejects of scraper making or were implements made and used upon the site. Almost none of the bifacial blanks, so common at other quarry manufacturing sites, were found at the Guajolote estate site (Holmes 1900: 415; 1919: 225). Some evidence of domestic life exists around the quarry, indicating that the obsidian workers lived,at least temporarily, at the site. Fragments of pottery are mixed with the debris of the shops, and are identical to the Aztec wares of Tenochtitlan (Holmes 1900: 416). It is therefore fairly certain that at least some of the work at this site was done by the Aztecs.

The small amount of ethnographic evidence that is available on Aztec stoneworking indicates that flaking was done by pressure with a wooden implement (Holmes 1900: 407). Obsidian was certainly important to the Aztecs, considering the fact that they used it extensively for such things as arrow and spear points, knives, razors, swords, mirrors, masks and ear ornaments (Ball 1941: 53; MacCurdy 1900: 421; Murdock 1934: 366). Another fact revealing some of the Aztec regard for obsidian is that although most of the Aztec gods were repellant, cruel and bloodthirsty, one that was not of that character was called Itzpapalotl, which means "Obsidian Butterfly" (Verril 1929: 185). The principal image of Tezcatlipoca in the City of Mexico was cut from obsidian. It is appropriate, considering its apparent ritual position, that obsidian was surnamed teotatl or "divine stone" (Bancroft 1893: Vol. 3: 237-238.

Another obsidian manufacturing site in the state of Hidalgo can be found about two miles from the town of Tulancingo. It consists of two mounds of chips and rejects which are about twenty feet across and eight to ten feet high. The nature of the debris indicates that there was a source of supply near the mounds although no traces are left of it. Some of the bifaces found were carefully finished while others were only roughly shaped. All of them were broken, but it seems that some of the fragments were pieces of implements from 10 to 17 centimeters long and from 5 to 6 centimeters wide, while others were pieces of larger implements up to 22 by 9 centimeters (Breton 1905: 265). At Zacaultipan, 22 leagues north of this site, there is another obsidian workshop--this one at the site of an outcrop. Driving south of Tulancingo for about four and a half hours on the road to Apam, "there is a ridge of obsidian, which has been worked, partly at so remote a period that a thick lichen has had time to grow on some of the chips in that extremely dry climate" (Breton 1905: 266). Fragments of roughly shaped pieces can be found in nearby caves, indicating that some of the tool manufacturing might have been carried on there.

In the state of Michoacan, at Zinapécuaro, there are obsidian outcrops in several places along with pits and heaps of "rejects." The pits at this site, which appear to have been regularly worked, are about two feet in diameter and about fifteen feet or more deep (Breton 1905: 266).

At Teuchitlán, in the state of Jalisco, there is a very large obsidian manufacturing site. There are three major concentrations of workings. The first is on a terrace above the town, where an abundant number of large, roughly flaked pieces cover the ploughed ground. The second concentration is at the foot of a hill, near a spring, and consists of flakes and "rejects" of all shapes and sizes. The flakes are usually broken and range from eight or nine inch razor-like blades to the smallest and thinnest possible (Breton 1905: 267). The third concentration of obsidian workings is about three miles from Teuchitlán, where some of the flakes are covered with a thick white crust. Breton feels that since obsidian takes a long time to weather, whenever flakes and "rejects" are found coated with a crust, a prolonged period must have ensued since they were worked (Breton 1905: 268). On an island in the lake of Magdalena, about 20 miles from Teuchitlán, Breton discusses a manufacturing site which had as its main product, she feels, conical cores for the production of blades. This is the only manufacturing site that she visited in Mexico where there were such objects, although she found them at temple sites and in burial deposits (Breton 1905: 268). If these cores are the ones that were used to produce the thin razor-like blades of the early inhabitants of this area, and if blades were actually made at this site, it is likely that this island was used as a living or a ceremonial site since, as mentioned above, the blades were much too delicate to be transported. It is not clear from her description whether or not an outcropping was located on the island.

Other utilized Middle American quarries are located at Pico de Orizaba, Veracruz; Zinapécuaro, Michoacan; La Joya (eighteen miles east of Guatemala City), at Fiscal and near Antigua (Ball 1941: 55; Holmes 1919: 127, 214, 227).

California

There are a great number of obsidian quarries in the western part of the United States which were used extensively by the Indians. Although quarries are located in almost all of the western states, discussion will be limited to a few of the better-described sites in California, Oregon, and in Yellowstone National Park.

About 140 miles northeast of Los Angeles and 20 miles southeast of Owens Lake are a group of warm mineral springs known as the Coso Hot Springs. Malcom F. Farmer (1937) has described an obsidian quarry located about three and one half to four miles east of the main group of springs. This is a mass formation of grey to black obsidian which varies in thickness from two to six feet and is underlain and capped by several feet of impure obsidian (Farmer 1937: 7). Extensive slides of obsidian fragments can be found from the ledge down the slope of the crater. The fragments consist of pieces that have fallen from the ledge and have broken naturally, leaf-shaped "blanks," and chips which Farmer feels are the by-products of blank manufacture (Farmer 1937: 8). Camp sites can be found to the east and north of the site. Many chips, nodules and fragments were found at the camps, indicating that these were living sites used by the obsidian workers. There were, however, no finished implements and few signs of domestic life found at these sites or at the quarry. It would therefore seem likely that these camps were of a much more temporary nature than those near the Guajolote site in Mexico.

The hammerstones found at this site are quite common among the debris, and are very interesting in that they are made from obsidian. They usually weigh about a pound, are approximately three to four inches long, two to three inches wide and two inches thick. They fit well into the hand, one end being round and the other end squared off. Batter marks are, in many cases, found on the rounded end. Farmer feels that these are probably due to use with a piece of antler, but states that "it is possible to remove flakes by direct contact with a core of the same material without fracturing the obsidian hammerstone" (Farmer 1937: 8-9).

A similar site in Grimes Canyon between Moorpark and Fillmore has been briefly described by Edwin F. Walker (1936). Here again the presence of a quantity of conchoidally fractured flakes indicates that artifacts were "roughed out" to reduce the weight of material that had to be carried back to camp.

A large area of obsidian nodules can be found on the east side of the Napa River, two and one half miles northwest of St. Helena. Many bifaces have been found among the flakes, along with large numbers of round hammerstones of sandstone, rhyoloite, quartzite or tuff. A series of shallow pits about six feet in diameter were dug to remove the small nodules from the soft white pumice in which they were embedded. Heizer and Treganza feel that the "digging tools could have been simply sharpened sticks, for the nodules occur here in a solidly packed loose aggregate like gravel in a stream bed" (Heizer and Treganza 1944: 304).

Another obsidian deposit (briefly referred to above on page 3), is located near Big Borax Lake, near Clear Lake, and was owned by the Elem, a Subsection of the Pomo. This site was not shared with other groups or regarded as neutral ground as were some other quarries (for example, see below, page 26). The extraction of the obsidian and the making of tools was a special occupation among the Elem, but considering the extent of the workings there must have been a considerable number of these specialists working over a long period of time and trading the obsidian products widely (Gifford 1960: 329; Heizer and Treganza 1944: 304-305).

At Cole Creek was another quarry (see above, page 3), where the Pomo obtained obsidian for making cutting implements (Heizer and Treganza 1944: 305; Loeb 1926: 179).

The location of eighteen other obsidian quarries in California is known (see Ball 1941: 8, 11, 15-16, 58; Heizer and Treganza 1944: 305-306).

Many of the large bifaces found at Northern California and Southern Oregon quarry sites were probably blanks for the manufacture of large obsidian knives. These knives were used in ceremonial dances by the Indians in "the quite distinctly specialized northwest culture area of California" (A. Kroeber 1905: 690). These knives, especially the large and multi-colored ones, were very highly prized (Hodge 1907: 718; Rust 1905: 688-689). A representative large black obsidian knife, obtained by Paul J. Fischer, measured 25 1/4 by 5 7/8 by 1 3/4 inches; the colored knives are usually somewhat smaller

(Fischer 1962: 1). These ceremonial knives are usually pointed on both ends and are very carefully worked. Many of these implements have been found in Northern California and Southern Oregon by archaeologist and artifact collectors (for example, see Anonymous 1955c: 3; Galbraith 1956: 4; A. Kroeber 1905: 694-695; Miles 1956: 2-3). Although these large double pointed knives were restricted to this area, other types of large obsidian knives have been found in other parts of California (Reimers 1961: 4).

Yellowstone National Park

Yellowstone National Park is the site of one of the best known obsidian quarries. In the vicinity of Obsidian Canyon there is a cliff of this material which is more than 100 feet thick in places (Brower 1897: 23; Hodge 1910: 102; Holmes 1879: 247). The obsidian is arranged in columns up to ten or twelve feet in width. Flakes and fragments of high quality obsidian cover the ground for many miles around this area and leaf-shaped bifaces are found here along with implements of other types (Brower 1897: 24; Holmes 1879: 250). One of the implements found is somewhat pyramidal in shape with a flat bottom and appears to have been used since the sharp edge at the base is worn (Holmes 1897: 249, figs. 2, 3, 250). This is probably a scraper. Considerable quantities of obsidian were removed from this site, which seems to have been neutral ground for quarrying purposes (Alter 1925: 232, 381; Wedel 1961: 274).

Oregon

Very little has been written about obsidian quarry sites in Oregon. Most of the information in this section has been obtained by personal observation or by personal communication with persons familiar with the sites.

The Cougar Mountain Site

This site was briefly visited in the spring of 1966 in the company of Mr. Robert Porter and family.

Cougar Mountain, the location of the site, is in Lake County, Oregon. It is best known for the cave excavated there by John Cowles of Rainier, Oregon. About a quarter of a mile separates the cave from the main obsidian flow.

The nodules of obsidian here are usually fairly small, not exceeding five or six inches in diameter. The obsidian is either glossy black, tar-like, or streaked with red. The workings cover several acres at the flow area, are thinly scattered and are usually on the top rather than on the sides of the mountain, although the unbroken nodules are as heavily concentrated on the sides as on the top. Natural, prismatically fractured pieces of obsidian occur in great quantities at the quarry. These needle-like pieces were found throughout the fill in Cougar Mountain Cave and were probably used as awls (Cowles n.d.: 21).

Several of the flakes collected appear to have been struck from prepared cores--probably rejected bifaces. Complete or broken bifaces, however, appear to have been rare at this site since none were found. This may be due to their having been roughed out and finished in the cave (see Cowles n.d.: 5). One thick flake found had been worked into a scraper-like object measuring 3 1/4 by 2 1/4 by 1 inch.

The only bifacially worked artifacts found were three cores that had been shaped into cleaver-like objects. One of these artifacts measured 3 1/2 by 3 by 2 inches and had its chopping or cutting edge on the side, while the other two averaged 4 by 3 by 2 inches and had their working edges on the end (one of these is illustrated on page 29). The use of these tools is unknown, but they would have been very effective on rough wood-working. Some hammerstones have been found at this site (Robert Porter, personal communication).

An interesting feature of this site is the fact that heavy concentrations of flakes are usually found near large trees. This may indicate that the Indians used the limbs of the trees as a wood supply or perhaps only that they preferred to work in the shade.

The working of obsidian was apparently not confined to the quarry area of the mountain since concentrations of flakes have been noticed far out into the flat areas in the direction of Fort Rock.

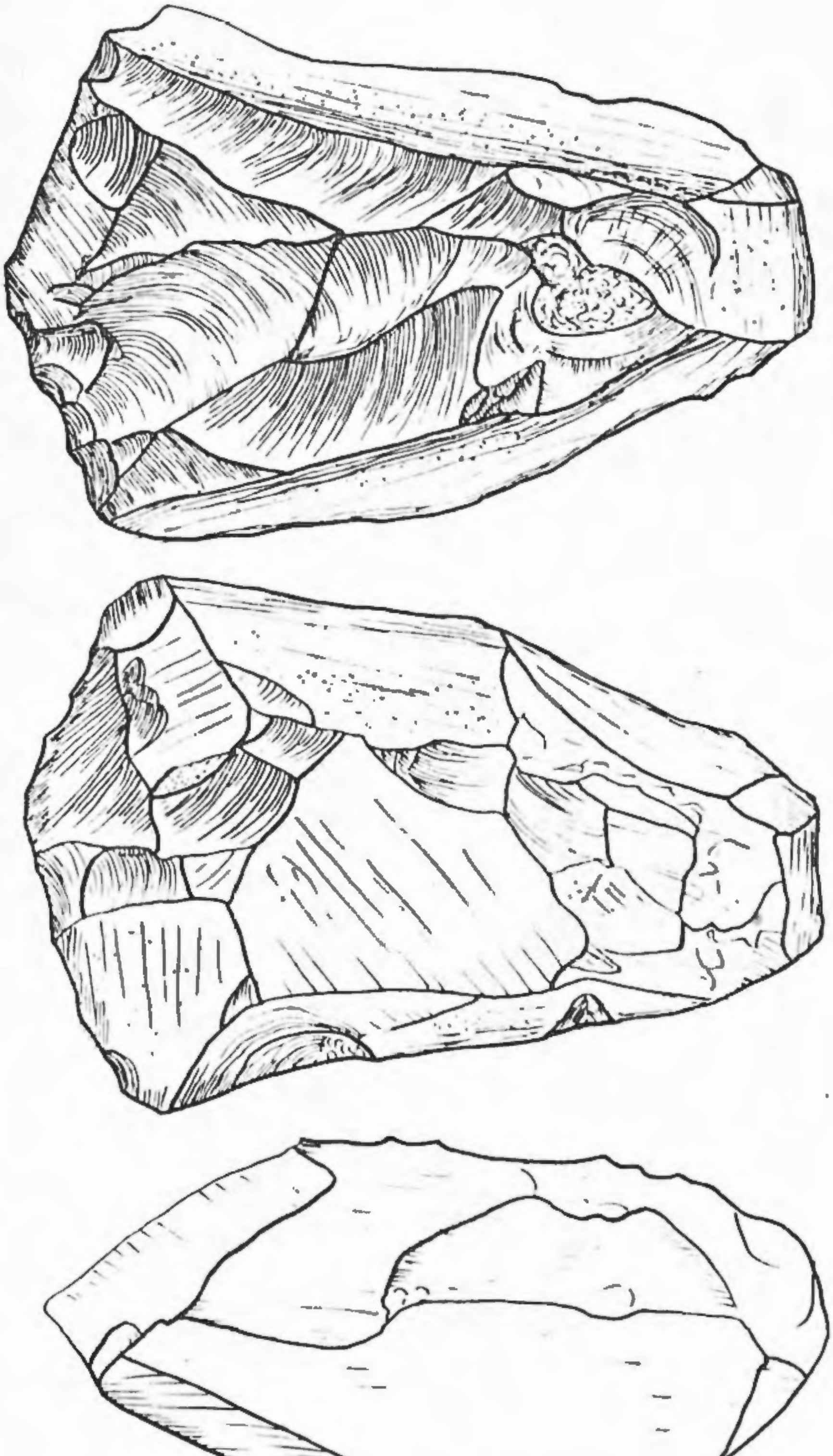


Fig. 1. - Cleaver-like artifact from Cougar Mountain Site

There is a good chance that Cougar Mountain Cave was, at least occasionally, used as a location for working the obsidian found at this quarry. Evidence for this is the fact that Cowles removed from the cave enough obsidian to fill "several trucks" (Cowles n.d.: 5). Also he states that "all evidence seems to indicate that these mountain camps were temporary. The vast number of artifacts found on the desert floor indicate these lowland camps were more permanent than those in the mountains" (Cowles n.d.: 49). This, the "lack of well defined cooking utensils" and the large number of bifaces such as are typical of quarry sites is good evidence that this cave was used for some initial manufacturing of artifacts, and, as mentioned above, perhaps explains the rarity of bifaces in the workings outside the cave (see Cowles n.d.: 18, 19, 50).

The Silver Lake Site

This site also was visited briefly in the spring of 1966 with Mr. Robert Porter and family.

The Silver Lake quarry is located about ten miles southwest of the town of Silver Lake, Oregon. The quarry extends over a considerable area (probably four to five square miles) of forested hills at an altitude of about 5000 to 6000 feet. The obsidian is found in nodules up to a foot or more in diameter. The obsidian is of two major types. The first is quite glossy and black in color. This type is found mostly at higher altitudes. The other type, found at lower elevations, is grey to black and is not as glossy as the first type. The rough, tar-like finish of this type is probably due to slower cooling (L. Kittleman, personal communication).

Traces of working of obsidian are apparent all over the hills, but in some places are covered by soil. Some of the heaviest concentrations of debris can be found in areas where the soil has been removed by logging or road clearing operations. Scattered flakes can be found hundreds of yards from the nodule concentrations.

In the area of the nodules, considerable quantities of very large flakes occur. A great deal of skill was presumably required to detach flakes as large as these (Porter, personal communication). In parts of the site, heavy concentrations of flakes can be found within small areas. These are probably areas where a stone knapper roughed out bifaces and possibly worked on other tools. This is at least partially confirmed by the fact that a careful search of the area usually produces pieces of worked and sometimes utilized obsidian.

Some of the flakes found at this site appear to have been struck from a prepared core--possibly a rejected biface. Others have been found that, due to extensive wear around the edges, appear to have been utilized.

Nineteen unifacially and bifacially worked pieces were found at this site during a brief visit in the company of

Mr. Robert Porter and family. Thirteen of these pieces appear to have been rejected due to breakage. Of the six apparently whole pieces, one seems to have been rejected because of the removal of too many flakes on one side, giving the artifact a bowed shape, while three were probably rejected due to faults in the material. The other two "whole" pieces were unifacially worked and very large, one measuring 5 by 3 1/2 by 1 1/4 inches and the other 7 by 4 1/2 by 3 inches. Judging from the size and extent of the flake scars, these pieces were not used as cores, but were worked into a definite shape. The use, if any, of these pieces is unknown. It has been suggested that they might represent practice flaking by apprentice quarry workers (Porter, personal communication) since they have been carefully shaped in places for no apparent reason. Learning the art of obsidian working certainly would take a considerable amount of training and no better place could be found for this training than at a quarry site.

Most of the artifacts found at this site were very roughly worked, the flake scars usually being quite large and the shape of the object rather ill-defined. Seven of the pieces, however, were fairly well worked, having smaller flake scars around the edges and a thinner, more regularly shaped appearance. All of these well worked pieces were fragments which indicates that they were broken in the process of shaping them more carefully. It also indicates that before the more careful work began on a piece, it was completely roughed out to detect any fault in the material since no pieces were found that were well worked in some places and not worked at all in others, and no well worked implements were found with recognizable faults in the material.

No specialized hammerstones have been found at the Silver Lake site, indicating either that nodules of obsidian were used or that implements were imported and were either too valuable to discard or were made from perishable materials.

The Glass Buttes Site

Probably the best known site in Oregon is the one at Glass Buttes in Lake County. The Glass Buttes are two prominant hills composed of volcanic rock, having as a main structural feature an anticline which has been greatly modified by faulting. They are covered with considerable quantities of black and variegated obsidian (Randolph 1935: 11-12; Waters 1927: 441). Some of the variegated obsidian is quite colorful and probably unique (Forbes n.d.: 41-42; Randolph 1935: 11). The workings cover several acres of the Buttes and are at least six feet deep in places (Forbes n.d.: 42).

Some information about the quarrying and working of obsidian on Glass Buttes was obtained from Mus-su-peta-na, a Karok stone worker, by P. L. Forbes (n.d.: 42-47). Of pertinence is the indication that if an arrowhead or a knife were broken in the making, the Karok, who came to Glass Buttes for the colored obsidian, believed that the gods were against them. The broken pieces, instead of being reworked into something else, were left on the ground and never touched again. This might at least partially explain the occurence of so many broken bifacially worked pieces, not only on Glass Buttes, but on all the quarry sites in this part of the west.

The Glass Buttes Site, like the Cougar Mountain Site, has considerable numbers of naturally fractured prismatic pieces. "The early Indians found these needle-like forms useful as real needles or piercing awls, for ornamental necklaces, and when broken into about two-inch lengths and sewed with sinews to the bottom of the squaws' buckskin skirts, were considered extremely decorative" (Randolph 1935: 27).

Other Oregon Quarry Sites

Other obsidian quarries in Oregon are located between East Lake and Paulina Lake, on Quartz Mountain and on Mount Taber in Portland. Large blanks have been found in a quarry site in the Valley of the Giants west of Highway 95 near the Oregon-Nevada border. Another quarry site is located in a canyon on the northwest side of Alkalai Lake. The flake concentration is greater in the upper part of this canyon, but scattered flakes can be found all the way into the lake bed. The location of these five sites was obtained from Mr. David L. Cole of the Museum of Natural History at the University of Oregon. Another obsidian quarry in Oregon is the Riley Site, which will be described in the next chapter.

Discussion

All of the material found at these quarries seems to fit into the classification presented in Chapter II. The hammerstones found at these sites are like those found at most quarry sites. Some interesting exceptions, however, are the hammerstones of obsidian found at the Coso Hot Springs site in California (see above, page 23). Very little is mentioned in the literature about the flakes in these quarries and not enough time was available for a careful examination of the flakes at the Cougar Mountain and Silver Lake sites. What is mentioned, however, seems to be adequately covered by the classification.

A special type of core appears to have been made in some of the Mexican sites for the production of blades. This, along with the apparent lack of bifacially worked pieces at these sites, sets them off from the other obsidian quarries in North America. These sites were probably used by the Aztecs and possibly other groups as a source of supply for obsidian to make blades.

The worked pieces found at these sites are probably mostly "blanks" for the production of knives or other large tools. Some interesting exceptions to this, however, are the scraper-like artifacts found by Holmes at the Guajolote estate site in Mexico and at Yellowstone National Park, and the cleaver-like artifacts found at the Cougar Mountain quarry.

From this examination of manufacturing sites at obsidian quarries, certain features seem important in this type of site and so will be examined for the Riley Site in the next chapter. First of all, some of these sites give evidence of blade-core industries. Although such sites discussed here were located in Mexico, there has been some discussion of blade-core industries in Oregon (see Dumond 1962). Secondly, the Riley Site as well as other sites in Southern Oregon and Northern California might have been used as sources for the large ceremonial blades of the Indians of the coastal portions of these states. This possibility will also be examined. Finally, a search will be made for any sort of special tools such as the scrapers or cleaver-like bifaces that were present at some of the quarries.

(13)

CHAPTER IV

THE RILEY SITE

Introduction

The Riley obsidian quarry is located four and one half miles southwest of Riley, Oregon, on Highway 395, on a raised arm of land extending across the highway from Squaw Butte. The main concentrations of workings are located between about 4.2 to 4.8 miles from Riley and about 900 yards separates the highway from the eastern border (Map 1). It was not possible to investigate the area to the west of the highway, although the concentrations appeared to be very light.

The climate, terrain, flora and fauna of this area are typical of the Great Basin (for a discussion of these subjects, see Cressman 1942: 13-17).

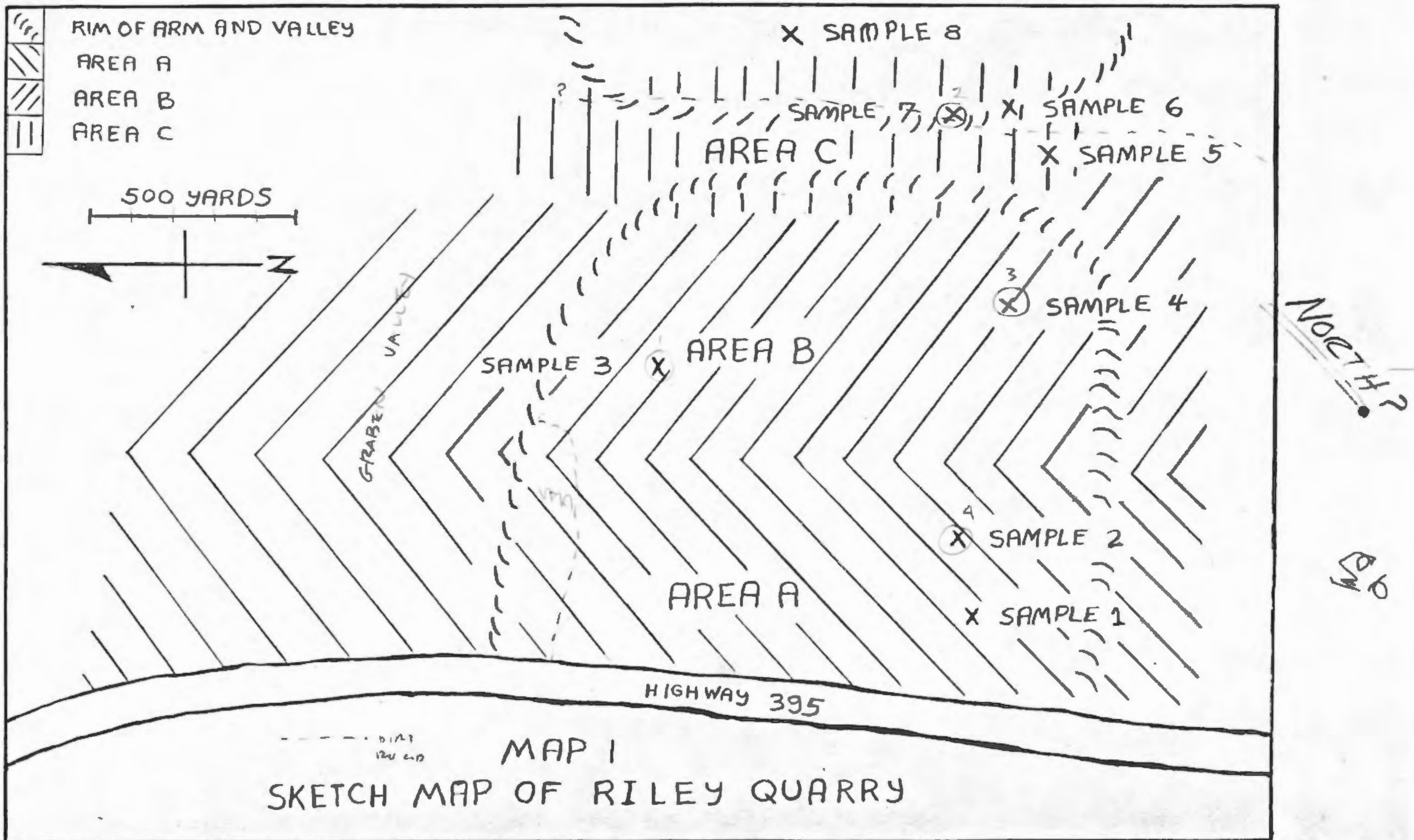
The obsidian found at this site is black and occurs in nodules that appear to be worn by water, sand or a similar agent, and which range in size from less than a half inch in diameter up to about a foot. The most commonly used nodules appear to have been from five to six inches in diameter. The nodules in the part of the quarry nearest the highway appear to be considerably smaller than those in the eastern part. While the nodules in the western part of the quarry seem to be scattered randomly, those in the eastern part appear in "stripes" which are about two to three feet wide and about 60 feet long. One would expect, therefore, that most of the larger tools would be commonly made in the eastern part of the quarry where there were heavy concentrations of large nodules.

Many naturally fractured prismatic pieces of obsidian can be found in almost all parts of the quarry. These fractures are probably due to stresses which occured during the cooling of the obsidian. The heavy patination on these pieces compared to the cultural debris and the fact that they appear to be water or weather worn suggests that the obsidian flows took place long before the quarry was worked.

Quarry Divisions

For purposes of this study, the Riley site will be divided into three areas (see Map 1, page 39). The first of the areas, area A, is the part of the quarry which extends from the highway east about 500 yards. This area is characterized by large quantities of very small nodules, scattered flakes and what appear to be scattered manufacturing areas. The small amount of obsidian in this area may be partially due to its nearness to the highway and therefore to tourists and rock collectors.

Area B extends from the eastern edge of the first area to a small valley 30 to 35 feet deep which runs approximately parallel to the highway about 900 yards away. This area has



MAP I

SKETCH MAP OF RILEY QUARRY

heavier concentrations of both cores and flakes and also has larger nodules, which occur here in the above mentioned "stripes."

The third area, area C, is located in the small valley and on its banks. This area is characterized by very heavy concentrations of unworked nodules, cores and very large flakes. The workings in this area appear to be several feet deep in places, and are often covered by soil, especially at the bottom of the valley.

Although area C marks the easternmost extension of the quarry site proper, many small concentrations of flakes can be found up to hundreds of yards to the east. The concentrations probably are places where the quarry workers brought nodules of obsidian to work them into artifacts. One of these concentrations was sampled.

Sampling Techniques

It was not necessary to do any excavation at this site since the material is located on the surface of the ground. Previous testing has provided no indication of any significant sub-surface deposits (Dumond, personal communication). The sampling falls under two main categories: (1) the selective collections made within the past few years by D. E. Dumond, and in 1965 by the author, and, (2) the random samples taken in 1965. These will be held apart analytically in this study. All the material collected is now stored in the preparation laboratory of the Museum of Natural History at the University of Oregon.

The samples taken from the Riley quarry in 1965 consist of eight collections each made within a one-meter circle. The samples were from points chosen randomly within each of the three areas mentioned above. Two samples were taken from area A, two from area B, three from area C and one from the area east of the quarry. More samples were not taken due to limitations of time and transportation facilities.

Within each area points to be sampled were chosen by proceeding to the approximate center of the area, obtaining an arbitrary direction by spinning a pointer on a shaft, and then pacing off a number of steps in that direction. The number of steps was determined by drawing a slip from a container that contained slips numbered from 1 to 99. If the direction led to a spot that was out of the area or to a location that would yield less than 100 pieces in a one meter circle, the sample was not taken and the process was repeated.

By "surface collections" it is meant that from the circle all possible pieces were taken that did not require excavation. Thus, if a piece was partially buried and could be removed without disturbing the soil around it, it was included, while pieces that would require digging to remove were not included.

Classification of Samples

The categories used in Tables 1-4 are those necessary for the description of the Riley material, and do not include characteristics which were not necessary for the classification of this material (for a more complete scheme of classification, see Chapter II). In the tables there are two sets of numbers. The numbers in parenthesis are the expected frequencies assuming a completely random distribution. The numbers not in parenthesis are the actual counts.

In Table 1, the first category is "non-utilizable flakes." This includes all those flakes which were felt by the writer to be not utilizable due to their irregular shape, extremely small size or their not having at least one good edge that could be used for cutting or scraping. Many of the flakes, however, that have been classified here as non-utilizable could conceivably lend themselves to use as gouges, drills, etc., but none of them showed any sign of having been so utilized.

"Utilizable" flakes are those that have or appear to have had at least one good cutting or scraping edge. Many of these flakes, in fact, show signs of having been utilized in that signs of wear in the form of many small chips can be found on their scraping or cutting edges. Only those that have consistent edge war, however, are here referred to as "used" flakes, since the irregular wear on some of the

"Utilizable" flakes could be due to either natural or artificial action (an example of a "used" flake can be seen on page 44; note especially the wear evident on the upper end).

Blades are a special category of flakes that are at least twice as long as they are wide and have other distinguishing features (see Dumond 1962: 419-420; the criteria used for blades at the Riley Site, however, do not include the necessity that there be evidence for previous removal of other blades. For example, see page 45). This category is included in the description of the Riley material because of the previous discussion of blades and blade cores in Oregon (Dumond 1962).

"Non-blades with pre-removal working" are those flakes which appear to have been removed from a core after several smaller flakes had already been removed from a core after several smaller flakes had already been removed from that part of the core so that the shape of the flake is at least partially determined before its removal. All of the flakes with this characteristic appear to have been removed from apparently unwanted pieces such as those discussed above (pages 15-16). A number of flakes with this attribute appear to have been utilized (for example, see page 47).

The division into small, medium and large flakes gives an indication of how the quarry was used in a particular area and also gives some indication of the size of the nodules

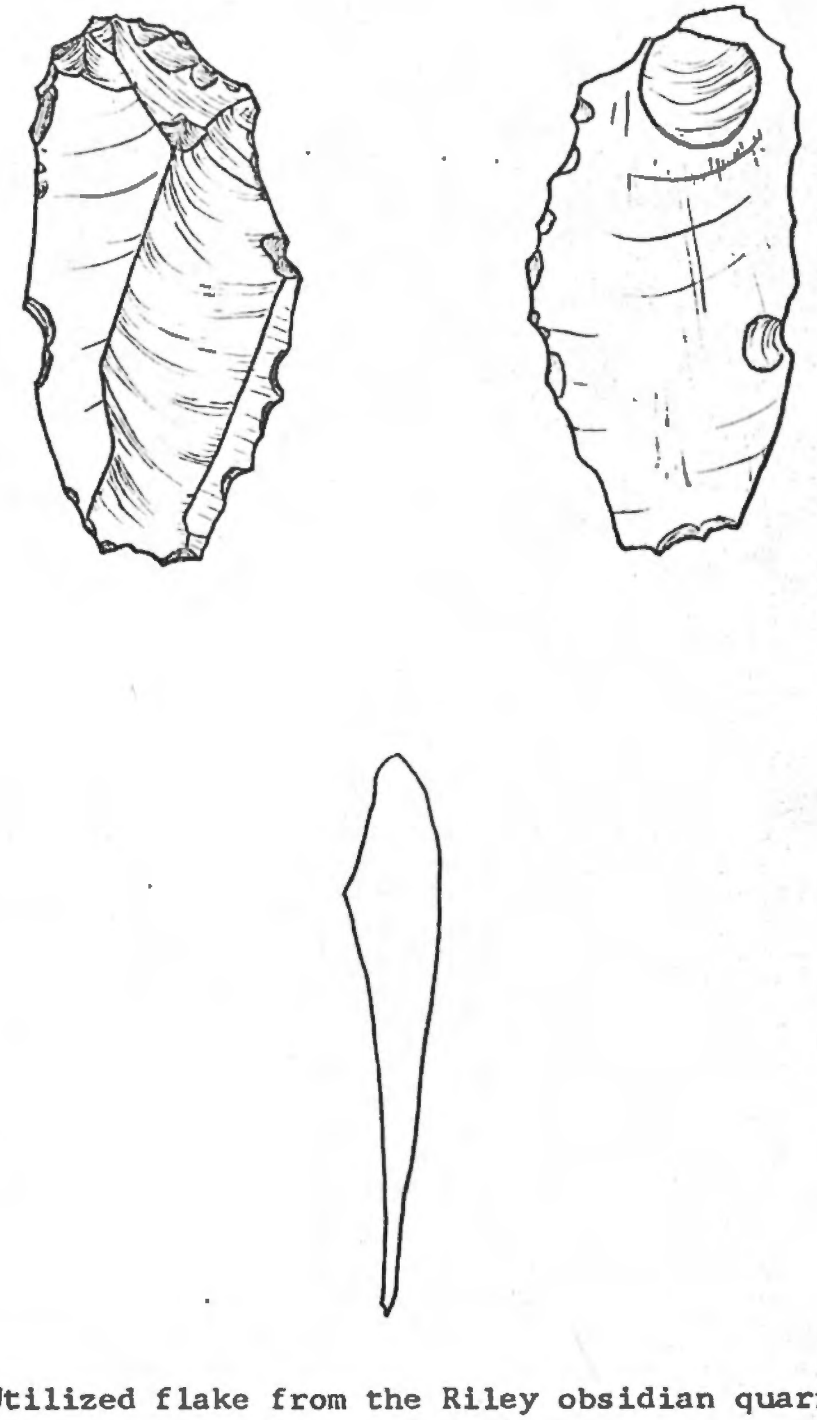


Fig. 2. - Utilized flake from the Riley obsidian quarry

Fig. 3. - Blade

used. "Small" flakes ranged from 1/8 inch to 1 1/2 inches in length. "Medium" flakes ranged from 1 1/2 inches to 4 inches and "Large" from 4 inches to 10 inches.

Many of the flakes and cores at the Riley site still had traces of cortex on them. The cortex of the nodules at this site usually has a very rough texture and is often reddish-colored in places. The presence of cortex on a large percentage of flakes can show two things. First, it can often indicate how close a group of flakes is to the source of nodules since the Indians probably roughed out pieces of obsidian before carrying them any distance and therefore removed most of the cortex. Secondly, it can give some idea of the variation in the size of nodules within a particular site, since, given the removal of flakes of a particular size, an area with smaller nodules will necessarily produce more flakes with traces of cortex than an area with larger nodules will, for the same mass of obsidian.

In the various non-random collections from this site, one very large discoidal core and a few conical blade cores occur as well as a number of interesting cores of other shapes, but none have a high enough frequency to warrant special discussion. In the randomly-chosen 1965 samples, with the exception of a single blade core in sample one, all of the cores were of a very generalized nature. This being the case, the only categories that were considered were small

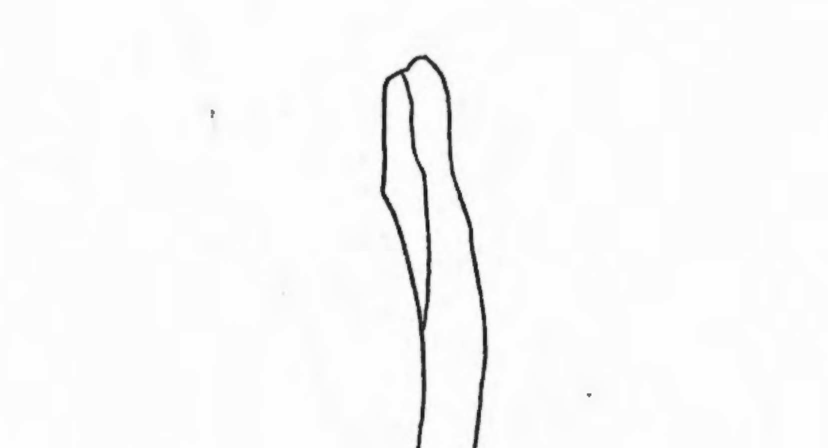


Fig. 4. - Flake with pre-removal working - utilized

(up to three inches in diameter), medium (from three to five inches in diameter), and large (over five inches in diameter) divisions and a separation between those cores with at least some cortex still on them and those with none (see Table 2). No great differences between the samples were noted except for the fact that the samples in area A lacked large cores while most of the others did not. No cores were present in sample eight, which was out of the quarry area (see below, page 56-57).

The "non-obsidian" pieces at this site (Table 3) are all pumice (Kittleman, personal communication). These pieces are much too light and crumbly to have been used for flaking.

The only evidence for hammerstones at the Riley site is the presence of a few unworked obsidian nodules with batter marks on them. There were none found in any of the random samples, and the few that were noticed at the site showed no evidence of special features, but were of nearly every shape and size. Because of the uncertainty of the identification, these few nodules are not classed as hammerstones.

The "naturally fractured" (Table 3) pieces can be distinguished easily from the artificially fractured ones by the fact that the former do not show signs of the removal of conchoidal flakes and are heavily patinated. They are usually pencil-thin and have a polygonal cross-section.

The unworked nodules (Table 3) in these samples are mostly limited to those which are less than one inch in diameter, since the larger ones are usually present only in the "stripes" found in the eastern part of the site, none of which were sampled.

The Samples

The location of the samples is given in Map 1. A discussion of each sample follows.

Sample One

This sample and sample number two are located in area A mentioned above (page 38). Sample number one is not typical of this area due to the large number of large flakes and cores (see Table 1, page 50 and Table 2, page 52). Also, a conical core which was found in this circle was the only one noticed in this area. The patination on this core was considerably less than that on most of the pieces found at the site, so it is not impossible that this core and the large blades found near it were produced by a recent non-Indian knapper. The striking platform, unlike the flake scars, was heavily patinated and did not show the marks that are typically left by the removal of a flake by artificial means. Thus the knapper, whoever he was, did not make the striking platform, but took advantage of a natural one. This core and the flakes struck from it account at least partially for the fairly high number of blades and large flakes in comparison to the expected frequencies for this sample.

Table 1

FLAKE CHARACTERISTICS*

	Non-Utilizable	Utilizable Used	Utilizable Not Used	Total	Blades	Non-Blade With Previous Working	Other Flakes	Total	Small	Medium
Site 1.	(136) 110	(1) 0	(16) 43	153	(1) 6	(3) 0	(150) 147	153	(138) 120	(1 1
Site 2.	(188) 190	(2) 4	(22) 18	212	(1) 0	(4) 0	(207) 212	212	(191) 178	(1 3
Site 3.	(1645) 1654	(14) 1	(194) 198	1853	(8) 9	(33) 20	(1812) 1824	1853	(1666) 1733	(15 9
Site 4.	(136) 106	(1) 7	(16) 40	153	(1) 1	(3) 12	(150) 140	153	(138) 69	(1 6
Site 5.	(647) 591	(6) 21	(76) 117	729	(3) 6	(13) 18	(713) 705	729	(656) 635	(6 7
Site 6.	(1018) 1006	(9) 11	(120) 130	1147	(5) 3	(20) 19	(1122) 1125	1147	(1031) 1009	(9 11
Site 7.	(3051) 3231	(26) 17	(360) 190	3438	(15) 10	(61) 40	(3362) 3388	3438	(3092) 3176	(29 23
Site 8.	(209) 143	(2) 0	(25) 93	236	(1) 0	(4) 31	(231) 205	236	(212) 203	(2 2
Total	7031	61	829	7921	35	140	7746	7921	7123	66
Non-Utilizable	-- --	-- --	-- --	-- --	(31) 0	(124) 0	(6876) 7031	7031	(6323) 6517	(59 44
Utilizable Used	-- --	-- --	-- --	-- --	(0) 0	(1) 26	(60) 35	61	(55) 20	(3
Utilizable Not Used	-- --	-- --	-- --	-- --	(4) 35	(15) 114	(811) 680	829	(745) 586	(7 14
Total	--	--	--	--	35	140	7746	7921	7123	6

Table 1

FLAKE CHARACTERISTICS*

	Blades	Non-Blade With Previous Working	Other Flakes	Total	Small	Medium	Large	Total	Cortex	Non-Cortex	Total
	(1)	(3)	(150)		(138)	(13)	(2)		(16)	(137)	
1	6	0	147	153	120	15	18	153	92	61	153
	(1)	(4)	(207)		(191)	(18)	(3)		(23)	(189)	
2	0	0	212	212	178	33	1	212	118	94	212
	(8)	(33)	(1812)		(1666)	(157)	(30)		(198)	(1655)	
18	9	20	1824	1853	1733	99	21	1853	201	1652	1853
	(1)	(3)	(150)		(138)	(13)	(2)		(16)	(137)	
15	1	12	140	153	69	68	16	153	20	133	153
	(3)	(13)	(713)		(656)	(62)	(12)		(78)	(651)	
72	6	18	705	729	635	72	22	729	129	600	729
	(5)	(20)	(1122)		(1031)	(97)	(19)		(123)	(1024)	
14	3	19	1125	1147	1009	117	21	1147	87	1060	1147
	(15)	(61)	(3362)		(3092)	(290)	(56)		(367)	(3071)	
43	10	40	3388	3438	3176	237	25	3438	191	3247	3438
	(1)	(4)	(231)		(212)	(20)	(4)		(25)	(211)	
23	0	31	205	236	203	28	5	236	8	228	236
?21	35	140	7746	7921	7123	669	129	7921	846	7075	7921
	(31)	(124)	(6876)		(6323)	(594)	(115)		(751)	(6280)	
	0	0	7031	7031	6517	442	72	7031	763	6268	7031
	(0)	(1)	(60)		(55)	(5)	(1)		(7)	(59)	
	0	26	35	61	20	37	4	61	3	58	61
	(4)	(15)	(811)		(745)	(70)	(14)		(86)	(740)	
	35	114	680	829	586	190	53	829	80	749	829
	35	140	7746	7921	7123	669	129	7921	846	7075	7921

Table 1 (Continued)

FLAKE CHARACTERISTICS*

	Non-Utilizable	Utilizable Used	Utilizable Not Used	Total	Blades	Non-Blade With Previous Working	Other Flakes	Total	Small
Blades	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	(31) 23
Non-Blades With Pre-Removal Working	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	(126) 80
Other Flakes	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	(6966) 7020
Total	--	--	--	--	--	--	--	--	7123
Small	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Medium	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Large	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Total	--	--	--	--	--	--	--	--	--

*Expected Frequencies Are in Parenthesis; Other Numbers Are Actual Counts.

Table 1 (Continued)

FLAKE CHARACTERISTICS*

Total	Blades	Non-Blade With Previous Working	Other Flakes	Total	Small	Medium	Large	Total	Cortex	Non-Cortex	Total
--	--	--	--	--	(31)	(3)	(1)		(4)	(31)	
--	--	--	--	--	23	2	10	35	10	25	35
--	--	--	--	--	(126)	(12)	(2)		(15)	(125)	
--	--	--	--	--	80	57	3	140	3	137	140
--	--	--	--	--	(6966)	(654)	(126)		(827)	(6919)	
--	--	--	--	--	7020	611	116	7746	833	6913	7746
--	--	--	--	--	7123	669	129	7921	846	7075	7921
	--	--	--	--	--	--	--	--	(761)	(6362)	
--	--	--	--	--	--	--	--	--	636	6487	7123
--	--	--	--	--	--	--	--	--	(71)	(598)	
--	--	--	--	--	--	--	--	--	151	518	669
--	--	--	--	--	--	--	--	--	(13)	(115)	
--	--	--	--	--	--	--	--	--	59	70	129
--	--	--	--	--	--	--	--	--	846	7075	7921

enthesis; Other Numbers Are Actual Counts.

Table 2

CORE CHARACTERISTICS*

Sample Number	Small	Medium	Large	Total	Cortex	Non-Cortex	Total
1	(4) 0	(5) 11	(3) 0	11	(7) 9	(4) 2	11
2	(1) 0	(1) 3	(1) 0	3	(2) 3	(1) 0	3
3	(3) 0	(4) 3	(2) 5	8	(5) 5	(3) 3	8
4	(3) 3	(4) 3	(2) 2	8	(5) 7	(3) 1	8
5	(12) 24	(16) 12	(8) 0	36	(23) 18	(13) 18	36
6	(9) 2	(13) 11	(7) 16	29	(19) 22	(10) 7	29
7	(3) 4	(4) 3	(2) 1	8	(5) 3	(3) 5	8
8	(0) 0	(0) 0	(0) 0	0	(0) 0	(0) 0	0
Total	33	46	24	103	67	36	103
Small	-- --	-- --	-- --	-- --	(21) 18	(12) 15	33
Medium	-- --	-- --	-- --	-- --	(30) 32	(16) 14	46
Large	-- --	-- --	-- --	-- --	(16) 17	(8) 7	24
Total	--	--	--	--	67	36	103

*Expected Frequencies in Parenthesis, Other Numbers are Actual Counts.

Table 3

NON-WORKED PIECES*

Sample No.	Non-Obsidian Pieces S	M	L	Tot.	Natural Fractures S	M	L	Tot.	Non-Worked Obsidian Nodules S	M	L	Tot.
1	(0) 0	(0) 0	(0) 0	0	(0) 0	(0) 0	(0) 0	0	(410) 419	(19) 12	(2) 0	431
2	(0) 0	(0) 0	(0) 0	0	(0) 0	(0) 0	(0) 0	0	(322) 322	(15) 23	(2) 4	349
3	(8) 7	(1) 3	(0) 0	10	(2) 0	(0) 3	(0) 0	3	(10) 10	(0) 0	(0) 0	10
4	(5) 2	(1) 2	(0) 2	6	(0) 0	(0) 0	(0) 0	0	(0) 0	(0) 0	(0) 0	0
5	(5) 6	(1) 0	(0) 0	6	(13) 13	(2) 1	(1) 2	16	(0) 0	(0) 0	(0) 0	0
6	(31) 32	(5) 5	(1) 1	38	(15) 17	(2) 1	(1) 1	19	(0) 0	(0) 0	(0) 0	0
7	(21) 23	(4) 2	(1) 0	25	(30) 31	(4) 4	(2) 2	37	(0) 0	(0) 0	(0) 0	0
8	(0) 0	(0) 0	(0) 0	0	(0) 0	(0) 0	(0) 0	0	(0) 0	(0) 0	(0) 0	0
Total	70	12	3	85	61	9	5	75	751	35	4	790

*Expected Frequencies in Parenthesis; Other Numbers are Actual Counts.

The very high number of flakes and cores with cortex on them is typical of this area and probably is an indication that the nodules in the part of the quarry were quite small (See pages 45, 47 above and Table 4 below).

The large number of small unworked nodules is also typical of area A (see Table 3, page 53).

<u>Sample Two</u>

This sample is much more typical of the western part of the quarry than is the first sample. Large flakes are rare and here, as in sample one, the high proportion of flakes with cortex on them (Table 4) is in accord with the fact that the nodules in this part of the site were small. The low total number of pieces in the first two samples compared to the other samples shows that the obsidian was more widely scattered in this part of the site.

Table 4

PROPORTION OF FIAKES WITH CORTEX: AREA A*

	Cortex	Non-Cortex	Total
Area A	(38) 210	(326) 155	365
Area B and C	(807) 636	(6749) 6920	7556
Total	846	7075	X^2=909 7921

*Expected Numbers Are in Parenthesis; Other Numbers are Actual Counts.

Sample Three

This sample was taken from Area B. The concentration of flakes in this area is much greater, as can be seen by the fact that the number of flakes in this sample is much more than in the first two samples combined. There is a large number of flakes that show pre-removal working which indicates that flakes were removed from previously worked pieces in this area. The high percentage of flakes without traces of cortex combined with the relatively high number of large flakes indicates that the nodules in this area were larger than in the western part of the site.

Sample Four

This sample cannot be indescriminately compared with the other samples because it is a partial sample, representing only about the top twenty percent of the pieces in the circle. A full sampling of this circle was not possible because of the great depth of the surface deposits. Material would fall in from the sides when a greater depth than the one sampled was attempted. The relatively low percentages of small and medium flakes are probably due to the fact that many have fallen to a lower level than that covered by the sample. This sample was also in area B, but was at the eastern edge of it.

Area B is characterized also by the presence of many "stripes" of nodules (see above, pages 37-38).

Samples Five, Six and Seven

These three samples were taken from areas of differing concentrations in the small valley which forms area C. Judging from the unusually high concentrations of flakes per unit area, it would seem that this part of the quarry was heavily used for stone working. The large number of non-utilizable flakes in this area (especially in sample seven) is at least partially due to the great quantity of very small flakes. This indicates that quite a bit of careful working was done here. One very interesting feature of the three samples in this area is that while the number of flakes increases from sample five to sample seven, the number of cores and used flakes decreases. With only three samples taken in this area, this could, of course, be due to coincidence. If, however, this tendency held true for further samples, it might indicate that the stone workers preferred to work new cores and to work on organic materials such as bone, antler and wood in areas not heavily covered with flakes. Mr. Porter (personal communication) has suggested that sharp flakes combined with flimsy or non-existent foot covering might have much to do with this.

Sample Eight

This sample is not in the quarry area itself, but several yards from its easternmost edge. Its lack of naturally fractured obsidian and unworked obsidian nodules is therefore accounted for. The comparatively high number of utilizable flakes is due to the low number of flakes with cortex and to the low number of very small flakes. The absence of used flakes is surprising considering the number of flakes that could have been used. The most notable feature of this sample is the large number of flakes with pre-removal working (see Table 5 below). These are all of small and medium size and appear to have been struck from worked pieces such as those described below. The very low number of flakes with cortex on them indicates that partially worked pieces were carried from the quarry to this spot, and there probably further worked. The lack of many "very small" flakes gives the impression that this area was not used for elaborate finishing of worked pieces, but more likely was a spot where flakes for tools and "blanks" were produced, even though no cores were found, due to the high frequency of "utilizable" flakes.

Table 5

PROPORTIONS OF FLAKES WITH PRE-REMOVAL WORKING: SAMPLE 8*

	Flakes with Pre-removal Working	Other Flakes	Total
Samples 1-7	(136) 109	(7549) 7576	7685
Sample 8	(4) 31	(232) 205	236
Total	140	7781	$X^2=190$ 7921

*Expected Frequencies in Parenthesis; Other Numbers are Actual Counts.

Worked Pieces

A total of 110 unifacially and bifacially worked pieces from non-random collections made at the Riley Site were examined (see Table 6, page 59). The exact provenience of the pieces or their location according to the "areas" described above could not be determined since many of these pieces were collected by others.

The great majority of these pieces seem to have been rejects or fragments of rejects of the "blanks" for the knives which have often been found in this part of Oregon (see Anonymous 1955a; 1955b; 1956; Arment 1965; Galbraith 1956a; 1956b; Garity 1961; Newhouse 1964; Praetorius 1964; Strong 1957). These bifacially worked pieces, of which 97 were examined, have been classified as to whether they are roughly-worked or well-worked, and whether they are fragmented or whole. They were considered well worked when the flake scars were quite small and the piece was well-shaped, and roughly shaped when the piece had larger flake scars and did not seem to have a well-defined shape. The difference between the two categories, however, is impressionistic rather than strictly objective. Out of the 97 blanks, 20 were well worked. All these were fragments (see Figures 5, 6, and 7 on pages 60-62). Of the 77 roughly-worked blanks, 62 were fragments and 15 appeared to be whole (for an example of the latter, see Figure 8, page 63). Whole examples range from 5 to 9 inches in length, 2 to 4 inches in width, and 3/4 to 1 3/4 inches in thickness.

Table 6

CHARACTERISTICS OF WORKED PIECES*

	Bifacially Worked	Unifacially Worked	Total	Whole	Fragment	Total	Cortex	Non-Cortex	Total
Roughly Worked	(84) 84	(5) 5	89	(23) 28	(66) 61	89	(13) 16	(76) 73	89
Well Worked	(20) 20	(1) 1	21	(6) 1	(15) 20	21	(3) 0	(18) 21	21
Total	104	6	110	29	81	110	16	94	110
Bifacially Worked	-- --	-- --	-- --	(27) 23	(77) 81	104	(15) 15	(89) 89	104
Unifacially Worked	-- --	-- --	-- --	(2) 6	(4) 0	6	(1) 1	(5) 5	6
Total	--	--	--	29	81	110	16	94	110
Whole	-- --	-- --	-- --	-- --	-- --	-- --	(4) 8	(25) 21	29
Fragment	-- --	-- --	-- --	-- --	-- --	-- --	(12) 8	(69) 73	81
Total	--	--	--	--	--	--	16	94	110

*Expected Numbers are in Parenthesis; other Numbers are Actual Counts.

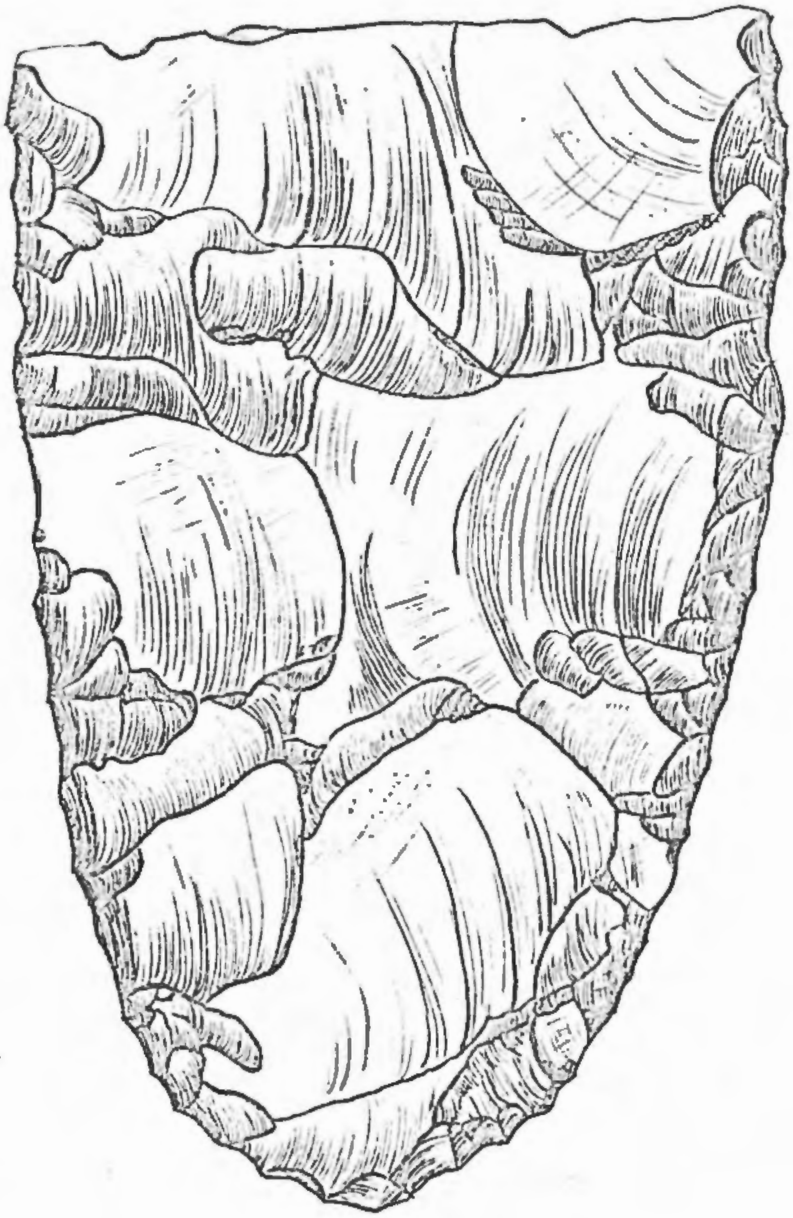


Fig. 5. - Well-worked blank fragment (View I)

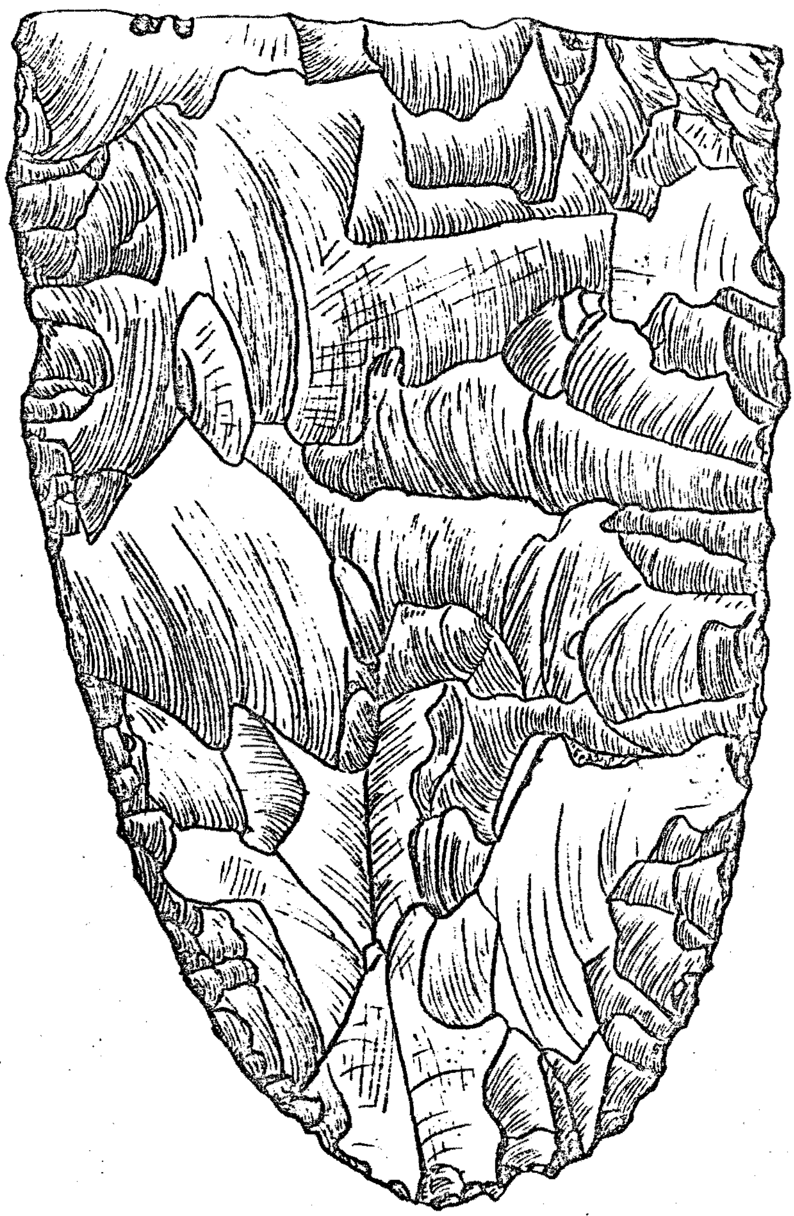


Fig. 6. - Well-worked blank fragment (View II)

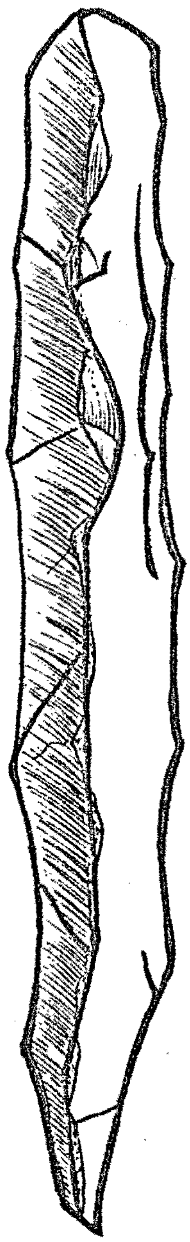


Fig. 7. - Well worked blank fragment (View III)

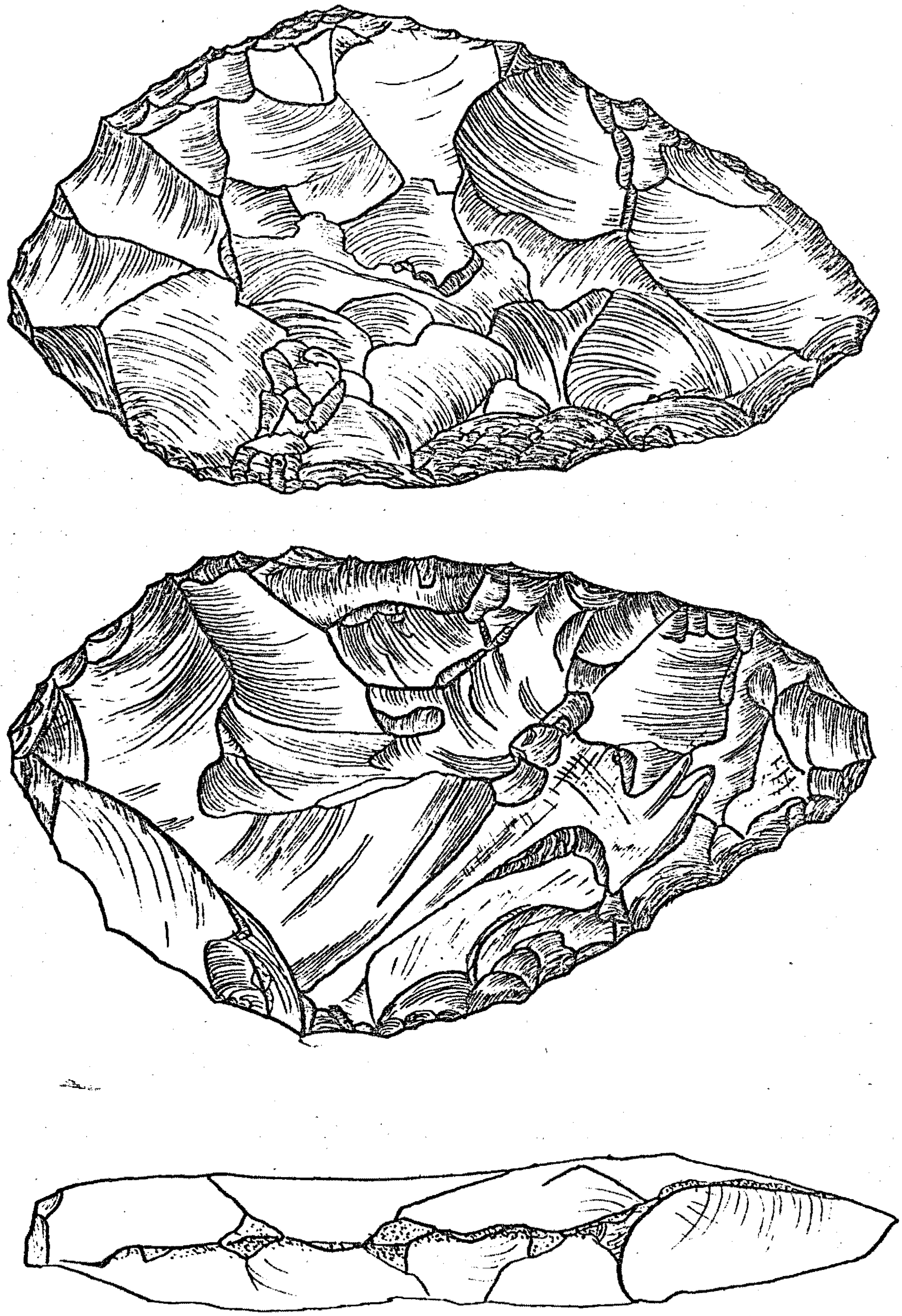


Fig. 8. - Roughly-worked blank from Riley site

Some of these whole and fragmented bifacial blanks may have been used as tools, but it is hard to tell since they have been worked from the edges, as can be seen by an examination of the flake scars, and experimentation has shown that it is impossible to tell the small flake scars due to chipping from those due to use on wood, bone or antler.

Because of their shape seven of the bifacially worked pieces examined were felt to have been not meant for use as blanks, but might have been tools for roughing out and shaping wood, bone or antler quarry tools or perhaps, as suggested by Bryan (1950), for the working of things such as bows, arrows and other necessities in the presence of an almost unlimited supply of material for tools. One of these, measuring 7 1/2 by 1 3/4 by 1 inch, appears to have been used as a scraping or gouging tool. Part of the piece was unworked and could have served as a handle (see Figures 9 and 10, pages 65-66). All seven of these pieces were roughly worked.

Six unifacially worked pieces were examined. Five of them were roughly worked and only one was well-worked. The well-worked piece seems to have been a scraper and shows definite signs of having been used (see Figure 11, page 67).

Ethnographic Information

The Riley site was probably worked, at least in later years, by Northern Paiute Indians. The particular group of Paiutes that inhabited the area for at least the last century

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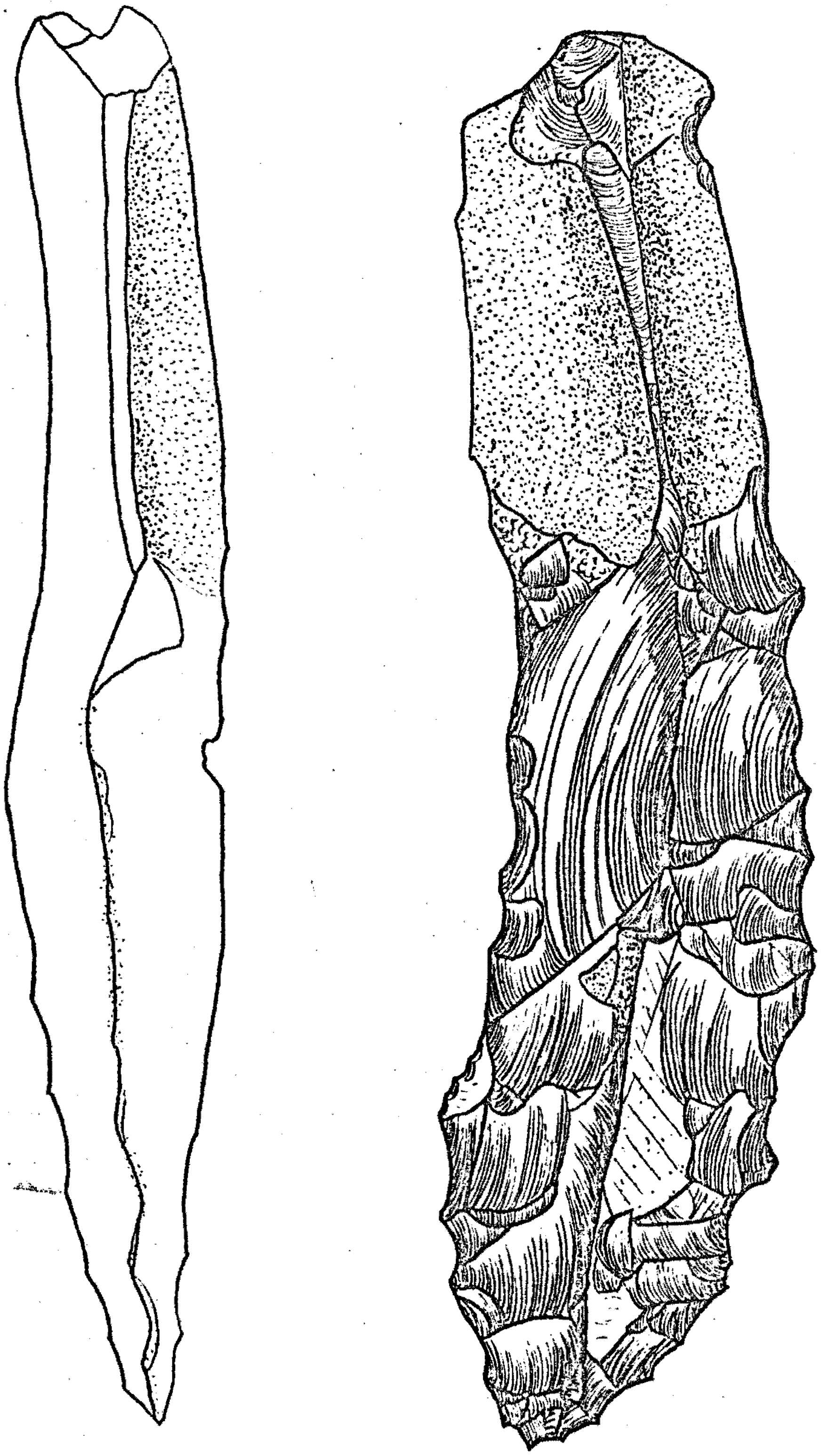

Fig. 9. - Bifacially worked piece from Riley site (Views I & II)

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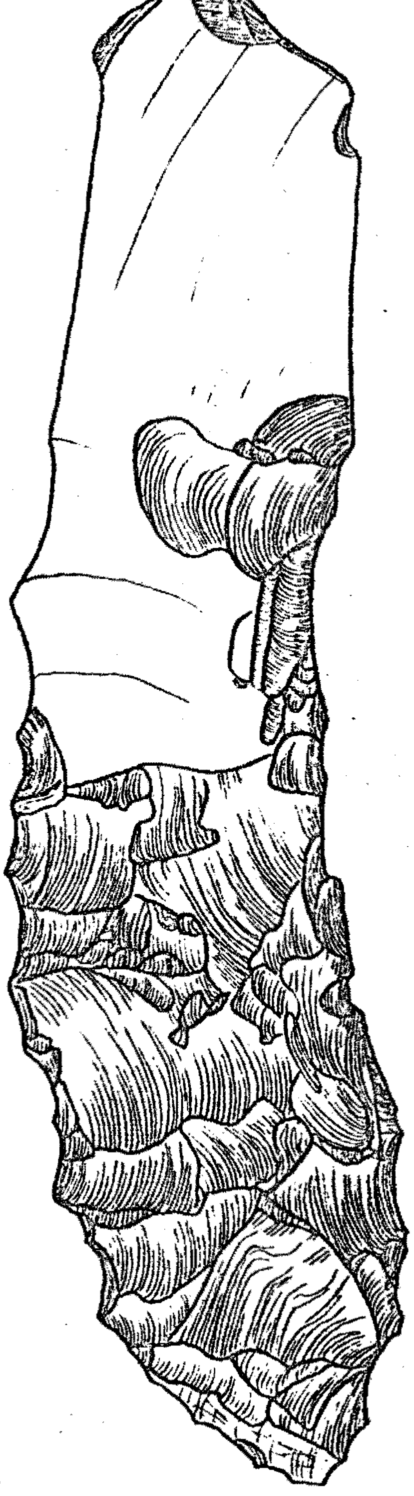

Fig. 10. - Bifacially worked piece from Riley site (View III)

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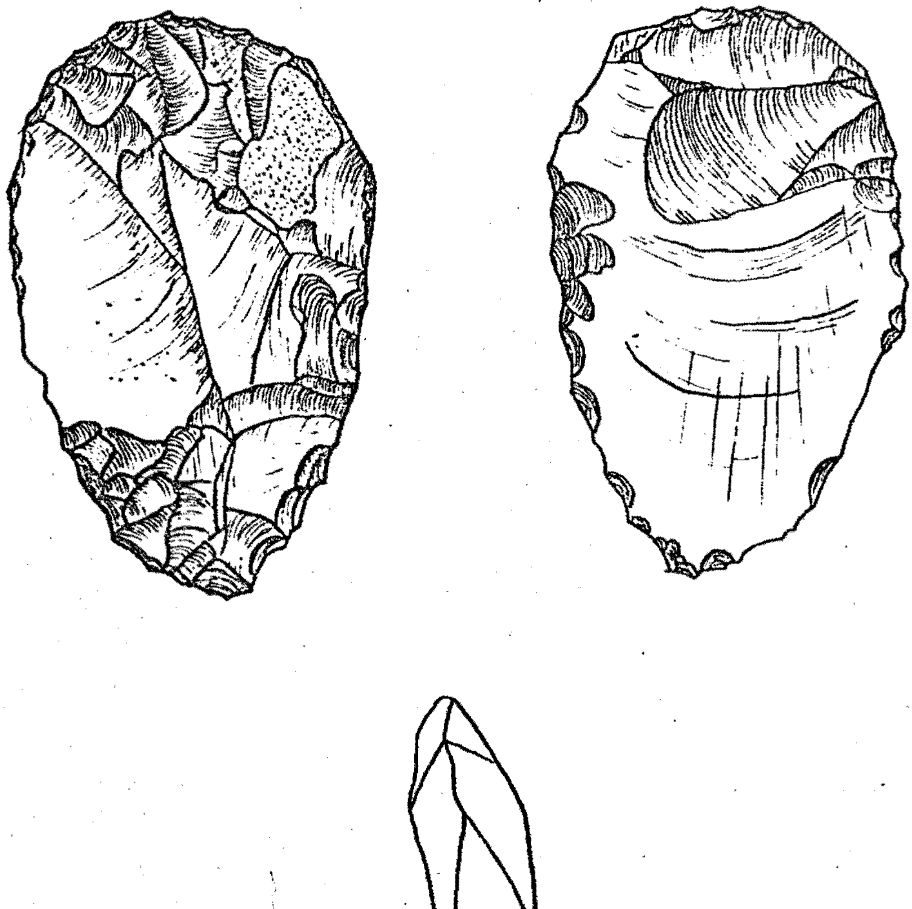

Fig. 11. - Utilized Scraper from Riley site

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or two were the Wada 'tika or Seed-eaters, who have been studied by Beatrice Blyth (Ray and Others 1938: 402-405). This group seems to have centered around Malheur Lake, going as far North as the northern boundaries of Harney Valley and wintering as far south as Roaring Springs in Catlow Valley. Other wintering sites were at Silver Creek, Harney, Diamond, Blitzen and Catlow Valleys (Ray and Others 1938: 402; Stewart 1939: map 1). Berreman (1937) also agrees that this area was inhabited by Northern Paiute bands. Murdock indicates that the Paiute had inhabited the area for a long time (Ray and Others 1938: 398). There is both ethnographic and archaeological evidence, however, of the existence of non-Paiute groups in the Northern Great Basin (Loud and Harrington 1929: 162-163).

The only information on the stone working techniques of the Seed-eaters is that they used sharply pointed flint flakers of antler or horn and that they used a buckskin pad to protect their hand while flaking (Stewart 1941: 383). An informant from the Tago band (another Northern Paiute group), insisted that flint was pressure flaked by the use of another piece of flint (Stewart 1941: 432). These accounts, unfortunately, do not give certain evidence on how rocks were worked at the quarry sites.

The stone knives used by the Seed-eaters were either unhafted and wrapped in buckskin or hafted in sinew, horn or bone (Stewart 1941: 382). The knives were also sometimes used as drills. Similar knives have been noted for other Paiute groups (Kelly 1932: 141).

In discussing the Suprise Valley Paiute, Kelly indicates that "hoe-shaped" obsidian implements which were found archaeologically were used occasionally in tanning, but were not manufactured by the Paiute (Kelly 1932: 138). Most of the obsidian scrapers and arrowpoints used by this group, according to Kelly's informants, were found archaeologically and not made.

Trade was carried on with Indian groups, from the Columbia River, although no specific mention has been made of the trading of obsidian (see Hopkins 1883: 110).

Discussion

The Riley site, as has been seen, seems to be generally similar to other quarry sites. The only exceptions to this are the apparent lack of campsites and hammerstones. The lack of campsites is probably due to their having been covered up by the constantly shifting sand in the area, although it is possible that they were so temporary and simple that they have left no obvious traces.

Hammerstones were probably brought in to the site and taken along when the work was done due to the inadequate materials for this type of tool found in this area. It is not very likely that obsidian nodules were used regularly as hammerstones because they often shatter during use and because no regular pattern could be found in either the size or the shape of the battered nodules found.

Although some of the differences within the quarry were possibly due to changes in manufacturing techniques or ways of exploiting the quarry over time, the major differences noted initially--that between the three areas, A, B, and C--can be explained by other than temporal factors, namely the differences in size and concentration of nodules. Minor differences can be found in the manufacturing processes carried on in different parts of the quarry as is indicated by the samples, but the most important thing noted is that, as indicated by sample eight, some of the work of rough shaping was carried on outside of the quarry proper.

Several things can be seen by examining the nodules, cores and flakes at the Riley site. First of all, there was probably no necessity for actually "quarrying" the material since the nodules lie in abundance on the surface of the ground. Although some exceptions have been noted, the cores found at this site indicate that most often a nodule was not flaked according to any set pattern, but probably in accordance with the needs of the flaker and the natural conformations of the nodule.

Although a few blades and three or four blade cores were found at the Riley site, the quantity is so small that it is fairly certain that there was no significant blade-core industry at this site, although their presence indicates that at least some of the quarry users knew the technique for making blades.

There is no indication that any pressure flaking was done at this quarry (or at any quarry). With the possible exception of some of the larger flakes found, all of those found at this site could have been removed by direct percussion. At least some amateur flakers have not been able to remove such large, straight flakes as are found at this site, by direct percussion. There is a possibility, then, that other means of stone working were used at this site, such as the use of the large pressure flakers mentioned in Chapter II.

Many of the flakes found showed indications of pre-removal working. These are probably produced either during the production of worked pieces such as are found in this site or are flaked from a reject of one of these pieces. Some of these flakes and some of the flakes without pre-removal working show definite signs of having been utilized. What these flakes were used for is not certain, but it is possible that they were used for sharpening or shaping flaking tools or perhaps used to work other tools of wood, bone, antler, or some similar material.

The worked pieces found at this site seem to be of two types. The first type includes whole and fragmented pieces thought to be "blank" rejects. Because the nodules are not large enough, the blanks produced at this quarry could not have been used for the large ceremonial blades as are found along the coast of Southern Oregon and Northern California, but, since they conform both in size and shape, were probably used to make the knives that have been found archaeologically in the Riley area and described ethnographically for the Paiute Indians.

The other worked pieces, which seem to be scraping or carving tools, as well as some of the blank rejects, were probably used for the same purposes as the utilized flakes discussed above.

CHAPTER V

CONCLUSIONS

Due to the very similar nature of the material found at the quarries examined in this study, the classification suggested in Chapter II has shown itself to be adequate for the description and study of material from these sites.

The main products of the quarries of North America seem to have been "blanks" from which tools were later finished. These take the form of both worked blanks for later elaboration into knives and other large pieces, and flakes from which smaller tools were made. Finished tools, however, seem to have been made and utilized at some quarries. Flakes also appear to have been used at some quarries. What these tools and flakes were used for is not clear, but it seems likely that they were, as Holmes suggested, used for the shaping and repairing of flaking tools. It must be kept in mind, however, that the only non-stone flaking tools that seem to have been used at quarry manufacturing sites are large pressure flakers, such as those described by Catlin, and bone or antler punches for removal of flakes by indirect percussion. If finished tools and utilized flakes were found at quarries where it was certain that no non-stone flaking tools were used, it would indicate that tools other than those used at the quarry were worked on at this site as was suggested by Kirk Bryan.

Hammerstones are the most commonly found tool from quarry manufacturing sites. No careful study of hammerstones has been made, but judging from the information available on these implements, the classificatory distinctions suggested in this work would be adequate for such a study. At the Riley site there were no hammerstones found, indicating that either non-stone flaking tools were used or that hammerstones were brought in from elsewhere and taken away after the work at the quarry was completed. There is some indication that nodules of the quarry material were occasionally used to work other nodules (see above, page 23), but this does not seem to have been true for the Riley site. Most of the work done at quarries was probably done with these "heavy-duty" tools since there is no indication that very careful working and shaping of tools was done at quarry sites. The fine finishing and shaping of artifacts was very likely done elsewhere--probably at camp sites, since this is where broken pieces of finely worked artifacts are found along with very small flakes.

Of the flakes found at North American quarries, certainly one of the most important types is that of blades. These and the conical cores used to produce them are found mainly in Mexico where the technique for making these pieces reached a high enough level that the flakes could be used as tools without further working being done. Another easily distinguishable type of flake found at these sites is the sort with pre-removal working. In most North American quarries this is probably due, as mentioned in the last chapter, to removal from a worked blank or a reject of a worked blank.

The campsites that have been found near many of the quarries were probably used to work on mostly the initial manufacturing of tools as is usually done at the quarry itself. These camps give the impression of being very temporary and not very elaborate indicating that they were only meant to be used for a short period of time--probably only long enough to rough out an adequate supply of blanks which were then carried away.

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